Combined use of butachlor and cowpea for weed management in okra production

Christian C. Obiazi[1*], Gideon O. Okogu[1], Onyemechi Ugbo[2], Sunday I Alama[3], Chukwuma S. Uwabor[3], John F. Akpomedaye[4] and Felicity O. Otite[3]

[1] Department of Agronomy, Delta State University, Abraka, Nigeria

[2] Department of Agricultural Extension, University of Delta, Agbor, Nigeria

[3] Department of Soil and Land Resource Management, Faculty of Agriculture, Dennis Osadebay University, Anwai, Asaba, Delta State, Nigeria

[4] Department of Vocational Education (Agricultural Science Unit), Faculty of Education, Delta State University, Abraka, Nigeria

Correspondence Author: Christian C. Obiazi

Received 2 March 2024; Accepted 5 April 2024; Published 18 April 2024

Abstract

For large-scale crop cultivation manual weeding is unviable. The use of herbicides shrinks manual labor requirements; but herbicide's weed control efficacy is not at its peak for a prolonged period, especially for a long-duration crop. The study's objective was to test the supplementary attributes of cowpeas in prolonging the suppression of weeds in okra plots. Treatments involved in the study were: Butachlor at 1.0 kg a.i./ha + cowpea at 40,000 plants/ha, Butachlor at 2.0 kg a.i./ha + cowpea at 40,000 plants/ha), Hoe-weeding at 3, 6, and 9 weeks after sowing, and Weedy Control. Weed Control Rating, weed biomass, cowpea grain yield, okra pods/plant, and pod yields were measured. Combined use of Butachlor at 2.0 kg a. i./ha plus cowpea maintained a similar weed control rating with Hoe weeded control up till 8 weeks after sowing and became less effective at 10 weeks growth stage, it also resulted in significantly greater average grain yields (344.4 kg/ha) than when the lower rate of herbicide concentration of 1.0 kg a.i./ha was used (181.3 kg/ha). HighButa had a greater mean okra pod yield (3.1 t/ha) than LowButa (2.1 t/ha), but it was less than the yield of the hoe-weeded control (4.2 t/ha), the weedy plot had pod yield of 1.1 t/ha. Uninterrupted weed interference in okra plots resulted in a 73.8 % average loss in okra pod yield. Combination of cowpea with butachlor prolonged weed suppression in okra, such methodology is therefore recommended.

Keywords: cowpea grain yield, okra pod yield, weed biomass, weed control rating

Introduction

Okra is exported in small quantities to meet the needs of African residents outside the continent (Adeniji, 2003) [2]. In Nigeria, okra is cultivated for its young fleshy fruits and the young leaves used in soup because of their mucilaginous property and nutrient contents (Rehm and Espig, 1991) [18]. Takano (2015) [22] noted that okra contains A and C vitamins, and it is also a good source of calcium and iron; it contains starch, fat, ash, riboflavin, and thiamine as well. Okra contains non-essential and essential amino acids that perform a very important for man and are similar to that of soybean. The crop, which is rich in ascorbic acid, also contains high levels of vitamins A and B and various minerals, especially iodine (Philip *et al*., 2010) [17].

Togun *et al.* (2001) [23] noted that some soil types can limit okra growth and yield performance, and the effect becomes pronounced with those inherently low in fertility. Inappropriate fertilizer application may result in unbalanced partitioning of nutrients to form foliage and pods, yet a balance between foliage production and pod (or fruit) production is necessary for maximum yield. Using extra nitrogen on vigorous plants may be avoided until fruiting begins; this is to limit plant growths in order to avoid okra from producing a lot of foliage with little flowering and subsequent low fruit production (Kemble *et al*., 1995) [6]. Ugbomeh *et al* (1998) [24] noted the superiority of farm yard manure over NPK 15-15-15 fertilizer for okra productivity, but also observed that for optimum performance of okra, there is need to apply the mixture at optimum level; in their study, the optimum levels were 15000 kg of farm yard manure and 2000 kg of NPK 15-15-15/ha. In addition to importing organic manure to the land where farming is going on to improve soil fertility for crops, Obiazi (1995) [10] suggested that pruning derived from other cultural practices in the farm such as pruning from live yam stakes can be applied as mulch around our crops to improve the fertility of soil. Very good yield of okra fresh pods has also been reported by Onyibe *et al.* (2021) [15] who achieved this high yield by the incorporation of burnt and fresh yam peels which could also results in high plant nutrients availability, promote soil organic matter, improve soil structure, ensure high yield of crops such as okra, increase availability of nutrients and reduce environmental hazards that the yam peels may cause in communities that cultivate and eat lots of yam.

In an environment all the time, weeds are present to cause a decrease in crop quality and yield (Obiazi, 1991; Obiazi, 2018) [8, 11]. Under large-scale operation, the convenient weed control method is the use of herbicides (Ayeni, 1987) [4]. The use of herbicide technology is still confronted with many problems, the major one being a low level of knowledge of the technology on the part of farmers and on the part of some of those who advise them. For this reason, the technology is subjected to misuse in terms of the type of herbicide to use, the rate, method, and time of application. Thus, there have been several reports of herbicide failures and/or phytotoxicity. Only a timely application and the use of the right chemical at the correct rate can ensure success in this situation.

Use of butachlor as an herbicide is popular in South America and Asia (Ou *et al.*, 2000) [16]. Butachlor was used successfully by Obiazi (2022) [12] for effective weed control in okra in the same environment where this study was carried and recommended that butachlor should be among the herbicides considered for pre-emergence application to control weed in okra plots in places like Asaba, Nigeria.

The economic pressure on farmers to produce at the lowest costs and the changing environmental influences, like soil erosion or water availability, have led to the adoption of no-till practices some years ago. The use of no-till practices is expected to further increase globally. In most cases, the shift to no-till systems causes too much dependence on herbicides. The changes in price of herbicides in the past years played a significant role in the embracing of no-till farming pattern, and it brought about an increase in herbicide costs as well as herbicide resistance, and in particular glyphosate resistance. Nevertheless, the acreage for no-till is expected to increase, especially in areas where no-till is still of low proportion (Emden *et al.*, 2003) [5].

Weed control using chemical is insufficient in Nigeria because of the narrow weed spectrum controlled and the little persistence of current herbicides, and some weeds also escape the destructive effects of the applied herbicides through the mechanism of seed dormancy (Akinyemiju, 1992) [3]. In transplanted tomatoes, Okereke (1983) [14] reported good weed control when lower rates of metribizin were combined with mulching. Similarly, cultural weed control can be combined with low-growing crops such as melon to smother weeds in long-season vegetables such as okra and pepper varieties. Unamma *et al.* (1986) [25] discovered that combined use and pre-emergence herbicides and cowpea in cassava/maize intercrop provided added economic returns unlike two hoe weeding operations. Obiazi (2024) [13] noted that herbicide usage reduces the need for manual labor; as time goes on, the efficacy of the herbicide to check the weeds wears off, mostly in long-duration crops. Smith (1997) [21] added that okra suffers attacks from pathogens and pests; such pathogens and pests make use of weeds as alternative hosts. Smith and Ojo (2007) [20] noted that peasant farmers do not produce optimum okra pod yield because of non-adherence to recommended weed and crop management practices. The need to complement narrow intra-row spacing with manual weeding for effective control of weed in okra so as to achieve optimum pod yield in okra has been suggested.

A common weed control method, hoe-weeding, is expensive and inappropriate for large-scale production (Obiazi and Ojobor, 2013; Singh and Singh, 1981) [9]. For large-scale crop cultivation with high weed density and prolonged germination, manual weeding is impracticable. Thus, screening of some herbicides is important (Singh and Singh, 1981; Khan and Khan, 2003) [7]. However, most herbicide recommendations have failed to give season-long weed control, necessitating the need for supplementary hoe-weeding. However, integrated weed management may provide a very good approach to weed management.

The objective of the study was to evaluate the effectiveness in okra production of the integrated use of butachlor and cowpea for weed management.

Materials and methods

An experiment was put in place at the Departmental Farm of Agronomy located in Asaba at the former campus of Delta State University in Nigeria. The rainy season begins in April and comes to an end in November. Asaba has rainforest ecology.

Cutlass was used to slash the vegetation where, and stumps of trees in the farm were manually removed with hoes and spades; thereafter, the land was delineated into plots.

Seeds of cowpea, known locally as iron brown, were bought from the most popular market in Asaba called Ogbeogonogo.

Okra seed was soaked with water overnight and put under a shade and dried. Apron star was sprinkled on the seeds to protect the seeds against pests and diseases, Apron star is made up of insecticide and fungicide. Ten grams of Apron star was applied to every 4 kg of seeds before sowing. Cowpea seeds were dressed the same way. Planting of okra seeds at about 2 cm depth was done at a spacing of 50 cm with 50 cm within-row spacing; following the recommendation of Nihort (1986) [25], it came up to be at a plant density of 40 000 plants/ha.

In May 2017, the study was started again by planting okra seeds at the rate of three per hole. Each plot had sixteen okra stands. Iron brown cowpea, which is the cover crop, was also sown at the rate of three seeds per stand using a spacing of 50 cm by 50 cm, resulting in sixteen stands per plot.

At 3 week's growth stage, data were taken, and then cowpea and okra thinning to one seedling per stand was carried out.

Fertilizer application

The soil used for the experiment had sand of 814 g kg^{-1}, silt of 76 g kg^{-1}, and 110 kg^{-1} of clay. The soil with a pH of 5.7 was slightly acidic. Okra was supplied with nitrogen by the application of urea at fifty kg of N/ha. The fertilizer applications took place 3-week and 6-week growth stages of the crops, according to the Federal Fertilizer Department (2002).

Weed data collection

Weed control rating data was gathered as defined by Willard (1958) on the basis of a -100 rating system, and "0" meant an absence of weed control or lack of weed control effect, and "100" means having a complete effect, meaning complete weed destruction. Most of the rates in between these extremes have deficient control of weeds plus moderate effects, and "100" indicates weed destruction completely, a complete effect.

The weeds within each quadrat were cut at soil surface level and collected; this activity was carried out every two weeks from four to ten Weeks After Sowing (WAS); the aim was to assess the biomass of the weeds after oven drying at 70 ºC to a constant weight and put up as kg/ha. Data for weed biomass at six WAS was collected before the regular hoe-weeding slated for that stage.

Phytotoxicity evaluation on okra

The visual injury rating on okra was executed on a 0–10 scale, with 0 meaning no injury and 10 corresponding to a complete okra kill; this was done at 3 WAS.

Analysis of data

Collected data on weed and okra were analyzed with ANOVA. Means of treatment comparison were done at 5% probability level using DMRT at a significant F-value (Gomez and Gomez, 1984).

Results and discussion

Weed control rating

The plots hoe-weeded thrice had significantly higher Weed Control Rating (WCR) than their respective integrated weed control treatments involving 1.0 kg a.i./ha herbicides (lower herbicide rates) as from 8 WAS up to 10 WAS in both years. Integrated use of butachlor and cowpea significantly affected WCR in the okra plots from four to ten weeks of growth stage (Table 1). In the 2017 trial, hoe-weeded control had superior WCR than the integrated weed control treatments.

At six and eight weeks's growth stages, the integrated weed control treatments had superior WCR than the weedy check. The integrated weed control treatments with higher herbicide concentrations had superior WCR than the ones with lower herbicide concentrations. At ten WAS, the integrated weed control treatment with 2.0 kg a.i./ha butachlor was superior to the ones with 1.0 kg a.i./ha butachlor in WCR but was less effective in weed control compared with hoe-weeded control in the two years.

The two integrated treatments and hoe-weeded control treatments started displaying a superior weed control rating than the weedy control right from the week four growth stage; this trend continued up to ten weeks after sowing. In 2017, the higher rate of butachlor had greater WCR than the treatment involving the lower rate of butachlor. At the six-week growth stage, HighButa had overtaken the LowButa; this trend continued up until the ten-week growth stage, when the data collection stopped.

Table 1: Effect of treatments on weed control rating

	Weed control rating (%)			
Weed control treatment	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**
2016				
Butachlor (1.0) + Cow	83.3 a	67.7 c	62.3 b	45.0 c
Butachlor (2.0) + Cow	91.7a	83.7a	86.7 a	79.0 b
Hoe-weeded	94.7a	76.0 b	87.3 a	92.3 a
Weedy check	0.0 b	0.0 d	0.0 c	0.0 d
SE ±	2.56	4.34	3.24	2.42
2017				
Butachlor (1.0) + Cow	79.7 c	67.3 c	68.3 b	46.0 c
Butachlor (2.0) + Cow	85.7 b	83.7 a	81.0 ab	77.0 b
Hoe-weeded	92.0 a	80.3 ab	87.0 a	94.7a
Weedy check	0.0 d	0.0 d	0.0 c	0.0 d
SE ±	1.96	2.51	4.49	3.43

Cow = cowpea planting at 40,000 plants/ha, Hoe-weeded = Hoe- weeding at 3, 6, and 9 WAS, Weedy check = Un-weeded plots, WAS = Weeks After Sowing

Table 2: Effects of weed control treatments on weed biomass

	Weed biomass (g/m^2)			
Weed control treatment	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**
2016				
Butachlor (1.0) + Cow	2.7 b	15.6 c	65.1 b	123.5 b
Butachlor (2.0) + Cow	2.1 b	11.9 d	57.7 c	89.0 c
Hoe-weeded	2.3 b	19.6 b	19.4 d	12.6 d
Weedy check	25.0 a	67.3 a	127.8 a	234.9 a
SE ±	0.89	1.01	1.67	2.21
2017				
Butachlor (1.0) + Cow	2.6 b	18.7 b	68.8 b	118.7 b
Butachlor (2.0) + Cow	1.9 b	12.7 c	59.1 c	93.6 c
Hoe-weeded	1.9 b	22.1 b	23.9 d	16.2 d
Weedy check	20.1 a	70.3 a	130.9 a	229.4 a
SE ±	1.16	1.53	2.04	2.41

WAS= WEEKs after sowing, Cow = cowpea planting at 40,000 plants/ha, Hoe-weeded = Hoe- weeding at 3, 6, and 9 WAS, Weedy check = Un-weeded plots

Weed biomass

Integrated use of butachlor at 1.0 or 2.0 kg a.i./ha and cowpea at 40,000 plants/ha had lower weed biomass compared to weedy control between 4 and 10 WAS (Table 2). From 6 to 10 weeks after sowing, the integrated weed control involving the higher concentration of butachlor had higher weed biomass weeds than hoe-weeded. Weed control method with the lower and higher butachlor concentrations were different in weed biomass.

Cowpea grain yield

Concentration of applied butachlor had significant effect on cover crop grain yields (Figure 1). Cover crop grain yields ranged from 179.4 to 349.0 kg/ha. Integration of butachlor 2.0kg a.i./ha and cowpea resulted in significantly greater grain yields than when the lower rate of herbicide concentration of 1.0 kg a.i./ha was used.

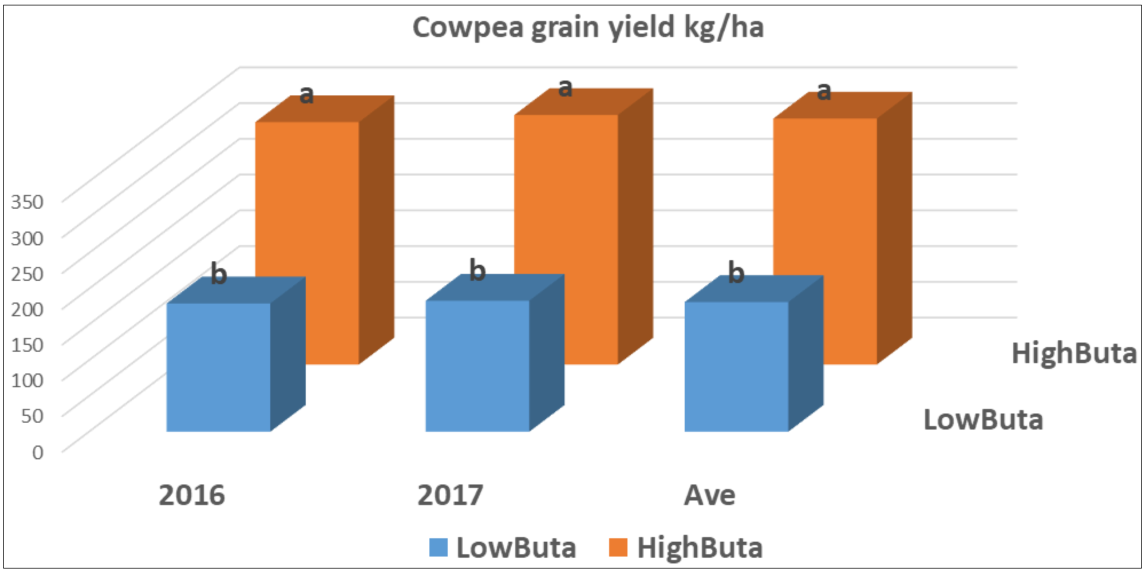

Fig 1: Effect of combined use of butachlor and cowpea on grain yield

Yields within the same year with similar letters are not significantly different

LowButa = Butachlor at 1.0 kg a.i./ha + Cowpea at 40,000 plant/ha

HighButa= Butachlor at 2.0 kg a.i./ha + Cowpea at 40,000 plant/ha

Ave = Average yields for 2016 and 2917.

Okra fresh pod yield

All the integrated weed control methods resulted in significantly higher okra fresh pod yields (1.8–3.1 t/ha) than those of weedy check (0.9–1.2) (Table 4). Plots that received hoe-weeding at 3, 6, and 9 weeks after sowing produced significantly greater okra fresh pod yields than any of the integrated treatments. The integrated weed control methods with higher concentrations of herbicide had a higher pod yield than the ones with lower concentrations, and they all produced more fresh pods than the ones in the weedy control.

Table 4: Okra fresh pod yield as influenced by weed control treatments

	No. of pods /plant			Okra fresh pod yield (t/ha)		
Treatment	2016	2017	Ave.	2016	2017	Ave.
Butachlor (1.0) + Cow	7.4 b	7.4 b	7.4 b	1.8 c	2.4 c	2.1 c
Butachlor (2.0) + Cow	7.6 ab	8.3 b	8.0 b	3.0 b	3.1 b	3.1b
Hoe-weeded	8.9 a	11.4 a	10.0 a	3.9 a	4.5 a	4.2 a
Weedy check	2.4 c	3.3 c	2.9 c	0.9 d	1.2 d	1.1 d
SE ±	0.53	0.33	0.50	0.12	0.18	0.12

WAS= WEEKs after sowing, Cow = cowpea planting at 40,000 plants/ha, Hoe-weeded = Hoe- weeding at 3, 6, and 9 WAS, Weedy check = Plot left un-weeded throughout the experimentation

1.0 = Use of Butachlor at 1.0 kg a.i./ha, 2.0 = Use of Butachlor at 2.0 kg a.i./ha

Number of okra pods per plant

Integrated use of butachlor at 1.0 or 2.0 kg a.i./ha and cowpea at 40,000 plants/ha significantly affected the number of fresh okra pods per plant (Table 4). Okra plants were sown in plots hoe-weeded three times, and all the integrated weed control treatments had okra plants with a significantly higher number of okra pods in weedy check.

Hoe-weeded had the highest number of okra pods in both years, and were comparable to the values obtained in okra plants sown in plots treated with butachlor at 2.0 kg a.i./ha plus cowpea at 40,000 plants/ha in 2016.

References

1. Adeboye OC, Oputa CO. Effects of galex on growth and fruit nutrient composition of Okra (Abelmoschus esculentus L. Moench). Ife Journal of Agriculture. 1996;18.1 and 2:1-9.
2. Adeniji OT. Inheritance Studies in West Africa Okra (Abelmoschus caillei (A. Chev.) Stevels) Unpublished M.Sc. Thesis University of Agriculture Abeokuta, 2003, 59p.
3. Akinyemiju AO. Weed control in maize with metholachlor alone and in combination with atrazine. Nigerian Journal of Weed Science. 1992;5:53-62.
4. Ayeni AO. Maize Production in Nigeria: Problems and prospects. Journal of Food Agriculture. 1987;2:123-129.
5. Emden FHD, Llewellyn RS, Burton MP. Technical Forec Society. 2003;03:40-41.
6. Kemble JM, Sikora EJ, Zehnder GW, Patterson MG. Guide to Commercial Okra Production. Alabama Cooperative Extension System. Your Expert for Life. Publications Home Page. ACES Homepage. Country Offices. Printable Copy (HTML), 1995, p4.
7. Khan NU, Khan SU. Integrated weed management in upland cotton. Pakistan Journal of Weed Science Research. 2003;9(3and 4):185-192.
8. Obiazi CC. Cassava production and utilization in Nigeria: Problems and prospects. Abraka Journal of Agriculture. 1991;1(1):111-121.
9. Obiazi CC, Ojobor SA. Production Challenges of Cassava and Prospects. 2013; Journal of Biology, Agriculture and Healthcare. 2013;3(14):31-35.
10. Obiazi CC. Sustainable supply of stakes for yam production. Journal of Sustainable Agriculture. 1995;5(3):133-138.
11. Obiazi CC. Food and feed potentials of cassava: The challenges of prussic acid in the tubers Journal of Agriculture and Food Environment. 2018;5(3):69-79.
12. Obiazi CC. Impact of hoe weeding levels on maize and cassava yields in an intercrop. International Journal of Phytology Research. 2022;2(3):24-29.
13. Obiazi CC. Integrated weed control in okra using pendimethalin and selected cover crops. Journal of Scientific and Engineering Research. 2024;11(7):1-7.
14. Okereke OU. Weed control in transplanted dry and rainy season tomato (Lycopersicon esculentum L.) crops with paraquat and metribuzin. Paper Presented at the Vlth Annual Conference of the Horticulture Society of Nigeria, Nsukka, 1983.
15. Onyibe CE, Obiazi CC, Erutor GJ. Effects of Yam Peels on Soil Chemical Properties, and Yield of Okra (Abelmoschus esculentus L. Moench.) in Asaba, Nigeria. 2021;8(3):49-57.
16. Ou YH, Chung PC, Chang Y-C, Ngo F QH, Hsu KY, Chen FD. Butachlor, a suspected carcinogen, alters growth and transformation characteristics of mouse liver cells. Chemical Research in Toxicology. 2000;13(12):1321-1325.
17. Philip CB, Sajo AA, Futuless KM. Effects of spacing and NPK fertilizer on the yield and yield components of okra (Abelmoschus esculentus L.) in Mubi, Adamawa State. Nigerian Journal of Agronomy. 2010;9:131-134.
18. Rehm S, Espig G. The Cultivated Plants of the Tropics and Subtropics: Cultivations, Economic Value, and Utilization. CTA (The Technical Centre for Agriculture and Rural Co-operation) Verlag Josef Margrave Scientific Books, Priese GmbH, Berlin, Germany, 1991, 552p.
19. Singh SB, Singh SP. Effect of time of weeding on growth and seed yield of okra. Indian Journal of Weed Science. 1997;13(1):11-17.
20. Smith MAK, Ojo IK. Influence of intra-row spacing and weed management system on gap colonization of weeds, pod yield and quality in okra [Abelmoschus esculentus (L) Moench] African Crop Science conference Proceedings. Printed in El- Minia, Egypt. 2007;8:313-317.
21. Smith MAK. Influence of Bidens pilosa interference on growth and yield of okra. Proceedings of the 15th Annual Conference of Horticultural Society of Nigeria (HORTSON) 8 – 11th April, National Horticultural Research Institute, Ibadan, 1997, 154-160.
22. Takano J. Health Benefits of Okra, 2015, 1p. Retrieved July 12, 2017 from http://www.pyroenergen.com/articles07/okra-health-benefits.htm.
23. Togun AO, Akanbi WB, Adebayo AG, Oni O. Response of okra (Abelmoschus esculentus (L.) Moench) to soil types from different agroecological zones of Nigeria. Nigeria Journal of Ecology. 2001;3:50-55.
24. Ugbomeh GMM, Obiazi CC, Akpomedaye JFO. Effect of Farm Yard Manure (FYM) and NPK 15-15-15 Fertilizer on Okro Yield: Implications for Extension Education for Women Farmers in Delta State of Nigeria. The Nigerian Journal of Rural and Community Development. 1998;6(1):11-16.
25. Unamma RPA, Ene LCC, Odurukwe SO, Eyinnia T. Integrated weed management for cassava intercropped with maize. Weed Research. 1986;26:9-17.