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The Influence of Timing and Frequency of Weeding on the Performance of Cowpea (*Vigna unguiculata* (L.) Walp.) in A Dry Forest Ecology in Nigeria

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ABSTRACT

Weeding sequence on cowpea [*Vigna unguiculata* (L.) Walp.] was assessed in a field trial and two pot experiments between 1999 and 2001. The cowpea plots were subjected to six weeding regimes in each trial. The weeding regimes were weed-free control (T1), weeding at 2, 6 and 10 weeks after planting (WAP) (T2), weeding at 3, 6 and 9 WAP (T3), weeding at 4 and 8 WAP (T4), weeding at 2 and 6 WAP (T5), and weedy control (T6). The experimental design was randomized complete block with three replications. Significant means were compared with LSD at 5% probability level.

The seed yield of T1 and T2 were similar but significantly ($P \leq 0.05$) greater than T3 and T5 that were in turn significantly greater than T4. All the treatments had significantly ($P \leq 0.05$) greater seed yield than the weedy (T6) control which had 77.69% grain yield reduction. The commonest weed species on the cowpea field were *Euphorbia heterophylla, Pennisetum pedicellatum, Chromolaena odorata and Phyllantus amarus*. However, the commonest weeds encountered in the pot experiments were *Sporobolus pyramidalis, Mariscus alternifolius, Oldelandia corymbosa and Acalypha segetalis*. On economic basis, two weeding at 2 or 3 WAP and at 6 WAP may be adequate for cowpea production in the forest ecology of Nigeria.

Keywords: Cowpea, growth, harvest index, interference, weeding regimes.

INTRODUCTION

About 94% of the world cowpea is produced in Africa with Nigeria being the major exporter (FAO, 1997). Anon. (1985) reported that Nigeria and Niger Republic account for about 49% of world production of cowpea. Cowpea is grown in many agro-ecological zones including rainforest, sudan savanna, and sahel savanna,as well as the cool climates in central, eastern and southern Africa (Emechebe and Shoyinka, 1985). Cowpea is a good source of forage, hay and silage for livestock and serves as cover crop and green manure to maintain the productivity of soils (Onwueme and Sinha, 1991). The nutritional value of cowpea is in its high (20-30%) protein content (Stanton, 1966). Quin (1977) reported 23-25% and 50-67% for protein and starch contents respectively. Rachie (1985) reported that in West and Central Africa, cowpea constitutes the cheapest source of dietary protein for the low income sector of the population.

Despite the uses of cowpea, low yields averaging 50-350 kg/ha are recorded at farmers' level due to drought, low soil fertility, diseases and pests including weeds (Rachie, 1985; Mortimore *et al*., 1977, Karungi *et al*., 2000). Though insect pests constitute the major constraints to cowpea production (Singh et al.1990), a number of weed species including *Striga gesnerioides, Synedrella nodiflora, Talinum triangulare, Acanthospermum hispidum, Amaranthus spinosus, Commelina benghalensis, Brachiaria sp., Digitariasp., Cynodon dactylon, Paspalum sp., Eleusine indica, Euphorbia heterophylla Vernonia galamensis*, etc. are important in the production and contribute to the subsidiary position of the crop in the farming system (Fadayomi, 1979; Akobundu, 1982 and Poku and Akobundu, 1985).

The effects of weeds on crop performance depend on weed flora, duration of interference of weed with the crop, crop cultivar, crop stocking density, semblance in phenology and growth habit of weed and the crop and the environmental factors including light, water, nutrient, and allelopathy (Poku and Akobundu, 1985; Ogunyemi *et al*., 2001). Ayeni (1982) reported that the impact of weed interference with cowpea is more severe in the late season than in the early season because of limited available moisture. Fadayomi (1979) reported that in cowpea left weedy for the first four to six weeks after planting, high density (0.5m × 0.25m)plots had significantly higher yield than low

density (1m × 0.3m) plots. Weeds, apart from interfering with the performance of cowpea, also increase insect pest damage and reduce the effectiveness of insecticides (Moody and Whitney, 1974). For example, field observations had shown that *Chromolaena odorata* serves as alternative host to *Aphis craccivora*, an insect vector of Cucumber Mosaic Virus (CMV) in cowpea. Also, infestations by *Maruca (testulalis) vitrata*, a pod damaging hemipterous bug, and seed damage by *Cydia ptychora* were highest on weedy cowpea plots subjected to two,three or four weedings (Ofuya, 1989).

The impact of weed interference on the performance of a crop also depends on timing and frequency of weeding. Studies had revealed that the critical period of weed interference in cowpea production is between the first 20-40 days of growth (Medrano *et al*., 1973; Moody, 1973; Fadayomi, 1979), and that two weeding activities within 5-6 weeks of crop emergence resulted in negligible cowpea yield loss (Moody, 1973; Enyi, 1975). Uncontrolled weed growth has been variously reported to account for 25-80% reductions in cowpea grain yield (Nangju, 1980; Lagoke *et al*., 1982; Poku and Akobundu, 1985). Lagoke *et al*. (1982) further reported that while clean-weeding increased the yield of cowpea by 85%, weeding only once increased the yields by only 40%. This paper is a report of evaluation of two and three weeding frequencies and the timing of the weeding on the performance of cowpea [*Vigna unguiculata* (L.) Walp.] in the dry forest ecology of Southwestern Nigeria, using Ife brown cultivar.

MATERIALS AND METHODS

The study was conducted in Ibadaan (latitude 7°30'N; longitude 3°54'E; altitude 234m ASL). The rainfall in Ibadan is bimodal with the two peaks in June and September. The total rainfall and pan-evaporation, averaged over 10 years (1989-1998), were 1120.06mm and 1141.13mm respectively. The number of raindays averaged 111 days over the period (Awodoyin, 2001).

The trials were conducted in the second half of the rainy season (August-October) in 1999 as field experiment and two times, as pot experiments in the dry season (October-December) in 2000 and first half of the rainy season (March-May) in 2001. The field study was located in the crop garden and the pot experiments on the roof-top garden in the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan. The seeds of Ife brown cultivar used for the study were obtained from the genetics section in the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan.

The field study was sown in a sandy clay loam soil with low organic carbon (1.45%) and low total nitrogen (0.18%). The plot was under a short fallow of weeds with the flora dominated by *Chromolaena odorata*. The soil used for the two pot culture experiments was collected from the field study site. The treatments were weed-free control (T1)[achieved by weeding at 2, 4, 6, 8 and 10 weeks after planting (WAP)], weeding three times at 2, 6 and 10 WAP (T2), weeding three times at 3, 6 and 9 WAP (T3), weeding two times at 4 and 8 WAP (T4), weeding two times at 2 and 6 WAP (T5) and weedy (unweeded) Control (T6). The plants were sprayed with lambda-cyalothrin (karate) at the rate of 5.0ml/litre of water at 4, 6 and 10 WAP to control insect pests at vegetative, flowering and post-flowering stages respectively.

The experimental design on the field was randomized complete block with three replications. Plot size was 1.2m × 1.2m with a spacing of 0.6m between rows and 0.3m within row. Three plants were tagged per plot for growth and yield analyses. The plants were harvested at maturity (before the pods dehisced), partitioned into pods, shoot and root, oven-dried at 80°C for 48 hours and weighed to determine the dry matter accumulation. The plants were assessed for shoot dry weight, root dry weight, total plant dry weight, number of pods per plant, seed dry weight, 100-seed weight, husk dry weight, seed:husk ratio and harvest index. The treatments were compared by subjecting the data to analysis of variance (Gomez and Gomez, 1984). Mean separation was made using least significant difference (LSD) at 5% level of probability. Three quadrats (25cm x 25cm) were randomly laid within each plot at final harvest (16 WAP) to assess weed spectrum and density of each species.

In each of the pot culture experiments, seventy two plastic pots (24cm surface diameter, 24cm deep) were filled with top soil. The pots were arranged in a randomized complete block design with four replications and with three pots allocated to each treatment in each block. In the 2000 dry season trial, the pots were adequately watered daily, whereas in the 2001 first half rainy season trial, the pots were watered only if there was no rain in two days. Excess water drained off from the perforations at the base of the pots. All other treatments and assessments were as in the field experiment. For the weed spectrum assessment the weed species in the pots at final harvest (16 WAP) were identified and counted per pot surface area (531 cm^2).

Table 1. Weather data for Ibadan at the three trial periods (1999 2nd rainy season, 2000 dry season and 2001 1st rainy season).

Months	Total Rainfall (mm)	Total pan-evaporation (mm)	Temperature (°C)		Relative humidity (%)	
			minimum	maximum	minimum	maximum
	1999 2nd rainy season					
August	94.25	105.83	22.31	28.67	72.35	99.14
September	182.28	95.03	22.24	28.29	71.79	99.06
October	312.98	117.29	22.27	30.13	67.95	99.03
Total	589.57	318.15	-	-	-	-
Average	-	-	22.27	29.24	70.70	99.08
	2000 dry season					
October	93.80	135.77	22.06	30.77	63.79	98.90
November	0.00	147.29	23.21	32.88	49.28	99.00
December	0.00	148.98	20.61	33.21	36.78	97.69
Total	93.80	432.04	-	-	-	-
Average	-	-	21.96	32.29	49.95	98.53
	2001 1st rainy season					
March	68.80	193.38	23.40	35.20	42.00	99.00
April	93.30	165.16	22.80	33.00	57.00	99.00
May	153.80	149.96	22.50	31.90	64.00	99.00
Total	315.90	508.50	-	-	-	-
Average	-	-	22.90	33.37	54.30	99.00

Source: International Institute of Tropical Agriculture, Central Station, Ibadan.

RESULTS AND DISCUSSION

The performance of cowpea was less in the pot experiments than the field study as a result of growth restriction by soil volume in the pots. The relatively high moisture stress and high temperature at the two periods of the pot experiments might have aggravated the poor performance of the cowpea. The rainfall: evaporation ratio in the 2000 and 2001 trial periods were respectively 0.22 and 0.62 compared to the 1.85 ratio in the 1999 trial period (Table 1).

On the field, the T1 plants performed significantly ($P < 0.05$) better than T4, T5 and T6 plants in terms of total dry matter accumulation (Table 2). In terms of total plant dry weight, T1, T2, T3, T4 and T5 outyielded the T6 (weedy) plants by 62%., 58%, 57% and 53% respectively. The plants that received three weedings (T2 and T3), irrespective of timing, had better dry matter than those that received two weedings (T4 and T5), though the differences were not significant. The root dry weight and stem dry weight followed the same trend. However, for number of pods per plant, the plants that received three weedings at 4 weeks interval (T2) had similar performance with the weedfree plants (T1) but significantly ($P < 0.05$) better than the plants that had two weedings. In all the growth parameters considered, the performance of plants that received two weedings at 2 and 6 WAP (T5) were similar to those that received three weedings at 2, 6 and 10 WAP (T2) and those that received three weedings at 3, 6 and 9 WAP (T3) (Table 2). This may imply that the critical period of weed interference in cowpea in the Nigerian dry forest region is 2-3 WAP. Delaying the first weeding in the two weeding frequency till 4 WAP (T4) and 2 WAP (T5) respectively resulted in 22% and 18% biomass yield reduction compared to the weedfree (T1) plot. The three weedings T2 and T3 respectively had 8% and 11% reduction on biomass yield.

In terms of most of the grain yield attributes, except seed yield, T1, T2, T3 and T5 were not significantly ($P < 0.05$) better than T4 that was in turn significantly ($P < 0.05$) better than T6 (Table 3). However, in terms of seed yield, T1 and T2 were similar but significantly ($P < 0.05$) better than T3 and T5 that were in turn significantly ($P < 0.05$) better than T4. All the treatment were significantly ($P < 0.05$) better than the weedy control (T6) that resulted in about 77.69% grain yield reduction. Compared to weedfree plots, the three weedings

Table 2. Biomass yield (g/plant) and number of pods of Ife Brown cowpea subjected to varying frequency and time of weeding in Ibadan.

Treatments	Shoot dry weight (g)	Root dry weight (g)	Number of pods	Seed dry weight (g)
	Field (1999 2nd rainy season)			
T1 (weedfree)	12.21	1.98	37.64	15.00
T2	11.02	1.83	34.09	13.67
T3	10.93	1.78	33.25	12.67
T4	10.58	1.69	29.31	10.33
T5	10.90	1.76	30.80	11.67
T6 (weedy)	6.72	1.06	14.35	5.00
LSD (5%)	1.09	0.16	5.23	2.83
	Pot Trial 1 (2000 dry season)			
T1 (weedfree)	2.31	0.65	13.95	9.38
T2	3.30	2.14	16.17	9.63
T3	3.06	1.69	16.25	11.75
T4	2.88	2.30	16.12	8.75
T5	3.24	1.75	15.25	10.50
T6 (weedy)	2.06	0.72	7.80	6.63
LSD (5%)	ns	ns	3.75	2.62
	Pot Trial 2 (2001 1st rainy season)			
T1 (weedfree)	2.05	0.89	8.30	6.25
T2	1.92	0.80	9.12	8.13
T3	2.80	0.98	10.48	8.60
T4	1.50	0.88	9.90	7.25
T5	1.86	0.80	9.91	7.00
T6 (weedy)	2.38	0.53	5.07	2.50
LSD (5%)	ns	ns	2.75	2.76

Table 3: Grain yield (g/plant) of Ife Brown cowpea subjected to varying frequency and time of weeding in Ibadan.

Treatments	Seed DW	Husk DW	Seed: Husk ratio	Harvest Index
	Field (1999 2nd rainy season)			
T1 (weedfree)	19.95	3.04	12.01	0.53
T2	18.18	2.80	11.91	0.53
T3	16.60	2.55	11.75	0.50
T4	13.06	2.11	11.42	0.44
T5	15.09	2.25	11.61	0.49
T6 (weedy)	4.45	0.91	10.96	0.31
LSD (5%)	3.02	0.70	0.48	0.05
	Pot Trial 1 (2000 dry season)			
T1 (weedfree)	5.23	1.43	14.13	0.45
T2	6.99	1.53	14.76	0.46
T3	8.48	1.66	13.51	0.52
T4	7.69	1.47	15.99	0.50
T5	7.23	1.65	14.96	0.48
T6 (weedy)	3.34	0.88	13.81	0.44
LSD (5%)	0.89	0.34	ns	ns
	Pot Trial 2 (2001 1st rainy season)			
T1 (weedfree)	5.61	1.27	13.33	0.47
T2	4.92	1.43	15.02	0.54
T3	5.74	1.66	17.36	0.55
T4	4.75	1.36	15.50	0.58
T5	2.65	1.50	16.37	0.57
T6 (weedy)	3.30	0.69	13.49	0.30
LSD (5%)	0.45	0.48	ns	0.14

DW = dry weight

resulted in about 12.82% grain yield reduction while the two weeding resulted in about 29.45% grain yield reduction. The results compared to 40-80% grain yield reduction due to uncontrolled weed that was reported by Poku and Akobundu (1983). Ahlawat *et al.* (1980) reported that unweeded cowpea suffered up to 85% grain yield loss. Comparing the response of cowpea cultivars to uncontrolled weed, Nangu (1980) reported yield reductions of 25%, 33%, 45% and 54% for VITA 1, VITA 5, ER-1 and TVx33-1G respectively.

It is clear from the harvest indices that three weedings with the first at either 2 or 3 WAP (T2 and T3) and the second at 6 WAP, and two weedings with the first at 2 WAP and the second at 6 WAP (T5) were similar and not significantly different from the weedfree (T1) treatment (Table 3). This may further imply that adequate weed control within the first 6 WAP enhances the performance of cowpea. Often, beyond 6WAP the cowpea plants have developed large enough canopy to suppress accompanying weeds.

Fadayomi (1979) reported that the critical period of weed interference in cowpea production is between 20-40 days. Moody (1973) working in the savanna region of Northern Nigeria recommended two weedings for cowpea during the first 4-6 weeks. He further reported that in most cases competition does not commence until about two weeks after emergence and recommended that control of weeds must be ensured in the first 25-33% of the life cycle of a crop. Also Enyi (1973), working in central region of Tanzania, recommended three weedings for cowpea during the first 4-6 weeks. Akobundu (1982) reported that two weedings within the first 5 WAP are necessary in cowpea fields to minimize yields reductions.

In the two pot experiments, the treatments were not significantly different with regard to shoot dry weight and 100-seed weight (Table 2). However, they were significantly ($P < 0.05$) different with regards to total plant dry weight, number of pods, seed dry weight and harvest index. The T2, T3, T4 and T5 plants performed slightly better than T1 (weedfree) plants. However, the five weeding treatments (T1-T5) were significantly ($P < 0.05$) better than the weedy (T6) control in terms of total plant dry weight and seed yield. The consistently high weed population in the weedy (T6) treatment resulted in intense competition with cowpea for growth factors. The weed species mostly encountered on the field were *Euphorbia heterophyla, Pennisetum pedicellatum, Chromolaena odorata and Phyllanthus amarus* (Table 4). However, in the pot experiment weeds mostly encountered were *Sporobolus pyramidalis, Mariscus alternifolius, Oldelandia corymbosa and Acalypha segetalis* (Tables 5 and 6). From this study it may be concluded that in the dry forest ecology two weedings, first at 2 or 3 WAP and the second at 6 WAP, may be adequate for the production of cowpea.

Table 4: Weed spectrum and density (plant/m^2) in cowpea plots (1999 Field Trial).

Weed species	T1	T2	T3	T4	T5	T6
Ageratum conyzoides	-	-	3.20	4.27	4.27	-
Boerhavia diffusa	2.13	3.20	4.27	6.40	7.47	-
Brachiaria lata	-	-	2.13	-	6.40	5.33
Chromolaena odorata	-	1.07	-	3.20	-	9.60
Cynodon dactylon	10.67	9.60	8.53	6.40	9.60	4.27
Euphorbia heterophylla	-	3.20	6.40	4.27	5.33	19.20
Euphorbia hirta	-	2.13	-	-	2.13	-
Fluerya aestuans	-	3.20	-	6.40	4.27	-
Gomphrena celosoides	-	-	-	4.27	3.20	-
Mariscus alternifolius	-	-	3.19	-	-	-
Oldenlandia corymbosa	5.33	5.33	-	8.53	4.27	-
Pennisetum pedicellatum	-	-	-	-	-	16.00
Phyllanthus amarus	-	4.26	9.60	7.47	10.64	8.51
Setaria barbata	-	3.20	4.27	-	5.30	6.40
Synedrella nodiflora	3.20	-	5.33	6.40	6.40	-
Talinum triangulare	1.07	2.13	-	4.27	-	5.33
Tridax procumbens	-	-	-	3.20	5.33	5.33

Table 5: Weed spectrum and density (plant/pot) in cowpea Pot Trial (2000).

Weed species	T1	T2	T3	T4	T5	T6
Acalypha segetalis	-	-	-	-	-	5.00
Commelina benghalensis	-	-	-	-	-	3.33
Cyperus rotundus	3.33	5.00	-	3.33	6.67	-
Eragrostis tenella	3.33	8.33	8.33	25.00	18.33	23.33
Mariscus flabelliformis	-	-	-	-	-	15.00
Oldelandia corymbosa	48.33	6.67	11.67	13.33	18.33	61.67
Perotis indica	8.33	3.33	-	3.33	6.67	21.67
Portulaca oleracea	3.33	11.67	10.00	3.33	6.67	21.67
Setaria barbata	33.33	-	-	-	-	-
Sporobolus pyramidalis	145.00	125.00	178.33	115.00	95.00	368.67
Talinum triangulare	-	-	1.67	-	1.67	6.67

Table 6: Weed spectrum and density (plant/pot) in cowpea Pot Trial (2001).

Weed species	T1	T2	T3	T4	T5	T6
Acalypha segetalis	1.67	-	-	-	-	46.67
Crotalaria retusa	3.64	-	11.67	10.00	-	-
Cyperus rotundus	20.00	-	-	-	1.67	21.67
Eragrostis tenella	3.33	-	-	-	-	6.67
Euphorbia hirta	5.00	1.67	5.00	-	3.33	16.67
Indigofera hirsuta	-	-	-	-	6.67	8.33
Mariscus flabelliformis	3.33	-	-	-	-	25.00
Mariscus alternifolius	11.67	-	-	1.67	-	43.34
Oldenlandia corymbosa	40.00	6.67	-	68.30	1.67	13.33
Phyllanthus amarus	-	-	-	-	-	16.67
Physalis angulata	-	-	-	-	-	6.67
Sporobolus pyramidalis	45.00	6.67	68.30	-	1.67	13.33
Synedrella nodiflora	4.67	1.67	-	-	-	5.00
Talinum triangulare	1.67	-	-	-	-	3.33

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