Research Note

Economic Evaluation of Methods of Weed Control and Insecticide *(Lamdacyhalothrin)* Rates in the Production of Cowpea (*Vigna Unguiculata* L)Walp) in the Southern Guinea Savanna of Nigeria

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Abstract

Field trials were conducted in two locations, at the Teaching and Research (T&R) Farm of the College of Agriculture, Kwara State University and Ga-Alanu Village, Malete, in the 2015 cropping season. The aim was to determine the economic benefits of different methods of weed control applied together with insecticide rates in the production of cowpea. The experiment consisted of 18 treatments; three insecticide(Lambdacyhalothrin) rates, 0 ml, 175 ml (8.75 g ai/ha) and 350 (17.5 g ai/ha) ml/ha and six methods of weed control (pendimethalin at 1.5 kg a.i/ha, pendimethalin at 2.0 kg a.i/ha, pendimethalin at 1.5 kg ai/ha + one supplementary hoe weeding (SHW), metholachlor (1.5 kg a.i/ha) + Diuron (0.6 kg a.i/ha), hoe weeding at 3 and 6 weeks after sowing (WAS) and a weedy check. The treatments were laid out in randomized complete block design (RCBD) fitted into split plot arrangement and replicated three times. Results showed that insecticide rates at 175 ml and 350 ml/ha and pendimethalin at 2.0 kg ai/ha and pendimethialin at 1.5 kg a.i/ha plus one SHW at 6 WAS produced the maximum cowpea grain yield and were also more cost-effective and profitable in the production of cowpea in the southern Guinea savanna of Nigeria.

Keywords: Cowpea; Cost-effectiveness, Pesticides, Production, Profitability; Weed Control.

Introduction

Cowpea *(Vigna unguiculala (L.)* Walp) is one of the most important food grain legumes in the tropics, including Africa which accounts for 64% of the world production (Timko and Singh, 2008). Sub-Saharan Africa was reported to account for about 70% of total world production (IITA, 2009). Also more than 5.4 million tones of dried cowpeas are produced worldwide with Africa producing nearly 5.2 million, (AGRONIGERIA, 2017). Nigeria the largest producer and consumer accounts for 61% of production in Africa and 58% worldwide.

Cowpea is very popular and unique in that it produces food for man and fodder for livestock. It has high potential to increase income of both farmers and traders (Owolade *et al*., 2004). Both the grain and the haulm are valuable dietary proteins for the human population in Africa and their livestock (Fatokun, 2002).

Though cowpea has many important uses, the crop is attacked by a spectrum of pest species (Isubikalu *et al*., 2000). Farmers obtained low world average yield of cowpea due to these field pests. For instance, average world yield of cowpea grain is quite low at less than 0.3 tonnes/ha. Within Africa, average cowpea yield vary dramatically from 0.05 – 0.55 tonnes/ha (Cisse*et al.,* 1995). Alghali

(1992) reported 200 – 300 kg/ha in Nigeria and more than 2000 kg/ha under research environment (Rusoke and Rubaihayo, 1994). Two of the major pests of cowpea in the humid tropics are weeds (Ayeni, 1992) and insects (Jackai and Adalla, 1997). A serious constraint to increased and sustainable production of cowpea is the damage caused by field insect pests particularly during the flowering and post-flowering growth stages (Singh *et al*., 1990; Obeng-Ofori, 2007). Ogunwolu (1990) reported that *Maruca testulalis* Geyer, reduced cowpea yield by 72.1% in 1985 and 48.1% in 1986. Also, Singh *et al*. (1985, 2003) and Kitch (1998) reported that 60 to 80% of grain losses in cowpea have been attributed to the activities of insect pests. Weeds aggravate diseases and insect pest problems by serving as alternative hosts. Yield loss in cowpea due to weeds was 12.7 – 60% (Li*et al*., 2004) and can be as high as 82% (Tripathi and Singh 2001).

The main methods of weed control in tropical agriculture include cultural methods (hand pulling, hoe weeding, and slashing), animal power, mechanical, chemical, biological and integrated methods of weed control (Remison, 2003). Labrada (2005), reported that the main weed control method by small-holder farmers in the developing countries is either hand-weeding or hoe weeding. Farmers still rely heavily on this traditional strenuous weed control method which offer little hope for expanding the present farm size. Hoe weeding method is labour intensive, expensive and strenuous and labour is often not available at peak work load (Khan *et al*., 2000). It is estimated that about 40-60% of production cost is spent on manual weeding (Remison, 1979). These disadvantages have made the use of herbicides for weed control appear useful (Dadari, 2003; Silva, 2003). Chemical weed control is a practical and economic alternative to hand weeding. If herbicides are applied appropriately, they could prevent weed infestation from planting to harvesting and promote higher plant population. Though chemical weed control has many advantages over hoe weeding, there is need to reduce the amount of herbicides applied for weed control in order to cut cost and mitigate the problem of environmental build-up of herbicide residues. This calls for integrated weed management approach. This involves the combination of two or more methods of weed control to effectively and efficiently bring down weed infestation below the threshold level. Similarly, higher cowpea yield can be attained by recommending appropriate, effective and efficient pest control methods. Most farmers use insecticides to control insect pests on their farms. However, there are concerns among farmers that insecticide residue may persist in crop grains and residue such as cowpea haulms which could affect both human and animal health. A case study is the ban on importation of Nigeria beans to European Union as a result of higher level of pesticides in the beans (The Guardian, 2016).

Although the use of herbicide alone and in combination with other weed control methods have been reported to be more profitable than hoe weeding in the production of various crops in Nigeria (Shrock and Manoco, 1980; Okereke, 1983; Usoroh, 1983; Singh and Lagoke, 1984, Ogungbile and Lagoke 1986; Adigun *et al*., 1993, Imoloame *et al*., 2010. and Imoloame, 2014), there is dearth of information on the profitability of integrating herbicides and insecticide applications for the production of cowpea in the southern Guinea savanna of Nigeria. Therefore the objectives of this study was to carry out an economic evaluation of the use of different methods of weed control in combination with different rates of *Lambdacyhalothrin (Karate)* insecticide in the production of cowpea in the southern Guinea Savanna of Nigeria.

Materials and Methods

Field trials were conducted at two locations, at

the Teaching and Research (T&R) Farm of the College of Agriculture, Kwara State University and Ga-Alanu Village, a farming community, five kilometers from the T&R farm of the University, both located in Malete (Lat.08° 71'N; Long.04° 44'E.) in Moro Local Government Area of Kwara State in the Southern Guinea Savanna ecological zone of Nigeria.

The experimental area of T&R farm was cropped with cowpea the previous year in 2014, and has been put under cultivation every year, while the land at Ga-Alanu had been left fallow for three years before the experiment. The gross size of experimental area which was 1,127.5m^2 in each location was ploughed, harrowed, leveled and demarcated into plots. The plot size was 4.0 x 4.0 m leaving a distance of 1 m and 0.5 m between replications and sub-plots respectively.

NPK 15-15-15 was broadcast and raked into the soil in each plot at the rate of 20 kg /ha before planting. Three seeds of cowpea var. IAR-48 (high yielding but highly susceptible to insect pests) were planted per hole at a spacing of 75 x 50 cm and were later thinned to two plants/stand to give a plant population of 53,333 plants / hectare in both locations. Herbicide was applied pre-emergence a day after sowing with a CP15 knapsack sprayer and a green nozzle which was calibrated to deliver herbicide at an application rate of 250 liters/ha. Similarly, insecticide *Lambda-cyhalothrin* was applied to the cowpea four times from pre-flowering to flowering stages of crop growth at two week intervals.

The experiment consisted of Karate 2.5 EC insecticide, (*Lambda-cyhalothrin*) application at the three rates, 0 (control), 175 (8.75 g ai/ha) and 350 ml/ha (17.5 g ai/ha); and six methods of weed control, pendimethalin at 1.5, and 2.0 kg ai/ha, pendimethalin at 1.5 kg ai/ha + one supplementary hoe weeding (SHW), metolachor (1.5 ai/ha) + Diuron (0.6 kg ai/ha), weeding at 3 and 6 WAS, and a weedy check. The treatments were laid out in a randomized complete block design (RCBC) fitted into a split plot arrangement and replicated three times. The insecticide rates were allocated to the main plots while the herbicide rates were allocated to the sub plots. Harvesting of cowpea was done on a net plot of 8 m^2 and the two border rows on either sides of the plot was discarded to minimize error.

Economic analysis

Information on the cost of all the cultural practices from land preparation to harvesting and processing was collected from Kwara State Agricultural Development Programme (KWASADP), Ilorin , an agency responsible for extension services in Kwara State , Nigeria. The price of 1 kg of cowpea in 2015 was obtained from the open market to calculate the selling income/ revenue. The economic assessment was done for different treatments to determine the most cost-effective or profitable method for the production of cowpea.

The economic analysis was carried out using partial budgeting (Okoruwa *et al*., 2005) and the method of Joshua and Gworgwor (2001) to calculate the gross margin (profit) and cost benefit ratio respectively of the methods of weed control combined with different rates of *Lambdacyhalothrin* insecticide as follows:

GM = TR- VC

TR = (Ys X Ps)

VC = M + L

Where:

GM	=	Gross margin/ ha for each Treatment
TR	=	Total revenue (Naira) for each Treatment
VC	=	Variable cost (Naira) for each Treatment
Ys	=	cowpea grain yield(Kg//ha)

for each Treatment
Ps = Price of cowpea per Kg
M = Value of material input (seeds, fertilizer, insecticide, herbicides)
L = Value of Labour (land preparation, planting, insecticide and herbicide, fertilizer application, harvesting, processing and packaging).

Also, the cost benefit ratio was determined using the following equation:

$$\text{Cost benefit ratio} = \frac{TCP}{I}$$

where TCP is total cost of production and I is income.

Results

The weeds that were prevalent among others in the cowpea plots included *Paspalum scrobiculatum* and *Setaria barbata,* while the

Table 1: Yield of Cowpea Treated with Combination of Insecticide, Herbicide and Manual Weeding Practices in two locations

Treatments	Yield (kg/ha) in T&R Farm	Yield (kg/ha) in Ga-alamu	Average Cowpea Yield (kg/ha)
0ml of *Lamdacyhalothrin*			
P 2 kg ai/ha	200.0cde[1]	692.8a	446.4a
P1.5 kg ai/ha + one SHW@ 6 WAS	313.2cde	679.7a	496.5a
Weeding@3&6 WAS	407.7abcde	483.5a	445.6a
M+D (1.5+0.6 kg ai/ha)	256.6bcde	999.0a	627.8a
P 1.5 kg ai/ha	66.1de	839.3a	452.7a
Weedy check	145.4de	598.6a	372.0a
***Lamdacyhalothrin* (8.75 g ai/ha)**			
P 2 kg ai/ha	318.7cde	1674.6a	996.7a
P1.5 kg ai/ha + one SHW@ 6 WAS	646.1a	1249.9a	948.0a
Weeding@3&6 WAS	433.2abcd	1270.1a	851.7a
M+D (1.5+0.6 kg ai/ha)	500.6ab	831.0a	665.8a
P 1.5 kg ai/ha	448.5abc	936.8a	692.7a
Weedy check	272.7bcde	787.6a	530.2a
***Lambdacyhalothrin* (17.5 g ai/ha)**			
P 2 kg ai/ha	496.6abc	989.9a	729.8a
P1.5 kg ai/ha + one SHW@ 6 WAS	338.7bcde	1285.0a	811.9a
Weeding@3&6 WAS	260.9bcde	1085.8a	673.0a
M+D (1.5+0.6 kg ai/ha)	184.0cde	1282.2a	733.1a
P 1.5 kg ai/ha	197.8cde	730.5a	464.2a
Weedy check	67.7e	1178.1a	622.9a

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (DMRT). P = Pendimethalin Herbicide, SHW = Supplementary hoe weeding, M+D= Metolachlor + Diuron Herbicides WAS = Weeks After Sowing.

insects were *Megalurothrips sjostedti* and *Maruca testulalis*. Table 1 shows the yield of cowpea treated with pesticides (herbicide and insecticide) in the two locations. Application of lower rate of *lambdacyhalothrin* insecticide at 8.75g ai/ha together with pendimethalin at 1.5kg a.i./ha produced the highest grain yield of cowpea (646.1kg/ha) at the Teaching and Research Farm which was significantly greater than the rest of the treatments but was comparable with application of lower dose of insecticide with metolachlor+diuron at 1.5+0.6 kg a.i./ha (500kg/ha), pendimethalin at 2.0kg a.i./ha (496.6kg/ha), pendimethalin at 1.5kg a.i./ ha (488.5kg/ha), weeding at 3 and 6 WAS (433.2 kg/ha) and two hoe weeding at 3 and 6 WAS without herbicide treatment (407.7kg/ha). In Ga-alanu and the average of the two locations, the grain yield of cowpea did not significantly differ among treatments. The lowest cowpea yield (66.1.kg/ha) was produced from pendimethalin at 1.5kg a.i./ ha that was not treated with insecticide.

The average total cost of production of cowpea was highest in plots that were treated with two hoe weeding at 3 and 6 WAS (₦76,800.00) (₦76,625.00) and (₦72, 850.00) with or without *lambdacyhalothrin* insecticide treatment. The lowest average cost of production was incurred by the weedy check in combination with the different insecticide rates. *Lambdacyhathrin* insecticide at 8.75 g ai/ha together with the pre-emergence application of pendimethalin at 2.0 kg ai/ha resulted in the highest average revenue (₦179,406.00) followed by plots treated with lower rates of *lambdacyhalothrin* at 8.75gai/ha and pendimethalin at 1.5 kg ai/ha plus one SHW at 6 WAS (₦170,640.00) and weeding at 3 and 6 WAS (₦153, 306.00). The lowest average revenue was generated from the plots that were left weedy and without insecticide treatment (₦66,960.00).

The highest average gross margin/ profit was recorded from plots treated with lower rates of *lambdacyhalothrin* insecticide at 8.75g ai/ha integrated with the application of pendimethalin at 2.0kg ai/ha (₦107,881.00), followed by *lambdacyhalothrin* at 8.75g ai/ha integrated with the application of pendimethalin at 1.5kg ai/ha plus one SHW at 6 WAS (₦91,515.00) and weeding at 3 and 6 WAS treated with the lower rate of insecticide (₦75,515.00) (Table 2). The rest of the treatments gave lower gross margin/profit.

Two hoe weeding at 3 and 6 WAS without insecticide application had the highest cost-benefit ratio (1:0.888), while the lowest cost-benefit ratio was incurred by plots treated with pendimethalin at 2.0kg ai/ha and *Lambdacyhalothalin* at 8,75g ai/ha (1:0.395) followed by plots treated with pendimethalin at 1.5kg ai/ha plus one SHW at 6WAS and *Lambdacyhalothrin* at 8.75g ai/ha (1 :0.436).

Table 2: Economic Evaluation of Methods of Weed Management and *Lambdacyhalothrin* rates in Cowpea Production

Treatments	Average variable cost /ha (N)	Average Revenue/ha (N)	Gross Margin/Profit (N)	Cost-benefit C/B ratio
0 ml of *Lamdacyhalothrin*				
P 2 kg ai/ha	67, 050	80, 352	13, 302	0.834
P1.5 kg ai/ha + one SHW@ 6 WAS	70, 650	89, 370	18, 720	0.791
Weeding@3&6 WAS	72, 850	82, 008	9, 158	0.888
M+D (1.5+0.6 kg ai/ha)	64, 717	113, 004	48, 287	0.573
P 1.5 kg ai/ha	65, 650	81, 486	15, 836	0.805
Weedy check	57, 850	66, 960	9, 110	0.864
***lamdacyhalothrin* (8.75 g ai/ha)**				
P 2 kg ai/ha	70, 825	179, 406	107,881	0.395
P1.5 kg ai/ha + one SHW@ 6 WAS	74, 425	170, 640	91,515	0.436
Weeding@3&6 WAS	76, 625	153, 306	75,515	0.500
M+D (1.5+0.6 kg ai/ha)	68, 492	119, 844	50,652	0.572
P 1.5 kg ai/ha	69, 425	124, 686	54,561	0.557
Weedy check	61, 625	95, 436	33, 111	0.646
***Lambdacyhalothrin* (17.5 g ai/ha)**				
P 2 kg ai/ha	71, 000	131, 364	58,964	0.540
P1.5 kg ai/ha + one SHW@ 6 WAS	74, 600	146, 142	70,142	0.510
Weeding@3&6 WAS	76, 800	121, 140	42,940	0.634
M+D (1.5+0.6 kg ai/ha)	68, 667	131, 958	61,891	0.520
P 1.5 kg ai/ha	69, 425	83, 556	12,731	0.830
Weedy check	61, 800	112, 122	48,922	0.551

* Calculation of income was based on the current price of cowpea at N180/ kg
SHW= Supplementary hoe weeding WAS= Weeks After Sowing
M+D= Metolachlor + Diuron Herbicides P = Pendimethalin Herbicide

Discussion

A combination of *Lamdacyhalothrin* at 8.75 g ai/ha and pre-emergence application of pendimethalin at 2.0 kg ai/ha, pendimethlin at 1.5 kg ai/ha plus one SHW at 6WAS and hoe weeding at 3 and 6 WAS gave higher cowpea grain yield probably as a result of their ability to effectively control both insect and weeds infesting the crop. This is similar to the findings of Takim and Uddin II (2010) who reported increase in cowpea grain yield as a result of effective control of weeds and insects.

The highest average cost of production of cowpea was incurred from plots that were

given two hoe weeding at 3 and 6 WAS with and without insecticide treatment. One of the disadvantages of hoe weeding is that it is an expensive method of weed control compared to chemical method. This finding is confirmed by the report of Adigun and Lagoke (2003), Imoloame *et al*. (2010) and Imoloame (2014) that hoe weeding is expensive. The lowest average cost of production was incurred from herbicide treatments that were not sprayed with insecticides. This is due to the fact that no money was spent on the purchase of insecticide. The application of *Lamdacyhalothrin* at 8.75g ai/ha and pendimethalin at 2.0 kg ai/ha and *lambdacyhalothrin* at 8.75g ai/ha and pendimethalin at 1.5 kg ai/ha plus one SHW at 6WAS generated the highest gross margin/ profit. This shows that a combination of these pesticides is not only effective in controlling pests and increasing the yield of cowpea, it is also profitable and holds a lot of promise for the farmers. Lagoke *et al*.(1986) has reported that herbicide use are more profitable than hoe weeding in the production of most crops in Nigeria. The application of *Lamdacyhalothrin* at 8.75g ai/ha and pendimethalin at 2.0 kg ai/ha and *lambdacyhalothrin* at 8.75g ai/ha and pendimethalin at 1.5 kg ai/ha plus one SHW at 6WAS also gave the lowest cost-benefit ratios in the production of cowpea. This could have resulted from the ability of the insecticide rates and method of weed control to effectively control pest and significantly increase cowpea grain yield and thereby reduce the cost of production.

Conclusion

It can therefore be concluded that pesticide application in the combination of 8.75g ai/ha of *lambdacyhalothrin* insecticide and pendimethaloin at 2.0kg ai/ha or application of *lambdacyhalothrin* at 8.75g ai/ha and pendimethalin at 1.5kg ai/ha plus one SHW at 6WAS is recommended to farmers as a means for increasing production and generating more profit for farmers involved in the production of cowpea in the southern Guinea Savanna of Nigeria.

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