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Evaluation of Pre-Emergence Herbicides for Weed Control in Cowpea (*Vigna unguiculata* (L.) Walp.) in a Forest - Savanna Transition Zone

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Authors' contributions

This work was carried out in collaboration between the authors. Author OS designed the study, performed the statistical analysis, wrote the protocol, and the first draft of the manuscript. Author UEU assisted in the organization of the data, reviewed the manuscript and literature, designed the economic analyses of the study and prepared the manuscript for publication. Authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: To evaluate the efficacy and economic benefits of selected pre-emergence herbicides for weed control in cowpea.
Study Design: Randomized complete block design with four replications was used.
Place and Duration of Study: Research and Teaching Farm of Ambrose Alli University in Ekpoma (Lat. 6° 45'N, Long. 6° 8'E), in a forest-savanna transition zone of Nigeria, between August and December 2005 and August and December 2006.
Methodology: Five weed control treatments evaluated against unweeded control were; Codal gold(R) (250g prometryne + 162.5 g metolachlor per litre) at a rate of 1.65 kg a.i ha^{-1}, Galex(R) (Metolachlor 250g + metobromuron 250g per litre) at the rate of 3.0 kg $a.1.ha^{-1}$; Pendilin(R) (Pendimethalin 500g per litre) at a rate of 2.0 kg a.i ha^{-1}, one hoe – weeding at 3 weeks after planting (WAP) and two hoe weeding at 3 and 7 WAP.
Results: Herbicides treatments and hoe weeded twice gave an acceptable (≥70%) weed control in both years. Cowpea yield was best under Codal gold at 1.65 kg a.i ha^{-1} (with an average yield of ≥ 1600kg ha^{-1}) while the unweeded control had the poorest yield (between 800 and 900 kg ha^{-1}) in both years. The highest profit was obtained under Codal gold at 1.65 kg a.i ha^{-1} and the lowest in plot hoe weeded twice. The highest cost benefit ratio

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(CBR) of 24.61 in 2005 and 28.21 in 2006 were recorded with Codal gold^{R} treated plot while the lowest of 1.25 and 1.22 were obtained in 2005 and 2006 respectively under plot hoe weeded twice.
Conclusion: Codal gold$^{(R)}$ at 1.65 kg a.i ha^{-1} was better than the other herbicides tried, in reducing weed infestation in cowpea as evidenced on the performance, yield of cowpea and higher economic returns. With the range of herbicides tried in this study, Codal gold$^{(R)}$ at 1.65 kg a.i ha^{-1} appears to be the best herbicide for weed control in cowpea under the present study.

Keywords: Cowpea; herbicides; weed smothering efficiency; CBR.

ABBREVIATIONS

CBR: Cost Benefit Ratio; LSD: least Significant Difference; ANOVA: Analysis of Variance; CBN: Central Bank of Nigeria.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* (L) Walp.) is an annual legume that is widely cultivated in Nigeria mainly for its edible seeds. A more recent and reliable statistics, by Food and Agricultural Organization (FAO) and cited by IITA reported that about 7.56 million tons of cowpea were produced annually on about 12.76 million hectares of land [1]. Sub – Saharan Africa was reported to account for about 70% total World Production [1]. Nigeria is still said to be the world largest cowpea producer where about 2 million tones are produced per annum. This is followed by Niger (650,000 tons) and Mali with 110, 000 tones [2].

Average world yield of cowpea grain is quite low at less than 0.3 ton/ha. Within Africa, average cowpea yields range from 0.05 to 0.55 ton/ha [3]. In Nigeria, about 200-300 kg ha^{-1} [4] and more than 2000kgha^{-1} under research environment [5]. Among other factors limiting cowpea production, inadequate weed control had been identified as a major contributory factor for yield gap. Uncontrolled weed growth and/or inadequate weed control in the crop have been reported to account for 40-80% reduction, in grain yield [6,7]. Crop losses by weeds could be aggravated by delay in weeding or inability to weed through the entire crop growth period. However, studies of the thresh hold levels of weeds have shown that complete weed eliminations is not essential for high yields [8], probably because the crop can also compete strongly with weeds, after the critical period of weed interference.

The critical period of weed competition for cowpea is the first 3 – 4 weeks of crop growth [9]. Weed competition has the capability of lowering vegetative growth, flowering, fruiting and seed production, which will determine yield. Whenever possible, several weed control methods which include, cultural, biological or chemical could be used separately or in combination to give the desired result [10].

Weed reduced crop yield by interfering with crop growth. Hand weeding limits agricultural productivity because there is a limit to the amount of land area that can be weeded even when the labor is free [11]. Hand weeding required over 50% of the farmers' time leaving him and his family with little or no time for other activities [11]. Use of herbicides may therefore provide a timely and adequate alternative to hand weeding as this will not only remove the drudgery associated with it but also lower the cost of weeding and provide

protection for crop against early weed competition when pre-emergence herbicides are used [11].

Presently, existing herbicides for pre-emergence weed control in cowpea are no longer consistent in their spectrum of effective weed control. This may be as a result of some weeds becoming resistant to these herbicides. Codal gold$^{(R)}$ which is one of the recently introduced new herbicides in the early twenty (20th) century in Nigeria had not been widely experimented upon by farmers. Hence, the objective of this study was to assess the effectiveness of selected pre-emergent herbicides [Galex$^{(R)}$ and Pendilin$^{(R)}$(old herbicides) and Codal gold$^{(R)}$ (new herbicide)] for weed control and their economic returns in cowpea.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted between August and December, 2005 and repeated in the same season of 2006 at the Teaching and Research Farm of Ambrose Alli University (Latitude 6^0 45^1, 6^0 8^1 E and an altitude of 313 metres above sea level) in the forest – savanna transitions zone of Nigeria. The experimental site was under short fallow for about two (2) years, previously cropped to maize. Pre-cropping vegetation in the experimental site was dominated by siam weed (*Chromoleana odorata* (L) R.M. King & Robinson), goat weed (*Ageratum conyzoides* Linn) ,broom weed (*Sida acuta* Burm F) ,guinea grass (*Panicum maximum* Jacq*)* and *Cyperus* spp. Soil samples were randomly collected from 10 spots (0-15cm depth) over the entire field using an auger before the commencement of the experiment. The soil samples were bulked and mixed thoroughly for analysis. The soil analysis results are presented in Table 1.

The soil in both years was neutral sandy, moderate organic carbon, low nitrogen and acidic. Phosphorus (P) and Potassium (K) values were adequate. Number of rainy days and total rain fall during the trials are presented in Table 2.

The total rainfall was 2176.7mm distributed over 104 days in 2005 and 2145.8mm distributed in 2006 over 125 days in 2006 (Table 2).

2.2 Field Procedures

The land was manually slashed, stumped before leveling the soil surface with spades. Plot size was 3m x 4m with an alley way of 1m among plots and between replicates. There was thus, a total of 28 plots occupying an experimental area of 23m× 19m (437m^2) corresponding to approximately 0.04ha. There were six (6) treatments involved in the experiment and which included no weeding(control), weeding once at 3 weeks after planting (WAP), weeding twice at 3 and 7 WAP, Galex$^{(R)}$ at 3.0kg a.i./ha, Codal gold$^{(R)}$ at 1.65 kg a.i /ha and pendilin$^{(R)}$ at 2.0kgai/ha. The chemical names of the herbicides are shown in Table 3.

Table 1. Physico- chemical properties of the top soil (0-15cm) of the experimental site before cropping in 2005 and 2006

Soil Properties	Values		Methods
	2005	2006	
Sand (g/kg)	950.00	951.00	[12]
Silt (g/kg)	45.00	46.00	[12]
Clay (g/kg)	5.00	3.00	[12]
p^H (H_2O, 1.1)	6.20	6.50	[13]
Organic carbon (g/kg)	14.00	12.00	[14]
Total N (g/kg)	0.90	0.70	[15]
Available P (mg/kg)	15.40	16.78	[16]
Exchangeablecations (cmol/kg)			
Ca	3.90	3.70	[17]
Mg	2.10	1.90	[17]
K	0.29	0.26	[17]
Na	0.30	0.24	[17]
TE A (cmol/kg)	0.60	0.40	[17]
ECEC (cmol/kg)	7.19	6.50	[18]

TEA = Total Exchangeable Acidity; ECEC = Effective Cation Exchange Capacity; TEB = Total Exchangeable Bases.

Table 2. Monthly and Rainfall during 2005 and 2006 trial

Months	2005		2006	
	Rainy Days	Rainfall Days (mm)	Rainy Days	Rainfall Days (mm)
January	1	60.2	2	5.3
February	3	107.0	2	9.2
March	3	45.2	6	96.9
April	6	108.0	5	112.0
May	10	180.9	13	234.1
June	17	376.8	15	292.7
July	21	439.6	19	449.9
August	7	38.3	15	348.1
September	20	351.6	28	554.2
October	12	320.2	19	41.2
November	2	145.7	1	2.2
December	2	3.2	0	0.0
Total	104	2176.7	125	2145.8
Mean	8.69	187.4	10.42	178.8

Source: Edo State Agricultural Development Project (EADP), Irrua, Edo State, 2005 and 2006.

Table 3. Chemical names of herbicides used in the study

Trade name	Common/Chemical names
Pendilin®	Pendimethalin [*N*-(1-ethylpropyl)–3,4–dimethyl-2,6-dinitrobenzenamine] [19]
Galex ®	Metobromuron [N^1 –(4- bromophenyl)–*N*-methoxy–*N*-methylurea]+ Metolachlor,[2-chloro–*N*-(2-ethyl–6-methylphenyl)–*N*-(2-methoxy-1-methylethyl) acetamide] [19]
Codal gold ®	Prometryne, [*N, N*^{1}- bis (1-methylethyl)-6-(methylthio)–1,3,5-triazine–2, 4-diamine + Metolachlor ,[2-chloro–*N*-(2-ethyl–6-methylphenyl)–*N*-(2-methoxy-1-methylethyl) acetamide] [19]

The cowpea cultivar Ife brown (IT84S-2246-4) used for the experiment was obtained from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. Cowpea seeds were planted on 30th of August in 2005 and 31st of August 2006 at a spacing of 60cm×25cm. Two seeds were planted per hole and the seedlings thinned to one per stand at 2WAP, giving a desired population of 66667 plants/ha. No fertilizer was applied to the crop. The herbicides were applied at the specific rate of each herbicides using CP3 knapsack sprayer calibrated to deliver approximately 250L/ha at 210kpa using a red polijet nozzle [20]. The first hand weeding was done by hoeing at 3WAP and the second weeding at 7 WAP in both years.

2.3 Data Collection and Analysis

Weed density was recorded at final harvest. Weed samples were collected from 1m x 1m quadrat per plot, bulked and oven dried at 80^0C for 48 hours. Weed smothering efficiency (WSE) of the different weed control methods was calculated according to [21].

$$WSE\% = \frac{WDWC - WDWT}{WDWC} \times \frac{100}{1}$$

Where:

WSE = Weed smothering Efficiency.
WDWC = Weed dry weight of unweeded control.
WDWT = Weed dry weight in treated plots.

The crop parameters determined were:
Number of leaves/ Plant: The numbes of leaves were obtained by physical count of six (6) tagged plants randomly selected from the net plots ($3m^2$). The average of the 6 plants was taken as number of leaves per plant.

Plant height: This was done by randomly selecting 6 plants from the net plot size of $3m^2$ and measured their vine length from the soil level to the tip of the apical bud with a measuring tape. The mean of the plant heights was recorded per plant.

Leaf area: This was done by randomly selecting 6 plants and tagged. The leaf area was determined by graph tracing method. The total leaf area per plant was calculated as leaf area multiplied by the number of leaves using the procedures described by [22].

Days to 50% flowering: This was estimated by counting the number of days from sowing to the time when half of the plants start to produce flowers.

Number of seeds/plant: This was estimated as:

$$\frac{number\ of\ seeds\ per\ net\ plot}{number\ of\ plants\ per\ net\ plot}$$

Number of pods/plant: This was estimated as:

$$\frac{number\ of\ harvested\ pods\ per\ net\ plot}{number\ of\ plants\ per\ net\ plot}$$

2.4 Cowpea Grain Yield

Harvesting was assessed from net plot of $3m^2$. The pods were handpicked and four pickings were done at weekly intervals starting from 56 days after planting (DAP). The pods were sun dried for one week and then shelled. The grain yield in each net plot was weighed with weighing balance and the weight recorded. The yield per net plot was extrapolated to kilograms per hectare (kg/ha).

The statistical model of the trial was based on randomized complete block design. All agronomic data were subjected to ANOVA and, where appropriated means were separated using Fisher's protected LSD at 5% level of probability.

2.5 Economic Assessment

Economic evaluation of the weed control treatment was done using partial farm budgeting [23] at prevailing labor and market costs of materials to estimate revenue. Sale revenue was obtained by multiplying the final grain yield (kg ha^{-1}) by the market price (₦ kg^{-1}). This is represented below in the following formula:

(i) Revenue = Yc x Pc (where, Yc = cowpea yield in kilogram/ ha; Pc = Price of cowpea grain. The profit was calculated by subtracting the costs of production from the sale revenue represented as follows:
(ii) Profit (net revenue) = Revenue – Total cost of Production
(iii) Simple proportion of total cost of weed control (cost of production) and net revenue (profit) were used to determine the cost/ benefits ratio (CBR) of each of the weed control treatment as follows:

$$Cost\ Benefit\ Ratio\ (CBR) = Profit\ (net\ revenue)/\ Total\ cost\ of\ production.$$

3. RESULTS

3.1 Weed Growth and Control

Weed density and weed dry weight were significantly influenced by weed control treatments at final harvest in 2005 and 2006 cropping seasons (Table 4).

Table 4. Effect of the weed control treatments on weed density, biomass, and weed smothering efficiency at harvest in 2005 and 2006 cropping season

Treatment	Rate (kg a.i./ha)	Weed density (no/m^2)		Weed dry weight (g/m^2)		Weed smothering efficiency (WSE) (%)	
		2005	2006	2005	2006	2005	2006
No weeding	-	197.00	222.25	118.85	202.00	-	-
Codal gold$^{(R)}$	1.65	61.25	67.00	15.58	19.50	87.08	90.35
Galex$^{(R)}$	3.0	90.00	116.00	19.93	29.75	82.72	85.27
Pendilin$^{(R)}$	2.0	90.25	117.00	20.78	28.00	83.06	86.07
Weeded x 1 (3WAP)	-	125.00	151.25	85.00	84.25	29.19	58.67
Weeded x 2 (3 + 7WAP)	-	90.25	115.75	23.50	31.00	80.18	84.56
LSD(P = 0.05)		4.667	9.548	7.139	2.510	1.134	3.286

All the herbicides reduced weed density considerably over the weedy checks. Codal gold$^{(R)}$ at 1.65 kg a.i /ha was most effective in suppressing weeds compared to the rest of the treatments. The differences observed on weed density for plots treated with Galex$^{(R)}$ at 3.0 kg a.i /ha, Pendilin$^{(R)}$ at 2.0 kg a.i /ha and plots hoe – weeded twice were not significant, but they differ significantly from plots hoe weeded once. Weed dry weight was significantly reduced by herbicide application in both years.

In 2005 the lowest weed dry weight was recorded in Codal gold$^{(R)}$ treated plots at 1.65 kg a.i /ha but it was similar with Galex$^{(R)}$ at 3.0 kg a.i /ha and Pendilin$^{(R)}$ plots at 2.0 kg a.i /ha but differs significantly from plots hoe-weeded twice. Though plot hoe weeded twice had high weed dry weight, it was comparable with that of Galex$^{(R)}$ at 3.0 kg a.i /ha and Pendilin$^{(R)}$ treated plots at 2.0 kg a.i /ha. In 2006, plots hoe- weeded twice differ significantly ($P < 0.05$) in dry weight from Pendilin$^{(R)}$ treated plots at 2.0 kg a.i /ha, but it had a comparable value with that of Galex$^{(R)}$ treated plot at 3.0 kg a.i /ha. Weed smothering efficiency in both years was distinctly higher in Codal gold$^{(R)}$ plots at 1.65 kg a.i /ha than Pendilin $^{(R)}$ treated plots at 2.0 kg a.i /ha, Galex$^{(R)}$ treated plot at 3.0 kg a.i /ha, plot hoe weeded twice (3 and 7 WAP) and plot hoe weeded once (3 WAP) in that order.

3.2 Vegetative Growth Characteristics

Leaves produced in unweeded plots was significantly lower than the treatment plots. Plots treated with Codal gold$^{(R)}$ at 1.65 kg a.i /ha had the highest number of leaves. There were no significant differences ($P>0.05$) among Galex$^{(R)}$ at 3.0 kg a.i /ha, Pendilin$^{(R)}$ at 2.0 kg a.i /ha and plots hoe weeded twice in leaf production but they differ significantly from plots hoe – weeded once (Table 5).

Plant height was significantly influenced by different herbicides treatments (Table 5). Among the treatments Codal gold$^{(R)}$ at 1.65 kg a.i /ha produced the tallest plants while the shortest plant was observed in weedy check. There were no significant different among Galex$^{(R)}$ at 3.0 kg a.i /ha, Pendilin$^{(R)}$ at 2.0 kg a.i /ha and plot- hoe weeded twice since uniform plant height were observed in them, but they differ from plot hoe weeded once, which had medium plant height.

Leaf area showed significant difference (P<0.05) among the treatments. Codal gold(R) plot at 1.65 kg a.i /ha recorded the highest leaf area which differs significantly from other treatments. There were no significant difference in cowpea leaf area in Galex(R) at 3.0 kg a.i /ha, Pendilin(R) 2.0 kg a.i /ha and plots hoe weeded twice but they differ from plots hoe-weeded once.

Table 5. Effect of weed control treatments on cowpea height and leaf area

Treatment	Rate (kg a.i./ha)	Plant height (cm)		Leaves /plant (no)		Leaf Area /plant (cm^2)	
		2005	2006	2005	2006	2005	2006
No weeding	-	64.75	72.78	16. 50	17.25	511.2	614.0
Codal Gold(R)	1.65	107.48	115.25	31.75	35.25	1591.6	1735.0
Galex(R)	3.0	97.10	102.50	25.50	27.25	1178.9	1271.3
Pendilin(R)	2.0	97.03	103.00	25.75	27. 75	1191.7	1272.3
Weeded x 1 (3WAP)	-	89.88	91.75	20.00	22.00	817.0	910.8
Weeded x 2 (3+7WAP)	-	96.03	102.00	25.50	27.00	1173.0	1268.3
LSD(P = 0.05)		2.503	2.021	1.150	1.499	55.22	65.35

3.3 Effects of Weed Control Treatment on Yield and Yield Components of Cowpea

In 2005, there were no significant difference (P>0.05) among the herbicides treated plot and plot that were hoe weeded twice in terms of number of days to 50% flowering but they differ significantly from plot hoe weeded once and unweeded plots (Table 6). The unweeded plot took the highest time to reach 50% flowering which was comparable to plots hoe weeded once. In 2006, unweeded plots differ significantly from other treatments by the time it took to reach 50% flowering. Codal gold(R) at 1.65 kg a.i /ha had the shortest number of days to 50% flowering but it was not significantly difference from Galex(R) at 3.0 kg a.i /ha, Pendilin(R) at 2.0 kg a.i /ha and plot hoe weeded twice which differ significantly from plot hoe weeded once (Table 6).

In 2006, Codal gold(R) treated plot at 1.65 kg a.i /ha had significantly the highest number of pods than other treatments. The second highest number of pods was produced in plots treated with Pendilin(R) at 2.0 kg a.i /ha but it was not different from Galex(R) treated plot at 3.0 kg a.i /ha and plot hoe weeded twice. Plot hoe weeded once differ significantly from the rest of the treatments including the weedy check which had the lowest number of pods (Table 6)

In 2005, there was no significant difference (P>0.05) among the treatments although Codal gold(R) at 1.65 kg a.i /ha had a slight number of seeds/pod. In 2006, the number of seeds/ pod differs significantly. Weedy plots recorded the lowest number of seeds/pod but it was not different from plots hoe weeded once. Codal gold(R) treated plots at 1.65 kg a.i /ha recorded highest number of seeds/pod but the value was comparable with that of Pendilin plots at 2.0 kg a.i /ha. No significance difference was observed among Galex(R) at 3.0 kg a.i /ha, Pendilin(R) at 2.0 kg a.i /ha and plots that were hoe weeded twice. The grain yield of cowpea was significantly (P<0.05) affected by the weed control treatments in the two years of study (Table 6). Cowpea grain yield followed the trend Codal gold(R) at 1.65 kg a.i /ha > Pendilin(R)

at 2.0 kg a.i /ha > Galex(R) at 3.0 kg a.i /ha > Two hoe weedings > one hoe weeding> weedy plots.

Table 6. Effect of weed control treatment on yield and yield components of cowpea

Treatment	Rate (kg a.i /ha)	Days to 50 flowering		Pods/plant (no)		Seed \pod (no)		Grain yield (kg/ha)	
		2005	2006	2005	2006	2005	2006	2005	2006
No weeding	-	52	52	9	11	10	9	814.00	905.25
Codal Gold(R)	1.65	46	46	13	14	11	13	1652.50	1841.25
Galex(R)	3.0	46	46	11	13	10	12	1180.00	1236.50
Pendilin(R)	2.0	46	46	11	13	10	12	1185.83	1240.75
Weeded x 1 (3WAP)	-	50	50	10	12	10	10	999.93	1085.50
Weeded x 2 (3+7WAP)	-	46	46	11	13	10	12	1171.67	1230.50
LSD(P = 0.05)		3	21	2	0.6	NS	1	81.528	36.085

3.4 Economic Evaluation

The value of the outpu per hectare (total revenue) from the use of pre-emergence herbicides varied from ₦119, 991.6 to ₦ 198, 300 in 2005. (Table 7) The highest revenue (₦ 198, 300) was recorded under Codal gold(R) plot at 1.65 kg a.i /ha followed by Pendilin(R) treated plot at 2.0 kg a.i /ha while the lowest was recorded under plot hoe weeded once (₦119, 991.6) compared to the rest of the treatments. Similar trend was observed in 2006 with Codal gold(R) at 1.65 kg a.i /ha recording the highest revenue (₦293, 362.5) followed by Pendilin(R) treated plot at 2.0 kg a.i /ha while the lowest was recorded under plot hoe weeded once (₦141, 115) compared to the rest of the treatment.(Table 8) The above results were due to differences in yield/ha recorded by the different treatments with Codal gold(R) at 1.65 kg a.i /ha resulting in the highest yields.

Plots hoe weeded twice at 3 and 7WAP recorded the highest cost of production (N62, 400) followed by plots hoe weeded once (N31, 200) compared to other treatments while the lowest was recorded under Galex(R), treated plots at 3.0 kg a.i /ha (N6, 850) in 2005. In 2006, the same trend was observed with the highest cost of production incurred by weeding at 3 and 7WAP compared to all other treatments while Galex ® treated plots at 3.0 kg a.i /ha resulted in the lowest cost of production.

Table 7. Economics evaluation of the use of pre emergence herbicides in cowpea production in 2005 cropping season

Treatment	Rate (kg a.i./ha)	Rate (L/ha)	Herbicides cost N/ha	Time of treatment application (man – hr/ha)	Cost of treatment application (N/ha)	Total cost N/ha	Grain yield (kg/ha)	Revenue (N/ha)	Net Revenue (profit) N/ha	CBR
Codal gold (R)	1.65	4	7000	5	850	7,850	1,652.50	198,300.00	190,450.00	24.26
Gale(R)	3.0	5	6000	5	850	6,850	1,180.00	141,600.00	134,750.00	19.67
Pendilin(R)	2.0	5	6500	5	850	7,350	1,185.83	142,299.60	134,949.60	18.36
Weeded x1	3 WAP	-	0.00	120	31,200	31,200	999.93	119,991.60	88,791.60	2.85
Weeded x 2	3 + 7 WAP	-	0.00	240	62,400	62,400	1,171.67	140,600.40	78,200.40	1.25
Unweeded	-	-	0.00							

N128.65 = $1(Exchange rate of naira to US dollar Central Bank of Nigeria [24]
CBR = Cost of benefit Ratio = Net Revenue / Total Cost.
1kg of cowpea = N120.00; 1litre of Codal gold® = N1, 750.00; 1litre of Galex® = N1, 200.00; 1litre of Pendilin = N1, 300.00.
Cost of application of herbicides = 150/hr. knapsack (hired) = N100 / treatment.
Cost of hand weeding = N260/hr (N600- N700 = (N1300 average) between 7.00 am – 12 noon = 5. hours approximately.

Table 8. Economics evaluation of the use of pre-emergence herbicides in cowpea production in 2006 cropping season

Treatment	Rate (kg a.i./ha)	Rate (L/ha)	Herbicides cost N/ha	Time of treatment application (man – hr/ha)	Cost of treatment application (N/ha)	Total cost N/ha	Grain yield (kg/ha)	Revenue (N/ha)	Net Revenue (profit) N/ha	CBR
Codal gold (R)	1.65	4	7200	5	1,020	8,220	1,841.25	239,362.50	231,142.50	28.12
Galex(R)	3.00	5	6250	5	1,020	7,270	1,236.50	160,745.00	153,475.00	21.11
Pendilin(R)	2.00	5	6750	5	1,020	7,770	1,240.75	161,297.50	153,527.50	19.76
Weeded x1	3 WAP	-	0.00	120	36,000	36,000	1,085.50	141,115.00	105,115.00	2.92
Weeded x 2	3 + 7 WAP	-	0.00	240	72,000	72,000	1,230.50	159,965.00	87,965.00	1.22
Unweeded	-	-	0.00							

N125.83 = $1 (Exchange rate of naira to US dollar [24]
CBR = Cost of benefit Ratio = Net Revenue/Total Cost.
1kg of cowpea = N130.00;1litre of Codal gold(R) = N1, 800.00;1litre of Galex(R) = N1, 250.00;1litre of Pendilin(R) = N1, 350.00.
Cost of application of herbicides = 180/hr. knapsack (hired) = N120 / treatment.
Cost of hand weeding = N300/hr (N700- N800) = (N1500 average) between 7.00am – 12noon = 5 hours approximately.

In 2005, the highest net revenue (profit) (N190, 450) was obtained under Codal gold(R) plots at 1.65 kg a.i /ha and the lowest under plots hoe-weeded twice (N78, 200.4). Similar trend was observed in 2006 with Codal gold(R) at 1.65 kg a.i /ha having the highest profit of (N231, 142.5) and the lowest in plot hoe weeded twice (N87,965). The highest cost benefit ratio (CBR) (24.26) was recorded in Codal gold(R) plot at 1.65 kg a.i /ha and the lowest in plot weeded twice (1.25). In 2006, the same trend was observed, Codal gold plot at 1.65 kg a.i /ha had the highest CBR (28.12) and the lowest in plot hoe weeded twice (1.22).

4. DISCUSSION

The high weed density recorded in the weedy plots in both years which invariably result to high weed dry weight could be attributed to low ground cover by cowpea vines. Also, the low weed density observed in the herbicides treated plots could be attributed to effective weed control of the herbicides and their ability to control weed beyond the critical period of cowpea growth. The adequate weed cover by cowpea vine led to smothering effect of the weeds judging from low weed population and low weed dry weight which invariably led to increase in weed smothering efficiency (WSE).

Hoe – weeding once at 3WAP was obviously not adequate for effective weed control in cowpea since it was not comparable to twice hoe weedings. The low weed density and low dry weight in plot hoe weeded twice results to high WSE. The cowpea vines were able to smother weeds in plots hoe weeded twice compared to plot hoe weeded once which had moderate increase in weed dry weight. The moderate increase in weed dry weight could be attributed to frequent re-occurrence and persistent characteristics of weeds.

Hand weeding and herbicide application significantly encouraged vigorous growth in cowpea. Weed competition delayed the number of days to 50% flowering and considerably reduced the yield and yield components of cowpea in the unweeded. According to [25] the low yield obtained from weedy plots may be due to competition from natural flora. The higher grain yields obtained from the herbicide – treated plots compared to hand-weeding could be due to minimal weed competition with cowpea and herbicides treated plots. Weedy plots gave the lowest grain yield as a result of intense weed competition. The percentage yield reduction in the current study was 30.53% in 2005 and 26.43% in 2006. This study has confirmed earlier reports of a possible yield loss due to weed infestation in cowpea [8, 26].

The yield difference per hectare recorded by the different treatments account for the variation observed in value of output/ha (total revenue) in both years. Codal gold(R) at 1.65 kg a.i /ha was the most profitable method of weed control in both years. It had the highest grain yield coupled with low weed control cost. Although grain yield was high in plots hoe weeded twice, the cost of weeding was also high consequent upon scarcity of labor at time of weeding, thereby reducing the profit. This confirms the report of [27] that hoe weeding is expensive. It also shows the advantage of herbicide application over hoe weeding in reduction of cost of production in cowpea. This agrees with the findings of [28] that a very lucrative cost – effective was recorded due to application of bactril-M on wheat and the gain in yield from hand weeded plot was nullified with additional cost of weeding. The results obtained from economic evaluation is also in conformity with that of Chikoye *et al.* (2005) who noted that chemical control is a better alternative to manual weeding because it is cheaper, faster and gives better weed control.

5. CONCLUSION

The applied herbicides enhanced cowpea productivity, through enhanced growth and yield of cowpea by reducing weed infestation. Consequent on the condition of the present study and spectrum of herbicide use or tried, Codal gold(R) at 1.65 kg a.i /ha seem to be the best or most effective herbicide for reducing weed infestation in cowpea in the forest transition zone of Edo State Nigeria.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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