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Crime and Punishment?: The Mental Health Outcomes of Female Rape Survivors of a Single Rapist

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ABSTRACT

Previous literature on rape has discussed the mental health of rape survivors and the criminal punishment of rapists, but little to no research has been conducted on the effect of a rapist’s being criminally punished on the rape survivor. The purpose of the research was to investigate whether rapists’ being criminally punished betters or worsens the mental health of the survivors. Participants were given a link to an online survey that asked them questions regarding the general nature of the rape committed against them, the criminal aspect of the rape committed against them, and the severity at which they suffered from select mental health symptoms on the DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure—Adult. The results showed that a rapist’s being criminally punished had a positive and significant correlation with feeling that someone could hear one’s thoughts, or that one could hear what another person was thinking (r(57)=.305, p<.05) and a positive correlation with drinking more than four alcoholic drinks in a single day (r(57)=.322, p<.01). These results could have mixed interpretations. The biggest indicator of more mental health problems, however, was the age at which participants were raped and also their current age. Participants who were younger now and at the time of their rape were more likely to suffer from select mental health problems. These results suggest that much should be done to help younger women who have been raped.

Keywords: Rape, Mental Health, Rape survivors, Mental Health Outcomes

INTRODUCTION

Eighteen percent of U.S. women will be raped or be confronted with attempted rape (Paul et al., 2014). Rape is a very serious crime, and anyone who commits it could face multiple consequences if convicted. Although rape is a very serious thing to happen to a person, the Rape Abuse & Incest National Network has recently estimated that over 99% of rapists face no criminal punishment for their crimes (Kebodeaux, 2017). In this literature review, I examine the negative mental health effects of rape, why rape survivors do and do not report their rape, why rape survivors do and do not participate in their investigation, influential factors in a rape sentence, and the treatment effects for trauma.

Literature Review

Mental Health Effects of Rape

Rape can have very negative mental health outcomes. The most common negative mental effect symptom associated with rape is post-traumatic stress disorder (PTSD). Multiple psychologists have conducted empirical and theoretical research on PTSD associated with rape (Conard, Young, Hogan, & Armstrong, 2014; Frazier, 2000; Grey, 2016; Hansen et al., 2018; Hickey, Feinleib, Kirwin, & Gardner, 2017; Kaukien and DeMaris, 2009; Kilcommons, Morrison, Knight, & Lobban, 2008; Murray, 2012; Paul et al., 2014; Rossellini et al., 2017; Schafran, 1996; Tihonen, Bäckström, Söndergaard, & Helström 2014). Some rape survivors experience specific forms of PTSD. Military sexual trauma (MTS) is a form of PTSD that women who are in the military suffer from (Conrad et al., 2014). Also, rape trauma is a form of PTSD where rape survivors are reluctant to report their rape, struggle to come to
terms with the fact that they were raped, revisit where they were raped, and are numb to their feelings (Murray, 2012). In addition to PTSD, rape survivors are also prone to depression. Tiihonen et al. (2014) conducted mental health assessments of 317 female survivors of rape over a 6-month period. Almost 50 percent of participants had developed depression. Kaukien and DeMaris (2009) and Paul et al. (2014) conducted meta-analyses to find the association between depression and rape survivors. Along with stress and depression, alcohol addiction and substance abuse can be a mental health problem associated with rape. Kaukien and DeMaris (2009) analyzed the survey results of 1,363 female survivors of rape or attempted rape to find that alcohol and substance abuse is a common problem among rape victims. Paul et al. (2014) and Schafran (1996) conducted literature reviews and also found this association.

Psychotic experiences are another negative mental health effect associated with rape. Kilcommons et al. (2008) conducted personal interviews and self-report measures with 26 rape survivors and only self-report measures with 24 rape survivors. All participants experienced delusional experiences to some extent. A little over 46% experienced auditory hallucinations and a little over 46% also experienced visual hallucinations. While there are many harmful mental health symptoms of rape, the most severe symptom is suicide. Many rape survivors have suicidal thoughts and commit suicide because they do not know how to deal with their trauma (Conrad et al., 2014). Because of rape, many people’s mental health is severely at risk.

**Why Women do not Report Rape**

Although rapists risk severe punishments when they commit their crimes, they are not punished as often as they should be. As previously stated, over 99% of rapists face no criminal punishment for their crimes (Kebodeaux, 2017). Many personal factors contribute to a women’s decision to not report the person who raped them. Self-blame is a common reason why women do not report the rape committed against them (Grey, 2016). Kahn, Jackson, Kully, Badger, and Halvorsen (2003) and Wolitzky-Taylor et al. (2011) both conducted extensive literature reviews to find that being under the influence of alcohol at the time of the rape is one reason why women blame themselves for the rape committed against them. Ahrens, Campbell, Ternier-Thames, Wasco, and Sejl (2007) also conducted a thorough literature review to find that women are less likely to report rape when they do not suffer stress from the rape. For example, a rape survivor who experiences daily stress from the rape is more likely to report their rapist as opposed to someone who is numb or indifferent to their experience. Although multiple rape resources exist, a large portion of women has stated they were unaware of how to report a rape. Wolitzky-Taylor et al. (2011) analyzed the data of 3,001 survivors of rape that were interviewed about their rape in 2006 to find more information on the reporting aspect of rape. In the study, 44% of women that did not report their rape did so because they were unaware of how to report their rape. Not only do some women not know how to report a rape, but some struggle to come to terms with the fact that they were raped. Denial is a common reason why women do not report the rape committed against them (Grey, 2016). Kahn et al. (2003) conducted a literature review and found that over half of rape victims did not consider their experience as rape even though it met the legal definition of rape.

A common personal factor that influences a rape survivor’s decision is fear. Many rape survivors do not report the person who raped them for the following fears: fear of the rapist, fear of the perception of others, fear that reporting will make things worse, fear that their family will find out, fear of the justice system, fear of a job demotion, and fear of publicity (Ahrens et al. 2007; Conrad et al., 2014; Grey, 2016; Hickey et al., 2017; Kahn et al., 2003; Rosellini et al., 2017; Wolitzky-Taylor et al., 2011). Another influential factor in a rape survivor’s decision to not report the person who raped them is their relationship with that person. Women are less likely to report their rape if they knew the person who raped them or if they were in a previous intimate relationship with that person (Kahn et al., 2003; Wolitzky-Taylor et al., 2011).

An important legal aspect that impacts a rape victim’s decision to report the person who raped them or not is evidence. In the study conducted by Wolitzky-Taylor et al. (2011), the researchers found that half of the participants in their study that did not report their rapist did so because they did not believe they had enough evidence to lead to a conviction. Although
rapists can face serious punishment for their serious crime, they are often not reported for multiple reasons.

**Why Women do Report Rape**

While many female rape survivors do not report the person who raped them, some women do report the rape committed against them. A common reason that rape survivors report the rape committed against them is that they want help. Ahrens et al. (2007) conducted interviews with 102 female rape survivors to ask them questions about the first time they told someone about their rape. A large portion of the rape survivors initiated social support for personal, emotional, and social reasons to deal with the rape. Woltzky-Taylor et al. (2011) found that women often report rape to help with their fear of HIV/AIDS, fear of STDS, and fear of becoming pregnant. Not only do women report rape because they want to receive help, but women also report rape because they want to help others. Ahrens et al. (2007) and Woltzky-Taylor et al. (2011) both found that some women report rape to deter future rapes. Woltzky-Taylor et al. (2011) discussed that rape survivors reported their rape because rape is illegal and because they wanted their rapist to be punished. Their study also showed over 80% of participants that reported their rape to the police were encouraged to do so by someone else. Also, the study showed that women are more likely to report the person who raped them when they do not know that person, when they sustain injuries from their rape, when the person who raped them uses weapons, and when they experience stress from their rape. Although many rapists go unreported, some are reported for their serious crime.

**Effects of Telling Someone about Rape**

Just telling someone about the rape committed against them can have an impact on the mental health of rape survivors. Clinicians often believe that rape survivors benefit from telling someone about their rape because disclosure allows rape survivors to receive mental health help, and disclosure can help secure safety for rape victims (Ruggiero et al., 2004). Ruggiero et al. (2004) wrote that telling someone about any stressful event in one’s life is associated with healthier psychological functioning.

Improved mental health may not necessarily apply, though, to people who are impacted by stressful events that are much more serious than the daily hassles of life. Gidron, Peri, Connolly, and Shalev (1996) recruited fourteen adults with PTSD from a hospital for trauma treatment. Ten participants were seeking treatment for their trauma from a car accident, one was seeking treatment for trauma from a cardiac arrest, one was seeking treatment for trauma from a work accident, one was seeking treatment for trauma from military combat, and one was seeking treatment for trauma from a terrorist attack. The researchers gave a survey to the participants that asked about their mental health. The researchers then randomly assigned participants to write about their daily activities or to write about their traumatic experiences and then talk about it to someone. Participants did their assigned task for 20 minutes for three consecutive days. After the three days, the researchers gave the participants the same survey that asked them questions about their mental health. After five weeks, a researcher gave the participants the survey again. The results of the study showed that participants that had to write about their traumatic experiences and then talk about them were more likely to have intrusive thoughts and use avoidant coping methods.

Catten, Follette, Rasmussen Hall, and Palm (2002) also did not find any results that suggested disclosure helped with the negative mental health outcomes of people that suffer trauma from a serious event. Batten et al. (2002) recruited 61 female survivors of childhood sexual abuse that were not in therapy at the time of the study. Participants took surveys that evaluated their sexual abuse, their relationship with their parents, how likely they are to show aggression, their physical health, and their mental health. The participants were randomly selected to a control group or an experimental group. For three days, the participants assigned to the control group were asked to write about time management for twenty minutes. For three days, the participants assigned to the experimental group were asked to write detailed information about their rape and how their rape affected how they react around others. On the last day, all participants took a survey that asked what they thought about their responses to the previous surveys. Every other week for 12 weeks, the researchers called the participants and asked them how their mental health and physical health were on a scale of 0 to 10. The researchers then conducted a statistical analysis of the data and found that there was...
no significant relationship between writing about sexual assault and alleviated mental health symptoms. Because of the differing results from the consulted studies, Ruggiero et al. (2004) conducted their own study to examine the effects of rape victims’ telling someone about the rape committed against them. Ruggiero et al. (2004) explored these effects deeper by studying the effects of the timing of the rape survivors’ telling someone about their rape. In order to examine the mental health of childhood female rape survivors, the study’s researchers looked at 3,200 completed surveys created by the National Women’s Study and used a subsample of 288 women that had been raped before they turned 18. The researchers then analyzed this sample. The study showed that higher rates of PTSD and depression were associated with waiting over a month to disclose a rape compared to those reported within a month. Ahrens et al. (2007) also conducted a study to examine the effects of rape survivors’ telling someone about their rape. In the study conducted by Ahrens et al. (2007) disclosure initiated by others was associated with negative feelings and disclosure initiated by the rape survivors was associated with positive feelings. The majority of participants felt better after disclosing their rape, but 1/3 felt worse. While just telling someone about a rape is not necessarily reporting, it can also affect a rape survivor’s mental health.

**Effects of Reporting and Arresting**

Reporting rape can have negative and positive effects on a rape survivor’s mental health. Kaukinen and DeMaris (2009) gathered data from the Violence and Threats of Violence against Women and Men in the United States Survey, 1994-1996 collected by Tjaden and Thoennes (2009). Kaukinen and DeMaris (2009), though, only analyzed the data from 1,363 female survivors of rape or attempted rape. Kaukinen and DeMaris (2009) then completed a data analysis to find out the relationship between reporting a rape survivor’s rapist, arresting a rape survivor’s rapist and the mental health of the rape survivors. The study showed that there was no relationship between seeking help and lessened binge drinking, but there was a relationship between arresting the rapist and lessened binge drinking. Also, disclosing the rape and police arresting the rapist were associated with higher rates of depression for some rape survivors and lower rates of depression for other rape survivors. These conflicting findings are mostly attributed to the fact that every rape survivor responds differently to the rape committed against them.

Wolitzky-Taylor et al. (2011) conducted a study to examine how female rape survivors felt after reporting the person who raped them. Wolitzky-Taylor et al. (2011) analyzed the data of 3,001 survivors of rape that were interviewed about their rape in 2006 to find more information on the reporting aspect of rape. The study showed multiple positive experiences associated with reporting the rape. Over 90% of people that reported their rape were happy with their decision. Eighty-four percent of people that reported their rape would report their crime again. Over 70% of women that reported the rape committed against them felt as if the police believed that their rape really did happen. Over 50% knew that someone was arrested or convicted in relation to their rape. Sixty percent were content with how authorities treated them. Reporting and arresting a rape survivor’s rapist can have different mental consequences that impact victims.

**Why Rape Victims do and do not Participate in Investigations**

Just as there are multiple reasons why rape survivors do and do not report the person who raped them, multiple reasons also exist for why rape survivors do and do not participate in the investigations of their rapists. Dismissed rape cases continue to be a problem in the United States. In most cases, the only people to be present during the committing of the rape are the rapist and the rape survivor, and little evidence is often available. Thus, the testimony of the rape survivor is very important in the trial of the rapist. Hansen et al. (2018) reviewed literature on the likelihood of a rape survivor’s participation in their investigation and found that between 26% and 48% of rape trials are often dismissed because rape survivors do not testify. They also found that survivors are more likely to cooperate in their rape investigation when they do not know their rapist, when they are injured, and when they have forensic evidence to prove their rape. Survivors are more likely to cooperate when police officers are kinder. Conversely, survivors are less likely to cooperate in their rape investigation when they know their rapist, when they do not endure any physical harm, when
they do not have forensic evidence to prove their rape, and when police officers are not very kind. Different factors influence a rape survivor’s decision to actively participate in a rape investigation, and these factors can have a huge impact on whether a rapist is criminally punished or not.

**Effects of Testifying**

Not only does a report and an arrest of a rapist have potential mental health effects for survivors, but testifying can also have an impact. A common belief among some people is that the trials of rapists trigger traumatic memories for their survivors with PTSD (Orth & Maercker, 2004). To examine this belief, Orth and Maercker (2004) conducted a cross-sectional study of 137 survivors of rape and nonsexual assault and a longitudinal study of 31 survivors of rape and nonsexual assault. Both groups of participants were given the same questionnaire that asked questions about their rape and having to testify at the trial of their rapists. The cross-sectional participants conducted the study only once, but the longitudinal participants took the survey before the cross-sectional study began and again after it was completed. These studies showed no significant relationship between rape trials and retraumatization. The authors urged caution with these findings since everyone is different in their response to potentially stressful situations. Rape survivors can still experience stress through a long trial waiting time, fear of the perception of others involved in the trial, an unjustified verdict, and the process of the trial. Testifying can have negative, positive, or no effects, depending on the person.

**Influential Factors in a Rape Sentence**

Although rapists risk a lengthy prison sentence when they commit their crime, they all do not necessarily serve a lengthy sentence. Multiple factors influence the prison sentence of a rapist. Kebodeaux (2017) discussed these factors. A rapist’s previous criminal record and the seriousness of their crime are the main predictors of the length of their sentence for any crime. Most rapists, though, do not have a previous criminal record. Thus, many rapists are often given lenient sentences. In 2015, Stanford swimmer Brock Turner raped an unconscious 23-year-old woman behind a dumpster. Although Turner committed a serious crime, Turner was given only six months in the county jail and only served three because the judge did not want to interfere with Turner’s promising swimming career. Rapists like Brock Turner that are first-time offenders and are viewed as model citizens with bright futures ahead of them are less likely to receive severe rape sentences because they are seen as less likely to rape again. Lenient sentences could possibly offer an explanation for why the recidivism rate among rapists is high. Rapists often rape again after their first rape. Not only that, but the majority of rapes committed are committed by rapists that have raped before.

Demographics of rapists and rape victims can also influence the length of a rape sentence. Myers and LaFree (1982) obtained the police, prosecution, and court records of 945 defendants that were charged with felonies in Indianapolis, Indiana from 1970 to 1976. One-hundred-seventy-six of the defendants were accused of rape, 373 were accused of property crimes, and 396 were accused of other crimes. To reduce confounding variables, rapes that occurred with property crimes or other violent crimes were excluded. The researchers then conducted a statistical analysis of the demographic variables and found that unemployed rapists were more likely to be imprisoned. Also, sentences were also shown to be longer when they were committed by a black man and when the victim was white, female, or both.

The nature of a crime can also impact the length of a rape sentence. Rapists are more likely to serve lengthy sentences when there are multiple witnesses to the rape (Kebodeaux, 2017). The nature of the rape, though, has more of an impact in terms of the community’s perception of the rape. Rapes that occur when a rape survivor is under the influence of drugs and alcohol or when a rape survivor knows their rapist are often viewed as less severe than rapes that occur when victims are sober and are raped by a stranger.

The states’ rape guidelines can also be influential in a rape sentencing (Kebodeaux, 2017). In regard to any crime, the different types of sentencing schemes are determinate, indeterminate, mandatory minimum, and presumptive guidelines. The states have the right to determine which schemes are used for which crimes. Determinate sentences are fixed sentences and are subject to reviews by parole boards. Indeterminate sentences are unfixed sentences that allow judges to set their own maximum and minimum
sentences, and a parole board then determines the length of a sentence. Mandatory minimums are fixed minimum sentences that criminals serve for their crimes. Presumptive guidelines are set suggestions for the length of a crime. Twenty-nine states use determinate sentencing, and twenty states use indeterminate sentencing. All fifty states and Washington D.C. have some form of mandatory minimums, but the interpretation of these mandatory minimums varies. Brock Turner was sentenced to six months in prison but served only three months for his rape; however, in response to the public outcry of Turner’s sentencing, California governor Jerry Brown has created mandatory minimums for sexual assault. Previous California sexual assault laws were harsher towards unconscious survivors of sexual assault, but unconscious and conscious survivors are now treated as equal. Also, in California, probation is now also not available for sexual assault committers that are classified as rapists. Because different factors impact the sentencing of a rape, different rapists receive different rape sentences.

The Effects of Treatment

Although rape can have severe consequences on survivors’ mental health, the negative mental health symptoms of rape can be possibly alleviated with treatment. Depression and PTSD are mental health problems that can be helped with treatment. Frommberger et al. (2004) conducted a study to examine the effects of cognitive-behavioral therapy (CBT) and the antidepressant paroxetine on PTSD and depressive symptoms in patients. One of the most frequent PTSD producers in the study was sexual violence. The study’s participants were 21 patients; ten received CBT, and 11 received paroxetine. The participants received treatment for 12 weeks, and the study’s researchers gave structured clinical interviews to assess the participants’ mental health. At the end of the 12-week period, the participants that received CBT and the participants that received paroxetine had significantly decreased PTSD and depressive symptoms; however, at the 6-month follow-up, the participants that received paroxetine had slightly increased PTSD symptoms as opposed to the further decreased PTSD symptoms of the participants that received CBT. Depending on the type of treatment, rape victims can have their mental health problems decreased.

SUMMARY

Rape can cause a person to develop PTSD, depression, alcohol and substance abuse, and psychotic experiences. Although rapists commit serious crimes, most never face any criminal punishment. Women often do not report their rape for legal factors and a wide variety of personal factors. Women do report their rape to help themselves and to help others. Disclosing a rape, reporting a rape, testifying at a rape trial, and seeking treatment for a rape all can have different mental health effects for a rape victim. Multiple factors influence a survivor’s decision to participate in an investigation of their rape, and multiple factors influence the rape sentence of a victim’s rapist.

Reviewing the peer-reviewed journals shows the importance of my research. Information on the mental health effects of rape survivors exists, and information on the criminal punishment of rapists exists; however, little to no information exists on the different mental health of rape survivors whose rapist was criminally punished as opposed to those whose rapist was not criminally punished. Thus, I conducted correlational research to find evidence that suggests a relationship between these two variables. The purpose of this research study was to learn more about rape survivors’ mental health conditions after rape and how they can be better helped. The research question was “What are the different mental health outcomes of rape victims whose attackers were criminally punished as opposed to rape victims whose attackers were not criminally punished?” My hypothesis was that female rape survivors of a criminally punished rapist will have higher or lower mental health issues than female rape survivors of a non-criminally punished rapist, depending on the circumstances. The operational definition of rape was the United States’ Department of Justice’s definition of rape, which is defined as “the penetration, no matter how slight, of the vagina or anus with any body part or object, or oral penetration by a sex organ of another person, without the consent of the victim.” The operational definition of criminally punished was defined as receiving at least the minimum state sentence. The operational definition of negative mental health outcomes was defined as anxiety, PTSD, suicidal thoughts, and any other mental illness. The operational definition of positive mental
health was defined as the absence of the aforementioned negative mental health outcomes. A rape survivor’s rapist’s being criminally punished can allow rape victims to have a sense of closure; however, rapists that are criminally punished do not necessarily serve a lengthy sentence (Ahrens et al., 2007; Paul et al., 2014; Ruggiero et al., 2004; Wolitzky-Taylor, 2011). Also, Kaukinen and DeMaris (2009) showed that there was no relationship between seeking help and lessened binge drinking, but there was a relationship between arresting the rapist and lessened binge drinking; however, disclosing the rape and police arresting the rapist were associated with higher rates of depression for some rape survivors and lower rates of depression for some rape survivors. Because of the different results of telling someone about a rape, reporting a rapist, and arresting a rapist, it was predicted that rape survivors with rapists that were not criminally punished would have both less negative mental health outcomes and more negative mental health outcomes than rape survivors with rapists that were criminally punished.

METHODS

Participants

Fifty-nine female rape survivors were participants in the survey. Forty-nine participants were Caucasian, four were of multiple ethnicities, four were African-American, one was Hispanic, and one was a Native American or native Alaskan. The average age of participants was 36.43 (SD = 14.095). Current ages ranged from 19 to 70. The average age of participants at the time of the rape was 20 (SD = 9.557). Ages at the time of rape ranged from 3 to 52. The average years ago that the participants were raped was 16.37 (SD = 15.194). This time ranged from four months ago to 67 years ago.

Participants were recruited through emailing every non-specific-time-frame rape resource on the Rape, Abuse & Incest National Network website, every non-specific-time-frame Mississippian rape therapist on Psychology Today’s website, and every non-specific-time-frame rape support group on Psychology Today’s website. For example, if any organization, therapist, or group therapist dealt specifically with child sex abuse, they were not contacted to prevent skewed results. Those contacted were given the online link to the survey and the flyer for the survey to share with clients. Also, when applicable, the psychological, counseling, and psychiatric organization of each state was messaged to inform their members of the survey so that they could do the same thing. When applicable, the district attorney of each county in the country was also emailed the same information to make the survey known to past and former clients.

Materials and Procedures

Participants accessed the survey through an online link. The survey asked demographic questions, general questions about the rape committed against the participant, the DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure—Adult questions minus the ones that pertained to the questions about sleep, and questions about the trial and conviction aspect of the rape committed against them. The questions about sleep were excluded because there was no relevant information found about the effects of rape on sleep. A link to the RAINN (Rape Abuse & Incest National Network) resources page was provided on the first page of the survey and on the last page of the survey should participants be triggered from the survey. The answers were then analyzed for significant relationships through IBM SPSS Software.

RESULTS

Frequencies

Table 1 lists the ages of the participants now, at the time they were raped, and how long ago the rape took place. All figures are in years. Table 1

Table 2 lists how many participants reported their rape to the authorities; how many reported their rape to a friend, family member, or community member; and how many knew the person who raped them.

Table 3 lists the reasons that participants who did not report their rape gave for not reporting. Many participants gave multiple reasons for not reporting. Some of these can fit into a broad category such as different kinds of fear and different relationships with the rapist. These frequencies are below.
Table 1 *Ages and length of time since rape was committed*

<table>
<thead>
<tr>
<th>Current Age</th>
<th>Age at time of rape</th>
<th>How long ago rape was committed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>10-20</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>21-30</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>31-40</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>41-50</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>51-60</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>61-70</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2 *Reporting the rape*

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you report the rape to the authorities?</td>
<td>23</td>
<td>36</td>
<td>59</td>
</tr>
<tr>
<td>Did you tell someone?</td>
<td>22</td>
<td>37</td>
<td>59</td>
</tr>
<tr>
<td>Did you know the person who raped you?</td>
<td>47</td>
<td>12</td>
<td>59</td>
</tr>
</tbody>
</table>

Table 3 *Reasons for not reporting rape*

<table>
<thead>
<tr>
<th>Reasons for not reporting rape</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear of retaliation against self or others</td>
<td>5</td>
</tr>
<tr>
<td>Unspecified fear</td>
<td>3</td>
</tr>
<tr>
<td>Fear of not being believed</td>
<td>4</td>
</tr>
<tr>
<td>Fear of being blamed</td>
<td>1</td>
</tr>
<tr>
<td>Rapist was friend, boss, partner, etc.</td>
<td>5</td>
</tr>
<tr>
<td>Rape was incest</td>
<td>4</td>
</tr>
<tr>
<td>Previously told people didn’t believe them</td>
<td>4</td>
</tr>
<tr>
<td>Didn’t comprehend</td>
<td>4</td>
</tr>
<tr>
<td>Dissociation</td>
<td>3</td>
</tr>
<tr>
<td>Didn’t want family or others to know</td>
<td>3</td>
</tr>
<tr>
<td>Didn’t know how to or think to</td>
<td>3</td>
</tr>
<tr>
<td>Didn’t want it to be a big deal</td>
<td>3</td>
</tr>
<tr>
<td>Alcohol involvement</td>
<td>1</td>
</tr>
<tr>
<td>Lack of support</td>
<td>1</td>
</tr>
<tr>
<td>Shame</td>
<td>1</td>
</tr>
<tr>
<td>Lack of evidence</td>
<td>1</td>
</tr>
<tr>
<td>Previous consensual relationship with rapist</td>
<td>1</td>
</tr>
<tr>
<td>Unspecified reason</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 4 lists the reasons why participants who reported their rape did report their rape. Unlike participants that did not report, most of the participants only gave one reason for reporting.

Table 4 *Reasons for reporting rape*

<table>
<thead>
<tr>
<th>Reasons for reporting</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouraged by someone</td>
<td>7</td>
</tr>
<tr>
<td>Didn’t want it to happen to someone else</td>
<td>7</td>
</tr>
<tr>
<td>Wanted prosecution</td>
<td>4</td>
</tr>
<tr>
<td>Safety concern</td>
<td>2</td>
</tr>
<tr>
<td>Pregnant</td>
<td>1</td>
</tr>
<tr>
<td>Mandatory situation</td>
<td>1</td>
</tr>
<tr>
<td>Empathy for rapist</td>
<td>1</td>
</tr>
<tr>
<td>Physical injuries</td>
<td>1</td>
</tr>
<tr>
<td>Having to report other crime</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5 lists how often participants received therapy for the rape committed against them. This information is provided below.

Table 5 *Therapy for rape*

<table>
<thead>
<tr>
<th>Question</th>
<th>None</th>
<th>Daily</th>
<th>Weekly</th>
<th>Bi-weekly</th>
<th>Monthly</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much therapy did you receive?</td>
<td>30</td>
<td>0</td>
<td>23</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 6 lists the responses to questions about prosecuting the participant’s rape cases. Not all participants reported their rapes to authorities. Not all who reported the rape had their cases go to trial.

Table 6 *Information on the trials of the rape cases*

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>For another case</th>
<th>Pending trial</th>
<th>My case did not go to trial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the person who raped you go to trial for raping you?</td>
<td>7</td>
<td>48</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>59</td>
</tr>
<tr>
<td>Did you testify in the trial of the person who raped you?</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>40</td>
<td>59</td>
</tr>
<tr>
<td>Did the person who raped you serve jail time for raping you?</td>
<td>4</td>
<td>52</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>59</td>
</tr>
</tbody>
</table>

As part of the surveys, participants answered questions about possible mental health issues they are currently experiencing. Table 7 lists the responses of the participants to these questions and how often the participants experience these symptoms. The responses corresponded to the following scale: Slight
was rare or less than a day or two. Mild was having symptoms over several days. Moderate was having symptoms for more than half the days, and severe was having symptoms nearly every day.

Table 7  Mental Health Problems

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Slight</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little interest or pleasure in doing things</td>
<td>15</td>
<td>10</td>
<td>17</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Feeling down, depressed, or hopeless</td>
<td>9</td>
<td>15</td>
<td>11</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Feeling very irritated, grouchy, or angry</td>
<td>11</td>
<td>10</td>
<td>17</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>Feeling nervous, anxious, frightened, worried, or on edge</td>
<td>7</td>
<td>14</td>
<td>8</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Feeling panic or being frightened</td>
<td>14</td>
<td>12</td>
<td>9</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Avoiding situations that make you anxious</td>
<td>9</td>
<td>7</td>
<td>15</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Thoughts of actually hurting yourself</td>
<td>32</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Hearing things other people couldn’t hear, such as voices even when no one was around</td>
<td>46</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Feeling that someone could hear your thoughts, or that you could hear what another person was thinking</td>
<td>46</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unpleasant thoughts, urges, or images that repeatedly enter your mind</td>
<td>19</td>
<td>10</td>
<td>8</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>Feeling detached or distant from yourself, your body, your physical surroundings, or your memories</td>
<td>19</td>
<td>15</td>
<td>9</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Not knowing who you really are or what you want out of life</td>
<td>18</td>
<td>13</td>
<td>7</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Not feeling close to other people or enjoying your relationships with them</td>
<td>9</td>
<td>15</td>
<td>12</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Drinking at least 4 drinks of any kind of alcohol in a single day</td>
<td>35</td>
<td>11</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Using drugs illicitly</td>
<td>41</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
**Significant Correlations among the variables**

There were several significant correlations between the circumstances of the rape, the age of the participants at the time of the rape and whether they reported the rape.

Table 8 *Correlations between conditions*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age at time of rape</td>
<td>_</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Did you know the person who raped you?</td>
<td>-.320*</td>
<td>_</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Did you report the rape to the authorities?</td>
<td>-.344*</td>
<td>-.277*</td>
<td>_</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Did you tell a friend, relative, or community member about the rape committed against you?</td>
<td>-.344*</td>
<td>-.277*</td>
<td>-.277*</td>
<td>_</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. How much therapy did you receive?</td>
<td>-.019</td>
<td>-.003</td>
<td>.328**</td>
<td>.328**</td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>6. Length of time rapist served</td>
<td>.218</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.075</td>
<td>_</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>.337**</td>
<td>.337**</td>
<td>.337**</td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

**Relationships between Conditions and Symptoms**

Table 9 lists the many correlations between the conditions of rape and the mental health symptoms of rape. Most of these correlations were between current age and mental health symptoms and also how long ago the rape was and mental health symptoms. There were also correlations between symptoms and age at the time of rape, therapy, whether or not the rapist went to trial, whether or not the rapist served jail time, and the length of time the rapist spent in jail.
Table 9

**Correlations between Conditions and Symptoms**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Current age</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Age at time of rape</td>
<td>.238</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. How long ago rape was</td>
<td>.806**</td>
<td>-.363**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Therapy</td>
<td>-.019</td>
<td>.205</td>
<td>-.137</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Rapist’s serving time</td>
<td>-.148</td>
<td>.039</td>
<td>-.126</td>
<td>-.073</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Case going to trial</td>
<td>-.162</td>
<td>-.144</td>
<td>-.107</td>
<td>.091</td>
<td>.301*</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Length of rapist’s time in jail</td>
<td>.218</td>
<td>.243</td>
<td>.053</td>
<td>.075</td>
<td>.156</td>
<td>.284*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Nervous</td>
<td>-.345**</td>
<td>-.013</td>
<td>-.320**</td>
<td>-.098</td>
<td>.149</td>
<td>.167</td>
<td>-.097</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Angry</td>
<td>-.293*</td>
<td>.060</td>
<td>-.300**</td>
<td>-.009</td>
<td>.111</td>
<td>-.112</td>
<td>-.116</td>
<td>.664**</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Little interest</td>
<td>-.240</td>
<td>.165</td>
<td>-.328**</td>
<td>.358**</td>
<td>.108</td>
<td>.130</td>
<td>.022</td>
<td>.574**</td>
<td>.659**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Avoidance</td>
<td>-.279*</td>
<td>.030</td>
<td>-.296*</td>
<td>.111</td>
<td>.072</td>
<td>.117</td>
<td>-.097</td>
<td>.747**</td>
<td>.646**</td>
<td>.472**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Hear thoughts</td>
<td>-.336**</td>
<td>-.117</td>
<td>-.263*</td>
<td>.212</td>
<td>.305*</td>
<td>.189</td>
<td>.048</td>
<td>.331**</td>
<td>.092</td>
<td>.226</td>
<td>.253*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Thoughts of hurting self</td>
<td>-.239</td>
<td>-.273*</td>
<td>-.061</td>
<td>.163</td>
<td>.055</td>
<td>.043</td>
<td>-.047</td>
<td>.398**</td>
<td>.247</td>
<td>.195</td>
<td>.301*</td>
<td>.444**</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>14. Detached</td>
<td>-.422**</td>
<td>-.113</td>
<td>-.335**</td>
<td>-.085</td>
<td>-.078</td>
<td>-.026</td>
<td>-.256*</td>
<td>.536**</td>
<td>.559**</td>
<td>.299*</td>
<td>.478**</td>
<td>.251</td>
<td>.241</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Not close with others</td>
<td>-.319*</td>
<td>-.019</td>
<td>-.277*</td>
<td>-.023</td>
<td>-.018</td>
<td>.052</td>
<td>-.182</td>
<td>.768**</td>
<td>.643**</td>
<td>.442**</td>
<td>.670**</td>
<td>.281*</td>
<td>.285</td>
<td>.706*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Not know self</td>
<td>-.424**</td>
<td>-.047</td>
<td>-.337**</td>
<td>-.045</td>
<td>.047</td>
<td>.058</td>
<td>-.084</td>
<td>.569**</td>
<td>.628**</td>
<td>.419**</td>
<td>.435**</td>
<td>.168</td>
<td>.295</td>
<td>.769*</td>
<td>.746*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Frightened</td>
<td>-.344**</td>
<td>.039</td>
<td>-.359**</td>
<td>.139</td>
<td>.062</td>
<td>.037</td>
<td>-.077</td>
<td>.885**</td>
<td>.707**</td>
<td>.526**</td>
<td>.831**</td>
<td>.382**</td>
<td>.399</td>
<td>.597*</td>
<td>.739*</td>
<td>.580*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. 4+ alcoholic drinks</td>
<td>-.180</td>
<td>.109</td>
<td>-.210</td>
<td>.084</td>
<td>.322*</td>
<td>.288*</td>
<td>.167</td>
<td>.434**</td>
<td>.352**</td>
<td>.183</td>
<td>.397**</td>
<td>.262*</td>
<td>.191</td>
<td>.361*</td>
<td>.368*</td>
<td>.369*</td>
<td>.465*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Feeling down</td>
<td>-.255*</td>
<td>-.043</td>
<td>-.204</td>
<td>.214</td>
<td>-.027</td>
<td>-.015</td>
<td>-.154</td>
<td>.700**</td>
<td>.785**</td>
<td>.716**</td>
<td>.623**</td>
<td>.239</td>
<td>.282</td>
<td>.541*</td>
<td>.661*</td>
<td>.619*</td>
<td>.702*</td>
<td>.337*</td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).  ** Correlation is significant at the 0.01 level (2-tailed).
An independent t-test was run with going to trial as the grouping variable and the mental health outcomes as the testing variables. There were no significant differences in the mental health outcomes for those whose rape cases went to trial vs. those whose cases did not go to trial; however, there was one trend. For those whose rape cases went to trial, there was a trend for reporting and having more than four alcoholic drinks in a single day (t(55) = 1.677, p = .099). An ANOVA was conducted to see which variables accounted for the variability in having 4+ drinks a day. On its own, “Did the rape committed against you go to trial?” was not a significant source of variation (F (4, 56) = 3.554, p = .012). Also, on its own, “Did the person who raped you serve time for raping you?” was also not a significant source of variation (F (4, 56) = 4.733, p = .002). However, there was a significant interaction (combining having one’s case go to trial and having one’s rapist sentenced on having 4+ drinks a day).

DISCUSSION

The research question asked, “What are the different mental health outcomes of rape victims whose attackers were criminally punished as opposed to rape victims whose attackers were not criminally punished?” A rapist’s going to trial correlated with drinking more than four alcoholic drinks in a single day (r(57) = .288, p < .01). This correlation could suggest that a survivor’s rape case going to trial led to increased drinking for the rape survivor. This relationship could also be explained outside of the correlation as a more traumatic rape leads to a longer sentence and increased drinking. The independent t-test and ANOVA further showed trends in significance between a rape survivor’s going to trial and a rape survivor’s drinking more than four alcoholic drinks in a single day. These tests indicate that there was a difference in drinking based on whether the rape cases went to trial.

There was a relationship with a rapist’s serving time and feeling that someone could hear your thoughts, or that you could hear what another person was thinking (r(57) = .305, p < .05), and there was a relationship with a rapist’s serving time and drinking more than four alcoholic drinks in a single day (r(57) = .322, p < .01). While these results could suggest that a rapist’s serving time leads to the rapist’s victim having these mental health problems, these results could also be interpreted differently. The correlations could also suggest that the rape was prosecuted because of some particularly cruel or traumatic experiences, which could be associated with more mental health issues, even later in life. The fact there were no relationships between a rapist’s serving time and other mental health problems can be attributed to the fact that only seven participants obtain legal retribution for the rape committed against them as opposed to the fifty-two that did not.

While a rapist’s serving time produced two positive correlations with mental health symptoms, the length of time a rapist served produced a negative correlation. The length of time a rapist served correlated with feeling detached or distant from one’s self, body, physical surroundings, or memories (r(57) = -.256, p < .05). This correlation could suggest that the longer time a rapist served in prison, the less likely the survivor was to suffer from feeling detached or distant from one’s self, body, physical surroundings, or memories.

Although therapy is widely accepted as useful in helping with one’s mental health problems, therapy correlated with only little interest or pleasure in doing things (r(57) = .358, p < .01). This correlation could be an indication having little interest or pleasure in doing things is a very common reason why rape survivors go to therapy. The majority of participants (30) in the study never went to therapy to help with their rape, and a portion of these women do not really suffer from any mental health problems.

Not only did therapy have a positive correlation with one of the mental health symptoms in the survey, but it also had two positive correlations with two of the conditions of rape. Therapy correlated with reporting the rape to the authorities and telling a friend, family, or community member about the rape (r(57) = -.328, p < .01). Therapy is often used to help people with their personal lives, and therapy’s giving rape
survivors the strength to let others know about their rape. The correlation can also mean that telling someone about the rape was related to seeking help from a therapist. Thus, those who reported the rape committed against them were more likely to have received therapy.

Although reporting a survivor’s reporting their rapist can be an empowering experience, it is not always a fruitful one. As previously stated, the Rape Abuse & Incest National Network has recently estimated that over 99% of rapists face no criminal punishment for their crimes (Kebodeaux, 2017). In the present study, reporting the rapist and telling someone about the rapist correlated negatively with the length of time that the rapist served ($r(57)=-.337, p<.01$). This correlation shows the unfortunate realization that even though some rape survivors report the person who raped them, the person who rapes them is not always punished. Also, the length of time a rapist served correlated negatively with knowing the rapist ($r(57)=-.337, p<.01$). This correlation can be analyzed as those who know the person who raped them are more reluctant to report. Thus, the rapist is less likely to serve a jail sentence even at all.

Although there were multiple conditions that produced correlations, the most influential one was present and past time. How long ago the rape was had negative correlations with little interest or pleasure in doing things; feeling very irritated, grouchy, or angry; feeling nervous, anxious, frightened, worried, or on edge; feeling panic or being frightened; feeling that someone could hear your thoughts, or that you could hear what another person was thinking; feeling detached or distant from yourself, your body, your physical surroundings, or your memories; not knowing who you really are or what you want out of life; and not feeling close to other people or enjoying your relationships with them. These correlations suggest that the less time between the time of rape and when the survey was taken, the more likely that the rape survivor was to suffer from these mental health problems. Also, age at the time of rape correlated with thoughts of actually hurting yourself ($r(57)=-.273, p<.05$). This correlation suggests at those who were younger at the time of their rape are more likely to suffer from this mental health problem.

Age at the time of rape also correlated with conditions of the rape. Age at the time of rape correlated with knowing the rapist ($r(57)=-.320, p<.01$), reporting the rapist ($r(57)=-.344, p<.01$), and telling someone about the rape ($r(57)=-.344, p<.01$). These correlations can be explained through the fact that younger rape survivors are more likely to be raped by someone they know. Thus, they do not report or tell someone about the rape committed against them out of fear.

Current age also had correlations with nine symptoms. Current age had negative correlations with feeling very irritated, grouchy, or angry; feeling nervous, anxious, frightened, worried, or on edge; feeling panic or being frightened; feeling that someone could hear your thoughts, or that you could hear what another person was thinking; feeling detached or distant from yourself, your body, your physical surroundings, or your memories; not knowing who you really are or what you want out of life; and not feeling close to other people or enjoying your relationships with them; and avoiding situations that produce anxiousness. These correlations suggest that the younger the current age of participants, the more they are likely to suffer from these mental health problems.

Limitations

Although many significant relationships were found in the study, what is not found can be just as important as what is found. The biggest limitation of the study was limited statistical power. The people that were e-mailed when applicable include every non-specific-time-frame rape resource on the Rape, Abuse & Incest National Network website, every non-specific-time-frame Mississippian rape therapist on Psychology Today’s website, every non-specific-time-frame rape support group on Psychology Today’s website, and the district attorney of every county in the country. This was done in order to obtain a broad, representative sample of rape survivors across the country, but only 59 rape survivors took the survey. This is
understandable, though, because rape is a very traumatic thing that can happen to a person and can be difficult to even take a survey about; however, more could have been made known if the sample size was larger. Out of the 59 rapists discussed in the surveys, only seven were punished as opposed to the fifty-two that were not.

One limitation of the study was the accuracy of the findings in the survey is based on the assumption that the participants correctly answered the questions. Although the survey was anonymous, participants could still be reluctant to admit they have mental health problems. Also, there is always the possibility that participants incorrectly answered some questions because they did not understand them or that they could not remember certain aspects of the rape committed against them.

A limitation of the study was also that a 5-point scale was used. Using scales with 7 or 15 data points makes it easier to find significant differences than a smaller Likert-type 5-point scale. More participants are needed when a 5-point scale is used because the differences in between the numbers is smaller. For example, more participants are required to find a significant difference between 3.7 and 4.0 than 3.7 and 6.0 or 10.0.

Another limitation of the study was that it was only accessible to female rape survivors of a single rape. Survivors of a single rape were sought to not create an imbalance between the results of those who had multiple rapists that did not go criminally punished, multiple rapists that did go criminally punished, a single rapist that was criminally punished, and a single rapist that was not criminally punished. The survey could have found a way to include victims of all types of rapists without creating results that could be seen as invalid. Only female survivors were sought because men are less likely to be raped, and it would have been harder to find men that were raped. Thus, there was a chance that only a small number could have been found, and a minuscule sample size would produce unreliable results. The survey could have taken a chance and included men anyway to add more people to the survey and create a larger sample.

**Implications**

The results of the study show that more can be done to educate young people about rape. This education would be greatly beneficial if it came as early as possible. The majority of participants (39) were 20 or younger when they were raped. The younger a participant was, the more likely they were to be raped by someone they knew and thus, less likely to report or tell someone about the rape committed against them. Four of the participants did not report their rape because they did not understand what happened to them. Although not all who had this reason were young at the time of their rape, the fact that it was a reason among at least one is still a concern. While talking to children about sexual assault can be controversial and very troubling, it can be very beneficial. Schools should make use of sexual assault awareness programs to help educate students on what is and what is not rape and the many different negative mental health consequences rape can have. Schools should also utilize assertiveness resistance programs in order to decrease the risk of sexual victimization for vulnerable populations. The younger participants in the study were more likely to suffer from multiple mental health problems and those who were younger at the time of their rape were more likely to have thoughts of hurting themselves. It can only take one thought of hurting one’s self to decide to take one’s own life. When schools educate students about rape, they could also educate the students that the school is a safe environment where they can report rape, and thus, be less at risk for mental health issues.

Educating students about rape can also be useful so that participants know how to react when someone else is raped. Four of the participants reported that no one believed them when they told them about the rape committed against them. Rape is a very traumatic thing to happen to a person, and not being believed when telling others about it can be very harmful. Students should be educated to be open when a rape survivor tells them about what happened to them
so that they can use this thinking now and into adulthood, preventing them from making a terrible situation even worse.

Although the current study revealed much that could be done to help survivors of rape, even more research could be done. The current study could be repeated with more time so that a large sample of rape survivors with cases that went to trial and also a rapist that was criminally punished can be recruited. Research could also be done to identify which types of therapy are most successful on survivors of rape so that they can be helped in the best way possible. Also, research could be done to find what makes rapists more likely to serve lengthy sentences, so that the survivors of the rape they committed against them can get the justice they deserved. Currently, rape is a terrible thing to happen to a person, and it always will be; however, more research can help mitigate its effects or decrease the rate at which it is happening.

REFERENCES


REVIEW PAPER

Impacts of Wildfires on Human Health, Ecology, and Economy: An Overview

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ABSTRACT

Wildfires have existed since prehistoric times occurring regularly as a natural phenomenon of the forest’s ecosystems. The discovery of 440-million-year-old fossils of charred remains of plants show that the history of wildfires can be traced back to the Silurian period. Such fossil records became more frequent with the progression of geological time. Larger and sustained wildfires may negatively impact human health, environment, and economy. Conversely, wildfires are also vital for life cycles and the continued survival of some plant species. Thus, wildfires play an important role in the renewal of some ecosystems. In recent years, wildfires have become more frequent with escalated intensity and duration, and have been conjoined with massive health, ecologic, and economic consequences. Expanding anthropogenic activities and climate variability may have contributed to the current rise in the wildfire frequency, intensity, and duration. Studies indicate that wildfire smoke containing various gases and particulate matter may produce short- to long-term human health consequences, including death. If the frequency, amplitude, and duration of wildfires maintain or surpass the current course, it could produce drastic implications on human health, lifestyle, and the environment, and may affect the flora and fauna of various ecosystems. This paper focused on the impacts of wildfires on human health, ecology, and economy, as well as the impacts of shifting climatic conditions on the frequency and severity of wildfires.

Key Words: Wildfire, forest fire, climate change, human health, ecological and economic consequences

INTRODUCTION

Wildfires, also known as forest fires, are uncontrolled fires that burn wildland vegetation. Wildfires are a ubiquitous part of the Earth’s ecosystem. For hundreds of millions of years, wildfires have been burning the forests, savannas, grasslands, and other wildland vegetation throughout the continents under varieties of climatic conditions. The United States Forest Service (USFS) has described wildfires as forces of nature which are nearly impossible to prevent and are as difficult to control (USFS, 2021).

The initiation of wildfires requires three basics elements: fuel, atmospheric oxygen and ignition. These elements are referred to as the fire triangle. Under favorable conditions such as low humidity and high temperature, both dead and living forest biomass could be used as fuel (Bond and Keane, 2017) and the ignition could be natural or anthropogenic in origin (Figure 1).

Wildfires may occur naturally such as a lightning strike, or due to an accidental or deliberate human made spark. According to National Park Service (NPS), in the U.S., about 85% of the wildfires are caused by human activities (NPS, 2021a). According to a National Geographic (NG) publication, forests remain most vulnerable to wildfires during the spring and summer months when long stretches of dry climates persist and dry and dead vegetations, fallen tree leaves, tree limbs, tree roots, grasses, and soil organic matter contribute to fuel such fires. Some plants such as, acacia, bamboo, chamise, cypress, Douglas fir, red cedar, juniper, palm, pampas grass, pine (Taylor, 2020) and plant parts containing resins (NG, 2019) are highly flammable and are capable of boosting wildfires (Figure 1).
The history of wildfires can be traced back to the Silurian period (about 444-419 million years ago) when terrestrial plants evolved, which is evident by observing fossils of 440 million years old charred remains of plants (Scott, 2000; Glasspool et al., 2004). Wider buildup of charred materials (charcoals) appeared about 345 mya, in the late Paleozoic Era (Falcon-Lang, 2000; Scott, 2000; Keeley, 2009), which could be associated with a rise in atmospheric oxygen levels, facilitating the combustion processes. Oxygen started to build up in the atmosphere about 2 billion years ago (Bond and Keane, 2017) and during the Carboniferous Period (about 359 to 299 mya), the level reached a peak of 31% (Berner, 2006), compared to the current level of 21%. During the Permian Era (about 299-252 mya) and Triassic Periods (about 237-201 mya), the atmospheric oxygen level fell and so did the charred fossil materials (Keeley, 2009).

The number and the size of forest fires fluctuates from year to year. Data indicate that since the 1980s, the extent of areas burned due to wildfires have increased and between 1983-2020, an average of about 70,000 wildfires per year have been documented (EPA, 2020d). Climatic conditions such as rain, drought, wind, and temperature play major roles impacting the size and duration of wildfires (Borunda, 2020). The topography of forest lands may also play a role in the spread of wildfires (NG, 2019). Low intensity and balanced wildfires have beneficial effects on the forest ecology including removing invading plants, supporting seed germination and growth of conifer plant species, maintaining natural wood cycling, and providing soil nutrients. However, fires with higher frequencies and intensities can produce unwanted impacts on ecology, economy, and human health. Studies indicate that over the years, wildfire frequencies, duration and intensities have increased all over the world (Figures 2 and 3), and climate change models forecast that wildfire incidence and austerity will increase in the near future (Murphy et al., 2018). However, according to the National Oceanic and Atmospheric Administration (NOAA), the increases in temperature have not been ubiquitous and parts of the United States (particularly in the West) are more susceptible to wildfires (NOAA, 2021).

Larger wildfires produce substantial damages to natural resources, property, human health, ecology, and the environment. While the immediate and direct costs associated with fires could easily be determined, the long-term health and environmental consequences from wildfires and fire toxicants are subject to further studies.
Human Health Impacts

In recent years, stricter regulatory controls have improved the overall air quality in the USA. However, the increased frequency of wildfires tends to produce negative effects. Large fires consume huge amounts of oxygen, thus depleting oxygen in the surrounding environment. Wildfires typically produce huge amounts of heat and smoke, with the smoke containing various hazardous substances capable of causing adverse health effects. Such hazardous materials include aldehydes, benzene, carbon monoxide, nitrous oxide, polycyclic aromatic hydrocarbons, and various organic compounds (WHO, 1999).

Studies in 2012 indicated that smoke from wildfires contained over 50% methene and 20%
particulate emissions (Black et al., 2017). Wakefield (2012) reported that smoke from wildfires may contain various toxicants that could be categorized into: (1) asphyxiant gases, such as carbon monoxide, carbon dioxide, and hydrogen cyanide, and these asphyxiant gases can cause narcosis due to central nervous system dysfunction; (2) irritants, such as hydrogen chloride, hydrogen bromide, hydrogen fluoride, sulfur dioxide, phosphorus pentoxides, acrolein, formaldehyde, ammonia, chlorine, and phosgene which can cause sensory irritation and other injuries depending on the degree of exposure; and (3) complex molecules, such as polycyclic aromatic hydrocarbons, dioxins, isocyanates, and other particulate matters (PM). Additionally, metal oxides, such as chromium trioxide and arsenic trioxide may also be produced. All these substances have various deleterious health effects such as cancer, mutation, reproductive, endocrine, and respiratory dysfunctions, skin irritation and allergy (Kim et al., 2013; Kogevinas, 2001; Karol and Dean, 2008; Chu et al., 2019; Stevens, 2010).

Exposure to these combustion products, especially carbon dioxide, carbon monoxide, and hydrogen cyanide along with environmental oxygen depletion may cause tissue hypoxia leading to unconsciousness or death. Irritant products from fire mostly affect the eyes and the upper and lower respiratory systems. The extent of damage from such irritants may depend on the exposure duration along with the type and concentration of the irritant materials. Wakefield (2012) stated that the main health hazard from exposure to wildfires would be organic irritant gases. Smoldering wildfires, i.e., fire without flames, which occur due to incomplete combustion of forest materials have also been reported to produce toxins. However, since these toxins are low in concentration, they are unlikely to cause serious health concerns (Wakefield, 2012).

Finley et al., (2012) stated that the main pathways of human exposure to wildfires are: (1) heat, smoke and smoldering materials suspended in the air, (2) chemical products from burning vegetation, and (3) PM contaminated water from the fires. The authors also indicated that older people, pregnant women, and those with poor socio-economic status and/or predisposition to cardiac and respiratory disorders were more vulnerable and likely to suffer more from exposure to wildfire smoke.

PM are a major air pollutant contributed by burning forest vegetation, and according to the US EPA (Environmental Protection Agency), PM contained in smoke pose the biggest health threat (EPA, 2021a). These microscopic particles can affect the eye and the respiratory system. PM can pass through respiratory tracts and become deposited in the terminal bronchi and lung alveoli. An increase in PM concentration could be associated with higher mortality rates. An East European study indicated that elevated levels of PM from wildfires that affected about 64% of the population in Finland, caused an increase in daily all-cause mortality (Hanninen et al., 2008). An Australian study reported a 5% increase in non-accidental daily mortality rate caused by air pollution from bush fires (Johnson et al., 2011).

Even with these data, the long-term health consequences from exposure to wildfire emission products is not fully understood and is subject to further investigations.

**Ecological Impacts**

**Positive Impacts**

Although wildfires are sometimes dangerous to humans and other animals, low intensity fires produce positive environmental effects. According to NG reports, many ecosystems benefit from periodic wildfires as fires are essential to revitalize forest ecology. Low intensity wildfires clean up debris on the forest floor, remove dead trees and competing vegetations, remove unhealthy plants, and kill insects and pests harmful to plants (NG, 2020). Remarkably, the animal fatalities from wildfires are low in many areas as animals escape the fires by moving to safer areas or burrowing into the grounds (NG, 2020).

The life cycle and sustained survival of some plant species vitally depends on wildfires. According to U.S. National Park Service (NPS), long-term survival of 33 plant species in Everglades National Park depends on fire (NPS, 2021b). Wildfires help the release and germination of seeds of certain plant species, such as scrub, chamise, jack pine, lodgepole pines, and certain types of lilies and lilacs (NPS, 2021b; NG, 2020). According to
American Forest Foundation (AFF), fires support new growth of plant species and maintain the natural cycle of woods’ growth and replenishment (AFF, 2021). Fires promote sprout of aspen, birch, and willow from their roots (NPS, 2021b). Planned or prescribed fires are often used to prevent future devastating wildfires that could occur by removing organic matter on forest floors serving as fuel.

Additionally, wildfires help provide soil nutrients, support growth for vegetation and provide food for herbivorous animals and birds. Barkley (2019) stated that wildfires can improve the fodder quality for wildlife for a few to many years following the fire occurrence. For a short term, dead animals and burned plant materials provide food for scavengers and small animals. Bark beetle and other insect population growths are found to be supported by fires (Barkley, 2019; NG, 2020).

Fires also play an important role in supporting habitat requirements for the biota in the wetland ecosystems. Wetland hydrology is a complex system and is influenced by both the biotic and abiotic factors in the environment. Fires play significant role in maintaining hydrology, nutrient, soil chemistry, organic matter deposition, and flora and fauna composition of the wetlands (Neary et al., 2005). Wetlands are generally more shielded from wildfires and thus provide refuge for wildlife from fires (Barkley, 2019).

Wildfires are crucial for the vitality of boreal forests (Taiga) which represent about 30% of the global forest areas (IBFRA, 2021). Boreal forests grow in high-latitude environments where freezing temperatures exist for 6 to 8 months. The boreal ecozone is extended in parts of Russia, China, Japan, Norway, Sweden, Finland, Canada, and the United States (IBFRA, 2021). Boreal forests occupy about two-thirds of Eurasia, and in Russia, they cover about 12 million square kilometers, which is one of the largest biomes in the world. Wildfires play an important role in the thawing of the upper soil layers (active soil layers) in boreal forests during the summer months by removing the surface vegetation and organic soil layers, thus helping the vitality of the forest (Jafarov et al., 2013).

**Negative Impacts**

Wildfires are periodic phenomenon in most terrestrial ecosystems. Anthropogenic or deliberate fires are being used as tools to manage various forestlands. Such fires may produce a wide range of effects on soils, water, and the biota of the ecosystems (Neary et al., 2005). The forest ecosystems can be impacted by the frequency, severity, and the extent of the wildfires (Lesmeister, et al., 2019). Wildfires affect the soil quality, and consequently, can affect the flora and fauna. Fires can change soil texture, density, porosity, pH, and moisture content (Jhariya and Raj, 2014). Vegetation and organic matter that cover soil surface, helps prevent soil erosion. Fires that destroy these soil coverings, expose soils to direct weather which may lead to excessive soil erosion (Neary et al., 2005). Letey (2001) reported that high surface temperature from fires can incinerate soil organic matter and cause the soil to be hydrophobic. Such loss of soil consistency may lead to erosion and destruction of ecosystems and biodiversity. Fires can enhance carbon and nitrogen availability in soil which may cause increased microbial activity and decrease soil carbon sequestration (Wang et al., 2012). Conversely, fire may also reduce soil micro-organism biomass affecting the nutrient cycling and soil fertility (Swallow et al., 2009; Sun et al., 2011). Understandably, loss of soil productivity can affect the distribution of flora and fauna of the forestlands.

Fires may considerably impact wildlife by altering their habitats. In a short run, wildfires reduce the shrub density and promote the growth of herbs. As fires reduce the number of trees and allow more sunlight on forest floor, herbs flourish (Sheuyange et al., 2005). Fires also promote the growth of fire-tolerant plant species over the intolerant ones. Studies indicate that repeated fires can destroy forest flora and negatively impact the fauna including endangered species due to habitat modification and destruction. The extent of such impact depends on the extent of habitat change (Jhariya and Raj, 2014). Invertebrates, especially insect populations get severely affected by wildfires, while animals living in moist habitats such as amphibians and reptiles are least affected.
Fish mortality in the wetlands and water bodies can also be linked to wildfires. Accumulation of debris from fires and application of fire retardants to control fires were found to be responsible for killing fish population during wildfires (Neary et al., 2005). Wildfires may also lead to the loss of nesting resources in birds. Loss of habitat and nesting resources following wildfires for swift parrots, a cavity nesting bird, have been reported, causing the birds to miss reproduction opportunities (Stojanovic et al., 2016). Bosso et al., (2018) reported loss of habitats for bat species following a severe wildfire.

Ozone (O3), a greenhouse gas, is known to produce negative effects on human health and ecosystems (Jaffe and Wilder, 2012). According to United States Environmental Protection Agency (EPA), while O3 in the upper hemisphere provides shield against solar ultraviolet rays, O3 produced at ground level is a health hazard (EPA, 2021b). Wildfire emissions and high temperature help form atmospheric O3. Global wildfires are linked to approximately 3.5% of annual global tropospheric O3 production. In the USA, the current permissible O3 level in the air is 75 ppb (parts per billion) by volume. However, the increasing frequency of wildfires are likely to contribute to elevated levels of O3 in the troposphere as has been recorded at monitoring sites (Jaffe and Wilder, 2012). Ozone is a major component in smog and may cause various respiratory problems such as throat irritation, coughing, inflammation of the bronchi, lung tissue damage, and reduced lung functions. Since O3 can be carried by wind, it can affect distant areas (EPA, 2021b).

Ground level O3 can enter plant leaves and alter photosynthesis. Reduction in photosynthetic activities affects plant’s nutrient supply, causing sluggish plant growth, and makes plants weak and vulnerable to diseases. Such effects on plants may produce negative impacts on various ecosystems, resulting in loss of plant diversity and subsequent loss of animal, insect, and fish populations (EPA, 2021c).

Climate Change Impacts

Climate change is thought to be a long-term phenomenon which could be slowly shifting the Earth’s weather pattern. A sizeable number of scientists acknowledge the concept of climate change which suggests the Earth has been gradually warming up. However, recent data from the NOAA indicate that the warming has not been ubiquitous across the United States. For example, temperatures in the Northern Plains and Upper Midwest have actually cooled from 1981-2010 to 1991-2020. Precipitation was another factor with those areas west of the Rocky Mountains being wetter while the Southwest was much drier (NOAA, 2021).

Thus, increased temperature in the west along with a drier climate has made that part of the U.S. more susceptible to wildfires with 2020 being a record setting year for fires in California (Cal Fire, 2021). Both anthropogenic activities such as those that produce greenhouse gases and non-anthropogenic activities such as volcanic eruption, and cosmological radiation may have been contributing to global warming. Furthermore, the increases in temperature appear to correlate with solar activity in the past, although recent years have not (Cubasch, et al., 1997; Xia et al. 2017). Using theoretical methodologies, and mathematical and computer models, researchers predict that the Earth will continue to warm up in the upcoming centuries (Zaman, 2015; Gray, 2019).

Global warming is contributing to fast changing weather pattern, affecting various ecosystems, and may lead to widespread drought in the next 30-90 years (Dai, 2013). Such changes in weather pattern may have amplified drought in drying out forests and made them more vulnerable to wildfires (NG, 2020).

According to Union of Concerned Scientists (UCS), USA, the frequency, duration and intensity of wildfires are growing all over the world and affecting more communities (UCS, 2020). High temperatures and low humidity are two important factors in the ignition and sustainability of wildfires. Such conditions support both natural and anthropogenic-ignited fires. Lightning ignitions have increased since 1975 and lightning has been
identified as the key factor in causing boreal wildfires in North America (Veraverbeke et al., 2017).

According to a report produced by National Aeronautics and Space Administration (NASA), over the past decade, the earth has gradually warmed up. Data indicate, that since 1880, the earth’s atmosphere has warmed up by 1.9 F and the fire seasons have extended across about 25% of the global forestlands (NASA, 2019). The past five years were recorded as the warmest years. This report also indicates that the increase in temperature has introduced added fuel in nature to ignite and speed up wildfires. The years 2017, 2018 and 2020 caused the most devastating wildfires in the history of California, and in 2019 wildfires burned millions of acres in Alaska and Siberia (Gray, 2019).

A 2021 report produced by Oregon Climate Change Research Institute (OCCRI), Oregon State University, stated that in Oregon, wildfire frequency and area burned were increased between 1984 and 2018. Since 1895, Oregon’s annual temperature has increased by 2.20 F per century and projected to increase by 50 F by the 2050s. The report also projected a decrease in summer precipitation and an increase in winter precipitation (OCCRI, 2021). During the wildfire occurrences, the state of Oregon experienced moderate to severe drought and about 80% of the state experienced drought status (Burns, 2020).

Another measurement of increased wildfire activity is the increased levels of O3 in the troposphere. As stated earlier, wildfires contribute about 3.5% of global tropospheric O3, annually. Sites that monitor air quality increasingly show elevated levels of O3, perhaps due to increases in the frequency of global wildfires (Jaffe and Wigder, 2012).

Economic Impacts

Economic factors associated with wildfires include both direct and indirect losses. The direct losses include loss of lives, physical injuries, psychological impacts, loss of infrastructures, and ecological impacts, such as loss of habitats, and agricultural losses. Indirect losses involve economic decline of community, destabilization of utility services and housing market, and health and environmental impacts from fire hazards and fire retardants (Thomas et al., 2015). The economic costs from long-term health consequences due to wildfire pollution exposures are yet to be determined.

As stated earlier, there is a global rise in the frequency and amplitude of wildfires. Wildfires cause major disruptions to ecology, agriculture, housing, health, and tourism (Mancini et al., 2018). This article will only address a few wildfire predicaments among the many that the world is currently experiencing.

In a 2015 publication, National Institute of Standards and Technology (NIST) of the U.S. Department of Commerce estimated that the annual economic costs from wildfires could range anywhere between $71.1 billion to $347.8 billion USD (Thomas et al., 2015). The western U.S. has experienced a growing frequency of wildfires for decades. In 2018 alone, the state of California suffered an estimated $148.5 billion in total damage from wildfires, with $27.7 billion in capital loss, $32.2 billion in health care cost, and $88.6 billion in indirect costs (Wang et al., 2021).

Amazon rainforest fires directly threaten the economy and environment of South America and indirectly that of other continents. The resources such as timber and rubber from the Amazon rainforest contribute over $8 billion in the Brazilian economy, but the fires, suspected to be contributed to by massive deforestation, casts doubt on the sustainability of the resources. Additionally, this can also impact the rainfall and agriculture in the South and North Americas, (Czajk, 2019).

Australia is known for its enriched wild habitats. It is home to a variety of indigenous animals, including 200 kind of mammals, 200 kinds of reptiles, and 350 kinds of birds. Some of these amazing animals are dingoes, flying foxes, kangaroos, koalas, platypuses, possums, Tasmanian devils, and tree kangaroos. Australian bushfires hugely impact the Australian economy and its wild habitats. According to a United Nations Environment Program (UNEP) report, between 2019-2020, bushfires have burned over 18-million
hectares (about 45-million acres) of land, 5,900 buildings including 2,800 homes, caused human fatalities, and killed millions of animals. About 80% of all terrestrial plants and animals live in the forests. Wildfires are destroying the biodiversity at an alarming rate, and currently, over a million species are facing extinction globally (UNEP, 2021).

Points of Concerns

1. The frequency, duration and intensity of wildfires are growing all over the world, affecting more communities (UCS, 2020). Climate change models also forecast that the wildfire incidence and austerity will further increase and remain high in the near future (Murphy et al., 2018).

2. It is disturbing fact that about 85% of the wildfires are caused by anthropogenic reasons (NPS, 2021a), producing substantial damages to natural resources, property, human health, ecology, and the environment.

3. Heat and smoke from wildfire contain a large number of hazardous substances as previously described. All these substances have various deleterious health effects such as cancer, mutation, reproductive, endocrine, and respiratory dysfunctions, skin irritation and allergy (Kim et al., 2013; Kogevinas, 2001; Karol and Dean, 2008; Chu et al., 2019; Stevens et al., 2010; Wakefield, 2012). However, the long-term health consequences from these fire toxicants are not completely understood.

4. Wildfires produce a wide range of effects on soils, water, and the biota of ecosystems (Neary et al., 2005; Lesmeister, et al., 2019). By destroying the vegetation and organic matters that covers the soil, wildfires lead to soil erosion (Neary et al., 2005), alteration of soil texture, density, porosity, pH, and moisture content (Jhariya and Raj, 2014; Letey 2001). Such impacts on forest soil may lead to destruction of biodiversity and ecosystems.

5. Fires decrease soil carbon sequestration (Wang et al., 2012), nutrient cycling and soil fertility (Swallow et al., 2009; Sun et al., 2011), leading to loss of soil productivity thus affecting the distribution of forest flora and fauna.

6. Fires impact wildlife by altering or destroying their habitats (Sheuyange et al., 2005; Bosso et al., 2018), causing them to miss reproduction opportunities (Stojanovic et al., 2016).

7. High temperatures from wildfires help produce tropospheric O3, a human health hazard at ground level (EPA, 2021b). Increased frequency of wildfires contributes to elevated levels of O3 in the troposphere as recorded at monitoring sites (Jaffe and Wilder, 2012). Ozone is a major constituent in smog and may cause respiratory illnesses such as throat irritation, coughing, bronchitis, lung damage, and reduced lung functions, and since O3 can be carried by wind, it affects distant areas (EPA, 2021b). Ozone affects photosynthesis, making plants weak and vulnerable to diseases, resulting in loss of plant diversity and subsequent loss of fauna (EPA, 2021c).

8. Slowly shifting Earth’s weather patterns and global warming may lead to widespread drought in the next 30-90 years (Dai, 2013). This will potentially make the forests more vulnerable to fires (NG, 2020). Recent data from the NOAA indicate that the warming has not been ubiquitous across the United States, and the Southwest parts are drier than the rest of the country (NOAA, 2021), making these areas vulnerable to drought and fire.

9. The economic impact of wildfires can obviously be associated with loss of private property, farmlands and various businesses destroyed by the fires. People have lost both their homes and livelihood due to widespread destruction by wildfires across the globe (Diaz, 2012).

10. Kochi, et al. (2010) noted that potential damage to health also has direct and indirect economic impact including the cost of medical care, loss of labor and pain and suffering due to health damage.

Prevention and Management

According to NFPA (National Fire Protection
Association), in the U.S., over 45 million homes and 72,000 communities which are intermingled with the wildlands and are exposed to threats from wildfires (NFPA, 2021). Wildfire management is costly as it requires significant preparedness and mitigation efforts. With the cooperation of federal, state, and local entities, the U.S. Forest Service (USFS), a federal agency under the U.S. Department of Agriculture (USDA) has been managing wildfires in national forests for over a century (USFS, 2021). The Bureau of Land Management (BLM), another important agency under the U.S. Department of Interior, is responsible for managing fires on 245-million acres of public land in the United States (BLM, 2021). For the past few decades, fire seasons have been prolonged, and wildfires became more intense and larger in size, causing increasingly challenging tasks for fire management. Wildfire prevention and management must involve both the fire management authorities and the residents around the wildland communities.

Fire management authorities use preventive methods such as, fuel treatments (pruning and removal of selective trees to create open spaces in the forests), prescribed burns (setting intentional fires to burn off excessive vegetation and dead plant materials) and construction of gutter trenches (digging deep and wide trenches on the downhill slopes around the fire perimeter to catch rolling firebrands to prevent fires below the fire-lines) to prevent large wildfires from spreading. Some basic fire safety tips for the residents around the fire-prone wildlands should include clearing dead vegetation, leaves and other debris within 10 feet of the house; clearing flammable materials such as, gas tanks, firewood within 30 feet of the house; pruning trees to keep the lowest branches 6-10 feet above the ground; keeping lawns hydrated; maintaining an emergency supply kit that must include medications, important documents and identification; and consulting the local fire department about the preparation and evacuation plans in the event of a wildfire (NFPA, 2021). Wildfires cannot always be prevented, but such mitigations will definitely be useful to reduce the fire damages.

**DISCUSSION AND CONCLUSION**

Like hurricanes, floods, and tornados, wildfires are considered a force of nature that is almost impossible to prevent and difficult to control. While smaller to moderate wildfires have some environmental benefits, such as aiding seed germination of some plant species, cleaning up debris on forest floors, removing dead trees and competing vegetations, removing unhealthy plants, and killing insects and pests that are harmful to plants, larger wildfires are capable of producing significant health, ecological, and economic damages. Some of these damages such as loss of lives, physical injuries, loss of infrastructure, property, and agriculture are direct, and relatively easy to measure. However, long-term human health consequences from asphyxiant gases, such as carbon monoxide, carbon dioxide, and hydrogen cyanide, and particulate matters produced during larger wildfires, and the broader ecological and environmental impacts, such as loss of habitat, and disruption of animal reproductive cycles are not easily comprehensible and will require long-term studies to fully understand. The Human Health Impacts, Environmental Impacts and Points of Concerns sections of this paper have addressed some of these key issues.

Although the impact of human activity on increases in temperature is still a subject for debate, there is no question that humans have been responsible for most (85-90%) of the increase in wildfires, occurring via either accidental or deliberate mechanisms. The fact that temperatures have gone up in sections of the United States does implicate this as a contributing factor to the increased wildfires seen in recent years. Another factor that has not been addressed by anyone to our knowledge is the fact that the current COVID-19 pandemic has potentially led to an increase in outdoor activity particularly in those going outside of urban areas for recreation. It is certainly possible that many of these individuals were not as experienced in outdoor protocols for campfires or were not as careful with other elements such as cigarettes, which may have led to an increase in accidental anthropogenic causes. Regardless, the increase in wildfires has unwanted and detrimental impacts on human health, economy, and the ecology of our planet.


Massive Wildfires Across the Globe: Could They be Linked to a Surge in Extreme Weather Conditions?

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ABSTRACT

Wildfires are natural occurrences of the forests’ ecosystems and vital for the renewal of biomes and survival of some plant species. Studies indicate that in recent times, in many parts of the world, the frequency, extent, and austerity of wildfires have been escalating and occurring in places where they rarely occurred before. Several reports indicate that the environment is gradually warming up and is associated with severe droughts that could be responsible for such wildfire escalations. The humans’ role in climate change is vastly debated. Whereas some scientists believe that the current rise in atmospheric temperature is due to the changes in solar activities and is a part of natural climate cycle where humans have no accountabilities, the others disagree and suggest that the rise in atmospheric temperatures is aided by anthropogenic activities. Regardless of the scientific opinions on the mechanism of climate change, shifting climatic conditions are evidenced and supported by many scientific studies. This paper reports on some brutal wildfire activities in 2021 that severely impacted various parts of the world where extreme weather conditions were reported and where drought and environmental temperature surpassed all previous records.

Key Words: Wildfires, forest fires, severe weather, drought, environmental temperature, climate change

INTRODUCTION

Wildfires, also known as forest fires, are a ubiquitous part of the wildland ecosystems. For hundreds of millions of years, wildfires have been actively burning the forest lands (USFS, 2021) and playing a crucial role in the renewal and vitalization of the forests. Each year, wildfires occur in many parts of the world in most continents, especially during the hot and dry seasons during the summer months. These fires may be triggered naturally by lightening, and by anthropogenic activities such as unextinguished camping materials, cigarettes, faulty electrical or mechanical equipment, or arson (Daley, 2017).

Various factors such as low precipitations, arid climate, strong winds, and poor forest-land management are known to instigate and facilitate wildfires (Borunda, 2020). Studies indicate that in recent years, global wildfires are becoming larger, more intense, and occurring in places such as Yakutsk, Siberia where they rarely occurred before. In recent months (2020 – present), drier-than-average climate conditions may have been creating forests crucibles in Siberia, Southwest Canada, Europe, Western US, and South America, and making these areas susceptible to scorching wildfires (Kottasova, 2021).

Studies indicate that excessive drought and heat could be the result of shifting climate and a major factor in increasing wildfire activities in the Western part of the US and around the world. Such shifting climate could be due to a result of the composition and intensity of solar radiation reaching the earth’s surface (Haigh, 2011) and solar variations over a longer period (Cubasch, et al., 1997). However, reports also suggest that from 1979 to 2015, anthropogenic activities could be responsible for about 55% of the fuel aridity across
western US forests, and that has increased the wildfire potential in recent decades. However, the increase in temperature has not been uniform across the United States. In fact, temperatures in the Northwest Plains and Upper Midwest were actually cooler overall from 1991-2020 (Lindsey, 2021). Whichever is the driving mechanism, shifting might have contributed to warmer and drier conditions facilitating wildfire risk, frequency, and intensity (Abatzoglou and Williams, 2016; Borunda, 2020). This article will focus on the recent unusually larger and intense global wildfires, and wildfires occurring in areas they rarely occurred before.

**Massive Wildfires Across the Globe**

**Wildfires in Western United States**

According to a report from National Interagency Fire Center (NIFC), as of August 26, 2021, 41,768 wildfires have burned over 4.8 million acres in the USA and 88 large wildfires were active in the states of Montana, Idaho, Washington, California, Oregon, Wyoming, Minnesota, Colorado, Nevada, New Mexico, Utah, South Dakota, and Michigan, scorching 2,436,690 acres of lands (Figure 1). California was being the most hard-hit as 11 large fires were burning through 1,354,625 acres of lands triggering an evacuation of over 42,000 people (NIFC, 2021).

**Dixie Fire in California**

At present, the Dixie fire (Figure 2) in the northwestern California is the largest forest fire burning in the US. This fire started on July 13, 2021, and by September 9, it was only 59% contained. Since then, this fire has consumed over 928,000 acres, destroyed the town of Greenville, burned more than 1,300 structures and threatened another 2,100 (CBSN, 2021) and caused over a billion dollars in damages. (Chediak, 2021). The fire was suspected to be sparked by an electrical problem. Currently, this is the largest single wildfire in California history, second to the August Complex Fire (several nearby fires merged into one) of 2020 (CDP, 2021, Chappell, 2021; Wolff, 2021) that burned through over a million acres (CDP, 2021).

According to Dr. Scott Stephen of Fire Science Laboratory at UC Berkeley, the extreme wildfires in California are mainly due to poor forest management policy - severe drought and hotter weather conditions only account for about 25% of the issue. Too much flammable undergrowth, high tree densities, and fire suppression policies are playing major roles in producing devastating Californian wildfires. Adequate prescribed burns and thinning out forest vegetation should help improve the current situation (Wolffe, 2021).

According to an NBC News report of August 9, 2021, excessive heat waves that were sweeping across the western US (San Francisco to the Washington-Canada border), could rise 20^0 F above the average summer-time temperature. and set new records. Extreme droughts caused by such high temperatures and low humidity could further worsen the current wildfires and ignite new ones (Lewan and Prociv, 2021).

**Bootleg Fire in Southern Oregon**

The Bootleg Fire in southern Oregon (Figure 2) that started in early July of 2021, was fully contained in mid-August (Ives et al., 2021) after destroying 413,000 acres (Freda, 2021). This fire started by lightning strike and is another disastrous wildfire in western US history in the summer of 2021. The fire burned for 39 days on 650 square mile area and was fought by approximately 2,000 fire fighters. As of August 16, 2021, other 29 large wildfires were burning in Oregon and Washington, consuming 887,069 acres, and involving over 8000 firefighters (Hallman, 2021).
Wildfires in Southern and Western Canada

Canada contains about 9% of the world’s forests and is prone to wildfires during the summer months. As of mid-July of 2021, Canadian Interagency Forest Fire Center has recorded a total of 3,925 wildfires. In 2021, wildfires showed up early and they were more frequent and forceful as compared to previous years. In Canadian provinces of British Columbia (BC), Ontario, Alberta, Manitoba, and Saskatchewan, intense wildfires aided by record high temperatures have caused significant property damages and triggered forced evacuations. The fire situation in BC was more consequential than the other provinces (Aziz, 2021). On July 29, 2021, BC observed a temperature of 118° F, the highest temperature ever recorded in BC (Gabbert, 2021).

Hot and dry weather conditions have prompted a year of higher-than-average wildfire activities in BC. On July 29, 2021, BC recorded 248 active wildfires that prompted evacuation orders. Between April and mid-August 2021, wildfires burned over 4,500 sq. kilometers in BC (Gabbert, 2021). On August 16, 2021, BC had 268 active wildfires intensified by high winds prompted over 6,000 properties under evacuation orders (Brown et al., 2021). According to another report from Canadian Wildland Fire Information System, in 2021, over 13,000 square miles have been burned in BC, Manitoba, and Ontario (Dixon, 2021).

Another report showed that intense heat prompted wildfires in Lytton, a town about 150 miles northeast of Vancouver where temperature reached 121° F, which was a Canadian record. Fire consumed the entire town (Diaz, 2021). Experts say, drought and extreme heat and lack of rainfall leading by shifting climate might be responsible for such unprecedented fire situations in Canada.

Wildfires in Southern Europe

Southern Europe is struggling with deadly forest fires aided by one of its worst heat waves. Fires have burned vast forest areas into ashes, caused forced mass evacuations and immobilized the tourist industry. In southern coast of Turkey and neighboring Greek mainland and islands, uncontainable wildfires sustained by strong winds forced overnight evacuations. In August 2021, Turkey evacuated thousands of people by land and sea overnight. Over 180 fires burned hundreds of square miles of forests, causing massive injuries and deaths (Kitsantonis and Specia, 2021).

The prime minister of Greece cautioned the public of record-breaking heat and fires. Intense fires in Greece were massive in dimensions and intensity. According to a fire service spokesperson, as of August 5, 2021, 120 fires were burning across Greece. One large fire alone, destroyed scores of homes and thousands of acres of forest in Athens, Greece. On August 6, 2021, Greece’s public was cautioned that intense winds could further aggravate
the fire situation. According to European Forest Fire Information System, in 2021, wildfires have burned 681, 424 and 403 square miles in Turkey, Greece and Italy, respectively (Dixon, 2021). Also in 2007, intense wildfires in Greece killed scores of people (Kitsantonis and Specia, 2021).

Figure 2: (A) Dixie Fire the largest single wildfire in California history, Credit: AP Photo/Noah Berger; (B) Bootleg Fire of southern Oregon, Credit: KATU2/ABC News; (C) Fire burning in British Columbia, Canada, Credit: BC Ministry of Transportation; (D) Wildfires across Yakutia, Siberia, Russia, Credit: Reuters: Roman Kutukov; (E) Wildfire burned area in Mugla, Turkey, Credit: Yasin Akqul/AFP/Getty Images; (F) Wildfire in Limni, Greece, Credit: NurPhoto/Getty Images.

Wildfires in Russia

Russia is experiencing the hottest and driest summer since the end of the 19th century (Dixon, 2021), and Moscow has observed the hottest month of June in 120 years when temperature reached 94.46° F (The Guardian, 2021). According to Associated Press (AP), many scientists consider that shifting climate had triggered the record high temperature in Russia, caused the permafrost to melt, and triggered hundreds of wildfires (AP, 2021).

In Siberia, wildfires are not uncommon, they occur as an annual cycle of the Siberian wildlands. However, in 2021, due to extreme drought, hot weather and strong winds, Siberian wildfires were intense (AP, 2021; Dixon, 2021), sustained an unusually high temperature of 102° F and the heat waves aided triggering hundreds of wildfires which already have burned over 3.7 million acres of Siberian lands (The Guardian, 2021).

Yakutsk, the capital of Yakutia, Siberia (also known as the Republic of Sakha), is known to be the coldest city in the world with the lowest temperature (-83° F) ever recorded. According to the governor of Siberia's Yakutia region, in 2021, Yakutia experienced the driest and hottest summer in 150 years (Johnson, 2021). In July 2021, the city was found to be covered with smoke clouds from nearby wildfires, facilitated by weeks of heatwaves and strong winds (Kottasova, 2021). This smoke was likely to contain dangerous levels of pollutants such as benzene, hydrogen cyanide, ozone, and particulate matters.

According to Greenpeace (2021), since the beginning to August 2021, wildfires have burned more than 62,300 square miles in Russia. Copernicus (the European atmospheric monitoring agency) reported that the smoke from the Siberian wildfires drifting across the Arctic and North Pole covering more than 2 million square miles (Dixon, 2021). Mark Parrington, a senior scientist at the European Centre for Medium-Range Weather Forecasts, stated that this year's fires in Siberia...
already had emitted more carbon than some of the previous years (The Guardian, 2021), contributing to heat trapping greenhouse gases and leading to further catastrophic consequences. These wildfires also have raised concerns about further thawing the permafrost and peatlands and releasing carbon stored in the tundra (The Guardian, 2021).

For the past three years, Siberia is being confronted with devastating wildfires releasing enormous amounts of carbon dioxide in the atmosphere, and some scientists have suggested that the warming trend in Siberia is a climate crisis (Troianovski and Heitmann, 2021). According to a report published in August, Siberian wildfires were reported to be larger than all combined wildfires in the US, Canada, Greece, Turkey, and Italy (Dixon, 2021). The ABC News also reported that the Siberian wildfires were bigger than all other fires in world combined (Reevell, 2021).

**DISCUSSION AND CONCLUSIONS**

In 2021, massive wildfires were reported across the world (Abatzoglou and Williams, 2016; Aziz, 2021; Diaz, 2021; Dixon, 2021; Johnson, 2021; Kitsantonis and Specia, 2021; Kottasova, 2021; Reevell, 2021). This year has been phenomenon in rising extreme weather conditions and devastating wildfires. In the western part of the USA, large wildfires are common. However, the year 2021 has been exceptionally active in wildfire occurrences. According to National Interagency Fire Center, by mid-August, 40,474 wildfires burned 4.0 million acres in the USA as compared to 35,878 fires that burned 2.4 million acres in 2020 (NIFC, 2021). Around this time, 197 large wildfires were reported in 13 states alone. The states of Montana, Idaho, Oregon, and California experience some of the most devastating wildfires (III, 2021).

Studies indicate that for decades the earth’s climate is changing, and the warming trend is reported in multiple studies (Hansen et al., 2012; Abatzoglou and Williams, 2016; Borunda, 2020; Chow and Skinner, 2021; Raghuraman et al., 2021; UN, 2021). While most scientists agree that the climate is getting warmer, the mechanism of climate change is debated. It has been long discussed that the composition and intensity of solar radiation reaching the earth’s surface could influence the regional and global climates (Haigh, 2011) and solar variations over a longer period could influence a larger climate variation (Cubasch, et al., 1997). On the other hand, anthropogenic activities also have been implicated for climate change. In a recent paper published in Nature, the researchers measured the Earth Energy Imbalance (EEI) during 2005-2015. EEI is the difference between the energy Earth absorbs from the sun and the amount it emits back into the space. Using climate model simulations, the authors argued that it is extremely unlikely (with < 1% probability) that the change in Earth’s temperature is caused by internal variability, and it is rather primarily influenced by human activities (Raghuraman et al., 2021). Similarly, a comprehensive report published in August 2019 by United Nations (UN) Intergovernmental Panel on Climate Change, also echoed the very similar concern (UN, 2021). Whether the climate change is due to fluctuation of solar radiation or by anthropological activities, or a combination of both, changing climate is real and the Earth is gradually warming up, and this phenomenon could be responsible for widespread drought and heatwaves aiding the devastating wildfires occurrences across the globe.

**ACKNOWLEDGEMENTS**

The authors would like to acknowledge Rakeen Zaman at Bagley College of Engineering, Mississippi State University, USA, for his valuable assistance with the graphics presented in this paper.

**REFERENCES**


ABSTRACT

A pond is one of the freshwater bodies described as a lentic freshwater body. This study was conducted on a pond located at Alcorn State University close to the University main gate. Our previous studies on water quality or pollution have involved lotic bodies of water, namely, Rivers and Creeks. The purpose of this study is to determine the quality of the water in the pond near the Alcorn State University main gate and to find out if it meets the Mississippi Water Quality Criteria (MSWQC). Water samples were collected two times during February and March of 2016 from 3 different locations. The water samples were taken to the Biology laboratory and tested chemically according to methods described in the LaMotte water pollution detection kits supplied by Carolina Biological Supply Company. There were 10 chemical tests conducted and the results were averaged, recorded, and analyzed. Also, the water samples were cultured on nutrient agar and MacConkey agar to detect coliform bacteria. The physical characteristics checked, showed that the water was colorless, odorless and transparent (not turbid). The chemical tests showed that the pond water met the MSWQC except for alkalinity, carbon dioxide, hardness and phosphate. Although the water met most of the MSWQC, the biological tests showed that the water contained coliform bacteria and is therefore polluted.

Key words: water quality, pond, Alcorn State University, Mississippi.

INTRODUCTION

Water in a freshwater pond does not flow like water in a river, and is described as a lentic freshwater body. It is also considered a surface water body as opposed to underground water. Ponds are a lot like vegetable gardens. Vegetables need a rich soil with a balanced pH and ample nutrients for growth. So do ponds. If the pond is skewed, or if nutrients are limited, you tend to get poor growth of fish (where this is a catfish pond) as observed by Neal (2021).

A freshwater body has a water with little or no salt as opposed to marine water with salt hence this is a study on a lentic freshwater body, a pond, located on the campus of Alcorn State University and close to the University Main Gate (Figure 1).

We have conducted several water quality or pollution studies on lotic bodies of water (flowing water) both within the State of Mississippi such as on Lower Mississippi River (Acholonu and Harris, 2011), on Pascagoula River (Acholonu and Hopkins, 2014), on Mud Island Creek and Coles Creek (Hopkins and Acholonu, 2015) and on Big Black River (Acholonu and Vaughan, 2015). and outside the State such as on Freshwater bodies in New Orleans, LA (Acholonu and Jenkins, 2007); on surface waters of Houston and Galveston (Acholonu and Owens, 2012), on River Nworie in Owerri, Imo State Nigeria (Acholonu, 2016). (See Table 1 for a complete list)

The previous studies focused on water pollution or water quality involving lotic bodies of water, namely, rivers and creeks. The purpose of this study was to determine the quality of the pond near Alcorn State University Main Gate, and to determine if it meets the Mississippi Water Quality Criteria (MSWQC). In addition, a comparison is made between the lentic body of water with studies conducted on lotic bodies of water.
Figure 1 (top row) Photographs of the front gate entrance to the Alcorn State University Campus, and (bottom row) aerial footage demonstrating the location of the freshwater lentic pond (31°52’27.1” N, 91°08’14.3” W); (yellow arrow).
## Table 1: List of Most Water Quality Studies Done on Lotic Bodies of Water

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Study Title and Reference</th>
</tr>
</thead>
</table>
MATERIALS AND METHODS

Study Location

This study was conducted on a pond located near the main gate of Alcorn State University (Figure 1). Going into the campus, the pond is on the left side, and near the Tennis Courts and within the Willie Mae Latham Taylor Park. Figure 2 shows a panoramic view of the pond.

Sample Collection

Water samples were collected two times during February and March of 2016 from three different locations about 50 meters apart (Figure 3). The samples were taken to the Biology Laboratory and tested chemically as was done in previous studies (Acholonu and Jenkins 2007; Acholonu and Hopkins 2014) and according to the methods indicated in the LaMotte Water Pollution kits supplied by Carolina Biological Supply Company. There were 10 chemical tests conducted and the results were recorded, averaged, and analyzed. The physical characteristics were also checked and recorded. In addition, the water samples were cultured on nutrient agar and MacConkey Agar to detect coliform bacteria, a biological test. The results were confirmed by running the Lauryl Tryptose Broth Fermentation tests.

Figures 3A- A student collecting water samples. Note the student wearing a hip boot (see arrow) to be able to collect water at a deeper level (Figure 3B) Dr. Acholonu and the Environmental Biology class at collection site.
RESULTS

The physical characteristics showed that the water was colorless, odorless, and transparent (not turbid). The chemical tests showed that the pond water met the MSWQC except for alkalinity, carbon dioxide, hardness, and phosphate (See Table 2 and Fig. 4). The biological tests showed the presence of coliform bacteria (See Figure 5), and confirmed with the Lauryl Tryptose Broth Fermentation Tests (See Figure 5).

Table 2: Chemical Parameters of the pond Tested and Results. (All test results are in parts per million (ppm))

<table>
<thead>
<tr>
<th>Characteristics/chemical parameters</th>
<th>Trip #1</th>
<th>Trip #2</th>
<th>Average</th>
<th>MSWQC/EPA STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity*</td>
<td>130</td>
<td>120</td>
<td>125</td>
<td>3.08</td>
</tr>
<tr>
<td>Ammonia-Nitrogen</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>10</td>
</tr>
<tr>
<td>Carbon Dioxide*</td>
<td>30</td>
<td>25</td>
<td>27.5</td>
<td>10</td>
</tr>
<tr>
<td>Copper</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>8.85 - 6.28</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>6.0</td>
<td>8.0</td>
<td>7.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Hardness*</td>
<td>80</td>
<td>68.7</td>
<td>74.4</td>
<td>50</td>
</tr>
<tr>
<td>Iron</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Nitrate</td>
<td>2.2</td>
<td>1.1</td>
<td>1.65</td>
<td>10</td>
</tr>
<tr>
<td>pH</td>
<td>8.5</td>
<td>6.5</td>
<td>1.65</td>
<td>5.6 – 9</td>
</tr>
<tr>
<td>Phosphate*</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Physical characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odor</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>Colorless</td>
<td>Colorless</td>
<td>Colorless</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>Clear</td>
<td>Clear</td>
<td>Clear</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Chemical Parameters of the Pond Tested and Results. (All test results are in parts per million (ppm))
### TABLE 3. Parameter test results from the pond that exceeded the MSWQC and those of some MS lotic bodies of water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alkalinity</th>
<th>Carbon dioxide</th>
<th>Hardness</th>
<th>Phosphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acholonu et al. 2021 Pond in ASU</td>
<td>125.0</td>
<td>27.5</td>
<td>74.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Acholonu and Hopkins 2014 Pascagoula</td>
<td>70.0</td>
<td>20.1</td>
<td>95.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Acholonu and Vaughn, 2015 Big Black River</td>
<td>53.7 (Fall)</td>
<td>4.3</td>
<td>57.0</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>24.4 (Winter)</td>
<td>2.0</td>
<td>22.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Hopkins and Acholonu 2015 Mud Island Creek</td>
<td>129.1</td>
<td>28.1</td>
<td>104.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Coles Creek</td>
<td>73.1</td>
<td>17.7</td>
<td>78.4</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Table 4. Biological test result of pond water and those of some MS lotic bodies of water.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acholonu et al. 2021 Pond in ASU</td>
<td>Polluted</td>
</tr>
<tr>
<td>Acholonu and Hopkins 2014 Pascagoula</td>
<td>Polluted</td>
</tr>
<tr>
<td>Acholonu and Vaughn 2015 Big Black River</td>
<td>Not Done</td>
</tr>
<tr>
<td>Hopkins and Acholonu 2015 Mud Island Creek</td>
<td>Polluted</td>
</tr>
<tr>
<td>Coles Creek</td>
<td>Polluted</td>
</tr>
</tbody>
</table>
Figure 5 Coliform Bacterial growth from collected water sample from the pond indicative of water pollution, and confirmed using the Lauryl Tryptose Broth Fermentation test which confirms a polluted water source (white arrow gas bubble).

**DISCUSSION AND CONCLUSION**

One of the objectives of this study was to find out if the pond located in the campus of Alcorn State University met the MSWQC. Another is to find out if it is polluted. Based on the findings, it can be concluded that the pond water met the MSWQC except for the four pollutants mentioned above, namely, alkalinity, carbon dioxide, hardness and phosphate. It is, in addition, biologically polluted. Evidence of the presence of coliform bacteria is an indication that pollution mainly caused by fecal contamination from warm-blooded animals including humans is there (Acholonu and Hopkins 2014)

Since this is our first study on a pond water, we have established a baseline data and recommend that more of this kind of study be conducted by subsequent investigators.

A comparison between the pond water and some of the lotic bodies of water we previously surveyed showed the following: The contaminant, alkalinity, from the pond is 2nd highest of all surface waters studied. Carbon dioxide is also the 2nd highest. Hardness is the 3rd highest, and phosphate is the 2nd highest. Based on these findings, there was no unusually high contaminant concentration in the pond water (See Table 3) Also the biological tests showed that both the pond water and the other lotic bodies of water surveyed, were polluted except for one where the biological study was not conducted (See Table 4). We see no plausible explanation for these kinds of results, and it must be noted that while contaminants in lotic water can move with the running water and vary from time to time, those in pond water may not vary as much but rather remain suspended. This is the reason why pond contaminants need to be monitored from time to time especially when it is a catfish pond. What may alter the concentration of contaminants in the pond may be rainwater, runoffs getting into the pond and human factors.

A review of literature shows that several water quality studies have been done on lotic surface water bodies in Mississippi such as rivers, streams, estuaries and even lakes (lentic water bodies). For example, Caffey et al. (2002); Mississippi Department of Environmental Quality (2018); VanderMeuler (2019); Myers et al. (2020). However, comparatively few have been done on ponds, especially in Southwestern Mississippi. The few, include studies by Neal et al. (2016), Neal (2021) and Avery (2021). It is thus recommended that more pollution studies be conducted on pond water in this area and its water quality monitored periodically, especially as catfish is produced from ponds(catfish ponds) in Mississippi and Mississippi is the greatest producer of catfish in the US (Dickson (2021). More attention should be paid to catfish ponds and their water quality, and this should be
monitored periodically especially for parameters of concern and in so doing, help to ensure that the State of Mississippi continues to be the highest producer of catfish and heed the observation made by Neal (loco. cit.) in which he said that ponds are a lot like vegetable gardens.

ACKNOWLEDGMENT

We are grateful to Dr. Donzell Lee, the then Executive Vice President and Provost of Alcorn State University for his financial assistance in the procurement of materials and supplies for this investigation.

We are also grateful to some of the students of the Environmental Biology Class who participated in the running of some tests. Grateful acknowledgement is paid to Dr. Frank Mrema, Department of Agriculture, ASU and Prof. Robert Sizemore, Department of Biology, ASU for reading over the manuscript and offering useful suggestions.

LITERATURE CITED


## SUMMER SCIENCE & ENGINEERING SYMPOSIUM| 2022

**Organized By:** Mississippi Academy of Sciences and Mississippi State University  
**Venue:** Mississippi State University, Bost Conference Center Mississippi State, (Starkville Campus), MS 39759

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- Dr. Jason Keith, Co-Chair  
- Dr. Scott T. Willard, Co-Chair  
- Dr. Ham Benghuzzi, MAS Divisional Advisor

### Program Committee
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  Mississippi State University  
- **Local Arrangement Coordinator:** Dr. Raju Bheemanahalli  
  Mississippi State University  
- **Awards Committee Coordinator:** Dr. Michelle Tucci  
  University of Mississippi Med Center

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- Mississippi State University’s  
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Dr. Loston Rowe, Indigo Ag.
My Magnificent Journey in Ag Science and Technology

Loston Rowe was raised on a family farm near West Point, MS. After graduating from Aberdeen High School, he attended Mississippi State University, earning both bachelor’s and master’s degrees in the Dept. of Plant and Soil Sciences. He then went on to complete his Ph.D. in Weed Science/Herbicide Physiology in the Crop and Soils Sciences Department at Michigan State University. Dr. Rowe started his professional career with the agricultural products division of the DuPont Company. Over his storied career with DuPont, he held numerous professional and leadership positions in research, product development, sales, and marketing.

Dr. Rowe currently works as grower relations executive with Indigo Ag. Indigo is an ag tech startup company based in Boston, Mass., and has the mission to improve grower profitability, environmental sustainability, and consumer health by using natural microbial-based products, along with digital cloud-based technologies. In his role with Indigo, Dr. Rowe manages the company’s collaboration efforts with strategic farmer partners across the US.

Dr. Rowe realizes that agricultural sciences and food production impacts each one of us every single day. Throughout his career, he has worked to improve student awareness of the many exciting careers in ag and has mentored numerous young professionals into the ag industry. Dr. Rowe was recently named the inaugural recipient of Michigan State University’s Diversity, Equity, and Inclusion Award, which recognized his professional accomplishments, service, and contributions to diversity within agriculture. Dr. Rowe also has served on the Mississippi State University CALS Advisory Board, as well as being named a Mississippi State University Alumni Fellow. He, along with his siblings, established the James Robert and Betty Rowe Endowed Scholarship at Mississippi State in honor of their parents.

Dr. Rowe currently resides in the Memphis, TN area with his wife, Rita, who is a fellow Bulldog graduate.
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ABSTRACTS

3-MINUTE ORAL PRESENTATIONS (3M-O)

3M-O01 CURRENT SPECIES DISTRIBUTION MODEL FOR AMERICAN CHESTNUT (CASTANEA DENTATA) IN MISSISSIPPI STATE

Segun Michael Adeyemo, Joshua Granger
Department of Forestry, Mississippi State University, Mississippi State, MS

Castanea dentata is an economically and ecologically important multifunctional tree. The modeling of existing habitat suitability for American chestnut (AMC) in the 82 counties of Mississippi State, with a total area of 12,544,406 hectares is motivated by the species scarcity in Mississippi states. The modeling process used forty-one (41) occurrence records, which were verified and filtered to remove any duplicates. Due to the scarcity of AMC stands in Mississippi, data on occurrences was gathered through the United States Department of Agriculture (USDA) Forest Service contact. ArcGIS was used to create the pseudo-absence (by = 1000) as the absence data. 19 bioclimatic variables from WorldClim with a 30-seconds spatial resolution, USGS National Elevation Dataset with one arc-second resolution with 30 m resolution, and soil pH and soil sand content (%) from SSURGO database with 30 m resolution were used as predictor variables. All the predictor variables listed were resampled to the same resolution and extent using the ‘resample’ function in the raster package in RStudio. The Variance Inflation Factor (VIF) was calculated in RStudio using the usdm package’s ‘vifstep’ function with a threshold of 10 to eliminate the multicollinearity problem, and 9 variables were chosen for the model. Bio 2, bio 4, bio 5, bio 8, bio 9, bio 13, bio 14, bio 15, bio 16, bio 19, per Sand, Soil PH, and DEM variables were selected. usdm function was adopted to define the model formulation which includes the data (species presence and pseudo-absence data as well as the predictor variables), the methods (generalized linear model – ‘glm’, boosted regression trees model – ‘ranger’, random forest model – ‘rf’, support vector machine classifier – ‘svm’, and maximum entropy – ‘maxent’), and the settings for the data evaluation where subsampling techniques was used with 2 replicates for each method. For model evaluation, true skill statistics (TSS) and area under the ROC (receiver operating characteristic) curve (AUC) scores were used. To reduce bias and offer a relative assessment of the relevance of each predictor variable across all selected modeling algorithms and improve prediction accuracy, the ensemble modeling method was utilized to combine all five methodologies. The AMC’s predicted habitat suitability was divided into five categories, ranging from "not suitable" to "very suitable". The final habitat suitability prediction showed that all five algorithms had TSS and AUC ratings of more than 0.9, which were assembled. The historic natural range of AMC habitat suitability in Mississippi is significantly reduced, and the model result indicates that the maximum temperature of the warmest month is the key factor contributing to the reduction in its natural range.

3M-O02 SPATIAL AND TEMPORAL VARIATION IN SOCIAL DETERMINANTS OF HEALTH (SDH) AND COVID-19 RELATED HEALTH OUTCOMES IN THE UNITED STATES.

S M Asger Ali, Kathleen Sherman-Morris, Qingmin Meng, Shriniidhi Ambinakudige
Department of Geosciences, Mississippi State University, Mississippi State University, Mississippi State, MS

Since the outbreak in early January 2020, COVID-19 has been responsible for more than 88 million cases and 976 K deaths across the United States. The death toll put the United States at another tragic milestone as the number surpassed the deaths caused by the 1918 flu. The pandemic, however, did not similarly affect the whole United States and studies showed that the health impact related to COVID-19 significantly varies with socio-economic and demographic characteristics. In this study, we have examined the spatial pattern of COVID-19 in the USA and its associations with Social Determinants of Health (SDH) by utilizing County Health Rankings & Roadmaps (CHRHR) dataset. Using Geographic information systems (GIS), GeoDa, and SPSS, we conducted exploratory and spatial regression between cumulative COVID-19 cases and deaths based on three periods: 1) January 20, 2020 – June 30, 2021; 2) July 1, 2021 – November 30, 2020; and 3) December 1, 2021 – April 30, 2022. The findings of our analysis revealed significant hotspots of cumulative cases and deaths across the lower south-east and upper north-west USA. Our analysis also showed significant associations between SDH variables and COVID 19-related health outcomes. For example, the percentage of adult smoking, prevalence of diabetes, adult obesity, residential segregation and population older than 65 were significantly associated with both cases and deaths in all three periods. Our analysis demonstrated the usefulness of SDH in predicting the spatial burden of COVID-19 disease and mortality in the USA.

3M-O03 FACTORS INFLUENCING FRUIT-EATING FISH DIVERSITY IN THE AMAZON BASIN

Karelld Viviana Coronado
Wildlife, Fisheries and Aquaculture Department, Mississippi State University, Mississippi State, MS

Introduction: The interaction between fruit-eating fishes and flooded forest plants is very ancient in South America, dating back to the Late Cretaceous. Almost half of all the fish species that consume fruits inhabit South American wetlands (up to 150 of 275). The synchronicity between fruiting and the flooding season to facilitate seed dispersal by water or fish and that during lengthy flooded seasons, fishes spend ~ 87% of their time in floodplain habitats are part of the evidence of the close relationship between flooded forests and frugivorous fishes. However, it is not clear yet what are the factors that sustain the high diversity of frugivorous fishes in the Amazon River basin. Objective(s)/Hypothesis(es): The aim of this work is to assess the influence of variables such as flooded forest diversity, flooded forest extent, white-water river proportion, and elevation on the frugivorous fish species in the Amazon River basin. We expect that all the predictor variables have a positive relationship with frugivorous fish richness except for elevation, as lower elevation values relate to more floodable areas, providing habitat for the fishes. Methods: The area of study corresponds to the Amazon River basin. The units of analysis were sub-basins (n=144). We used occurrence data for frugivorous fishes from the Amazon Fish Database. We calculated vegetation diversity using occurrence data for tree species present in the floodplain forest retrieved from GBIF. We used the floodplain delineation database compiled by Nardi et al (2019) to estimate the flooded forest extent.
White-water river proportion was retrieved from SNAAP. Elevation data for each spatial analysis unit was extracted from a Digital Elevation Model with 90m spatial resolution (Saatchi, 2013). To test our hypothesis we performed a Generalized Linear Model, using the Poisson distribution. Results: The results of the GLM showed that vegetation richness, flood extent area, and white-water river proportion have significant effects on frugivorous fish diversity (p<0.001). However white-water proportion has a negative relationship, while vegetation richness and flood extent area showed a positive relationship with frugivorous fish diversity. Implications/Conclusions: The results, in part, supported our hypothesis that more diversity in vegetation could offer more diversity of food resources for frugivorous fishes and that a more extensive flood extent area is associated with providing habitat for fishes around forests. This study provides valuable information for a better understanding of the intricate relationship between forests and fish that can be used to inform conservation strategies in the Amazon region.

3M-O04 AN APPLICATION OF H2O AUTOMATED MACHINE LEARNING IN SOIL CARBON MAPPING

Jannatul Ferdush, Zia Ahmed, Varun Paul, Shrinidhi Ambikadigude, Padmanava Dash
Department of Geosciences, Mississippi State University, Mississippi State, MS

Soil carbon (SC) comprises the largest terrestrial pool of the global carbon cycle while being frequently disturbed by several environmental factors. Most of the previous studies focused on soil organic carbon (SOC) for digital soil mapping, but a combined study with soil total carbon (STC) and inorganic carbon (SIC) is rare. Though the Machine Learning (ML) algorithms can predict SC variability with a high level of performance, most of the approaches skirted the model’s key insights and local interferences, namely “Black Box”. In this study, Explainable artificial intelligence (XAI) on a stack ensemble model through H2O Auto ML was performed to visualize STC, SIC, and SOC variability with the hypothesis that using model agnostic techniques can improve the explainability of SC maps and address the “Black Box” issue. The addition of residuals with the stack ensemble of six base learners performed relatively better than the normal stack ensemble, with 54%, 45%, and 52% improved RMSE for STC, SIC, and SOC, respectively. Land cover type, soil pH, total nitrogen, and vegetation index were identified as the top four crucial factors for predicting SOC, whereas bulk density, precipitation, soil pH, and temperature described IC. A combined impact of soil, climatic, and environmental variables was assumed to be responsible for heterogeneous local variability. The H2O Auto ML algorithms used in this study can be utilized to predict and potentially future C loss under diverse climate conditions and allow diverse knowledge groups to adopt a new interpretable ML algorithm with a better understanding.

3M-O05 MOLECULAR CLONING AND EXPRESSION PROFILING OF RYANOXIDE RECEIVER, A TARGET OF DIAMIDE INSECTICIDES, IN SOYBEAN LOOPER, CHRYSOIDEIXIS INCLUDENS

Sena Ishbilir, Beverly Catchot, Fred R. Musser1, Seung-joon Ahn1
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The soybean looper (Chrysodeixis includens) (Lepidoptera: Noctuidae) is one of the most deteriorating pests of soybean due to its defoliation damage and reported to be responsible for 16% of total insect damage in soybean in Mississippi. Diapase insecticides such as chlorantraniliprole have been successful to manage the pest for more than a decade. However, field cases with failure of diapidamides against soybean looper have increased the possibility of resistance development, leading us to study the molecular mechanism of the diamide resistance in soybean looper. We cloned the full-length sequence of Ryanoxide receptor (RyR) gene which encodes an intracellular Ca²⁺ channel in muscle tissues. Since the gene has a long coding sequence, we took a strategy to subclone partial sequences and then to combine them later, resulting in an extraordinarily long coding sequence (15,360 kb). In addition, we assessed the RyR gene expression levels in different tissues and developmental stages, comparing 10 different larval tissues and six different developmental stages, respectively. Ultimately, we treated the insecticide, chlorantraniliprole, against third instar larvae by feeding to measure the gene induction levels. Further studies are currently running in order to understand the molecular mechanisms of the diamide resistance in this pest species.

3M-O06 SOCIAL AND SPATIAL INEQUITY OF ACCESS BETWEEN TRANSIT AND AUTO TRAVEL MODES ACROSS AMERICA

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This study examines the Modal Access Gap (MAG) between transit and automobile modes to employment in the 45 most populated American Metropolitan Areas. We calculate auto and transit access to employment and augment it with data from the American Community Survey and the Smart Location Database. We employ a Spatial Lag Model to explore sociodemographic and built-environment correlates of MAG and the bivariate local indicator of spatial association to create cluster maps to offer a way to assess the spatial equity of MAG as it relates to carless households. The findings indicate that: (1) regardless of the travel-time threshold, the automobile has an advantage over transit in providing access to opportunities, (2) block groups with low MAG are concentrated and clustered in the Central Business District, (3) Millennials and car-free households are more likely to reside in areas with lower accessibility gap to employment, and (4) areas with high access gap and high proportion of carless households have a higher percentage of African Americans and low-income households. We recommend using the bivariate spatial autocorrelation analysis to identify areas where the gap in accessibility and proportion of households without vehicles can be used to identify areas of unusually high or low combinations of these variables. This combination is then used to prioritize different planning actions. We also show that this spatial identification captures racial and economic differences in the underlying population and can help address inequities in accessibility, particularly in high access gap, high carless areas.

3M-O07 MECHANISTIC ROLES OF LYSR-TYPE TRANSCRIPTIONAL REGULATOR IN VIRULENCE AND ADAPTATION OF LISTERIA MONOCYTOGENES VIRULENCE

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Listeria monocytogenes is an important foodborne pathogen that is well adapted to survive in wide environmental niches owing to many transcriptional regulator proteins encoded by its genome. Among these proteins are genes encoding uncharacterized LysR-type transcriptional regulators (LTTRs). The LTTRs are integral as either activators or repressors of gene expression associated with amino-acid metabolism, nitrogen fixation, oxidative stress, biofilm formation, and virulence. This study aimed to explore the contribution of 1031 encoding LTTRs in L. monocytogenes virulence. To achieve this, F2365Δ1031 mutant was constructed by gene deletion in L. monocytogenes strain F2365, and in-vivo virulence activities and stress responses were tested. After 3 days post-infection, bacterial burdens of the wild-type F2365 strain in the spleen and liver were significantly higher than those mice infected
with F2365A1031. The expression of lysteriolysin O protein and phospholipase activities were significantly lower in the F2365A1031 mutant than in the wild-type. Furthermore, the 1031 gene negatively impacted the biofilm and plaque formation, but the intracellular replication shows no significant reduction compared to the wild-type. The loss of 1031 significantly impacts the glucose and nitrogen utilization, whilst the mutant showed better utilization of nitrogen from glutamine source than from ammonium sources. In the presence of oxidative stress mediated by 6mM, 8mM, and 10mM H2O2, F2365A1031 mutant significantly adapts better than the wild-type. This study is the first to demonstrate the association between the 1031 gene and virulence in L. monocytogenes. This regulator can be a useful target for vaccine and drug development against listeriosis.

3M-O08 DROUGHT AND HEAT STRESS EFFECTS ON SOYBEAN YIELDS
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Climate change has increased the frequency of heatwaves and periods of prolonged drought spells in most soybean-growing areas globally. The co-occurrence of heat and drought during pod filling can cause significant yield and quality losses in soybeans. However, information related to combined stress effects on the genetic potential is limited. In this study, ten soybean cultivars grown under non-stress conditions were subjected to four different treatments (100% irrigation) characterized as natural growing conditions, heat (38 °C daytime), drought (50% irrigation), and heat and drought (38 °C+50% irrigation) during pod filling stage. Individual drought or heat and combined stress treatment-induced changes in yield (pod number, pod weight, seed number, seed weight, 100-seed weight) components and quality (protein and oil) compositions were quantified. The average of all measured parameters was lower in the combined stress treatment relative to the control treatment. The pod weight was reduced by 48%, pod number was reduced by 35%, the number of seeds by 42%, and seed weight by 43% under combined heat and drought stress compared to that under control. The seed protein and oil content were negatively correlated in soybeans. Both heat and drought stress resulted in a marked reduction in yield and quality components; drought resulted in more damage than heat stress. Understanding the reproductively, physiological, yield, and quality responses of soybean to interactive stress would assist in breeding soybeans with improved tolerance to future unfavorable climates.

3M-O09 THE FUNCTION OF TOP1 AND TOP2 THIMET OLIGOPEPTIDASES IN CONTROLLED PROTEOLYSIS UNDER THE INNATE IMMUNE RESPONSE
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Proteolysis is an irreversible protein posttranslational modification essential for regulating numerous physiological and pathological processes. Complete proteolysis contributes to the maintenance of cellular proteostasis through protein degradation and turnover. Controlled proteolysis produces peptides with biological activity and emerges as a regulatory process of plant immunity. The repertoire of plant bioactive peptides remains largely uncharacterized. Thimet oligopeptidases (TOPs) are conserved metalloendopeptidases and critical components of the effector-triggered immunity (ETI) that mediated by infection with P. syringae carrying AvrRpt2 effector. Differential analysis facilitated the characterization of functional changes associated with TOPs activity and generated TOPs substrate candidates for in vitro screening. Peptides increased in abundance in top1top2 plants compared to wild-type. Out of these, 21 were screened to act as bioactive peptides, and 13 were selected for testing. WT and top1top2 plants were grown in the presence or absence of peptides and challenged with Pst avrRpt2, followed by bacterial growth quantification. Plants treated with two APX1 peptides had compromised ETI. These results indicate that peptides generated through controlled TOP proteolysis contribute to ETI.

3M-O10 IMPACT OF DROUGHT STRESS AT DIFFERENT PHASES OF CORN DEVELOPMENT
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Water demand by corn plants varies depending on crop growth and development stages. Low rainfall or insufficient soil moisture content can affect plant health and physiological processes and potentially causes a reduction in ear size. The risk of potential yield loss due to drought stress often occurs around the reproductive stage by damaging the reproductive and grain filling events. Therefore, drought stress tolerance in corn can only be improved by understanding how the corn plant responds to stress at different phases. Independent experiments were performed to quantify the impact of drought on several morph-physiological and yield-associated phenotypes. We used the pot-culture facility to develop functional relationships between moisture content and early-season vigor traits. Corn was exposed to five levels of soil moisture treatments (100%, 80%, 60%, 40%, and 20% of irrigation) at the V2 growth stage for 28 days. The canopy temperature of control-grown plants had a 5 °C cooler canopy than stressed plants. A decrease in soil moisture content decreased plant functional traits (stomatal conductance and transpiration), plant height, leaf number, and biomass. An increase in anthocyanin and flavonoid content with reduced chlorophyll content was recorded. Further, corn exposed to drought stress (40% irrigation) decreased stomatal conductance and increased leaf temperature during grain filling. On average, there was a decrease of 64% in grain yield in the drought-stressed plant compared to control (100% irrigation). Knowledge of corn physiology and growth responses to drought stress at critical growth stages is necessary to develop climate-resilient cultivars for future climatic conditions.

3M-O11 TEMPERATURE EFFECTS ON THE SHOOT AND ROOT GROWTH, DEVELOPMENT, AND BIOMASS ACCUMULATION OF CORN
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Temperature is a critical environmental factor regulating plants’ growth and yield. Corn is a major agronomic crop produced globally over a vast geographic region, and highly variable climatic conditions occur spatially and temporally throughout these regions. Current literature lacks a comprehensive study comparing the effects of temperature on above versus below-ground growth and development and biomass partitioning of corn measured over time. An experiment was conducted to quantify the impact of temperature on corn’s early vegetative growth and development. Cardinal temperatures (Tmin, Topt, and Tmax) were estimated for different aspects of above- and below-ground growth processes. Plants were subjected to five differing day/night temperature treatments of 20/12, 25/17, 30/22, 35/27, and 40/32 °C using sunlit controlled environment growth chambers for four weeks post-emergence. Corn plant height, leaves, leaf area, root length, surface area, volume,
numbers of tips and forks, and plant component part dry weights were measured weekly. Cardinal temperatures were estimated, and the relationships between parameters and temperature within these cardinal limits were estimated using a modified beta function model. Cardinal temperature limits for whole plant dry weight production were 13.5 °C (Tmin), 30.5 °C (Topt), and 38 °C (Tmax). Biomass resources were prioritized for the root system at low temperatures and leaves at high temperatures. Root growth displayed the lowest optimum temperature compared to root development, shoot growth, and shoot development. The estimated cardinal temperatures and functional algorithms produced in this study, which include both above and below-ground aspects of plant growth, could be helpful to update crop models and could be beneficial to estimate corn growth under varying temperature conditions. These results could also be applicable when considering management decisions for maximizing field production and implementing emerging precision-based spatial technologies.

**3M-O12 A GLUCOSE-CONJUGATING ENZYME THAT IS HIGHLY EXPRESSED IN THE SILK GLANDS OF MOTHS**

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Uridine diphosphate glycosyltransferase (UGT) is a multigene family of enzymes responsible for catalyzing glycosylation of small molecules. These enzymes participate in the detoxification of xenobiotics and biotransformation of endobiotics, where glucose conjugation increases the water solubility of lipophilic aglycone compounds. The latest genomic analysis of the corn earworm (Helicoverpa zea), a serious agricultural pest species feeding on numerous economically important plants, identified 45 different UGT genes. We found a UGT gene (UGT34) showed high levels of expression exclusively in the silk gland tissue, a tissue which is not believed to be directly involved in detoxification, but was not expressed in the other tissues, such as central nervous system, guts, fat body, and Malpighian tubules. Quantitative and real-time PCR were used to analyze the expression levels of UGT34 in different instar stages and silk gland sub-segments. This revealed that UGT34 is relatively expressed at all instar levels and prominently expressed in the middle and posterior subsegments of the silk glands. Additionally, the same analysis was carried out on a different Noctuidae moth species, the soybean looper (Chrysodeixis includens), resulting in similar gene expression trends, suggesting an important role of UGT34 in the silk glands of moths. RNA interference (RNAi) was utilized in this study but found to be unsuccessful in determining UGT34 function. Silk plays a critical role in feeding, protecting, and metamorphosis in many lepidopteran species. Altogether, the present study implies that UGT34 plays an important role in silk glands, yet its molecular and physiological function is being explored.

**HIGH SCHOOL STUDENT POSTERS (HG-P)**

**HS-P01 UTILIZING A CONSUMER- GRADE UAV TO MONITOR CORN GROWTH**

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Approximately 60% of the annual rainfall occurs outside of the crop growing season in Mississippi State. A large amount of rainfall has resulted in severe soil erosion on farmlands. This problem causes degradation of soil health and water quality through runoff. To resolve this issue, growers intend to plant cover crops after harvest to hold soil and nutrients. This study is aimed to monitor corn growth and development for investigating the effects of cover crops and poultry litter. A consumer-grade unmanned aerial vehicle (UAV) with a digital camera were flown over two fields for multiple days during the cover crop growing season and after the corn emerged. The experiment fields are located at the Mississippi Agricultural and Forestry Experiment Station in Pontotoc County, Upper Coastal Plain Region, Mississippi State. By using Pix4Decapure (Pix4D S.A., Prilly, Switzerland) to plan UAV missions, a series of red-green-blue (RGB) images were acquired. The images were then processed on Pix4Deload (Pix4D S.A., Prilly, Switzerland) to create orthomosaic images that fully cover the experiment fields. The normalized difference photosynthetic vigor ratio (NDPVR) images were created; as a result, the values of each experimental plot were extracted using QGIS (https://qgis.org/en/site/). The NDPVR data were used to compare corn growth in different plots with and without cover crops or poultry litter. The results indicated that there is a positive association between corn growth and cover crops or poultry litter. This study suggested that cover crops and poultry litter could enhance corn growth in the humid region.

**UNDERGRADUATE STUDENT POSTERS (UG-P)**

**UG-P01 ASSESSING THE INFLUENCE OF BIOGEOGRAPHY ON SOIL MICROBIAL COMMUNITIES**

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Soil microbial communities are the major drivers of the agroecosystem, mainly aboveground biotic communities, plant species diversity and productivity. Microbial communities differ substantially between the soil types and under different land management systems. Understanding the variable influence of soil microbial community composition on seedling establishment is important for early seedling growth and development. The focus of this study is to understand how the soil microbial diversity and their interactions with soil factors contribute to specific soil functions. In this study, to assess the differential microbial communities, ten soil samples with different soil characteristics were collected across the state of Mississippi. Sample locations were chosen with a wide range of natural and cultivated systems, including farms, forests, Prairies, edge of the abandoned lime pit, parent materials, slope classes and undisturbed lands. The top 0–10 cm soil samples were collected and homogenized during sampling to create a composite sample for each sampling site. The collected soil samples were stored in a cooler, transported to the laboratory, and stored at -20°C. Further, to evaluate the distinct soil microbial communities, the soil slurries of each sample will be prepared using sterile phosphate-buffered saline (PBS) and live microbes will be confirmed by plating the soil slurries on LB agar media. Finally, the community level physiological profile of the soil will be analyzed using Biolog Ecoplates. This metabolic profile will be used to analyze the environmental influence of each soil on the microbial communities and subsequently the soil functions.

**UG-P02 HAPTOGLOBIN AS A MEASURE OF INFECTION PROGRESSION IN A RAT MODEL OF IMPLANT-BASED OSTEOMYELITIS**

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Orthopedic disease or trauma causes a complex immunological response, inducing changes in circulating immune cells and proteins...
Large bone defects often require reconstructive procedures and are most commonly caused by trauma, congenital disorders, or cancer. Current treatments for bone injuries are limited due to a finite supply of donor bone for bone grafting procedures. Additively manufactured, or 3D printed, bone scaffolds have the potential to alleviate this problem and allow for patient specificity in scaffold geometry and material composition. A bone scaffold made of poly(lactic-co-glycolic acid) polymer and nanohydroxyapatite ceramic would have the advantages of being biodegradable, readily available, and mechanically strong for application in load-bearing bone. A current challenge in 3D printing bone scaffolds is the development of protocols that ensure repeatability in the size and shape of the scaffolds. In this experiment, scaffolds were 3D printed using a CELLINK BIOX2 printer which controls temperature, pressure, and speed of printing. To examine the accuracy of the printed scaffolds to their as-designed geometry, an analysis of images collected via three imaging modalities was performed. Layer-by-layer images were collected during printing via a camera attachment on the printer. Additionally, micro-CT scanning and surface profilometry were performed post-printing to capture 3D volumes and surface topology, respectively. The in-print images were compared to the post-printing images, to offer insight into the accuracy of the print and to inform selection of printing parameters. The next steps in this research will be to analyze images for various printing parameters. This work is important in alleviating the current limitations in bone defect repair and would be an advancement towards personalized medicine.

UG-P05 HIGH-THROUGHPUT METHOD FOR PHENOTYPING SEED QUALITY COMPOSITION IN CORN AND SOYBEAN

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Seed quality of corn and soybean are directly related to plant-human health and international trade. Over the years, genetic enhancement of seed quality traits has been neglected due to a lack of high throughput screening tools. Traditionally, laboratory-based destructive seed quality (protein, oil, starch, and other) measurement methods are laborious, expensive, and time-consuming. The newly developed Near-Infrared Reflectance Spectroscopy (NIRS) helps phenotype many samples for quality traits without seed grinding possible. This study examined the genetic variability in soybean and corn's seed compositions (protein, oil, and starch) using the NIR DA7250. NIRS reproduces highly consistent scans, which indicates the accuracy of the high throughput instrument in detecting variations in seed quality compositions. Soybean (10 genotypes) and corn (27 genotypes) showed a wide range of diversity in seed composition. Soybean seed contains 36.0% to 40.6% protein, 20.6% to 22.7% oil and 1.2% to 2.5% starch. Similarly, we investigated natural variation in seed quality composition of corn genotypes. Mature corn seed starch varied from 54.5 to 63.8 %, followed by protein (10.1 to 15.3 %) and oil (2.9 to 5.1 %). Starch in mature corn seeds was negatively correlated with protein ($r = -0.70, p<0.05$). A positive correlation was noted between protein and oil ($r = 0.60, p<0.05$). These results indicated the accuracy and reliability of the high-throughput approach in capturing the genetic variability of composition traits in corn and soybean crops.

UG-P06 MORPHOLOGY, BEHAVIOR, AND LIFE CYCLE OF THE HIBISCUS SAWFLY, ATOMACERA DECEPTA (HYMENOPTERA: ARGIDAE)

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Atomacera decepta, commonly known as the hibiscus sawfly, is considered a minor pest, but it feeds on the foliage of several ornamental plants, including hollyhocks, rose mallows and some other Hibiscus plants, turning it to a lacy skeletons of leaf veins. Such a voracious appetite of the sawfly is an interesting mode of feeding among different herbivorous insects. However, little is known about this insect species. The purpose of this research is to collect basic data of its morphological and behavioral characteristics and to provide better understanding for future research. Discovering characteristics of A. decepta has been performed through a few projects. (1) Morphological features of larvae and adults were investigated by observational examinations and scanning electron microscope (SEM). (2) Observations of live sawflies in the natural habitat as well as in the lab were conducted to grasp their basic behaviors and life cycle. (3) The larvae were dissected to find out what internal organs might be involved in allv299@msstate.edu defensive mechanism. (4) Finally, the whole body transcriptomes were obtained by Illumina HiSeq2000 for the future investigation on digestive and detoxifying enzymes in larvae. As a result, this project has provided clearer information about this less-studied insect, but, at the same time, gave an opportunity for more questions to be addressed. A basic understanding of A. decepta characteristics would pave a way for future research on its digestive physiology and defensive chemistry.

**UG-P07 EFFECTS ON PRODUCTION, WELFARE AND BEHAVIOR ON LAYERS TRANSFERRED FROM A CAGED TO CAGE-FREE ENVIRONMENT**

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A six-week study was conducted to evaluate the behavior, welfare, and production effects on laying hens with a history of cage system after being transitioned to a cage-free environment. A total of 84 Hy-Line W-36 laying hens at the age of 70-weeks were used in the experiment. Each pen consisted of seven birds and contained identical littered floors, waterlines with nipple-drinkers, hanging feeders, and wooden perches. Furthermore, each pen also contained a Hikvision® Night Vision camera to observe the behaviors of the hens at various points of time during the day. Hens were adapted for one week for acclimation to the cage-free environment. The production performance data calculated were the following: feed consumption (FC), hen day egg production (HDEP), hen day egg mass (HDEM), and feed conversion ratio (FCR). The production performance data was analyzed as a completely randomized design (CRD) comparing with weeks as a factor, with PROC GLM procedure SAS 9.4. Furthermore, four welfare evaluations were also conducted throughout the trial evaluating the paw, comb, and feather scores. Welfare data was analyzed with PROC FREQ procedure and subjected to Fisher’s Exact test. Feed consumption (FC) slowly increased post-adaptation through the 73rd week of life, thereafter, FCR-g began at 1.90 and increased to a ratio of by the 74th week. There were no differences in HDEP, HDEM, and average egg weight. The positive increase in dust-bathing behavior after the transfer, or an increase in infighting due to lower amounts of feed present at this time. Comb lesion percentage remained at 5.78% through the first two scoring evaluations, but steadily decreased to 3.95% by the final evaluation (P=0.0733). Thus, as indicated through the welfare results, post-adaptation welfare for hens decreases for comb and feathers, as birds become adjusted to one another and the environment. The focus of energy usage may have shifted from that of constant egg production to body maintenance due to age. Furthermore, four additional weeks were observed to give hens the time required to increase feed consumption and properly convert it. As consumer preference towards alternatively produced eggs in the market becomes more prevalent, further extensive studies that evaluate welfare become more essential to continue the growth of the egg industry.

**UG-P08 DOES SEED SIZE AFFECT GERMINATION UNDER CHILLING STRESS IN COTTON?**

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The current cotton planting dates in Mississippi are often exposed to temperatures above optimum and low rainfall during the peak flowering and boll formation. These challenges can partially be alleviated by adopting early-season planting. However, seedling emergence percentage and post-emergence seedling vigor are hampered by early-season planted cotton due to chilling weather. Under chilling conditions, the seed must be able to germinate and become established. This poses the question of whether seed size has any effect on germination under chilling conditions. This study aimed to evaluate the impact of cotton seed size on germination under chilling stress to explore the relationship between seed size and germination under chilling stress. We measured the seed size variations using cotton cultivars accessible to producers and suitable for production in the U.S. southern region. A wide range of variation in 100-seed weight (7.3-10.5 g) was observed among the cotton cultivars. Using the seeds available in their commercial form, including the seed treatment, germination ability parameters are being measured as a function of seed size under optimum (28 °C) and chilling (18 °C) temperature conditions. Additionally, measured radicle and plumule lengths will be used to explore the relationships between seed size and seed vigor on chilling tolerance. A cotton cultivar with the highest seed germination percentage and fitness traits might provide opportunities for farmers to shift planting dates towards cooler temperatures.

**UG-P09 INVASIVE AQUATIC PLANT SPECIES DETECTION ON NVIDIA JETSON NANO USING DEEP LEARNING AND COMPUTER VISION**

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Invasive aquatic plants are vulnerable to the infestation and uncontrolled spread of invasive aquatic plant species. Such species, if left unchecked, can hinder the growth of native plants as well as animals in that ecosystem. Sometimes floating invasive plants like water hyacinth can displace native submerged plants and co-dependent wildlife entirely by blocking the necessary sunlight for photosynthesis and suitable temperature and disturbing vital gaseous exchange between water and air, making it toxic. The solution to this problem is to correctly identify and treat these plants with suitable herbicides, however, doing so is a very time-consuming and labor-intensive task. It requires highly skilled personnel with knowledge and experience with identifying such invasive plants, and there are only a few that have the time and
resources to do it. With machine learning methods getting traction in almost every field, it can be very useful in automating the detection and identification of invasive plants as well. There are only a handful of research that aimed at using deep learning for plant species identification. The aim of this project was to put together a detection tool implementing deep learning algorithms and computer vision techniques to detect and identify 8 most commonly found invasive species in Mississippi’s wetland ecosystems. This was achieved using a micro controller called Nvidia Jetson Nano (nano) running deep learning models like Convolutional Neural Network (CNN) and Resnet-18 that were trained over 1600 hand-taken images of those 8 plant species. Moreover, Mobilenet-ssd was used as the detection architecture for live detection with the help of a low-resolution camera connected to the nano. Once fully optimized, this tool can be deployed on automated robots like crawlers, water boats, or even drones to do real-time detection and identification of each invasive plant in the vision frame.

**GRADUATE STUDENT POSTERS (GS-P)**

**GS-P01 COUPLING CLIMATIC AND OCCURRENCE DATA TO UNDERSTAND AND PREDICT ANNUAL SURVIVAL OF REDBANDED STINK BUG**  
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The non-native redbanded stink bug (RBSB), Piezodorus guildinii (Westwood), (Hemiptera: Pentatomidae), first emerged as an economically important pest of soybean in Louisiana in 2000. Drivers of interannual fluctuations in the distribution of RBSB populations are poorly understood, but such fluctuations may depend on the cold tolerance of overwintering RBSB, a chill susceptible species. Using geospatial analysis of climate data, cold tolerance metrics, and occurrences of RBSB across the southeast over the past two decades, we examined the relationship between winter weather and RBSB presence in the southeastern United States. We hope these efforts improve annual forecasts of economically significant RBSB populations across soybean growing regions of the Southeastern United States.

**GS-P02 ASSESSING THE RELATIONSHIP BETWEEN SOIL HEALTH AND SURFACE RUNOFF WATER QUALITY IN THE MISSISSIPPI DELTA**  
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Enhancing soil health and understanding its interaction with the environment is essential due to its potential impacts on crop productivity, nutrient cycling, and water quality. The goal of this study is to explore relationships between soil health and runoff water quality from agricultural fields, under different management scenarios in a Mississippi Delta watershed. A soil/health quality index was determined using the Soil Management Assessment Framework (SMAF). Nine (9) soil health indicators (aggregate stability, microbial biomass carbon, soil organic carbon, bulk density, beta-glucosidase enzyme, Mehlich 3 extractable phosphorus and potassium, electrical conductivity and pH) were selected to compute the SMAF based on the soil data collected by the USDA-ARS National Sedimentation Laboratory in Beasley Lake Watershed near Inverness, MS. Runoff water samples from fields managed under row crops, vegetative buffers, or Conservation Reserve Program (CRP) were analyzed for the years 2008 and 2012. Preliminary results showed that soil health quality improved for all management treatments in 2012 as compared with 2008. There was a significant reduction in orthophosphate-P and total Kjeldhal nitrogen measured in surface runoff in 2012 relative to 2008. These surface runoff water quality parameters were positively correlated with the soil quality/health indicators aggregate stability (R=0.56), and microbial biomass carbon (R=0.85), respectively. Overall, areas managed under CRP had higher soil health indicators and improved runoff water quality, while row crops fields had the lowest indicators, those management practices that improve soil health have a benefit on runoff water quality in agricultural landscapes of the Mississippi Delta.

**GS-P03 GLOBAL DIETARY AND HERBAL SUPPLEMENT USE DURING COVID-19 - A SCOPING REVIEW**  
**Ishaan Arora, Rahel Mathews**  
Food Science Nutrition and Health Promotion, Mississippi State University, Mississippi State, MS

The lack of effective treatment options for COVID-19 has raised many concerns among populations in its first two years, prompting many attempts to find alternative options to prevent the disease from spreading or to slow the progression of the infection. The aim of this scoping review is to summarize dietary supplement use in the general public published to date, during COVID-19 pandemic. A systematic search was conducted in December 2021 following PRISMA guidelines. PubMed, ERIC, and Scopus databases were searched, and 956 results were screened for eligibility. Fourteen cross-sectional studies from 11 countries and 3 continents were examined. All studies were large population surveys investigating healthy eating and supplement use during COVID-19. Vitamin C, vitamin D, zinc, and multivitamins were the most widely reported, as well as natural/herbal products such as ginger and honey. The most common reason cited for supplement use was to strengthen the immune system and to prevent infection of COVID-19. These studies reported that populations are relying on healthcare providers, family, friends, and social media to learn about supplement use. Future studies on the treatment of COVID-19 should

**GS-P04 ROLE OF BRANCHED-CHAIN FATTY ACIDS IN LISTERIA MONOCYTOGENES PATHOGENESIS**  
**Q M Monzur Kader Chowdhury**, Seto Ogunleye, Shangshang Wang, Thu Dinh, Mark L. Lawrence, Hassam Abdelhamied  
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Listeria monocytogenes is a food-borne bacterial pathogen that can survive and multiply in a wide range of temperatures, including refrigerators in food storage. The ability of L. monocytogenes to survive at low temperatures leads to frequent recalls of contaminated food products and fatal outbreaks of listeriosis. A critical mechanism that enables L. monocytogenes to grow at low temperatures is the ability to retain its normal membrane fluidity through branched-chain fatty acids (BCFA) synthesis. Branched-chain α-keto acid dehydrogenase (BKD) plays a vital role in BCFA biosynthesis pathway. BKD is a multi-subunit enzyme complex composed of four polypeptides: a dihydrolipoamide dehydrogenase (E3), a dehydrogenase (E1α), a decarboxylase (E1β), and a dihydrolipoamide acyltransferase (E2) encoded by lpd, bkdA1, bkdA2, and bkdB gene respectively. We constructed BKD deficient L. monocytogenes strain by in-frame deletion method. Our result showed that BKD is required for full L. monocytogenes virulence in mice, growth kinetic at lower temperatures by maintaining membrane fluidity, and plaque formation in L2 fibrobactin. Furthermore, locking PrfA in its “active” conformation (PrfA+) restored the wildtype phenotype (virulence, cold tolerance, BCFA composition, and membrane fluidity) in Bkd-deficient strains. This
result indicates that PrfA* allows the BKD-deficient strain to bypass the biochemical step that requires BKD for the biosynthesis of BCFA under relevant host conditions. It is not fully understood how PrfA*, a regulator that enables virulence, would influence BCFA biosynthesis. Further study will investigate this mechanism. This study demonstrates a novel role of PrfA and BKD complex inлистерial pathogenesis, which may provide insight into the development and application of antimicrobial agents.

GS-P05 PHENOTYPIC CHARACTERIZATION OF SOYBEAN CULTIVARS FOR HEAT AND DROUGHT STRESS TOLERANCE
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Soybean production is projected to face a significant impact of climate changes, with an increased frequency of heatwaves occurring along with periods of prolonged drought spells. The coincidence of these stressors during pod filling is expected to affect the yield and quality of soybean. We hypothesized that the soybean cultivar with individual drought or heat stress tolerance might not show the combined stress tolerance. To address this hypothesis, we (i) quantified yield and quality traits responses of soybean under control (100% irrigation+32°C daytime temperature), drought (50% irrigation), heat (38°C daytime temperature), and combined stress (38°C daytime temperature +50% irrigation) conditions; (ii) compared the tolerance score of soybean cultivars across the stress treatments. All cultivars’ yield components and quality (protein and oil) composition varied under stress treatments compared to the control. Averaged across soybean cultivars, the magnitude of the decrease followed the order of heat stress < drought stress < combined stress for the seed yield per plant. The pod weight was reduced by 48%, pod number by 35%, seed number by 42%, and seed weight by 43% under combined heat and drought stress compared to that under control. The seed protein and oil contents were significantly affected in response to treatments. Drought stress had a greater impact on yield compared to heat stress. Stress susceptibility index in heat or drought did not show a significant correlation with combined stress, indicating that the selection of soybean for individual stress might not perform under combined stress conditions.

GS-P06 DESIGN OF A PERFUSION-COMPRESSION BIOREACTOR FOR EVALUATING IMPLANT OSSEOINTEGRATION
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Mechanical loading in vivo is necessary for new bone formation leading to successful implant osseointegration. Our objective is to develop a perfusion-compression bioreactor system that will apply a physiologically relevant perfusion flow and mechanical compression regime to study implant osseointegration in vitro. The system consists of a bioreactor chamber, a perfusion flow set-up, and a mechanical loading frame. The bioreactor chamber is equipped with inserts allowing for specimens of varying sizes to be cultured. A bioreactor chamber capable of maintaining a large bone explant (d=10 mm, h=7 mm) allows for enough tissue to examine the effects of mechanical stimuli while preserving the native bone matrix and tissue integrity. A peristaltic pump perfuses culture media throughout the bioreactor chamber, inducing stimulatory shear stresses on the specimen and facilitating nutrient exchange and waste removal from the culture environment. On the aluminum and steel loading frame, a captive stepper motor linear actuator in line with a micro load cell allows for dynamic compression of the specimen and recording of the applied force. A custom LabVIEW program allows for force feedback control of the stepper motor actuator. Future work will involve the addition of a Linear Variable Differential Transformer (LVDT) to monitor explant displacement during compression. The perfusion-compression bioreactor system can be used to guide orthopedic implant design, reduce the need for animal models in initial implant osseointegration studies, and further our understanding of how differing mechanical loading regimes affect implant osseointegration.

GS-P07 LEAF MASS PER AREA, NITROGEN, AND δ15N REFLECT PHOTOSYNTHETIC CAPACITY, WATER, NITROGEN USE, AND TRADEOFFS ACROSS EASTERN COTTONWOOD AND HYBRID POPLARS
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Eastern cottonwood (DD) and six taxa of Populus hybrids (P. deltoides × P. maximowiczii (DM), P. deltoides × P. nigra (DN), P. deltoides × P. trichocarpa (DT), P. trichocarpa × P. deltoides (TD), P. trichocarpa × P. maximowiczii (TM), P. deltoides × nigra × maximowiczii (DN+M)) were selected and planted at two sites in the southeastern U.S. to select most productive and high water use efficiency (WUE) taxa and clones. During the first growing season, gas exchange and stable isotope carbon and nitrogen were measured in July. We found that under a low nitrogen site (Monroe site, 0.49 mg/g of N), DD exhibited the highest leaf nitrogen content (LNC) and WUEiso than some Populus hybrids. In contrast, under high nitrogen site (Pontotoc site, 1.06 mg/g of N), some of the hybrids exhibited higher LNC and WUEiso than DD. Although gas-exchange data calculated WUE were positively and significantly correlated with WUEiso, different patterns of WUE across DD and hybrids were observed. LNC was significantly and positively correlated with WUEiso, different patterns of WUE across DD and hybrids were observed. Drought stress is one of the major abiotic stresses. Moreover, climate change may also lead to increase the intensity, duration and frequency of drought stress. Silicon has recently been recognized as an important element in plant nutrition. In our previous study, it has been shown that supplying soybean with soluble silicon in the soil could improve vegetative growth and biomass production under water limiting conditions. However, the mechanism how silicon alleviates water deficit stress is not understood. Moreover, the previous studies do not have enough information about the interaction of silicon with chloroplast proteins. In this study, we examined the effects of silicon application on chloroplast proteins expression.
plants were cultivated in pots containing soil supplied with 2 millimolar solution of sodium silicate. Equal amounts of sodium chloride were used to reverse the effects of sodium along with control plants. Intact chloroplasts were isolated from the leaves of silicone-treated and control plants exposed to water stress. Proteins were then extract from isolated chloroplasts. Two-dimensional gel electrophoresis and mass spectrometric approaches were used to identify differential chloroplast proteins in response to silicon application under water deficit stress. Proteins that shown differential expression in response to silicon application include photosynthetic proteins and enzymes. These results suggest that silicon application could affect enzymes important for photosynthesis and stabilize photosynthetic proteins and enzymes under water deficit stress.

GS-P99 AUTOMATED MEANS FOR WOOD FAILURE PREDICTION
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The current method for estimating wood failure using the American Society for Testing Material ASTM D5266-13 (2020) standard is highly subjective, requiring visual evaluation and mental estimation, and having made only minor advancements over the years. Additionally, various techniques have been proposed with the goal of improving the current protocol. However, none of them have been accepted as an accurate method by ASTM. Convolutional neural networks (CNN) have been demonstrated as a robust and trustworthy method for classifying, detecting, and segmenting objects in images in many different fields. To the best of our knowledge, there is no study to estimate wood failure using CNN. The overarching goal of this research is to use artificial intelligence/machine learning (AI/ML) to estimate wood failure in bonded three-ply hardwood plywood from mechanical shear strength specimens. The CNN approach needs to be accurately trained and validated with different parameters, namely wood and adhesives types, to be able to correctly generalize and predict truly unseen data. In preliminary experiments, we created a CNN based on the SegNet network. We trained and validated our approach with custom manufactured plywood. Shear specimens were prepared and tested. Pictures of 99 shear bonded areas were taken. These pictures were processed to create input masks from the failed areas. Eighty (80) pictures and input masks were used for training, and nineteen (19) for validation. The CNNs’ prediction was tested on the validation set using four metrics and achieved accuracy = 0.99, F1-Score = 0.99, Matthew’s Correlation Coefficient (MCC) = 0.98, and Jaccard Index (J) = 0.98. The next step of this research involves increasing the dataset and comparing the CNN’s prediction with external evaluators’ results. The major expected outcome of this research is that AI/ML will provide support to the wood composites industry, with a tool that estimates real wood failure with fast and highly accurate results, and with limited subjectivity.

GS-P10 CUTTING PROPAGATION OF SWEETBAY MAGNOLIA
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Sweetbay magnolia (Magnolia virginiana) is native to the southeastern United States, as well as areas in Pennsylvania, Delaware, Maryland, New York, New Jersey, and Massachusetts. It can survive from hardiness zones 5 to 9. Propagation of sweetbay magnolia from vegetative cuttings has been noted to be difficult among the different cultivars. Two studies were conducted in order to provide growers with relevant cutting propagation recommendations. The first study, conducted in 2020, was to determine if basal wounding and/or hormone source would improve rooting of sweetbay magnolia cuttings when treated with a basal quick dip in a range of indole-3-butyric acid (IBA) concentrations. The auxin formulation applied was Hortus IBA (Hortus IBA Water Soluble Salts™). The interaction between basal wounding and level of auxin had no significant effect on any data parameter collected. Basal wounding alone had no significant effect on any data parameter collected. Auxin level did not have a significant effect on growth index or cutting quality. Root percentage, root number, root quality, and average root length (of three longest roots) were all significantly affected by auxin level. Overall results suggest that dipping sweetbay cuttings in Hortus IBA at 5000 ppm, 7500 ppm, 10000 ppm, regardless of basal wounding, will result in a higher quality liner. Building off the findings of the 2020 study, a second study was conducted in 2021 to determine if auxin application method and/or propagation substrate could further improve rooting of sweetbay magnolia cuttings. Treatments included two substrates (100% pine bark or 100% perlite) and six methods of auxin application (no auxin, quick dip, single over-the-top spray, single over-the-top spray with surfactant, multiple over-the-top sprays, and multiple over-the-top sprays with surfactant). The auxin formulation applied was Hortus IBA (Hortus IBA Water Soluble Salts™) at a concentration of 10000 ppm, as per the results of the first study. After treatment application, cuttings were inserted into 12 cm containers and placed under intermittent mist. The interaction between substrate and auxin application method had no significant effect on any data parameter collected. Substrate alone had a significant effect on root number and root percentage, but no significant effect on average root length (of three longest roots) or root quality. Auxin application method did not have a significant effect on average root length (of three longest roots) or root number. Root percentage and root quality were both significantly affected by auxin level. Within the substrate types, auxin application method had a significant effect on root percentage in 100% pine bark, but not in 100% perlite. Auxin application method had no significant effect on root number of pine bark or perlite. Overall results suggest that sweetbay cuttings propagated into 100% pine bark with Hortus IBA 10000 ppm applied via a quick dip, single over-the-top spray, single over-the-top spray with surfactant or multiple over-the-top sprays, will result in a higher quality liner.

GS-P11 FUNGAL ACTIN SUSCEPTIBILITY TO THE ANTIFUNGAL OCCIDIOFUNGIN, USING S. CEREVISIAE SHUFFLE STRATEGY
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Occidiofungin is a novel antifungal with a broad spectrum of activity against yeast and filamentous fungi. Studies have identified actin, a highly conserved protein found in all eukaryotic cells, as its biological target. Comparing S. cerevisiae with C. glabrata and C. albicans, the ACT1 gene codes for a protein that shares 100% and 94% amino acid identity, respectively. Interestingly, previous studies have shown that C. albicans and C. glabrata exhibit a 2-4-fold resistance to occidiofungin relative to S. cerevisiae. This study aims to identify whether these amino acid differences in the ACT1 gene contribute to occidiofungin susceptibility. Using a haploid S. cerevisiae ACT1 shuffle strain in which the genomic copy of ACT1 was deleted but present on a URA3 plasmid, the functionality of ACT1 gene products from C. albicans and C. glabrata were analyzed. Functional complementation measured cell doubling time, actin protein levels, and nuclear positioning. Data indicates that cells expressing the ACT1 gene from C. albicans or C. glabrata exhibited characteristics indistinguishable from that of S. cerevisiae. Data for susceptibility to occidiofungin by minimum inhibitory concentration assays also indicate a similar sensitivity profile as S. cerevisiae. These finding suggests that amino acid
differences in the actin protein between S. cerevisiae and C. albicans are not responsible for the variances in occidiofungin sensitivity, which points to other factors contributing to these differences. Additional studies to include testing of ACT1 from other fungal organisms that require >10-fold higher concentrations of occidiofungin relative to S. cerevisiae will help strengthen these findings.

GS-P12 INEQUITY OF ACCESS TO EMPLOYMENT FOR SOCIALLY VULNERABLE POPULATION ACROSS AMERICA

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This study examines spatial mismatch for low-wage American minorities living in areas where transit offers better access to high-wage employment. The analysis has been conducted across the 50 most populated American metropolitan areas. We measure the spatial distribution of high and low-wage employment and then calculate Transit Access Gap between high and low-wage employment opportunities. This data is augmented with the socio-economic characteristics of residents to identify the areas of spatial mismatch. Four main findings are obtained. First, as the time threshold increases, the transit access gap between high-wage and low-wage employment increases. Second, transit provides better access to high-wage employment compared to low-wage employment. This indicates that the transit system not only fails to facilitate access to low-wage employment for socially vulnerable communities rather it acts as a catalyst to aggravate the spatial mismatch. Third, among different sociodemographic cohorts, African-Americans experience the highest spatial mismatch. In Rochester 50%, Hartfield 44%, and Philadelphia 42% of low-income African-Americans reside in areas where the transit system offers access to high-wage employment. Fourth, the ratio of the vulnerable population facing spatial mismatch to the vulnerable population who does not face mismatch is higher among the carless households compared to other sociodemographic groups. This ratio is higher in Dallas, Rochester, and Baltimore with 7, 5.6, and 4.7 values, respectively. This study offers a snapshot of how socially vulnerable communities experience spatial mismatch in America. It can, therefore, help to decrease social inequity by detecting areas in need of transit service improvement.

GS-P13 IMPACTS OF EARLY SEASON DROUGHT STRESS ON CORN GROWTH AND DEVELOPMENT

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Drought is a severe threat to agriculture production that affects all growth stages of plants, including corn (Zea mays L.). One of the significant factors associated with higher yield potential is seedling vigor at the early vegetative stage. To investigate how corn plants respond to drought stress at the early vegetative stage, we have performed additional studies to include testing of ACT1 from other fungal organisms that require >10-fold higher concentrations of occidiofungin relative to S. cerevisiae will help strengthen these findings.

GS-P14 PREDICTING YIELDS OF RAINFORED COTTON USING UNMANNED AERIAL SYSTEM DATASETS

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Cotton (Gossypium spp.) is the most economically important fiber crop grown in the southern U.S. and globally. Early yield prediction can provide information to make informed management decisions and estimate the market value more accurately. However, in-season yield prediction is challenging due to in-field variability in soil types and environmental variables. Most yield prediction studies have focused on ball counting within a portion of the field. This study evaluated the potential of using cotton fiber pixel area and plant height to predict the final cotton yields under rainfed conditions. A field experiment was conducted in 2021. An unmanned aerial vehicle (UAV) carrying a five-band multispectral sensor was flown at 60 m above ground level before crop harvest or at 153 days after planting (DAP). Similarly, a UAV-mounted LiDAR sensor was deployed to collect structural and topographic data. The multispectral imagery was used to extract the projected cotton fiber pixel area. A support vector machine algorithm was applied to the imagery to segment the cotton fiber pixel from the cotton canopy and background soil with an overall accuracy of 99%. Bare ground data collected using the LiDAR sensor was used to make a digital terrain model, and the LiDAR collected data at 153 DAP was used to create a crop surface model. Multiple linear regression was performed between observed cotton yield and projected cotton fiber area and plant height. Results showed a strong correlation ($r^2 = 0.82$, $p < 0.001$) between UAV-derived datasets and observed cotton yield at harvest.

GS-P15 IMPACT OF NITROGEN AND SULFUR APPLICATION ON YIELD AND QUALITY OF MISSISSIPPI CORN

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There has been a drastic decline in atmospheric industrial ejections due to an improvement in the SO2 pollution management strategies in the last two decades, reducing sulfur (S) deposition to soils. However, the soil S withdrawal is steadily increasing due to high yielding cultivars, low tillage intensity, increased use of fertilizer with minimal to no S. Therefore, to determine the corn yield response to S and N and their interactions in rainfed corn in Mississippi, studies were conducted at three different locations (Starkville, Brooksville, and Stoneville). Experiments were set up in a randomized complete block design with four replications with a decreased by 46% (P1316 YHR) and 40% (A6659 VT2RIB). Root to shoot ratio increased with decreasing soil moisture levels. This study improved our understanding of how corn plants adjust their physiology and shoot-root traits in response to varied soil moisture content. The functional relationships developed through this study can be used to create crop modeling, predict plant performance, and improve agronomic practices under stressful conditions. In addition, the phenotypic data generated from this study can help to prioritize traits associated with the early-season drought tolerance in corn.
total of 13 treatments each including a control. The treatments included multiple N and S rates. The optical sensors (SPAD, Crop circle, and Mica Sense) were used at each location to sense corn’s in-season N and S status at different growth stages. The results were variable across different locations where Stoneville showed significant yield response to N and S, Brooksville responded only to N, and Starkville corn yield was not affected by any fertilizer. The highest recorded yield was at rates (336 kg. N ha⁻¹ & 67 kg. S ha⁻¹) and (336 kg. N ha⁻¹ & 45 kg. S ha⁻¹) at Brooksville and Stoneville respectively. Within each N rate, non-significant incremental S trends were noted at Brooksville and Stoneville. Conclusively, it was found that the yield responses are location-specific and based on the local soil characteristics and health. Therefore, soil testing is suggested to make nutrient management decisions.

GS-P16 AGRONOMIC OPTIMUM NITROGEN RATE FOR MAIZE (ZE A M A I Z E L.) PRODUCTION IN MISSISSIPPI
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The variable influence of the environment on nitrogen (N) supply and demand dictate the need for yearly updated fertilizer N recommendations. Currently, crop yield goal (CYG) methods are used by 34 land grant universities, including Mississippi State University, which does not consider environmental variations. This research tested the efficacy of CYG by distinguishing the agronomic optimum N rate (AONR) and economic optimum N rate (EONR) for Mississippi corn production. A total of 12 treatments in 2020 and 11 in 2021 were replicated four times over four locations in a randomized complete block design. The optimums were calculated by fitting linear, quadratic, linear-plateau, and quadratic-plateau models by means of four different goodness of fit measures. Furthermore, differences between a calculated CYG rate using the Mississippi yield goal equation and AONR were compared. Overall, AONR varied from 134 kg ha⁻¹ to 252 kg ha⁻¹ at different management levels. When comparing the AONR to the CYG rate, the CYG rate would over recommend N in each of the possible comparisons with differences ranging from 4 kg ha⁻¹ to 93 kg ha⁻¹ greater than the AONR. Differences between AONR highlight variability caused by factors such as soil, environment, and their interaction with N supply and demand, which is unaccounted for by the CYG method.

GS-P17 GENOMIC DIVERSITY IN BERMUDAGRASS (CYNODON SPP.) REVEALED BY SINGLE NUCLEOTIDE POLYMORPHISMS
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The development of new cultivars and the advancement of bermudagrass breeding is hampered by a lack of information about genetic and phenotypic diversity in bermudagrass (Cynodon spp.). To exploit diversity in bermudagrass, a total of 206 common bermudagrass (C. dactylon var. dactylon) and African bermudagrass (C. transvaalensis) accessions of worldwide origin were assembled for this study. DNA sequencing libraries were prepared following the genotyping-by-sequencing (GBS) protocol with ApeK1 enzyme and sequenced with 101 bp single end reads on an Illumina Novaseq SP platform. With a minor allele frequency of 0.05 and a minimum call rate of 0.5, a total of 37,496 raw SNPs were called de novo using the UNEAK pipeline of TASSEL 3 standalone. Population structure was assessed by running the ADMIXTURE program ranging from 2 to 8 populations. The results of admixture found to be consistent with principal component analysis (PCA) and phylogenetic analysis. According to principal component analysis (PCA), PC1, PC2, and PC3 explained 15.6 %, 10.1 %, and 3.8 % of the genetic variance in the germplasm panel, respectively. The various genetic diversity parameters nucleotide diversity or average pairwise divergence (θ), estimated mutation rate or expected nucleotide diversity (θ), Tajima’s D statistic, and Fst statistic has been calculated to look at the genetic diversity. Genotypic data will greatly help in the genetic dissection of agronomic traits by genome-wide association studies (GWAS) in the future. Genomic diversity analysis revealed substantial amount of variation in the panel, demonstrate the overall potential of population for further genetic studies and its capability to generate new varieties in breeding programs.

GS-P18 EXPLORING THE MICROBIAL PROFILE OF RAW GOAT MILK FROM MISSISSIPPI FARMS AND UNDERSTANDING PRODUCER FOOD SAFETY PRACTICES AND PERCEPTIONS
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Currently, 30 states allow the sale of raw milk, including Mississippi, which imposes strict regulations that limit sales to very small farmers (n<9 goats). These regulations are largely management-based and not food-safety related. The objectives of this exploratory research were to analyze the microbial profile of raw goat milk from Mississippi farms and assess food safety practices and perceptions of dairy goat farmers in Mississippi to identify deficiencies and opportunities for improvement in raw goat milk safety. Raw milk samples (n=30) were collected by farmers using their everyday milking techniques and enumerated for pathogenic bacteria and fecal indicators. Pathogens are dangerous microorganisms that are often causative agents in foodborne outbreaks leading to human illness. Farm management and milk handling practices data was collected through a knowledge-based survey designed in Qualtrics and distributed through social media groups targeting dairy goat producers in Mississippi (n=29). Staphylococcus spp. was present in most (70%) milk samples but aligned with the drying-off period at the end of lactation. E. coli, Enterobacteriaceae, and coliforms were observed in 13.3%, 33.3%, and 40% of samples, respectively; no Salmonella spp. or Listeria monocytogenes were detected. The survey highlighted farmers’ need for educational opportunities on safe milk handling with an emphasis on handwashing and the effects of pasteurization. Most producers (80.8%) are willing to invest more in their farms, creating strategic opportunities for extension outreach to help with market expansion and sustainability. Overall, training accessibility could help producers nationwide by encouraging safe milk handling and best management practices.

GS-P19 IN EVALUATION ON THE EFFECTS OF ADDITIONS AND DELETIONS OF SPECIFIC NUTRIENT MANAGEMENT STRATEGIES ON CORN YIELD AT DIFFERENT PLANT DENSITIES
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Improved nutrient management strategies are needed to increase yield production and quality while maintaining soil health. The present study aimed to determine the suitable cultural practices for improved corn production in Mississippi. Two experiments were set up at Verona and Stoneville, MS, in a randomized complete block design with four replications. Treatments included row configurations (single and twin-row), plant populations (79074 and 98842 seeds ha⁻¹), and one included stepwise additions and other stepwise deletions of different nutrients. The nutrients tested were two nitrogen rates (235 and 314 kg N ha⁻¹), phosphorus (45 kg P ha⁻¹), potassium (60 kg K ha⁻¹), and sulfur (15 kg S ha⁻¹).
SPECTROSCOPY (PWS)

GS-P20 EGG SHELL STRENGTH IN THREE CAVITY-NESTING DUCKS IN MISSISSIPPI

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Wood ducks (Aix sponsa), hooded mergansers (Lophodytes cucullatus), and black-bellied whistling ducks (Dendrocygna autumnalis) are sympatric secondary cavity-nesting duck species in the southeastern United States. Interspecific clutches are common, eggs accumulate in nests from parasitic laying, and strife between females may occur, potentially subjecting eggs to breakage. Understanding the durability of eggs of these species is important for explaining variation in nest and egg hatching success. Our prediction was that eggshell breaking strength (EBS) of hooded merganser eggs would be the greatest among the three species. We collected a total of 67 fresh eggs of the species from nest boxes at two sites in Mississippi in spring-summer 2021. We measured eggshell strength using an Instron Universal Testing Machine (Model 3345; Instron Inc., Norwood, MA) and eggshell thickness using a micrometer (Ames, IA). We measured EBS (Newtons) at the equators of all eggs. We used Tukey’s pairwise comparison to test for differences in eggshell strength among species. Mean EBS differed among all species (P < 0.0001) and was greatest in hooded merganser, followed by black-bellied whistling duck and wood duck. The EBS was 120.05 (SD = 12.03, n = 7) for hooded merganser, 52.44 (SD =10.04, n=30) for black-bellied whistling duck, and 32.95 (SD =3.90, n = 30) for wood duck. Eggs of hooded merganser had the highest EBS, likely attributed to greater eggshell thickness among these species. Our results are preliminary, and further analyses will explore if eggshell strength correlates inversely with egg breakage in our study, and we will investigate mineral composition of eggshells for the three species.

GS-P21 OPTICAL PROBING OF STRUCTURAL ALTERATION OF BRAIN TISSUES IN PROGRESSIVE ALZHEIMER’S DISEASES USING PARTIAL WAVE SPECTROSCOPY (PWS)

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Alzheimer disease (AD) is the most common form of dementia, characterized pathologically by amyloid plaques and neurofibrillary tangles. One of the earliest overt signs of AD is a loss of cognitive function. It has been reported that AD affects the nanoscale structure of the brain cells which begins long before the cognitive symptoms appear. However, these alterations are undetectable in the initial stages with currently used bulk diagnostic techniques such as MRI and OCT. Thus, the elucidation of a neuroimaging method that can uniquely characterize these structural disorders at nanoscale is imperative for clinical diagnosis. Recently developed finer-focused partial wave spectroscopy (PWS) is a sensitive technique for probing nanoscale structural alterations in cells/tissues in terms of the average structural disorder strength. Results of PWS technique measurements of brain tissues from an animal model and human subjects show significant increase in the disorder strength with the progression of AD relative to their controls. The increased disorder strength can be explained by the higher mass density fluctuations caused by the rearrangements of macromolecules due to deposition of the amyloid beta protein and damage in DNA with progress of AD. This structural alteration may be reflected in other clinical parameters for early detection of AD and possible treatment.

GS-P22 DETERMINING THE EFFICACY OF OCCIDIOFUNGIN AGAINST CANDIA ALBICANS BIOFILM

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Biofilm formation is a complex process that involves cell attachment to a surface, colonization, and maturation. Candida albicans biofilm consists of a structured network of mixed cell morphotypes within an extracellular matrix complex (ECM). Heterogeneous cell layers within a protective ECM confers resistance against clinical antifungals. Targeting of morphologically diverse cells by antifungal agents may be key to biofilm prevention. The antifungal compound occidiofungin is effective against the yeast form of Candida species. Recent work has shown that occidiofungin also inhibits hyphae formation in C. albicans and C. tropicalis. Given these findings, we aim to determine whether occidiofungin can target the heterogeneous cell population found in Candida biofilms by measuring its efficacy at different biofilm stages and correlating these to changes in biofilm structure. C. albicans biofilms formed on silicon elastomer were used to determine the minimum concentration of occidiofungin required to eliminate cells at three stages of biofilm formation: attachment, initiation, and maturation. Antifungal efficacy was evaluated using an XTT assay to measure metabolic activity and CFU assay to quantify viable cells. XTT results indicate that occidiofungin targets cells at all stages of biofilm with a higher concentration required to eradicate cells in a mature biofilm compared to the attachment and initiation stages. CFU data confirms a reduction in viable biofilm cells. These combined results suggest that occidiofungin may be an effective antifungal agent for C. albicans biofilm-associated infections. Future plans include determining the impact of occidiofungin exposure on the architecture of biofilm by confocal and scanning electron microscopy.

GS-P23 EFFECT OF ALLELOPATHIC SWEET POTATO VARIETIES ON PALMER AMARANTH GROWTH: A GREENHOUSE STUDY

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The present study was conducted with 17 varieties of sweet potato to evaluate the allelopathic effect of sweet potato on the growth of Palmer amaranth (Amaranthus palmeri). The study was conducted in the Department of Plant and Soil Sciences greenhouse at Mississippi State University, MS, under controlled conditions. The experiment was carried out in a stair-step setup, and data was collected for plant height, biomass, and chlorophyll content. Palmer amaranth showed a significant height reduction in the presence of sweet potato varieties Morado, 529, Centennial, Heart-O-Gold, and

1), potassium (112 kg K ha−1), sulfur (22 kg S ha−1), and zinc (11 kg Zn ha−1). An additional fungicide application was applied to the last treatment for the additions and five out of six treatments for the deletions. At Verona, all three main effects of population, rows, and fertilizer significantly affected corn yield in the addition study. Similarly, in the deletion study, we found a three-way interaction among the main effects. In 2020 at Stoneville, fertilizer was the only factor that affected corn yield in both studies. In 2021 at Stoneville, population and fertilizer significantly affected corn yield in the addition study. Population and rows significantly affected the corn yield in the deletion study, while fertilizer treatments showed no effect. Overall, most of the factors that produced higher yields were site-specific and based on soil characteristics and health. Producers should determine soil deficiencies before deciding the appropriate nutrient management strategy.
Hatteras. The reduction in Palmer amaranth's height was above 80% in the presence of variety Morado at four weeks after transplantation (WAT), while the reduction was above 70% in the presence of varieties 529 and Centennial, compared to Palmer amaranth control. Reduction in chlorophyll content at 4 WAT was above 50% in the presence of varieties 529, Centennial, and Hatteras. Varieties Hatteras, Evangeline, Covington, 529, and Centennial drastically reduced Palmer amaranth dry biomass. Results of the ANOVA for weekly plant height showed that the variation among the sweet potato varieties is significant, thus suggesting different sweet potato varieties have different effects on Palmer amaranth growth. Some of these varieties have already been reported to produce allelochemicals (Soni et al., 2020). The present findings show that sweet potato varieties Centennial, Evangeline, Hatteras, 529, and Morado suppressed the Palmer amaranth growth and can be considered for further allelopathic studies to identify the cause and pathway responsible for weed growth suppression.

**GS-P24 EVALUATION OF CORN GROWTH USING RECOVERED NUTRIENTS FROM BIOELECTROCHEMICAL SYSTEMS**

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A growing environmental concern is excess nutrients being introduced to water bodies. Agriculture and municipal wastewater are composed of many essential nutrients that can be used for plant and crop growth. A proposed environmental solution is to use recovered nutrients in the place of virgin fertilizer. Bioelectrochemical treatment systems (BES) were used to treat synthetic agricultural (DWW) and synthetic municipal wastewater (SWW) for nutrient recovery. An experiment took place using the expended BES that treated the DW and SWW by crushing them and amending the topsoil with them to evaluate corn plant growth. The BES were constructed using biochar, terracotta, and bentonite. A total of four soil amendments were used, biochar (BS), terracotta (TS), BES-DWW, and BES-SWW. The amendment made up 10% of the growing medium for each soil group. A control soil of unamended topsoil was used. There was a total of 12 corn plants grown in each of the five soil groups for a total of 60 plants. The corn plants were treated with three different nutrient treatments: 100% Hoagland nutrition solution, 50% Hoagland nutrition solution, and 0% Hoagland nutrition solution. The plants received the nutrient treatment once a day for 30 seconds. The experiment lasted for 38 days at the Environmental Plant Physiology Laboratory at the Rodney Foil Plant Science Research facility of Mississippi Agriculture and Forestry Experiment Station at Mississippi State University. The plants were analyzed for various agro-morphological traits, gas exchange, and pigments. The results confirmed that the BES-SWW and BES-DWW soil amendments can improve corn plant growth.

**GS-P25 CONSTRUCTION AND CHARACTERIZATION OF AEROMONAS HYDROPHILA MUTANTS AND OPTIMIZATION OF VACCINATION AGAINST MOTILE AEROMONAS SEPTICEMIA IN CATFISH**

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Aeromonas hydrophila is a Gram-negative facultatively-anaerobe rod causing motile Aeromonas septicemia (MAS) in fish. MAS has been an important problem in the channel catfish industry, causing rapid and high mortalities. Approved antibiotics are added to fish feed for treatment of MAS, but moribund fish become anorexic, limiting the effectiveness of medicated feed. Also, antibiotic use adds to the production cost and results in antimicrobial-resistant strains. Thus, vaccine-based prevention of MAS is a good alternative. In this work, 24 A. hydrophila genes involved in bacterial virulence systems such as the type IV secretion system, secretion pathway, twin-arginine translocation system, flagellar system, and lipopolysaccharide assembly were deleted in-frame.Safety and efficacy testing of these mutants in channel catfish by intraperitoneal injection resulted in four attenuated and protective A. hydrophila strains. During vaccination, fish mortality rates were % 5-10. After 21 days post-vaccination, the challenge of vaccinated fish with wt A. hydrophila resulted in 72-96% relative percent survival. Vaccination in A. hydrophila is challenging, and hence, we also optimized injection and immersion vaccination methods. The attenuated strains are expected to be potential vaccine candidates against MAS in catfish.

**GS-P26 DETERMINING OPTIMAL PARTICLE SIZE FOR CROP LEAF NUTRIENTS USING FOURIER TRANSFORM MIDINFRARED SPECTROSCOPIC ANALYSIS**

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Fourier Transform Mid-Infrared (FT-MIR) spectroscopy is a reliable tool for estimating the chemical properties of plants and soils in laboratory settings; however, this method requires fine-ground samples, as large particles may compromise model accuracy. Fine grinding is time-consuming and expensive, as large sample sets are necessary for model calibrations. There have been no studies on the effect of grinding on plant leaf MIR spectroscopy. The objectives were to determine the optimal leaf particle size required for accurate model calibrations of leaf nutrients. For that, a Bruker Alpha II spectrometer was used to measure absorption from 8000-350 cm-1 of coarsely ground leaf samples (n = 150) from 12 crops. Samples were scanned after grinding for 2, 5, and 10 minutes. The particle size distribution of 20 samples was measured at each grinding level using an optical microscope and image processing. Models were calibrated and validated for spectra at each grinding level using partial least squares regression for 11 different chemical properties, including N, P, and K. The average particle size for non-fine-ground samples was 21 μm, decreasing ~10 μm after grinding for 2 minutes. Additional grinding produced little change. Model predictions for non-fine-grinding and after two minutes of grinding were the highest in accuracy, with an average r2 of 0.88 and 0.85, respectively. We found that leaf particle size of 10-20 μm was sufficient for accurate model predictions. Additional grinding was less effective in reducing particle size and providing accurate models.

**GS-P27 STRUCTURED ILLUMINATION REFLECTANCE IMAGING AS NEW TECHNIQUE FOR DETECTING BROILER BREAST FILLETS AFFECTED BY MUSCLE MYOPATHY**

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Muscle myopathies or defects (e.g., white striping, woody breast) downgrade quality of broiler meat, which are reportedly to cause loss of hundreds of millions of dollars annually for the U.S. poultry production. White striping (WS) is manifested as white streaks in muscle tissues, while woody breast (WB) is characterized by hard,
pale and convex meat. Visual inspection is currently practiced for assessing myopathy conditions including white striping in broiler meat. However, this method is prone to human evaluation error, labor-intensive, and costly. Image techniques under conventional uniform illumination have been investigated for assessing broiler meat quality, including checking for myopathies. However, their performance is not always satisfactory, especially for detecting subtle defects with few visual symptoms. Structured illumination or light, as opposed to uniform illumination, is potentially more effective for enhanced imaging of biological tissues. The method shines spatially modulated and patterned light over samples. This study presents a novel proof-of-concept evaluation of the utility of structured-illumination reflectance imaging (SIRI) for detecting the myopathy condition in broiler breast fillets. Images of myopathy-affected chicken fillets were acquired by an in-house assembled broadband SIRI system under phase-shifted sinusoidal illumination at different spatial frequencies. The acquired pattern images were demodulated into direct components (DC) and amplitude components (AC) at each spatial frequency, from which texture and statistical features were then extracted for building discriminative models. Machine learning classifiers including Nearest Neighbor and Linear Discriminative Analysis were used for classifying chicken fillets into four grades according to the severity of myopathy. The classification accuracy based on DC and AC images at different spatial frequencies was assessed to determine the optimum spatial frequency of illumination patterns for myopathy assessment of broiler meat. SIRI would provide a potentially useful tool for enhanced detection of muscle myopathies of broiler meat.

GS-P28 STUDYING THE EFFECTS OF THROUGH-THICKNESS REINFORCEMENTS ON SANDWICH COMPOSITE T-38 MAIN LANDING GEAR STRUT DOORS

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The use of sandwich composite materials in the aerospace industry has increased in recent years, since sandwich composites have a high strength-to-weight ratio and often exhibit a superior bending stiffness over traditional materials such as aluminum. However, one of the main issues with sandwich composites is the face-sheet-core separation due to low out-of-plane mechanical properties. 3D stitching in sandwich composites can provide the necessary through-the-thickness reinforcement to enhance the interlaminar tensile and shear strengths. The objective of this study is to apply through-thickness stitching to composite T-38 doors to study the effects of stitching on sandwich structures and gain a better understanding of their effectiveness in full-scale structural applications. Finite element analysis (FEA) is used to establish critical loading points and reinforcement areas as well as determine the locations of stress concentrations developed while under load. This is accomplished through the comparison of two finite element models (FEMs) based on a sandwich composite door and currently in-service titanium door. Each composite door will utilize a 110 kg/m³ machined foam core and incorporate varying stitch densities based on a previous study. Figure 1 shows an example of a stitched composite strut door with the optimal stitch density of 0.0093 stitches/mm². These results are the groundwork for performing structural level testing of the doors once the fabrication process has been completed.

GS-P29 CROP FIELD PATH PLANNING FOR AUTONOMOUS TRACTOR BASED SYSTEM AND OBSTACLE FUSION

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The time it takes to plant and collect crops in agriculture manually can significantly affect food distribution and increase the expenses to farmers. The implementation of autonomous vehicles can significantly enhance the production and harvesting of crops in agriculture, which will result in reduced expenses in the production and distribution of crops. A typical farming plantation can have several different crops growing at once, resulting in irregular-shaped crop fields due to the available space a farmer has for crop production. Considering this, we need to develop a dependable system that must be capable of handling the irregularly shaped fields to be implemented in real-world crop environments. Our research aims to develop a multidisciplinary path planning algorithm for unmanned vehicles in various areas such as seed placement, crop maintenance, dusting, and surveillance. An autonomous seed and harvesting tractor-based robot is used to effectively demonstrate the efficiency of the proposed model, along with a surveillance and crop-dusting drone used for exploring and surveying the crop fields. The proposed model contains a global path planner, an obstacle approximation and fusion algorithm, a local navigator, and a path smoothing algorithm to develop a near-optimal path. Utilizing these methods, we can navigate and survey through crop fields with little ease and computational effort with the proposed model. The proposed methods show great potential to navigate various poly-shaped crop fields effectively and safely, thus, offering a valuable component for the robot. The feasibility and effectiveness of the proposed methods are validated by simulation and comparison studies.

GS-P30 INSECTICIDE APPLICATION EFFICACY OF SUAS COMPARED TO TRADITIONAL DELIVERY SYSTEMS

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Small and large uncrewed aerial systems (sUAS and UAS, respectively), also referred to as uncrewed aerial vehicles (or UAVs), have been used for agricultural purposes as technology advances for remote sensing and observing. Needed is an evaluation and expansion of sUAS in agriculture. Treating crops and crop pests with sUAS (UAS weighing less than 24.95 kg (55 lb)) is one way to maximize the use of sUAS in agriculture. This paper will address the efficacy of sUAS insecticide efficacy to control common crop pests of the midsouth region. sUAS application will be compared to self-propelled spray equipment in a variety of crops commonly grown in the midsouth region.

GS-P31 CONCUSSION REPORTING AMONG COLLEGIATE CLUB ATHLETES

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The current study investigates concussion-reporting among U.S. collegiate club athletes. There is robust evidence that a large proportion of college-aged athletes have sustained unreported concussions, but there is a lack of research specifically on club-level athletes. It is predicted that these players self-report significantly fewer professionally diagnosed concussions than total concussions sustained. Participants completed a survey about health, sports, and concussion history as part of a larger study on cognitive performance post-concussion. Participants included 26 male, club athletes (M=19.84 years old, SD=1.28, range=18-23) recruited from a university in the southeast United States. Exclusion criteria included an existing or prior learning disability diagnosis, ADHD, or other serious neurological issues. Participants self-reported experiencing a significantly higher number of concussions (M=2.38, SD=1.44) than were documented by a professional (M=0.39, SD=1.20); t(25)=3.41, p<.01. Details were provided for 62 total
conclusions. Of note, 19.2% of participants (N=5) reported having none of their concussions professionally diagnosed, and 26.9% of participants (N=7) indicated their first concussion was never diagnosed. Conclusions: Results support the assertion that concussion non-disclosure is a significant issue among college-aged U.S. club athletes. Current findings highlight the need for research to better understand and encourage these reporting behaviors and how coaches and those who work with these athletes can promote increased, accurate concussion-reporting.

GS-P32 BENEFITS OF NEONICOTINOID SEED TREATMENTS ON THRYVON COTTON

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In the Mid-South, thrips are an important early season pest on cotton. Mississippi planted over 500,000 acres of cotton in 2020, all of which were infested with tobacco thrips Frankliniella fusca (Hinds), which resulted in about $6.5 million of economic losses. Therefore, cotton is typically treated with a preventative thrips control product at planting and generally about 25-30% requires an additional foliar treatment to reduce damage from thrips. A new Bacillus thuringiensis strain (ThryOn®, Bayer CropScience, St. Louis, MO) has been developed that provides good control of thrips. Currently, there is some debate about the need for an insecticide seed treatment to improve thrips control. We conducted a study to determine if the addition of an imidacloprid seed treatment improves efficacy against tobacco thrips and to determine if reduced rates of seed treatments (100, 75, 50, 25, and 0% of the labeled rate) provide benefits for thrips control in ThryOn cotton. Preliminary results suggest that a 50% seed treatment rate of imidacloprid provided similar control and yield protection as a 100% imidacloprid seed treatment rate. These preliminary data suggest that ThryOn cotton could be utilized with a reduced rate of imidacloprid compared to other current commercial varieties, drastically decreasing the number of neonicotinoids released in the environment.

GS-P33 COMPARISON OF VIS-NIR AND MIR SPECTROSCOPY FOR ESTIMATION OF TOTAL CARBON AND NITROGEN USING A MISSISSIPPI SOIL DATASET

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Reflectance spectroscopy in the visible and near-infrared (vis-NIR) and mid-infrared (MIR) ranges has emerged as a promising tool for quantitative soil analysis, with the potential to replace or complement the traditional lab-based wet-chemical analysis of certain soil properties. However, the soil property estimation using spectroscopy has not been tested for Mississippi soils. The goal of this study was to examine the accuracy of total carbon (TC) and total nitrogen (TN) estimation using vis-NIR and MIR spectroscopy. For this purpose, a total of 184 soil samples from two depths between 0-15 cm were collected from a commercial cotton farm in the northern Mississippi State, USA. A subsample of each sample was sent to a lab for TC and TN measurements using the conventional combustion method. The vis-NIR reflectance (350 to 2,500nm) and mid-infrared (MIR) spectra of the samples were measured using an ASD LabSpec 4 spectrometer with an attached muglight accessory. Attenuated Total Reflectance (ATR) and Diffuse Reflectance Infrared Fourier Transform (DRIFT) spectra for all samples were acquired using a Bruker Alpha II spectrometer in the MIR range (1,250 to 28,570nm). Partial least squares regression was applied to calibrate models using 75% of the data and validated by the remaining data. The results showed that the R² values for TC and TN estimations from DRIFT, ATR, and ASD were 0.87, 0.82, 0.70, and 0.84, 0.70, 0.56 respectively. Overall, MIR spectra were more effective at predicting TC and TN of soils compared to vis-NIR reflectance spectra.

GS-P34 A COMPARATIVE CONTENT ANALYSIS OF TWO LOCAL TELEVISION (A) ABC-AFFILIATE WKNR-TV (LICENSED TO NASHVILLE, TN) AND (B) DUAL CBS/CW- AFFILIATE WHLT (LICENSED TO HATTIESBURG, MS) BROADCASTER’S TORNADO WARNING COMMUNICATION

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Despite the rise in prominence of smartphone alerts in delivering tornado warning messages, local television is still an important source to help individuals understand their personal risk from tornadoes. While the content of text-based weather alerts and other short messages communicated through social media have been the subject of past research, in-depth analyses of the content of broadcast tornado warning coverage are limited. This study attempts to fill gaps in our knowledge regarding the content of the hours of coverage devoted to tornado warning communication each year by closely examining two local television news station’s coverage of two separate events from 3rd March 2020 and 19th April 2020. The two local television news stations were network affiliates from Nashville, TN, and Hattiesburg, MS. The length of Nashville coverage was just over 3 hours, while the Hattiesburg coverage was 2 hours 33 minutes. A combination of deductive and inductive coding approach was used to summarize the content of the broadcasts in NVivo. The analysis explored the content for several elements based on past research including jargon and metaphors used, recommendations for protective action, and messages related to lead time and locations. Other themes emerged from the analysis including ways the broadcast meteorologists continued to monitor the situation and ways they communicated the severity of the hazard. We found that both stations heavily use radar products (e.g., velocity and reflectivity) although it significantly varies between stations. For example, the Hattiesburg coverage had a higher percentage of velocity products (56%) than Nashville coverage (34%). However, for reflectivity, Nashville has a higher percentage (52%) than Hattiesburg (23%). In addition to visual components, we also found several differences in verbal sections. The broadcast meteorologists in the Hattiesburg coverage more frequently used meteorological words such as ‘lead time’, ‘mesocyclone’, ‘wind gust’, ‘shear’ ‘wall cloud’, and categories (‘EF3’, ‘EF4’) compared to the Nashville coverage. In the Hattiesburg transcript, the broadcast meteorologist also used quantitative information such as frequency of hazard events (i.e., 443 ‘lightning strikes’) to describe the severity of the situation. Finally, references such as “information from National Weather Service” (such as confirmed and expired tornado warnings) was more often used in the Hattiesburg tornado warning coverage.

GS-P35 NOVEL USE STRATEGIES OF NPV-HELIGEN IN MISSISSIPPI SOYBEAN

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The cotton bollworm, Helicoverpa zea (Boddie), is a yield limiting insect pest of cotton and soybean in the Mid-southern U.S. In Mississippi during the 2020 growing season, yield losses exceeding 1.68 million bushels of soybeans resulted from bollworm infestations. Nuclear Polyhedrosis Virus (NPV) is a baculovirus used as a form of biological control targeting lepidopteran larvae in many agricultural production systems. Heligen® is a Heliothis NPV that has been formulated to provide control of bollworm infestations in certain crops. We conducted two studies to determine the residual of Heligen and the feeding habits of bollworms after virus ingestion.

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To evaluate residual time, we applied Heligen to a soybean field and evaluated its efficacy at different time intervals (0, 12, 24, 36, 48, and 72 hours post-application in laboratory bioassays with treated leaves. Preliminary results indicated that Heligen remained viable for up to 48 hours in the field. To evaluate the feeding habits of bollworms at the ½” and ¾” life stages, Heligen exposed larval and untreated larvae were weighed at 0 (before diet exposure), 4, and 7 days. At 4 days after exposure, body weight was reduced anywhere from 56 to 86% for larvae exposed to Heligen compared to control larvae. Together, these studies suggest that Heligen can be an effective form of biological control when larvae are exposed between 0-48 hours of application at the ½” and ¾” life stage.

GS-P36 PATTERNS AND PROCESS OF SANDBAR REVEGETATION ON THE MISSOURI NATIONAL RECREATIONAL RIVER

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Decades of flow regulation have reduced sandbar area and recruitment of cottonwood and willow along the Missouri River. Conflicts exist between managing sandbars for habitat (removing vegetation) for threatened sandbar-nesting birds (i.e., Piping Plover) and allowing natural recruitment of early successional riparian woodland (set-aside bars) that may support other species and ecological values. Recent changes in topography, geomorphology, and vegetation were examined on sandbars that have been “set aside” from management within seven reaches of the Missouri National Recreational River (MNRR) in southeastern South Dakota, USA. An existing time series of maps of sandbar land cover, derived from satellite imagery, was analyzed using ArcGIS to track vegetation and geomorphic changes from 2008-2016. Digital Elevation Models (DEMs) were used to detect elevational changes from 2012-2014/2016, the years following the 2011 flood. Sandbar area was highest on most reaches in 2012 and declined thereafter, and most areas did not show significant elevation changes from 2012-2014/2016. Cottonwood was the most frequent tree species, followed by Russian olive, while sandbar willow was the most abundant shrub species. Redcedar and sweet clover were the most frequent woody and herbaceous invasive plant species, respectively. My findings will inform managers from the National Park Service and US Army Corps of Engineers about how the sandbars in the MNRR have evolved since the 2011 flood. This information is critical for managing the bars in a way that will balance the needs of sandbar-nesting birds and the multiple species of birds and other wildlife that use early successional riparian vegetation.

GS-P37 AUTONOMOUS BROILER MORTALITY DETECTION AND REMOVAL ROBOTS

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Manual collection of broiler mortality on a daily basis is time and labor-consuming, and an autonomous robotics system can solve this issue effectively. Among many components of developing the autonomous poultry mortality detection and removal system, robot path planning is one of the essential parts and is not yet utilized for robot navigation in a broiler house. Therefore, this paper proposes a broiler mortality detection and removal system consisting of two robots, one broiler mortality detection robot that searches the entire broiler house for dead broilers and indicates the position of the dead birds, while the other broiler mortality removal robot performs collection and removal of dead broilers. The broiler mortality detection robot can precisely and efficiently search, identify and indicate dead broilers through the broiler house environment and historical data of the broiler mortality. It contains a coverage-directed self-adaptive path planner, and You Only Look Once (YOLO) V4 broiler mortality detector. The other broiler mortality removal robot composing of a multi-target path planner achieves the function of removing broiler mortality in the minimum traveling distance with collision-free trajectories. Moreover, equipped with the onboard LIDAR equipment, a local reactive navigator is introduced to simultaneously avoid static and dynamic obstacles (i.e., live birds and feeding and drinking lines). The proposed methods show great potential to navigate the poultry detection and removal robots in broiler houses efficiently and safely, thus being a useful component for robotics. The feasibility and effectiveness of the proposed methods are validated by simulation and comparison studies.

GS-P38 RELATING INSECTICIDE EFFICACY TO HONEYBEE TOXICITY


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The use of foliar insecticides is critical for management of tarnished plant bug, Lygus lineolaris (Palisot de Beauvois), in cotton (Crow et al. 2020, George et al. 2021). In the Mid-South region of the U.S., multiple insecticide applications are generally required each year to prevent severe economic losses (Cook and Threat 2021). Although foliar insecticides are important for crop protection, they have been linked to honeybee, Apis mellifera (L.), decline in many parts of the world (Krupke et al. 2012, Lawrence et al. 2016). The response of bees to multiple insecticides is highly variable, but so is the level of control of tarnished plant bug in cotton. Therefore, it is important to consider both efficacy against the target pest and toxicity to honeybees when choosing insecticides for crop protection when honeybees are present.

GS-P39 ASSESSING THE RELATIONSHIP BETWEEN SOIL HEALTH AND SURFACE RUNOFF WATER QUALITY IN THE MISSISSIPPI DELTA


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Enhancing soil health and understanding its interaction with the environment is essential due to its potential impacts on crop productivity, nutrient cycling, and water quality. The goal of this study is to explore relationships between soil health and runoff water quality from agricultural fields, under different management scenarios in a Mississippi Delta watershed. A soil/health quality index was determined using the Soil Management Assessment Framework (SMAF). Nine (9) soil health indicators (aggregate stability, microbial biomass carbon, soil organic carbon, bulk density, beta-glucosidase enzyme, Mehlich 3 extractable phosphorus and potassium, electrical conductivity and pH) were selected to compute the SMAF based on the soil data collected by the USDA-ARS National Sedimentation Laboratory in Beasley Lake Watershed near Inverness, MS. Runoff water samples from fields managed under row crops, vegetative buffers, or Conservation Reserve Program (CRP) were analyzed for the years 2008 and 2012. Preliminary results showed that soil health/quality improved for all management treatments in 2012 as compared with 2008. There was a significant reduction in orthophosphate-P and total Kjeldhal nitrogen measured in surface runoff in 2012 relative to 2008. These surface runoff water quality parameters were positively correlated with the soil quality/health indicators aggregate stability (R=0.56), and microbial biomass carbon (R=0.85), respectively. Overall, areas managed under CRP had higher soil health indicators and improved runoff water quality, while row crops fields had the lowest indicators, those management practices that improve soil health may

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have a benefit on runoff water quality in agricultural landscapes of the Mississippi Delta.

**GS-P40** THE BRAIN TRANSCRIPTOME IN A MILD MODEL OF EXPERIMENTAL AUTOIMMUNE ENCEPHALOMYELITIS: SIMILARITIES TO MS AND IMPACT OF CANNABIDIOL

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Experimental autoimmune encephalomyelitis (EAE) is a robust animal model that imitates human multiple sclerosis (MS). However, EAE symptoms are variable and can range from asymptomatic to tail and limb paralysis. To analyze our mild EAE model compared to MS and the impact of CBD, the brain transcriptome was compared to MS lesions that were obtained from an online repository. Female C57BL/6J mice were immunized with Complete Freund's Adjuvant, Heat-killed Mycobacterium tuberculosis, and myelin oligodendrocyte glycoprotein. Twenty-four hours after induction, mice were treated with 75mg/kg CBD or corn oil via oral gavage. RNA sequencing (RNA-Seq) was performed on the brains. Reads were assessed for quality, trimmed, and mapped to the GRCh38 genome. Differential expression analysis was performed in CLC Genomics Workbench (Qiagen). Differentially expressed genes (DEGs) with a false discovery rate (FDR): $S \leq 0.05$ were considered significant. RNA-Seq was repeated on various MS lesions and healthy controls that was obtained from the gene expression omnibus (GSE138614) and mapped to GRCm39 genome. DEGs were modeled in Ingenuity Pathway Analysis (Qiagen) to identify canonical pathways. Pathway analysis revealed that symptomatic EAE mice shared many canonical pathways with MS active lesions. Notably, the number one gene that was increased asymptomatic, CBD treated EAE mice was oxytocin (Fold Change$=1.311$, FDR$=0$). Results present evidence that mild EAE is a valid model that mirrors MS active lesions. The variability in immunization success and neuroprotection by CBD, may provide insight into mechanisms that are shared between EAE and MS as well as success with CBD treatment.

**GS-P41** INVESTIGATION OF LOW-HIGH FIDELITY TURBULENT MODELS IN SCRAMJET ENGINES

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The design of high-speed vehicles at the hypersonic range has been a challenging task due to non-linear aero-thermal-structural interactions. Additionally, the interaction of shock waves with the turbulent boundary layer promotes flow separation due to adverse pressure gradient at the point of impingement. In the case of air-breathing engines like scramjets, shock-induced separation can lead to localized heating, low-frequency large scale unsteadiness of the shock structure, acoustic noise at the intake, and a decrease in the stagnation pressure, which are responsible for the drop in the efficiency of the engines. However, shock wave interactions may not always result in negative consequences. For example, in the scramjet flow, they can be used as a source for air-fuel mixing, and in external flows, they can be used to split the shock system, thereby decreasing the drag. Hence, it is essential to understand the mechanism behind the control phenomenon. In our previous work we have studied the predictive capability of low to high fidelity turbulent models for an external flow configuration involving shock wave-turbulent boundary layer interaction, which is the case of a flow in which wall-generated-turbulence dominates. The results indicated that only the DHRL model coupled with ILES could capture the separation characteristics successfully, while the other models like URANS, PANS, and IDDES over predicted the flow separation. In the present work, we will investigate the predictive capability of different turbulent models in the hypersonic flow for the scramjet configuration used by DLR, which is the case of a flow involving both the wall-generated turbulence and free-shear turbulence.

**GS-P42** INVESTIGATING PHYSIOLOGICAL RESPONSES TO NOVEL EXOGENOUS HORMONE TREATMENT IN AN ANURAN MODEL SPECIES

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Due to inadequate simulation of environmental cues to stimulate the hypothalamo-pituitary-gonal axis within *ex situ* settings, amphibians in captive breeding programs often require treatment with exogenous hormones to release gametes for reproduction. Synthetic and non-synthetic forms of Gonadotropin Releasing Hormone (GnRH) can be administered with and without dopamine antagonists to stimulate gamete release in anuran species. In this study, a commercially available hormone mixture Ovaprim™ containing salmon GnRH and the dopamine antagonist Domperidone was used to induce spermiation in a model anuran species the Fowler’s toad (*Anaxyrus fowleri*) and physiological responses of weight change and spermiation response were recorded. Males were treated with 300 µl of Ovaprim (n=15) and urine was collected over a 24-hour time course, with toad weights taken at each time point. Toads were considered responders if they gave a spermic urine sample. Sperm parameters were analyzed including motility, abnormality, and concentration. Of the 15 individuals given Ovaprim™, 11 gave spermic urine at least once during the time course (73%). Rather than uniformly distributed sperm within urine, aggregations of sperm within viscous matrices of additional biochemical components occurred in samples from 6 individuals given Ovaprim™ Using a Wilcoxon signed rank test, we found that weight increased significantly ($p<0.05$) between time points during the first 3 hours due to fluid retention possibly due to the dopamine antagonist influencing aquaporin activation. Induction of spermiation using this treatment results in the release of sperm within aggregations of biological material and fluid retention in the model species *Anaxyrus fowleri*.

**GS-P43** WINEGRAPE QUALITY OF ‘MIDSOUTH’ FOLLOWING EITHER LEAF REMOVAL OR SHOOT THINNING

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Low total soluble solids and high titratable acidity limit ‘MidSouth’ use as a red wine grape. However, leaf removal or shoot thinning could potentially improve these fruit qualities. Average berries per cluster, berry weight, cluster weight, crop yield, yield to pruning weight ratio (Ravaz index) (kg/kg), total soluble solids, titratable acidity, juice pH, monomeric anthocyanin pigment, and total phenolic content were measured in ‘MidSouth’ vines after receiving one of three treatments: either post-fruit set leaf removal, post-fruit set shoot thinning, or neither leaf removal nor shoot thinning (control) treatments. Shoot thinned vines had lower crop yields and Ravaz index and higher total soluble solids and monomeric anthocyanin pigment and total phenolic content in 2021 wine. Leaf removal vines had lower juice pH in 2020 and higher monomeric anthocyanin content and total phenolic content in 2021 must. Because these treatments did not appear to have enough of a desired effect on ‘MidSouth’ winegrape quality, leaf removal and shoot
thinning at post-fruit set cannot be recommended for improving the quality in ‘MidSouth’ in South Mississippi.

**GS-P44 EVALUATION OF SURFACTANTS FOR USE IN ONE-TIME FOLIAR AUXIN APPLICATIONS IN THE PROPAGATION OF WOODY ORNAMENTALS**

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Use of foliar applications are increasing in the nursery and greenhouse industry. However, previous research has shown that insufficient auxin is being absorbed or translocated to the site of action. Addition of surfactants to foliar applications of auxin has been theorized to help with the absorption and translocation of auxin to the site of action. Research was conducted to determine whether addition of surfactants to one-time foliar applications of indole-3-butyric acid (IBA) would be as effective as the current industry standard, the basal quick dip. Terminal cuttings of common camellia (Camellia japonica) and Teddy Bear® magnolia (Magnolia grandiflora ‘Southern Charm’) were sprayed to the drip point using Hortus IBA Water Soluble Salts at concentrations of 0 ppm, 500 ppm, 1,000 ppm, or 1,500 ppm or dipped for 1 sec in a solution of either 4,000 ppm or 2,500 ppm for camellia or magnolia, respectively. A foliar application of 1,500 ppm after sticking was as effective as the basal quick-dip for cuttings of Teddy Bear®, while other spray treatments were less effective. A basal quick-dip was more effective than a foliar spray for rooting cuttings of camellia.

**GS-P45 COMPARING PORTABLE AND BENCH-TOP MID-INFRARED SPECTROMETERS FOR MACRO AND MICRONUTRIENTS ESTIMATION OF MAIZE**

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Quick and accurate decisions are critical for efficiently managing the plant nutrients as global food demands rise in tandem with the world’s fast-rising population. Compared to conventional laboratory analysis, spectroscopic techniques to estimate plant nutrients has multiple benefits, i.e., rapid, affordable, and non-destructive. This study aimed to compare the prediction accuracies of two spectrometers (Bruker AlphaII- 400 to 4000 nm, ArcOptix - 2000 nm to 6000 nm) operated in two distinct modes. To this end, the Diffuse Reflectance Infrared Fourier Transform (DRIFT) spectra of 154 maize leaves were obtained using the ArcOptix spectrometer, followed by fine grinding to obtain both DRIFT and Attenuated Total Reflectance (ATR) spectra using the Bruker AlphaII. The fine-ground samples were also analyzed for eleven nutrients (N, P, K, Ca, Mg, Zn, S, Cu, B, Fe and Mn) following the conventional laboratory approach. Partial least squares regression (PLSR) was used to calibrate models using 75% of the data, then validated with the remaining set. The best model performance was observed was for Nitrogen using ArcOptix spectrometer ($R^2 = 0.81$ and Ratio of Performance to Deviation (RPD) = 2.21) followed by Phosphorus ($R^2 = 0.8$ and RPD = 2.16) and Potassium ($R^2 = 0.78$ and RPD = 2.01) acquired from Bruker AlphaII spectrometer in ATR mode. Both spectrometers predicted all the macronutrients (N, P, K, Ca, Mg) and two micronutrients (Zn and Mn) with $R^2 > 0.6$. The ATR spectra yielded the best accuracies for all calibrated models, and DRIFT spectra from both spectrometers showed similar performances.

**GS-P46 UNDERSTANDING VASCULAR CALCIFICATION THROUGH THE LENS OF CANONICAL WNT SIGNALING**

KarLee McNeil

Arteriosclerosis, characterized by hardening of the arteries, is a dangerous precursor to a degenerative condition called vascular calcification. Vascular calcification is a process by which a phenotypic transition of vascular smooth muscle cells causes generation of osteoblast mimicking cells within arteries. This process is initiated by the wingless-related integrated (WNT) pathway mimicking osteogenesis as mechanical stress from arterial injury leads to this remodeling. There are many causes of calcification which include diabetes, kidney failure, and obesity. Based on data from the American Heart Association and the National Institutes of Health in 2017, someone in the United States dies of cardiovascular disease every 37 seconds. Vascular calcification can be an underlying cause of these often-fatal events and is becoming more heavily studied due to a lack of characteristic symptoms. Once calcification begins, buildup of hydroxyapatite in arteries can lead to hypertension and a decrease in arterial compliance and elasticity. Often, calcification is not discovered until a heart attack or stroke occurs because it is not screened for and has no obvious symptoms. Current protocols focus on treatment of calcification and not consequences associated with it the disease. Considering the lack of treatments to prevent and reverse calcification, a novel therapy for treatment of this disease is long overdue. By studying human arterial smooth muscle cells and confirming the role of WNT-Signaling as it relates to calcification, a possible therapeutic target for calcification can be identified.

**GS-P47 TINY THRIPS BIG PROBLEMS**

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¹Mississippi State University, Mississippi State, MS; ²University of Tennessee

Foliar-applied insecticide treatments may be necessary to manage thrips in cotton (Gossypium hirsutum L.) under severe infestations or when at-planting insecticide seed treatments do not provide satisfactory protection. The most common foliar-applied insecticide is acephate. Field observations in Tennessee suggest that the performance of acephate has declined. Thus, the first objective was to perform leaf-dip bioassays to assess if tobacco thrips, Frankliniella fusca (Hinds), in cotton production regions have evolved resistance to foliar applied insecticides. A second objective was to assess the performance of commonly applied foliar insecticides for managing thrips in standardized field trials in Arkansas, Tennessee, Mississippi, and Texas. For both objectives, several insecticides were evaluated including acephate, dicrotophos, dimehotoa, lambda-cyhalothrin, imidacloprid, and spinetoram. Field trials and bioassays were completed from 2018 to 2021. Dose-response bioassays with acephate were performed on tobacco thrips field populations and a susceptible laboratory population. Bioassay results suggest that tobacco thrips have developed resistance to acephate and other organophosphate insecticides; however, this resistance seems to be most severe in Arkansas, Tennessee, and the Delta region of Mississippi. Resistance to other classes of insecticides were perhaps even more evident in these bioassays. The performance of these insecticides in field trials was variable, with tobacco thrips only showing consistent signs of resistance to lambda cyhalothrin. However, it is evident that many populations of tobacco thrips are resistant to multiple classes of insecticides. Further research is needed to determine heritability and resistance mechanism(s).
GS-48 EFFECT OF INTEGRATING COVER CROPS AND GRAZING ON SOIL MICROBIAL COMMUNITY COMPOSITION, FUNCTION AND SOIL HEALTH IN EAST-CENTRAL MISSISSIPPI SOYBEAN PRODUCTION

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Integrating crop and livestock systems have been considered an important systems-based decision to improve soil health, fertility, and increase carbon sequestration. Adoption of conservation systems that reduce soil disturbance and increase residue cover through cover crops are considered important strategy to improve soil health. A two-year study (2019-2021) at Coastal Plain Branch Experiment Station in Newton, MS aimed to evaluate soil microbial diversity related to soil health in an Integrated Crop-Livestock System (ICLS) in the warm, humid regions, specifically southeastern USA. Cover crop treatments included mixture of Oats, Crimson clover and Tillage Radish. Genomic DNA was extracted from collected soil samples from grazed paddocks during soybean (Glycine max) establishment. Amplicons targeting bacterial 16S rRNA genes and fungal ITS2 regions were sequenced. Taxonomic assignment and microbial diversity characterization were performed using QIIME2® bioinformatics pipeline. Soil properties were measured and analyzed in SAS® 9.4 using PROC GLM (p < 0.05). Soil bacterial diversity showed no significant difference across treatments. However, soil fungal diversity pattern showed significant difference across treatments. Correlation between soil properties and soil microbial diversity using Canonical Correspondence Analysis (CCA) and Mantel test showed significant influence on fungal diversity due to carbon (rm = 0.2581, p = 0.022), nitrogen (rm = 0.2921, p = 0.0165), electrical conductivity (rm = 0.1836, p = 0.0583) in yr. 2021, and on bacterial diversity due to EE-GRSP (rm = -0.1888, p = 0.0693) in yr. 2020. It is important to perform long-term study to determine the change in microbial diversity due to cover crops and grazing for sustainable agriculture.

GS-P49 QUASI ID MODELLING OF A SCRAMJET ENGINE CYCLE

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Giving the fact that scramjets are the hope for achieving sustained hypersonic flight, many domestic and international efforts have been deployed in order to produce a better understanding of the aircraft engine. In this thesis, a model describing the thermodynamic cycle of the device has been proposed. The goal is to provide a descriptive insight on how the different design parameters affect the flow characteristics throughout the engine, thrust production, and other engineering constraints. The model adopts a 2D-planar inlet design to calculate the properties within the section, accurately predicts the flow separation and pressure jumps within the isolator, provides a comprehensive combustion model based on mixing efficiency and adiabatic flame concept, and finally evaluates the performance of the nozzle based the law of thermodynamics and compressible flow governing equations. The model also predicts the failure of the engine to self-start, among other things. A comparison to other models has been provided to validate the results of discussed approach.

GS-P50 EFFECTS OF INTEGRATING COVER CROPS AND POULTRY LITTER ON DRYLAND SOYBEAN YIELD AND SOIL HYDRAULIC PROPERTIES

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The Mississippi region is known for its fertile land for agricultural production. However, continuous crop production has been found to decrease the soil organic matter, water holding capacity and increase soil erosion, runoff, and nutrient leaching in recent years. A field experiment was conducted from 2017 through 2022 at Pontotoc County in the eastern Mississippi to evaluate the effects of different cover crops (cereal rye, native vegetation, vetch, mustard/cereal rye, and wheat) along with the use of organic amendment (poultry litter) on dryland soybean yield and soil properties. Data collection for this study included water holding capacity, saturated hydraulic conductivity of soil (Ksat), biomass and grain yield of soybeans. The results indicated that the poultry litter application over the course of the study has improved the soybean biomass as compared to treatments of commercial inorganic fertilizer and no fertilizer inputs. The soybean grain yield has been increased when poultry litter was applied as compared to commercial fertilizer treatment (82 vs. 69 bu/ac) and when compared with no fertilizer treatment (82 vs. 50 bu/ac) in the year 2021. Poultry litter increased Ksat by 8% (1.49 vs. 1.38 cm min⁻¹) compared with the soil received commercial fertilizer. Overall, the poultry litter application improved Ksat as compared to commercial fertilizer application and no fertilization treatments but cover crops did not change the soil properties or increase soybean yield.

GS-P51 BEST MANAGEMENT PRACTICES EFFECTIVENESS ON STREAM WATER QUALITY IN LIVESTOCK MANAGEMENT AREAS

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This study evaluates the pre and post-implementation effects of a Best Management Practices (BMPs) set on the variation of stream health and water quality along the reach flowing through the MSU Dairy Farm. The BMPs include stream-crossings, riparian zone planting/fencing. Water quality monitoring consisted of bi-weekly grab sampling and in-situ testing from July 2019 to March 2022. Results evidenced poor water quality conditions for pre-implementation. Concentrations of total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) increased along the stream reach, which does not meet nutrient criteria for MS streams. Water quality detriment is influenced by upland and land use activities; unrestricted cattle access to the stream; and sediment supply from active streambanks. Post-implementation results indicate that BMPs significantly (p<0.05) impact stream water quality, reducing nutrient and sediment concentrations and improving physicochemical water quality parameters. Despite reductions, TP and TN concentrations remain above the established nutrient criteria. The removal efficiency in summer, fall, and winter was, respectively, 48%, 39%, and 42% for TSS; and 17%, 31%, and 32% for TN. TP concentrations decreased by 18% for summer and fall but increased by 19% during winter. Reductions in temperature and increases in dissolved oxygen suggest a positive shading effect on water quality. Reductions in pH and turbidity demonstrate the success of the BMPs in mitigating the impact of the livestock management area. Overall, despite the partial effectiveness of BMPs, additional conservation practices above the study area are needed to accomplish the criteria of the attained use for the stream.
GS-P52 ANTI-CANCER EFFECTS OF WATERCRESS EXTRACT ON GROWTH AND FUNCTIONS OF OVARIAN CANCER CELL LINES

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Ovarian cancer (OVCA) is the fifth leading cause of death in postmenopausal women in comparison to all other gynecologic malignancies. Late detection of OVCA is common as screening is done mostly in women over 65. This delay in screening coupled with poor prognosis presents the need for novel treatment measures. For years, natural occurring products are in prominence as anti-cancer therapeutics. The current study is carried out on one gm of coarsely crushed watercress leaves which were extracted in methanol and further filtered through a 0.22-µm filter. HPLC analysis evidenced that watercress extract has significant amount of kaempferol in it. Kaempferol (kaemp) is known to produce anti-cancerous effects in various types of cancer cells. The purpose of our experimentation is to observe the differential cellular activity (growth analysis, metabolic activity, autophagy) in the presence of wcen and kaemp. We used Hey A8 and Hey MDR, two isogenic ovarian cancer cell lines along with a mouse embryonic fibroblast (MEF) cell as a non-cancerous normal cell line for all the experiments related to wcen and kaemp. Cellular studies revealed that wcen and kaemp treatment inhibited the cell viability of both HeyA8 and HeyARMDR cells by 50%; however, promoted the growth of non-cancerous MEF cells which indicates the selective nature of cellular toxicity of wcen and kaemp. The wcen and kaemp both mediated oxidative stress in OVCA cells were further determined by detecting the elevated level of reactive oxygen species (ROS) through DCFDA fluorescence. We have further shown that wcen and kaemp treatment is inducing formation of autophagic vesicles in OVCA cells. Cancer cells are equipped with altered metabolic activities including enhanced glucose uptake and lipogenesis. Kaemp treatment reduces glucose uptake and lipid droplet biogenesis along with increased acidification of the cells as demonstrated by increased lysotracker red fluorescence. Overall, our data indicates anti-cancer activities of both wcen and kaemp in the OVCA cell lines which could be implicated by targeting various pathways simultaneously. Our preliminary finding creates a better understanding between the oncogenic signaling pathway and the influence of plant products in the chemoresistance and proliferation of ovarian cancer. Further studies are underway.

GS-P53 EVALUATION OF COVER CROP INFLUENCE ON POTASSIUM UPTAKE DYNAMICS IN THE SOUTHEASTERN COTTON BEL

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Growers and industry workers have planted and researched cover crop relevancy in cotton for many years. Potassium is essential to cotton in its growth and development. It is integrally involved in the metabolism of plant and water relations. Cover crops serve as a potassium placeholder in the offseason of a cash crop. Limited research exists evaluating the dynamics of cover crops in correlation with potassium in cotton grown in the Mid South. Field experiments were conducted in 2021 and 2022 to determine the potassium uptake dynamics in the Mid south cotton belt. Experiments were established at three different sites in Mississippi, The R.R. Foil Plant Science Research Center (Starkville, MS), MAFES Black Belt Branch Experiment Station (Brooksville, MS), and the North Mississippi Research and Extension Center (Verona, MS). Cereal ryegrass was sown at 59 kg per ha-1, Crimson Clover was sown at 20.4 kg per ha-1 and a blend at half the rate of each cover crop. Cover crop biomass was measured in a metered square before planting in each plot. Plots were fertilized using 0-0-60 (Muriate of Potash) at two different application timings and two different application scenarios. The first application timing occurs at cover crop termination and the second application occurs at pinhead square. The scenarios include a full rate of 160 kg ha-1 at cover crop termination or pinhead square or 50% at cover crop termination followed by 50% at pinhead square. Phytogen 400 W3FE was planted in 4-row plots and evaluated on leaf K+ content, yield, and fiber quality.

GS-P54 SYNTHESIS AND BINDING STUDIES OF TWO ISOMERIC NITRO-SUBSTITUTED DIPODAL UREAS FOR ANIONS: COMPARISON OF THEIR BINDING AFFINITY BY BOTH EXPERIMENTAL AND THEORETICAL METHODS

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Two simple isomic nitro-substituted dipodal ureas L1 and L2 have been synthesized by the reaction of p-sulfolenediamine with 2- and 3-nitrophenyl isocyanate, respectively. The binding affinity of these receptors has been investigated thoroughly by colorimetric, UV-Vis and NMR studies for a wide range of anions. Comparative studies from UV-Vis and NMR titrations demonstrate that the meta-nitro substituted receptor (L1) exhibits an enhanced binding for the anions investigated, as compared to the ortho-nitro analogue (L2). Colorimetric studies suggest that L1 effectively detects fluoride and bicarbonate showing an intense color change while a visible color change is observed for fluoride, acetate, bicarbonate, and dihydrogen phosphate in DMSO. DFT calculations support the experimental data showing the superior binding with L1 for anions as compared to L2. Acknowledgement: The project was supported by the US Department of Defense (Grant Number W911NF-19-1-0006).

GS-P55 THERMAL DATA DE-IDENTIFICATION FOR CROSS-SYSTEM PROCESS-DEFECT MODELING FOR METAL-BASED ADDITIVE MANUFACTURING

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The objective of this research is to develop a secured data sharing mechanism for additive manufacturing (AM) process data that masks the printing path information while retaining the critical quality control characteristics. There is a need of aggregating AM process data since large amounts of training data are necessary to develop a reliable machine learning model for in-situ AM certification. However, a core problem in data aggregation from multiple AM users is the data privacy concern of sharing process raw data, which usually contain confidential design information. This is a major challenge for small-to-medium-manufacturers (SMM), where collecting copious amounts of data is prohibitively expensive. The proposed Adaptive Design De-identification for Additive Manufacturing (ADAM) methodology applies an adaptive de-identification approach to mask the printing path information contained within the AM thermal history. Furthermore, support vector machine (SVM) classifiers are leveraged to evaluate the performance of the proposed ADAM methodology on its ability to de-identify printing path information, while simultaneously preserving data utility, i.e., anomaly detection accuracy. A real-world case study based on the fabrication of a cylindrical shaped disk, using the directed energy deposition (DED) process, is used to validate the proposed method. The results demonstrate a significant improvement in the protection of confidential design information contained within the AM thermal
Rabbit production has a quick turnover and requires efficient financial strategizing to remain profitable. The study assessed the optimization of two diets and their effects on growth performances and cost-benefit analysis. Nine (9) weaned Mini Rex rabbits were randomly assigned to one of two dietary treatments (Commercial Feed and Gourmet Pet Food) in a completely randomized design experiment. Rabbits were placed in individual cages with ad libitum access to water and fed 300 grams daily for approximately 33 days. Daily feed intake was determined, and the rabbits were weighed weekly. Proximate analysis and cost-benefit analysis of these feeds were conducted to compare the nutritional compositions and provide insights into the feed's economic impact.

The results revealed that the Gourmet Pet Food had a higher dry matter (DM) and fat content and lower ash and crude fiber content when compared to the Commercial feed. Also, each rabbit in the feeding trial gained weight. However, the rabbits from both treatments had similar average daily gains at the end of the trial. The cost-benefit analysis revealed that the Commercial feed is more economical than the Gourmet Pet Feed.

GS-P56 GROWTH PERFORMANCE AND COST-BENEFIT OF RABBITS FED COMMERCIAL FEED AND GOURMET PET FOOD

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GS-P57 CHEMICAL CONTROL OF ERIGERON SUMATRENSIS WITH CROSS-RESISTANCE TO ACETOLACTATE SYNTHASE INHIBITORS

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The selection of fleabane populations resistant to the herbicide chlorimuron-ethyl is an emerging phenomenon in most soybean and corn producing regions of Brazil. Studying herbicides with different modes of action in weed management systems is an important tactic to combat acetolactate synthase (ALS) inhibitor resistance. Currently, most herbicides used as an alternative or complement to chlorimuron-ethyl are also ALS inhibitors, such as diclosulam and cloransulam-methyl. Since the repeated use of herbicides with similar modes of action has resulted in the development of herbicide-resistant weed biotypes, there is a critical need to rotate herbicide modes of action. In our previous study, a resistant population showed cross-resistance to chlorimuron-ethyl and cloransulam-methyl applied post-emergence, and cross-resistance to chlorimuron-ethyl and diclosulam applied pre-emergence. Chlorimuron-ethyl resistance was, therefore, observed in two different modes of application (pre-and post-emergence). The objective of this work was to evaluate alternative herbicides for the control of a Sumatran fleabane population with cross-resistance to ALS inhibitor herbicides. Two greenhouse experiments were conducted, one with pre-emergence applications and another in post-emergence. The control percentage at 28 days after the application was evaluated. The use of residual herbicides for fleabane control is an essential tool for its management since the success of the herbicides applied post-emergence is linked to the stage of the plants and the environmental conditions at the time of application. Alternative herbicides to ALS inhibitors effective in fleabane control may be recommended in rotation with different modes of action to curtail resistance. The herbicides tembotrione, mesotrione, clomazone, amicarbazon, metribuzin, atrazine, flumioxazin, fomesafen, trifluralin, s-metolachlor, pyroxasulfone, and indaziflam evaluated pre-emergence in this work were efficient to control the resistant population (100% control). In post-emergence, saflufenacil and ammonium glufosinate isolated or associated with glyphosate, glyphosate+2,4-D, and glyphosate+dicamba are practical tools for management (more than 98% control). The contact herbicides paraquat, diquat, and [paraquat+diuron] also provided effective control (100% control). The results obtained in this study present options for pre and post-emergence control of the resistant population with cross-resistance to ALS inhibitors.

1-Investigator Posters (I-P)

I-P01 INFLUENCE OF COVER CROPS AND FERTILIZER TREATMENTS ON THE SOIL MICROBIAL COMMUNITY DYNAMICS IN A DRYLAND SOYBEAN PRODUCTION SYSTEM

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Soil microbial communities play indispensable roles in maintaining soil health by improving soil organic matter dynamics, nutrient cycling, altering biochemical soil environment and ultimately crop productivity. Soil management practices affect soil microbiome, however, the variability of microbial communities to soil management practices and its relationship to soil quality is complex. In this study, changes in the soil bacterial and fungal communities were evaluated in response to no-till, cover crops and fertilizer treatments in dryland soybean production system. We conducted two experiments, early and late planting of soybeans at Pontotoc Ridge-Flatwoods Branch Experiment Station, MS, USA. Soil samples were collected at the time of planting and amplicon sequencing of 16S rRNA and ITS2 genes was used to study the bacterial and fungal community composition. In the early planting, poultry litter amendment and cover crops significantly influenced soil bacterial diversity. However, greater fungal diversity was observed in the inorganic fertilizer treatment. The Mantel test of correlations showed that the soil pH and EE-GRSP were significantly correlated with bacterial communities. In the late planting, microbial diversity and richness remained unaffected by cover crops and fertilizer treatments. We observed a similar abundance of beneficial bacterial and fungal phyla in both experiments which play a major role in organic matter decomposition and nutrient cycling. Microbial community composition varied by planting dates and exhibited temporal and spatial variability. This study suggests that long-term research is needed to assess the impact of soil management practices on soil microbiota and its implications for soil quality in soybean production.
I-P02 HARNESSING THE GENETIC POTENTIAL OF CORN HYBRIDS FOR BETTER SYNERGY WITH THE COVER CROP FARMING SYSTEM

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Corn growth and development possess a wide phenotypic diversity that is influenced by genotype (G), environment (E), and management (M). Limited research has focused on understanding corn hybrids’ role in sustainable farming. We phenotyped how corn hybrids respond to reduced nitrogen (N) with and without a cover crop farming system. The treatments included were cover crops (Australian winter peas and cereal rye) and N treatments: no cover crop (NCC) with 100% N (270 kg ha⁻¹), cereal rye cover crop with 75% N (RCC), and peas cover crop with 50% N (PCC), and subplots were five corn hybrids. Treatments had a significant effect on growth, physiology, yield, and quality. At 36 days after planting, early-season shoot biomass was notably greater in PCC>NCC>RCC. Likewise, PCC increased mean chlorophyll content by 20% compared to NCC. Even with 50% reduced N application, corn shoot biomass showed no difference between PCC and NCC at maturity. Corn yield was reduced by 37% under RCC compared to NCC. ‘NK15730-3110’ and ‘MC4319’ recorded the nonsignificant difference in yield between PCC and NCC treatments when averaged over five hybrids. Kernel protein was significantly affected by treatment and hybrids. Interestingly, treatments had no significant effect on kernel starch content. Our findings suggest that combining leguminous cover cropping (peas) with the right genetics could be the best alternative to reduce fertilizer-intensive farming without compromising yield and quality. Our study indicates the need for more collaborative efforts better to understand the G × E × M interactions to develop farmer-friendly management tools to sustain yield and quality.

I-P03 ANALYSIS OF SOIL ORGANIC CARBON AND %-NITROGEN IN MISSISSIPPI CROPLANDS USING HYPERSPECTRUM & DEEP LEARNING NEURAL NETWORKS

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This work is a surface soil reflectance spectroscopy (hyperspectral) study to estimate soil organic Carbon (SOC) and percent-Nitrogen (%N) concentration. The objectives are (1) to improve estimation accuracy (2) evaluate alternate signal representations and (3) discrete non-exhaustive search to ascertain dependencies on the band-wise estimates to SOC and %N. This research contributes to the development of remote sensing based non-invasive, accurate, rapid, and cheaper methods for estimating SOC and %N storage in agricultural ecosystems to monitor nutrients and ensure sustained plant health. For 349 Soil samples collected from croplands across Mississippi, 3494 hyperspectral signatures (over 10 signatures per sample) and their corresponding laboratory SOC and %N ground-truth measurements (dry combustion analyzer) were collected. A Spectral Evolution handheld spectroradiometer recorded data in the wavelength range of [350, 2500] nm using a soil probe. This study currently restricts to soil samples with SOC ∈ [0.0, 4.0] and %N ∈ [0.05, 0.42]. Linear discriminant analysis (LDA) on a quantized dataset showed the possibility of the estimates being distinguishable from only using the hyperspectra. We compare the estimation performance of regression [multilinear regression (MLR), support vector regression (SVR), ridge regression (RR), random forest (RF), gradient boosting (GB)] and (2) convolutional neural network-based approaches on the following data representations: raw spectrum, principal component analysis (PCA) representation, and Wavelet projection. Our experiments show MLR models, RR models, SVR models yielding $R^2 \in [0.8, 0.9]$ and decision tree models, such as RF and GB, yielding $R^2 \in [0.85, 0.92]$. (346 July 2022, Vol 67 No 3)
SUSTAINING MEMBERS

Alcorn State University  
Belhaven College  
Delta State University  
East Central Community College  
Gulf Coast Community College  
Holmes Community College  
Itawamba Community College  
Jackson State University  
Millsaps College  
Mississippi Gulf Coast Community College  
Mississippi Museum of Natural Sciences  
Mississippi State University  
Mississippi College  
Mississippi Valley State University  
Mississippi University for Women  
Northwest Mississippi Community College  
Pearl River Community College  
University of Mississippi  
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Author Guidelines

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Manuscripts must adhere to the following format:

- One inch margins on 8.5 x 11 inch paper;
- Text should be left-justified using twelve point type;
- Double spaced throughout, including the title and abstract;
- Arabic numerals should be used in preference to words when the number designates anything that can be counted or measured (7 samples, 43 species) with 2 exceptions:
  - To begin a sentence (Twenty-one species were found in…)
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- Avoid personal pronouns.

Format

Abstract. In 250 or fewer words summarize any new methods or procedures critical to the results of the study and state the results and conclusions.

Introduction. Describe the knowledge and literature that gave rise to the question examined by, or the hypothesis posed for the research.
Materials and methods. This section should describe the research design, the methods and materials used in the research (subjects, their selection, equipment, laboratory or field procedures), and how the findings were analyzed. For all human and animal studies please indicate Institutional Approval in this section.

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Acknowledgments. Colleagues and/or sources of financial support to whom thanks are due for assistance rendered in completion of the research or preparation of the manuscript should be recognized in this section rather than in the body of the text.

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Literature cited. List references alphabetically. Cite references in the text by author and year of publication (e.g., Smith, 1975; Black and Benghuzzi, 2011; Smith et al., 2010; Smith, 2011a, 2011b). The following examples illustrate the style to be used in the literature list.


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