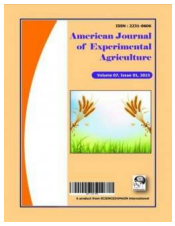

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Comparative Evaluation of Hoe-weeding and Pendimethalin Spray Regimes on Weed Management in Cowpea (*Vigna unguiculata* (L) Walp.) in North Central Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author ABO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author JA reviewed the experimental design and all drafts of the manuscript. Authors ABO and JA managed the analyses of the study. Author ABO performed the statistical analysis. Authors ABO and JA read and approved the final manuscript.

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ABSTRACT

Field trials were conducted at the Teaching and Research farm of Landmark University Omu-Aran during the cropping seasons of 2013 and 2014 to test the best time of Pendimethalin application in comparison with hoe weeding on weed management and performance of cowpea (*Vigna unguiculata (*L) Walp.). The treatments were the weed management practices: Hoe weeding at 3 and 6 weeks after planting (WAP); Pre-plant Pendimethalin (3 days before planting, DBP); Pendimethalin at Planting; Post-plant Pendimethalin (2 days after planting, DAP) and weedy check control. Obtained results showed that Pendimethalin, irrespective of time of application showed no significant germination percentage reduction in comparison with the control or hoe weeding. All the Pendimethalin sprayed plots gave effective weed biomass reduction similar to those obtained from

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the hoe weeded plots. Higher yield factors in terms of number of leaves, number of branches, plant height, and pod weight per plant were consistently similar and highest in the Pendimethalin and hoe weeded plots. Irrespective of time of Pendimethalin application, similar values of number of pods per plant, pod length and number of grains per plot were obtained with hoe weeded plots which were higher than the control. Lower pod weight and grain yields were obtained in Pendimethalin at planting when compared with the pre-plant, post-plant Pendimethalin and hoe weeding which recorded the highest pod and grain yields. Establishment rate showed that Pendimethalin applied at planting and post-plant resulted into lower field seedlings count at 4WAP. It is concluded that Pendimethalin applied three days before planting gave effective weed control and produced the highest cowpea grain yield in the study area.

Keywords: Pendimethalin; hoe-weeding; cowpea; yield.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp.) is leguminous crop with an annual production of about 7.6 million tons on about 12.8 million hectare of land. Of this annual world production, Sub-Sahara Africa accounts for about 70% [1,2]. Nigeria accounts for about 2 million tons on about 3.75 million ha annually making her to be the world's largest producer and consumer of cowpea [3,4]. Being a fast growing crop, cowpea curbs erosion by covering the ground, fixes atmospheric nitrogen, and its decaying residues contribute to soil fertility [5]. Cowpea production is affected by a number of factors among which inadequate weed management had been identified as a major contributory factor for yield reduction. Yield reduction in cowpea can be critical if weeds are not controlled especially during the first 3 – 4 weeks of crop growth which is the critical period of weed competition for cowpea [6].

Reports have shown that uncontrolled weed growth or poor weed management in cowpea may result to grain yield reduction of between 40 and 80% reduction, in grain yield [7,8,9]. Although complete weed elimination may not be needed in cowpea due to the fact that the crop can compete with weed after the critical period of weed interference [10] weeds may habour pest that may lead to yield reduction if uncontrolled. It has been estimated that about 70% of farmer's labour is expended on weeding [11] and inadequate and high cost of labour due to the use of traditional hoe weeding has reduced the farm size cultivated by farmers [12]. Various pre-emergence herbicides have been evaluated for weed control in cowpea but the present work aims at investigating the effects of pre and post-plant Pendimethalin in comparison with hoe weeding in the derived savannah zone of North central Nigeria.

2. MATERIALS AND METHODS

Field experiments were carried out in the Teaching and Research Farm of Landmark University Omu Aran Kwara during the cropping seasons of 2013 and 2014. Omu-Aran (8°25′ N, 4°40′ E) is located in the North Central Nigeria with a mean annual bimodal rainfall pattern of about 1232 mm. The Town is 400 m above sea level. The soil composition at the experimental site is a sandy clay loam alfisol with 58, 20 and 22% sand, clay and silt respectively. Randomly collected soil samples from 2 spots per plot at a depth of 0-15 cm were bulked and thoroughly mixed for routine soil analysis and the soil was found to have a pH of 6.5, organic matter of 5.5%, 0.21% N, 228 ppm K, and 6.85 mg/Kg P. The experimental site had been cropped with maize but without herbicidal weed management. Predominant weed species at the site prior to cropping were: *Chromoleana odorata* (L) R.M. King & Robinson; *Tithonia diversifolia* L, *Ageratum coniziodes* Linn; *Cyperus* spp. and *Pancum maximum* Jacq.

The experimental design was a randomized complete block replicated four times. The treatments were the weed management practices: Hoe weeding at 3 and 7 weeks after planting (WAP); Pre-plant Pendimethalin (3 days before planting); Pendimethalin at Planting; Post-plant Pendimethalin (2 days after planting) and weedy check control. The Pendimethalin was applied at 2.0 Kg a. i. ha^{-1}.

The field was cleared using cutlass, thrashes packed and ridged using the Nigerian hoe. 4 ridges of 6 m long were made into each plot that constituted the weed control treatments. Cowpea, Ife brown variety (IT84S-2246-4) used for the experiment was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Planting was done in

October of 2013 and April 2014 at a spacing of 25 cm within ridges and 90 cm between ridges. Two seeds were planted per hole and the seedlings thinned to one per stand at 2 weeks after planting.

The herbicide was applied using Knapsack sprayer calibrated to deliver 250 l of the spray solution per hectare. Each 15 l water capacity sprayer was mixed with 120 ml of Pendimethalin [*N*-(1-ethylpropyl)–3,4–dimethyl-2,6-dinitrobenze-namine] [13]. Pre-plant Pendimethalin was applied three days before planting while post-plant Pendimethalin was applied a two days after planting and Pendimethalin was sprayed immediately after planting. Weeds were sampled at 4WAP in a 1 m^2 quadrant at random in two locations per plot. Weed density and fresh weed biomass were determined from the collected weed samples. Germination counts and percent survival were made at 2WAP and 4WAP respectively. Plant height and number of branches were determined at 4 and 6WAP respectively. Cowpea yield and factors in terms of number of pods per plant, pod length, pod weight and grains per pod were determined from ten randomly selected plants per plot.

All data collected were subjected to statistical analysis of variance and treatment means compared using the Duncan's multiple range tests (DMRT).

3. RESULTS

Effects of weed control treatments on germination percentage, seedling survival at four weeks after planting (WAP) and plant height at four weeks after planting (WAP) are presented in Table 1. The germination percentages observed were identical irrespective of weed control treatments. Field count (survival %) of cowpea plants were similar in all the treatments except in the Pendimethalin applied at planting and post planting which showed significant lower survival rate. Plant height at 4WAP showed that the weedy check plots recorded the shortest plants while the tallest plants were observed in the pre-plant Pendimethalin applied plots and the hoe weeded plots. While the Pendimethalin applied post and at planting were similar in height, the pre-plant application produced taller plants than them.

Table 2 shows the effects of hoe weeding and Pendimethalin spray on weed density, weed biomass and number of leaves per plant. Weed density assessment were identical in all the Pendimethalin sprayed plots in the two seasons. Hoe weeding produced higher weed density than Pendimethalin in both seasons irrespective of time of spray. The highest weed biomass was recorded in the weedy check plots while the least was recorded in the post-plant Pendimethalin application. Lower weed biomass reduction was recorded in hoe weeded plots than all the Pendimethalin applied plots irrespective of time of application.

Number of leaves per cowpea plant showed that pre-plant Pendimethalin and hoe weeding gave identical and highest number of leaves per plant in both trials. Pendimethalin at planting also gave similar number of leaves per plant as post-plant Pendimethalin application. The control had the lowest number of leaves per plant.

Effects of weed management on number of branches, number of pods and pod length per cowpea plant are presented in Table 3. Number of branches per plant was identical in hoe weeding, pre- and post-plant Pendimethalin spray. The lowest number of branch was recorded in the control plots. The number of pods per plant was similar in hoe weeding and all the Pendimethalin sprayed plots. The weedy check plots produced the lowest number of pods per plant. The shortest pods were observed in the control experiment. Hoe weeding and the Pendimethalin sprayed plots produced similar pod length in both trials.

Table 4 shows the effects of hoe weeding and Pendimethalin on cowpea pod weight, number of seeds per pod and grain yield per hectare. The highest pod weight was recorded in the pre-plant Pendimethalin and hoe weeded plots. Although Pendimethalin at planting and post-planting gave similar pod weight per plant, they were lower than the pre-plant Pendimethalin spray. Number of seeds per pod was uniform in all the treatments except in the control experiment which produced the lowest number of seeds.

Grain yield recorded in the hoe weeded plots and pre-plant Pendimethalin sprayed plots were similar and highest. Pendimethalin sprayed at planting gave lower grain yield than those sprayed pre-planting but not significantly different ($P \leq 0.05$) from the post-plant Pendimethalin spray plots. The lowest yield was recorded in the control.

Table 1. Effects of hoe weeding and Pendimethalin on germination percentage, survival rate and plant height

Treatments	Germination %		Survival %		Plant height	
	2013	2014	2013	2014	2013	2014
Control	99.6a	100a	99.6a	98.0a	11.7c	12.0c
Hoeing	100.0a	99.0a	99.3a	97.4a	16.1a	16.8a
Pre-plant Pendimethalin	98.0a	99.2a	97.0a	99.2a	16.2a	17.0a
Pendimethalin at planting	97.9a	95.0a	85.6b	86.4b	14.5b	14.8b
Post-plant Pendimethalin	98.6a	100.a	89.5b	87.6b	14.1b	15.8b

Means with the same alphabet(s) within column are not significantly different P≤0.05 according to the Duncan's multiple range tests

Table 2. Effects of hoe weeding and Pendimethalin on weed density, weed biomass and number of leaves per plant

Treatments	No. of leaves plant^{-1}		Weed density (Nom^{-2})		Weed biomass (gm^{-2})	
	2013	2014	2013	2014	2013	2014
Control	10.7d	11.0c	33.0a	26.0a	214.5a	186.7a
Hoeing	17.7ab	18.6a	8.0b	7.1b	41.0b	45.2b
Pre-plant Pendimethalin	18.0a	18.9a	4.7c	5.1c	32.3c	38.4c
Pendimethalin at planting	15.3b	16.5b	4.5c	5.0c	31.1c	37.8c
Post-plant Pendimethalin	16.8b	16.6b	4.7c	4.5c	32.8c	36.6c

Means with the same alphabet(s) within column are not significantly different P≤0.05 according to the Duncan's multiple range tests

Table 3. Effects of hoe weeding and Pendimethalin on number of branches, number of pods and pod length per plant

Treatments	No. of Branches plant^{-1}		No. of Pods plant^{-1}		Pod length	
	2013	2014	2013	2014	2013	2014
Control	2.8c	2.4c	6.7b	7.0b	7.4b	8.6b
Hoeing	5.3a	6.2a	22.0a	24.0a	17.5a	16.8a
Pre-plant Pendimethalin	5.6a	6.0a	21.3a	23.3a	18.1a	17.9a
Pendimethalin at planting	3.7b	4.9b	22.0a	21.5a	17.3a	16.6a
Post-plant Pendimethalin	4.8a	5.5ab	20.9a	22.0a	17.5a	17.2a

Means with the same alphabet(s) within column are not significantly different P≤0.05 according to the Duncan's multiple range tests

Table 4. Effects of hoe weeding and Pendimethalin on pod weight per plant, number of seeds per pod and grain yield per hectare

Treatments	Pod weight plant^{-1} (g)		No of grains Pod^{-1}		Grain Yield (t ha^{-1})	
	2013	2014	2013	2014	2013	2014
Control	26.5c	29.7c	8.5b	7.5b	0.15c	0.18c
Hoeing	81.0a	87.3a	16.1a	15.8a	1.17a	1.10a
Pre-plant Pendimethalin	82.1a	84.6ab	16.5a	16.0a	1.37a	1.38a
Pendimethalin at planting	67.6b	79.5b	15.6a	15.8a	0.98b	0.91b
Post-plant Pendimethalin	70.2b	80.4b	15.9a	16.1a	1.01b	0.98b

Means with the same alphabet(s) within column are not significantly different P≤0.05 according to the Duncan's multiple range tests

4. DISCUSSION

The identical germination percentage and plant survival observed in this work suggest that the pre-plant herbicide (Pendimethalin) used at the rate applied posed no phytotoxicity to the germination of cowpea. Also the lower plant survival observed in the post planting Pendimethalin and those applied at planting compared to the pre-plant application suggests

that the pre-plant Pendimethalin application is save for weed control in cowpea. It further suggests that Pendimethalin applied pre-plant to cowpea might have dissipated into the soil to the level that it became non-toxic to cowpea after it might have caused lethal effect to weed seeds and germinating weed seeds. The shorter plants and lower number of leaves observed in the post-plant Pendimethalin and Pendimethalin at planting compared with the pre-plant Pendimethalin probably suggests that the herbicide might be toxic to cowpea at the rate applied during these periods of application. Similar reports have it that application of metobromuron plus metolachlor mixture was well tolerated by cowpea and suppressed the weed effectively when applied pre-emergence, but its post-emergence application was lethal to cowpea [14].

Similar weed reductions were observed in the Pendimethalin applied plots in terms of density and biomass irrespective of time of application. This herbicide showed superior weed control over the manual hoe weeding twice at 3 and 6 WAP.

Weedy check plots showed lower yield factors and yield when compared to the hoe weeded and Pendimethalin sprayed plots. These yield losses in the uncontrolled plots reflect the higher competitive weed effects in these plots. Possible yield loss due to weed infestation had been reported [10,15]. In the present work, comparable yields were observed in the hoe weeded and pre-plant Pendimethalin plots in both seasons. Despite similar number of grains per pod in both hoe weeded and Pendimethalin plots, lower grain yields were observed in the plots that received Pendimethalin at and post-planting. This suggests higher toxicity to the plant at this time of application of the herbicide as also observed in the lower survival rate and number of leaves per plant as well as plant height.

5. CONCLUSION

It is apparent from this study that pre-plant Pendimethalin herbicide application at the rate used is safe for cowpea production as against the other times of application (at or post-planting) which adversely reduced growth and consequently reduced yield even though it gave satisfactory weed control. Despite the comparable yield obtained in hoe weeded and pre-plant Pendimethalin plots in this work, the herbicide use will still be preferred due to the economic benefit that may be involved as reported by many authors [16,17,18].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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