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EFFECT OF PLANTING SEQUENCE ON THE PERFORMANCE OF OKRA (*Abelmuoscus esculentus* L. Moench) AND TOMATO (*Solanum lycorpersicum*) MIXTURE

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ABSTRACT

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Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology Minna, Gidan Kwanu Campus. The experiment was to determine the effect planting sequence on the performance of okro and Tomato mixture. The treatment consisted sole okro and Tomato, transplanting tomato seedlings two weeks before tomato seedlings were transplanted, sowing of okro seeds and transplanting of tomato at the same time, okro (Clemson spineless) and tomato(Roman VF) were used as treatments. Data collected include plant height, number of leaves, number of branches, leaf area, days to 50% flowering, number of fruits, fresh fruit weight, fruit length, fruit girth and fruit yield. The result showed that highest plant height was observed where okro was intercropped with tomato while the least plant height was recorded where okro was planted as sole crop. The fresh fruit weight, fruit length and fruit yield of tomato was significantly higher for sole tomato compared to intercropped sequence. However, yield from inter cropped okro was statistically affected, even though sole okro had a relatively higher fruit yield. Inter cropping okro two weeks after sowing tomato/okro and two weeks after sowing okro/tomato gave land equivalent ratio (LER) values of 1.53 and 1.55 respectively. This result showed that higher productivity per unit area could be achieved by growing them as sole crop.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench] is vegetable crop widely eaten in Africa. It is an annual plant that is fast growing. It is the most important vegetable crop (fruit) and a source of energy for human utilization. Okra position first before other fruit vegetable crops (Babatunde *et al.,* 2007). Production of Okra is widely spread across the tropics (Udoh *et al.,* 2005). Okra cultivation has been widely practiced and can be found in almost every country in Africa. Eke *et al.* (2008); Udoh *et al.,* (2005); Mbah, Nottindge and Kele (2009) reported that in human diet fresh okra fruit is a good source of plant proteins, vitamins and minerals. Okra young fruits are boiled as vegetable and are used as a soup thickener (Kahlon *et al.,* 2007); Saifullah and Rabbani, 2009). Utilization of immature okra pods is important as it is in that stage most of the nutrients content are present in high amount and it can be consumed in diverse forms (Ndunguru and Rajabu, 2004). Fresh young immatured okro fruit can be eaten fresh, boiled or cooked (Akintoye *et al.,* 2011).

Tomato (*Solanum lycopersicum*) is a member of fruit vegetable crop positioned the second most important fruit crop (FAO, 2009). Tomato is an herbaceous and annual plant frequently and widely grown in many northern states of Nigeria where irrigation facilities are available. Tomatoes are grown in small holdings especially in the southern states of Nigeria and sometimes intercropped by the local farmers. This is because, heavy rainfall, fungal and bacterial diseases limit the production of tomatoes in a large scale. Tomato consumption is believed to benefit the heart among other things. Medically, tomato contains lycopene (natural anti-oxidant) which has been found to prevent prostate cancer by nullifying cancer causing free radicules (Durrant, 2008). Tomato fruit can be use as raw material in canning industries (tomato puree). They are also used for preparation of tomato sauces and tomato juice (Anyanwu *et al.,* 2003).

Generally the important of vegetables cannot be over emphasized, they contain valuable food ingredients, which can be successfully utilized to build up and repair the body (Bakhru, 2003; Edet and Etim, 2007). The growth and yield response of vegetable crops especially tomato and okra has been reported to be greater under mono cropping compared to mixed cropping but the practice often associated with a succession of serious setback among which are too much use of resources (water, nutrient, soil, vegetation) with the possibility of creating contamination caused by pesticide and fertilizer application which threatens the earth by destruction of natural ecosystem (Reganold, 1992). There are few documents on the effect of intercrop tomato and okra as well as assessing the yield advantages of the system. In recent times, there has been an increasing facts that the use of poor cultural practices in intercropping particularly the practice of sowing date, crop density in addition to conventional cultivars are the major yield limiting factors (Abdalbagi *et al.,* 2010). Crop failure under adverse environmental conditions can be minimize under intercropping and also gives a higher total return per unit area of land (Ijoyah and Jimba, 2011). In intercropping, there are some socio-economic, biological and ecological advantages compared to monocropping (Maluleke *et al.,* 2005). Tsubo *et al.* (2005), observed that the productivity of crops in multiple cropping systems (Intercropping) depend on several factors, including planting date, planting density,

cultivated varieties, soil management and agriculture practices (fertilization, irrigation, etc). Hussain (2003) observed intercropped of tomato and okra gave the highest land equivalent ratio (LER). The maximum LER value was in tomato intercrop with egg plant.

MATERIALS AND METHODS

Field experiment was conducted at the Teaching and Research Farm of crop production Department of Federal University of Technology Minna, Gidan kwanu campus located at latitude 6^0 33 E and longitude 9^0 37 N in the southern Guinea Savannah Zone of Nigeria. The average rainfall ranges between 750mm to 1250mm. Okro cultivars (Clemson spineless and tomato cultivar (Roma VF) were used. Tomato seedlings were raised in perforated plastic rubber containing soil (sandy loam) in the nursery for five weeks before being transplanted onto the experimental field. The seedlings were shaded against direct impact of solar radiation, wind and heavy rainfall by providing shade while the plastic rubbers were kept weed free and watered daily. Vigorous and health seedlings were selected and transplanted onto the field and spaced at 50cm within the rows and 75cm between the rows. Hoe weeding was carried out every two weeks after planting. Tomato plants were staked using wooden poles to support the young plants. Data collected include plant height, number of leaves, number of days to 50% flowering, leaf area, fruit size, number of fruits, fresh fruit weight, and fruit yield. The collected were subjected of analysis of variance (ANOVA) using SAS (2002) statistical package and means were separated by Ducan Multiple Range Test (DMRT) at 5% level probability.

RESULTS

Plant height of Tomato in Tomato/Okra mixtures: The result (Table 1) showed that plant height of tomato increases with the age of the crop up to 8WAT. The highest plant height of tomato was observed where tomato and okro were planted on the same day. The lowest plant height of tomato was recorded in plots where okro was intercropped with tomato after two weeks of transplanting. There was no statistical difference in plant height of sole tomato and intercropped tomato at 2WAT, 4WAT, 6WAT and 8WAS. Plant height of okra in tomato/okra mixtures: The plant between sole okro and intercropped at 2WAS, 6WAS, and 8WAS differed significantly (Table 2). However, there was no significant difference in plant height among the treatments at four weeks after transplanting. The highest okro plant height was recorded at 8WAS in plots where okro and tomato where planted at the same time while the lowest plan height was observed at 2WAS and 8WAS where okro was planted in tomato plots after two weeks of transplanting tomato. The result revealed that the highest number of leaves of tomato was recorded at 8WAT when tomato was transplanted as sole crop (Table 3). There was significant difference in the number of leaves at 2 and 8 WAS (Table 4). Highest number of leaves was recorded at 8WAS when okro was sown two weeks after tomato was transplanted.

The result in table 5 showed that the highest number of branches was recorded in both sole and intercropped okro. The number of branches increases up to the time of harvest. However, there was no significant difference in the number of branches at four weeks after sowing. The result in table 6 revealed that there were significant differences in leaf area of okro at 2, 6, and 8(WAS). Largest leaf area of okro was observed at 6WAS when okro was planted as sole crop but decreases with maturity. AT 8WAS okro intercropped with tomato recorded the highest leaf area. Table 7 shows that there was significant difference leaf area of okra at 2, 6 and 8 (WAS). Largest leaf area of okra was recorded at 6 WAS when Okra was planted as sole crop but decreased with time of crop maturity. At 8WAS okra intercropped with tomato recorded the highest leaf area. However, at 4 WAS, result showed statistically that there was no significant difference between the treatments. Number of days to 50% flowering, number of fruits fresh fruit weight, fruit length, fruit girth and fruit yield of tomato in tomato/okro mixture: The result (Table 8) shows that there was significant difference in fresh fruit weight and fruit yield in all the planting sequence. The highest number of fresh fruit per plant, fruit diameter and fruit yield were recorded in sole tomato.

Number of days to 50% flowering, number of fruits fresh fruit weight, fruit length, fruit girth and fruit yield of okro in okro/ tomato mixture: The result showed that the number of days to 50% flowering. Pod length, pod girth, and number of okro per plant were significantly different when planted either as sole crop or intercrop with tomato. The highest fruit weight was recorded when okro and tomato were planted at the same time while the highest fruit yield was obtained when okro was planted as sole crop (Table 9). Treatment effect on efficiency of tomato/okro mixture as measured by the crop land equivalent ratio (LER) and percentage land saved. The result (Table 10) indicated that planting okro two weeks after tomato was transplanted the highest LER of 1.55 and percentage land saved (35.5%) which was closely followed by transplanting of tomato two weeks after sowing of okro.

Table1: Effect of planting sequence on plant height (cm) of tomato in a tomato/okra mixture

	Plant height per plant (cm)			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	22.5	29.6	51.0	75.8
2WAT Tomato/Okro	20.3	24.8	41.8	67.0
2WAS Okro/Tomato	22.1	28.1	44.7	70.3
Tomato/Okro same time	19.0	27.6	46.5	76.7
SE±	2.1	2.2	3.6	3.5
LSD(0.05)	NS	NS	NS	NS

WAT= Weeks after transplanting; NS=Not Significant

Table 2: Effect of planting sequence on Plant height (cm) of okro in a tomato/okra mixture

	Plant height per plant (cm)			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	8.7	18.7	33.5	61.1
2WAT Tomato/Okro	6.0	18.7	39.6	43.6
2WAS Okro/Tomato	9.7	17.7	32.2	62.6
Tomato/Okro same time	9.0	17.7	32.9	63.5
SE±	1.0	2.5	1.6	2.3
LSD(0.05)	3.6	NS	5.4	7.9

WAT= Weeks after transplanting; NS=Not Significant

Table 3: Effect of planting sequence on number of leaves of Tomato in a tomato/okra mixture

	Number of leaves per plant			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	7	15	27	35
2WAT Tomato/Okro	7	14	22	29
2WAS Okro/Tomato	6	15	26	32
Tomato/Okro same time	6	15	25	32
SE±	0.4	0.9	3.5	3.9
LSD(0.05)	NS	NS	NS	NS

WAT= Weeks after transplanting; NS=Not Significant

Table 4: Effect of planting sequence on number of leaves of okro in a tomato/okra mixture

	Plant height per plant (cm)			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	6	11	11	15
2WAT Tomato/Okro	5	9	10	12
2WAS Okro/Tomato	6	12	12	17
Tomato/Okro same time	6	11	11	15
SE±	0.1	0.7	0.6	0.8
LSD(0.05)	0.5	NS	NS	2.7

WAT= Weeks after transplanting; NS=Not Significant

Table 5: Effect of planting sequence on number of branches of okra in a tomato/okra mixture

	Number of branches per plant			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	6	8	8	9
2WAT Tomato/Okro	5	7	7	7
2WAS Okro/Tomato	6	9	9	9
Tomato/Okro same time	6	8	8	9
SE±	0.1	0.5	0.5	0.2
LSD(0.05)	0.5	NS	1.8	0.8

WAT= Weeks after transplanting; NS=Not Significant

Table 6: Effect of planting sequence on leaf area of tomato in a tomato/okra mixture

	Leaf area (cm^2)			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	9.0	35.7	29.9	47.2
2WAT Tomato/Okro	6.7	23.8	30.2	36.9
2WAS Okro/Tomato	8.2	25.7	31.0	40.8
Tomato/Okro same time	7.5	31.3	33.7	37.6
SE±	0.6	4.2	5.5	4.2
LSD(0.05)	2.2	NS	NS	NS

WAT= Weeks after transplanting; NS=Not Significant

Table 7: Effect of planting sequence on leaf area of Okra in a tomato/okra mixture

	Leaf area (cm^2)			
Treatment proportion	2WAT	4WAT	6WAT	8WAT
Sole	38.1	66.5	134.7	77.9
2WAT Tomato/Okro	22.4	53.6	74.8	73.2
2WAS Okro/Tomato	36.9	52.4	76.7	106.9
Tomato/Okro same time	33.6	73.9	99.7	85.7
SE±	3.0	10.5	10.3	8.9
LSD(0.05)	10.3	NS	35.8	30.9

WAT= Weeks after transplanting; NS=Not Significant

Table 8: Effects of planting sequence on number of days to 50% flowering, number of pods, fresh pod weight, pod length, pod girth, and fresh yield of tomato in tomato/okra mixture

Treatment proportion	Days to 50% flowering	No of pods/ plant	Fresh pod weight/ plant	Pod length (cm)	Pod Girth (cm)	Fresh pod yield (kg $ha^{-1)}$
Sole	35.3	52.1	2618.6	6.1	4.9	2182.2
2WAT Tomato/Okro	41.7	34.3	1803.1	6.0	4.9	1502.6
2WAS Okro/Tomato	37.3	30.0	1505.4	5.7	4.6	1254.5
Tomato/Okro same time	36.3	26.3	1252.0	5.7	4.4	1043.4
SE±	2.4	8.3	313.7	0.1	0.1	261.4
LSD(0.05)	NS	NS	1085.6	NS	NS	904.7

WAS = Week after Sowing; NS = Not Significant

Table 9: Effects of planting sequence on number of days to 50% flowering, number of pods, fresh pod weight, pod length, pod girth, and fresh yield of okra in tomato/okra mixture

Treatment proportion	Days to 50% flowering	No of pods /plant	Fresh pod weight/plant	Pod length (cm)	Pod Girth (cm)	Fresh pod yield (kg $ha^{-1)}$
Sole	39.0	7.9	113.2	10.5	2.9	104.5
2WAT Tomato/Okro	42.3	6.6	107.3	8.8	2.6	89.4
2WAS Okro/Tomato	40.3	7.3	127.0	12.0	3.0	98.9
Tomato/Okro same time	39.0	7.4	133.3	11.7	3.0	98.6
SE±	0.5	0.2	12.1	0.8	0.1	5.8
LSD(0.05)	1.7	0.8	NS	NS	0.2	NS

WAS = Week after Sowing; NS = Not Significant

Table 10: The efficiency of tomato/okra mixture as measured by the crop land equivalent ratio (LER) and percentage (%) land saved

Treatment proportion	Yield ($kgha^{-1)}$		Tomato	LER	Total	% Land
	Tomato	Okro		Okra	LER	Saved
Sole	2182.2	104.5	1.00	1.00	1.00	1
2WAT Tomato/Okra	1502.6	89.4	0.69	0.86	1.55	35.5
2WAS Okra/Tomato	1254.5	98.9	0.58	0.95	1.53	34.7
Tomato/Okra Same time	1043.4	98.6	0.48	0.94	1.42	29.6

DISCUSSION

Plant height of Okra plant was significantly higher under okra/tomato mixture compared to sole cropping. The same trend was also observed in plant height of tomato planted same time with okra. The positive intercropping relationship between tomato and okra, better moisture and nutrient utilization might have induced a significant

higher plant height in okra. This result is in agreement with the findings of (Ijoyah and Jimba, 2012) who reported better plant height of okra when intercropped with maize. Okra planted two weeks before introducing tomato was observed to have a significantly higher number of leaves and number of branches when compared to sole okra, 2WAT tomato/okra, and tomato/okra same time. This might be as a result of early establishment of the okra seedlings before the tomato seedlings were transplanted. The higher number leaves can also be attributed to the number of branches. More branching encourages more leaf production. This result is not in agreement with the findings of (Ijoyah and Jimba, 2011). The authors reported no effect of intercropping on the number of leaves and branches of okra.

Okra planted two weeks before introducing tomato was observed to have a significantly higher leaf area at 8 WAS. Although, leaf area was significantly higher in sole Okra when compared to 2WAT tomato/okra, 2WAS okra/tomato and okra/tomato same time, this decreased with crop maturity. The higher leaf area of sole okra at 6WAS compared to intercrop might be due to competitive effect for growth resources when both crops are in mixtures. The decline in leaf area might be as a result of senescence and fallen off of the older leaves, which encouraged re-growth of new leaves. This view agreed with the findings of Madu and Nwosu (2001) who reported that yams planted sole, generally have greater efficiency in utilizing the growth environment, thus promoting a larger leaf area. The fresh fruit weight, fruit length and fresh fruit yield (kg/ha) of tomato was significantly higher for sole tomato than that of tomato/okra mixture. The higher fruit yield recorded in sole tomato might be attributed to larger fruit weight and leaf area. This view was supported by (Moniruzzaman *et al.*, 2007) who observed a correlation between leaf area and yield. This also agreed with the findings of (Ijoyah and Jimba, 2012) that reported a depression in okra yield by 24.5 % and 25.9 % in two seasons when intercropped than when planted solely.

The days to 50 % flowering, number of okra fruits, fruit length (cm), and fruit girth (cm) of okra was significantly affected by intercropping. However, the fresh fruit yield was not statistically affected, although sole okra recorded a relatively higher fruit yield (kg/ha). This might be as a result of a better soil moisture conservation, thus, promoting a greater absorption of growth resources. Ogindo and Walker, (2005) who reported that Intercrops have been identified as a process that soil conserve water. Barhom (2001) also reported that water capture by intercrops was higher at about 7 % compared to monocropped. Intercropping okra 2WAT tomato/okra and 2WAS okra/ tomato gave land equivalent ratio (LER) values of 1.55 and 1.53 respectively. Thus, indicating that higher productivity per unit area was achieved by growing the two crops in mixtures than growing them separately.

CONCLUSION

From the results obtained, it can be concluded that it is beneficial to intercrop okra and tomato. This is associated with a greater yield, higher land equivalent ratio greater than 1.0 indicating that there was greater productivity per unit area. In addition, a greater percentage of land was saved that can be used for other agricultural purposes. The competitive pressures between both crops were low, Such that both had a positive intercropping effect, indicating that both crops are complementary and suitable in mixtures.

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