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Yield and economic evaluation of maize and tomato as affected by cropping systems and some growth stimulants

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ABSTRACT

Tomato is grown during late summer under field conditions is exposed to heat stress which affects fruit setting, productivity and quality. Thus, tomato cultivations require protection against hot weather to improve fruit setting, productivity and quality under these unfavorable conditions. Thus, two field trails were carried out at the Experimental Farm of the Fac. of Agric., Moshtohor, Benha Univ., Egypt, during late summer seasons of 2016 and 2017, to evaluate the performance of tomato cv. Super Strain B solid or intercropped with maize, cv. SC 176 or TWC 324, under foliar application of some growth stimulants to improve flower set, tomato and maize production as well as land use efficiency and economics of intercropping. The treatments were assigned at random in strip- plot design in three replications. The vertical strips were occupied with the foliar application of growth stimulants (without spraying (control), Salicylic acid at 100 (SA1) and 200 ppm (SA2) and yeast extract at 5% (YE1) and 10% (YE2). Cropping systems (solid tomato, solid maize SC 176, solid maize TWC 324, intercropping tomato/maize SC 176 and tomato/maize TWC 324) were arranged in horizontal strips. Results clearly indicated that:

Spraying maize and tomato plants with growth stimulants significantly increased growth, yield and its components, quality traits (grain protein content of maize and fruit contents of TSS and vitamin C) and reduced unmarketable yield compared with control. The maximum values of these traits were achieved by applying YE2, except, fruit contents of TSS and vitamin C. The best results for these two traits were gained by SA2. The highest increases in grain yield ha^{-1} was 12.80 and 11.67 % for maize and 18.27 and 18.90 % for total fruit yield ha^{-1} and 20.10 and 19.70% for marketable yield ha^{-1} for tomato when YE2 was used compared to control treatment in first and second seasons, respectively.

Intercropping maize with tomato significantly increased topmost ear leaf area, No. of green leaves $plant^{-1}$, ear characters and grain protein content %. Meanwhile, the maximum grain yield ha^{-1} was detected under solid maize cv.176 (7.67 ton) as average in both seasons.

The maximum values of plant fresh and dry weights, fruit number $plant^{-1}$ and setting %, fruit weight, fruit yield per plant and total and marketable yield per ha were achieved by intercropping tomato with maize TWC 324 and using YE2 in both seasons. Intercropping tomato with maize TWC 324 and YE2 resulted in maximum values of LER estimated to 2.02, ATER 1.69, net return L.E. 53,906 ha^{-1} and MAI L.E. 41,263 ha^{-1} as average of the two seasons.

Key words: intercropping, tomato, maize, growth stimulants, yield and quality.

Introduction

In Egypt, the late summer tomato market is from the open field planting during June up to August. During this period, temperature can exceed 35°C under field condition resulting in either non-uniform growth and poor fruit yield or even completely failure of tomato cropping in a great part of the cultivated area (Pressman *et al.,* 2002). Saeed *et al.* (2007) found that high temperature during reproductive development caused significant increment in flower drop and significant decrease in fruit set and consequently fruit yield was decreased to a great extent. Therefore, many trails has been carried out for increasing fruit set and fruit yield of tomato by application of safe, cheap and efficient

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strategies, e.g. foliar application with some plant growth stimulants (Salicylic acid and yeast extract) and/or intercropping tomato with other plants to protect it from heat stress during late summer .
Salicylic acid (SA) is known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Hayat *et al*., 2010). In recent years, there have been an increasing number of reports on the protective effect of exogenously applied SA on abiotic stresses, such as high temperature (Adams *et al., 2001*) and salinity stresses (Khodary, 2004). Salicylic acid enhanced the vegetative growth, photosynthetic rate and dry mass production in corn and soybean (Khan *et al.*, 2003 and Khodary, 2004). SA has been reported to induce flowering in a number of plants much earlier as compared to the untreated control (Martin-Max *et al.,* 2005). Spraying tomato plants with salicylic acid increased vegetative growth, dry weight, yield and its components (Ali *et al.,* 2009 and Javaheri *et al*., 2012 and 2014). Foliar application of SA significantly increased No. of leaves plant^{1}, leaf area, yield components, yield ha^{-1} and crude protein of maize by increasing SA concentrations up to 200 mg L^{-1} (Amin *et al.,* 2013 and Zamaninejad *et al., 2013)*.

Yeast extract was suggested to share a beneficial role during vegetative and reproductive growth stage through improving flower formation and their set of some plants due to its high auxin and cytokinin contents and enhancement of carbohydrate accumulation (Barnett *et al.,* 1990). Also, it has stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (El- Desouky *et al.,* 2000 and Wanas, 2006). In addition, improving growth, flowering and fruit setting of tomato plants by using foliar application with yeast extract was reported by (Abou-Aly, 2005 and Wanas, 2006). Application of yeast as bio fertilizer significantly increased maize grain and stalks yield, 1000-grain weight and weight of ear/plant (El- Dissoky *et al.,* 2013).

A shade net house can modify environmental conditions but to reduce cost of artificial shading, increase land utilization rate and adding additional income to farmers intercropping tomato with other field crops is suggested. Intercropping not only minimize risks due to crop failure under adverse environmental conditions but also achieve higher monetary return and more stable income and also give additional advantages with associated cropping system as compared to mono-crop cultures (Ijoyah and Jimba, 2011). Several researchers have conducted trails on the effect of intercropping some field crops to protect tomato plants. Pino, M-de-los and Terry (1994) found that reducing light intensity by shading, increase fruit set significantly at high temperature and tomato yield was more in intercropping than monocropping. Tomato intercropped with maize increased number and weight of fruit/plant, total and marketable yields (Sharma and Tiwari, 1996). Abd El-Aal and Zohry (2003) found that intercropping tomato with maize maximized utilization of land and water. The damage of tomato fruits was decreased and marketable yield increased. This was attributed to maize plants that act as a shadow on tomato plants and protect fruits from sun rays and reduced the effect of direct burning on fruits. Abd El-Hady *et al.* (2013) showed that the increasing in yield components might due to wide distance between plants under intercropping condition. Intercropping tomato with other crops increased productivity, land equivalent ratio, and total income than tomato solid crop (Hussain *et al*., 2008; Upadhyay *et al.,* 2010, Mohamed *et al.*, 2013 and and Abd El-Gaid *et al.,* 2014).

The aim of this study is to investigate the influence of foliar application of growth stimulants and intercropping maize with tomato, as a tool to protect tomato plants against thermal stress, on yield quantity and quality, land equivalent ratio and net return.

Materials and Methods

Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Benha University, Egypt, during late summer seasons of 2016 and 2017. Tomato (*Solanum lycopersicum* Mill) cv. Super Strain B and two maize hybrids (S.C. 176 and T.W.C. 324) were used. The plot area was 20 m^2 (5 beds each of 1 m width and 4 m length). Each experiment was laid out in strip- plot design with three replications. Vertical strips were occupied with foliar application of some growth stimulants (1- without spraying (control), 2- Salicylic acid at 100 ppm (SA1), 3- Salicylic acid at 200 ppm (SA2), 4- yeast extract at a concentrate of 5 % (YE1) and 5-yeast extract at 10 % (YE2)). Cropping systems were (solid tomato, solid maize SC 176, solid maize TWC 324, intercropping tomato/maize SC 176 and tomato/maize TWC 324) were arranged in horizontal strips. Soil of the experimental farm was clay loam in texture with pH 7.8, method described by Jackson (1973) and Black (1965). Soil mechanical and chemical analyses are shown in Table (a) while Table (b) show air temperature in Qalubia region during the two seasons of study.

Table (a): Soil mechanical and chemical analyses of the experimental farm (as an average of the two seasons of study).

Physical analysis		Chemical analysis			
		Cations meq/l		Anions meq/l	
Coarse sand	7.26%	Ca^{++}	7.26	CO_3^{--}	Zero
Fine sand	17.14%	Mg^{++}	3.02	HCO_3^-	4.14
Silt	22.40%	Na^+	5.36	Cl^-	4.81
Clay	53.20%	K^+	0.83	SO_4^{--}	7.52
Texture class: clay loam					
Soil pH	7.81	Available N	21.3 mg/kg		
E.C, dS/m	1.63	Available P	8.43 mg/kg		
Organic matter	1.59%	Available K	117.4 mg/kg		

Table (b): Monthly air temperature in Qalubia region during the two seasons of the study.

Months	first season 2016			Second season 2017		
	Max °C	Min °C	Relative humidity%	Max °C	Min °C	Relative humidity%
April	29.5	6.2	61	39.0	11.8	64
May	40.8	11.5	59	44.1	16.5	61
June	39.0	18.6	66	39.7	19.7	72
July	38.1	17.8	74	42.9	23.8	73
August	37.7	17.4	73	43.4	23.5	75
September	38.4	17.7	64	39.8	19.6	69

Four weeks old tomato transplants were set up into the field at a distance of 30 cm apart between transplants on one side of the bed ($33.32x10^3$ plants ha^{-1}), in solid or intercropping system. Transplanting was done on 13th and 15th of April, harvesting beginning from July until 16th and 18th of August in first and second seasons, respectively. Maize verities were planted on 13th and 16th of May and harvested on 3rd and 5th of September in 2016 and 2017 seasons, respectively. Intercropped maize was planted on other side of tomato bed in hills at 60 cm and thinned later to two plants $hill^{-1}$ ($33.32x10^3$ plants ha^{-1}). Solid maize was planted as recommended (47.6 $x10^3$ plants ha^{-1}). The spray treatments were started after 25 days from transplanting and then 2 weeks intervals (five times) through the growing season. Calcium super phosphate (15.5% P_2O_5) 357 kg ha^{-1} was added during soil preparation. Ammonium nitrate (33.5% w) as N fertilizer was added at a rate of 476 kg Nha^{-1} in three equal doses at first, second and third irrigation of tomato. Potassium sulphate (48% K_2O) was applied at 357 kg ha^{-1} at four time. The first portion took place before transplanting, second and third were added at one month intervals, whereas the last doses added after third doses by two weeks intervals. Cultural management, fertilization, irrigation and disease and pest control programs were followed according to the technical recommendations for the two crops.

Analysis of yeast stock solution:

Analysis of prepared yeast stock solution was: total protein (5.3%), total carbohydrates (4.7%), N (1.2%), P (0.13%), K(0.3%), Mg (0.013%), Ca (0.02%), Na (0.01%); micro-elements (ppm), Fe (0.13), Mn (0.07), Zn (0.04), Cu (0.04), B (0.016), Mo (0.0003), IAA (0.5 µg/ml) and GA (0.3 µg/ml) according to Wanas, (2006).

Data obtained on:

Maize:

At 90 days form planting ten maize plants were taken randomly from each plot to determined plant height (cm), No. of green leaves $plant^{-1}$, leaf area of topmost ear. At harvest the following data were obtained: ear length and diameter (cm), No. of rows ear^{-1}, No. of grains row^{-1}, ear grain weight (g), 100-grain weight (g) and grain yield ha^{-1} (ton) as well as grain protein content %. Total nitrogen in grains was determined by Kjeldahl method according to A.O.A.C. (1980). Protein % was calculated by multiplying the N by the converting factor 6.25 (Hymowitz *et al.* 1972).

Tomato:

At 90 days from transplanting three plants from each experimental plot were randomly taken to determine vegetative growth parameters i.e., Plant height, No. of branches $plant^{-1}$, fresh and dry weights of plants as well as flowering growth parameters such as No. of flowers $plant^{-1}$, setting %. yield parameters i.e., No. of fruits $plant^{-1}$, average fruit weight, fruit yield $plant^{-1}$, total, marketable and unmarketable fruit yields (ton ha^{-1}) were estimated from total weight of all picking up to the end of the experiment.

Setting % = number of fruits $plant^{-1}$ / number of flowers $plant^{-1}$

Fruit chemical quality were determined according (A.O.A.C., 1990) for fruit juice total soluble solids (TSS%) using hand refractometer and fruit juice Vitamin C (ascorbic acid) content (mg/100ml juice) by titration with 2-6 dichlorophenol indophenol pigment.

Competitive relationships and yield advantages:

1-Land equivalent ratio (LER) was described by Willey (1979). Land equivalent ratio was determined according to the following formula:

$$LER = Y_{ab}/Y_{aa} + Y_{ba}/Y_{bb}$$

Where: Yaa and Ybb were pure stand of crop a (tomato) and b (maize), respectively. Yab is mixture yield of a and Yba is mixture yield of b crop.

2-Area Time Equivalent Ratio (ATER): provides a comparison of the yield advantage of intercropping over monocropping in terms of time taken by component crops in intercropping systems according to Hiebsch (1980).

$$ATER= (LER_{Tomato}\, xDC + LER_{Maize}\, xDC)/Dt.$$

Where LER is land equivalent ratio of crop, DC is duration (days) taken by crop in monocropping, Dt is days taken by whole intercropping system from planting to harvest.

3-Monetary advantage index (MAI): Suggests that the economic assessment should be in terms of the value of land saved; this could probably be most assessed on the basis of the rentable value of this land. MAI was calculated according to the formula, suggested by Willey (1979).

MAI = [Value of combined intercrops x (LER–1)]/LER

4- Net return:

Net return ha^{-1} = total return – (fixed cost of tomato + variable cost of maize). The market price for tomato fruit (marketable yield) and maize grain was 1468 L.E.ton^{-1} and 2313 L.E.ton^{-1}, respectively, as an average for the two seasons (Bulletin of Statistical Cost Production and Net Return, 2016).

The statistical analysis was carried out for each crop separately according to Snedecor and Cochran (1988), using MSTAT-C (1980). LSD at 0.05 level of probability was used to compare between treatment means.

Results and Discussion

Maize:

1. Effect of growth stimulants:

Data in Table (1) indicated clearly that plant height, No. of green leaves $plant^{-1}$ and leaf area of topmost ear of maize were significantly influenced by growth stimulants. Foliar application with yeast extract at 10 % (YE2) give the greatest values of these traits followed by yeast at 5% (YE1) and salicylic acid at 200 ppm (SA2), showed no significant differences among studied traits except leaf area of topmost ear. Whereas the lowest values of these traits were gained with control. These results may be due to the secretion of cytokinins, increasing the levels of endogenous hormones in treated plants, which increased cell division and cell elongation, increasing the metabolic processes rate and levels of hormones (indol acetic acid IAA and gibberellins GA_3). These results confirmed by Amin *et al.,* (2013) and El- Dissoky *et al* (2013).

Yield components of maize were significantly influenced by growth stimulants, except No. of rows ear^{-1} in both seasons, as shown in Table (1). The highest values of ear length, ear diameter, 100-grain weight and ear weight of grains were obtained when maize plants sprayed with yeast extract at 10% (YE2), except number of grains row^{-1} where the highest values were detected with salicylic acid at 200 ppm (SA2). Whereas maize plants untreated (control) were the lowest values of these traits. Differences between YE2 and SA2 were significant in most traits but with few exceptions related to ear length and ear grain weight in the first season and ear diameter in both season.

Grain yield ha^{-1} and grain protein content followed the same trend as shown with yield components of maize and were significantly affected by growth stimulants (Table 1). The maximum grain yield ha^{-1} (6.96 and 6.70 ton ha^{-1}) was obtained by YE2 treatment compared to control (6.17 and 6.00 ton ha^{-1}) in 2016 and 2017 seasons, respectively. The increments in grain yield over control were 3.40, 8.10, 7.13, and 12.80% in first season, and 4.00, 9.33, 5.00 and 11.67% in second season, compared with SA1, SA2, YE1 and YE2. Similarly, spraying maize plants with YE2 increased grain protein content over than control, SA1, SA2 and YE1 by 15.77, 14.89, 8.16 and 3.45% and 15.06, 15.03, 7.59 and 3.62%, respectively, in 2016 and 2017 seasons.

The enhancing effect of yeast extract and salicylic acid on maize plants may be due to yeast extract has stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation. Likewise, plants treated with SA flowered earlier than non-treated plants, consequently, increased grain yield and yield components due to the effect of physiological and biochemical processes that led to amelioration in vegetative growth and active assimilation translocation from source to sink (Martin-Max *et al.,* 2005, Amin *et al.,* 2013, El- Dissoky *et al.,* 2013 and Zamaninejad *et al.*, 2013).

Table 1: Effect of growth stimulants on growth, yield and yield components of maize in 2016 and 2017 seasons.

Traits / Treatment	Plant height (cm)	Green leaves $plant^{-1}$ (No.)	leaf area of topmost ear (cm^2)	Ear length (cm)	Ear diameter (cm)	Rows ear^{-1} (No.)	Grains row^{-1} (No.)	100-grain weight (g)	Ear grain weight (g)	Grain yield ha^{-1} (ton)	Grain protein content (%)
	2016 season										
Without	276.61	13.37	684.83	20.14	4.76	13.54	39.80	29.50	152.51	6.17	8.165
SA1	279.38	13.81	707.44	21.07	4.82	13.66	41.24	29.94	168.13	6.38	8.228
SA2	280.56	14.68	728.84	22.39	4.93	13.72	43.49	29.68	173.92	6.67	8.740
YE1	282.26	14.93	732.76	21.63	4.82	13.98	41.45	30.29	172.99	6.61	9.138
YE2	282.51	15.45	747.39	22.63	4.94	13.73	41.57	31.23	176.82	6.96	9.453
LSD 0.05	4.88	0.53	9.32	0.37	0.11	N.S	0.87	0.36	5.89	0.22	1.082
	2017 season										
Without	270.62	13.67	707.99	20.65	4.61	13.44	39.18	29.11	150.00	6.00	8.168
SA1	272.42	13.60	744.43	21.57	4.78	13.28	42.05	29.86	160.97	6.24	8.170
SA2	274.16	14.31	679.34	21.91	4.83	13.50	43.00	30.32	171.78	6.56	8.735
YE1	277.09	14.89	716.38	20.98	4.80	13.55	39.37	31.44	167.40	6.30	9.070
YE2	278.49	15.36	6.09	22.35	4.92	13.55	40.65	32.00	176.95	6.70	9.398
LSD 0.05	5.90	0.54	10.89	0.32	0.10	N.S	0.45	0.32	4.38	0.19	0.952

Without (control), SA1 at100 ppm, SA2 at 200 ppm,YE1 at 5% and YE2 at 10 %

2. Effect of cropping system:

Data analysis in Table (2) indicated that values of plant height, No. of green leaves plant^{-1} and leaf area of topmost ear were significantly affected by cropping systems in both seasons. The highest maize plants were achieved under solid maize systems compared with intercropping systems. Since dense planting (in solid culture) resulted in more shading which in turn stimulate internode to increased plant height. Similar result was reported by Gebru *et al.,* (2015) he stated that plant height and internodes length increased with increasing plant population because of competition. On the other hand, intercropping maize with tomato reduced leaf ageing and increased ear leaf area. These results may be due to this system formed better above – ground conditions especially light intensity for maize growth and development than those of sole culture as well as residual effect of tomato fertilizer. Values of these traits tended to increase with maize SC 176 than maize TWC 324 in intercropping or solid system.

Yield and yield component of maize significantly affected by cropping system, except No. of rows ear^{-1}. Differences could be due to variation between two maize varieties, as shown in Table (2). Intercropping maize with tomato significantly had increased ear length, ear diameter, No. of grains row^{-1}, 100-grain weight and ear grain weight by 12.72, 12.60, 5.08, 8.66 and 9.74 % and 10.30, 14.08, 6.91, 6.94 and 10.75% for these traits in first and second seasons, respectively. Productivity of intercropping over sole cropping has been attributed to better use of solar radiation, nutrients and water. Similar results were obtained by Hussain *et al*., (2008) and Abd El-Hady *et al.* (2013).

Grain yield ha^{-1} of sole maize was significantly higher than intercropped ones by 32.12 and 30.14% in both seasons, respectively. Since grain yield appeared to be directly proportional to the number of plants per unit area of land. On the other hand, intercropping maize with tomato increased grain protein content by 5.44 and 6.03% over solid planting of maize, in the two seasons, respectively. These increases may be due to the residual effect of high amounts of nitrogen fertilizer, which applying for tomato. Results are in accordance with those reported by Hussain *et al*., (2008) and Abd El-Hady *et al.* (2013).

With respect to maize varieties, the highest values of ear characters were obtained with SC 176 compared with TWC 324 cultivar, except 100-grain weight which behaved the reverse. Similarly, grain yield ha^{-1} of maize cultivar 176 behaved in parallel way as ear grain weight in the two seasons. Grain yield and grain protein content of SC 176 was surpassed that of TWC 324 cultivar. These observations may be attributed to the highest no. of green leaves plant^{-1} and leaf area of topmost ear of maize SC176 that contributed mainly in interception more solar radiation which reflected on increased grain yield (Lamlom *et al.,* 2015).

Table 2: Effect of cropping systems on growth, yield and yield components of maize in 2016 and 2017 seasons.

Traits / Treatment	Plant height (cm)	Green leaves plant^{-1} (No.)	leaf area of topmost ear (cm^2)	Ear length (cm)	Ear diameter (cm)	Rows ear^{-1} (No.)	Grains row^{-1} (No.)	100-grain weight (g)	Ear grain weight (g)	Grain yield ha^{-1} (ton)	Grain protein content (%)
	2016 season										
C1	279.51	13.92	730.02	20.80	4.60	14.43	42.46	28.01	172.20	7.84	8.570
C2	272.04	15.67	762.49	23.62	5.17	14.48	44.81	29.93	187.16	5.98	9.024
C3	287.71	13.27	683.26	19.76	4.53	13.00	38.50	29.75	149.87	7.09	8.456
C4	281.80	14.93	705.23	22.10	5.11	12.99	40.26	32.83	166.27	5.32	8.928
LSD 0.05	1.96	0.42	4.28	0.24	0.09	0.30	0.81	0.21	4.91	0.18	0.246
	2017 season										
C1	273.75	13.83	707.99	21.04	4.51	13.96	40.83	28.34	164.05	7.49	8.540
C2	267.78	15.66	744.43	23.30	5.13	14.27	44.23	29.70	179.90	5.75	9.042
C3	282.48	13.09	679.34	19.84	4.44	12.76	38.14	30.70	149.92	6.89	8.366
C4	274.21	14.88	716.38	21.79	5.08	12.86	40.20	33.44	167.81	5.30	8.884
LSD 0.05	2.00	0.26	6.09	0.29	0.08	0.43	0.26	0.19	3.85	0.15	0.310

C1=solid maize SC176, C2= maize S.C.176 intercropping with tomato, C3= solid maize 324, C4= maize TWC 324 intercropping with tomato.

3. Interaction effect:

Data in Table (3) showed that the interaction effect of growth stimulants and cropping systems on some maize characters. Intercropping maize SC 176 had the highest number of green leaves plant^{-1} and leaf area of topmost ear when treated with YE2, while treated SC 176 with SA2 produced the highest number of grains row^{-1}. The heaviest 100-grain weight was obtained under intercropping maize TWC 324 and YE2 was used. The maximum values of ear grains weight (196.19g) were obtained from intercropping SC 176 maize and YE2 treatment in first season. Whereas this hybrid achieved the highest grain weight ear^{-1} with SA2 (189.32g) followed by using YE2 (188.24g), in the second season, but without significant differences. On the other side, the lowest values were showed with solid maize TWC 324 and untreated with growth stimulants, except, 100-grain weight.

As for grain yield ha^{-1}, data indicated that solid SC176 was the highest grain yield under YE2 treatment in both seasons. On the opposite, untreated TWC 324 with growth substance gave the lowest value of grain yield under intercropping system in the two seasons. These results indicated that the importance of yeast and salicylic acid in improvement growth, yield and yield component of maize (Amin *et al.,* 2013, El- Dissoky *et al.,* 2013 and Zamaninejad *et al.*, 2013).

Table 3: Interaction effect between growth stimulants and cropping systems on maize characters in 2016 and 2017 seasons.

Treatment \ Traits		Green leaves (No.)		leaf area of topmost ear (cm^2)		Grains row^{-1} (No.)		100-grain weight (g)		Ear grain weight (g)		Grain yield ha^{-1} (ton)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Without	C1	12.21	12.03	693.33	687.57	40.43	40.41	27.38	26.76	158.51	155.15	7.62	7.30
	C2	14.90	15.65	731.30	706.64	42.40	41.13	29.43	28.05	163.58	162.35	5.43	5.35
	C3	12.06	11.88	645.55	649.98	36.93	36.20	29.13	29.85	142.64	139.25	6.76	6.58
	C4	14.30	15.10	669.15	673.20	39.45	38.96	32.07	31.77	145.32	143.25	4.86	4.75
SA 1	C1	13.67	13.38	704.41	689.62	41.93	42.03	28.52	28.14	169.42	160.47	7.71	7.56
	C2	14.08	14.59	757.64	699.23	44.59	46.40	29.65	29.50	189.35	175.27	5.78	5.49
	C3	12.28	12.15	677.35	662.85	39.14	38.87	29.47	29.89	150.23	143.90	6.99	6.82
	C4	14.50	14.27	690.35	685.59	39.30	40.90	32.10	31.89	163.52	164.23	5.04	5.09
SA2	C1	14.62	14.51	735.37	710.20	43.47	42.97	27.97	28.37	172.54	170.35	7.96	7.60
	C2	15.70	15.43	763.24	751.59	46.98	47.83	29.70	28.73	193.24	189.32	6.13	5.99
	C3	13.29	12.91	701.97	700.70	40.29	39.14	29.27	30.32	153.24	153.24	7.13	7.03
	C4	15.10	14.37	714.78	754.28	43.22	42.06	31.78	33.87	176.66	174.21	5.44	5.60
YE1	C1	14.26	14.30	742.09	730.00	43.16	39.02	27.89	28.95	180.20	158.26	7.92	7.25
	C2	16.00	15.92	778.20	778.55	44.87	43.00	29.97	30.73	193.42	184.33	6.01	5.60
	C3	14.37	14.25	686.10	672.83	38.61	37.07	30.14	31.40	152.34	153.00	7.16	6.97
	C4	15.10	15.10	724.66	715.85	39.15	38.40	33.17	34.69	165.98	174.02	5.34	5.36
YE2	C1	14.84	14.91	774.91	722.58	43.33	39.70	28.29	29.49	180.32	176.00	7.97	7.75
	C2	16.93	16.72	782.09	786.15	45.23	42.80	30.89	31.48	196.19	188.24	6.53	6.32
	C3	14.35	14.25	705.34	710.35	37.53	39.41	30.72	32.04	150.88	160.21	7.42	7.03
	C4	15.67	15.57	727.23	752.99	40.17	40.70	35.02	35.00	179.88	183.33	5.91	5.68
LSD 0.05 Ax B		1.23	1.28	11.17	10.89	1.48	1.39	0.43	0.35	13.63	12.45	N.S	0.52

C1=solid maize 176, C2= maize S.C.176 intercropping with tomato, C3= solid maize 324, C4= maize TWC 324 intercropping with tomato.

Tomato:

1. Effect of growth stimulants:

Effect of some foliar spray treatments on vegetative growth characteristics, showed in Table (4) indicated that plant height, No. of branches plant^{-1}, plant fresh and dry weights were significantly increased as a result of spraying tomato plants with growth stimulants compared with the control. Spraying tomato with YE2 followed by YE1 scored the highest values for these traits with significant difference in most cases in the two seasons. These increases may be attributed to the role of yeast extract as a source of growth promoters which affect plant cell division and elongation. These results are in agreement with those mentioned by El- Desouky et al. (2000) and Wanas, (2006).

Data in Table (4) indicated that foliar application of the different growth stimulants had a significant increase in number of flowers plant^{-1} and fruit set percentage compared with the control. Yeast extract at 10% (YE2) treatment gave the highest values of number of flowers followed by salicylic acid at 200 ppm (SA2) treatment, vice versa for fruit setting %. In this concern, Saeed *et al.* (2007) found that high temperature during reproductive development caused significant increment in flower drop and significant decrease in fruit set, consequently fruit yield was decreased to a great extent. Therefore, using growth regulators may stimulate the setting of tomato fruits which is considered an important parameter and prediction for the expected yield.

Additionally, data in Table (4) revealed that all tested foliar applications of the different growth stimulants improved tomato yield and its components i.e., fruit number and weight, yield plant^{-1} and total, marketable and unmarketable yield ha^{-1} as well as T.S.S and vitamin-c as compared with the control. However, the highest fruit yield per plant and ha were obtained as a result of using yeast extract at 10% (YE2) followed by using salicylic acid at 200ppm (SA2), yeast extract at 5% (YE1) and salicylic acid at 100ppm (SA1) in a descending order compared with the control. The increases in total fruit yield ha^{-1} for SA1, YE1, SA2 and YE2 more than control were (8.09, 14.42, 16.31 and 18.27 %) in 2016 and (8.62, 9.32, 16.00 and 18.90 %) in 2017 season, respectively, and marketable were (9.65, 14.55, 18.07and 20.10 %) in first season and (10.39, 8.59, 18.34 and 19.70%) in second seasons, respectively. On the other hand, spraying tomato with salicylic acid at 100 ppm followed by control reduced the production of unmarketable fruit yield compared with yeast extract, during the two seasons. Furthermore, the greatest fruits T.S.S. and vitamin-c contents were obtained by 200 ppm SA-sprayed plants, followed by yeast extract at 10 % in the two seasons. These results are connected with the improvement of vegetative growth and the increase in No. of flower plant^{-1} and setting %. That indicated that beneficial role of yeast extract during vegetative and reproductive growth through improving flower formation and their set of some plants due to its high auxin and cytokinin contents and enhancement of carbohydrate accumulation (Barnett *et al.,* 1990, Abou-Aly, 2005 and Wanas, 2006). Also, salicylic acid stimulates the flowering of tomatoes much earlier compared to control (Martin-Max *et al.,* 2005 and Javaheri *et al.,* 2012). SA had a protective effect on abiotic stresses, such as high temperature (Liu *et al*., 2006, and Wang and Li, 2006).

Table 4: Effect of growth stimulants on growth, flowering, yield and its components of tomato in 2016 and 2017 seasons.

Traits / Treat.	Plant height (cm)	Branches plant^{-1} (No.)	F. weight plant^{-1} (g)	Dry weight plant^{-1} (g)	Flowers plant^{-1} (No.)	Fruit setting %	Fruits plant^{-1} (No.)	Fruit weight (g)	Yield plant^{-1} (kg)	Total fruit yield (Ton ha-1)	Marketable yield (Ton ha-1)	Unmark. yield (Ton ha-1)	TSS %	Vitamin C (mg/100g F.w)
2016 season														
Without	57.44	11.36	467.7	82.1	81.35	20.91	17.14	79.05	1.34	40.77	34.92	5.85	8.2	28.5
SA 1	59.36	12.37	497.6	85.9	86.61	21.58	18.69	78.27	1.45	44.07	38.29	5.78	8.9	33.8
SA2	64.65	13.10	538.9	87.6	95.79	23.53	22.54	72.66	1.59	47.42	41.23	6.19	9.6	36.8
YE1	66.40	13.57	630.4	90.2	91.83	21.30	19.56	80.31	1.56	46.65	40.00	6.64	9.0	32.1
YE2	70.47	13.83	642.9	92.4	99.53	23.22	23.11	81.16	1.73	48.22	41.94	6.28	9.3	33.2
LSD 0.05	5.72	0.45	5.78	0.57	4.90	0.63	0.59	2.44	0.04	2.09	1.33	0.12	0.3	0.92
2017 season														
Without	59.55	10.99	523.2	87.4	86.39	17.64	15.27	83.15	1.28	40.01	34.36	5.65	8.9	33.2
SA 1	63.58	12.49	531.1	89.7	85.29	20.94	17.86	80.49	1.43	43.46	37.93	5.53	9.5	42.1
SA2	66.90	12.95	559.4	91.8	91.16	22.52	20.53	77.62	1.58	46.41	40.66	5.75	9.9	47.0
YE1	67.49	12.56	632.9	95.2	91.41	20.38	18.63	81.59	1.51	43.74	37.31	6.43	9.7	40.4
YE2	71.18	13.64	722.8	106.0	101.52	20.45	20.76	87.00	1.71	47.57	41.13	6.11	9.9	42.4
LSD 0.05	2.51	0.70	14.42	1.18	2.05	1.06	0.45	2.65	0.02	1.95	1.12	0.17	0.2	0.93

Without (control), SA1 at100 ppm, SA2 at 200 ppm ,YE1 at 5% and YE2 at 10 %

2. Effect of cropping system:

Results in Table (5) clearly indicated that plant height, No. of branches plant^{-1}, plant fresh and dry weights, No. of flowers plant^{-1} and setting % were significantly affected by intercropping in both seasons. Intercropping tomato with maize significantly increased plant height, plant fresh and dry weights, No. of flowers plant^{-1} and setting % compared to solid tomato. Results seemed to be cogent and plausible, since intercropping resulted in more shading which in turn stimulates internode to length and increased plant height. On the other hand, No. of branches plant^{-1} behaved the reverse, values tended to decrease with intercropping compared to solid tomato. Maize SC 176 caused a significant reduction in No.of branches plant^{-1} compared to maize TWC 324. These data could be attributed to SC 176 that had the highest leaf area of topmost ear (Table 1) which decreased solar radiation penetration within tomato canopy that increased inter-specific competition among maize and tomato plants on environment resources especially light (Mohamed *et al.,*2013).

Yield components of tomato (No. of fruits plant^{-1}, average fruit weight, fruit yield per plant) and total, marketable and unmarketable yield ha^{-1}, fruit T.S.S and vitamin-c contents) were significantly influenced by intercropping system in the two seasons as shown in (Table, 5). Data revealed that these traits were improved significantly with intercropping tomato with maize over solid system. These observations might be due to shading effect of maize which protected tomato plants from negative effect of high temperature and sun rays that enhanced these traits. These results are in harmony with those obtained by (Pino,M-de-los and Terry, 1994 and Sharma and Tiwari, 1996).

The increases in total and marketable yield in intercropping system tomato/maize TWC 324 over solid tomato were (13.58 & 16.24% for total and 20.70 & 25.25 % for marketable) and (12.93 & 14.74% and 18.31 & 20.85%) when SC 176 was intercropped with tomato, respectively, in 2016 and 2017 seasons. The damage of tomato fruits was decreased and marketable yield increased. This was attributed to maize plants that act as shadow on tomato plants and protected fruits from sun rays and reduced the effect of direct burning on fruits. These results are agreed with those obtained by Abd El-Aal and Zohry (2003), Upadhyay *et al.* (2010), and Mohamed *et al.* (2013). Intercropping tomato with TWC 324 achieved higher total and marketable yield ha^{-1} compared with SC 176. These results could be attributed to TWC 324 decreased interspecific competition between the intercrops for basic growth resources during growth and development of tomato which reflected positively on fruit number and weight plant^{-1} and total fruit yield. Science, it is had lowest no. of green leaves plant^{-1} and leaf area of topmost ear (Table 1) could be allowed more solar radiation penetration to adjacent tomato plants which reflected positively on yield and yield components of tomato compared to maize SC 176. These results are in agreement with those obtained by (lamloum *et al.,* 2015).

Table 5: Effect of cropping systems on growth, flowering, yield and its components of tomato in 2016 and 2017 seasons.

Traits / Treat.	Plant height (cm)	Branches plant^{-1} (No.)	F. weight plant^{-1} (g)	Dry weight plant^{-1} (g)	Flowers plant^{-1} (No.)	Fruit setting %	Fruits plant^{-1} (No.)	Fruit weight (g)	Yield plant^{-1} (kg)	Total fruit yield (Ton ha^{-1})	Marketable yield (Ton ha^{-1})	Unmarketable yield (Ton ha^{-1})	TSS % %	Vitamin C (mg/100g F.w)
2016 season														
C1	59.44	13.16	532.4	85.2	84.94	21.13	18.05	78.52	1.40	41.32	34.06	7.26	8.8	31.0
C2	64.41	12.35	560.1	88.7	94.50	22.42	21.03	77.82	1.59	46.93	41.11	5.82	9.1	34.0
C3	67.13	13.03	574.0	89.0	93.62	22.78	21.53	78.54	1.61	48.03	42.66	5.36	9.0	33.7
LSD 0.05	1.45	0. 22	4.48	0.44	0.99	0.69	0.43	0.69	0.04	0.79	1.05	0.05	0.2	0.71
2017 season														
C1	59.51	13.06	572.6	90.3	90.88	18.33	16.69	82.23	1.38	40.44	33.86	6.59	9.4	39.2
C2	67.84	11.72	600.9	95.6	90.71	21.06	19.31	80.93	1.54	45.67	40.06	5.61	9.6	41.6
C3	69.87	12.82	608.2	96.1	91.87	21.76	19.83	82.74	1.58	46.40	40.92	5.48	9.8	42.3
LSD 0.05	1.63	0.52	11.17	0.92	0.94	0.59	0.35	1.07	0.01	1.00	0.36	0.08	0.1	0.72

C1=solid tomato, C2= maize S.C.176 with intercropping tomato, C3= maize TWC 324 intercropping with tomato

3. Interaction effect:

Data in Table (6) indicated that interaction between growth stimulants and cropping systems had significant influence on No. of branches plant^{-1}, plant fresh and dry weights and fruit number plant^{-1} in the two seasons and fruit setting % in the first season. The highest values for number of branches plant^{-1} were obtained by sprayed solid tomato with yeast extract at 10% (YE2). On the other hand, the lowest number of branches plant^{-1} was detected when intercropping tomato with maize SC 176 without spraying. Meanwhile, intercropping tomato with maize TWC 324 and using YE2 achieved the maximum values of plant fresh and dry weights, fruit number plant^{-1} and setting % in both seasons, except fruit number and setting % only in the second season. The minimum values of the previous traits were obtained by interplanting tomato with maize SC 176 and untreated by growth stimulants. Moreover, all studied growth stimulants significantly improved tomato fruit yield as compared with control plants in the two seasons. Anyhow, the best results of fruit weight, fruit yield per plant and per ha, unmarketable were gained by yeast extract at 10%, whereas the highest values of fruit T.S.S and vitamin-c contents were obtained from those sprayed with SA at 200 ppm as compared with control in the two seasons.

Competitive relationship and monetary advantages of intercropping:

Land Equivalent Ratio (LER):

Results of LER values indicated that all intercrop combination gave more yield advantage as compared with sole cropped tomato or maize (Table 7). All LERs values obtained exceeded the unit and ranged from 1.82 to 2.02, indicated that intercropping saved 82% to 102% more land. Tomato contribution was greater than that of maize in both seasons. The highest LER (2.02) was detected by growing tomato with maize TWC 324 cultivar and treated by yeast extract at 10% (YE2). While, the minimum values of LER were achieved by intercropping maize SC 176 with tomato without foliar application of growth stimulants or treated with SA1. This indicated that intercropping tomato with maize maximized utilization of land (Abd El-Alal and Zohry, 2003 and Upadhyay *et al.,* 2010). Similarly, foliar application with growth stimulants enhanced productivity of maize and tomato (Zamaninejad *et al., 2013* and Javaheri *et al*, 2014).

Area Time Equivalent Ratio (ATER):

Area time equivalent ratio provides more realistic comparison of yield of intercropping over monocropping in terms of time taken by component crops in the intercrop maize with tomato. Data in Table (7) showed that higher ATER (1.69) was influenced by intercropping system and growth stimulants foliar application as average of two seasons. Values of ATER behaved the same trend of LER, since treated tomato and maize TWC 324 with YE2 under intercropping system had the highest value of ATER (1.69). Meanwhile, intercropping maize SC 176 with tomato without spraying had the lowest values (1.52) of ATER. The results are in harmony with those obtained by Mohamed *et al.* (2013).

Net return and Monetary Advantage Index (MAI):

The net return and MAI gained from each intercropping systems exceeded that obtained from pure stand of tomato or maize, as average of two seasons (Table 7). The monetary advantage behaved the same course of change as the net return. The data also revealed that the more the increase of LER value was, the more net return and MAI obtained. The highest values of net return (L.E. 53.906 ha^{-1}) and MAI (41,263 L.E ha^{-1}) were achieved when intercropping maize TWC 324 with tomato under foliar application of Yeast extract at 10% (YE2). Maize SC176 treated by SA at 200 ppm which had net return (L.E. 53.706 ha^{-1}) was at par with the previous treatment. This result may be due to maize SC had grain yield higher than maize TWC324. On the other hand, untreated maize SC 176 cultivar and tomato with growth stimulants under intercropping system had lower values of net return and MAI (39,949 and 29,517 L.E. ha^{-1}) as average of the two seasons. Higher returns under intercropping systems explained the suitability of intercropping systems to be adopted on a commercial scale (Abd El-Gaid *et al.,* 2014). These data conformed by Hussain *et al*., (2008); Upadhyay *et al.* (2010); Ibrahim *et al. (*2011) and Abd El-Hady *et al*., (2013).

Table 6: Interaction effect between growth stimulants and cropping systems on growth, flowering, yield and its components of tomato in 2016 and 2017 seasons.

Treatment \ Traits		Branches plant^{-1} (No.)		Fresh weight plant^{-1} (g)		Dry weight plant^{-1} (g)		Fruits plant^{-1} (No.)		Fruit setting %		Fruit weight (g)		Yield plant^{-1} (kg)		Total fruit yield (Ton ha^{-1})		Marketable yield (Ton ha^{-1})		TSS %		Vitamin C (mg/100g F.w)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Without	C1	12.24	12.34	432.3	515.7	80.3	86.3	14.45	13.68	19.23	14.37	80.23	82.87	1.14	1.13	37.65	37.53	30.39	30.15	8.1	8.8	27.7	30.5
	C2	9.85	8.80	472.7	526.3	82.0	87.3	18.20	15.80	21.44	18.91	78.94	83.07	1.44	1.32	41.89	40.91	36.34	35.92	8.3	8.8	28.6	33.6
	C3	11.98	11.83	498.0	527.7	84.0	88.7	18.77	16.32	22.07	19.64	78.97	83.50	1.46	1.39	42.77	41.58	38.03	37.01	8.2	9.0	29.3	35.4
SA 1	C1	12.64	12.75	483.0	517.3	82.3	87.0	16.92	16.13	20.59	18.77	80.04	82.77	1.36	1.32	41.53	40.91	34.14	34.6	8.6	9.3	31.2	40.7
	C2	12.01	12.32	503.0	534.0	88.0	90.7	19.86	18.81	22.02	22.23	77.19	79.14	1.47	1.46	45.05	44.55	39.85	39.15	9.1	9.7	35.6	42.7
	C3	12.45	12.39	506.7	542.0	87.3	91.3	19.29	18.65	22.12	21.82	77.59	79.56	1.53	1.49	45.62	44.92	40.88	40.05	8.8	9.5	34.6	43.0
SA2	C1	13.26	13.73	517.7	519.3	85.0	88.0	19.92	17.25	22.96	19.87	74.32	80.13	1.44	1.43	42.1	40.79	34.36	33.49	9.6	9.7	34.2	45.1
	C2	12.95	12.12	542.7	581.0	89.0	94.0	23.61	21.44	23.76	22.96	73.51	75.62	1.66	1.65	49.6	48.72	44.31	44.58	9.6	9.9	38.6	47.5
	C3	13.1	13.01	556.3	578.0	88.7	93.3	24.10	22.91	23.86	24.72	74.16	79.12	1.67	1.67	50.55	49.72	45.02	43.92	9.8	10.2	37.6	48.3
YE1	C1	13.63	12.59	612.0	613.0	89.3	89.3	18.08	17.10	21.13	18.47	81.38	82.14	1.47	1.39	42.6	41.36	34.82	34.61	8.7	9.5	30.4	38.4
	C2	13.42	12.06	637.3	637.3	91.3	98.3	20.46	19.22	20.90	20.85	79.62	80.71	1.61	1.55	48.29	44.81	41.66	37.94	9.2	9.6	32.5	41.5
	C3	13.65	13.02	642.0	648.3	90.0	98.0	20.13	19.58	21.88	21.82	79.93	81.91	1.60	1.58	49.05	45.05	43.53	39.37	9.0	9.9	33.4	41.1
YE2	C1	14.05	13.88	617.0	697.7	89.3	101.0	20.90	19.30	21.75	20.19	81.62	87.25	1.57	1.60	42.7	41.63	36.57	36.44	9.1	9.7	31.5	41.1
	C2	13.52	13.19	644.7	725.7	93.0	107.7	23.94	21.43	23.96	20.33	79.83	86.13	1.80	1.74	49.81	49.36	43.39	42.69	9.3	9.9	34.6	42.8
	C3	13.93	13.86	667.0	745.0	95.0	109.3	24.48	21.54	23.95	20.82	82.04	87.61	1.82	1.80	52.14	50.71	45.86	44.25	9.4	10.1	33.5	43.4
LSD 0.05 Ax B		0.95	0.86	10.01	24.97	0.99	2.05	0.82	0.60	N.S	0.72	1.50	2.49	0.06	0.04	2.88	2.75	1.23	0.89	0.34	0.29	1.59	1.61

C1=solid tomato, C2= maize S.C.176 with intercropping tomato, C3= maize TWC 324 intercropping with tomato

Table 7: Effect of growth stimulants and cropping systems on land equivalent ratio (LER), area time equivalent ratio (ATER) net return and monetary advantage index (MAI) as average of two seasons.

Growth substance	Cropping system	LER			ATER	Net return (L.E. ha-1)	MAI (L.E. ha-1)
		L Tomato	L Maize	LER			
Without	Tx M.176	1.10	0.72	1.82	1.52	39,949	29,517
	Tx M.324	1.12	0.72	1.84	1.54	40,567	30,190
SA1	Tx M.176	1.09	0.74	1.83	1.53	45,463	32,214
	Tx M.324	1.10	0.73	1.83	1.53	45,489	33,056
SA2	Tx M.176	1.19	0.78	1.97	1.65	53,706	38,619
	Tx M.324	1.21	0.78	1.99	1.67	52,414	38,989
YE1	Tx M.176	1.11	0.77	1.88	1.57	46,297	33,637
	Tx M.324	1.12	0.76	1.88	1.57	47,590	35,250
YE2	Tx M.176	1.18	0.82	2.00	1.67	52,488	39,791
	Tx M.324	1.22	0.80	2.02	1.69	53,906	41,263
Solid tomato		1	-	1	-	30,430	
Solid maize SC 176		-	1	1	-	5,179	
Solid maize TWC 324		-	1	1	-	3,255	

Tx M.176 = maize S.C.176 intercropping with tomato, Tx M.324 = maize TWC 324 intercropping with tomato.

Conclusion

Intercropping maize TWC 324 with tomato and spraying with YE2, protected tomato plants during late summer from negative effect of high temperature and increased setting % and marketable yield as well as productivity of unit area and net return.

References

A. O. A. C., 1980. Official Methods of Analysis, 15th Edition. Association of Official Analytical Chemists, Washington, DC.,USA.

Abd El-Aal, A.I.N. and A.A. Zohry, 2003. Natural phosphate affecting maize as a protective crop for tomato under environmental stress conditions at Toshky. Egypt. J. of Argic. Res., 81:937-953.

Abd El-Gaid, M.A., M.H. Al-Dokeshy and D. M.T. Nassef, 2014. Effects of intercropping system of tomato and common bean on growth, yield components and land equivalent ratio in new valley governorate. Asian J. of Crop Sci., 6: 254-261.

Abd El-Hady, M. A., R. A. Marey and M. A. Abou-Keriasha, 2013. Protection of tomato plants against cold and frost conditions by intercropping under Sohag governorate. J. Plant Production, Mansoura Univ., 4 (7): 1077-1096.

Abou-Aly, H.A., 2005. Stimulatory effect of some yeast application on response of tomato plants to inoculation with bio fertilizer. Ann. Agric. Sci., Moshtohor, 43(2): 595-609.

Adams, S.R., K.E. Cockshull and C.R.J. Cave, 2001. Effect of temperature on the growth and Development of Tomato Fruits. Annals of Botany, 88: 869-877.

Agriculture Statistics, 2016. Summer and Nile Crops. Agriculture Statistics and Economic Sector, 2nd Ed., Ministry of Agriculture and Land Reclamation, Egypt.

Agriculture Statistics, 2016. Winter Crops. Agriculture Statistics and Economic Sector, 1st Ed., Ministry of Agriculture and Land Reclamation, Egypt.

Ali, A.A., T.B. Ali and K.A. Nour, 2009. Antioxidants and some natural compounds applications in relation to tomato growth, yield and chemical constituents. Ann. Agric. Sci., Moshtohor, 47(4): 469-477.

Amin, A.A., A.A. Abd El-Kader, A.F. M. Shalaby, F.A.E. Gharib, R. M. El-Sherbeny and J. A. Teixeira da Silva, 2013. Physiological effects of salicylic acid and thiourea on growth and productivity of maize plants in sandy soil. Communication in Soil Sci. and Plant Anal., 44: 1141-1155.

Barnett, J. A., R. W. Payne and D. Yarrow, 1990. Yeast characteristics and identification. Cambradge. Camb. CBZBR, pp 999.

Black, C. A., 1965. Methods of Soil Analysis. Amer. Soc., Agron. Inc., Madison, Wisconsin, USA.

El-Desouky, S.A., El-S. Fathy and S. Farid, 2000. High temperature tolerability in tomato: evaluation of some genotypes for late summer plantings. Ann. Agric. Sci., Moshtohor, 38(1): 179-197.

El-Dissoky, R. A., E. M. Morsy and M. A. El-Shazly, 2013. Beneficial effect of potassium fertilization and yeast strains on maize plants grown on salt affected soil. J. Soil Sci. and Agric. Eng., Mansoura Univ., 4 (9): 827-842.

Gebru, H., K. W. Tsadik and T. Tana, 2015. Effect of planting patterns in tomato (*Lycopersicon esculentum* Mill) and maize (*Zea mays* L.) intercropping on growth, yield and yield traits of the two crops in Wolaita Zone, Southern Ethiopia. J. of Bio., Agric. and Health., 5 (1):39-49.

Hayat, Q., S. Hayat, M. Irfan and A. Ahmad, 2010. Effect of exogenous salicylic acid under changing environment: A review. Envi. and Exp. Botany, 68: 14-25.

Hiebsch, C.K., 1980. Principles of intercropping "Effect of N fertilization and crop duration on equivalence, ratios in intercrops versus monoculture comparisons." PhD. Thesis North Carolina State Univ., Raliegh, N.C.Y. USA.

Hussain, S. A., N. Ali, A. Rab and M. Shah, 2008. Yield and economic dynamics of intercropping in summer vegetables. Sarhad J. Agric., 24, (1):31-36.

Hymowitz, T. F.; P. Collins and W. M. Walker, 1972. Relationship between the content of oil, protein and sugar in soybean seed. Agron. J. 64: 613-616.

Ijoyah, M.O. and J. Jimba, 2011. Effects of planting methods, planting dates and intercropping systems on sweet potato-okra yields in Makurdi, Nigeria. Agric. Sci. Res. J., 1:184-190.

Jackson, M.L., 1973. Soil Chemical Analysis. Prentice Hall of Indian Private Limited New Delhi. 5 (2): 177-184.

Javaheri, M., A. Dadar, M. Babaeian, 2014. Effect of salicylic acid spray in seedling stage on yield and yield components of tomato. J. Appl. Sci. & Agric., 9(3): 924-928.

Javaheri, M., K. Mashayekhi, A. Dadkhah and F.Z. Tavallaee, 2012. Effects of salicylic acid on yield and quality characters of tomato fruit (*Lycopersicum esculentum* Mill).Intl J. Agric. Crop Sci., 4 (16): 1184-1187.

Khan, W., B. Prithviraj and D. L. Smith, 2003. Photosynthetic responses of corn and soybean to foliar application of salicylates. J. Plant Physiol., 160: 485-492.

Khodary, S.F.A., 2004. Effect of salicylic acid on the growth, photosynthesis and carbohydrate metabolism in the salt stressed maize plants. Int. J. Agric. Biol., 6: 5-8.

Lamlom, M. M., Sh. I. Abdel-Wahab, T. I. Abdel-Wahab and E. K. Gendy, 2015. Residual effects of some preceded winter field crops on productivity of intercropped soybean with three maize cultivars. Amer. J. Bio. Sci., 3 (6): 226-242.

Liu H.T., W.D. Huang, Q.H. Pan, F.H. Weng, J.C.Zhan, L.Yan, S.B. Wan and Y.Y. Liu, 2006. Contributions of PIP2-specific-phospholipase C and free salicylic acid to heat acclimation-induced thermo tolerance in pea leaves. J. Plant Physiol., 163(4): 405-416.

Martin-Mex R., E. Villanueva-Couob, T. Herrera-Campos, A. Larque-Saavedra, 2005. Positive effect of salicylates on the flowering of African violet. Sci. Hort. 103: 499-502.

Mohamed, W. KH., N.R. Ahmed and W.M. Abd El-Hakim, 2013. Effect of intercropping, dates of sowing and N fertilizers on growth and yield of maize and tomato. Egypt. J. Appl. Sci., 28 (12B): 625-644.

MSTATC, 1980. A Microcomputer Program of the Design Management and Analysis of Agronomic Research Experiments. Michigan State Univ., USA.

Pino M-de-los, A., M.E. Domini, E. Terry, M. Bertoli and R. Espinosa, 1994. Maize as a protective crop for tomato in conditions of environmental stress. Cultivos Tropicales, 15(2): 60-63. (CAB Abstract 960301572).

Pressman, E., M.M. Peet and D.M. Pharr, 2002. The effect of heat stress on tomato pollen characteristics is associated with change in carbohydrate concentration in the developing anthers. Ann. of Bot., 90:631-636.

Saeed, A., K. Hayat, A.A. Khan and S. Iqbal, 2007. Heat tolerance studies in tomato (*Lycopersicon esculentum* mill.). Int. J. of Agri. & Bio., 9(4): 649-652.

Sharma, N.K. and R.S. Tiwari, 1996. Effect of shade on yield and yield contributing characters of tomato cv. Pusa Ruby. Recent Hort., 3:89-92.

Snedecor, G.W. and W.G. Cochran, 1988. Statistical Methods. 6th Ed. Iowa State Univ. Press, Ames, Iowa, USA., 325-330.

Upadhyay, K.P., M.D. Sharma, S.M. Shakya, G. Ortiz-Ferrara, T.P. Tiwari and R.C. Sharma, 2010. Performance and profitability study of baby corn and tomato intercropping. Pak. J. Agric. Sci., 47 (3): 183-193.

Wanas, A.L., 2006. Trails for improving growth and productivity of tomato plants grown in winter. Ann. Agric. Sci. Moshtohor., 44(3): 214-231.

Wang, L.J. and S.H. Li, 2006. Salicylic acid-induced heat or cold tolerance in relation to Ca2+ homeostasis and antioxidant systems in young grape plants. Plant Sci., 170: 685-694.

Willey, R.W., 1979. Intercropping, its importance and research needs. Part 1: Competition and yield advantages. Field crops Abst., 38: 1-10.

Yang, Z.M., J. Wang, S.H. Wang and L.L. Xu, 2003. Salicylic acid-induced aluminium tolerance by modulation of citrate efflux from roots of Cassia tora L. Planta, 217: 168-174.

Zamaninejad, M, S, K. KhavariKhorasani, M. Jami Moeini, and A.R. Heidarian, 2013. Effect of salicylic acid on morphological characteristics, yield and yield components of corn (*Zea mays* L.) under drought condition. Euro. J. Exp. Bio., 3(2):153-161.