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An Evaluation of Weed abundance and Community Diversity in Response to Pendimethalin Application and Manual hoe Weeding in Cowpea

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ABSTRACT
The authors examined the impact of different rates of pendimethalin and its potency over manual weeding on weed species composition, density and diversity in cowpea, in a field experiment that had pendimethalin rates at (0.5, 1.5, 2.5, 3.5 kg a.i ha^{-1} followed by supplementary hoe weeding (SHW) at 42 days after sowing (DAS), 2 hoe weeding at 21 and 42 DAS and untreated weedy control; in Minna, Nigeria. The treatments were arranged in a randomized complete block design and replicated three times in each year of the study. The results showed that with increase in pendimethalin application, weed taxa density decreased and was lowest in the application of 2.5 kg a.i ha^{-1} pendimethalin+1 SHW at 42 DAS. Weed species belonging to the *Asteraceae, Papilionioideae, Poaceae, Onagraceae, Cyperaceae, Commelinaceae* and some unidentified minor broad leaves dominated the weed community, as their presence could not be inhibited by pendimenthalin nor manual weeding. The lowest weed community diversity in terms of evenness and richness occurred when pendimenthalin was applied at 3.5 kg a.i ha^{-1} + 1 SHW at 42 DAS. The eigenanalysis also showed that the total variation in composition of the weed taxa were due to the first four components instead of twenty, which accounted for 96.5% of the total variation in the weed community composition. The result suggests that pendimethalin application at higher rates had an effect on the weed community diversity in cowpea.

Keywords: Cowpea, Pendimethalin, Weed abundance, Weed community diversity

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an important food legume crop grown in Nigeria, where the largest quality is produced in the world (Ayeni *et al.*, 1996).The crop is currently cultivated on an average of 1 metric ton per annum, with an average yield of 300 kg ha^{-1} of grain (Amatobi and Maigida, 2005). Unfortunately, the crop is susceptible to early weed interference (Ayeni *et al.*, 1996). These weed species are widespread in the agro ecologies where the crop is produced and aggressive in their growth habits when found in association with the crop, hence the traditional method of manual weeding employed by farmers in Nigeria is often inefficient in terms of weed control in the crops (Ayeni *et al.*, 1996).

There are several herbicides recommended for weed control in cowpea in Nigeria (National Advisory Committee on Weed Control (NACWC), (1994). One of the single formulated herbicide commonly found in the Nigerian market is pendimethalin usually applied as a selective pre-emergence (Smith, 2006). It is also reported that weed communities evolve constantly in response to crop management practices, which does not only affect crop growth but the diversity and growth of the associated weeds (Derksen *et. al.*, 1995).They also hypothesized that the diversity of weed communities may determine the nature of weed management strategies required, and the changes in diversity may be an indication of potential weed management problems.

However there is little or no previous report on effect of application of pendimethalin on weed community dynamics in cow in Nigeria. In this work, the application of pendimethalin at different rates and manual hoe weeding was investigated to underscore weed diversity in cowpea. This study determined the effect of different rates of pendimethalin on weed species abundance, richness and community diversity in cowpea; and to evaluate its potency over traditional practices.

MATERIALS AND METHODS

Study site and experimental procedures

The experiment was conducted in the rainy seasons of 2007 and 2008 at the teaching and research farm of the Federal University of Technology, Gidan Kwano, Minna (latitude 9° 37' N, longitude 6° 33' E) located in the southern Guinea savanna zone of Nigeria.

The treatments were laid out in a randomized complete block design in three replicates. The treatments were series of pendimethalin doses at

(1) PH1 i.e 0.5 kg a.i, (2) PH2 i.e 1.5 kg a.i, (3) PH3 i.e 2.5 kg a.i, (4) PH4 i.e 3.5 kg a.i; followed by supplementary hoe weeding (SHW) at 42 days after sowing (DAS), (5) HWC i.e hoe weeded control at 21+42 DAS and (6) UWC i.e untreated weedy control.

The herbicide was applied to the soil surface immediately after sowing of cowpea seeds with a knapsack sprayer in a spray volume of 2401 ha^{-1} through a blue nozzle at a delivery rate of 2.4 l/min. The plot size was 12 m^{-2} consisting of four ridges, at a row spacing of 75 x 40 cm, maintained at 2 plants per stand, at 20 kg ha^{-1}. The land was manually ridged with an African hand hoe. Cowpea seed (var. Kanannado (local) – large white seeds, black eyed) were sown on August 17, 2007 and August 8, 2008 respectively. No fertilizer was applied to the cowpea crop.

Data collection

Weed counts were taken from two 0.5 x 0.5 m quadrat placed along a diagonal in each treatment plot at intervals of 20 DAS three times. All weeds present in each quadrat were clipped from the soil level, separated, counted and oven - dried at 80 °C to a constant weight.

Statistical analysis

The raw density data for each weed species were used to determine three diversity indices as described by Derksen *et al.* (1995) and Yin *et al.* (2006) as follows:

Shannon's diversity index (H')

$$= (N \log N - \sum n \log n)\, N^{-1}$$

Where: N is the total weed density in a plot:
n is the weed density of each species present in a plot.

The H' was used to calculate the overall assessment of weed species diversity.

Shannon's (E) was calculated to determine the species evenness as follows: $E = H' (\ln N)^{-1}$

To evaluate the species richness, an estimate of Margalef's D_{mG} index was calculated as follows:

$$D_{mG} = (S - 1)(\ln N)^{-1}$$

Where S is the number of species in each plot.

Analysis of variance (ANOVA) was then performed on the diversity estimates (Shannon's diversity, evenness and richness), to determine the treatment effects with respect to the indices. Duncan Multiple Range Test (DMRT) at $P \leq 0.05$ level of probability was finally performed to separate the means under each diversity estimates.

The weed community taxa were later subjected to Eigenanalysis, after the data had been arcsin transformed to meet parametric assumptions (Swanton *et al.*, 1999 and Yin *et al.*, 2006). The variations observed in weed community were used to determine the extent of departure in any of the treatment.

RESULTS AND DISCUSSION

Weed taxa were broadly classified into 20 taxa during the experiment in which unidentified tiny weed species were classified into minor broadleaves, grasses or sedges. The weed taxa and their density in the community varied according to the treatments (Table 1). As expected more weeds were observed in UWC, but a comparison between the treatments showed that the density of *Asteraceae* (AST), *Papilionioideae* (PAP), *Verbanaceae* (VER), *Loganiaceae* (LOG), *Cyperaceae* (CYP), *Malvaceae* (MAL), *Mimosoideae* (MIM), and *Scrophulariaceae* (SCR) were the highest under PH1. This was also the case with PAP under PH2, *Commelinaceae* (COM) under PH4, and *Poaceae* (POA), *Onagraceae* (ONA), *Rubiaceae* (RUB), *Solanaceae* (SOL), Minor grasses (MGR), Minor broadleaves (MBL) and Minor sedges (MSD) under HWC. Weed taxa densities generally decreased with further increase in herbicide rates as shown under PH4. Total weed taxa density in PH1 was the highest, while it was lowest in PH3. On the overall, seven weed taxa were observed to be common to all the treatments, which included the AST, PAP, POA, ONA, CYP, COM and MBL. The occurrence of weed taxa and their densities varied under the different weed management treatments of chemical control and manual weeding. This finding suggested that weeds of various taxa responded to various herbicide rates, hence weed shifts occurred in response to pendimethalin rates and manual weeding. Similar findings have been documented. Similar findings have been documented by Culpepper (2006) though in glyphosate - based weed management programme in combination with other herbicides. Weed species production can also be stimulated by the application of low rates of pendimethalin, but can be counteracted by increases in the application rates. For example, weed taxa density in the control treatment and plots with the lowest pendimethalin rates were high, but low in plots that received higher rates of herbicides which could be attributed to the efficacy of pendimethalin. But our finding also

Table 1: Weed taxa density under different weed management strategy

Weed taxa	Density (Plants/Plot)					
	PH1	PH2	PH3	PH4	HWC	UWC
Asteraceae (AST)	768	457	355	462	454	959
Papilionaceae (PAP)	3	3	1	1	2	3
Verbanaceae (VER)	18	0	1	0	1	14
Poaceae (POA)	127	57	42	30	185	330
Loganiaceae (LOG)	22	6	1	0	19	43
Commdinaceae (COM)	5	25	19	56	11	21
Malvaceae (MAL)	6	1	1	0	0	7
Mimosoideae (MIM)	1	0	0	0	0	9
Rubiaceae (RUB)	1	2	5	0	48	86
Sterculiaceae (STE)	0	1	0	1	1	3
Lamiaceae (LAM)	0	0	0	0	1	56
Convulvolaceae (CON)	0	0	0	0	0	6
Scrophularacae (SCR)	10	0	1	0	6	80
Euphorbiaceae (EUP)	2	0	0	0	0	3
Solanaceae (SOL)	1	0	0	0	5	11
Minor grasses (MGR)	0	0	0	0	12	0
Minor broad leaves (MBL)	1	3	3	1	81	23
Minor sedges (MSD)	4	0	0	0	11	0
Total density	1177	645	513	600	1084	2072

PH1 – 0.5 kg a.i ha^{-1} pend. + 1SHW at 42DAS, PH2 – 1.5kg a.i ha^{-1} pend.+1SHW at 42DAS, PH3 – 2.5kg a.i ha^{-1} pend + 1SHW at 42DAS, PH4 – 3.5kg a.i ha^{-1} pend. + 1SHW at 42DAS, HWC – Hoe weeding control at 21 + 42 DAS, UWC – Untreated weedy control, pend – pendimethalin, SHW – Supplementary hoe weeding, DAS –Days after sowing

indicated that some weed species in the *Papilionioideae, Poaceae, Onagraceae, Cyperaceae, Commelinaceae* and some unidentified minor broad leaves were not controlled by the application of pendimethalin at low or high rates, or by manual weeding. This is an indication of changes in weed dynamics as a result of this herbicide as observed elsewhere with glyphosate in glyphosate resistant crops like soybean and maize (Puricelli and Tusca, 2005; Tuesca and Puricelli, 2007). These weeds taxa could also be considered tolerant to pre-emergence application of pendimethalin, which concurred with Krausz *et al.* (1996) who reported that some weeds occurring in arable crops may be tolerant to glyphosate and may therefore require higher rates or multiple applications of the herbicide for adequate control.

Table 2 presents estimates of the three indices ranks. Based on Shannon's H$'$ measurement, weed diversity decreased the most under PH4, but was not significantly ($P \leq 0.05$) different from UWC and PH2. The weed community evenness (E) assessed also showed that evenness was lowest in PH4, and highest in HWC which did not differ between UWC, PH2 and PH1 irrespective of the treatment used. Furthermore, the evenness of the weed communities showed the extent of response to the herbicide and manual weeding treatments. In the same vein, when the aspect of the community richness (D_{mG}) was assessed, richness was lowest in PH4, but higher in UWC and no differences were observed among HWC, PH1, PH2 and PH3. On the overall, weed diversity, evenness and richness consistently decreased under PH4. While PH4 consistently decreased the weed diversity, evenness and richness; HWC, UWC and PH2 rather increased the community diversity; and HWC, UWC, PH2 and PH1 maintained a high weed community evenness and richness. Our findings revealed that pendimethalin application at higher rates had a tremendous effect in reducing the weed diversity indices. The higher richness and diversity observed with the application of lower rates could be attributed to the emergence and survival of more weed species, but concurred with the application at higher rates. Similar findings had been observed in pre-application counts with glyphosate (Tuesca and Puricelli, 2007). These authors also reported a greater effect on reduction in density and richness of summer herbaceous

Table 2: Mean Shannon's H' and E, and Margalef's D_MG indices under different weed management strategies

Treatment (DMG)	Shannon's (H) (Diversity)	Shannon's (E) (Evenness)	Margalef's (Richness)
PH1	0.42bcd	0.08abc	1.52a
PH2	0.49abc	0.11ab	1.32a
PH3	0.27cd	0.07bc	1.28a
PH4	0.18d	0.05c	0.51b
HWC	0.73a	0.14a	1.73a
UWC	0.66ab	0.13a	1.76a
SE ±	0.09	0.02	0.18

Value followed by the same letters in a column are not significantly different at $P \leq 0.05$ level. PH1 – 0.5 kg a.i ha^{-1} pend. + 1 SHW at 42DAS, PH2 – 1.5kg a.i ha^{-1} pend.+1SHW at 42DAS, PH3 – 2.5kg a.i ha^{-1} pend + 1SHW at 42DAS, PH4 – 3.5kg a.i ha^{-1} pend. + 1SHW at 42DAS, HWC – Hoe weeding control at 21 + 42 DAS, UWC – Untreated weedy control, pend – pendimethalin, SHW – Supplementary hoe weeding, DAS –Days after sowing

annual weeds with glyphosate in combination with some residual herbicides in glyphosate resistant soyabean-maize rotation.

The overall weed composition measured using the eigenanalysis, showed that the total variation in the composition of the weed taxa could be accounted for by four components only instead of twenty. These four components accounted for 96.5% of the total variation in the original data. The first component accounted for 39.3% of the total variation, while second accounted for 37.4%. The third and fourth components accounted for another 11.1% and 8.7% proportion, respectively. The first four components are expressed in equations 1 to 4. It can be observed that the majority of the eigenvectors gave negative weighted indices, as a result of their correlation coefficient matrix; where weed taxa density having higher proportion or presence in a plot allowed a lesser or sparse presence of another species in the same plot. The eigenanalysis also showed that 6 weed taxa (x_1, x_4, x_5, x_6, x_{11} and x_{15}) had the highest indices of equally close values. These were closely followed by 5 other taxa (x_2, x_3, x_7, x_{13}, and x_{14}). The remaining 8 taxa had a minimal contribution to the proportion of variance in the first component, which also indicated that these 8 taxa were sparsely present. Conversely, their population density/counts were significantly reduced by the aftermath effect of the treatments understudy. In the same vein, the second component had 7 variables or vectors with higher indices. These variables x_9, x_{10}, x_{12}, x_{14}, x_{16}, x_{17}, x_{18} and the remaining 13 variables contributed very small amount to this component. This was the trend with the other components.

CONCLUSION

Weed taxa density in cowpea decreased with increase in application rates of pendimethalin such that total weed taxa density were high under UWC, PH1 and HWC but lowest in PH3. Weed

$$P_1 = -0.30x_1 - 0.23x_2 - 0.27x_3 - 0.35x_4 - 0.35x_5 - 0.35x_6 - 0.22x_7 + 0.10x_8 - 0.19x_9 + 0.11x_{10} - 0.31x_{11} - 0.05x_{12} - 0.29x_{13} - 0.02x_{14} - 0.32x_{15} + 0.04x_{16} - 0.10x_{17} + 0.08x_{18} - 0.09x_{19} + 0.08x_{20} \quad (1)$$

$$P_2 = 0.18x_1 - 0.04x_2 - 0.02x_3 + 0.03x_4 + 0.01x_5 - 0.03x_6 + 0.16x_7 + 0.16x_8 - 0.26x_9 - 0.34x_{10} - 0.06x_{11} - 0.36x_{12} - 0.12x_{13} - 0.36x_{14} - 0.10x_{15} - 0.36x_{16} - 0.35x_{17} - 0.30x_{18} - 0.07x_{19} - 0.31x_{20} \quad (2)$$

$$P_3 = -0.11x_1 - 0.04x_2 - 0.16x_3 + 0.12x_4 + 0.05x_5 + 0.05x_6 + 0.32x_7 - 0.28x_8 - 0.25x_9 - 0.07x_{10} + 0.16x_{11} - 0.09x_{12} - 0.20x_{13} - 0.14x_{14} - 0.17x_{15} - 0.11x_{16} + 0.00x_{17} + 0.34x_{18} + 0.61x_{19} + 0.28x_{20} \quad (3)$$

$$P_4 = 0.07x_1 + 0.37x_2 + 0.41x_3 - 0.12x_4 - 0.14x_5 + 0.03x_6 + 0.28x_7 - 0.48x_8 + 0.18x_9 + 0.11x_{10} - 0.32x_{11} - 0.06x_{12} - 0.26x_{13} - 0.07x_{14} - 0.20x_{15} + 0.08x_{16} - 0.13x_{17} - 0.04x_{18} - 0.20x_{19} + 0.10x_{20} \quad (4)$$

species in the *Asteraceae, Papilionioideae, Onagraceae, Cyperaceae, Commelinaceae, Poaceae* and some unidentified minor broadleaves dominated the communities. The PH4 treatment (3.5 kg a.i ha^{-1} pendimethalin + 1 SHW at 42 DAS) maintained lowest weed community diversity in terms of evenness and richness. The study also showed that the first four components accounted for 96.5 % of the total variation in the weed community composition understudy. The variation in weed taxa density can be explained by only four components, which accounted for 39.3, 37.4, 11.1 and 8.7 % for a large proportion of the variance respectively.

REFERENCES

Amatobi, C. I. and Maigida, D. N. (2005): Cowpea. In: Idem, N. U. A. and F. A. Showemimo eds. Major legumes and Oil seeds of Nigeria: Principles of Production and Utilization. pp 66-76.

Ayeni, A. O., Ikuenobe, C. E. and Majek, B. A. (1996). Effects of imazaquin and imazaquin–based herbicides mixtures on cowpea (*Vigna unguiculata*), soybean (*Glycine max*) and selected weeds. *Nigerian Journal of Weed Science* 9: 49–56.

Culpepper, S. (2006): Glyphosate induced weed shifts. *Weed Technology* 20: 277-281.

Derksen, D. A., Thomas, A.G., Lafond, G. P., Loeppky, H.A. and Swanton, C. J. (1995): Impact of post emergence herbicides on weed community diversity within conservation tillage systems. *Weed Research* 35: 311 – 320.

Krausz, R.F., Kapusta, G. and Mathews, J. L. (1996): Control of annual weeds with glyphosate. *Weed Technology* 10: 957 – 962.

National Advisory Committee on Weed Control (NACWC) (1994): Weed control recommendations for Nigeria. Series No.3 Department of Agriculture, Federal Ministry of Agriculture, Afrika–Link Books, Ibadan, pp. 27–70.

Puricelli, E. and Tuesca, D. (2005): Weed density and diversity under glyphosate–resistant crop sequences. *Crop Protection* 2: 533–542.

Smith, M. A. K. (2006): Comparing weed and crop seedling response to pre–emergence pendimethalin application in *Corchorus olitorius* and *Abelmoschus esculentus*. *Crop Protection* 25: 1221–1226.

Swanton, C. J., Shresthan, A., Roy, R. C., Ball Coelho, B. R. and Knezevic, S. Z. (1999): Effect of tillage systems, N and cover crop on the composition of weed flora. *Weed Science* 47: 454–461.

Tuesca, D. and Puricelli, E. (2007): Effect of tillage systems and herbicide treatments on weed abundance and diversity in a glyphosate resistant crop rotation. *Crop Protection*, 26: 1765–1770.

Yin, L., Cai, Z. and Zhong, W. (2006): Changes in weed community diversity of maize crops due to long–term fertilization. *Crop Protection* 25: 910 – 914.