



Journal of the Mississippi  
Academy of Sciences

**Editor**

Kenneth J. Curry  
University of Southern Mississippi

**Associate Editor**

Maureen Corcoran  
Corps of Engineers  
Waterways Experiment Station

**Abstracts Editor**

John Boyle  
Mississippi State University

---

*The Journal of the Mississippi Academy of Sciences* (ISSN 0076-9436) is published in January (annual meeting abstracts), April, July, and October, by the Mississippi Academy of Sciences. Members of the Academy receive the journal as part of their regular (non-student) membership. Information regarding subscriptions, availability of back issues, and address changes is available from the Mississippi Academy of Sciences, 405 Briarwood Drive, Suite 107E, Jackson, MS 39206-3032; telephone: 601-977-0627.

The *Mississippi Academy of Sciences* maintains a website for Academy announcements, the latest issue of this journal, and general information about the Academy. The address is <http://www.msstate.edu/Org/MAS/MAS.HTML>

*Editorial policy* is located on the inside front cover. *Information for contributors* is located on the inside back cover. Manuscripts and inquiries about publication and information about advertising should be sent to the editor: Kenneth J. Curry, University of Southern Mississippi, Post Office Box 5018, Hattiesburg, MS 39406-5018.

## Contents

### Research Articles

- 116 **Production and Utilization of Cool-season Plantings for White-tailed Deer**  
Andreas Leidolf, Robert L. Dew, and Harry A. Jacobson
- 121 **Edema on Tropical Soda Apple (*Solanum viarum* Dunal) and Sticky Nightshade (*Solanum sisymbriifolium* Lamarck)**  
Hamed K. Abbas, Charles T. Bryson, and J.J. Heitholt

### Departments

- 114 **Editorial**—Ken Curry
- 128 **President's Column**—Robin Rockhold
- 129 **Executive Officer's Column**—John Boyle
- 130 **Mississippi Junior Academy of Sciences**—Joan Messer
- 132 **Divisional Reports**

**OFFICERS OF THE  
MISSISSIPPI ACADEMY OF SCIENCES**

President .....	Robin Rockhold
President-Elect .....	Susan Nodruft
Immediate Past-President .....	Catherine Perry Cotten
Executive Officer .....	John A. Boyle
Journal Editor .....	Kenneth J. Curry
Junior Academy Director .....	Joan Messer
Directors .....	Maureen Corcoran Portia Harris Charles Swann
Administrative Assistant .....	Cynthia Huff

**Editorial**

**Call for Volunteers**

*Poster Sessions.* When I first affiliated with the Mississippi Academy of Sciences, the annual meeting was about a day and half long with talks starting on Thursday and ending Friday around noon. Now talks continue through Friday late afternoon. We are still growing and accommodating that growth by encouraging more poster sessions. This is important, since we cannot find a suitable meeting place with more breakout rooms than the hotel/convention centers we have been using and we are not quite big enough for a three day meeting. The importance of poster sessions to the Academy was felt strongly at our meeting in February when we had the largest demand for posters ever (over 70 on Friday). We need somebody to help with this important aspect of the Academy annual meeting. The person would be responsible for getting the backboards and easels to the meeting, setting them up both

on Wednesday night and Thursday night (for the Thursday and Friday sessions respectively), and taking them down for return to their storage facility in Jackson. The person would also be responsible for maintenance of the easels, i.e., we need somebody that can repair the wooden easels. Interested in getting involved? Contact John Boyle, Rob Rockhold, or me.

*Associate Editor: Photographer, etc.* Each year this April issue of the journal contains some photographs of the annual meeting. The job of photography has been passed around among various volunteers with various levels of success. I am looking for an Associate Editor to be responsible for taking photographs at the annual meeting. I would also like some help in identifying and securing advertising for the journal to help offset printing costs. Interested in getting involved? Contact me.—Ken Curry

**Education Members**

Organizations that assist the Mississippi Academy of Sciences in its efforts to promote science in Mississippi

**Alcorn State University  
Belhaven College  
Delta State University  
Millsaps College  
Mississippi-Alabama Sea Grant Consortium  
Mississippi Delta Community College  
Mississippi Gulf Coast Community College  
Mississippi State University**

**MSU Agricultural & Forestry Expt. Station  
Mississippi University for Women  
Mississippi Valley State University  
Pearl River Community College  
University of Mississippi  
University of Mississippi Medical Center  
University of Southern Mississippi**

[insert Ohaus advertisement here]

# Production and Utilization of Cool-season Plantings for White-tailed Deer

Andreas Leidolf<sup>1</sup>, Robert L. Dew, and Harry A. Jacobson<sup>2</sup>

Department of Wildlife and Fisheries, Mississippi State University, Mississippi State, MS 39762

We determined forage production and utilization for 3 cool-season forage combinations for white-tailed deer (*Odocoileus virginianus*) in the Interior Flatwoods of Mississippi in 1994 and 1995: crimson clover (*Trifolium incarnatum* L.)/wheat (*Triticum aestivum* L.), ladino clover (*T. repens* L. f. *lodigense* Hort. ex Gams)/wheat, and arrowleaf clover (*T. vesiculosum* Savi)/wheat. Cool-season plantings produced from 893 to 1105 kg/ha (dry weight) of forage over a 6-month period. Cumulative production was highest for ladino clover/wheat. Cumulative utilization by deer ranged from 309 to 578 kg/ha of forage dry weight, and was significantly higher for crimson clover/wheat (65%) than ladino clover/wheat (28%) or arrowleaf clover/wheat (29%). Management implications regarding selection of cool-season forages are discussed.

Food plots are a common feature of white-tailed deer (*Odocoileus virginianus*) management. Wildlife managers in the southeastern United States have used food plots since 1935 (Larson, 1966, 1969; Halls and Stransky, 1969). Providing food plots as part of a management program can have demonstrable advantages for white-tailed deer, including the potential to increase deer numbers, deer harvest, hunter success, hunter density, hunter satisfaction, deer quality, and deer observability (Short, 1975; Vanderhoof and Jacobson, 1989).

White-tailed deer are known to feed on a wide variety of vegetation over the course of a year (Halls, 1973). However, several authors have emphasized that nutritional content of native forage in the southeastern U.S. often is inadequate to meet the seasonal nutritional needs of deer (Goodrum and Reid, 1962; Blair et al., 1977; Mitchell, 1980; Thill and Morris, 1983; Newsom, 1984; Johnson and Dancak, 1993). Short (1975) reported that, as early as November, quantities of digestible dry matter consumed by southern deer may be insufficient to satisfy basal metabolism.

Forage plantings for deer have been suggested to compensate for deficiencies in native vegetation (Halls and Stransky, 1969; Halls, 1973; Short, 1975; Crawford, 1984). Segelquist and Rogers (1974) showed that cool-season agronomic forages could

replace low-quality native winter forages. In other studies, supplemental feeding using a pelleted ration has been shown to increase body weight, antler size, and productivity of white-tailed deer (Ozoga and Verme, 1982). During late summer and winter stress periods, supplemental planting of agronomic forages can become essential for deer survival. Seasonal protein needs are elevated in deer during lactation, before initiation of antler growth, during fawn development, and in preparation for and during the late fall-winter stress period (Lay, 1956; Short, 1966). Vanderhoof and Jacobson (1989) reported that most cool-season forages commonly planted for white-tailed deer contain more crude protein than native vegetation. To attract deer, most authors recommend planting of annual grasses, such as wheat (*Triticum aestivum* L.), common oats (*Avena sativa* L.) or common rye (*Secale cereale* L.), and annual or perennial clovers (*Trifolium* spp.), all of which can provide sufficient levels of protein (Larson, 1966; Halls, 1973; Vanderhoof and Jacobson, 1989).

Several studies conducted in the 1960's examined production and utilization of forage plantings for white-tailed deer in the Southeast (Davis, 1961; Handly and Scharnagel, 1961; Webb, 1963). More recently, Vanderhoof and Jacobson (1989) evaluated the effects of agricultural food plantings on white-tailed deer in southern Mississippi. Higginbotham

---

<sup>1</sup>Author for correspondence. Current address: Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210.

<sup>2</sup>Current address: Route 4, Box 4438, Athens, TX 75751.

(1991) evaluated warm and cool season supplemental forages in east Texas with regard to production, utilization, and nutritional quality. Waer et al. (1992) studied the production and nutritional quality of selected food plantings in eastern Alabama, and Feather and Fulbright (1995) examined nutritional quality of warm-season forages in south Texas.

Our objectives were to determine the levels of production and utilization by white-tailed deer of 3 combinations of commonly planted agronomic forages in east-central Mississippi. We also sought to determine preferences by deer for certain forage combinations.

## MATERIALS AND METHODS

The study was conducted on the John W. Starr Memorial Forest, located in Oktibbeha and Winston Counties, in the Interior Flatwoods physiographic region of east-central Mississippi. Covering an area of ca. 3,300 ha., the Starr Forest consists of 54% upland pine and pine/hardwood forest, 28% bottomland hardwood forest, and 18% pine plantations. The climate of Oktibbeha county is warm and humid, influenced mainly by the subtropical latitude, the extensive landmass to the north, and the warm temperatures of the Gulf of Mexico (Brent, 1973). Annual precipitation averages 133 cm, with monthly precipitation ranging from 7.7 cm in October to 14.8 cm in March. Temperatures range from an average low of 5.0°C in January to an average high of 27.1°C in July (National Oceanic and Atmospheric Administration, 1992). The average annual number of frost-free days is 226 (Brent, 1973).

In fall of 1994, we selected 18 existing food plots on the Talking Warrior and Noxubee River Units of the Starr Forest, ranging in size from 0.2 to 1.2 ha, for this study. We then randomly assigned each food plot 1 of 3 cool-season forage combinations. Plots were broadcast seeded in early October. Forage combinations used were crimson clover (*T. incarnatum* L.)/wheat, ladino clover (*T. repens* L. f. *lodi-gense* Hort. ex Gams)/wheat, and arrowleaf clover (*T. vesiculosum* Savi)/wheat. Within each food plot, we randomly established five 7-m x 7-m sampling plots, which were marked with 36-inch wire flags. A circular wire enclosure 1.5 m tall and 0.5 m wide was set up on each sampling plot. Enclosures were staked to the ground to prevent deer and other animals from moving them.

Production and utilization on each food plot were assessed monthly from December 1994 to May 1995, when the study had to be discontinued. All plots were clipped on or around the 15<sup>th</sup> of each month. Forage within each enclosure and from an equal area outside the enclosure was clipped to ground level. After clipping, the enclosure was moved to a different, randomly determined location. For this purpose, each sampling plot was divided into 25 1-m<sup>2</sup> quadrats, allowing for a 1 m buffer on all sides. Because sampling was destructive, a quadrat that had been clipped was not sampled again. During each clipping period, food plots were visited in a random, predetermined sequence to reduce bias associated with time of sampling.

Forage samples were oven dried at 60°C for 72 hrs. (Short, 1966; Wolf and Ellmore, 1975), and weighed to the nearest 0.1 g. Samples obtained from the 5 sampling plots within each food plot were averaged for each month. Production for month *t* was determined by subtracting the forage dry weight from outside the enclosure during month *t-1* from the forage dry weight from inside the enclosure during month *t*. Utilization for month *t* was determined by subtracting the forage dry weight from outside the enclosure for month *t* from the forage dry weight from inside the enclosure for month *t*. All herbivory was attributed to white-tailed deer; because fencing to exclude the only other major herbivore present, the eastern cottontail (*Sylvilagus floridanus*; Daugherty and Owens, 1993), was not feasible, our estimates of forage utilization by deer may be slightly inflated. Cumulative production and utilization over the growing season was derived by summing respective measures for each month.

We used analysis of variance (ANOVA) to test for differences in cumulative production, utilization, and percent utilization (utilization/production) of forage combinations. Following a significant ( $P < 0.05$ ) ANOVA, Tukey's studentized range test was used to separate means while controlling Type I experimental error (Day and Quinn, 1989). Because data for all variables were normally distributed, we did not transform data. We tested for homogeneity of variance using the SAS macro HOMOVAR. For each test conducted, we also assessed the power ( $1 - \beta$ ) of a performed (*post hoc*) test using single and two-factor ANOVA power analysis (Zar, 1996). Monthly production and utilization were assessed qualitatively.

**Table 1. Cumulative production, utilization by white-tailed deer (*Odocoileus virginianus*), and percent utilization of 3 cool-season forages (clover [*Trifolium* spp.]-wheat [*Triticum aestivum* L.] combinations) on John W. Starr Memorial Forest, Oktibbeha and Winston Counties, Mississippi, December 1994–May 1995.**

	Crimson/wheat	Ladino/wheat	Arrowleaf/wheat
Production	893 ±122 A <sup>a</sup>	1105 ±96 A	1080 ± 173 A
Utilization	578 ± 187 A	314 ±64 B	309 ± 64 B
Percent utilization	65% A	28% B	29% B

<sup>a</sup>Means separated by Tukey’s studentized range test; values sharing a letter are not significantly different (P>0.05).

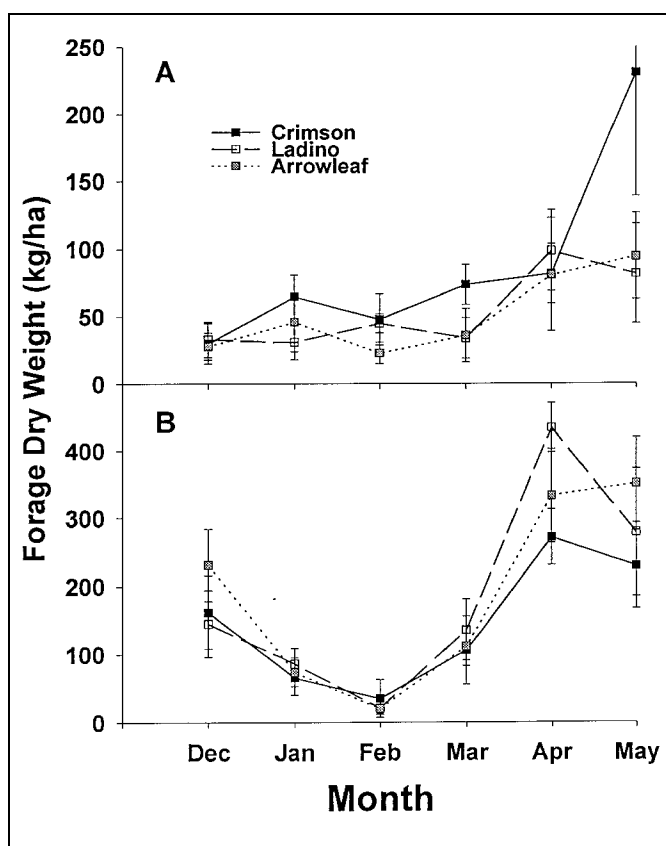
## RESULTS

Of the 3 forage combinations examined, ladino clover/wheat produced the most biomass (1105 kg/ha), followed by arrowleaf clover/wheat (1080 kg/ha) and crimson clover/wheat (893 kg/ha; Table 1). However, differences in mean cumulative production among forages were not statistically significant. Power to detect significant differences was low ( $1-\beta < 0.35$ ). Monthly production also was similar for all 3 forage combinations, and was lowest in February (Figure 1). Both ladino clover/wheat and crimson clover/wheat production peaked in April, at 434 kg/ha and 272 kg/ha, respectively. Production for arrowleaf clover/wheat was highest in May with 351 kg/ha (Figure 1). Crimson clover matured in May, whereas production of arrowleaf and ladino clover continued into June and July.

Mean cumulative forage utilization by white-tailed deer was significantly higher (P<0.05) for crimson clover/wheat (578 kg/ha) than for ladino clover/wheat (314 kg/ha) and arrowleaf clover/wheat (309 kg/ha; Table 1). Monthly utilization over a 6-month period was highest for crimson clover/wheat, except in December and April, when ladino clover/wheat was utilized more. Monthly utilization for crimson clover/wheat and arrowleaf clover/wheat peaked in May at 231 kg/ha and 95 kg/ha, respectively. From April to May, utilization of crimson clover/wheat increased by almost 200%. Utilization of ladino clover/wheat was highest in April with 99 kg/ha. Lowest utilization for all 3 forages was during the winter months (Figure 1).

Percent utilization of crimson clover/wheat was 65% (Table 1), significantly higher (P<0.05) than the

2 other forage combinations. Percent utilization of ladino clover/wheat (28%) and arrowleaf clover/wheat (29%) did not differ significantly (P>0.05).



**Figure 1. Utilization by white-tailed deer (*Odocoileus virginianus*; A) and production (B) of 3 cool-season forages (clover [*Trifolium* spp.]-wheat [*Triticum aestivum* L.] combinations) on John W. Starr Memorial Forest, Oktibbeha and Winston Counties, Mississippi, December 1994–May 1995.**

## DISCUSSION

Overall, production of agronomic forages was low compared to other studies. Biomass produced in this study was 35–45% of production figures reported by Vanderhoof and Jacobson (1989) for southern Mississippi, 30–70% of figures reported by Webb (1963), and 50–60% of figures reported by Johnson and Dancak (1993) for related cool-season forages in Louisiana. We attribute this notable discrepancy to a difference in cultivation practices, which were less intense as in these other studies. Also, precipitation was extremely high, and almost all food plots had waterlogged soils until late February. These conditions may have been responsible for the low productivity we observed for all 3 forage combinations through February (Figure 1). We believe that cumulative production was highest for ladino clover/wheat (Table 1), because this forage combination was probably best suited to the wet site conditions.

Plots planted in arrowleaf clover/wheat, a combination best suited for drier sites, did well initially, but decreased in productivity with increased precipitation in late winter. As soils dried in late spring, production of arrowleaf clover/wheat increased markedly (Figure 1). Arrowleaf clover also matures later than the other clovers used. Production of crimson clover/wheat peaked in April, and declined visibly in May as plants matured. These results support findings of earlier studies by Johnson et al. (1987) and Waer et al. (1992). Production of ladino clover/wheat peaked in April, which supports an earlier report by Waer et al. (1992).

Forage utilization by white-tailed deer was comparable to figures reported by Johnson and Dancak (1993), but only 20–30% of that observed by Vanderhoof and Jacobson (1989). Although we did not evaluate the availability of native forage during the course of this study, we believe that the low utilization may have been due to a greater availability of native forage resulting from the unusually mild and wet winter.

In 1994, white-tailed deer on the Starr Forest preferred crimson clover over ladino and arrowleaf clover, which supports earlier findings by Vanderhoof and Jacobson (1989). Even when production of crimson clover/wheat declined in May, utilization increased dramatically, as deer consumed the standing crop. These results are not consistent with Webb (1963), who reported a preference by white-tailed

deer for ladino over crimson clover. Vanderhoof and Jacobson (1989) found no significant difference among crimson clover, ladino clover, and arrowleaf clover/wheat combinations with regard to total digestible nutrients, crude protein, phosphorus, and calcium. Thus, although deer may not be deriving additional nutritional benefits from using crimson clover at a higher rate, it may be more palatable to them than other species of clover.

Utilization of arrowleaf clover/wheat was low throughout the winter, but increased markedly in spring (Figure 1). We suspect that deer responded to increased availability of this forage during that period, while plots seeded in crimson clover/wheat and ladino clover/wheat were beginning to mature. Ladino clover/wheat, although it provided the highest cumulative production, was only utilized at low to intermediate rates throughout the 6-month period (Figure 1). In contrast, Vanderhoof and Jacobson (1989) indicated that deer will readily utilize ladino clover after crimson clover becomes unavailable.

In summary, supplemental plantings can be an effective means of providing nutritional forage to white-tailed deer, although agricultural crops should never be a substitute for maintaining quality native habitat. To improve forage quality for deer using cool-season plantings, forages used must be higher in nutritive value than available native forages, produced in sufficient quantities, and utilized at a significant rate. Because the three forages tested did not differ significantly in cumulative production, consideration in selecting cool-season forages should be given to deer utilization and preference. Crimson clover was preferred by white-tailed deer; as an early and reliable producer of quality forage, it is also noted for its good reseeding potential. We recommend using crimson clover, in combination with annual grasses (wheat, oats, or rye) and a late maturing species such as arrowleaf or ladino clover, for use in cool-season food plots.

Because our study was limited to only one growing season and a relatively small geographic area, our results may not be representative of other areas, or be applicable under different weather conditions. For example, in a similar investigation, Vanderhoof and Jacobson (1989) found significant year and species-year effects, which led them to conclude that weather conditions and local edaphic factors might be more important determinants of forage production than the particular species chosen. Nevertheless, many of our results are supported by

findings of independent investigations, and therefore lend themselves to a certain amount of ecological inference. At the very least, our experiment represents a case study that further emphasizes the importance of planting a combination of early- and late-maturing cool-season crops. In this manner, palatable deer forage can be provided into early summer, when does are nursing their fawns, while at the same time insuring maximum production under varying weather and soil conditions (Vanderhoof and Jacobson 1989).

## ACKNOWLEDGMENTS

We gratefully acknowledge Walker Formulating Co. and the Forestry and Wildlife Research Center at Mississippi State University for funding this study. We thank Dr. J. Varco for his valuable suggestions regarding study design, and S. Durham, Dr. P. Gerard, T. J. Nuttle, and M. Weinstein for their help and suggestions regarding data analysis. Also, we thank S. C. Barras, T. J. Nuttle, Dr. E. C. Hellgren, and 4 anonymous referees for review of the manuscript. Finally, sincere appreciation is extended to P. Reynolds of the Mississippi Department of Wildlife, Fisheries and Parks, for his invaluable logistic support.

## LITERATURE CITED

- Blair, R.M., H.L. Short, and E.A. Epps, Jr. 1977. Seasonal nutrient yield and digestibility of deer forage from a young pine plantation. *J. Wildl. Manage.* 41:667–676.
- Brent, F.V., Jr. 1973. Soil survey of Oktibbeha County, Mississippi. U.S. Government Printing Office, Washington D.C. 94 pp.
- Crawford, H.S. 1984. Habitat management. Pages 629–646 in L.K. Halls, ed. *White-tailed deer: ecology and management*. Stackpole Books, Harrisburg, PA.
- Daugherty, J.M., and J.D. Owens. 1993. Wildlife habitat assessment John W. Starr Memorial Forest. Unpubl. report. Miss. State Univ., Mississippi State. 32 pp.
- Davis, J.R. 1961. Utilization and management of prepared food plots. Pages 11c–38c in No author. Annual report for 1961. Alabama Dept. Conserv., Montgomery.
- Day, R.W., and G.P. Quinn. 1989. Comparison of treatments after an analysis of variance in ecology. *Ecol. Monogr.* 59:433–463.
- Feather, C.L., and T.E. Fulbright. 1995. Nutritional quality and palatability to white-tailed deer of four warm-season forages. *Wildl. Soc. Bull.* 23:238–244.
- Goodrum, P.D., and V.H. Reid. 1962. Browsing habits of white-tailed deer in the Western Gulf region. *Proc. Natl. White-tailed Deer Disease Symp.* 1:9–14.
- Halls, L.K. 1973. Managing deer habitat in loblolly-shortleaf pine forest. *J. For.* 71:752–757.
- Halls, L.K., and J.J. Stransky. 1969. Game food plantings in southern forests. *Trans. North. Am. Wildl. and Nat. Resour. Conf.* 33:217–222.
- Handly, J., and J. Scharnagel. 1961. Growth and usage of permanent forage by deer and turkeys. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 15:24–26.
- Higginbotham, B.J. 1991. Evaluation of supplemental forages for the white-tailed deer (*Odocoileus virginianus*) in east Texas. D. F. Diss. Stephen F. Austin Univ., Nacogdoches, TX. 239 pp.
- Johnson, M.K., B.W. Delany, S.P. Lynch, J.A. Zeno, S.R. Schultz, T.W. Keegan, and B.D. Nelson. 1987. Effects of cool-season agronomic forages on white-tailed deer. *Wildl. Soc. Bull.* 15:330–339.
- Johnson, M.K., and K.D. Dancak. 1993. Effects of food plots on white-tailed deer in Kisatchie National Forest. *J. Range Manage.* 46:110–114.
- Larson, J.S. 1966. Problems in measuring food production on forest wildlife clearings. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 20:33–36.
- Larson, J.S. 1969. Agricultural clearings as sources of supplemental food and habitat diversity for white-tailed deer. Pages 46–50 in L.K. Halls, ed. *White-tailed deer in the southern forest habitat*. U.S. Dep. Agric., For. Serv., South. For. Exp. Stn.
- Lay, D.W. 1956. Some nutritional problems of deer in the southern pine type. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish. Comm.* 10:53–58.
- Mitchell, W.A. 1980. Evaluation of white-tailed deer and cattle diets in two southeastern pine forests. Ph.D. Diss., Miss. State Univ., Mississippi State. 236 pp.
- National Oceanic and Atmospheric Administration. 1992. Climate summary—Mississippi. National Climatic Data Center, Asheville, NC.
- Newsom, J.D. 1984. Coastal Plain. Pages 367–380 in L.K. Halls, ed. *White-tailed deer: ecology and management*. Stackpole Books, Harrisburg, PA.
- Ozoga, J.J., and L.J. Verme. 1982. Physical and reproductive characteristics of a supplementally fed white-tailed deer herd. *J. Wildl. Manage.* 46:281–301.
- Segelquist, C., and M. Rogers. 1974. Use of wildlife forage clearings by white-tailed deer in the Arkansas Ozarks. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 28:568–573.
- Short, H.L. 1966. Forage analyses for deer management studies. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 20:15–18.
- Short, H.L. 1975. Nutrition of southern deer in different seasons. *J. Wildl. Manage.* 39:321–329.
- Thill, R.E., and H.F. Morris, Jr. 1983. Quality of spring deer diets on Louisiana pine-hardwood sites. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 37:127–137.
- Vanderhoof, R.E. and H.A. Jacobson. 1989. Production and use of agricultural food plantings by deer on the Marion County Wildlife Management Area, Mississippi. Unpubl. report. Miss. State Univ., Mississippi State. 74 pp.
- Waer, N.A., H.L. Stribling, and M.K. Causey. 1992. Production and nutritional quality of selected plantings for white-tailed deer. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 46:274–286.
- Webb, L.G. 1963. Utilization of domestic forage crops by deer and wild turkeys with notes on insects inhabiting the crops. *Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm.* 17:92–99.
- Wolf, D.D., and T.L. Ellmore. 1975. Oven drying of small herbage samples. *Agron. J.* 67:571–574.
- Zar, J.H. 1996. *Biostatistical analysis*. Prentice Hall, Upper Saddle River, NJ. 662 pp.



# Edema on Tropical Soda Apple (*Solanum viarum*) and Sticky Nightshade (*Solanum sisymbriifolium*)

Hamed K. Abbas<sup>1</sup>, Charles T. Bryson, and J. J. Heitholt

U.S. Department of Agriculture, Agricultural Research Service, Stoneville, MS 38776

Weed biology research is often critical in the search for the causes of weed disease symptoms. The primary objective of this research was to determine why edema (blister-like growths 2 to 5 mm in diameter) symptoms were found on the abaxial leaf surfaces of tropical soda apple (*Solanum viarum* Dunal) (TSA) and sticky nightshade (*Solanum sisymbriifolium* Lamarck) (SNS) under greenhouse conditions at Stoneville, MS. Because edema symptoms are consistent with excess leaf turgor, a secondary objective of this research was to characterize the effect of three transpiration-reducing chemical treatments (Wilt-Pruf, LeafShield, abscisic acid) on the expression of edema in TSA, SNS, and several crop species. In a series of greenhouse studies, only TSA, SNS and jimsonweed (*Datura stramonium* L.), among 21 different species tested, exhibited edema. Wilt-Pruf (pineolene) treated jimsonweed exhibited more edema than untreated jimsonweed but the effect of Wilt-Pruf and abscisic acid on the other species was similar to the control treatments. Lack of effect from the foliar spray indicates that there are probably other environmental variables involved in causing edema. Overall, these findings may be the first step in attempts to find weaknesses in the growth, biology and life cycle of weeds such as TSA and SNS. Further research is needed before our findings can lead to effective control measures.

*Acanthopora* (Nee, 1991) is native to Brazil and Argentina, but has become a noxious weed in Florida, and is now spreading to other states (Mullahey et al., 1993; Mullahey and Cornell, 1994; Bryson et al., 1994). Currently, TSA has spread into much of the southeastern U.S.A. (Bryson and Byrd, 1994a, 1994b; Bryson et al., 1994; Byrd and Bryson, 1998) and has the potential to continue spreading in the U.S.A. (Patterson and McGowan, 1996).

While surveying for TSA in Mississippi (Bryson and Byrd, 1997), sticky nightshade (SNS), (*Solanum sisymbriifolium* Lamarck) was discovered in several Mississippi counties. Like TSA, SNS is an aggressive perennial with thorn-like prickles. It was introduced into the U.S.A. from South America, but has not spread as rapidly as TSA. Although TSA is relatively easy to control with some herbicides (Akanda et al., 1997), its spread continues at a rapid pace.

Because TSA and SNS have the potential to inflict economic losses on agriculture, effective control measures are needed. In the greenhouse, under conditions of high humidity, we have observed

TSA and SNS leaves and stems in some cases to exhibit edema, a physiological condition that is associated with the death of the plants. This physiological disorder has been observed on tomato (*Lycopersicon esculentum* Mill.) and cabbage (*Brassica oleracea* L.) leaves, especially in poorly ventilated greenhouses (Sagi and Rylski, 1978; Howard et al., 1994). It is caused by waterlogging of the leaf tissues, which results in raised, blister-like growths, 2 to 5 mm in diameter, on the lower leaf surface and sometimes the upper leaf surface as well (Fig. 1). This phenomena can be explained by the following: green, callus-like growths result when transpiration is restricted and root pressure continues to pump water to the leaves. The affected leaves showed necrotic lesions on the adaxial leaf surface opposite the blister-like growths which increase in size concomitantly with the abaxial increase in the blister-like growths. Once affected, the leaves begin to shrink, curl, dry out, die, and abscise. However, except for the aforementioned reports, we can find no reports where edema symptoms have been reported

---

<sup>1</sup>Author for correspondence.

on important weed species or whether edema may significantly suppress weed growth. If the causes of edema were known and the symptoms could be imposed upon TSA and SNS in the field, without harming crop plants, the threat of these weeds could be diminished. Therefore, the primary objective of this research was to compare several plant species for edema symptoms in the greenhouse. In attempts to induce edema, a second objective of this research was to characterize the effect of transpiration-reducing chemical treatments on the expression of edema in TSA, SNS, and several plant species.

## MATERIALS AND METHODS

**Plant Species and Environmental Conditions**—Several weed and cultivated species from 5 families were used in the experiments (Table 1). Three to five plants were raised from seed in each pots. Plants were grown in a greenhouse soil mixture from a Bosket silt loam soil (Mollic Hapludalf). TSA seeds and live roots were collected in Pearl River County, MS during the summer of 1994 and SNS seeds and roots were collected in Harrison County, MS in the fall of 1994. TSA and SNS plants were grown from seeds, one plant per pot in 500 ml pots, respectively. SNS (8 plants) and TSA (100 plants) were used in this study. The greenhouse was maintained at 30 to 35°C day and 25 to 30°C night, at 65 to 85% relative humidity, and a 13- to 14-h light period.

**Experiment 1—Preliminary Edema Evaluation**—Plants were observed from the seedling stage until 8 weeks after planting and data were collected on disease development. A disease rating scale of 0 to 3 was used to evaluate the symptoms as follows: 0 = healthy, 1 = green blister-like growths on the abaxial leaf surfaces but most of surface free of growths, 2 = green blister-like growths on the majority of abaxial leaf surfaces and mild necrotic lesions on upper leaf surfaces, and 3 = complete coverage of white-brown blister-like growths on the abaxial leaf surfaces, large necrotic lesions, stunting and leaf senescence. The experiment was a randomized complete block with ten replications (one pot per replication).

**Experiment 2—Investigation for Fungal and Bacteria Causes**—Infected tissues of SNS and TSA were tested for the presence of fungi such as white rust caused by *Albugo* spp. and downy mildew, *Peronospora* spp., by dissecting affected tissues and

looking for fungal structures such as mycelia and spores under the light microscope. Also, the affected tissue was checked for bacterial streaming from the blister-like growth and surrounding area or by an isolation procedure described by Saettler et al. (1989). Treatment of affected and healthy plants with the fungicide benomyl [methyl 1-(butylcarbamoyl)-2-enzimidazolecarbamate] was performed to rule out fungal causes of edema. TSA seeds were surface sterilized with 10% (v/v) sodium hypochlorite solution, planted in sterilized soil and watered from below to minimize chances of seed- or soil-borne diseases. In a separate test, plants from surface sterilized TSA seeds were compared to plants from unsterilized seeds for subsequent edema symptoms. The experiment was a randomized complete block with 10 replications.

**Experiments 3 and 4—Attempted Induction of Edema by Chemical Methods**—Because edema symptoms are consistent with excessive turgor pressure and dysfunctional stomata, foliar applications of stomata closing or blocking chemicals were applied in Experiments 3 and 4. In Experiment 3, three chemicals and two check solutions were tested. The chemicals were abscisic acid [ABA,  $\pm$  cis, trans-abscisic acid (A-1012) obtained from Sigma Chemical Co., St. Louis, MO], Wilt-Pruf (Wilt-Pruf Products, Inc., Essex, CT), and LeafShield (Aquatrols, Cherry Hill, NJ). In Experiment 3, concentrations of +ABA were  $10^{-5}$  M and  $10^{-4}$  M. Wilt-Pruf treatments were 1 part Wilt-Pruf concentrate to 5 parts water (1:5, v/v) and 1 part Wilt-Pruf concentrate to 10 parts water (1:10, v/v). LeafShield concentrations were 1 part LeafShield to 15 parts water (1:15, v/v) and 1 part LeafShield to 30 parts water (1:30, v/v). Wilt-Pruf is a Lewis acid catalyzed polymer of beta-pinene, one of the major constituents of pine oil consisting of 25% pineolene (di-1-*p*-menthene) and 75% inert ingredients. LeafShield is a liquid that consists of 14.86% paraffin, 7.42% oxidized polyethylene, 7.42% ethoxylated nonylphenol, 0.16% KOH, and 70.14% water. The pH of all diluted solutions was 6.

One of the check treatments was an adjuvant, Silwet L-77 (SW), which was applied to the foliage. The concentration of SW was 0.1%, 100  $\mu$ l SW to 100 ml water. Silwet L-77, is an organo-silicone surfactant (polyalkyleneoxide modified heptamethyltrisiloxane, Union Carbide, Tarrytown, NY). The final check treatment was the unsprayed control.

Plant species receiving foliar treatments were

TSA, SNS, black nightshade, jimsonweed, and tomato. Plants were sprayed with the above solutions until run-off and observed in the greenhouse for 2 weeks for edema-like symptoms. Plants were sprayed 2 to 3 weeks after emergence which happened to be the 5 to 7 leaf stage for our environmental conditions. For each pot, the number of plants with and without edema-like symptoms were measured at the end of the experiment and the percentage affected was calculated. In order to analyze the data statistically, the percentages were transformed using arcsin [ $\sqrt{(x/y)}$ ] where  $x$  = number of plants exhibiting edema and  $y$  = total number of plants (Steel and Torrie, 1980). The experimental design was a randomized complete block with three replicates and a factorial arrangement of the spray treatments and plant species. Means were separated using SAS Proc Mixed (Littell et al., 1996).

In Experiment 4, only four treatments (three spray solutions and one check) were tested but two additional species were included. Only ABA ( $2 \times 10^{-4}$  M +ABA) and Wilt-Pruf (1:3, v/v) were foliarly applied and their concentrations were higher than the initial test. Controls included 0.01% (v/v) Tween 20 and unsprayed plants. The ABA and Wilt-Pruf treatments included 0.01% Tween 20. The two additional species, soybean [*Glycine max* (L.) Merr. cv. 'Pace'] and cotton [*Gossypium hirsutum* (L.) cv. 'Stoneville 474'], were tested. After 2 weeks, edema ratings and plant height were determined and data were transformed as previously described. The experimental design was randomized complete block with five replicates and a factorial arrangement of the four treatments. Means were separated as previously described.

## RESULTS AND DISCUSSION

**Experiment 1—Preliminary Edema Evaluation**—TSA and SNS plants exhibited blister-like growths, 2 to 5 mm in diameter, mainly on lower leaf surfaces but rarely on upper leaf surfaces (Fig. 1). TSA and SNS were the only two species among several botanical families that showed the above symptoms in our first experiment (Table 1). Cucumber, squash, Texas gourd, sicklepod, hemp sesbania, soybean, cotton, prickly sida, velvetleaf, tomato, bellpepper, eggplant, jimsonweed, and black nightshade were not affected (Table 1). The symptoms appeared on the lower leaves first and then progressed to upper leaves. The symptoms are

consistent with a physiological disorder called "edema."

**Experiment 2—Investigation for Fungal and Bacteria Causes**—Affected tissues were negative for the presence of any pathogenic bacteria or pathogenic fungi (data not shown). Absence of a pathogen was also confirmed by L. M. Treeful, plant pathologist/consultant, St. Paul, MN. Foliar benomyl application did not prevent this disease. Surface sterilization of TSA seeds also failed to prevent edema (data not shown).

**Experiment 3—Attempted Induction of Edema by Chemical Methods**—An analysis of the edema data from Experiment 3 indicated a strong plant species  $\times$  chemical interaction. Therefore, edema data for each species and chemical treatment are presented separately. Data were also averaged across spray concentrations. For SNS, none of the treatments induced more edema than the unsprayed control or Silwet (Table 2). For TSA, none of the treatments increased edema above the control but ABA and LeafShield induced more edema than Silwet. For jimsonweed, Wilt-Pruf induced more edema than all treatments but Silwet.

**Experiment 4—Attempted Induction of Edema by Chemical Methods**—With higher concentrations of ABA and Wilt-Pruf, the analysis of variance showed species had significant differences in reaction to the chemical treatments. For TSA, Wilt-Pruf and ABA induced more edema than the unsprayed control (Table 3). For SNS, the unsprayed control exhibited more edema than ABA and Wilt-Pruf, therefore, the treatments did not induce edema. For jimsonweed, Wilt-Pruf induced more edema than the other three treatments and caused developing leaves to split lengthwise in several sections. Leaves with edema symptoms were smaller and showed chlorosis. Eisa and Dobrenz (1971) reported that eggplant leaves with edema had fewer chloroplasts than unaffected leaves. Overall, the data from Experiments 3 and 4 indicated that the treatments were sometimes, but not consistently associated with edema.

Jimsonweed treated with Wilt-Pruf were stunted in comparison to the control. Soybean treated with Wilt-Pruf that exhibited phytotoxic damage including necrotic lesions within 72 h after treatment. The four other species did not exhibit edema or other disease symptoms. Soybean continued to grow slowly and new leaves did not show necrotic lesions. However, Wilt-Pruf treated soybean were stunted and significantly shorter ( $P < 0.05$ ) compared with the

other three treatments. Plant heights were 163, 169, 176, and 120 cm for the control, Tween 20, ABA, and Wilt-Pruf treatment, respectively. Untreated

jimsonweed plants were 67 cm tall which was not different from the other treatments.

**Table 1. “Edema” ratings for 6 crop and 13 weed species from greenhouse grown plants.**

FAMILY Common name (Scientific name)	Edema Rating <sup>a</sup>	
	1-wk	8-wk
ASTERACEAE (COMPOSITE)	0	0
Common cocklebur ( <i>Xanthium strumarium</i> L.)	0	0
Sunflower ( <i>Helianthus annuus</i> L.)	0	0
CONVOLVULACEAE	0	0
Ivyleaf morningglory [ <i>Ipomoea hederacea</i> (L.) Jacq.]	0	0
Pitted morningglory ( <i>Ipomoea lacunosa</i> L.)	0	0
Purple moonflower ( <i>Ipomoea turbinata</i> Lag.)	0	0
CUCURBITACEAE	0	0
Creeping cucumber ( <i>Melothria pendula</i> L.)	0	0
Squash [ <i>Cucurbita pepo</i> var. <i>meloepo</i> (L.) Alef]	0	0
Texas gourd [ <i>Cucurbita texana</i> (Scheele) Gray]	0	0
LEGUMINOSAE	0	0
Sicklepod ( <i>Cassia obtusifolia</i> L.)	0	0
Hemp sesbania [ <i>Sesbania exaltata</i> (Raf) Rydb. ex A.W. Hill]	0	0
Soybean [ <i>Glycine max</i> (L.) Merr.]	0	0
MALVACEAE	0	0
Cotton ( <i>Gossypium hirsutum</i> L.)	0	0
Prickly sida ( <i>Sida spinosa</i> L.)	0	0
Velvetleaf ( <i>Abutilon theophrasti</i> Medik.)	0	0
SOLANACEAE	0	0
Tomato ( <i>Lycopersicon esculentum</i> Mill.)	0	0
Jimsonweed ( <i>Datura stramonium</i> L.)	0	0
Black nightshade ( <i>Solanum nigrum</i> L.)	0	0
Sticky nightshade ( <i>Solanum sisymbriifolium</i> Lamarck)	1	3
Tropical soda apple ( <i>Solanum viarum</i> Dunal)	1	3

<sup>a</sup>0-3 rating scale where 0 equals no edema to 3 (equals severe blistering, necrosis and stunting).

**Table 2. Percentage of leaves exhibiting edema for five plant species as affected by anti-transpirants. Values are averaged across spray concentrations.**

Chemical	Species				
	Sticky Nightshade (SNS)	Tropical Soda Apple (TSA)	Jimsonweed	Black Nightshade	Tomato
	----- % edema -----				
Control <sup>§</sup>	66 ab <sup>†</sup>	48 ab	0 c	0 a	0 a
Silwet	80 a	32 b	29 ab	0 a	0 a
ABA	82 a	54 a	17 bc	0 a	0 a
Leafshield	69 ab	62 a	20 b	8 a	0 a
Wilt-Pruf	63 b	35 b	48 a	6 a	0 a
Mean	72 A <sup>‡</sup>	46 B	23 C	3 D	0 D

<sup>†</sup>Values in the same column followed by the same letter were not significantly different ( $P > 0.05$ ) using the LSD test.

<sup>‡</sup>Mean values in the last row followed by the same capitalized letter were not significantly different ( $P > 0.05$ ) using the LSD test.

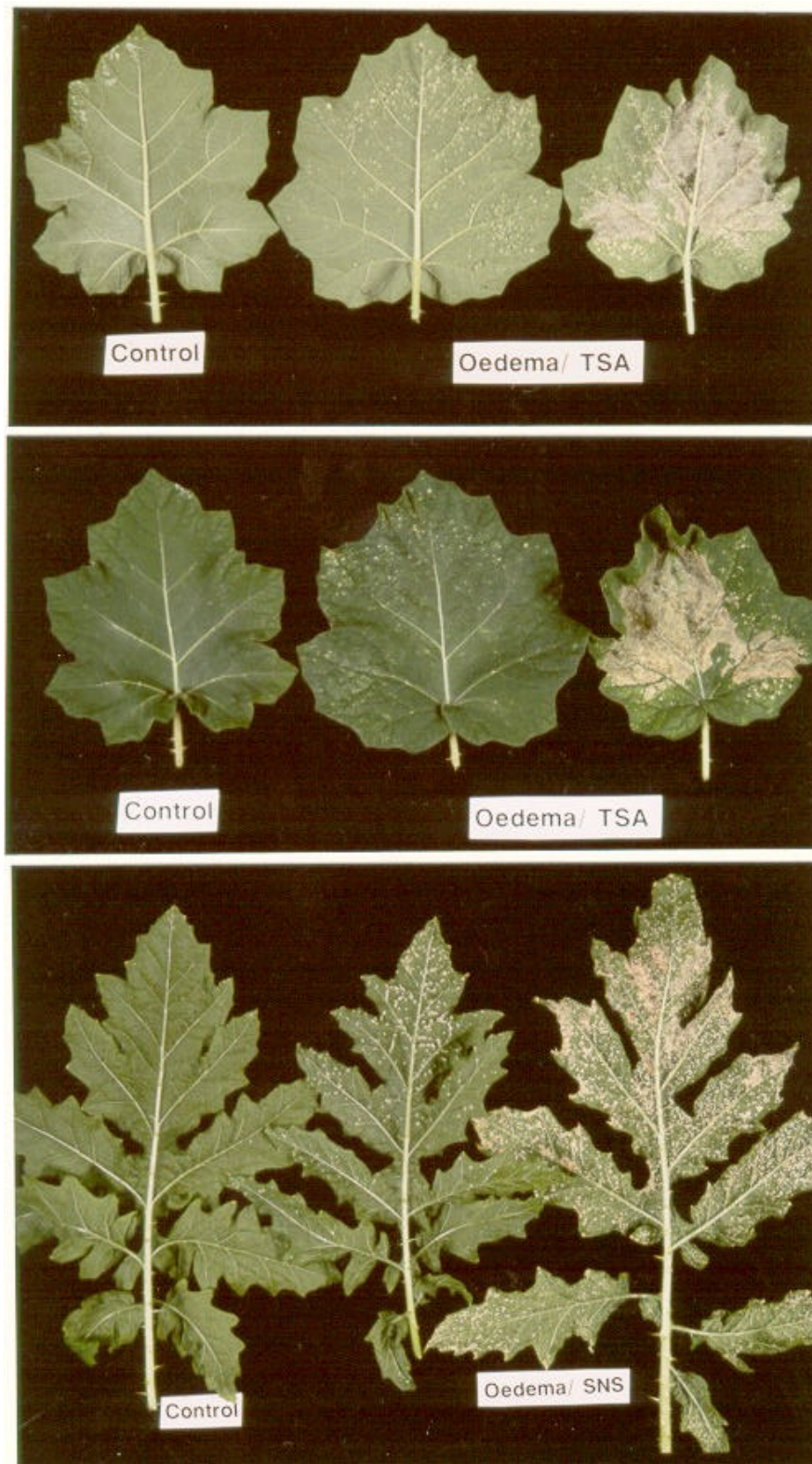
<sup>§</sup>Unsprayed.

**Table 3. Percentage of leaves showing edema after foliar applications of a control solution (0.01% Tween 20),  $2 \times 10^{-4}$  M abscisic acid (+ABA) or Wilt-Pruf (1:3 water, v/v).**

Chemical	Species						
	Sticky Nightshade (SNS)	Tropical Soda Apple (TSA)	Jimsonweed	Black Nightshade	Tomato	Cotton	Soybean
	----- % edema -----						
Control	66 a <sup>†</sup>	39 c	0 c	0 a	0 a	0 a	0 b
Tween 20	50 ab	55 bc	19 b	0 a	0 a	0 a	0 b
ABA	44 b	64 ab	23 b	0 a	0 a	0 a	0 b
Wilt-Pruf	39 b	76 a	66 a	0 a	0 a	0 a	0 b
Mean	38 B <sup>‡</sup>	58 A	27 C	0 E	0 E	0 E	0 E

<sup>†</sup>Values in the same column followed by the same letter were not significant different ( $P > 0.05$ ) using the LSD test.

<sup>‡</sup>Mean values in the last row followed by the same capitalized letter were not significantly different ( $P > 0.05$ ) using the LSD test.



**Figure 1. Edema; (Top)—Lesions on tropical soda apple (TSA) lower (abaxial) surfaces of the leaves and control. (Middle)—Lesions on TSA upper (adaxial) surfaces of the leaves and control. (Bottom)—Lesions on sticky nightshade lower (abaxial) surfaces of the leaves and control.**

## SUMMARY

Although we were able to characterize the extent that different species express edema, we were unable to consistently increase edema in TSA and SNS by applying different chemicals. One exception was Wilt-Pruf applied to jimsonweed which increased edema in both Experiments 3 and Exp. 4. ABA probably acts to reduce transpiration via a physiological process (Hartung and Davies, 1991) whereas LeafShield and Wilt-Pruf probably act via physical means. Because of the inconsistent results for most treatments, the data did not support the hypothesis that reducing transpiration would increase edema symptoms. Instead, our greenhouse conditions of low light intensity and high humidity probably played a critical role in establishing edema in TSA and SNS. Others have also found low light intensity (Sagi and Rylski, 1978), high humidity (Eisa and Dobrenz, 1971), high temperature (Eisa and Dobrenz, 1971), and light quality (Morrow and Tibbitts, 1988) to be critical for the establishment of edema.

This paper provides the first report of this physiological disorder “edema” on the very important and fast spreading weed, TSA. If treatments that increase edema on TSA and SNS can be found without damaging crop plants, our results may contribute to effective control measures.

## ACKNOWLEDGMENT

We thank Dr. L. M. Treeful, Plant Pathologist/Consultant, St. Paul, MN 55119, for confirming this disease. We also thank Ms. Bobbie J. Johnson, USDA-ARS, SWSRU, Stoneville, MS 38776, for the excellent plant culture.

## LITERATURE CITED

- Akanda, R.U., J.J. Mullahey, C.C. Dowler, and D.G. Shilling. 1997. Influence of postemergence herbicides on tropical soda apple (*Solanum viarum*) and bahiagrass (*Paspalum notatum*). *Weed Technol.* 11:656–661.
- Bryson, C.T., and J.D. Byrd, Jr. 1994a. *Solanum viarum* (Solanaceae), new to Mississippi. *Sida* 16:382–385.
- Bryson, C.T., and J.D. Byrd, Jr. 1994b. Tropical soda apple (*Solanum viarum* Dunal) in Mississippi. Mississippi Dept. Agric. & Commerce, Bureau of Plant Industry Bull., 2 pp.

- Bryson, C.T., and J.D. Byrd, Jr. 1997. History, biology, and management of tropical soda apple in Mississippi. *J. Miss. Acad. Sci. (Abstr.)* 42:14.
- Bryson, C.T., J.D. Byrd, Jr., and R. Westbrooks. 1994. Tropical soda apple (*Solanum viarum* Dunal) in the United States. Mississippi Dept. Agric. & Commerce, Bureau of Plant Industry Bull., 2pp.
- Byrd, J.D., Jr., and C.T. Bryson. 1998. Tropical soda apple (*Solanum viarum* Dunal) in Mississippi: 1997 update. *Weed Sci. Soc. Am. (Abstr.)* 38:29.
- Eisa, H.M., and A.K. Dobrenz. 1971. Morphological and anatomical aspects of oedema in eggplants (*Solanum melongena* L.). *J. Amer. Soc. Hort. Sci.* 96:766–769.
- Hartung, W., and W. J. Davies. 1991. Drought-induced changes in physiology and ABA. Pages 63–79 in: Davies, W. J. and H. G. Jones (eds.). *Abscisic acid: Physiology & Biochemistry*, Bios Scientific Publishers, Oxford, UK.
- Howard, R.J., J.A. Garland, and W.L. Seaman. 1994. Diseases and pests of vegetable crops in Canada. Canadian Phytopathological Society and Entomological Society of Canada, 554 pp.
- Littell, R.C., G.A. Milliken, W.W. Stroup, and R.D. Wolfinger. 1996. SAS system for mixed models. SAS Institute, Inc., Cary, NC. 633 pp.
- Morrow, R.C. and T.W. Tibbitts. 1988. Evidence for involvement of phytochrome in tumor development on plants. *Plant Physiol.* 88:1110–1114.
- Mullahey J.J., J.A. Cornell, and D.L. Colvin. 1993. Tropical soda apple (*Solanum viarum*) control. *Weed Technol.* 7:723–727.
- Mullahey, J., and J. Cornell. 1994. Biology of tropical soda apple (*Solanum viarum*): an introduced weed in Florida. *Weed Technol.* 8:465–469.
- Nee, M. 1991. Synopsis of *Solanum* section *Acanthophora*: a revision of interest for glycoalkaloid. Pages 258–268 in J.G. Hawkes, R.N. Lester, M. Nee, and N. Estrada, (eds.) *Solanaceae 111. Taxonomy, Chemistry, Evolution*. Royal Botanic Gardens Kew, Richmond, Surrey, UK.
- Patterson, D.T., and M. McGowan. 1996. Environmental limits to the distribution of tropical soda apple (*Solanum viarum* Dunal) in the United States. *Weed Sci. Soc. Am. (Abstr.)* 36:3.
- Saettler, A.W., N.W. Schaad, and D.A. Roth. 1989. Detection of bacteria in seed and other planting material. APS Press, American Phytopathological Society, St. Paul, Minnesota. 122 pp.
- Sagi, A., and I. Rylski. 1978. Differences in susceptibility to oedema in two tomato cultivars growing under various light intensities. *Phytoparasitica* 6:151–153.
- Steel, R.G.D., and J.H. Torrie. 1980. Principles and procedures of statistics: A biometrical approach. McGraw Hill Book Company. New York. 633 pp.

## President's Column

### Challenges and Opportunities for the New Millennium

I have just returned from Tupelo and the 63<sup>rd</sup> Annual Meeting of this Academy. The flush of success from that meeting offers a good basis for reflection on the progress of this past year. It also offers an excellent springboard for looking ahead to the leadership of Dr. Susan Nodurft, our incoming President, and to configuration of the Academy for entry into the next millennium.

The Tupelo meeting was a gamble for the Academy. We have not, in recent memory, attempted to hold a meeting outside of the traditional locations of Jackson and Biloxi. The Convention and Visitors Bureau of Tupelo has worked assiduously to court us to Tupelo. While all the numbers are not yet compiled, it appears as though there were no negatives associated with meeting in Tupelo. The Convention Bureau personnel were a major and very helpful presence at the meeting registration area, representatives of the Bureau met with the Academy leadership every day to ensure smooth operations, hotel and restaurant facilities were pleasant, and the convention facility itself seemed to accommodate our every need. We saw a 20% increase in the number of abstracts submitted to the meeting, with a total of approximately 360 being published. Two major symposia, a Neuropsychiatry symposium organized by Dr. John Piletz of the Health Sciences Division, and a symposium on History and Philosophy of Science, organized by Dr. Ken Curry, increased the scope of presentations at the meeting. Efforts such as these significantly improve attendance at and interest in the annual meeting. I strongly encourage greater efforts by our membership to develop symposia for next year's meeting as well. A greater presence of faculty and students from north Mississippi campuses was evident, although we did see fewer folks traveling from the southern reaches of the state. Altogether, the Tupelo site creates an equitable balance in the burden of travel for our members. We will be back in Biloxi next year for the millennial meeting and have not yet decided on a site for the 2001 meeting. If you have strong feelings about Tupelo as a potential site for the 2001 meeting, please pass them on to Cynthia Huff at the Academy office in Jackson or contact any of the Academy officers.

The 1999 Charles L. Dodgen Lecture was

presented by Harold Henderson, M.D., from the University of Mississippi Medical Center Division of Infectious Diseases, with the assistance of Ms. Sybil Jones. The title of the presentation, "The Face of HIV/AIDS in Mississippi" prefaced a truly captivating exposition of the disease processes, current treatment protocols and the epidemiology of HIV/AIDS in this state. A human "face" to the issues was provided by Ms. Jones, who proved to be a uniquely effective educator for the audience. In recognition of her abilities and efforts, we have offered Ms. Jones a honorary membership in the Academy.

Clearly, the challenges of managing our societies response to HIV/AIDS will be paramount as we begin the next millennium. As suggested by an editorial in the New York Times (Oct. 7, 1985):

"Fear and ignorance about AIDS can so weaken people's senses as to make them susceptible to an equally virulent threat: bigotry."

The efforts of bright, dedicated, and eloquent individuals like Dr. Henderson and Ms. Jones, and forums like the Academy's Dodgen Lecture, are our best defense against this threat. I hope to see more presentations of this type sponsored by our Academy in the future. As scientists, as educators, and as spokespersons to the public on issues of science policy, this is an area where we can make a difference.

In evaluating the activities of this past year, the Academy and its major efforts, the *Journal of the Mississippi Academy of Sciences*, and the Junior Mississippi Academy of Sciences, have done well. The *Journal* is now listed in three national abstracting agencies, publishes issues quarterly and is enjoying a real renaissance. The Junior Academy has once again sponsored outstanding science and has identified two gifted students, Mr. Amit Goel and Ms. Katie Underwood as our overall winner and Clyde Sheely second place awardee, respectively.

Nevertheless, while our Academy does appear to be flourishing, I will reiterate the theme that I introduced when I donned the mantle as President. We must strive to be pro-active and develop increasingly means of configuring our Academy for



the future. Dr. Nodurft's leadership promises to be tailor made to meet this challenge. Fresh, innovative and dedicated, I can anticipate that Dr. Nodurft will carry the Academy forward to new heights.

Based on my experience and President-Elect and as President, I will suggest three themes upon which Dr. Nodurft and the Academy can focus. These are: Membership, Information Technology and Corporate Sponsorship.

To deal with the last, first, the Academy got off to a great start on increasing corporate sponsorship last year as a result of the efforts of Dr. Rosalina Hairston. We need to redouble those efforts. Corporate sponsorship allows us to offer significant awards to our students and faculty, helps to provide honoraria that increase the attractiveness of speaking engagements at the Annual Meeting, and could be used to offset page charges and increase submissions to the *Journal*. I would challenge all members to submit ideas (and the names of potential contacts within corporate entities) to Ms. Cynthia Huff at the Academy office. These will be acted upon aggressively by the Academy leadership. However, we need to hear about such contacts and a personal connection always increases the chances of securing a sponsorship.

The issues of membership and information technology are closely linked in my mind. Information technology (IT) offers now and will continue to offer the greatest opportunity to bring new membership into our Academy. The community

college system, in particular, is intimately involved in training of this segment of the scientific/technical/educational population. We, as an Academy, need to aggressively court IT educators and scientists into the Academy. It would be prudent to consider establishment of an IT Division for the next annual meeting. I offer a second challenge to our members to step forward to assist us in organizing such a division and to secure the additional membership to support an IT division. I will also continue to work in establishment of a membership network for the Academy. I envision using the immediate Past-President as Membership Chair, and organizing the state into three zones, membership efforts for each of which would be coordinated by one of the three Academy Director's. An individual at each of our community colleges and four year institutions of higher learning would be designated as the membership contact for each campus. Through a network such as this, we can distribute information about the involvement of each campus in academy activities and maintain the type of communication that should reap additional benefits in increased membership. My final challenge will be for interested individuals at each campus to step forward and identify themselves to me as such contacts.

Every new challenge is a new opportunity for growth and productive change. I thank the academy for permitting me the challenges of leadership and look forward to continued service.—Rob Rockhold

## Executive Officer's Column

I'm happy to report that we had a successful meeting in Tupelo this year. The Board of Directors took a big chance by altering our normal pattern of meeting sites. Historically, we have moved between Jackson and Biloxi. With Jackson pricing itself out of our market and Biloxi not far behind, we have been exploring alternatives. Tupelo went to the top of our list after we had a site visit. However, scientists tend to be conservative and resist change. We had nightmares of a meeting with just Division Heads and Board members!

Instead of disaster, we had a real success. We set a record for number of abstracts this year, 360. This did not overburden our meetings because many were poster presentations. We had about 750 meeting

attendees which is slightly down from last year but still a sizeable number. This included a large number of scientists and students from the University of Mississippi. In past years their attendance has been fairly low; this meeting was geographically advantageous for them. We also had a very active vendor exhibit with over 20 presenters.

Beyond the numbers, we also had a meaningful meeting with many positive comments about the quality of presentations. We had a unique two person Dodgen presentation. Dr. Harold Henderson spoke to us about the biology and epidemiology of HIV and AIDS. We saw the human face of this tragedy when Dr. Henderson introduced us to one of his patients. She in turn told us of her various maladies and drug

protocols. The audience was mesmerized. At first no one was ready to ask a question, but then everyone had questions. It was an amazing Dodgen lecture.

As usual the meeting would not have worked without the work of many people. We are particularly thankful for the efforts of our Associate Executive Officer, Cynthia Huff and our indefatigable Journal Editor/Tactical Program Chair Ken Curry. Their planning and arrangements helped ease us into an unfamiliar venue. We'd also like to thank the Tupelo

Visitor's and Convention Bureau. They supplied a seemingly tireless group of workers to assist with our registration. Of course we need to thank our membership for turning out and showing off the good science being done in Mississippi. We'll be in Biloxi next year with our dates set for February 24, 25. By that time all of the Y2K disasters should have passed and we'll be charging into the new millennium (which we all know really starts on January 1, 2001).—John Boyle

### Mississippi Junior Academy of Sciences 1999 Paper Competition

The Mississippi Junior Academy of Sciences held its annual paper competition on January 30, 1999 at Mississippi College in Clinton, Mississippi. The host for this year's competition was Dr. Robert Hamilton of Mississippi College. The morning started with Katie Underwood, MJAS President, and Dr. Joan McCoy-Messer, MJAS Director, welcoming everyone to the competition. Next the individual competition started. The competition was well represented with one Class I category and with six Class II categories. Each category had one winner and one special recognition award, with the exception of a tie in one category.

The winner of the Class I category was Emily L. Almas with her paper, "The Effects of Caffeine on Weight Gain in Female Mice." The winner of the special recognition award for Class I was Gita Subramony with her paper, "A Study of Freeze Damage on Plant Cells and the Effect of Cryoprotectants."

The winners of the Class II categories are as follows: Emily Katherine Underwood, "The Design and Testing of a Portable Seismic Telemetry Station"; Mary Ann Sodachanh, "Analyze the Possible Inhibitory and Suppressing Effects of Chrysanthemum Extracts and Licorice Extracts on the Tobacco Mosaic Virus"; Amit Goel, "The Effects of *Commiphora mukul* on Cholesterol Levels of Hypercholesterolemic Rats and the Binding Ability of *Commiphora mukul* with Bile Salts that are key in the distribution of Cholesterol: A Two Stage Study"; Patrick Black, "The Use of Biofiltration for the Decontamination of Water"; Nathan Wilson, "Hypergravia and Growth: "Space Shuttle Inspired Research on the Home Planet"; Tiffany Williams, "A Comparison of Social Behaviors of Spider Monkeys (*Ateles fusciceps*) and Saki Monkeys (*Pithecia*)

at the Jackson Zoological Gardens"; and LaDerious Williams, "Student Experiences Versus Parents' Perception of Those Experiences as Possible Influences on School Violence."

Those awarded special recognition in Class II were as follows: Alexander Grant Clark, "2084: Security for the 21<sup>st</sup> Century"; John Benjamin Ward, "The Effect of Concentrated Garlic on *Escherichia coli* and *Staphylococcus epidydimis*"; Carrie Garner, "*Aleurites fordii* and Cancer: Is There a Link"; Jonathan Godwin, "Determining Paternal Spawning Behavior of Channel Catfish, *Ictalurus punctatus*"; Carrie Smith, "Can We Conserve Forests by Cashing in on Agricultural Wastes?"; and Raquel Sloan, "The Effect of Color on the Brain's Ability to Process Information."

After the competition, Dr. Janelle S. Pryor, professor at Mississippi College, gave a keynote address on "The Human Genome Project." Then everyone broke for lunch.

After lunch the divisional finalist competition was held. The winners of the competition are as follows: Honorable Mention: Patrick Black; Second Place: Emily Katherine Underwood; First Place: Amit Goel.

Then the business meeting was held. The new officers are as follows: President—Alexander Grant Clark; Vice-President—Patrick Black; Secretary—Nathan Wilson; Reporter—Leanne Sloan; Board Members: Regina Schommer, Jonathan Crownover, and Nicklaus Simpson. The 1999 Mississippi Junior Academy of Science Paper Competition was a huge success!!—Joan Messer

## Mississippi Junior Academy of Science 1999 Paper Competition



**Emily L. Almas, Class I (9<sup>th</sup> and 10<sup>th</sup> grade) overall winner.**



**Class II winners in each of the six categories (left to right): Mary Ann Sodachanh (Molecular Biology), Katie Underwood (Physics and Mathematics), LaDerious Williams (Behavior Sciences-tie), Patrick Black (Microbiology), Nathan Wilson (Physical Sciences), Amit Goel (Biochemistry), Tiffany Williams (Behavior Sciences-tie).**



**Special recognition in class II (left to right): Alexander Clark, John Wand, Pamela Conerly, Carrie Garner, Jonathan Godwin, Carrie Smith, Raquel Sloan.**



**Mississippi College Conference Speaker Dr. Janelle S. Pryor and Conference Liaison Dr. Rob Hamilton.**

## Divisional Reports

### Agriculture and Plant Science

A total of 14 oral presentations and 10 posters were delivered at this year's annual meeting. While the number of paper presentations remained the same as last year, poster presentations increased fivefold this year. Seven and three of the oral presentations were made by graduate and undergraduate students, respectively. Participation in the morning and afternoon sessions were excellent as both sessions were well attended. Similarly, the poster session also received good response and generated substantial interest between members and participants.



**Robin Case, Alcorn State University, wins first place in the graduate category in Agriculture and Plant Science. The award is presented by division chair Liang Huam.**

The division held its business meeting on February 26, 1999, at 3:15 p.m. Dr. James Garner, Mississippi State University was elected to the Division Chair position and Dr. Franklin Chukwuma, Alcorn State University to the Vice-Chair position. Based on the evaluation of a panel of three judges, the division made two graduate and one undergraduate student paper awards at the beginning of the business meeting. The cash awards were provided by Magee Graphics, Brookhaven and Dianne Frame Shop, Natchez. The award for best undergraduate paper was presented to Deron Burkepille of University of Mississippi for a paper entitled, "Toxicity Effects of the Organophosphate Insecticide Diazinon on Five Non-Target Freshwater Species." The first and second place graduate student papers were presented

to Robin Case of Alcorn State University and Jana Avant of University of Southern Mississippi, respectively. Their papers were entitled, "Assessing the Benefits and Costs of Using Black Plastic Mulch and Sweet Potato and Squash as Intercrops in Small-Scale Okra Cultivation" and "The Effect of Chitosan on Anthracnose Infection of Strawberry by *Colletotrichum acutatum*," respectively. Over all, the quality of the work presented was higher than in the past. Personally, I believe this division had a successful year as members were prompt and responsive to all types of request from the Academy. The meeting adjourned at 3:45 p.m.—Liang Huam

### Cellular, Molecular, and Developmental Biology

The sixty-third annual meeting of the MAS was a successful one for the Cellular, Molecular, and Developmental Biology division. There were thirty-three platform presentations, including eleven by undergraduate students, fifteen by graduate students, and one by high school junior Amit Goel, the overall winner of the Mississippi Junior Academy of Sciences competition. Nine posters were presented. The highlight of the divisional meeting was a presentation by invited speaker Dr. Brian Scheffler of the USDA portion of the National Center for the Development of Natural Products, based at the University of Mississippi.



**La Sharon Mosely, Mississippi University for Women, accepts the C<sup>2</sup> Corporation award for undergraduates from division chair Sarah Lea McGuire (left). Her mentor, Nancy Hopkins is on the right.**

Awards were presented for the best undergraduate and graduate student platform presentations. The award for the most outstanding undergraduate presentation sponsored by C<sup>2</sup> Corporation was presented to LaSharon Mosely of the Mississippi University for Women. The Fisher Scientific Biotechnology Award for the most outstanding graduate presentation went to Cecilia Chi-Ham of the University of Southern Mississippi. The superior quality of all of the student presentations is an indicator of the quality of students and mentors in our State.

At the division business meeting, Dr. David Carson, Mississippi University for Women, was elected chair for next year's meeting, and Dr. Peter Butko, University of Southern Mississippi, was elected division vice-chair. Special thanks go to Dr. Steve Case for his advice and continued efforts to improve the division, to Dr. David Carson for expert audio-visual assistance, and to C<sup>2</sup> Corporation and Fisher Scientific for sponsoring student awards. The division looks forward to continued success in the coming year.—Sarah Lea McGuire

## Health Sciences

The Health Sciences Division was chaired for 1998-1999 by John Piletz, and Zelma Cason was the Vice-Chairperson. We experienced substantial growth this year. Firstly, we had more abstracts than ever before. Abstracts were solicited by mailing packets to all previous members as well as to colleagues at our major universities and colleges in Mississippi rather than to just those at the University of Mississippi Medical Center (UMC) as had been the previous tradition. In addition, the organizers announced a brand new awards program. This included not only the endowed Douglas-Walker Award for overall best presentation, but also ten new awards in four categories: (1) High School Student Awards—first, second and third place, (2) Under-Graduate Student Awards—first, second and third place, (3) Post- Baccalaureate Degree Awards—first, second and third place, and (4) Research Technician Award. In mid-June when these awards were first announced, there was no assurance that our fund raising efforts would be successful, and so this was a step of faith. But, thankfully, we received sponsorship (\$330) from the Janssen Pharmaceutical Company for the student portion of these awards, as

well as from two private donors for the Research Technician Award (\$25). There was no cost to enter the contest. The result was a *major increase* in the number and quality of the abstracts. This year we had 75 submissions, compared to 32 abstracts the year before. To anyone's memory, this is the most abstracts that any division of the MAS has ever had. We certainly thank the Janssen Pharmaceutical Company for their generous support, as well as all of the paper presenters for making this such a success.



**Health Sciences Awardees (left to right): Krashard Byrd, 2<sup>nd</sup> place High School Award; Hai Hua Chen, Research Technician Award; Michelle Tucci, Douglas-Walker Award; John Piletz, division chair; Kimberly Cornelius, 1<sup>st</sup> place High School Award; Zelma Cason, division vice chair.**

The abstracts were judged by a diverse team of dedicated faculty members: Dr. Garth Bissette from UMC—Department of Psychiatry, Dr. Roger Johnson from UMC—School of Dentistry, Dr. Aaron Puckett from UMC—School of Dentistry, and Dr. Margaret Hall from University of Southern Mississippi. Each presentation was judged by standardized criteria with one-half value for the written abstract and one-half value for the oral presentation. Presentations were either a ten minute platform talk or a five minute poster defense. Fifty-six of the seventy-five abstracts were judged, and all of them were excellent. In several cases, the judges had to go to the 2<sup>nd</sup> decimal point to decide the winner. This year's "overall best" Douglas-Walker Award went to Michelle Tucci for her presentation entitled "Inhibition of PLD by administration of ethanol impairs translocation of NF-KB in macrophage cells." In the high school category the winners were: First Place, Kim Cornelius; Second Place, Krashard Byrd; Third Place, Edward Moore. In the Under-Graduate category the winners were: First Place, Gretl Zimmerman; Second Place, Brad

Franklin; Third Place, Jeremy Allen. In the Post-Baccalaureate Degree category the winners were: First Place, P. Patel; Second Place, H. Huang; Third Place, David Parks. The Research Technician Award went to Hai Hua Chen. We congratulate all of them, as well as their co-authors and mentors, on a job well done!

Another “first” of this year’s meeting was the symposium entitled “NeuroPsychiatry.” This is the first time to our knowledge that a symposium at the MAS has given Continuing Medical Education credits for physicians and nurses. For only \$10 the registrants more than the MAS registration fee, attendees could obtain 3 hours in Category 1 credit towards the AMA Physician’s Recognition Award. This CME Symposium was jointly sponsored by the MAS and the University of Mississippi Medical Center. Cynthia Huff of the MAS office kindly help us send out 650 announcements of this symposium. They were sent to all the psychiatrists and clinical psychologists, and to many general and family practitioners, in the northern half of our state. Three experts from UMC talked about the neurobiology and treatment of various psychiatric disorders. Dr. Angelos Halaris, Chairman and Professor of Psychiatry, reviewed the research programs at UMC on the neurobiology of clinical depression. Dr. Garth Bisette, Professor of Psychiatry, spoke on dementias—with emphasis on Alzheimer’s disease. Dr. Bill Wolverton, Director of the Division of Neurobiology and Behavior Research and Professor of Psychiatry, spoke on drug abuse—with emphasis on what has been learned from cocaine research with monkeys. The symposium was chaired by Dr. John Piletz, Professor of Psychiatry at UMC, who also made a presentation on his research for a blood test for depression. A question-and-answer session concluded the symposium on such topics as the neurobiology of schizophrenia and anxiety disorders. It was also announced that two summer undergraduate fellowships will be given to students to do 8 weeks of research in NeuroPsychiatry at UMC this summer; interested individuals can contact any of the symposium speakers. We are thankful to the Janssen Pharmaceutical Company for providing a free refreshment table and other amenities towards this symposium. Attendance at the symposium was about 50 people.



**Neuropsychiatry Symposium Speakers (left to right): John Piletz, Bill Wolverton, Garth Bisette, Angelos Halaris, Zelma Cason.**

The Divisional Business Meeting was held on Friday afternoon. The Chair thanked all of his co-workers, especially Zelma Cason, for all the hard work that went into making this meeting a big success. Special thanks should also go to Dr. Hamed Benghuzzi (UMC) and his students for helping to set up the easels for the poster session, and to Dr. Henry Nasrallah (UMC) who worked behind the scenes to arrange the award sponsorships from Janssen. The Chair also suggested that next year he would like to have individual “Session Chairs” at the meeting under the direction of the new Chair and Vice-Chair, to help distribute the work load during the meeting. He also mentioned that volunteers are always welcome to help by simply contacting the Chair at any time. His only “criticism” was that many students skipped the NeuroPsychiatry Symposium, and that this was embarrassing since we had attracted the Janssen Pharmaceutical sponsorship based on this symposium. He said that a small amount of surplus funds remained (\$65 from Janssen Pharmaceuticals) for our Division in hopes of continuing the awards program next year. Elections took place. Vice Chair Zelma Cason was the only nominee and she was unanimously elected Chair for 1999–2000. Dr. Aaron Puckett was the only nominee (from Zelma Cason) and he was unanimously elected Vice-Chair for 1999–2000.—John Piletz and Zelma Cason

## History and Philosophy of Science

A special symposium on the philosophy of science attracted nine papers including topics addressing science and pseudoscience, general philosophical concerns in life sciences, concerns with the concept of species, realism in physics, a model for a unified fields theory, and several papers concerned with the relationship between science and religion.

Officers representing the Southern Association for the History of Medicine and Science had discussed the possibility of meeting with the Academy in Biloxi in 2000. With this encouragement and some enthusiasm from Academy members about a new division, the matter was brought before the MAS board. The board voted to establish a new division. Dr. Rob Hamilton was elected as chair of the division for 2000 and Dr. Rob Waltzer was elected as vice chair.—Ken Curry



**Ray Westra, Belhaven College, delivers one of the symposium talks at the new division.**

## Mathematics, Computer Science and Statistics

The division of Mathematics, Statistics and Computer Science conducted a successful session with the presentation of papers on a wide range of topics. Authors included students and faculty from the University of Southern Mississippi, The University of Mississippi, Mississippi State University, Mississippi Valley State University, Florida State University, The Mississippi State Department of Health and Millsaps College.

Andrew Royappa of Millsaps College presided as chair of the division. At the divisional business meeting, Academy members elected Walter Brehm of the United States Air Force, Keesler AFB, to chair the division next year, and elected Dale Bowman of the University of Mississippi as vice-chair. The Mississippi Chapter of the American Statistical

Association also held its annual business meeting, electing Mary Baggett as vice-president and Todd Nick as representative to the Council of Chapters. The division looks forward to continued growth and activity next year.—Andrew Royappa

## Physics and Engineering

The Physics and Engineering Division of MAS was well represented at the Sixty-Third Annual Meeting, held at Tupelo, MS, February 25-26, 1999. In all there were thirty-four presentations—33 oral and 1 poster. Of these, nineteen papers were presented by students, graduate, undergraduate, and one from high school (MSMS). Majority of the papers were presented by physicists. Most of the papers were of excellent quality, and well presented. MSU had the leading number of presentations (14), followed by UM (10), ASU (4), USM (4), MSC (1), WES (1), and MSMS (1). The topics had large variation, including astrophysics, radiation physics, molecular vibration, liquid crystal. The papers presented by students were so good that it became difficult for me to grade for award. The meeting covered almost two full days. However, attendance by professors was poor and disappointing. We did not have volunteers to grade the students' papers for recognition and award. We have decided that the papers presented by each student was excellent, and therefore, every student's effort is appreciated and well recognized by the Division. We look forward to still stronger and better representation at the 2000 meeting.—Amin Haque

## Social Sciences

Several difficulties undermined the Division of Social Sciences meeting at this year's academy conference. First, the Academy was scheduled at the same time as the annual Southern U.S. meeting of anthropologists. Since the Social Sciences Division Chair, Dr. James Flanagan holds responsibilities in that other organization, he asked Dr. Ann Marie Kinnell, Vice Chair of Social Sciences, to take over the meeting.

The meeting was also not attended by Mississippi Social Scientists, possibly because the conference was held in Tupelo, a less popular site than Biloxi. The two morning sessions included only the Vice of the Divisions and one of the two presenters. The two

afternoon sessions were compressed into one meeting which was well attended (48 participants). The focus of that meeting was to initiate a social science study on minority students who are majoring in sciences and mathematics around the state. Surveys were distributed.

The Business Meeting followed with the election

of a new Chair (Ann Marie Kinnell) and a new Vice Chair (Emmanuel Nwagbosa). Members of the division discussed ways to strengthen the response for next year's conference. Addresses of Mississippi Social Scientists will be provided for the new Chair.—James Flanagan and Ann Marie Kinnell

[Editor's note: This abstract was received too late for inclusion in the January abstract issue of this journal.]

## HEALTH SCIENCES

### THE EFFECTS OF IMIDAZOLINES ON THE GROWTH OF MEG-01 CELLS

Tennille Howard\* and John Piletz, University of Mississippi Medical Center, Jackson, MS 39216

The effects of imidazolines on a human megakaryoblastic cell line known as MEG-01 were investigated. The cells were incubated at 37°C at 5% CO<sub>2</sub> in RPMI 1640 and 10% bovine serum. The drugs used were Moxonidine (MOX), Idazoxan (DX), Norepinephrine (NE), Yohimbine (YOH), and Agmatine (AGM). Moxonidine and Idazoxan have affinities for the imidazoline receptor, which may be a marker on human platelets for depression, although Norepinephrine and Yohimbine have an affinity for the imidazoline receptor, they show greater affinities for adrenergic receptors. Agmatine shows no specific affinity. The hypotheses were as follows: the imidazoline compounds MOX and DX will inhibit the growth of the cell line, the anti-proliferative effects will be greater with compounds having preferential affinity for imidazoline receptors rather than for adrenergic receptors, and Agmatine will have inhibitory effects. In the study, the attached cell number, the number of nuclei of attached cells, platelet like particles, and floating cell number were observed. The results obtained indicate that NE, AGM, YOH and YOH+NE inhibited attached cells. Nuclear division was inhibited by AGM, YOH, NE, and YOH+NE. The platelet like particles showed a reduction when YOH+NE was used. AGM, NE, and YOH inhibited the growth of the floaters. In sum, the imidazoline compounds DX and MOX did not have inhibitory effects. This research was supported by NIMH-COR Grant MK-16926-16.