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Growth and Yield Response of Okra Intercropped with Live Mulches

H.A. Akintoye, A.G. Adebayo and O.O. Aina
National Horticultural Research Institute, P.M.B. 5432, Ibadan, Nigeria

Corresponding Author: H.A. Akintoye, National Horticultural Research Institute, P.M.B.5432, Ibadan, Nigeria

ABSTRACT

The objective of the study was to compare the yield of okra grown under different weed management strategies. Field experiments were carried out in 2007 and 2008 cropping season at National Horticultural Research Institute, Ibadan, Nigeria. The experimental design was a split plot factorial fitted into a Randomized Complete Block Design (RCBD) with three replications. Okra was grown on plots with cucumber, melon and pumpkin (as live mulches), herbicide, hand weeding and control, under three nitrogen regimes. Results indicated that melon treatment produced the highest fruit yield (418.86 g) in 2007 while cucumber yield was highest (275.02 g) in 2008. There were significant differences in weed density among live mulches. Lower values were observed in okra grown with pumpkin. Pumpkin as a cover crop significantly controlled weed in both years but results in fruit yield reduction of okra.

Key words: Growth attributes, cover crops, nitrogen levels, weed management, vegetable production

INTRODUCTION

Okra (*Abelmosschus esculentus* L. Moench) belongs to the family Malvaceae. It is one of the prominent vegetable, crops grown in Nigeria and it is widely cultivated in the tropics. Okra is important because of its nutritive values that are present in the leaves and fruits (Schippers, 2000). Despite the nutritive values of okra, its production is very low in most developing countries. Most farmers in developing countries depend mainly on natural fertility of the soil and in addition, invest considerable labour in land preparation and weed control, so as to achieve a reasonable yield of the crop.

The cropping system among small scale farmers in developing countries is the practice of growing two or more crops at the same time during the same season on the same piece of land. Crop rotation and changes in type of cultivation, which serves as soil conservation measures, are considered to be inadequate in increasing crop production to meet food demand. Furthermore, traditional system of shifting cultivation is no more sustainable with increasing population and competition for limited land in developing countries (Taiwo *et al.*, 2007). The use of cover crops in vegetable production under favorable water and nutrient condition can increase yield by the modification of soil temperatures, soil evaporation and stimulation of soil fauna and formation of biospores.

Cover crop can improve soil fertility and reduce weed problem. It will also provide a source of nitrogen for subsequent crop (People *et al.*, 1995) reduce erosion (Flach, 1990) reduce run-off and contamination of soil water (Hoyt *et al.*, 1994) utilize soil nitrogen that might otherwise be lost to leaching (Stivers and Shennan, 1989), improve soil physical properties (Barber and Navarro, 1994), suppress nematodes population (Crow *et al.*, 1996) and reduce cost of weed management (Nancy *et al.*, 1996). Nitrogen is perhaps the most important limiting factor in vegetable production in Nigeria, because of the inherent low organic matter and the supply of N through chemical fertilizer is becoming increasingly important. Apparent N fertilization practices that maintain or increase production levels and simultaneously decrease ground water pollution potentials should be encouraged, since excessive application of fertilizers can result in high soil nitrate levels after crop harvest (Gordon *et al.*, 1993). Thus, increase the contamination of portable water, because nitrates remaining in the soil profile may leach to ground water.

The importance of soil nutrients and cover crop in improving vegetative growth and fruit yield of vegetable crops has not been well documented as alternative production system in Nigeria (Akintoye, 2003). Studies in the developed countries have shown the possibility of using cover crops as alternative weed management systems, but not all reported their effect on the primary crop (Barnes and Putnam, 1983; Bordelon and Weller, 1997). Their observation has generated interest in exploring the benefit of utilization of cover crop as a farming system in tropical climates.

Earlier studies (Adeoye and Onifade, 1999; Ikeorgu, 1999) demonstrated the use of different cover crops in various parts of Nigeria in recent past. Also Akintoye (2003) observed that the use of melon as live mulch resulted in higher fruit yield of sweet pepper. This study was carried out to investigate the suitability of cucurbit family (cucumber, melon and pumpkin) as cover crop in okra production.

MATERIALS AND METHODS

Field experiments were conducted at National Horticultural Research Institute (NIHORT) (7°25"N and 3°52"E), Ibadan, Nigeria, on a sandy loam soil in the 2007 and 2008 cropping season. The physical and chemical analysis of the soil collected between 0-15 cm soil depths indicated that the soil is 879 mg g^{-1} sand, 85 mg g^{-1} silt and 39 mg g^{-1} clay. The pH was 4.5, 4.4 mg g^{-1} C, 0.4 mg g^{-1} N, 3.20 mg kg^{-1} available P, 1.71 cmol kg^{-1} Ca, 0.76 cmol kg^{-1} Mg, 0.51 cmol kg^{-1} K, 18.1 mg kg^{-1} Mn, 1.45 mg kg^{-1} Zn and 6.90 mg kg^{-1} in 2007 and in 2008 prior to planting, the soil contained 6.1 mg g^{-1} C, 0.9 mg g^{-1} total N, pH of 7.3, 43.8 mg kg^{-1} of available P, the exchangeable Na, K, Mg and Ca respectively were 0.21, 0.24, 0.74 and 0.75 cmol kg^{-1} soil. The climatic conditions of the experimental site are shown in Table 1.

The experimental design was a split plot factorial fitted into a Randomized Complete Block Design (RCBD) with three replications. The treatment consisted of three Nitrogen (N) levels

Table 1: Climatic conditions of the experimental site

Year	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2007												
Total rainfall (mm)	0	0	17	69	237	223	255	139	286	245	132	3
Evaporation (mm)	5.6	6	6.3	6.1	5.2	5.3	4	4	4.3	5	4.1	4.7
Max Temp. (°C)	36	37	40	35	33	31	30	29	31	32	33	34
Air Temp. (°C)	25	29	29	29	28	26	25	25	26	27	27	27
Relative Humidity (%)	71	88	86	89	90	91	91	92	91	91	91	87
2008												
Total Rainfall (mm)	0	20	89	182	234	373	250	221	402	275	27	27
Evaporation (mm)	5.6	6.7	5.7	5.7	5.3	4.8	4.6	3.9	5.9	5.2	4.9	4.4
Max Temp. (°C)	33	37	34	33	31	30	28	28	29	32	34	33
Air Temp. (°C)	25	27	28	29	28	27	26	25	26	27	27	27
Relative Humidity (%)	77	81	68	89	89	89	90	90	90	88	88	87

(0, 40 and 80 kg ha^{-1}) sourced from Urea fertilizer (46% N) as the main plots while live mulches (cucumber, melon, pumpkin), hand weeding and herbicide served as the sub-plots. Okra variety (LD 88) obtained from NIHORT was planted at spacing of 50×50 cm. The live mulches were planted simultaneously with okra at spacing of 1 m apart.

Plots size was 2×3 m (6 m^2). Visual identification of weed was carried out 3 and 6 Weeks after Planting (WAP) and *Amarathus spinosus, Chromonella odorata, Tridax procumbens, Chocorus olitorus, Mucuna mucunoides, Momordica charantia, Cyperus esculentus* and *Melanthera scandens* were the major weed species identified on the experimental plots. After this an area of 1 m^2 was measured out at the centre of each plot with the use of a quadrant (1 m^2) and weed within the quadrant per plot were harvested, enveloped, oven dried at 75°C for 48 h and the weight were taken to determine the effectiveness of different live mulches in controlling weeds. Data on vegetative development were taken at 3WAP, 5WAP and at anthesis. Fruits were harvested nine days after flowering and subsequently at four days interval, the fresh weight of the fruits were recorded as the marketable fruit weight. Dry matter accumulation was taken at final harvest. All data collected were analyzed using analysis of variance procedure (SAS Institute, 1999). The means were separated at 5% probability (SE = 0.05).

RESULTS

Effect of nitrogen: Differences occurred among N levels for growth attributes (number of leaves, plant height and stem girth). The results on Table 2 illustrated that plant height, number of leaves and stem girth increased by the application of N up to 40 kg N ha^{-1}, at both years of study. Control plots gave lower values than the treated ones.

Weed biomass decreased with increase N fertilizer application. The Nitrogen application influenced weed growth; plots with 0 kg N ha^{-1} significantly recorded the highest weed biomass (Table 3). Results indicated that dry matter yield increased significantly by the application of N. The highest dry matter yield was obtained at 40 kg N ha^{-1} at both years of study (Table 4). Fruit yield increased significantly with increase in N application. The highest yields were obtained at 80 kg N ha^{-1}.

Effect of live mulch: Differences occurred among cover crops used for the experiment for all the growth parameters. Live mulches significantly affected the number of leaves; plant height and stem girth okra planted with herbicids significantly affected the number of leaves, plant height and stem girth (Table 5).

Table 2: Effect of nitrogen rates on growth attributes of okra grown in Ibadan, southwestern Nigeria

Nitrogen rate (kg ha^{-1})	No. of leaves	Plant height (cm)	Stem girth (cm)
2007			
0	11.78	49.46	4.00
40	12.44	53.78	4.07
80	13.11	33.51	4.91
SE(0.05)	0.67	1.47	0.17
2008			
0	8.97	45.21	4.19
40	9.67	47.01	3.97
80	9.78	45.68	3.92
SE(0.05)	0.38	3.90	0.18

Table 3: Effect of nitrogen rates on weed biomass of okra grown in Ibadan south western Nigeria

	Weed density (g plot^{-1})			
	2007		2008	
Nitrogen rate (kg ha^{-1})	3 WAP	6 WAP	3 WAP	6 WAP
0	179.20	205.66	177.47	183.96
40	142.75	115.90	140.12	117.02
80	153.27	93.48	153.82	95.84
SE (0.05)	6.31	6.27	3.13	2.10

Table 4: Effect of nitrogen rates on dry matter and fruit yield of okra grown in Ibadan south western Nigeria

	Dry matter yield (g plot^{-1})			
Nitrogen rate (kg ha^{-1})	Stem	Leave	Root	Fruit yield (g plot^{-1})
2007				
0	68.52	4.34	2.50	165.38
40	87.56	6.02	3.60	305.35
80	75.17	4.57	3.88	388.10
SE (0.05)	7.63	0.26	0.10	11.66
2008				
0	49.37	3.82	1.24	112.44
40	89.79	5.22	1.82	276.63
80	52.73	3.73	1.99	385.67
SE (0.05)	1.59	0.13	0.05	3.13

Table 5: Effect of live mulch on growth attributes of okra grown in Ibadan, south western Nigeria

Live mulches	No. of leaves	Plant height (cm)	Stem girth (cm)
2007			
Control	110.77	36.10	3.61
Hand weeding	17.20	69.21	5.42
Cucumber	15.11	57.14	5.10
Melon	14.00	60.59	4.66
Pumpkin	8.22	35.04	3.88
Herbicide	14.31	99.14	4.06
SE (0.05)	0.60	2.16	0.17
Contrast		Probability > F	
Cucumber vs. control	0.16	0.05*	0.05*
Melon vs. control	0.05*	0.01**	0.01**
Pumpkin vs. control	0.05*	0.02*	0.01**
Hand weeding vs. control	0.05*	0.01**	0.01**
Herbicide vs. control	0.09	0.05*	0.05*
Live mulch vs. control	0.08	0.05*	0.05*
2008			
Control	7.98	40.31	3.65
Hand weeding	14.21	53.62	4.65
Cucumber	9.034	4.67	3.66
Melon	10.03	44.79	4.20
Pumpkin	10.50	48.44	4.22
Herbicide	9.514	8.44	4.10
SE (0.05)	0.54	3.14	0.18

Table 5: Continued

Live mulches	No. of leaves	Plant height (cm)	Stem girth (cm)
Contrast		Probability > F	
Cucumber vs. control	0.14	0.05*	0.06
Melon vs. control	0.09	0.05*	0.01**
Pumpkin vs. control	0.05*	0.04*	0.05*
Hand weeding vs. control	0.01**	0.01**	0.01**
Herbicide vs. control	0.05*	0.05*	0.05*
Live mulch vs. control	0.05*	0.05*	0.05*

*=0.05, ** = 0.01

Table 6: Effect of live mulch on dry matter accumulation and yield of okra grown in Ibadan, south western Nigeria

	Stem	Leaves	Root	
Live mulches	------------------------------------($g\ plot^{-1}$)------------------------------------			Fruit yield ($g\ plot^{-1}$)
2007				
Control	43.16	3.12	2.16	110.76
Hand weeding	119.36	7.24	3.69	412.16
Cucumber	98.30	6.64	3.37	363.46
Melon	92.00	45.58	3.85	418.86
Pumpkin	40.92	2.71	2.758	6.52
Herbicide	66.12	3.94	3.122	62.17
SE (0.05)	7.76	0.26	0.10	11.66
Contrast		Probability > F		
Cucumber vs. control	0.05*	0.01**	0.05*	0.01**
Melon vs. control	0.05*	0.01**	0.01**	0.01**
Pumpkin vs. control	0.56	0.35	0.045	0.01**
Hand weeding vs. control	0.01**	0.01**	0.01**	0.01**
Herbicide vs. control	0.05*	0.05*	0.05*	0.01**
Live mulch vs. control	0.05*	0.05*	0.05*	0.01**
2008				
Control	46.12	3.62	1.72	132.16
Hand weeding	79.21	5.97	2.113	40.12
Cucumber	60.38	6.00	1.61	275.02
Melon	82.31	4.87	1.91	193.23
Pumpkin	49.20	1.91	1.53	106.49
Herbicide	53.78	4.81	1.69	207.51
SE (0.05)	1.59	0.13	0.05	10.82
Contrast		Probability > F		
Cucumber vs. control	0.14	0.05*	0.06	0.01**
Melon vs. control	0.09	0.11	0.01**	0.01**
Pumpkin vs. control	0.07	0.04*	0.05*	0.01**
Hand weeding vs. control	0.01**	0.01**	0.01**	0.01**
Herbicide vs. control	0.05*	0.05*	0.05*	0.01**
Live mulch vs. control	0.05*	0.05*	0.05*	0.01**

* = 0.05, ** = 0.01

Okra intercropped with cucumber had higher values among the growth attributes at both years of study, while pumpkin gave lower values. Similar trends were observed for dry matter accumulations (Table 6). However, hand weeded treatment had higher number of fruits and higher dry matter accumulation in both years of study. Highest fruit yield was observed with okra intercropped with melon in 2007 and cucumber in 2008. Pumpkin had the lowest fruit yield in both

Table 7: Effect of live mulches on weed density of okra grown in south western Nigeria

	Weed density (g $plot^{-1}$)			
	2007		2008	
Live mulches	3 WAP	6 WAP	3 WAP	6 WAP
Control	210.70	297.20	197.30	210.68
Hand weeding	167.12	173.08	169.30	162.10
Cucumber	208.44	189.80	202.08	188.04
Melon	177.95	194.078	197.47	158.98
Pumpkin	87.92	30.47	71.86	49.80
Herbicide	128.17	102.10	98.26	104.80
SE (0.05)	7.76	6.26	5.101	1.66
Contrast		Probability > F		
Cucumber vs. control	0.06	0.01**	0.05*	0.01**
Melon vs. control	0.05*	0.01**	0.01**	0.01**
Pumpkin vs. control	0.01**	0.01**	0.01**	0.01**
Hand weeding vs. control	0.01**	0.01**	0.01**	0.01**
Herbicide vs. control	0.05*	0.05*	0.05*	0.01**
Live mulch vs. control	0.05*	0.05*	0.05*	0.01**

* = 0.05, ** = 0.01

years. The trend in fruits yield was melon>cucumber>pumpkin in 2007 and cucumber>melon>pumpkin in 2008. Live mulch also significantly affected the dry matter partitioning into leaves, roots and stem (Table 6).

There were significant differences in weed density among live mulches. Lower values were observed in okra grown with pumpkin. Weed density of okra grown with pumpkin reduced significantly ($p = 0.01$) from 3 WAP to 6 WAP, this indicated that though pumpkin competes negatively with fruit yield of okra; it was able to suppress weed growth significantly (Table 7).

DISCUSSION

Many farmers in Nigeria are confronted with problems of weeds, soil degradation, soil erosion and crop failure during drought. Pressure on land as a result of population growth has made traditional bush fallow system no longer effective in combating these problems. These have given rise to research into the use of cover crop as a viable alternative to weed and soil protection problem. In addition to improving soil condition, live mulches also play major role in reducing cost of weed management (Nancy *et al*., 1996). Weed control is an expensive, time consuming operation as most farmers practice hand hoeing which in most cases is ineffective due to frequency of weeding required by most crops (Akintoye, 2003). Where herbicides are used, their inappropriate application often leads to phytotoxicity and environmental hazards.

Results from this study indicated differences in the ability of live mulches in controlling weeds. The introduction of pumpkin even though resulted in low fruit yield of okra, significantly reduced weed problem in okra production. This could be due to its ability to grow more vigorously than the main crop and other live mulches thus able to compete with weeds and unfortunately, the main crop, for available space, light and nutrients. Thick cover crop according to Teasdale (1993) are able to compete well with weeds during their growth cycle because they can prevent germinated weed seeds from completing their life cycle and reproducing. Even when weed seeds germinates, they often run out of stored energy for growth before building the necessary structural capacity to break through the cover crop live mulch layer. This according to Kobayashi *et al.* (2003) is known as cover crop smother effect.

Nitrogen application improved the vegetative growth of okra and cover crop and this enhanced their ability to smother weed. Plots with 80 kg N ha^{-1} had the lowest weed biomass; this might be due to the improved vegetative development and ground cover that resulted from nitrogen application. Anjum and Amjad (1999) and Omotosho and Shittu (2007) also reported that increasing levels of mineral fertilizers was observed to increase growth and yield of okra also differences were observed in dry matter accumulation and fruits yield of okra when intercropped with live mulches. Okra intercropped with cucumber and melon produced higher fruit weight than those of other live mulches. This observation was in line with the findings of Akintoye (2003) who also reported higher yield of sweet pepper grown with melon as live mulch. Bhadauria and Kumar (2006) reported more yield with mulched plants than those without plants and this they adduce to the cumulative effect of increased pod length and number of pod per plant. This study identified cucumber and melon as better live mulches for okra production, having produced higher fruit yield.

CONCLUSION AND RECOMMENDATION

The use of live mulch in vegetable production should be viewed as a sustainable production system that will bring about increase in yield of okra. However further studies are required in economics of production, time of introduction and populations of these live mulches in okra intercrop so as to increase the fruit yield.

REFERENCES

Adeoye, K.B. and O.S. Onifade, 1999. Cover crops adoption and forage seed production in Nigeria; Report for the subhumid zone cover crops for natural resource management in West Africa. Proceedings of the Workshop Organized by IITA and CIEPCA, Oct. 20-29, Cotonou, Benin, pp: 290-292.

Akintoye, H.A., 2003. Effects of cover crops on the fruit yield of sweet pepper in southwestern, Nigeria. Proceedings of the 21st Annual Conference of Horticultural Society of Nigeria, Nov. 10-13, School of Agriculture, Lagos State Polytechnic, Ikorodu, pp: 18-20.

Anjum, M.A. and M. Amjad, 1999. Response of okra (*Abelmoschus esculentus* L. Moench) to different levels of N, P and K fertilizers. Pak. J. Biol. Sci., 2: 794-796.

Barber R.G. and F. Navarro, 1994. The rehabilitation of degraded soils in Eastern Bolivia by subsoil and incorporation of cover crops. Hort Sci., 5: 247-259.

Barnes, J.P. and A.R. Putnam, 1983. Rye residues contribute weed suppression in no-tillage cropping system. J. Chem. Ecol., 9: 1045-1057.

Bhadauria, H.S. and V. Kumar, 2006. Effect of mulching on growth and productivity of Okra (*Abelmoschus esculentus* L.) moench under saline irrigation condition. Am. J. Plant Physiol., 1: 214-216.

Bordelon, R.P. and S.C. Weller, 1997. Preplant cover crops affect weed and growth in first year vineyard. Hort Sci., 32: 1040-1043.

Crow, W.T., E.A. Gnertal, E.A. Rodriguez and R. Kabana, 1996. Response of *Meloidogyne arenaria* and *M. incognita* to given manures and supplemental area in glass house culture. J. Nematol., 28: 648-654.

Flach, K.W., 1990. Low input agriculture and soil conservation. J. Soil Conservation, 45: 42-44.

Gordon, W.B., D.A. Whitney and R.J. Raney, 1993. Nitrogen management in furrow irrigated ridge-tilled corn. J. Prod. Agric., 6: 213-217.

Hoyt, G.D., D.W. Monks and T.J. Monaco, 1994. Conservation tillage for vegetable production. Hort Technol., 4: 129-135.

Ikeorgu, J.E.G., 1999. Cover crop for Natural Resource Management in West Africa. Proceedings of the Workshop Organized by IITA and CIEPCA, Oct. 20-29, Cotonou, Benin, pp: 290-292.

Kobayashi, Y., M. Ito and K. Suwanarak, 2003. Evaluation of smothering effect of four legume covers on *Pennisetum polystachion* sp. setosum (Swartz) Brunken. Weed Biol. Manage., 3: 222-227.

Nancy, G.C., M.A. Bennett, B.R. Stinner, J. Cardina and E.E. Regnier, 1996. Mechanism of weed suppression in cover crop-based production systems. HortScience, 31: 410-413.

Omotosho, S.O. and O.S. Shittu, 2007. Effect of NPK fertilizer rates and method of application on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) at Ado-Ekiti Southwestern, Nigeria. Int. J. Agric. Res., 2: 614-619.

People, M.B., D.E. Heridge and J.K. Ladha, 1995. Biological nitrogen fixation and efficient source of nitrogen for sustainable agricultural production. Plant Soil, 174: 3-28.

SAS Institute, 1999. SAS/STAT User's Guide. Version 7, 4th Edn., SAS Institute. Cary, N.C.

Schippers, R.R., 2000. African Indigenous Vegetables. An Overview of the Cultivated Species. Natural Resources Institute/ACP-EU Technical Centre for the Agricultural and Rural Cooperation, Charham, UK., Wagenigen, The Netherlands.

Stivers, L.J. and C. Shennan, 1989. Winter Cover Cropping in Processing Tomato Production. Am. Soc. Agron. Crop Sci. Soc. Madison, Wis., pp: 254.

Taiwo, L.B., J.A. Adediran and O.A. Sonubi, 2007. Yield and quality of tomato grown with organic and synthetic fertilizers. Int. J. Vegetable Sci., 13: 5-19.

Teasdale, J.K., 1993. Interaction of light, soil moisture and temperature with weed suppression by hairy vetch residue. Weed Sci., 41: 46-51.