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Period of Weed Control in Okra [*Abelmoschus esculentus* (L.) Moench] as Influenced by Varying Rates of Cattle Dung and Weeding Regimes

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Abstract

Field trials were conducted during 2005 and 2006 planting seasons to investigate the influence of cattle dung and the critical period of weed interference on growth and yield components of okra [*Abelmoschus esculentus* (L). Moench]. The study was a factorial trial laid out in a split plot design and replicated three times. The main plot comprised of four levels of cattle dung and the sub plots were three regimes of weeding. The growth attributes viz; plant height, number of leaves, leaf area and dry matter production differed significantly due to different treatments. These attributes increased significantly owing to the application of cattle dung which leads to continuous availability of nutrients to the plants as well as appropriate timing of weeding which reduced the influence of weed interference on the okra. Yield and yield components were influenced significantly by the application of cattle dung and weeding regimes. The highest fresh fruit yield (102.93 t ha^{-1}) was observed in plots that received 8 t ha^{-1}cattle dung and weeded at 3 and 6 weeks after sowing. Application of 8 t ha^{-1} of cattle dung as well as weeding at 3 and 6 weeks after sowing significantly enhanced okra growth and fruit yield. However, plots with sub-optimal cattle dung rate and infested with weeds until harvest produced the least dry matter and fresh fruit yield.

Keywords: cattle dung, weed interference, okra, growth, yield

Introduction

Okra [*Abelmoschus esculeentus* (L.) Moench] is a widely cultivated fruit vegetable found in almost every market in Nigeria (Akoroda *et al.,* 1985) and Africa (Schippers, 2000). It is usually grown on small farm holdings in mixtures with staple food crops such as yam, maize, cassava, cowpea and pepper or with various vegetable crops (Ayodele, 1983; Muoneke and Asiegbu, 1996; Olasotan, 2001; Odeleye, *et al.,* 2005).

Small holders in the tropics face the problem of maintaining productivity. In this respect, soil infertility is a major overriding constraints that affects all aspects of crop husbandry. The soils are poor in organic matter and available nutrients hence, productivity and sustainability decline over time. (Zingore *et al.,* 2003; Mbah, 2006). Decreasing soil fertility has also raised concerns about the sustainability of agricultural production at current levels. Future strategies for increasing agricultural productivity will have to focus on using available nutrient resources more efficiently, effectively than in the past. Livestock remains such as poultry manure and cattle dung are valuable resources, which may be useful as a supplement or replacement for inorganic fertilizers (Dyne and Gilbertson, 1978; Cecil *et al.,* 1997). In order to prevent the current global high price and short supply of mineral fertilizers and their deleterious effects on ecosystems, there is the need to develop a sustainable cropping system and soil fertility management through the supply of sufficient organic matter for optimum okra growth and yield.

Interestingly, crops and weeds have the same basic nutrient requirements (Foster, 1996). All plants require the same basic nutrients, but plants differ in the way they respond to nutrient availability (Blackshaw *et al.,* 2000). Making nutrient available to crops generally means making nutrients available to weeds (O'Donovan *et al.*, 2001). According to Liebman and Davis (2000) variation in crop and weed responses to soil fertility regimes indicate the need for a better understanding of interactions between management practices and species-specfic physiological and morphological characteristics. 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 interactions. In addition, the level of soil fertility determines the relative competitiveness between the crop and the weeds. At higher levels, or if an imbalance is favouring high levels of N, weeds like wild oat are generally more competitive than crops (SODRC, 2006). However, appropriate agronomic practices and management decisions can have a significant influence on the type and number of weeds interfering with crops. Understanding this relationship can help arable crop growers manage weeds through the avoidance of the critical period of weed competition with crops and various cultural management practices. The study presents optimum rates of cattle dung that would supply the adequate nutrient in a usable form at right time for healthy growth and optimal yield as well as an appropriate period during which weeds must be controlled to prevent unacceptable yield losses in okra.

Materials and methods

This study was conducted at the Teaching and Research Farm of the College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro, Ogun State, Nigeria. The study area lies at 7°12' N and 30°0' E longitude with an elevation of 250 m above sea level. It lies within the derived savannah agro-ecological zones in south western Nigeria. The soil of the experimental site is dominated by Ultisol. Generally, the monthly rainfall distribution pattern for Ayetoro is bimodal with peaks in June and September. Annual rainfall ranges from 1200 to 1450 mm spanning over eight months (March to October) with a dry spell in August.

The site had been under continuous cultivation for many years with corn, cassava, *Amaranthus cruentus, Celosia agentea, Corchorus olitorius, Solanium macrocarpon* and *Citrullus* spp. At land preparation, pre-planting soil samples were collected randomly per replication at a depth of 0-15cm for physical and chemical analysis. Samples were bulked to form a composite sample. The samples were air-dried, crushed and sieved through 2 and 0.5 mm meshes to determine pH (H_2O), total N, organic carbon percent (OC) available phosphorus (P), iron (Fe), copper (Cu) and zinc (Zn) also exchangeable cations following the methods of IITA (1982). Similarly, chemical and physical analysis of the cattle dung obtained from the cattle paddock in the College farm was carried out and the results are presented in Tab. 1.

Tab. 1. Pre-planting chemical and physical properties of soil and cattle dung used for the study

Property	Soil (mol kg^{-1})	Cattle dung*
pH (H_20)	5.08	1.80
OC (%)	0.81	18.00
Total Nitrogen (mg kg^{-1})	0.08	2.00
P (mg kg-1)	2.00	8.50
Exchangeable cations (cmol kg^{-1})		
K	1.78	7.00
Ca	0.48	8.24
Na	0.48	0.46
Mg	1.30	3.28
Micronutrients (mg kg^{-1})		
Cu	5.90	28.93
Mn	8.60	8.10
Fe	9.20	12.60
Zn	4.60	200.00
Silt	14.90	na
Clay	6.90	na
Sand	78.20	na
CEC	10.81	na

* Dry weight basis, na= Not available

The experimental design used was a split plot arrangement in a randomized complete block design with three replications. The main plots were four cattle dung levels (0, 4, 8 and 12 t ha^{-1}) based on previous study with poultry manure (Odeleye *et al.*, 2005) and the sub plots were three weeding regimes (weedy check, weeding at 3 and 5 weeks after sowing (WAS) and 3 and 6 WAS. Main and sub-plots area were 17.28 m^2 and 5.76 m^2 respectively. Three seeds of early maturing cultivars (NHAe47-4), were sown per stand at a spacing of 0.9 m x 0.4 m to obtain plant population of 125,000 plants ha^{-1}. Missing stands were supplied at one WAS, while seedlings were thinned to give the required plants per stand and population densities two WAS. Foliar and floral insects on the okra plants were controlled with regular sprays of 4.0 kg l^{-1} scent leaf (*Occimum gratisimum)* extract (Obadofin *et al.,* 2006). Weeding regimes were carried out on all the plots except the weedy check until six WAS.

Data collection

Data collection commenced at three WAS and was carried out fortnightly until 10 WAS. These sampling periods covered the active vegetative development, anthesis and physiological maturity in okra. Data were collected on growth parameters, yield parameter and dry matter components as described below.

Growth parameters

Two plants from the middle row were tagged to prevent border line effect from which data on growth attributes were obtained. The growth parameters taken per plant were height (cm), number of leaves produced and leaf area (cm^2).

Yield components

Matured fruits from the tagged plants were harvested every four days starting from 58 days after sowing. Number of fresh fruit/plant and weight (g) of fruits were taken.

Weed sample collection and biomass determination

Samples of weeds within 0.5 m^2 quadrant were collected, identified and classified based on floral morphology (broad or narrow) prior to weeding treatments. The interval between each sampling period was 1m and each plot was sampled four times once in each row. In order to determine the dry matter accumulation at each sampling period, weed samples were oven dried at 80°C for 48 hours.

Statistical analysis

Data on growth and yield parameters were subjected to analysis of variance (ANOVA) using a General Linear Model (GLM) of Statistical Analysis System (SAS Inst., 2000) the means were separated using Duncan Multiple Range Test (DMRT) at $P<0.05$.

Results and discussion

Growth parameters

The yield and yield components of okra were significantly ($p \leq 0.05$) affected by different weeding regimes and rates of cattle dung (Tab. 2). Okra plants on weedy check plots were significantly taller than those in other plots weeded at either 3 and 5 weeks or 3 and 6 weeks after sowing across all growth stages except at the maturity stage. The significantly taller okra plants on the weedy check could be as a result of competition with weeds for light as reported by Weiss (1983) and Ndarubu *et al.* (2003). Also, okra plant produced significantly more with broader leaves in the field weeded at the interval of 3 and 6 weeks after sowing throughout the growth stages compared to other weeding regime treatments. This implies that weed interference until 3 WAS did not have any adverse effect on the growth and yield components of okra. However, weed interference beyond the third week after sowing conferred deleterious effect on growth, yield and yield components of okra. This is probably because there was an unprecedented increase in weed density between the first period of weeding and the next thereby causing significant interference with okra growth and development. Similar findings have been reported by Alkamper (1976), Well and Cabredilla (1981), Abbaspour and Moghaddam (2004) and Adeosun (2005). This suggests that the critical period at which okra plant could tolerate weed competition falls within this range since most of the weeds encountered during the study were ephemeral (Tab. 4). Hence, the okra field needs to be kept weed free for the first two to three weeks and subsequently at six weeks after sowing in order to prevent yield loss due to weed competition. This agrees with the report of Scott *et al.* (1979) and Ayeni and Oyekan (1992) who reported that most crops have a certain range of tolerance to weed competition and length of period in which they are required to be weed-free. Also, the dry matter component of the okra plant was significantly higher in plots weeded at 3 and 6 WAS compared to the weedy checks (Tab. 2). This supposes that the manufactured photosynthates were partitioned into dry matter at this weeding regime perhaps because weed interference at this period had no adverse effect on the metabolic processes of this crop (Oworu, 1988; Gregory, 1989; Jörnsgård

Tab. 2. Influence of cattle dung and different weeding regimes on growth and dry matter yield of okra (*Abelmoschus esculentus* (L.) Moench)

Weeding regimes (WAS)		Plant height (cm) plant^{-1}	Number of leaves plant^{-1}	Leaf area plant^{-1} (cm^2)	Total dry matter yield plant^{-1} (g)
0		22.83b	1.00c	7.88b	1.00c
3 and 5		29.55a	4.00b	10.42a	6.33b
3 and 6		27.56a	8.00a	10.94a	18.37a
SE (±)		3.71	2.03	0.95	5.14
Rates of Cattle dung (t ha^{-1})					
0		18.52a	0.33b	9.12c	10.32c
4		21.27a	2.33ab	9.70b	33.80b
8		25.18a	4.00a	10.08a	60.20a
12		22.00a	5.33a	10.00a	66.70a
SE (±)		1.37	1.08	0.22	12.94
Interaction					
Cattle dung rate (tha^{-1})	Weeding regimes (WAS)				
0	0	0.00	0.00	0.00	0.00
	3 and 5	21.87	0.00	10.44	2.70
	3 and 6	24.67	2.33	11.40	6.20
4	0	0.00	0.00	0.00	0.00
	3 and 5	36.67	1.00	10.00	3.70
	3 and 6	27.13	0.67	10.51	3.60
8	0	13.07	0.33	8.18	1.50
	3 and 5	29.97	1.67	11.61	6.87
	3 and 6	32.50	2.00	10.46	7.87
12	0	10.00	0.33	6.55	0.01
	3 and 5	32.83	3.33	9.61	4.00
	3 and 6	23.17	1.67	11.38	14.37
Mean		21.74	1.11	9.75	4.24
SEM (±) (DF = 6)		3.28	0.31	0.45	1.20

Means followed by the same letter in a column are not significantly different at 5% level using Duncan's multiple range test (DMRT), WAS = weeks after sowing, SEM= standard error mean

Tab. 3. Influence of cattle dung and different weeding regimes on the fruits yield of okra (*Abelmoschus esculentus* (L.) Moench)

Treatments		Yield /plant		Fresh fruit yield (tha^{-1})
		Number of fruits	Fresh fruit weight (g)	
Weeding regimes (WAS)				
0		1.00b	2.55b	9.54b
3 and 5		6.00a	9.38a	35.19a
3 and 6		4.00a	11.83a	44.37a
Mean		3.67	7.92	29.70
SE (±)		1.45	2.78	14.74
Cattle dung rate (tha-^{1})				
0		0.67c	7.88b	29.55b
4		2.33ab	8.42b	31.59b
8		5.00a	13.62a	51.09a
12		3.67b	11.92a	44.70b
Mean		2.92	10.46	39.23
SE (±)		0.93	1.38	10.37
Interaction				
Cattle dung rate (kha^{-1})	Weeding regimes (WAS)			
0	0	0.00	0.00	0.00
	3 and 5	1.00	11.33	42.48
	3 and 6	2.00	15.68	58.80
4	0	0.85	2.02	7.59
	3 and 5	1.33	12.30	46.14
	3 and 6	1.67	23.52	88.20
8	0	0.33	1.73	6.48
	3 and 5	1.00	13.80	51.75
	3 and 6	2.33	27.45	102.93
12	0	1.00	2.01	7.89
	3 and 5	2.33	20.13	75.48
	3 and 6	1.33	13.43	50.28
Mean		1.29	12.75	47.83
SEM (±) (DF = 6)		0.20	2.41	31.28

Means followed by the same letter in a column are not significantly different at 5% level using Duncan's multiple range test (DMRT). WAS = weeks after sowing, SEM= standard error mean

Tab. 4. Pre dominant weeds identified during in the study area

S/no.	Broad leaves	Families	Grasses	Families	Sedges	Families
1.	*Euphorbia heterophylla* (L.)	*Euphorbiaceae*	*Acroceras zizanoideae*	*Poaceae*	*Cyperus difformis*(L.)	*Cyperaceae*
2.	*Euphorbia hirta* (L.)	*Euphorbiaceae*	*Eragrotis tenella* (Lin.) P. beauv. Ex Roem and chult.	*Poaceae*	*Cyperus iria* (L.)	*Cyperaceae*
3.	*Phyllantus amarus* Schum and Thonn	*Euphorbiaceae*	*Eleusine indica (L.)* Gaertn.	*Poaceae*	*Kyllinga squamulata (*Thorn.*)*	*Cyperaceae*
4.	*Portulaca olereaceae*(L.)	*Portulacaceae*	*Panicum maximum* (Jacq)	*Poaceae*		
5.	*Talinum triangulare* (Jacq.) Willd	*Portulacaceae*	*Seteria babata* (Lam) Knuth	*Poaceae*	*Cyperus happen* (L.)	*Cyperaceae*
6.	*Tridax procumbens* (L.)	*Asteraceae*	*Cynodon dactylon* (L.) Pers.	*Poaceae*		
7.	*Ageratum conyzoidea* (L.)	*Asteraceae*				
8.	*Synedrella nodiflora* Garetn.	*Asteraceae*				
9.	*Boerhvia diffusa* (L.)	*Nyctaginaceae*				
10.	*Amaranthus spinosus* (L.)	*Amaranthaceae*				
11.	*Commelina bengahalensis* (L.)	*Commelinaceae*				

et al., 1996). Several researchers have indicated that the end of CPWC was not stable but was highly dependent on the density, competitiveness, and emergence periodicity of the weed population (Evans *et al*., 2003; Norsworthy and Oliveira, 2004).

Growth and yield parameters of okra were significantly influenced by application of cattle dung. Application of 4 t ha^{-1} cattle dung enhanced stem elongation during vegetative and reproductive growth stages but the rate of stem elongation increased at a decreasing rate there after until maturity. This suggests that the application of a suboptimal nutrient level would be inadequate to sustain okra plant up to maturity. Application of 8 t ha^{1} cattle dung appeared to be optimum for the production of okra. This is evidenced from the results obtained for growth attributes and dry matter accumulation of okra (Tab. 2). This rate is in consonance with the recommendations of Agboola and Unamma (1984), Yayock *et al.* (1998). Ib'libner (1989) affirmed that okra requires large amount of nutrients (nitrogen) over a short period of time hence, slow availability of nitrogen is desirable. Increase in rate of cattle dung application beyond 8 t ha^{-1} tends to encourage dry matter production as observed when 12 t ha^{-1} of cattle dung was applied. This could be as result of the availability of an abundant nutrient supply which tends to accentuate dry matter accumulation in lieu of partitioning the assimilates into economic yield in the form of fruit. This finding agrees with the report of Akanbi (2002).

Fruit yield

The least fruit yield was recorded on weed-infested plots until harvest without cattle dung (Tab. 3). Application of 8 t ha^{-1} cattle dung and weeding at 3 and 6 WAS significantly increased the fruit yield of okra. This suggests that most of the assimilates were partitioned into economic yield principally because weed interference at this weeding regime and cattle dung rate did not confer any adverse effect on the source and sink metabolic process of the crop. This could be attributed to adequate canopy formation, which made it easy for the crop to intercept solar radiation better than the weeds, hence, making the weed interference less effective on the fruit yield of the crop. Oworu (1988) and O'Donovan *et al.* (1997) have also reported similar findings.

Interactive effect of weeding regimes and cattle dung rate showed that weeding of okra at 3 and 6 weeks after sowing and application of 8 t ha^{-1} cattle dung would be beneficial to okra production in term of fruit yield. At this rate and weed removal, the nutrient released tends to coincide with the exponential growth phase when nutrients released are utilized and converted to economic yield as against biological yield (Tab. 3). The least growth attributes and dry matter accumulation were observed in infested plots until harvest without the application of cattle dung. This revealed that efficient uptake and utilization of applied nutrient for okra growth, development and yield is dependent on appropriate timing of weed removal and rate of the applied nutrients. This is similar to the reports of Liebman and Davis (2000) and Adeosun (2005).

Conclusions

This study proposes the application of 8 t ha^{-1} cattle dung and weeding at 3 and 6 weeks after sowing as adequate for optimum growth, development and fruit yield of okra in savannah agro-ecology. This would be beneficial to the resources of poor small farm holders who dominated the farming enterprise in developing economies of the world (Balasubramanian *et al.,* 2007). In addition, technologies that advanced the weeding of crops at the critical weed competition period rather than haphazard weeding should be advocated among the small farm holders in order to reduce the financial burden of the cost of labour or yield loss due to untimely weeding.

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