

## Growth and Yield of Okra (*Abelmoschus Esculentus L. Moench*) as Affected by Planting Date and Weeding Regime in Northern Ghana

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### Abstract

This paper examines the effects of planting date (early planting, mid-season planting and late-season planting) and weeding regimes (two weeding before harvesting, three weeding before harvesting and weed free plots) on yield of Okra (*Abelmoschus esculentus L. Moench*) in the Tolon district of Northern Ghana. The results show that different weed species, categorized as broad leaves, grasses and sedges, were dominant depending on the planting date and weeding regime. While there was no significant interaction ( $p > 0.05$ ) between planting date and weeding regime on fruit yield, nor significant impact of planting date as a sole treatment on fruit yield, the results showed the existence of significant effect of weeding regime as a sole treatment on yield and yield parameters of okra ( $p < 0.05$ ). Triple weeding resulted in okra yields comparable to the weed-free treatments (mean of 6000 kg/ha to 6300 kg/ha,  $p > 0.05$ ) but significantly higher ( $p < 0.05$ ) and about triple the yield observed in the treatments with double weeding regimes (mean of 1800 kg/ha to 2300 kg/ha). As cost of production, besides the cost of weeding, remains same for all treatments, Triple weeding is recommended for the small-holder farmer. It is associated with less labor cost compared to continuous weeding in the weed free treatments, and the triple gains in yield could offset the additional labor cost incurred in the triple weeding compared to the double weeding regimes.

**Keywords:** Yield; Okra; Ghana; Food security; Poverty.



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### 1. Introduction

Across the resource-poor rural communities of northern Ghana, Okra (*Abelmoschus esculentus L. Moench*) remains an important source of livelihood, income to increase the living standards of rural farmers and buffer against food security [1]. Despite these importance, the yield of the crop is reported to be declining thus requiring the need to identify appropriate combination of technologies to improve yield and sustain rural livelihood [2]. It has long been postulated that the season of planting impacts yield and yield parameters of okra [3, 4]. Competition with weeds is also noted to be a major constraint to okra production as it eventually lead to crop losses due to weed activities including competition, allelopathy, acting as alternative host to pests and pathogens, adulteration of farm produce etc [5]. High yield losses up to 91% have been recorded in the in some fields [6]. Differences in the crops phenology at a given stage, prior to weed infestation and the stage of weed growth in response to soil fertility and nutrient availability helps to understand the interaction between management practices and species-specific physiological and morphological characteristics of plants [7]. Lieberman and Davis [7] also reported that, timing of nutrient availability relative to the demand by the crop and weeds, appears to be very important for determining the outcome of competitive interaction.

There are few studies conducted in Northern Ghana to find suitable planting dates and weeding regimes to help in obtaining good yield in okra. The aim in this study was, therefore, to evaluate the effect of different planting dates and weeding regimes on the yield and yield components of okra.

## 2. Material and Method

### 2.1. Experimental Sites

The research was conducted at three farming communities, Golinga, Nyankpala and Dalun, in the Northern region of Ghana. The area falls within the Guinea savannah zone [8]. Rainfall across the region is unimodal and starts from April – May; builds up slowly to a height in August-September before declining sharply in October-November. The total precipitation is about 1,100 mm per annum, with a range from about 800 mm to about 1,500 mm. Average ambient temperatures are high year round (about 28°C) but the harmattan months of December and January are characterized by minimum temperatures that may fall to 13°C at night. Geologically, the area consists of proterozoic rocks which differ in lithology and degree of metamorphism. Granite and metamorphic rocks are the main rock types and include biotite schists, biotite-hornblende gneisses, garnet-hornblende and garnet-biotite gneisses and schists. Others include: Albite-chlorite, sericite-quartz schists with interbedded acid tuffs,

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manganiferous phyllites and sandstones. The soil consists of laterites and are mostly Savannah Ochrosols and Luvisols/Lixisols (World Reference Base for Soil Resource; ISSS/ISRIC/FAO 1998). The soil is generally shallow, with low organic matter and gravelly on the undulating terrains. Natural vegetation includes grasses and trees. Common herbaceous plant species include those of the family Acanthaceae (e.g., *Monechma ciliatum* (Jacq.) Milne-Redhead) and Rubiaceae (e.g., *Diodia scadens* Sw.). Major grasses include those of the family Poaceae/Graminaea (e.g., *Digitaria horizontalis* Willd, *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult, *Schizachyrium exile* (Hochst.) Pilger, *Andropogon gayanus* Kunth, and *Dactyloctenium aegyptium* P. Beauv.). Tree species include those of the family Combretaceae (e.g., *Combretum lamprocarpum* Diels, and *Terminalia avicennoides* Guill. & Perr.), Leguminosae-Mimosoideae (e.g., *Entada africana* Guill. & Perr.) and Rubiaceae (e.g., *Gardenia ternifolia* var. *goetzei* (Stapf & Hutch.) Verdc. (Stapf & Hutch.) Verdc.). Shrub species include the family Euphorbiaceae (e.g., *Securinea virosa* (Roxb. ex Willd.) Pax & Hoffm.), and Fabaceae (e.g., *Chamaecrista mimosoides* (Linn.) Greene) (Kugbe et al., 2012). The region is subject to extreme bushfire outbreaks during the dry season (Kugbe et al., 2015). Agriculture predominates the economic activities of the people. Cultivated food crops include yam (*Dioscorea cayenensis* ssp. *rotundata* (Poir.) Lam.), corn (*Zea mays* Linn.), cowpea (*Vigna unguiculata* (L.) Walp.) and cassava (*Manihot esculenta* Crantz) [9]. Soils found at this place are well drained sandy loam which is good for the cultivation of vegetables and arable crops.

## 2.2. Site Preparation and Agronomic Practices

The experimental sites were sprayed with glyphosate, two weeks prior to ploughing and then harrowed. Seeds were soaked overnight in water before being sown.

## 2.3. Experimental Design

A 3 x 4 factorial experiment, laid out in a Randomized Complete Block Design (RCBD) was used, with each location serving as a replicate. Planting times for the design was in three folds. Early planting (P<sub>1</sub>, 17<sup>th</sup> June 2013 and 2015), mid-season planting (P<sub>2</sub>, 1<sup>st</sup> July 2013 and 2015) and late planting (P<sub>3</sub>, 15<sup>th</sup> July 2013 and 2015). Experiment was carried out in the 2013 and 2015 growing seasons. Total dimension of the experimental area was 20.5 m x 19 m with plot sizes of 4 m x 4 m. The weeding regimes employed were;

Weeding every four weeks (two weeding before harvesting) – W<sub>2</sub>

Weeding every three weeks (three weeding before harvesting) – W<sub>3</sub>

Weed free plot (no weeds till harvest) – W<sub>4</sub> and

Control (no weed control till harvesting) – W<sub>0</sub>

### 2.3.1. Treatment Combinations

- P<sub>1</sub>W<sub>0</sub> P<sub>2</sub>W<sub>0</sub> P<sub>3</sub>W<sub>0</sub>
- P<sub>1</sub>W<sub>2</sub> P<sub>2</sub>W<sub>2</sub> P<sub>3</sub>W<sub>2</sub>
- P<sub>1</sub>W<sub>3</sub> P<sub>2</sub>W<sub>3</sub> P<sub>3</sub>W<sub>3</sub>
- P<sub>1</sub>W<sub>4</sub> P<sub>2</sub>W<sub>4</sub> P<sub>3</sub>W<sub>4</sub>

Sowing was by direct seeding at a rate of 2 seeds per hill. Seedlings were thinned to one plant per stand two weeks after germination. There were a total of 12 treatments. A spacing of 60 cm x 45 cm was used between and within rows respectively. Standard agronomic practices including thinning, pest and disease control, and timely fertilizer application were practiced. Insect pests and diseases were controlled by spraying crops with Pyral 480 EC at a rate of 20 ml/15 L of water, then later with kombat 2.5 EC (Lambda Cyhalothrin) at a rate of 36 ml/15 L of water. Compound fertilizer in the form of N.P.K. 15:15:15 at a rate of 250 kg/ha and urea at a rate of 125 kg/ha were applied to the plants at 30 days after sowing [1].

## 2.4. Data Collection

Parameters for both growth and yield were collected. In each plot five plants were randomly tagged for data collection excluding border plants, and their average statistics computed. Growth parameters recorded were: Plant height (taken every two weeks by means of a ruler), number of leaves (recorded every two weeks by counting), number of branches (by counting). Yield parameters recorded were: Total number of flowers (by counting), number of days to 50% flowering, fresh pod weight (using a balance), dry pod weight (using a balance), number of seeds in pods (by counting), and pod length (by a ruler).

The sample dominance ratio (SDR) or weediness of broad leaf weeds, grasses and sedges was computed with the formula:

$$SDR = \frac{1}{2} \{d/(\sum d) + f/(\sum f)\} * 100 \text{ [10].}$$

Where;

SDR = sample dominance ratio

d = density of weed species

f = frequency of weed species

## 2.5. Data Analysis

SPSS (version 15.0) was used for all statistical analyses. Calculated data are reported as mean ± standard error of the mean. The statistical differences in means were analyzed using the analyses of variance (ANOVA) technique,

at a probability level of 0.05. Post hoc tests were run with the Duncan's multiple range test to determine the direction of variation.

### 3. Results

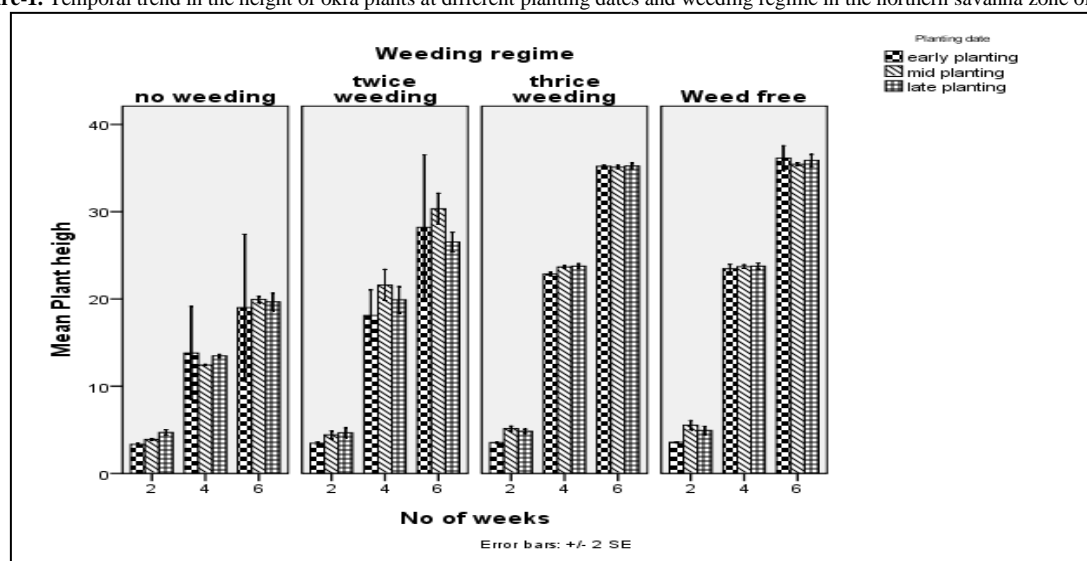
The year of cultivation (2013 and 2015) had no significant effect ( $p>0.05$ ) on the parameters measured. Though different weed species, categorized as broad leaves, grasses and sedges were identified in different treatments, the weed species were not significantly affected ( $p>0.05$ ) by the treatment combinations, and had similar species distribution in all treatments (Table 1).

**Table-1.** Dominant weed species identified in okro fields in northern Ghana during the 2013 and 2015 growing seasons

Category	Weed species	SDR %
Broadleaves		
	<i>Amaranthus spinosus</i>	7.5
	<i>Boerhavia diffusa</i>	6
	<i>Euphorbia hirta</i>	8.2
	<i>Cleome viscosa</i>	4
	<i>Hyptis suaveolens</i>	4.7
	<i>Ipomea eriocarpus</i>	4.3
	<i>Physalis angulate</i>	5
	<i>Mitracarpus villosus</i>	9
		<b>48.7</b>
Grasses		
	<i>Dactyloctenium aegyptium</i>	8
	<i>Imperata cylindrical</i>	6
	<i>Oldenlandia herbaceae</i>	6.8
	<i>Paspalum scrobiculatum</i>	5
	<i>Pennisetum pedicellatum</i>	6
		<b>31.8</b>
Sedges		
	<i>Cyperus rotundus</i>	5
	<i>Cyperus esculentus</i>	7.5
	<i>Cyperus difformis</i>	5
		<b>17.5</b>

While no significant interaction effect was observed between season of planting and weeding regime, nor sole season of planting ( $p>0.05$ ), sole weeding regime significantly ( $p<0.05$ ) affected okra yield and yield parameters (Table 2 and 3; Figure 1 to 3). The three weeding regimes and weed free treatments had better performance of okra in terms of plant height (Figure 1), number of leaves/plant (Figure 2), earliness to flower (Table 2), and fruit yield (Figure 3) than the double and no weeding plots. At all given weeks after sowing (eg. 6 weeks after sowing), plots with the weed free and 3 weeding regimes had plants with the thickest stem girth (3.11cm) while plants with the thinnest stem girth (1.23cm) were observed in plots with the no weeding treatments.

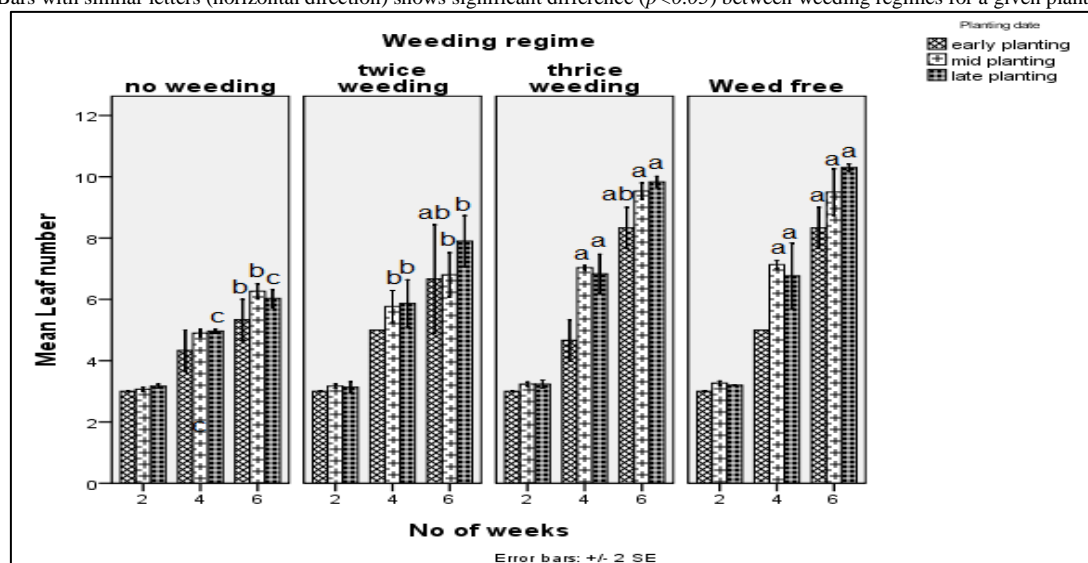
**Figure-1.** Temporal trend in the height of okra plants at different planting dates and weeding regime in the northern savanna zone of Ghana



The number of leaves varied among the treatments. There was no significant difference between weed free plots and weeding every two weeks (Figure 2). Number of leaves ranged from 5 to 10 leaves per plant. The plants in the

weedy check had least number of leaves whereas the weed free recorded the highest leaf number which was not significantly different from the number of leaves recorded in the thrice weeding regime.

**Figure-2.** Temporal trend in leaf number/plant of okra grown at different planting dates and weeding regime in the northern savanna zone of Ghana. Bars with similar letters (horizontal direction) shows significant difference ( $p < 0.05$ ) between weeding regimes for a given planting time.



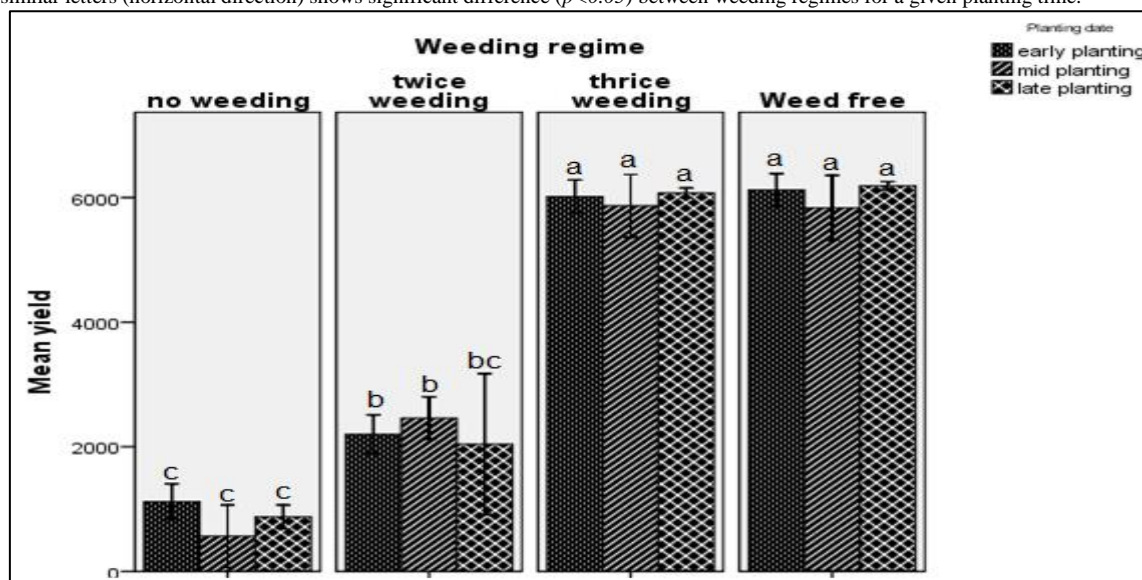
Days to 50 % flowering significantly varied between weeding regime ( $p < 0.05$ ), but was not affected by the season of planting (Table 2). Days to 50% flowering varied from 45 to 77 days. Lowest number of days to 50% flowering was observed in the weed-free plots while highest number of days to 50% flowering was observed in the treatments with no weed control (77 days). Weed free and 3 weeding regime treatments were comparable and superior to the weedy check and double weeding regime treatments. Similar observation as in the 50% flowering was observed for data collected for 50% fruiting. Weed free plots took the least number of days to attain 50% fruiting (50 days) while weedy check took 83 days.

**Table-2.** Effects of weeding regime on growth and yield parameters of okra in the northern savanna zone of Ghana

Treatment	Days to 50% flowering	Days to 50% fruiting	Plant height (cm)
Weed free (W4)	45 <sup>c</sup>	50 <sup>c</sup>	39 <sup>a</sup>
3 weeding (W3)	45 <sup>c</sup>	50 <sup>c</sup>	40 <sup>a</sup>
2 weeding (W2)	53 <sup>b</sup>	56 <sup>b</sup>	30 <sup>b</sup>
Control (W0)	77 <sup>a</sup>	83 <sup>a</sup>	29 <sup>b</sup>

Yields were significantly affected by the weeding regime (Figure 3). Plots treated with twice weeding and the weedy check recorded the lowest yield compared to those of the weed free and triple weeding regimes. But the yield of weed free and the W3 shows no significant differences ( $p > 0.05$ ).

**Figure-3.** Yield (kg/ha) of okra plants as affected by different planting dates and weeding regimes in the northern savanna zone of Ghana. Bars with similar letters (horizontal direction) shows significant difference ( $p < 0.05$ ) between weeding regimes for a given planting time.





## 4. Discussion

The results show that different weeding regimes affect the growth and yield of okra but not the time of planting. The weedy check in all the different planting dates recorded the lowest yield. This is an indication that okra is sensitive to weed competition. Especially, at the early stages of growth as also pointed out by Mncube and Banda [11], who observed that weed populations that were allowed to grow with the crop at emergence were more aggressive in terms of overall yield reduction than weeds that established later in the season. The results further show that keeping weeds in okra plots beyond 3 weeks after sowing (3WAS) could negatively affect fruit formation- a finding which is in agreement with earlier reports by Imoloame [5], who also noted that the critical period of weed interference is between 3 WAS and weed free until harvest, beyond which okra yield and yield parameters will be adversely affected.

The plots with better weed control also resulted in higher fruit yield which is in line with field observations by Law-Ogbomo, *et al.* [12] who reported that most of the assimilates were partitioned into pod yield principally because weed interference at this critical period of weed removal did not confer any adverse effect on the source and sink metabolic processes of the crop. Similar increases in yield as affected by weed management regimes have been reported by Imoloame [5], who attributed the increase in yield to a reduced competition for resources like nutrients, water and light.

## 5. Conclusion

While the season of cultivation may not affect the yield of okra in the northern region of Ghana, weeding at every two weeks (three weeding regimes before harvest) and maintaining a weed-free farm till harvest, are both associated with optimum okra yields in the savannah agro-ecological zone. To improve okra yield and sustain rural livelihood, triple weeding is recommended for okra cultivation. It results in okra yields that are comparable to weed-free treatments (mean of 6000 kg/ha to 6300 kg/ha,  $p>0.05$ ) but significantly higher ( $p<0.05$ ) and about triple the yield observed in the treatments with double weeding regimes (mean of 1800 kg/ha to 2300 kg/ha). It is also associated with less labor cost compared to continuous weeding in the weed free treatments. A recorded three fold gains in yield, compared to the yield of the double weeding regime, could be used to offset any additional labor cost incurred in the triple weeding regime, making it the best weeding regime to enhance okra production and generate income for the resource-poor okra farmer of northern Ghana.

## References

- [1] Oppong-Sekyere, D., Akromah, R., E. Y., Nyamah, E., Brenya, and Yeboah, S., 2012. "Evaluation of some okra (*Abelmoschus* spp L.) germplasm in Ghana." *African Journal of Plant Science*, vol. 6, pp. 166-178.
- [2] Sugri, I., Abdulai, M. S., Larbi, A., Hoeschle-Zeledon, I., Kusi, F., and Agyare, R. Y., 2015. "Participatory variety selection of okra (*Abelmoschus esculentus* L.) genotypes for adaptation to the semi-arid agro-ecology of Northern Ghana." *African Journal of plant science*, vol. 9, pp. 466-475.
- [3] Sing, K. P., Malik, Y. S., Lal, S., and Pandita, M. L., 1986. "Effects of planting dates and spacing on seed production of okra (*Abelmoschus esculentus* (L.) Moench)." *Haryana Journal of Horticultural of Science*, vol. 15, pp. 267-271.
- [4] Yadav, S. K. and Dhankar, B. S., 2001. "Seed production and quality of okra [*Abelmoschus esculentus* (L.) Moench] cv. Varsha Uphar as affected by sowing time and position of fruit on plant." *Seed Research-New Delhi*, vol. 29, pp. 47-51.
- [5] Imoloame, E. O., 2013. "Critical period of weed interference in okra (*Abelmoschus esculentus* (L.) Moench) in a humid forest and Rainforest-Savanna transition zones of Eastern and Western Nigeria." *International Journal of Agricultural Sciences*, vol. 3, pp. 610-614.
- [6] Olabode, O. S., Ogunyemi, S., and Awodoyin, R. O., 1999. "Response of okra (*Abelmoschus esculentus* (L.) Moench) to weed control by mulching." *Ghana Journal of Agriculture Science*, vol. 39, pp. 35-40.
- [7] Liebman, S. and Davis, A. S., 1999. "Interaction of soil, crop and weed management in low-external input." *Weed Research*, vol. 2000, pp. 27-47.
- [8] Kugbe, J., Fosu, M., Tamene, L. D., Denich, M., and Vlek, L. P. G., 2012. "Annual vegetation burns across the northern savanna region of Ghana: period of occurrence, area burns, nutrient losses and emissions." *Nutrient Cycling in Agroecosystem*, vol. 93, pp. 265-284.
- [9] Amikuzuno, J. and Donkoh, S. A., 2012. "Climate variability and yields of major staple food crops in northern Ghana." *African Crop Science Journal*, pp. 349-360.
- [10] Akobundu, I. O., 1987. *Weed science in the tropics. Principles and practices*. John Wiley & Sons.
- [11] Mncube, T. L. and Banda, H. R., 2017. "Crop-Weed Relationships in Okra [*Abelmoschus esculentus* (L.) Moench], Soybean (*Glycine max* L.) and Maize (*Zea mays* L.) in the Middleveld of Swaziland." *American Journal of Agriculture and Forestry*, vol. 5, pp. 73-83.
- [12] Law-Ogbomo, K. E., Osaigbovo, A. U., and Ewansiha, S. U., 2013. "Responses of okra (*Abelmoschus esculentus*) to various periods of weed interference in a humid tropical environment." *Journal of Agriculture and Rural Development*, vol. 16, pp. 1368-1371.