EFFECT OF TILLAGE AND SOIL-APPLIED HERBICIDES ON *MIMOSA INVISA* (MART.) CONTROL IN A HUMID TROPICAL ENVIRONMENT

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ABSTRACT

A two-year field study was conducted to evaluate the effects of tillage and soil-applied herbicides on *Mimosa invisa* (Mart.) control. The study was carried out in a split-plot arrangement with tillage methods (mound, ridge, no-till) as main plot treatment. The herbicides evaluated were codal at 2 and 3 kg a.i. ha^{-1}, diuron at 3 kg a.i. ha^{-1}, primextra at 3 kg a.i. ha^{-1} and imazapyr at 1.0 and 1.5 kg a.i. ha^{-1}. A herbicide free treatment was included as a check and was used to compute level of control by each herbicide relative to untreated check plot. The efficacy of the treatments on *M. invisa* was assessed weekly through seedling emergence. The density of *M. invisa* was similar in two tillage methods. The two tillage methods gave better control of *Mimosa* than no-till by reducing seedling emergence in the two years of the study. The no-till treatment had 50-61% (averaged over two years) more *Mimosa* seedlings than tilled plots. All the herbicides were more effective in controlling *Mimosa* in tilled than in no-tilled plots. The efficacy of the herbicides on *Mimosa* was in the order imazapyr > primextra > codal > diuron. These results indicate that *M. invisa* infestation could be reduced by tillage but a significant control of the weed could be achieved with appropriate herbicides in combination with tillage.

INTRODUCTION

The management of *Mimosa invisa* (Mart.) can be a significant challenge in cropping systems, plantations, rangelands, grazing lands, subsistence gardens and non-productive areas such right-ofways where it reduces crop yield, and interferes with other production ventures. The competitive nature of *M. invisa* in annual and perennial crops has been documented (Melifonwu, 1994; Alabi, 1999; Alabi *et al.*, 2001;Alabi and Makinde, 2002). Alabi *et al.*, (2001) reported over 85% cassava root yield reduction in a farm infested with natural population of *M. invisa*. Livestock poisoning from cyanide and nitrite after grazing *M. invisa* has been reported (Tungtrakanpoung and Rhienpanish, 1992).

No, effective method of control of this weed has been documented. The inability of farmers to manage the weed successfully has been attributed to the thorny nature of the foliage (Alabi, 1999; Alabi *et al.*, 2001) which makes hoe weeding difficult. A limited number of herbicides have been tested for its control. For example, single application of atrazine, or atrazine + metolachlor and betazon + propanil has shown poor control of the weed (Melifonwu, 1994). The inability of these herbicides to control *Mimosa* has been attributed to seed dormancy in the soil (Melifonwu, 1994; Alabi *et al.* 1999). There is need to screen more herbicides for *M. invisa* control and to integrate new and already tested herbicides with other weed management tactics for effective management of the weed. An important management factor to consider is tillage. For example, tillage has been shown to deplete weed seedbank (Swanton *et al.*, 2000; Unger *et al.*, 1999) which is the main source of weed infestation in crops. The effect of tillage on weed density and composition is well-documented in the temperate regions of the world. It has been reported to cause shifts in weed communities, species composition, and weed densities (Swanton *et al.,* 1993; Unger *et al.*, 1999). Shrestha *et al.* (2002) found that weed density was greater in conventional tillage than in no-tillage systems. The authors attributed the higher weed density to ploughing which could have brought weed seeds from lower soil profiles to a depth that was favorable for germination and emergence. Currently, the authors are not aware of any published work that has assessed the combined effects of herbicide and tillage on *M. invisa* control in the humid tropical environment where its effects on crop production are most evident. Ridge or mound making is a conventional tillage system commonly practiced by farmers.

The objective of this study was to evaluate the interaction of tillage and soil-applied herbicide on *M. invisa*. Specific questions to answer include: Does tillage lead to more seedling emergence than no-till conditions? Which of the tested pre-emergence herbicides controls *Mimosa* most? This information would be useful to farmers, livestock owners and environmentalist in making decisions on *M. invisa* control.

MATERIALS AND METHODS

Field research was conducted in 2002 at the Research Farm of the National Root Crop Research Institute, Umudike and in 2003 at the Michael Okpara University of Agriculture Research Farm, Umudike. The soil at both sites was Typic Paleudult. The experiment was setup in split plot arrangement of treatments with four replications. Tillage method was the main plot which was comprised of ridge, mound and no-till plots. The subplot treatments were metolachor + prometryn [as Codal ® 400EC] at 2 kg a.i. ha^{-1}, metolachor + prometryn at 3 kg a.i. ha^{-1}, diuron ® 800 WP at 3 kg a.i. ha^{-1}, imazapyr at 1.0 kg a.i. ha^{-1}, imazapyr at 1.5 kg a.i. ha^{-1}, metolachlor + atrazine [as Primextra ® 500 FW] at 3 kg a.i. ha^{-1} and untreated check. Mounds and ridges were used because they form major tillage practices by farmers in the study area (Akobundu, 1987). The experiment was conducted in uncropped plots. Each main plot was 28 m by 28m, whereas subplot was 4 m by 4 m in size each.

In both years clearing of vegetation and tillage were done by the second week in April. Pre-emergence herbicides were applied on 19 April in 2002 and on 12 May in 2003. *Mimosa emergence* was assessed in two 0.5 m by 0.5 m quadrats located in a diagonal transect across each subplot. The number of *M. invisa* seedlings in each quadrat was counted weekly starting on 3 May through 19 July 2002 and on 26 May through 21 July 2003. After seedlings were counted, they were pulled and removed from the quadrat.
Percentage control or reduction in *M. invisa* emergence relative to the untreated check plot was computed for each sampling date as:

$$\left(\frac{D_{ut} - D_{tr}}{D_{ut}}\right) 100$$

where D_{ut} = Density of *M. invisa* in untreated check plot and D_{tr} = Density of *M. invisa* in plots treated with herbicides for each sampling date. Seedling emergence data were subjected to analysis of variance (ANOVA) using the Mixed Model Procedure in SAS (1999). Means were compared with the standard error test at the 0.05 level of probability. Data were analyzed and presented separately for each year because of year differences [P = <.0001] and year by treatment interactions ([P = <.0001: Tillage x Year], [P = 0.0130: Herbicides]).

RESULTS AND DISCUSSION

Tillage effects

Tillage had a significant effect on density and magnitude of *M. invisa* emergence [P = <.0001]. The two tillage methods gave better control of *M. invisa* than no-till by reducing seedling emergence in 2002 and 2003 (Fig. 1). For example, the no-till plots had 50 and 57% (2002) and 61, and 54% (2003) more *Mimosa* seedlings than ridge and mound till plots, respectively. This result agreed with Buhler and Daniel (1988), and Stahl *et al.*, (1999), who reported greater weed density and extended weed emergence on no-till soils compared to tilled soils.

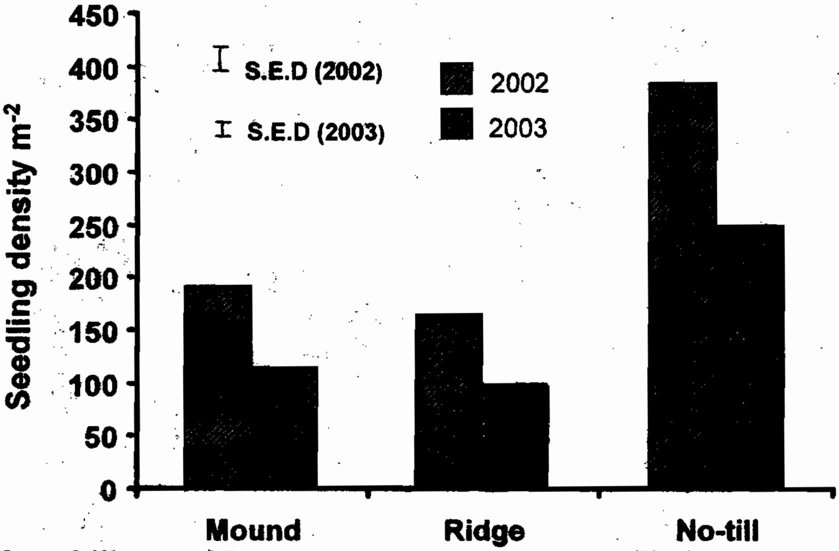

Fig. 1: The effect of tillage on *Mimosa invisa* emergence at Umudike in 2002 and 2003. Each bar represents total emergence 12 weeks after treatments.

This trend may in part be attributed to differential seed location in the soil profile as a result of soil movement during tillage. Previous studies have shown that no-till systems result in a seedbank that is concentrated in the surface layers of the soil (Cardina *et al.*, 1991), whereas deep tillage or plowing results in a seedbank that is more evenly distributed in the soil profile (Yenish *et al.*, 1992). In general, the density of *Mimosa* seedlings was higher in 2002 than in 2003. One plausible reason for this trend may be due to differences in the amount of precipitation received in the two years. Total amount of rainfall received during the study period was more in 2002 with a better distribution pattern than in 2003 (data not shown). This may have favoured germination and emergence of more *Mimosa* seedlings in 2002. Secondly, the experiment was repeated in a different location in 2003. Although no baseline data on soil seedbank of *Mimosa* from the different locations where the experiment was conducted, differences in the initial seedbank of *Mimosa* in the experimental plots may have resulted in the observed trend.

Herbicide effects

The density (average over tillage systems) of *Mimosa* 12 weeks after treatment (WAT) with herbicides is shown in Fig. 2. Herbicides significantly suppressed *Mimosa* emergence in 2002 [P = <.0001] and in 2003 [P = <.0001]. All plots treated with herbicides had fewer *Mimosa* seedlings compared with untreated check plots 12 WAT. The density of *Mimosa* was lowest in plots treated with imazapyr (two rates) in 2002 (Fig. 2a) and in 2003 (Fig. 2b) compared with the other herbicides and the untreated check plot. For example, the density *Mimosa* in plots treated with

imazapyr (average of two rates) was 61.5 plants m^{-2} in 2002 and 35.0 plants m^{-2} in 2003, compared with 667.0 and 465.9 plants m^{-2} in the untreated-check plots 12 WAT indicating that this herbicide was better in controlling the weed than the other herbicides. Compared with untreated check plot 91, 78, 71, 67, and 43% (2002) and 94, 91, 81, 74, 71, and 57% (2003)
Control of *Mimosa* was observed with imazapyr, primextra, codal and diuron, respectively. The efficacy of the herbicides on *Mimosa* was in the order imazapyr > primextra > codal > diuron. Averaged over tillage methods the two rates of imazapyr and of codal did not differ in efficacy in both years. A positive tillage by herbicide interaction was observed in 2002 [P = 0.009] and in 2003 [P = 0.0001] (Fig. 2).

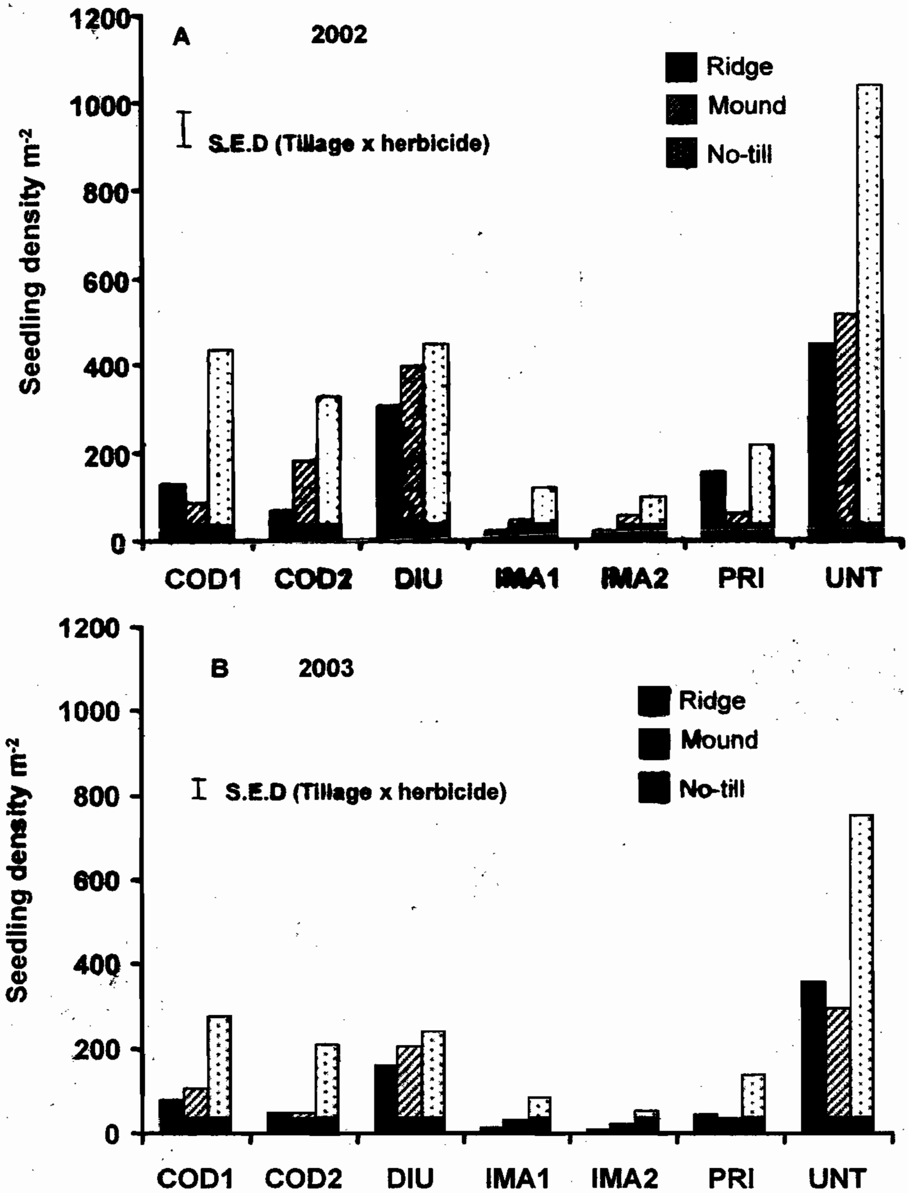

Fig. 2: The effect of tillage and pre-emergence herbicides on *Mimosa invisa* emergence at Umudike in 2002 and 2003. Each bar represents total emergence 12 weeks after treatments. The x-axis legends are represented as: COD1 = Codal at 2 kg a.i. ha^{-1}, COD2 = Codal at 3 kg

a.i. ha^{-1}, DIU = Diuron at 3 kg a.i. ha^{-1}, IMA1 = Imazapyr at 1.0 kg a.i. ha^{-1}, IMA2 = Imazapyr at 1.5 kg a.i. ha^{-1}, PRI = Primextra at 3.0 kg a.i. ha^{-1}, UNT = Untreated check.

All the herbicides were more effective in controlling *Mimosa* in tilled plots than in the no-tilled plots. For example, more *Mimosa* seedlings emerged in the no-till and herbicide treated plots than in tilled herbicide plots. This trend was more pronounced in plots treated with codal than in the other herbicides. For example the density of *Mimosa* in plots treated with codal (averaged over the rates) was 77, 62 and 243 plants m^{-2} (2002) in mound, ridge and no-till plots, respectively. A similar trend was observed in 2003. The most likely reason for differences due to tillage is that vegetation residue on the soil surface may be immobilizing the herbicides therefore making it unavailable for *Mimosa* control.

The duration of control of *Mimosa* varied significantly with type of herbicide (Fig. 3 &4).

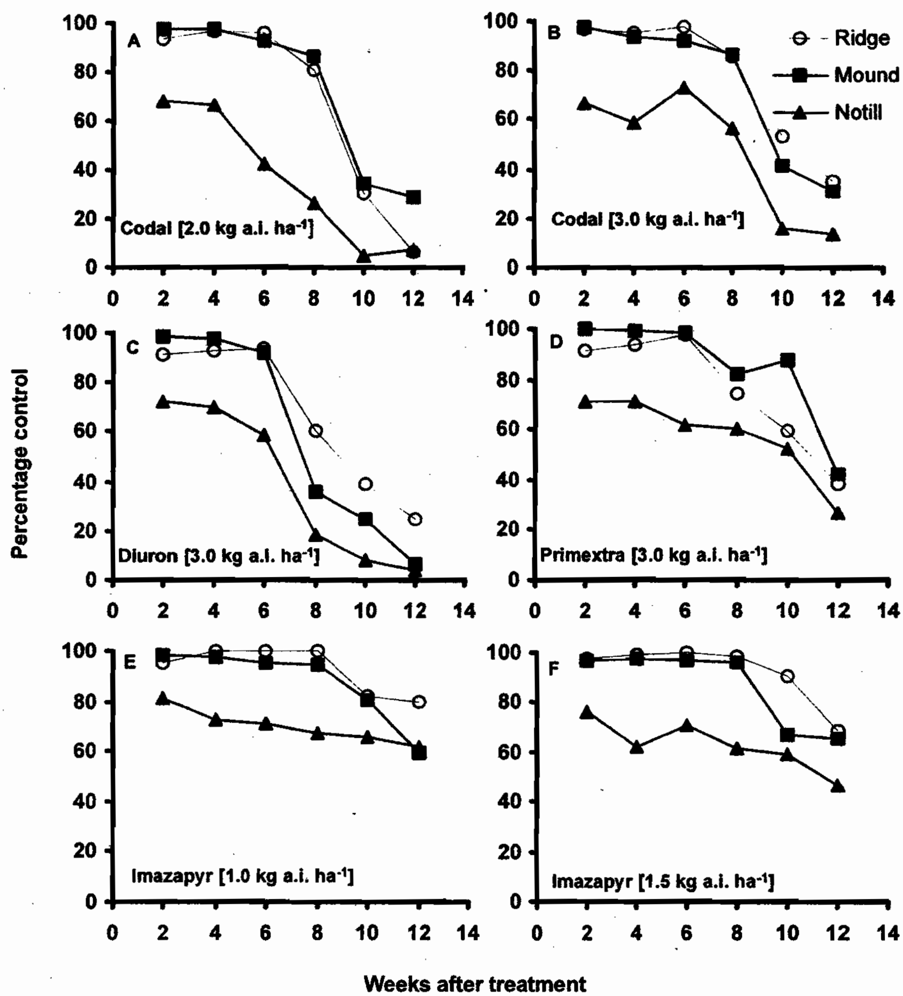

Fig. 3: *Mimosa invisa* control in Umudike in 2002 in mound, ridge and no-till plots as influenced by pre-emergence application of codal, diuron, imazapyr, primextra. Percentage was computed relative to untreated check plot.

The two rates of imazapyr maintained the same level of control and duration. Each rate provided >80% control of mimosa for about 8 WAT in 2002 (Fig.3e, 3f)) and 12 WAT in 2003 (Fig.4e, 4f) in tilled plots.

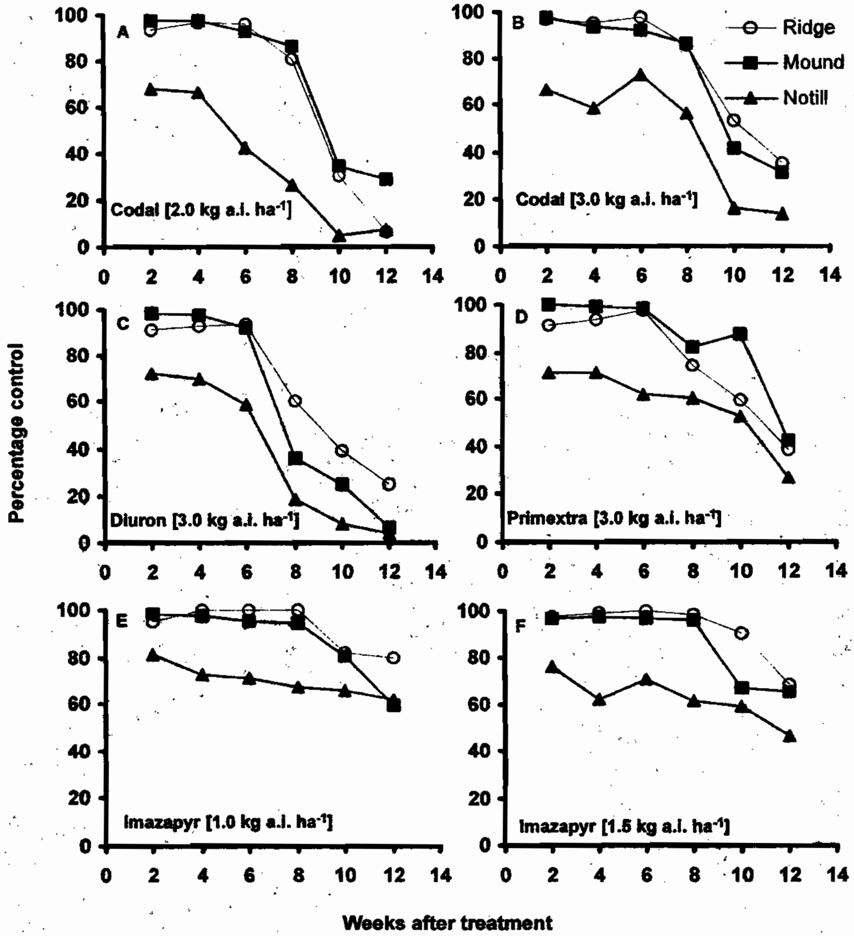

Fig. 4: *Mimosa invisa* control in Umudike in 2003 in mound, ridge and no-till plots as influenced by pre-emergence application of codal, diuron, imazapyr, primextra. Percentage was computed relative to untreated check plot.

In 2002, percentage control of *Mimosa* in imazapyr treated plots declined to 60% at 12 WAT. This trend was different in the no-till-imazapyr treated plots where percentage control was much lower with a more rapid decline after 4 WAT. The other herbicides provided > 80% control of *Mimosa* for about 6 WAT in both years except in plots treated with diuron in 2003 where > 80% control was maintained for 4 WAT only (Fig. 4c). In diuron treated plots >50% control was provided in mounded plots for about 4 WAT whereas in the ridged plots and no-till plots percentage control declined from > 80% after 2 WAT to zero control 12 WAT in both years. In other words, diuron did not suppress emergence long enough irrespective of tillage system.

The long lasting effect of imazapyr suggests persistence in the soil more than the other herbicides. This result agreed with Onyia (1997) who reported persistence of imazapyr up to 12 WAT at a field rate of 1.0 kg a.i. ha^{-1} in the Southern Guinea Savanna and 8 WAT in the Derived Savanna of Nigeria. Tillage practice and yearly variation in rainfall pattern can significantly affect the movement of herbicides and persistence in soil (Isensee and Sadeghi, 1994). In general, all the herbicides in no-till suppressed *Mimosa* emergence for short periods in both years. These results indicate that *M. invisa* infestation could be reduced by tillage but a significant control of the weed could be achieved with appropriate herbicides in combination with tillage.

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REFERENCES

Akobundu, I. O. (1987). *Weed Science in the Tropics: principles and practices.* John Wiley & Sons, New York. pp 255.

Alabi, B. S (1999). Weed control and corn tolerance from soil-applied RPA 201772. *Nigerian Journal of Weed Science* 13:913-925.

Alabi, B. S., Ayeni, A. O., Agboola, A. A., Majek, B. A. (2001). Giant sensitive plant interference in cassava. *Weed Science* 49:171-176.

Alabi, B. S., and Makinde, E. A.(2002). Effect of population levels of thorny mimosa on okra (*Abelmoscus esculentus* L.) growth and yield. *Moor Journal of Agricultural Research* 3(1): 54-58.

Buhler, D. D., and Daniel (1988). Influence of tillage systems on giant foxtail (*Setaria faberid*), and velvetleaf (*Abutilon theophrati*), density and control in corn (*Zea mays* L.). *Weed Science* 36: 642-647.

Cardina, J. E., Regnier, E., and Harrison, K. (1991). Long-term tillage effects on seedbanks in three Ohio Soils. *Weed Science* 39: 186-194.

Isensee, R. A. and Sadeghi, M. A. (1994). Effect of tillage and rainfall on atrazine residue level in soil. *Weed Science* 42:462-467.

Melifonwu, A. A. (1994). Control of *Mimosa invisa* in maize (*Zea mays* L.) with atrazine at its mixtures with alachlor and metolachlor. *Nigeria Journal of Weed Science* 8(4):6-9.

Onyia, N (1997). Monitoring imazapyr pesticide in soils of the moist savanna agroecological zones in Nigeria in relation to the control of *Imperata cylindrica* (L.): *A thesis in the Departement of Chemistry submitted to the Faculty of Science in partial fulfillment of the requirements for the degree of Doctor of Philosophy of the University of Ibadan. Pp173.*

[SAS] Statistical Analysis Systems. 1999. SAS User's Guide: Statistics. Cary, NC: Statistical Analysis Systems Institute. 956 p.

Shrestha, A., Knezevic, S. Z, Roy R. C., Ball-Coelh,o B. R., and Swanton, C. J. (2002) Effect of tillage, cover crop, and crop rotation on the composition of weed flora in a sandy soil. *Weed Research* 42: 76-87.

Stahl, B. A. L., Johnson, A. G., Wyse, L. D. Buhler, D. D., and Gunsolus, L. J. (1999). Effect of tillage on timing of *Setaria* spp. emergence and growth. *Weed Science* 47:563-570.

Swanton, C. J., Clements, D. R., and Derksen, D. A. (1993) Weed succession under conservation tillage: a hierarchal framework for research and management. *Weed Technology* 7: 286-297

Swanton, C. J., Shrestha, A., Knezevic, S. Z., Roy, R. C., and Ball-Coelho, B. R. (2000) Influence of tillage type on vertical weed seedbank distribution in a sandy soil. *Canadian Journal of Plant Science* 80: 455-457.

Tungtrakanpoung, N. Rhienpanish, K. (1992). The toxicity of Mimosa invisa Mart. var. inermis Adelbert to buffaloes.Buffalo Bulletin 11(2):30-31.

Unger WP, Miller DS, and Jones RO (1999) Weed seeds in long-term dryland tillage and cropping system plots. *Weed Research* 39: 213-223.

Yenish, J. P., Doll, D. J., and Buhler, D. D. (1992). Effects if tillage on vertical distribution and viability of weed seed in soil. Weed Science 40: 429-433. Framework for research and management. *Weed Technology* 7: 286-297.