

# Effect of Time of Weed Removal and Population Density on Weed Control and Crop Performance in Okra/Amaranthus Intercrop

## ABSTRACT

Intercropping is an agricultural system that provides enabling environment for weed control in field crop production. A field trial was conducted during the late wet seasons of 2011 and 2012 at the Research Farm of the Federal University of Agriculture, Alabata, Abeokuta (7°15'N, 3°25'E) in the forest savanna- transition zone of Ogun State, South Western Nigeria. The objective was to evaluate the effect of time of weed removal and population density on weed control and crop performance in Okra/Amaranthus intercrop. The experiment was laid out in a Randomized Complete Block Design (RCBD) in a Split- plot arrangement. The treatments consisted of three main plots and five sub plots replicated three times. The main plot treatments were hoe- weeding at 3 weeks after planting (WAP), weeding at 3 and 6WAP and weedy check, while the sub plots consisted of okra intercropped with amaranthus at 0.5g/m<sup>2</sup> or 1.0g/m<sup>2</sup>, okra sole and amaranthus sole at 0.5g/m<sup>2</sup> or 1.0g/m<sup>2</sup>. Results from the study showed that intercropping of okra with amaranthus reduced weed infestation significantly (p<0.05) compared to sole okra. Weed control treatments significantly (p<0.05) reduced weed infestation in the intercrop while cropping pattern did not have any significant effect (p<0.05) on the weed biomass, plant height, pod length, number of pods and pod fresh weight. Uncontrolled weed infestation led to 50.7% yield loss in okra. It is therefore concluded that intercropping of okra with amaranthus is an effective means of reducing weed pressure in okra production as well as increasing land productivity.

Key words: Intercropping, weed removal, cropping pattern, amaranthus, okra

## INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) which is also known as Lady's finger is one of the most important vegetable crop of the tropical and sub-tropical regions of the world (Schippers, 2000). Okra is a popular health food due to its high fibre, vitamin C and folate content. (Siemonsma & Kouame 2004). It is also known to be high in antioxidants, calcium and potassium. ( Duvauchelle, 2011).

Okra, because of its growth habit and importance in the diets of most Africans, is often grown as an annual in mixture with staple food crops such as Yam, Cassava, Maize, green amaranth in most agricultural zones of sub-saharan Africa ( Ikeorgu *et al.*, 1989; Muoneke and Asiegbu, 1996).

Weeds are the major constraints to efficient okra production. Losses in crop yield due to weed may be greater than those due to other plant pests and diseases (Orkwor *et al.*, (1994). Okra farmers use hand hoe for most farm operations, including weed control. Timing of weed removal has been shown to be more critical than the frequency of weeding in

yam/maize/okra/sweet potato intercrop. According to Orkwor et al 1994 the critical period of weed interference in the intercrop was between 3 and 16 weeks after planting. Weed interference in the mixture reduced yam tuber yield by 35%, maize by 60%, okra 79% and sweet potato roots by 80%. They observed that there was no added advantage in keeping the intercrop weed-free throughout the growing season.

The need to reduce the number of weedings in okra production has become imperative owing to the increasingly scarcity and high cost of labour.

Crop production per unit area must be increased because of remaining fixed or diminishing suitable land for food production. Intercropping through more efficient use of water, nutrient and solar energy can significantly enhance crop productivity compared to the growth of sole crops (Midmore, 1995).

Intercropping is the most popular cropping system in subsistence agriculture (Obadoni, 2010). It provides more profit through enhanced utilization of soil nutrients and space and reduces risk of crop failures due to weed, diseases and pest infestation. Intercropping also ensures efficient utilization of light and other resource, reduces soil erosion, suppresses weed growth and thereby helps to maintain greater stability in crop yield (Susan and Mini, 2005). A number of studies have shown that increased crop density would decrease the magnitude of effect of weed competition with crops (Andrade *et al.*, 2002; Teasday and Frank, 1983; Adigun, 1992; Adigun, 2001; Ismail and Hall 2001; Adigun 2002). Increase crop density has the advantage of shading weeds and better competitive advantage in crop production.

Green amaranth (*Amaranthus hybridus*) is one of the vital nutritious vegetable crop commonly intercropped with okra. The crop is mainly planted by broadcasting within the row or on the seed bed. Broadcasting green amaranth within the rows of okra is a procedure whereby the space which otherwise would have been occupied by weeds is replaced by the amaranth. The implication of this is that instead of the farmer wasting his time and resources to control weeds within the rows he would only need to remove the amaranthus and sell to enhance his income.

Till date there is paucity of information on the time of weed removal and population density and their effect on weed suppression and crop productivity in okra/amaranthus intercrop.

The objective of this study therefore was to investigate the effect of effect of time of weed removal and plant population density on weed control and crop performance in okra/amaranthus intercrop

## MATERIALS AND METHODS

Two field experiments were carried out at the Research Farm of the Federal University of Agriculture, Abeokuta (7<sup>0</sup>15'N, 3<sup>0</sup>25'E) in the Forest Savanna Transition agro-ecological zone of South Western Nigeria. The location has a bimodal rainfall distribution pattern which peaks in July and October. (Figure 1) The land had been left fallow for two years after which it was used to cultivate Chochorus and green amaranth. The soil used was a sandy loam with the physical and chemical properties shown in Table 1.

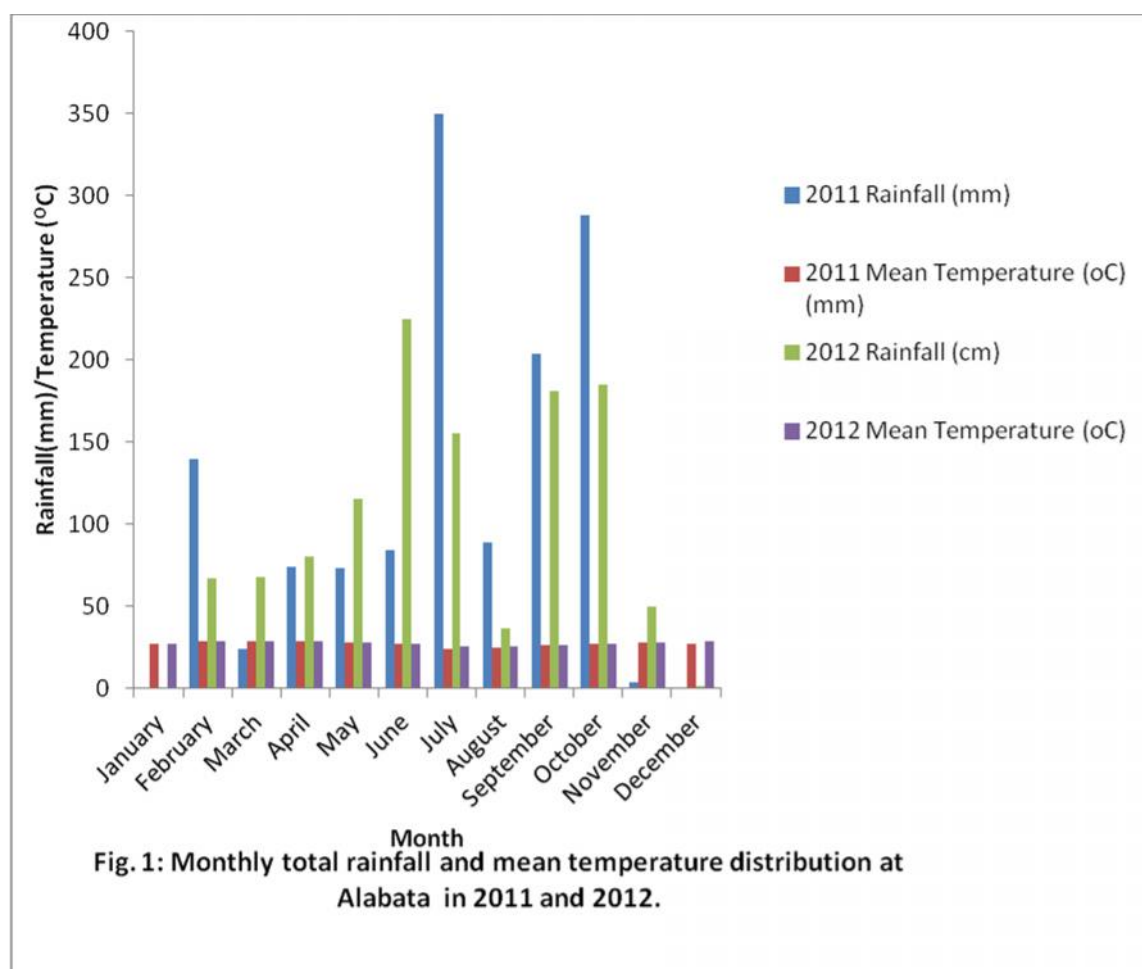
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80 Table 1: Soil Physico-chemical analysis of the Experimental Plot before Planting

| Soil property                          | 2011       | 2012       |
|----------------------------------------|------------|------------|
| pH (H <sub>2</sub> O)                  | 7          | 6.8        |
| pH (KCl)                               | 6.6        | 6.3        |
| Organic carbon (%)                     | 1.55       | 1.24       |
| Total Nitrogen %                       | 0.089      | 0.094      |
| Organic matter                         | 2.67       | 2.14       |
| Available P (mg/kg)                    | 21.63      | 16.44      |
| TEA (cmolKg <sup>-1</sup> )            | 0.3        | 0.3        |
| Ca (cmolKg <sup>-1</sup> )             | 8          | 5.6        |
| Mg (cmolKg <sup>-1</sup> )             | 5.2        | 5.3        |
| K <sup>+</sup> (cmolKg <sup>-1</sup> ) | 0.46       | 0.36       |
| Na (cmolKg <sup>-1</sup> )             | 0.64       | 0.22       |
| ECEC                                   | 14.6       | 11.78      |
| BS                                     | 97.95      | 98.75      |
| Sand (g/kg)                            | 694        | 730        |
| Silt (g/kg)                            | 130        | 124        |
| Clay (g/kg)                            | 176        | 146        |
| Texture                                | Sandy loam | Sandy loam |

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82 The following weed species were present during the pre-cropping stage at the experimental  
83 site; *Talinum triangulare* , *Ageratum conyzoides*, *Spigelia anthelmia*, *Mitracarpus villosus*,  
84 *Phyllanthus amarus*, *Euphorbia heterophylla*, *Tridax procumbens*, *Chromolaena odorata*,  
85 *Mucuna pruriens*, *Euphorbia herterophyll*, *Panicum maximum*, *Imperata cylindrical*, *Cynodon*  
86 *dactylon*, *Axonopus compressus*. and *Cyperus rotundus*.



## Experimental Design, Treatment and Plot size

The experiment was laid out in a Randomized Complete Block Design (RCBD) in a Split-plot arrangement which consisted of fifteen treatment combinations replicated three times. The main plot consisted three period of weed removal (WR) namely: hoe weeding at 3weeks after planting (WAP), weeding at 3 and 6WAP, weedy check while the sub plots which consisted of five cropping pattern (CP) okra intercropped with amaranthus at  $0.5\text{g/m}^2$  (P1), or  $1.0\text{g/m}^2$  (P2), sole okra, sole amaranthus at  $0.5\text{g/m}^2$  (population1), or  $1.0\text{g/m}^2$  (population 2). The gross and net plot sizes were  $4\text{m} \times 4\text{m}$  and  $3\text{m} \times 3\text{m}$  respectively.

## Cultural operation

The field was prepared manually using cutlass to remove the established vegetation. Marking out of the field and plot layout was also done while the seed bed was prepared using African hoe. An improved variety of okra (NHAE-47) and a local variety of green amaranth were obtained from NIHORT (National Horticultural Research Institute, Ibadan, Nigeria ). Three seeds of okra were planted at a spacing of  $90\text{ cm} \times 30\text{ cm}$  and later thinned to two plants, two

103 weeks after planting. Weeding operations were carried out as specified above in the treatments.  
104 Leaf eating beetles were controlled with cypermethrin at 10ml/10litres of water.

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## 106 Data collection

107 Data collected from the experiment included the following:

### 108 Weed Data

109 Weed samples were collected at 3, 6 and 9 weeks after planting from three random 0.5m<sup>2</sup>  
110 quadrat along a diagonal transect in each plot for identification by species, plant taxa and  
111 growth form. All plants within the quadrat were cut at the soil surface and weighed. Weed dry  
112 weights were later determined after oven-drying the samples at 70° C for 48 hours.

### 113 Okra growth and Developmental parameters

114 Okra Height: At 3, 6 and 9 WAP, the maximum height of the canopy was measured on five  
115 tagged plants in the central row with a meter rule. The average of the five measurements in  
116 each plot was recorded.

117 Days to 50% flowering and days to 100% podding. Number of days from planting to 50%  
118 flowering was recorded, when half of the plants flowered as well as the number of days when  
119 all the plants in each plot podded (100% podding).

### 120 Yield and yield components of Okra.

121 Five plants were tagged on each plot and yield components such as number of pods, pod  
122 length, pod girth, and fruit yield were determined. The number of pods was determined by  
123 cumulating the number of harvested pods for each plant. Pod length was measured with  
124 measuring tape from the base of the pod to the tip while the pod girth was taken with a venier  
125 caliper. The

126 fruit yield was determined by harvesting the fruits every 3 days.

### 127 Amaranthus growth and Yield parameters:

128 Amaranthus height: This was done by measuring from the base to the tip of five tagged  
129 plants at 3 and 6 WAP.

130 Fresh weight at harvest: At harvest, fresh weight of amaranthus in the net plot was taken.

### 131 The Land Equivalent Ratio (LER)

132 The Land Equivalent Ratio (LER) was calculated using the formular:

$$133 \quad \frac{\text{Yield of Intercropped X}}{\text{Yield of Sole X}} + \frac{\text{Yield of Intercropped Y}}{\text{Yield of Sole Y}}$$

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Where X = Okra and Y = Amaranthus. The LER was calculated to determine the relative advantage of intercropping over sole cropping

The data collected were subjected to analysis of variance (ANOVA) and treatment means were compared using Fisher's Protected Least Significant Difference (LSD) at  $P < 0.05$ .

## RESULTS

### Effect of time of weed removal and plant population density on weed specie composition and weed dry weight in Okra/Amaranthus intercrop.

In 2011, the most dominant weed species were *Ageratum conyzoides*, *Tridax procumbens*, *Euphorbia heterophylla* and *Panicum maximum* while in 2012, *Ageratum conyzoides*, *Tridax procumbens*, *Talinum triangulare*, *Axonopus compressus* had the highest weed intensity (Table 2). The weed control treatments had significant effect ( $p < 0.05$ ) on weed dry weight at 3, 6 and 9 WAP (Table 3). There was increasing weed biomass as the season progresses in plots where weeds were left uncontrolled. Weed removal at 3 WAP and weeding at 3 and 6WAP plots maintained a relatively constant weed biomass throughout the period of observation. The study also showed that there was no significant difference among the weed biomass in the pure stands of okra and amaranthus as well as their mixtures (Table 3). Interaction between the time of weed removal and plant population on weed dry weight was not significant.

### Effect of time of weed removal and plant population density of amaranthus on the growth and yield of okra in Okra/Amaranthus intercrop

Weed control treatments had no significant effect on plant height of okra at 3 WAP and 6 WAP (Table 4) and also had no significant effect on days to 50% flowering, days to 100% podding and dry matter production (Table 5). There was no significant difference among cropping systems and weed control methods on the days to 50% flowering and days to 100% podding of Okra. Interaction between the time of weed removal and plant population density of amaranthus on the growth of Okra was also not significant.

### Effect of weed removal and plant population density on the yield and yield components of okra in Okra/Amaranthus intercrop

Results from this study showed that pod length and fruit yield were significantly ( $p < 0.005$ ) affected by the time of weed removal (Table 6). Weed removal at 3 WAP compared favourably well with maximum values obtained from weeding at 3 and 6WAP period. The weeding at 3 and 6WAP plots and plot weeded 3 WAP gave 5.16 and 4.77 t/ha fruit yield respectively in 2011 while in 2012, weeding at 3 and 6WAP plots and plot weeded 3 WAP gave 2.92 and 2.80 t/ha fruit yield respectively. It was also observed that cropping system had no significant ( $p > 0.05$ ) effect on the fruit length, pod girth and fruit yield irrespective of the year of planting (Table 6).

## Effect of time weed removal and plant population density on the growth and yield of amaranthus in Okra/Amaranthus.

The effect of time of weed removal and plant population density of amaranthus on plant height, fresh and dry weight of amaranthus is presented on Table 7. The result indicated that time of weed removal and cropping pattern (intercropping) had no significant ( $p < 0.05$ ) effect on plant height and fresh weight of amaranthus. Furthermore, the interactions between the time of weed removal and plant population density on plant height and yield of amaranthus were not significant either.

### Intercrop Productivity:

The study showed that intercropping had advantage over sole crop. The Land equivalent (LER) of the okra/amaranthus intercrop population 1 and population 2 were 1.93 and 1.50 respectively.

### Discussion

In this study, comparable maximum fruit yield was obtained in weeding at 3 and 6WAP and plots weeded 3 WAP. Uncontrolled weed infestation led to 50.7 % yield loss in okra fruit yield while weed removal at 3 WAP only resulted in 5.2% yield reduction. In these treatments there were corresponding decreases in weed biomass (Table 2). Okra and amaranthus were observed to have higher canopy than the weeds. Obasi (1989) and Orkwor *et.al.*, (1991) observed that the most important feature of plants that determine their competitive ability for light is height. They reported that a successful competitor for light is the component that has its foliage at a higher canopy layer. Palaniappan (1985) also reported that in an intercropping situation, the taller component crop intercepted the major share of light such that the growth rates of the two crops would be proportional to the quantity of the photosynthetic active radiation they intercepted.

Fruit yield obtained in 2011 was generally higher than 2012. This could be attributed to ceasation of rain at the reproductive stage of the crops in 2012. This reduction in yield also reflected in the values obtained from the height of the crop (okra). The height of okra plants in 2011 almost doubled that of 2012 (Table 4). It was also observed that the yield of each component crop was higher at higher amaranth plant population ( $1.0\text{g/m}^2$ ). Amaranth through competition would have provided an environment of reduced weed biomass for okra. Several authors (Midmore *et al.*, 1995, Susan and Mini 2005, Olsantan and Bello (2004) have reported that weed suppression was stronger in intercrop than in monocultural components and at higher plant population.

This study showed that weed biomass increased with time in the weed infested plot while the rate of increase was constant in plots weeded 3WAP and weeding at 3 and 6WAP. Weeding at 3 WAP and weeding at 3 and 6WAP control methods significantly reduced weeds which resulted in increased yield and yield components of okra. From the values obtained from the Land Equivalent ratios (LER), there was yield advantage of intercropping okra with amaranthus. In this situation intercropping okra with amaranthus at  $0.5\text{g/m}^2$  and  $1.0\text{g/m}^2$  would have required 93 % and 50 % more land if planted in sole stands of okra and amaranthus respectively. This result agrees with the findings of Susan and Mini (2005) who worked on the

213 biological efficiency of intercropping okra with amaranthus. Their finding showed that the  
214 LER was greater than unity for wider and closer spacing (1.77 and 1.91) respectively.

## 215 CONCLUSION

216 This study showed that intercropping of okra and amaranthus could be a veritable way of  
217 reducing weed pressure in okra/amaranth intercrop as well as increasing land productivity. At  
218 high population density of amaranthus (1.0g/m<sup>2</sup>), and single- timed weed removal at 3 WAP,  
219 growth and optimum fruit yield of okra and amaranthus will still be sustained.

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286 **Table 2: Pre-cropping Weed specie composition of the experimental site in 2011 and 2012**

| Weed specie                   | Family        | Growth form | 2011 | 2012 |
|-------------------------------|---------------|-------------|------|------|
| <i>Ageratum conyzoides</i>    | Asteraceae    | ABL         | +++  | +++  |
| <i>Mucuna pruriens</i>        | Leguminosae   | PBL         | +    | -    |
| <i>Tridax procumbens</i>      | Asteraceae    | ABL         | +++  | +++  |
| <i>Spigelia anthelmia</i>     | Loganiaceae   | ABL         | ++   | ++   |
| <i>Mitracarpus villosus</i>   | Rubiaceae     | ABL         | ++   | -    |
| <i>Phyllanthus amarus</i>     | Euphorbiaceae | ABL         | +    | -    |
| <i>Euphorbia heterophylla</i> | Euphorbiaceae | ABL         | +++  | ++   |
| <i>Chromolaena odorata</i>    | Asteraceae    | ABL         | ++   | ++   |
| <i>Talinum triangulare</i>    | Portulacaceae | ABL         | ++   | +++  |
| <i>Panicum maximum</i>        | Poaceae       | PG          | +++  | ++   |
| <i>Axonopus compressus</i>    | Poaceae       | AG          | ++   | +++  |
| <i>Imperata cylindrical</i>   | Poaceae       | PG          | ++   | +    |
| <i>Cyperus rotundus</i>       | Cyperaceae    | PS          | ++   | +    |

287 += Low intensity, += moderate intensity, += high intensity, ABL= Annual Broadleaf, PG=Perennial Grass,  
 288 PS=Perennial Sedges

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292 **Table 3: Effect of time of time of weed removal and plant population on weed biomass in**  
 293 **okra/amaranthus intercrop in 2012**

| Treatment                       | Weed dry weight (g/m <sup>2</sup> ) |        |        | Mean Weed Dry Weight (g/m <sup>2</sup> ) |
|---------------------------------|-------------------------------------|--------|--------|------------------------------------------|
|                                 | 3WAP                                | 6WAP   | 9WAP   |                                          |
| <b>Time of weed Removal (W)</b> |                                     |        |        |                                          |
| Weedy check                     | 73.2b                               | 137.6c | 197.9b | 136.3b                                   |
| Weeding at 3 and 6 WAP          | 15.9a                               | 16.7a  | 16.0a  | 16.87a                                   |
| Weeding 3WAP                    | 61.1b                               | 62.6b  | 61.9b  | 61.9ab                                   |
| SED                             | 6.61*                               | 12.7*  | 16.7** | 29.2*                                    |
| LSD (0.05)                      | 18.4                                | 35.2   | 46.3   | 81.3                                     |
| <b>Cropping Pattern (C)</b>     |                                     |        |        |                                          |
| Okra Sole                       | 48.1                                | 78.5   | 101.7  | 76.10                                    |
| Sole amaranthus P1              | 52.8                                | 73.9   | 92.4   | 73.03                                    |

|                          |       |        |        |        |
|--------------------------|-------|--------|--------|--------|
| Sole amaranthus P2       | 52.0  | 73.0   | 90.3   | 71.77  |
| Okra+Amaranthus P1       | 49.2  | 72.3   | 89.5   | 70.33  |
| Okra +Amaranthus P2      | 48.3  | 63.6   | 85.6   | 65.83  |
| SED                      | 4.4ns | 7.0ns  | 7.3ns  | 3.02ns |
| LSD (0.05)               | 9.0   | 16.7   | 20.1   | 6.96   |
| <b>Interaction (WXC)</b> |       |        |        |        |
| SED                      | 9.5ns | 14.2ns | 15.1ns |        |
| LSD (0.05)               | 20.3  | 36.8   | 46.2   |        |

294 WAP= Weeks after planting, ns=not significant, \*=significant at 0.05, \*\*=significant at 0.001, P1= amaranthus  
 295 at 0.5g/m<sup>2</sup>, P2= amaranthus at 1.0g/m<sup>2</sup>

296 Figures followed by the same alphabets in a column are not significantly different by LSD test at 5% probability.

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298 **Table 4: Effect of time of weed removal and Plant population on Plant Height of okra in**  
 299 **okra/amaranthus intercrop in 2011 and 2012 wet seasons**

| Treatment                       | Plant Height (cm) |        |        |        |
|---------------------------------|-------------------|--------|--------|--------|
|                                 | 3WAP              |        | 6WAP   |        |
|                                 | 2011              | 2012   | 2011   | 2012   |
| <b>Time of weed Removal (W)</b> |                   |        |        |        |
| Weedy check                     | 34.09             | 9.80,  | 32.42  | 15.70  |
| Weeding at 3 and 6WAP           | 34.26             | 9.80   | 32.65  | 18.10  |
| Weeding 3WAP                    | 36.80             | 8.70   | 35.73  | 13.60  |
| SED                             | 2.30ns            | 0.75ns | 2.38ns | 2.61ns |
| <b>Cropping Pattern (C)</b>     |                   |        |        |        |
| Okra Sole                       | 35.73             | 9.18   | 34.17  | 17.50  |
| Okra+Amaranthus P1              | 35.28             | 10.10  | 33.48  | 14.60  |
| Okra +Amaranthus P2             | 31.14             | 9.71   | 33.15  | 15.3   |
| SED                             | 2.30 ns           | 0.75ns | 2.38ns | 2.61ns |
| <b>Interaction (WXC)</b>        |                   |        |        |        |
| SED                             | 3.99ns            | 2.00ns | 4.12ns | 4.51ns |

300 WAP= Weeks after planting, ns=not significant, P1= amaranthus at 0.5g/m<sup>2</sup>, P2= amaranthus at 1.0g/m<sup>2</sup>

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306 **Table 5: Effect of time of weed removal and plant population on plant height, days to**  
307 **50% flowering and days to 100% podding of okra in okra/amaranthus intercrop**  
308 **in 2012**

| Treatment                    | Plant Height (cm) |        | Days to 50% flowering | Days to 100% podding |
|------------------------------|-------------------|--------|-----------------------|----------------------|
|                              | 3WAP              | 6WAP   |                       |                      |
| <b>Weedy removal (W)</b>     |                   |        |                       |                      |
| Weedy check                  | 34.09             | 32.42  | 24.00                 | 46.90                |
| Weeding at 3 and 6WAP        | 34.26             | 32.65  | 28.60                 | 52.70                |
| Weeding at 3WAP              | 36.80             | 35.73  | 27.10                 | 52.10                |
| SE±                          | 2.30 ns           | 2.38ns | 2.84ns                | 5.51ns               |
| <b>Cropping pattern (C)</b>  |                   |        |                       |                      |
| Sole okra                    | 35.73             | 34.17  | 28.00                 | 52.60                |
| Okra+ Amaranthus P1          | 35.28             | 33.48  | 27.60                 | 47.00                |
| Okra+ Amaranthus P2          | 31.14             | 33.15  | 24.10                 | 52.10                |
| SE±                          | 2.30              | 2.38   | 2.84                  | 5.51                 |
| <b>Interaction SE± (WxC)</b> | 3.99ns            | 4.12ns | 9.33ns                | 9.55ns               |

309 WAP= Weeks after planting, ns=not significant, P1= amaranthus at 0.5g/m<sup>2</sup>, P2= amaranthus at 1.0g/m<sup>2</sup>

310 **Table 6: Effect of time of weed removal and plant population on pod length, number of**  
 311 **Pods and fruit weight of okra/amaranthus intercrop in 2011 and 2012 wet seasons**

| Treatment                       | Pod Length (cm) |        | Pod Girth (cm) |        | Number of Pods/plant |        | Fruit weight (t/ha) |         |
|---------------------------------|-----------------|--------|----------------|--------|----------------------|--------|---------------------|---------|
|                                 | 2011            | 2012   | 2011           | 2012   | 2011                 | 2012   | 2011                | 2012    |
| <b>Time of weed Removal (W)</b> |                 |        |                |        |                      |        |                     |         |
| Weedy check                     | 4.50            | 2.45a  | 4.11           | 1.91   | 9.89                 | 4.44   | 2.48a               | 1.50a   |
| Weeding at 3 and 6WAP           | 4.61            | 3.04b  | 4.41           | 2.36   | 11.02                | 7.33   | 5.16 b              | 2.92b   |
| Weeding 3WAP                    | 4.55            | 3.19b  | 4.16           | 2.36   | 10.67                | 6.33   | 4.77 b              | 2.80b   |
| SED                             | 0.38ns          | 0.18*  | 0.31ns         | 0.18ns | 0.85ns               | 0.29** | 0.85*               | 0.44*   |
| <b>Cropping Pattern (C )</b>    |                 |        |                |        |                      |        |                     |         |
| Okra Sole                       | 4.69            | 2.93   | 4.36           | 2.18   | 11.00                | 5.67   | 4.27                | 2.46    |
| Okra+Amaranthus P1              | 4.33            | 3.04   | 4.07           | 2.23   | 10.11                | 6.33   | 4.17                | 2.35    |
| Okra +Amaranthus P2             | 4.55            | 2.81   | 4.26           | 2.28   | 10.67                | 6.11   | 3.98                | 2.44    |
| SED                             | 0.38            | 0.18ns | 0.38           | 0.05ns | 0.85                 | 0.38ns | 0.36ns              | 0.07ns  |
| <b>Interaction (WXC)</b>        |                 |        |                |        |                      |        |                     |         |
| SED                             | 0.66ns          | 0.31ns | 0.54ns         | 0.19ns | 1.48ns               | 0.61ns | 0.62ns              | 0.456ns |

312 WAP= Weeks after planting, ns=not significant, \*=significant at 0.05, \*\*=significant at 0.001,, P1= amaranthus  
 313 at 0.5g/m<sup>2</sup>, P2= amaranthus at 1.0g/m<sup>2</sup>

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 315 Figures followed by the same alphabets in a column are not significantly different by LSD test at 5% probability.  
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320 **Table 7: Effect of time of weed removal and plant population on growth and yield**  
 321 **characteristics of amaranthus in okra/amaranthus intercrop in 2012**

| Treatment            | Plant Height (cm) |       |       | Fresh Weight at Harvest (t/ha | Dry matter(t/ha) |
|----------------------|-------------------|-------|-------|-------------------------------|------------------|
|                      | 3WAP              | 6 WAP | 9 WAP |                               |                  |
| Time of weed Removal |                   |       |       |                               |                  |

|                              |        |        |         |        |        |
|------------------------------|--------|--------|---------|--------|--------|
| <b>(W)</b>                   |        |        |         |        |        |
| Weedy check                  | 16.72  | 28.3   | 41.3    | 2.49   | 1.24   |
| Weeding at 3 and 6WAP        | 19.18  | 34.8   | 56.4    | 5.62   | 2.43   |
| Weeding 3WAP                 | 16.12  | 38.6   | 50.9    | 3.17   | 1.63   |
| SED                          | 2.32ns | 3.83ns | 5.83    | 0.98ns | 0.73ns |
| <b>Cropping Pattern (C )</b> |        |        |         |        |        |
| Sole amaranthus (P1)         | 16.57  | 34.00  | 42.4    | 3.65   | 1.88   |
| Sole amaranthus (P2)         | 19.00  | 34.80  | 52.3    | 5.18   | 2.15   |
| Okra+Amaranthus P1           | 16.59  | 31.7   | 50.1    | 3.56   | 1.21   |
| Okra +Amaranthus P2          | 17.36  | 35.1   | 47.2    | 2.64   | 1.80   |
| SED                          | 1.95ns | 4.23ns | 5.97ns  | 1.23ns | 0.55ns |
| <b>Interaction (WXC)</b>     |        |        |         |        |        |
| SED                          | 3.69ns | 7.41ns | 10.68ns | 2.09ns | 1.10ns |

WAP= Weeks after planting, ns=not significant, P1= amaranthus at 0.5g/m<sup>2</sup>, P2= amaranthus at 1.0g/m<sup>2</sup>

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