Research Article

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Effects of Farmyard Manure and Integrated Weed Management on Okra Growth Parameters (*Abelmoschus Esculentus* (L.) Moench) at Dadinkowa

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Abstract
Field trials were conducted during 2011 and 2012 cropping seasons at the Teaching and Research Farm of Federal College of Horticulture Dadinkowa in Sudan savanna agro-ecological zone of Nigeria. The objectives of the trial were; to determine the effects of farmyard manure and integrated weed management on okra growth. The treatments were laid out in a split-plot design with farmyard manure rates occupying the main plots; while integrated weed management rates were allocated to the sub-plots and replicated three times. Farmyard manure was applied to affected plots a week before sowing okra, while pendimethalin 500 EC was applied pre-emergence at the rate of 2.5 kg a.i. ha^{-1} immediately after sowing. Results revealed that the effects of farmyard manure and integrated weed management were significant on plant height (P≤5%), number of leaves plant^{-1}, number of branches plant^{-1} and leaf area plant^{-1}. It was observed that the control treatments of no farmyard manure applied and no weed control significantly gave lower means on okra growth parameters, while application of 4 t ha^{-1} of farmyard manure and weeding once at 2 + 4 + 6 + 8 WAS together with 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC significantly gave higher means on the same traits, as well as integrated weed management.

Keywords: Okra, Farmyard, Manure, Integrated, Growth, Weed, Management.

Introduction
Okra (*Abelmoschus esculentus* (L) Moench) is one of the most prominent and lucrative vegetables that can be eaten in cooked or processed form and the young fruits may also be eaten raw [1]. The nutritional composition of okra fruits includes calcium, protein, oil, carbohydrates, iron, magnesium and phosphorus [2]. Okra seeds contain approximately 21% protein, 14% lipids and 5% ash [2]. Besides other factors such as rainfall, temperature, relative humidity, solar radiation, pests and diseases for lower yields, lack of proper fertilizer application and effective weed management are also responsible for reduced yields and quality of okra [3-5].

In order to prevent the current global high price and short supply of mineral fertilizers and their deleterious effects on ecosystems, there is therefore the need to develop a sustainable cropping system and soil fertility management through the supply of sufficient organic matter for optimum okra growth. Making nutrients available to crops generally means making nutrients available to weeds [6]. The timing of nutrient availability relative to crop and weed demands upon nutrient supplies appears to be especially important for determining the outcome of competitive interaction [6]. In addition, the level of soil fertility determines the relative competitiveness between the crop and the weeds. At higher levels of N, weeds like *Cyperus rotundus, Cyperus esculentus, Imperica cylindrica, Cynodon dactylon* are generally more competitive than okra [5,7].

However, appropriate agronomic practices and management decisions can have a significant influence on the type and number of weeds interfering with okra. Understanding this relationship can help okra growers manage weeds through the avoidance of the critical period of weed competition with the crop and various cultural management practices [5,7].

In view of the importance of okra as a major source of protein, carbohydrates, vitamins and minerals, there is therefore the need for Nigerian farmers to adopt modern okra production technologies in order to increase its production through the use of farmyard manure as sources of plant nutrients and integrated weed management practices. In the study area of Dadinkowa Nigeria, farmers neglect the use of proper farmyard manure and integrated weed management in okra production. Therefore, the experiment was conducted to determine the effects of farmyard manure and integrated weed management, and to evaluate interaction effects of farmyard manure and integrated weed management on the growth of okra.

Materials and Methods

Field trials were conducted during the 2011 and 2012 cropping seasons at the Teaching and Research Farm of the Federal College of Horticulture; Dadinkowa situated in the Sudan savannah agro-ecological zone of Nigeria.

The design used for the experiment was a split-plot with farmyard manure rates (F 0 = 0 t ha^{-1}, F1= 2 t ha^{-1}, F2 = 4 t ha^{-1}, F3 = 6 t ha^{-1} and F4 = 8 t ha^{-1}) were assigned to main plot treatments and integrated weed management rates (W0 = No weeding + 0.0 kg a.i. ha^{-1} of pendimethalin 500 EC, W1 = Weeding once at 2 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC, W2 = Weeding once at 2 + 4 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC, W3 = Weeding once at 2 + 4 + 6 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC and W4 = Weeding once at 2 + 4 + 6 together with 8 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC) were assigned to sub-plot treatments and replicated three times. Three seeds of okra per holes were sown on the 28 June, 2011 and 2012 cropping seasons, using hand hoe at the rate of three seeds hole^{-1} and later thinned to two seedlings stand^{-1} at an inter and intra-row spacing of 50 cm and 50 cm respectively, during the first weeding two weeks after sowing.

The farmyard manure treatments were composted for three weeks and applied on the plots a week before sowing. Pendimethalin 500 EC was applied using a CP15 knapsack sprayer immediately after sowing to treated plots at the rate of 2.5 kg a.i. ha^{-1}. The first weeding started at 2 WAS and subsequent weeding followed at 4, 6 and 8 WAS. Data was collected from 2 WAS at an interval of 4 WAS up to end of the experiment.

Results

Effects of farmyard manure and integrated weed management on plant height of okra

Tables 1 shows that at 4 WAS in 2011 and 2012 cropping seasons, there were no significant ($P \leq 0.05$) differences on plant height of okra among the treatment means. However, at 8 WAS there were significant ($P \leq 0.05$) differences on plant height of okra. The control treatment of 0 t ha^{-1} of farmyard manure produced significantly lower plant height than plots receiving farmyard manure. The highest plant height was recorded at 8 t ha^{-1} of farmyard manure. Also, at 12 and 14 WAS, differences in plant height followed apparently the same pattern as at 8 WAS. Significant differences were observed on plant height due to integrated weed management.

The control treatment of no weed control significantly gave the lowest plant height, while weeding at 2, 4, 6 and 8 WAS together with 2.5 kg a. i. ha^{-1} of pendimethalin 500 EC applied, significantly produced a higher mean value.

Effects of farmyard manure and integrated weed management on number of leaves plant^{-1} of okra

Tables 2 shows that at 4, 8, 12 and 14 WAS in the 2011 and 2012 cropping seasons, there were significant ($P \leq 0.05$) differences on number of leaves plant^{-1} of okra among the treatment means. The control treatment of 0 t ha^{-1} of farmyard manure produced significantly lower mean value on number of leaves plant^{-1} than the rest of the treatments. The 8 t ha^{-1} of farmyard manure significantly gave the highest mean value among the treatments on number of leaves plant^{-1}. It also shows that at 4, 8, 12 and 14 WAS, there were significant ($P \leq 0.05$) differences among the treatment means due to integrated weed management (Table 2). The control treatment of no weed control significantly ($P \leq 0.05$) produced the lowest mean value on number of leaves plant^{-1}, while weeding at 2, 4, 6 and 8 WAS + 2.5 kg a. i. ha^{-1} of pendimethalin 500 EC significantly produced the highest mean value on number of leaves plant^{-1}.

Effects of farmyard manure and integrated weed management on number of branches plant^{-1} of okra

At 4 WAS in 2011 cropping season, there were no significant ($P<0.05$) difference on number of branches plant^{-1} of okra among the treatment means (Tables 3). On the other hand, at 4 WAS, in 2012 cropping season, there were significant ($P<0.05$) differences on number of branches plant^{-1} of okra. The control treatment (0 t ha^{-1} of farmyard manure) produced significantly lower number of branches plant^{-1} than plots that received farmyard manure. The highest number of branches plant^{-1} was recorded at 8 t ha^{-1} of farmyard manure applied. Also, at 8, 12 and 14 WAS, in 2011 and 2012 cropping seasons there were significant differences on number of branches plant^{-1} of okra, with the control of no farmyard manure significantly producing a lower mean value, whereas application of 8 t ha^{-1} of farmyard manure significantly produced the highest mean value on number of branches plant^{-1}. Significant differences were observed on plant height due to integrated weed management. The control treatment of no weed control significantly gave the lowest number of branches plant^{-1}, while weeding at 2, 4, 6 and 8 WAS together with 2.5 kg a. i. ha^{-1} of pendimethalin 500 EC applied, significantly produced higher means on number of branches plant^{-1}.

Effects of farmyard manure and integrated weed management on leaf area plant^{-1} of okra

Tables 4 shows that at 4, 8 12 and 14 WAS in 2011 and 2012 cropping seasons, there were significant ($P<0.05$) differences on leaf area plant^{-1} of okra among the treatment means. The control treatment of 0 t ha^{-1} of farmyard manure produced significantly lower leaf area plant^{-1} than plots that received farmyard manure. The highest leaf area plant^{-1} was recorded at 8 t ha^{-1} of farmyard manure applied.

Table 4 shows significant ($P<0.05$) differences were observed on leaf area plant^{-1} due to integrated weed management. The control treatment of no weed control significantly gave the lowest leaf area plant^{-1}, while weeding at 2, 4, 6 and 8 WAS combined with 2.5 kg a. i. ha^{-1} of pendimethalin 500 EC, significantly produced a higher mean value of leaf area plant^{-1}.

Plant height (cm)								
Source of variation	4WAS		8WAS		12WAS		14WAS	
	2011	2012	2011	2012	2011	2012	2011	2012
F0	6.84a	6.94a	25.34b	25.37b	41.49c	42.53c	43.20b	43.30b
F1	6.91a	6.98a	25.74b	25.76b	43.65b	43.75b	46.13ab	46.15ab
F2	6.93a	7.03a	25.98b	26.00b	44.23b	44.33b	46.33ab	46.43ab
F3	6.97a	7.07a	26.08b	26.10b	44.32b	44.42b	46.74a	46.84a
F4	6.99a	7.09a	28.73a	28.73a	46.59a	46.62a	48.16a	48.18a
SE±	024	0.26	0.94	0.97	0.98	1.00	2.05	2.07
W0	6.34a	6.92a	23.44b	25.27b	41.39c	41.23c	43.24b	43.34b
W1	6.41a	6.95a	23.54b	25.28b	43.45b	43.45b	46.23ab	46.25ab
W2	6.53a	6.96a	23.63b	25.32b	44.33b	44.43b	46.43ab	46.53ab
W3	6.62a	6.97a	23.78b	25.40b	44.35b	44.52b	46.64a	46.64a
W4	6.68a	6.98a	26.53a	28.73a	46.32a	46.58a	48.26a	48.68a
SE±	0.12	0.13	0.47	0.49	0.49	0.50	1.03	1.04
F x W	NS	NS	NS	NS	NS	NS	NS	NS

Table 1: Effects of Farmyard manure and Integrated Weed Management on Plant height of Okra. Means followed by the same letter (s) in a column are not significantly different according to Duncans' Multiple Range Test at 5% level of probability.

Number of leaves plant^{-1}								
Source of variation	4WAS		8WAS		12WAS		14WAS	
	2011	2012	2011	2012	2011	2012	2011	2012
F0	3.50c	4.70d	6.50b	7.70c	7.00b	8.20c	7.80b	9.00c
F1	3.60bc	4.80c	6.80b	8.00b	7.10b	8.30c	7.90b	9.10c
F2	3.70b	4.90c	8.20a	9.40b	8.30a	9.50b	9.30a	10.50b
F3	3.80b	5.00b	8.50a	9.70a	8.50a	9.70a	9.50a	10.70a
F4	4.00a	5.20a	9.00a	10.20a	9.20a	10.40a	10.10a	11.30a
SE±	0.11	0.11	0.74	0.74	0.75	0.75	0.76	0.76
W0	3.30e	4.50e	6.40e	7.60e	7.00d	8.20e	7.60e	8.80e
W1	3.40d	4.60d	6.80d	8.00d	7.10d	8.30d	8.00d	9.20d
W2	3.60c	4.80c	7.80c	9.00c	8.00c	9.20c	8.90c	10.10c
W3	3.80b	5.00b	8.50b	9.70b	8.50b	9.72b	9.60b	10.80b
W4	4.60a	5.80a	9.50a	10.70a	9.50a	10.80a	10.40a	11.60a
SE±	0.06	0.06	0.39	0.37	0.36	0.38	0.38	0.38
F x W	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effects of Farmyard manure and Integrated Weed Management on Number of leaves plant^{-1} of Okra. Means followed by the same letter (s) in a column are not significantly different according to Duncans' Multiple Range Test at 5% level of probability.

Number of branches plant^{-1}								
Source of variation	4WAS		8WAS		12WAS		14WAS	
	2011	2012	2011	2012	2011	2012	2011	2012
F0	2.40a	3.60b	4.70c	5.90c	7.00b	6.00c	7.80b	6.20c
F1	2.40a	3.60ab	4.80c	6.00bc	7.10b	6.00c	7.90b	6.40bc
F2	2.50a	3.70a	5.00bc	6.20b	8.30a	6.40b	9.30a	6.60b
F3	2.50a	3.70a	5.20b	6.40b	8.50a	6.60b	9.50a	6.80b
F4	2.50a	3.71a	5.80a	7.00a	9.20a	7.00a	10.10a	7.30a
SE±	0.12	0.12	0.45	0.45	0.75	0.38	0.76	0.42

W0	2.10d	3.30d	4.40d	5.60e	7.00d	5.70e	7.60e	5.90e
W1	2.10d	3.30d	4.60d	5.80d	7.10d	6.00d	8.00d	6.20d
W2	2.30c	3.50c	5.10c	6.30c	8.00c	6.30c	8.90c	6.60c
W3	2.60b	3.80b	5.40b	6.60b	8.50b	6.70b	9.60b	7.10b
W4	3.10a	4.30a	6.00a	7.20a	9.50a	7.30a	10.40a	7.60a
SE±	0.06	0.06	0.23	0.23	0.36	0.19	0.38	0.21
F x W	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effects of Farmyard manure and Integrated Weed Management on Number of branches plant^{-1} of Okra. Means followed by the same letter (s) in a column are not significantly different according to Duncans' Multiple Range Test at 5% level of probability.

	Leaf area plant^{-1} (cm^2)							
Source of variation	**4WAS**		**8WAS**		**12WAS**		**14WAS**	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**	**2011**	**2012**
F0	30.82b	40.94b	41.66c	51.61c	30.82b	40.94b	41.66c	51.61c
F1	31.68b	41.80ab	42.28bc	52.31b	31.68b	41.80ab	42.28bc	52.31b
F2	32.09ab	41.97a	42.69b	52.81a	32.09ab	41.97a	42.69b	52.81a
F3	32.52a	42.21a	43.00b	53.12a	32.52a	42.21a	43.00b	53.12a
F4	32.80a	42.92a	43.93a	53.29a	32.80a	42.92a	43.93a	53.29a
SE±	0.53	0.59	0.52	0.46	0.53	0.59	0.52	0.46
W0	29.97e	40.09d	41.88c	52.00c	29.97e	40.09d	41.88c	52.00c
W1	30.50d	40.62c	42.52b	52.60b	30.50d	40.62c	42.52b	52.60b
W2	31.21c	41.33b	42.63b	52.65b	31.21c	41.33b	42.63b	52.65b
W3	32.96b	42.41a	43.25a	53.28a	32.96b	42.41a	43.25a	53.28a
W4	35.28a	42.50a	43.28a	53.40a	35.28a	42.50a	43.28a	53.40a
SE±	0.27	0.30	0.26	0.23	0.27	0.30	0.26	0.23
F x W	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Effects of Farmyard manure and Integrated Weed Management on Leaf area plant^{-1} (cm^2) of Okra. Means followed by the same letter (s) in a column are not significantly different according to Duncans' Multiple Range Test at 5% level of probability.

Discussion

The results of the experiment showed that farmyard manure application significantly influenced the growth of okra. Application of farmyard manure improved growth attributes of okra [8]. The highest values were maintained by the application of 4-8 t ha^{-1} of farmyard manure, while growth characters were also considerably improved by the application of 2, 4 and 6 t ha^{-1} of farmyard manure [8]. This kind of positive influence of farmyard manure on okra dry matter production and partitioning had been reported by [8]. Akanbi WB, at al. also indicated that higher dry matter production at higher rates of farmyard manure favoured the development of plant growth parameters which culminated into the production of more fruits [9]. When nutrients were available in the suitable proportion or quantity the photosynthetic activity of okra were considerably favoured. This may have improved light interception, dry matter production, accumulation and partitioning [8,10].

Growth parameters were significantly influenced by the application of farmyard manure. The 8 t ha^{-1} of farmyard manure maintained the highest traits in the 2011 and 2012 cropping seasons. Though the traits obtained with application of 8 t ha^{-1} of farmyard manure were not significantly higher than 4 and 6 t ha^{-1}. Significant enhancement of growth traits of okra with farmyard manure application corroborates the report of [11]. This implied that adequacy for the supply of nutrients was necessary for optimum okra growth.

Weeding once at 2 + 4 + 6 and 8 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC significantly produced higher means of okra growth parameters than the other treatments. The control of no weeding + 0.0 kg a.i. ha^{-1} of pendimethalin 500 EC significantly produced lower means of growth parameters of okra. Anzalone A, et al. demonstrated that growth of weeds was drastically reduced with the application of mulches and herbicides [12]. Plant height, number of leaves plant^{-1}, number of branches plant^{-1} and leaf area plant^{-1} from the unweeded plots were significantly lower than weeded plots.

This reveals that weed interference beyond 4 WAS had an adverse effect on these parameters. The results also showed that keeping weeds beyond 4 WAS in okra plots caused a higher flower abortion. These led to reduction in growth and consequently lower traits. Okra has a certain range of tolerance to weed competition and length of period in which it is required to be weeding free [2,6,13]. It is a known fact that weed interference with okra has always led to growth reduction [2,6,13].

Conclusions

From the results, it was observed that the control treatment of no farmyard manure, significantly gave the lowest mean values of treatments, while application of 4 t ha^{-1} of farmyard manure significantly gave the highest mean values of treatments in all parameters measured. The control treatment of no weeding, significantly produced the lowest mean values while, weeding at 2 + 4 + 6 and 8 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC significantly gave higher mean values in all parameters studied. Therefore, application of 8 t ha^{-1} of farmyard manure and weeding at 2 + 4 + 6 and 8 WAS + 2.5 kg a.i. ha^{-1} of pendimethalin 500 EC was recommended for optimum okra growth in Dadinkowa, as well as integrated weed management in okro production in the study area.

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