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ORIGINAL ARTICLES

Evaluation of yield and its components of intercropped tomato – garlic in New Valley Governorate.

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ABSTRACT

A field experiment was conducted during the 2009-2010 and 2010-2011 seasons in the Regional Agriculture Research Station; New valley governorate to study the effect of different intercropping system (T_{1a} : Sole tomato, T_{1b} : Sole garlic, T_2 (1 tomato plant : 1 garlic plant),T_3 (1 tomato plant : 2 garlic plants), T_4 : (1 tomato plant : 3 garlic plants) . This experiment was laid out in randomized complete block design (RCBD) with three replicates. The obtained results in the two growing seasons revealed that the highest tomato and garlic yields were produced by T_{1a} and T_{1b} (27.4 and 9.6 ton/feddan for sole tomato and garlic, respectively in the first season, being 28.5 and 9.9 in the second season in the same order) while the lowest tomato and garlic yields (25.6 and 0.8 ton/feddan for tomato and garlic, respectively in the first season, being 26.4 and 0.8 ton/feddan in the second season in the same order) were produced by T_2 (1tomato:1garlic). On the other hand, T_4 treatment (1tomato plant: 3 garlic plants) produced the second highest values in this respect. Intercropping evaluation parameter and aggressiveness suggested that tomato was dominant crop. The land equivalent ratio (LER) of tomato/garlic intercropping was more than unit. Also, Land equivalent coefficient (LEC) was the same for both seasons. Moreover, the highest net profit was obtained from T_4 (1tomato plant: 3 garlic plants) but the lowest net profit was obtained from sole garlic (T_{1b}).

Key words: Intercropping, tomato, garlic, land equivalent ratio, land equivalent coefficient, aggressiveness and net profit

Introduction

Intercropping has been identified as a promising system that results in an effective use of land and other resources (Remison, 1982), efficient utilization of water and soil nutrients (Sharma *et al.,* 1979) and reduction in the cost of production (Bijay *et al.,* 1978). Intercropping if properly managed and looked after can go a long way to solve the problems of low productivity per unit area and sustainability of a production system (Ahmad and Saeed, 1998). It helps in maintaining the soil fertility and making efficient use of nutrients (Aggarwal *et al.,* 1992) and ensures economic utilization of land, labor and capital resources (Moris and Garrity, 1993).Using intercrop system is one of providing nutrition by using from exist equipment. Intercropping is from plants pattern of natural sustainable like intact forest that shows, always combination of genius prefer than single genus (Preston, 2003). Nahid (2012) stated that it is economical to have lettuce and garlic in a green leaf stage intercropping. By having two garlic rows of lettuce with simultaneous planting and harvesting lettuce and garlic in green stage in the province. Considering that the productivity of a crop is limited by the amount of resources and is mainly determined by how efficiently the crop can use them, the species composing an intercropping should be contrasting in some of their agro-botanical characteristics, such as size, architecture, cycle, growth rate, demand for nutrients, demand for light, etc. Tomato and garlic are of great economic importance in Egypt vegetable market. They were chosen for this study because they match the very important, and perhaps the most important, criterion for achieving success under intercropping conditions. Thus, one of the reasons for this choice of crops was to exploit their temporal and/or spatial complementarities. So, the aim of this study to evaluate of yield and yield components of tomato – garlic intercrop in New Valley government and make economic study for this.

Materials and Methods

An experiment was conducted during two successive winter growing seasons (2009-2010 and 2010-2011) in the Regional Agriculture Research Station; New Valley, El-Kharga. The soil texture is sandy loam (Table 1 and 2).

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Table 1: Chemical soil analysis of the experimental site.

$CaCO_3$ %	P (ppm)	N (ppm)	SO_4 meq/L.	CL meq/L	HCO_3 meq/L	K meq/L	Na meq/L	Mg meq/L	Ca meq/ L	PH	EC
7.05	12.50	60	8.0	7.0	0.45	1.96	4.48	1.65	6.58	7.90	1.55

Table 2: show the mechanical soils analysis of the experimental sits

Sand	Silt	Clay	Texture
84.32	4.0	11.68	Loamy Sand

This experiment was conducted to assess yield and its component of tomato (main crop) and garlic (secondary crop).This experiment was conducted in randomized complete block design (RCBD) with three replicates. Plot size was 10.5 m^2 (1m x 10.5 m long). Five treatments are used in this study as follow:

$T_{1\,(a):}$ Sole tomato (8400 plant / feddan)
$T_{1\,(b):}$ Sole garlic (100800 plant/ feddan)
$T_{2:}$ (1 tomato plant : 1 garlic plant), (8400 tomato plants: 8400 garlic plants/ feddan)
$T_{3:}$ (1 tomato plant : 2 garlic plants), (8400 tomato plants: 16800 garlic plants/ feddan)
$T_{4:}$ (1 tomato plant : 3 garlic plants), (8400 tomato plants: 25200 garlic plants/ feddan)

In this experiment, seeds of the tomato cultivar 'Supper strain B' were planted in nursery at August 15th in first and second seasons, then seedlings were transplanted in permanent field on 4th October in both seasons in hills 50 cm apart and 1m between laterals. Whereas tomato plants were planted in right side of lateral and garlic cloves were in opposite side in intercropping treatment while each single crops in sole treatments were cultivated in the same site of lateral. The distance between garlic clove and its others were 10 cm, and the distance between the tomato and garlic 15 cm.

Secondary crop (garlic) Strain Sids 40 derived from Chinese variety in Horticulture Research Institute was planted using cloves in front of tomato in 4th October in both seasons. Cloves were soaked in water for 12-16 hours in running water in burlap sacks then soaked in micronic sulfer solution 5 g / liter of water for 1/2 hour. All other cultural practices were applied as recommended for tomato production (main crop). The irrigation was done using drip irrigation system. The laterals spaced 1m from each other and also the drippers spaced 50 cm from each other.

Measured traits of tomato: Plant height, number of branches per plant, number of fresh fruits per plant, fresh fruit weight per plant (kg), average fruit weight (g), number of fresh fruits per kg and the total fruit yield (ton per feddan) were calculated .These traits were determined using random sampled of ten plants per plot. The fruites were collected in about eight times in each season.

Measured traits of garlic: Number of cloves per bulbs, weight of single clove, bulb diameter, weight of single bulb and total yield ton per feddan and the following parameters were recorded using ten randomly sampled plants per plot.

Intercropping Efficiency Parameters:

Land Equivalent Ratio (LER) was determined according to Willey (1979) where,

LER= intercropping yield of main crop/pure stand yield of main crop + intercropping yield of secondary crop/pure stand yield of secondary crop.

Land equivalent coefficient (LEC) = LAxLB, Where, LA = LER of main crop and LB = LER of intercrop (Adetiloye *et al.*, 1983). Aggressiveness values were determined according to McGilchrist (1965), where

Aggressiveness for main crop = (intercropping yield of main crop/expected yield of main crop) - (intercropping yield of secondary crop/expected yield of secondary crop) and

Aggressiveness for secondary crop = (intercropping yield of secondary crop/expected yield of secondary crop)-(intercropping yield of main crop/ expected yield of main crop);

The expected yield = yield of sole crop X the fraction of the area occupied (1.0 for tomato and 0.5 for secondary crop in the presently used cropping system (garlic).

Net profit:

The net profit of tomato and garlic yield was calculated using the followed formula:

$NP= [(Y\times P) - Tc]$

Where NP is the net profit (\$ $feddan^{-1}$), Y the yield (ton $feddan^{-1}$), P the yield price (\$ ton^{-1}), and T_C is the total costs (\$ $feddan^{-1}$) (Younis *et al*., 1991). The costs were 163.93 \$ and 409.84 \$ per feddan for tomato and garlic, respectively (Agricultural Statistics Bulletin 2009/2010).

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Statistical Analyses and Mean Separation Procedure:

All collected data were subjected to analysis of variance (ANOVA) procedure using the MSTAT-C Statistical Software Package (Michigan State University, 1983) and means were separated using the least significant differences method (LSD) at 5% level of significance, Gomez and Gomez (1984), only when a significant "F" test was obtained.

Results and Discussion

Yield parameter of tomato:

Data presented in (table 3) revealed that the intercropping had a significant influence on all studied traits in the two growing seasons. T_4 treatment produced the tallest tomato plants (65.9 and 68.6cm in first and second seasons, respectively) while the shorter plants (54.9 and 57.2 cm in first and second seasons, respectively) were obtained from T_2. Plants grow in dense vegetations at the risk of being out-competed by neighbors. To increase their competitive power, plants display adaptive responses, such as rapid shoot elongation (shade avoidance) to consolidate light capture (Keuskamp *et al*.2010). Here too, the T_4 treatment gave the highest mean values of number of branches plant^{-1}(7.4 and 7.7 branch plant^{-1}in first and second seasons, respectively). This is to be expected since the same treatment was gained the tallest plants and consequently number of nodes and branches. Also, the illustrated data focused that the high significant effect of intercropping system on number of fruits plant^{-1}. Solid tomato treatment and T_4 intercropping treatments gained the highest mean values (67.7 and 70.9 in first and second seasons, respectively) and the differences between the mentioned treatments were not significant at 0.05 level. This is logic since the T_4 and T_1 treatments produced the maximum values concerning of number of branches plant^{-1} and consequently high number of fruits plant^{-1}. Also, T_4 (1 tomato plant: 3 garlic plants) gained the highest mean values of fruit weight and fruits weight plant^{-1}(63.9 g and 4.4 kg for fruit weight and fruits weight plant^{-1} in the first season being 67.2g and 4.6 kg in second season in the same order). The highest weight of fruits plant^{-1} as resulted to the highest fruit weight produced by T_4 treatment. But, the reverse was true with regard to number of fruit kg^{-1} whereas the T_4 treatment gave the lowest number of fruit kg^{-1} in both seasons of study. This is logic since the same treatment gained the heaviest fruit weight and consequently produced the lowest number of fruit in kg. Moreover, the present data indicated that the maximum fruit yield feddan^{-1} (27.4 and 28.5 ton/ feddan in the first and second seasons, respectively) was obtained from solid treatment followed by T_4 treatment which produced 26.7 and 28.0 ton / feddan in the same order. While the minimum fruit yield feedan^{-1} was gained by T_2 treatment. Similar trend was obtained by Pilatti *et al*. (1994) and sayed *et al*, 2008.

Yield parameter of garlic:

Data presented in Table 4 revealed that the intercropping system had a significant effect on the all studied traits in the two growing seasons. T_4 produced the highest values of number of cloves head^{-1} (17.0 and 16.6 cloves head^{-1} in the first and second seasons, respectively) while the lowest mean values in this respect (13.00 and 12.5 cloves head^{-1} in the first and second seasons, respectively) were obtained by T_{1b} and T_2 in the first and second seasons, respectively. Also, the data revealed that clove weight was affected significantly by the treatments in both seasons. The lowest values of clove weight were obtained from T_4 treatment (3.4 and 3.3 g clove^{-1} in first and second seasons, respectively). The reduction in clove weight in crowded planting system (T_4) was due to the competition between plants for nutrients, light, water and soil which led to the previous result. Here too, the present data show that the bulb diameter reacted significantly to treatment studied in both seasons. The minimum mean values of bulb diameter (3.4 and 3.3 cm in the first and second seasons, respectively) were obtained from T_4 treatment. This may be due to the lowest size of cloves in T_4 treatment. Moreover, the T_2 treatments gave the highest mean value of bulb weight (94.9 g) in the first season while the highest value of bulb weight (95.1 g) in the second seasons was obtained from T_1 (sole). On the other hand the lowest mean values in this respect were obtained by T_4. This is logic since the same treatment gained the lowest values with regard to clove weight. Here too, the maximum fresh yield means values (9.6 and 9.9 ton feddan^{-1} in the first and second seasons, respectively) were obtained from T_{1b} treatment (sole) while the lowest mean values in this respect were obtained from T_2 treatment (1tomato plant : 1 garlic plant). These increases in fresh yield in solid garlic planting system could explain by the increases in number of plants and bulb weight in the T_{1b} treatment.

Intercropping efficiency:

The measures of intercrop efficiency determined in the study follow similar trend for both seasons (Table 5). For tomato, the highest partial LER value was obtained from T_3 and T_4 treatments (1tomato plant : 2 garlic

plants and 1tomato plant: 3 garlic plants, respectively). For garlic, the highest partial LER value was also obtained at T_3 and T_4 (1 tomato plant: 2 garlic plants and 1 tomato plant: 3 garlic plants, respectively).

Total Land Equivalent Ratio (LER) value was greater than unit in all treatments in both seasons, thus intercropping in all treatments increased the efficiency of soil use and demonstrate yield advantages for the intercropped plots.

In particular, 1 tomato plant : 3 garlic plants (T_4) gave the highest LER of 1.12 in both seasons, implying that 12% more land would be used as compared sole crops to produce the yield obtained under intercropping situations.

LEC values followed a trend similar to that of LER. This is consistent with findings of Ofori and Sterm (1987), Susan and Mini (2005) and Kabura *et al.* (2008).

The values of aggressiveness suggested that the main crop (tomato) dominated over secondary crop (garlic) in this study.

The effect of tomato-garlic intercropping on total cost, total return and net profit $ per feddan over two years is shown in table 6. T_{1b} (sole garlic) had the lowest net profit compared to intercropped 1tomato: 3 garlic plants (T_4) which had the highest net profit followed by T_3 (1tomato plant : 2 garlic plants), sole tomato (T_{1a}) and 1 tomato plant : 1garlic plant (T_2). This could be due to the high LER produced by T_4.

Table 3: Yield attributes of tomato as influenced by intercropping

Traits	Plant height, (cm)		No.of branches/plant		Fruits No./plant		Fruits weight /plant (kg)		Fruit weight (g)		No. of fruits /Kg		Fruits yield ton/feddan	
Treatments	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_{1a}-Sole tomato	64.1	66.7	6.6	7.0	67.7	70.5	3.9	4.1	56.7	59.1	17.7	18.3	27.4	28.5
T_2-1 tomato:1 garlic	54.9	57.2	6.5	6.6	45.0	46.4	2.8	2.9	60.0	61.8	15.6	16.0	25.6	26.4
T_3-1tomato:2garlic	62.2	64.8	6.4	6.8	65.7	68.4	3.8	3.9	55.1	57.3	17.1	17.8	26.6	27.6
T_4-1tomato:3garlic	65.9	68.6	7.4	7.7	67.5	70.9	4.4	4.6	63.9	67.2	14.7	15.5	26.7	28.0
L.S.D 0.05	0.9	0.8	0.1	0.1	2.3	2.1	0.7	0.6	0.8	0.7	0.3	0.3	0.2	0.2

Table 4: Yield attributes of garlic as influenced by intercropping

Traits	Number of cloves		Clove weight (g)		Bulb diameter		Bulb weight (g)		Fresh yield ton/feddan	
Treatment	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_{1b}-Sole garlic	13.0	12.6	7.2	7.3	5.3	5.3	93.6	95.1	9.6	9.9
$T_2$1tomato:1garlic	13.0	12.5	7.3	7.1	5.3	5.1	94.9	91.4	0.8	0.8
T_3-1 tomato:2garlic	14.0	13.8	6.0	6.1	4.5	4.4	84.0	82.6	1.4	1.4
T_4-1 tomato: 3 garlic	17.0	16.6	3.4	3.3	3.4	3.3	58.0	56.5	1.4	1.4
L.S.D 0.05	0.6	1.7	1.1	0.6	0.7	0.4	8.1	6.4	0.3	0.4

Table 5: Effect of intercropping on land equivalent ratio, land equivalent coefficient and aggressiveness in tomato based cropping system.

	LER						LEC		AGGRESSIVENESS			
	2010			2011			2010	2011	2010		2011	
	Partial		Total	Partial		Total						
Treatments	Tomato	Garlic	Sum	Tomato	Garlic	Sum			Tomato	Garlic	Tomato	Garlic
T_2- 1tomato:1garlic	0.93	0.08	1.01	0.93	0.08	1.01	0.07	0.07	0.77	-0.77	0.77	-0.77
T_3- 1tomato:2garlic	0.97	0.15	1.12	0.97	0.14	1.11	0.14	0.14	0.68	-0.68	0.69	-0.69
T_4-1tomato:3garlic	0.97	0.15	1.12	0.98	0.14	1.12	0.15	0.14	0.68	-0.68	0.70	-0.70

Table 6: Effect of Tomato-garlic intercropping on total cost, total return and net profit $ per feddan over two years.

Treatments	Total cost	Total return	Net profit
T_{1a}:Sole tomato	726.9	4576.6	3849.7
T_{1b}:Sole garlic	847.5	3988.9	3141.4
T_2:1 tomato: 1 garlic	759.7	4580.1	3820.4
T_3:1 tomato: 2 garlic	792.5	5016.0	4223.5
T_4:1 tomato : 3 garlic	825.2	5064.1	4238.9

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