International Journal of Research in Agricultural Sciences
Volume 1, Issue 4, ISSN (Online) : 2348 – 3997)

Evaluation of Weed Control Methods in Dry and Rainy Seasons Cowpea in Sudan Savanna Ecology

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***Abstract* – A field study was conducted at teaching and research farm of Bayero University Kano during the dry and rainy seasons of 2008 to determine the effect of various weed control methods on yield and yield components of cowpea. The study consisted of 15 treatments comprising 13 herbicide combinations with or without supplementary hoe weeding, two-hoe weeded and weedy check plots arranged in randomized complete block design with 3 replications. The experimental sites were largely dominated by broad leaved weed species which were higher in the dry season site than in the rainy season site. Among different weed control methods, two hoe weeding had consistently and significantly produced higher pod yield, number of pods per plant, number of grains per pod, 100-seed weight and grain yield per hectare. Among the herbicide treated plots, Pre-emergence application of Metolachlor and Prometryn (at both rates) followed by supplementary hoe weeding had performed significantly better than the other herbicide treated plots with the respect to pod yield, number of pods per plant, number of grains per pod and 100-seed weight. Maximum reduction in weed dry weight was observed with two hoe weeding. The weedy check recorded the highest weed dry matter and the lowest grain yield. Comparable grain yield were recorded among pre-emergence application of Metolachlor and Prometryn followed by supplementary weeding, or with post emergence application of Fluazifop alone. Significant correlation among grain yield, yield components and weed dry weight was recorded in both seasons.**

***Keywords* – Cowpea, Weed Control, Herbicides, Yield, Yield Components.**

I. Introduction

Growing cowpea is a popular choice for farmers across Africa. It is widely-cultivated, with millions of smallholders dependent on it for food, feed and a source of income. The grain provides cheap source of protein, while the haulms are cut and stored for use as fodder. As a nitrogen-fixing legume, cowpea also helps improve soil fertility on marginal land and cereal crops such as maize, millet and sorghum can be sown after cowpea cropping. The production of cowpea is however, constrained by a number of factors especially weeds (Verkleije and Ekuijper, 2000; Singh, 2005) which compete with the crop during the early stages of growth and cause serious reductions in yield (Obadoni *et al.*, 2009 ; Olorunmaiye,2010) and may make harvesting difficult. The use of herbicides has increased recently among farmers in the region especially on high value crops. It is faster and less laborious though may lead to crop injury if not properly used. Thus, the choice of best herbicide, herbicides combinations, and proper time of application and proper dose of herbicide is the most important consideration for lucrative returns. Chemical weed control combined with other cultural practices may practically help in reducing weed competition, crop losses and labour cost (Chattha *et al*., 2007). Akobundu, (1987) reported that Metolachlor and Pendimethalin were likely to be effective against annual grasses in cowpea. Similarly, Lagoke *et al.* (2006) reported that Metolaclor, Prometryn, Norflurazin and Diuron can be used to effectively control weeds in cowpea. Fluazifop-butyl applied post-emergence in cowpea significantly reduced the growth and development of *Cynodon dactylon* (Rao, 2004). In view of the weed problems in cowpea, field studies were undertaken to investigate the influence of different weed control measures on yield and yield components of cowpea.

II. Materials and Methods

Two field experiments were conducted during dry and rainy seasons of 2008 at the teaching and research farm of the Faculty of Agriculture, Bayero University, Kano (12^0 03'N, 8^0 32'E; 481 m above sea level) which lies in the Sudan savanna zone. The soil texture of the dry season site was clay loam; organic carbon, 0.34%; total N, 0.31%; available P, 7.0 ppm and pH, 6.9; while that of rainy season site was loamy sand; organic carbon, 0.37%; total N, 0.89%; available P, 9.92 ppm and pH, 6.0.

The fields were disc harrowed twice, leveled and marked into different replicates and plots and bounded. Seeds of cowpea variety IT90K-277-2 treated with a seed dressing chemical 'Alpron plus' 60 SD at the rate of 10g/8kg of seeds were manually sown in holes 4 cm deep and 25 cm apart, on rows spaced 75 cm apart. Fertilizer was side placed a week after sowing (WAS) using mixture of NPK (15-15-15) and Single super phosphate (18% P_2O_5) to supply 20 kg N ha^{-1}, 40 kg P_2O_5 ha^{-1} and 20 kg K_2O ha^{-1}. The dry season crop was sown on 5th March, 2008 while the rainy season crop was sown on 14thJuly, 2008. The crops were sprayed at weekly interval with low volume insecticidal mixture of 50g Cypermethrin and 500g Dimethoate at the rate of 1 liter/ha beginning from 4 WAS until harvest.

The experiment consisted of 15 treatments comprising of 13 herbicides combinations with or without supplementary hoe weeding, two hoe - weeded and a weedy check arranged in randomized complete block design with three replications. The gross and net plot sizes were 9 m^2 and 3.0 m^2, respectively. Herbicides were sprayed in the morning using knapsack sprayer at a pressure of 2.1 kg cm^{-2}.

Data were collected at harvest on weed dry weight, number of pods per plant, number of grains per pod, pod yield per hectare, grain yield per hectare and 100-seed weight. Weed samples were taken from 1 m^2 quadrant for dry matter determination. The weed samples within the quadrant were identified by species and cut from ground level, cleaned and oven dried at 75°C to constant weight and weighed using electric weighing balance. The number of pods from each net plot area were counted and divided by the total number of plants to obtain the number of pods per plant. To obtain the number of grains per plant, twenty pods were randomly selected from each net plot area, threshed and the grains counted and the mean recorded. The pods collected from each net plot were sun dried and weighed with electric weighing balance and the figure obtained were extrapolated to per hectare basis to obtain pod yield per hectare. All the harvested pods from the net plots were manually threshed and the grains obtained were weighed using electric weighing balance and extrapolated to per hectare basis to obtain grain yield per hectare. From the grain yield, 100-seeds were randomly selected and weighed using electric weighing balance to obtain 100-seed weight. The data generated were subjected to statistical analysis of variance using SAS package. Where treatment means were significant, they were separated using DMRT at 5% level of probability. Correlation analysis was carried out among the grain yield and yield components as suggested by Dewey and Lu (1959).

III. Results and Discussion

Higher weed occurrences were recorded under dry season condition (Table 1). Broad leaved weeds were the most occurring species followed by narrow leaved weeds and then sedges. Both narrow and broadleaved weeds had emerged more under the dry season condition than rainy season. This might be due to hydromophic nature of the soil at the site for the dry season study, which was more conducive for growth and development of various weed species. Similar observations were reported by Akobundu (1987).

Data presented in Table 2 revealed that the number of pods per plant and number of grains per pod were significantly affected by weed management in both seasons. The highest number of pods per plant were obtained by two hoe weeding which were also statistically similar to pre-emergence application of Metolachlor and Prometryn (at 0.82 and 1.03 kg a.i. ha^{-1}) with supplementary hoe weeding in the dry season but statistically different from these treatments under rainy season. Weedy check had the least number of pods per plant in both seasons. Among the herbicide treated plots, Pre-emergence application of Metolachlor and Prometryn followed by supplementary hoe weeding had the highest number of pods per plant. Combinations of these weed control methods increased number of pods suggesting that integrating the weed control strategies enhanced their weed inhibitory capability. The low pod number of weedy check showed the effect of competition for nutrients and other resources of the environment. These finding are consistent with those obtained by Abdelhamid and El-metwally (2008); Olorunmaiye and Olorunmaiye (2008).

Table 1: Weed species and their level of infestation in dry season and rainy season Cowpea

Weed species	Level of Infestation	
	Dry season	Rainy season
Narrow leaved		
Cynodon dactylon	***	-
Dactyloctenium aegyptium	**	*
Digitaria dibilis	*	-
Eichnoclor species	**	-
Eleusine indica	*	*
Panicum maximum	**	-
Sorghum bicolor	**	-
Broad leaved		
Amaranthus spinosus	*	
Cassia tora	**	*
Cleome viscose	*	-
Corchorus oliterius	*	*
Crotelera retusa	**	-
Euphorvia hirta	**	-
Ipomea acquatica	***	*
Ipomea asorifolia	**	*
Portulaca oleracea	***	-
Mitracarpus villosus	**	*
Sedges		
Cyperus rotundus	**	*
Kyllinga squamulatus	**	*

*=1-25% occurrence, **=26-50% occurrence, ***=51-75% occurrence and ****=76-100% occurrence

Table 2: Influence of weed control methods on number of pods per plant and number of grains per pod in dry season and rainy season cowpea

Treatment	Rate kg ai/ha	Number of pods/plant		Number of grains/pod	
		DR	RN	DR	RN
Metolachlor and Prometryn	0.82	10.2b-e	59.7b	8.4b	7.53b
Metolachl Metolachlor and Prometryn	1.03	6.2de	43.2b	10.9ab	9.8ab
Metolachlor and Prometryn	1.24	20.2abc	51.3b	10.6ab	9.2ab
Metolachlor and Prometryn fb SHW	0.82 fb SHW	27.4ab	83.5b	14.3a	9.5a
Metolachlor and Prometryn fb SHW	1.03 fb SHW	30.3a	84.6b	14.6a	10.3a
Fluazifop	0.3	15.2bcd	40.5b	9.7b	9.8ab
Fluazifop	0.4	14.8b-e	43.4b	11.9b	11.1a
Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.3	17.0bcd	68.5b	12.6b	9.4ab

Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.4	19.3abc	53.7b	10.7ab	10.8ab
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.3	4.7de	70.4b	11.4ab	9.26ab
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.4	11.7b-e	67.1b	12.6ab	9.2 ab
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.3	21.4abc	48.3b	11.6ab	8.6ab
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.4	9.5cde	59.6b	8.8b	9.6ab
Two hoe weeding at 3 and 6 WAS		30.6a	165.0a	14.6a	12.3a
Weedy check		2.2e	21.3c	3.6c	3.9c
SE ±		3.89	9.32	0.94	1.19

Means followed by the same letter in the same column are not significantly different at 5% level of probability. a.i. = active ingredient; ha = hectre; fb= followed by; SHW= supplementary hoe weeding; DR= dry season; RN= rainy season.

Two hoe weeded plots also produced higher number of grains per pod which were statistically similar to those obtained by pre-emergence application of Metolachlor and Prometyrn followed by supplementary hoe weeding or by post-emergence application of Fluazifop (0.4 kg a.i. ha^{-1}) in the rainy season and other combinations as shown in table 2. Weedy check had the least number of grains per pod which was statistically different from all other treatments in both seasons. The higher number of grains per pods of two hoe weeded plots as well as the herbicide treatments mentioned above, resulted in effective weed control causing maximum nutrient utilization by the crop and hence higher number of grains per pods as against the weedy check which suffered from weed competition for limited environmental resources (solar radiation, water and nutrients) which ultimately led to low production and assimilation of photosynthates and reduced growth (Chattha *et al.*, 2007)**.**

The effect of weed control treatments on pod yield and weed dry weight were significant (Table 3). Two hoe weeded plots had produced the highest pod yield which was statistically different from all other treatment in the both seasons except the use of Metolachlor and Prometryn followed by fluazifop (0.82 fb 0.4; 1.03 fb 0.3 and 1.03 fb 0.4 kg a.i. ha^{-1}). Weedy check produced the least pod yield. This trend was in line with the effect of the treatments on the number of pods per plant. The result also revealed that weed dry weight were significantly reduced by weed management practices compared to non weeded treatment in both seasons except the pre-emergence application of Metolachlor and Prometryn at 0.8 kg a.i. ha^{-1}. Two hoe weeded plots achieved the highest weed suppression as indicated by its lowest weed dry matter. Similar opinion was reported by Abdelhamid and El-metwally (2008). Among the herbicide treatment, pre-emergence application of Metolachlor and Prometryn at 0.82 Kg ai /ha had the highest weed dry weight which is statistically different from other herbicide treated plots indicating the weakness of this rate of herbicide in weed control due to its fast degradation. However, when this rate of herbicide was followed by supplementary weeding, weeds were effectively controlled as indicated by lower weed dry weight.

Table 3: Influence of weed control method on pod yield and weed dry weight of dry season and rainy season cowpea

Treatment	Rate kg a.i. ha^{-1}	Pod yield Kg ha^{-1}		Weed dry weight Kg ha^{-1}	
		DR	RN	DR	RN
Metolachlor and Prometryn	0.82	402c-f	1022bcd	21000a	2167a
Metolachlor and Prometryn	1.03	188ef	1166bcd	10333cd	867b
Metolachlor and Prometryn	1.24	422c-f	1333bcd	18000b	933b
Metolachlor and Prometryn fb SHW	0.82 fb SHW	666bcd	1566bc	8000cde	147b
Metolachlor and Prometryn fb SHW	1.03 fb SHW	833b	1900ab	7000de	138b
Fluazifop	0.3	500cde	1177bcd	10667cd	733b
Fluazifop	0.4	464c-f	822cd	13000c	567b
Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.3	366c-f	1511bc	10333cd	467b
Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.4	752bc	1688abc	7000de	333b
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.3	315def	1722abc	10000cde	333b
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.4	417cdf	1700abc	10667cd	467b
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.3	566c-e	1022bcd	9667cde	436b
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.4	139ef	966bcd	9000cde	533b
Two hoe weeding at 3 and 6 WAS		1354a	2522a	5000e	133b
Weedy check		46f	233e	23000a	3667a
SE ±		127.6	278.6	1575	840

Means followed by the same letter in the same column are not significantly different at 5% level of probability. *Weed cover score 1 – 10 scale: 1 = uncovered space, 10 = completely covered
a.i. = active ingredient; ha = hectare; fb= followed by; SHW= supplementary hoe weeding; DR= dry season; RN= rainy season.

The effect of weed control treatment on 100- seed weight and grain yield were significant (Table 4). The two hoe weeded plots and many of the herbicide treatments recorded significantly higher seed weight compared to weedy check and Metolachlor and Prometryn at 0.82 Kg a.i. ha^{-1} and 1.03 Kg a.i. ha^{-1} under the rainy season. This may be attributed to the associated effect of these treatments on number of grains per pod which followed similar trend. Weeds are known to have high competitive advantages, hence the amount of water and mineral salt from soils that are supposed to be used by the crop for development were diverted to support weed growth. This caused lower grain filling resulting in shriveled and smaller grains. The effect on grain yield indicated that two hoe weeded plot had the highest yield ($p < 0.05$) in both seasons while weedy check plots had the least though at par with some herbicide treatments during the dry season. Keeping the fields weed free twice had consistently showed promise in other characters mentioned above which directly increased the grain yield. Among the herbicide treated plots, pre-emergence application of Metolachlor and Prometryn followed by supplementary hoe weeding or fluazifop recorded yields higher than the weedy check but was at par with many herbicide treatments.

Table 4: Influence of weed control method on 100-seed weight and grain yield Kg ha^{-1} at harvest in dry season and rainy season cowpea

Treatment	Rate kg a.i. ha^{-1}	100-seed weight(g)		Grain yield (Kg ha^{-1})	
		DR	RN	DR	RN
Metolachlor and Prometryn	0.82	11.7ab	10.3d	171cde	466bc
Metolachlor and Prometryn	1.03	10.9ab	11.4cd	130de	533bc
Metolachlor and Prometryn	1.24	10.6ab	13.9ab	243cde	688bc
Metolachlor and Prometryn fb SHW	0.82 fb SHW	13.3a	13.1abc	414cb	1033b
Metolachlor and Prometryn fb SHW	1.03 fb SHW	13.4a	13.2abc	597b	1088b
Fluazifop	0.3	10.8ab	14.3ab	257cde	700bc
Fluazifop	0.4	11.9ab	13.1abc	300cd	477bc
Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.3	12.6ab	14.2ab	260cde	1022b
Metolachlor and Prometryn fb Fluazifop	0.82 fb 0.4	10.7ab	14.5a	269cde	811bc
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.3	11.3ab	13.1abc	220cde	800bc
Metolachlor and Prometryn fb Fluazifop	1.03 fb 0.4	13.3a	13.3abc	265cde	966b
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.3	11.6ab	12.4ab	277cde	566bc
Metolachlor and Prometryn fb Fluazifop	1.24 fb 0.4	9.3ab	13.0abc	768b	688bc
Two hoe weeding at 3 and 6 WAS		13.8a	14.8a	998a	1644a
Weedy check		8.8c	9.5e	25f	244c
SE $\pm$		1.20	0.61	79.7	56.1

Means followed by the same letter in the same column are not significantly different at 5% level of probability. a.i. = active ingredient; ha = hectare; fb= followed by; SHW= supplementary hoe weeding; DR= dry season; RN= rainy season.

Grain yield was found to be positively correlated with pod yield, number of pods per plant and 100-seed weight in both seasons (Tables 5 & 6). However, grain yield was not significantly correlated with number of grains per pod in both seasons, which might be genetically influenced.

The relationship between weed dry weight and grain yield, pod yield and number of pods per plant was negative ($p < 0.05$). This means that as, weed dry weight increased, grain yield and yield components of cowpea decreased due to competition between the cowpea and weeds for environmental resources (Rao, 2004).

Table 5: Simple correlation matrix between and yield component and weed dry weight on rainy season cowpea

	Grain yield	Pod yield	No. of pods/plant	No. of grains/pod	100-seed weight	Weed dry weight
Grain yield Per hectare	1.00					
Pod yield per hectare	**0.86256	1.00				
No. of pods per plant	**0.76251	0.61891	1.00			
No. of grains per pod	0.07412	*0.47146	-0.02927	1.00		
100-seed weight	*0.3267	*0.2748	*0.2434	*0.42353	1.00	
Weed dry weight	-*0.4423	*-0.4418	-*0.4419	-0.1394ns	-0.1914	1.00

*=significance at 5 % level of probability; **= significance at 1% level of probability

Table 6: Simple correlation matrix between and yield component and weed dry weight on dry season cowpea

	Grain yield	Pod yield	No. of pods/plant	No. of grains/pod	100-seed weight	Weed dry weight
Grain yield Per hectare	1.00					
Pod yield per hectare	**0.8664	1.00				
No. of pods per plant	**0.93015	**0.83631	1.00			
No. of grains per pod	0.05778	0.13947	0.136685	1.00		
100-seed weight	*0.33977	*0.27408	*0.25444	0.00512	1.00	
Weed dry weight	-*0.44238	*-0.4418	-*0.45236	-0.13947ns	-0.0914	1.00

*=significance at 5 % level of probability; **= significance at 1% level of probability

IV. Conclusion

The use of pre-emergence herbicide alone failed to give effective weed control. However, among the herbicide treated plot, better weed control was obtained in plots treated with pre-emergence application of Metolachlor and Prometryn at 1.03 kg a.i.ha^{-1} followed by supplementary hoe weeding or post-emergence application of Fluazifop at 0.4 kg a.i.ha^{-1}. Consequently, two hoe weeded plots gave the best weed control and had produced significantly higher yield and yield components in both seasons.

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Author's Profile

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