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IMPACT OF N, P and K AND ORGANIC FERTILIZER ON TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) GROWTH AND YIELD UNDER COOL PLASTIC TUNNEL CONDITIONS

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Abstract

The study was conducted in two successive summer seasons (2014/2015 and 2015/2016) in a cooled plastic tunnel at Shambat Research Station, Sudan, to determine the optimum dose of nitrogen, phosphorus, potassium (N, P and K) and organic (Shmookh Eltabeeh) fertilizer combinations to have high tomato growth and yield under evaporative cooling system. Two tomato hybrids, were used namely; Athyla and PGT107. The experiments were carried out in a split plot arrangements based on a randomized complete block design, the two tomato hybrids as main plot and eight fertilizer treatments as sub plot with three replications. The seedlings were transplanted on one side of 80 cm ridges and 40 cm plant spacing. Different combinations of nitrogen, phosphorus and potassium (T_1:13.4 g N + 5.0 g P+ 26.7 g K, T_2: 26.7 g N + 10.0 g P + 53.3 g K and T_3: 40.1 g N + 20.0 g P + 80.0 g K/ m^2) with or without organic fertilizer (2kg/m^2Shmookh Eltabeeh), in addition to a control without fertilizer, were tested. The organic fertilizer was incorporated in soil before planting, whereas the N, P and K doses were added as powder weekly after two weeks from transplanting. The means were compared using Duncan Multiple Range Test (DMRT) at P $\leq$ = 0.05. The results showed that there was no significant difference between the two hybrids in response to N, P and K combinations with or without organic. The results showed that T_2 from N, P and K combinations with or without organic fertilizer gave significant positive effects on all parameters tested in both seasons with the two hybrids. The growth and yield values were decreased with increased fertilizer dose above T_2 showing that excessive N, P and K fertilization (T_3 with or without organic) for high tomato yield under evaporative cooling system is not recommended.

***Keywords*: Tomato (Lycopersicon esculentum Mill.), Green house, Chemical fertilizer, Organic, Growth, yield**

I. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family *Solanaceae,* It is believed to be originated in South America where it grows as a perennial crop, and due to its high value as a crop it was distributed throughout the world [1], [2] and [3]. It is cultivated in large areas throughout the world with an average of 146 million metric tons of fresh fruits and comes second to potatoes in production [4] and [5]. It is a rich source of lycopene, minerals and vitamins (ascorbic acid and *b*-carotene) that acts as anti-oxidants and promotes good health [6].

In Sudan it is considered as one of the most important vegetables (of about 28% of the total area of vegetables) and comes after onion in production. It is grown country widely during the winter months (October – March) in a wide range of soil types [7] and [8].Summer tomato (April - July) can

only be produced [9], under protection technique (special traditional cultural practices to reduce the high temperature effects during flowering and fruit setting). Recently tomato off season production has been widely practiced under evaporative cooling system in plastic tunnels. Cool plastic tunnel tomato hybrids are indeterminate and require constant maintenance and physical support of the plants for long term fruit production. Indeterminate tomato varieties will need additional nitrogen as they continue to grow to produce fruits compared to determinate tomato varieties that stop active vegetative growth and increase production of fruits [10].

Due to seasonality of tomatoes production, sharp fluctuations in prices justify the role of the cool plastic tunnel in stabilizing production and prices. Cool plastic tunnel cultivation increases the production period. On the other hand, they enable off-season production that cannot be practiced under open field. As well, cool plastic tunnel have the merits of obtaining high crop yields in small area [11]. The fertilizer level used in developing countries is very low relative to the recommended level [12]. Fertilizers affect the level of output positively [13]. Use of fertilizers is one of most important factors facing vegetable production in cool plastic tunnel due to the high plants density, and the increased needs for plant nourishment. Use of organic fertilizers alone is not enough to obtain high productivity. Chemical fertilizers used must be high in purity and easily soluble in water [12].

The tomato crop is considered a crop with major fertilization requirements [14]. Commercial growers often apply higher rates than recommended fertilizers levels compared to open field production. [15] stated that response of tomato to urea was high; about 100 kg of urea / fed. Tomato also gave a good response to the application of chicken manure at Soba Research Sub-Station, Sudan. [16] reported that tomato in Khartoum State, Sudan responded to about 80 kg / feddan urea and the optimum rate of nitrogen applied is in a split doses depending on the sowing method. [17] stated that addition of fertilizers is important for getting higher tomato yield and adding high level of nitrogen (86k N/h) produced tomato yield similar to soil dressed with moderate nitrogen level (43kg N/h).

II. OBJECTIVES OF THE STUDIES

The objectives of this study was to investigate the effect of chemical (N, P and K) and organic combinations fertilizer on growth and yield components of two tomato hybrids and to determine the optimum and safe dose of fertilizers to be applied for tomato production in cooled plastic tunnels in Khartoum state, Sudan.

III. MATERIALS AND METHODS

This study was carried out in two successive summer seasons (2014/15 and 2015/16) in cooled plastic tunnel at Shambat Research Station, (Lat. 15^{o} 40′ N, Long.23^{o} 32′ E, and of 380 meters above sea level.) Agricultural Research Corporation (ARC), Sudan. The experimental units were in randomized complete block design (as split plots) with three replications. The two hybrids, namely Athyla and PGT107 used as main plot and fertilizer treatments as sub plot. The fertilizer treatments were as follows:

T_1 : 13.4 g N + 5.0 g P + 26.7 g K/ m^2
T_2 : 26.7 g N + 10.0 g P + 53.3 g K/ m^2
T_3 : 40.1 g N + 20.0 g P + 80.0 g K/ m^2
T_4 : Organic fertilizer 2.0 Kg /m^2.
T_5 : 13.4g N + + 5.0 g P+ 26.7 g K + 2kg organic/ m^2
T_6 : 26.7 g N + 10.0 g P + 53.3 g K +2kg organic / m^2
T_7: 40.1 g N + 20.0 g P + 80.0 g K +2kg organic / m^2
T_8: Control without fertilizers.

Soil in cool plastic tunnel was amended with a loamy soil of ($16m^3$). The experimental area in the cool plastic tunnel was prepared in bed 80cm wide “mustaba”. The spacing between plants

was 40 cm and 80cm interspacing "in mustaba". The plot size was 5.20m X 0.80m. The soil analysis was done before and after planting Table (1a, b and c) and chemical composition of the organic fertilizer used is shown in table (1 d).

Table 1 a: The experimental soils analysis before planting

Depth (cm)	$CaCo_3$ %	Mechanical analysis			Exchangeable Bases			O.C.	N	C/N
		Sand	Silt	Clay	Na	K	CEC			
0 - 30	5.8	34	42	24	1.4	0.4	25	0.390	0.037	11
30 – 60	5.9	33	40	27	1.3	0.7	27	0.468	0.038	12

Depth	Ava. P (ppm)	pH	EC ds/ m	Soluble cation and anions					Bulk density		Available moisture capacity (%)	
				Na	Ca	Mg	cl	HCo_3	Dry	wet	Wt.	Vol.
0 - 30	4.2	8.1	0.9	6.6	1.3	0.3	2.1	3.1	1.10	1.91	20.5	23.0
30 – 60	4.3	7.9	1.0	6.4	1.5	0.5	2.2	3.4	1.05	1.88	18.6	20.1

Table 1 b: The experimental soils analysis after first harvest: (first season)

Depth (cm)	$CaCo_3$ %	Mechanical analysis			Exchangeable Bases			O.C.	N	C/N
		Sand	Silt	Clay	Na	K	CEC			
0 - 30	4.0	33	41	26	1.72	0.60	26	0.390	0.039	11
30 – 60	4.2	31	42	27	1.61	0.80	26	0.468	0.038	12

Depth	Ava. P (ppm)	pH	EC ds/ m	Soluble cation and anions					Bulk density		Available moisture capacity (%)	
				Na	Ca	Mg	Cl	HCo_3	Dry	wet	Wt.	Vol.
0 - 30	4.1	8.0	0.97	6.8	1.4	0.5	2.0	2.9	1.80	1.40	20.3	23.0
30 – 60	4.0	7.9	1.0	6.7	1.9	0.4	2.3	3.2	1.83	1.69	18.2	20.0

Table 1 c: The experimental soils analysis after second harvest: (second season)

Depth (cm)	$CaCo_3$	Mechanical analysis			Exchangeable Bases			O.C.	N	C/N
		Sand	Silt	Clay	Na	K	CEC			
0 - 30	5.85	34	42	24	1.5	0.957	25	0.02	0.084	*
30– 60	4.73	35	35	30	1.8	0.581	26	0.11	0.083	*

Depth	Ava. P (ppm)	pH	EC ds/m	Soluble cation and anions					Bulk density		Available moisture capacity (%)	
				Na	Ca	Mg	cl	HCo_3	dry	Wet	Wt.	Vol.
0 - 30	3.2	8.1	0.556	1.6	6.5	1.5	*	2.9	*	0.0	14.3	20.27
30 – 60	1.9	8.1	0.500	1.5	1.7	7.5	*	3.0	*	2.21	20.70	29.30

Table (1 d): Organic matter analysis

Organic fertilizer	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	O.C. (%)
	1.3 - 1.5	1.9 – 2.2	4 - 7	3 – 5	1 -1.5	2.5- 3.5	20 – 24

The condition was controlled by evaporative cooling to provide temperature range (25 - 30^{o}C) and relative humidity of 65 - 77% at mid-day. Organic fertilizer was added 2kg /m^2 before transplanting. Nursery raised seedlings of both cultivars were planted on one side of 80 cm ridges and 40 cm plant spacing. Each experimental unit consisted of two north - south ridges (1.60m in width) and 5.20m in length. N, P and K combinations were added in equal doses weekly after two weeks from transplanting. Irrigation was done by using drip system and applied every day for 15 – 20 minutes. Chemical pests and diseases control, weeding and pruning of side branches were done when necessary. The crop harvest started after two and half months from transplanting and continued for three months. Fruit picking was done at 3 – 4 days interval for two month and weekly for the last month. The data collected were plant height, number of leaves/ plant, number of fruits/plant, fruit weight and yield/plant and per unit area (m^2).

Data were subjected to analysis of variance by computer program Gen Stat. The means were separated using Duncan's Multiple Range Test (DMRT) at P ≤ 0.05.

IV. RESULTS AND DISCUSSION

Growth parameters

The results in Table 2 and 3 showed that there was no significant difference between hybrids in response to N, P and K combinations with or without organic. The results also showed that the moderate dose T_2 (26.7 g N + 10.0 g P + 53.3 g of K/ m^2) with (2kg/m^2 of organic) or without organic fertilizer gave the highest plants with the highest number of leaves in both seasons, compared to the high dose (40.1 g N + 20.0 g P + 80.0 g K/ m^2) with or without organic which negatively affected both plant height and number of leaves / plant in both seasons. The highest plants of both hybrids (Athyla and PGT107) were (183.3 and 195 cm, respectively) with T2 alone in the first season and with organic were 198.3 cm of cultivar PGT107 in second season. The significant increase in growth may be due to N/K level of fertilizer used was optimum to promote tomatoes growth. This is in line with [18] who found that the highest tomato growth was obtained at (8.0kg+3.0kg+16.0kg NPK/300m^2). Moreover [19] reported that high levels of fertilizers used have a negative effect on tomato growth and yield. [20] stated that high accumulation of N, P and K in stems and leaves results in stunted plants. The result reflected that the excess use of fertilizers by tomatoes green house producers is not economically.

Table (2). Effect of chemical (N, P and K) and organic fertilizers on plant height (cm) of two tomato hybrids under cooled plastic tunnel

Treatments	Plant height (cm) Season 2014/015		Mean	Plant height (cm) Season2015/016		Mean
	Athyla	PGT107		Athyla	PGT107	
13.4 g N + 5.0 g P+ 26.7 g K/ m^2	175.3^{bc}	176.0^{bc}	175.7^{bc}	175.7^{ef}	186.1^{cd}	180.9^{b}
26.7 g N + 10.0 g P + 53.3 g K/ m^2	183.3^{ab}	195.0^{a}	189.2^{a}	185.5^{cd}	196.0^{ab}	190.8^{a}
40.1 g N + 20.0 g P + 80.0 g K/ m^2	157.3^{de}	164.3^{de}	160.8^{cd}	172.6^{fg}	181.7^{de}	177.2^{cd}
Organic fertilizer 2.0 kg /m^2.	149.3^{ef}	161.0^{de}	155.2^{d}	173.3^{fg}	184.0^{cd}	178.7^{bc}
13.4g N + + 5.0 g P+ 26.7 g K + 2kg organic/ m^2	162.0^{de}	166.0^{cd}	164.0^{cd}	173.9^{fg}	189.3^{bc}	181.6^{b}
26.7 g N + 10.0 g P + 53.3 g K +2kg organic / m^2	176.7^{bc}	178.7^{bc}	177.7^{b}	184.3^{cd}	198.3^{a}	191.3^{a}

40.1 g N + 20.0 g P + 80.0 g K +2kg organic / m^2	134.0^{f}	133.3^{f}	133.7^{e}	167.3^{gh}	170.0^{fg}	168.7^{de}
Control (without fertilizer)	144.7^{ef}	160.0^{de}	152.4^{d}	166.7^{gh}	164.0^{h}	165.4^{e}
Mean of hybrids	160.4	166.8		174.9	184.8	
SE ±	2.40			2.48		
CV%	6.15			2.90		

± Means with the same letters in the same column are not significantly different at P ≤ 0.05

Table (3). Effect of chemical (N, P and K) and organic fertilizers on number of leaves per plant of two tomato hybrids under cooled plastic tunnel

Treatments	Number of leaves/ Plant Season 2014/015		Mean	Number of leaves/ Plant Season 2015/016		Mean
	Athyla	PGT107		Athyla	PGT107	
13.4 g N + 5.0 g P+ 26.7 g of K/ m^2	32^{cd}	35^{ab}	34^{bc}	28^{bc}	29^{bc}	29^{bc}
26.7 g N + 10.0 g P + 53.3 g of K/ m^2	37^{a}	37^{a}	37^{a}	30^{b}	30^{b}	30^{b}
40.1 g N + 20.0 g P + 80.0 g of K/ m^2	30^{cd}	29^{ef}	30^{c}	26^{de}	27^{cd}	27^{d}
Organic fertilizer 2.0 kg /m^2	33^{bc}	34^{bc}	34^{bc}	28^{bc}	27^{cd}	28^{c}
13.4g N + + 5.0 g P+26.7 g of K+ 2kg organic/ m^2	32^{cd}	31^{de}	32^{c}	29^{bc}	29^{bc}	29^{bc}
26.7 g N + 10.0 g P + 53.3g of K +2kg organic / m^2	35^{ab}	36^{a}	36^{b}	33^{a}	32^{a}	33^{a}
40.1 g N +20.0 g P + 80.0 g of K+2kg organic / m^2	31^{de}	29^{ef}	30^{c}	29^{bc}	26^{de}	28^{c}
Control (without fertilizer)	29^{ef}	28^{f}	29^{d}	24^{f}	25^{ef}	25^{e}
Mean of hybrids	32.6	33.3		28.0	28.0	
SE±	1.02			0.69		
CV %	5.70			4.60		

±Means with the same letters in the same column are not significantly different at P ≤ 0.05

Yield and yield components

As shown in Table 4 the results showed that the dose (26.7 g N + 10.0 g P + 53.3 g of K/ m^2) with or without organic recorded high significant differences in fruit weight in both seasons. In the first season the heaviest fruits were (158.3 g and 144.3g) for hybrid Athyla and PGT107 respectively. The heaviest fruits of Athyla (135.0g) were obtained at (26.7 g N + 10.0 g P + 53.3 g K + 2kg organic/m^2) and from the same dose without organic for hybrid PGT107 (126.7g) in the second season. The results also showed that there was no significant difference between hybrids in response to N, P and K combination with or without organic.

Table (4). Effect of chemical (N, P and K) and organic fertilizers on average fruits weight (g) of two tomato hybrids under cooled plastic tunnel

Treatments	Mean fruit weight (g) Season 2014/015		Mean	Mean fruit weight (g) Season 2015/016		Mean
	Athyla	PGT107		Athyla	PGT107	
13.4 g N + 5.0 g P+ 26.7 g of K/ m^2 .	140.0^{bc}	136.7^{c}	138.4^{c}	133.7^{ab}	123.3^{de}	128.5^{a}
26.7 g N + 10.0 g P + 53.3 g of K/ m^2 .	158.3^{a}	144.3^{b}	151.3^{a}	131.7^{bc}	130.0^{bc}	130.9^{a}
40.1 g N + 20.0 g P + 80.0 g of K/ m^2	121.7^{de}	127.7^{d}	124.7^{cd}	126.0^{de}	121.7^{ef}	123.9^{ab}
Organic fertilizer 2.0 kg /m^2.	123.0^{de}	119.0^{e}	121.0^{d}	125.0^{de}	113.3^{fg}	118.4^{bc}

13.4g N + + 5.0 g P+ 26.7 g of K + 2kg organic/ m^2	137.5^{c}	135.7^{cd}	136.6^{c}	128.3^{cd}	125.0^{de}	126.7^{a}
26.7 g N + 10.0 g P + 53.3 g of K +2kg organic / m^2	151.7^{ab}	140.7^{bc}	146.2^{b}	135.0^{a}	120.0^{ef}	127.5^{a}
40.1 g N + 20.0 g P + 80.0 g of K +2kg organic / m^2	113.3^{ef}	102.0^{f}	107.7^{e}	124.0^{de}	121.5^{ef}	122.8^{ab}
Control (without fertilizer)	116.7^{ef}	123.3^{de}	120.0^{d}	118.3^{fg}	111.7^{g}	115.8^{c}
Mean of hybrids	132.8	128.7		127.7	125.4	
SE±	3.63			2.59		
CV %	4.40			3.80		

± Means with the same letters in the same column are not significantly different at $P \leq 0.05$.

As shown in Table 5 and 6 the yield / plant (fruits weight and number) were also positively affected by fertilizer application. The highest fruit weight and fruit number per plant recorded from T_2 without organic for both hybrids in both seasons, whereas there was no significant difference between hybrids in response to N, P and K combinations with or without organic. Increasing of fertilizer above T_2 with or without organic gave insignificant increase in fruit yield and number compared to control.

Table (5). Effect of chemical (N, P and K) and organic fertilizers on fruits yield (kg/ plant) of two tomato hybrids under cooled plastic tunnel

Treatments	**Fruit yield/ plant (kg) Season 2014/015**		**Mean**	**Fruit yield/plant (kg) Season 2015/016**		**Mean**
	Athyla	**PGT107**		**Athyla**	**PGT107**	
13.4 g N + 5.0 g P+ 26.7 g of K/ m^2	6.0^{bc}	6.2^{bc}	6.1^{bc}	6.3^{bc}	5.8^{bc}	6.1^{b}
26.7 g N + 10.0 g P + 53.3 g of K/ m^2	7.5^{a}	7.1^{a}	7.3^{a}	7.9^{a}	7.3^{ab}	7.6^{a}
40.1 g N + 20.0 g P + 80.0 g of K/ m^2	5.0^{de}	4.3^{de}	4.7^{d}	5.1^{cd}	4.8^{cd}	5.0^{c}
Organic fertilizer 2.0 kg /m^2	5.5^{cd}	5.1^{cd}	5.3^{c}	5.9^{bc}	5.4^{cd}	5.7^{c}
13.4g N + + 5.0 g P+ 26.7 g of K + 2kg organic/ m^2	6.3^{bc}	6.0^{bc}	6.2^{bc}	6.8^{ab}	6.5^{ab}	6.7^{b}
26.7 g N + 10.0 g P + 53.3 g of K +2kg organic / m^2	7.2^{a}	6.8^{ab}	7.0^{ab}	7.6^{a}	7.0^{ab}	7.3^{a}
40.1 g N + 20.0 g P + 80.0 g of K +2kg organic / m^2	4.7^{de}	4.2^{de}	4.5^{d}	4.9^{de}	4.4^{de}	4.7^{d}
Control (without fertilizer)	4.0^{de}	3.6^{e}	3.8^{e}	4.3^{de}	3.9^{e}	4.1^{e}
Mean of hybrids	5.8	5.4		6.0	5.5	
SE±	0.35			0.82		
CV %	4.0			9.4		

± Means with the same letters in the same column are not significantly different at $P \leq 0.05$.

Table (6). Effect of chemical (N, P and K) and organic fertilizers on number of fruits / plant of two tomato hybrids under cooled plastic tunnel

Treatments	**Number of fruit/ plant Season 2014/015**		**Mean**	**Number of fruit / plant Season 2015/016**		**Mean**
	Athyla	**PGT107**		**Athyla**	**PGT107**	
13.4 g N + 5.0 g P+ 26.7 g of K/ m^2	49^{ab}	46^{cd}	48^{b}	49^{bc}	45^{cd}	47^{bc}
26.7 g N + 10.0 g P + 53.3 g of K/ m^2	52^{a}	50^{ab}	51^{a}	58^{a}	57^{a}	57^{a}
40.1 g N + 20.0 g P + 80.0 g of K/ m^2	40^{ef}	35^{g}	38^{e}	42^{cd}	41^{cd}	42^{c}
Organic fertilizer 2.0 kg /m^2	46^{cd}	44^{de}	45^{c}	48^{bc}	47^{bc}	48^{b}
13.4g N + + 5.0 g P+ 26.7 g of K + 2kg organic/ m^2	48^{bc}	45^{cd}	47^{c}	54^{ab}	51^{bc}	53^{ab}
26.7 g N + 10.0 g P + 53.3 g of K +2kg organic / m^2	51^{a}	49^{ab}	50^{a}	56^{ab}	54^{ab}	55^{ab}
40.1 g N + 20.0 g P + 80.0 g of K +2kg organic / m^2	43^{de}	41^{e}	42^{d}	40^{de}	37^{e}	39^{d}

Control (without fertilizer)	35^{g}	32^{h}	34^{f}	36^{ef}	34^{f}	35^{e}
Mean of hybrids	46	43		48	46	
SE±		1.97			3.45	
CV %		4.70			7.10	

± Means with the same letters in the same column are not significantly different at $P \leq 0.05$.

Table 7 presented the fruit yield /m^2. In both seasons T_2 (26.7 g N + 10.0 g P + 53.3 g of K/ m^2) recorded the highest fruit yield kg/m^2 for both hybrids. Increasing of fertilizer above the moderate N, P and K dose plus organic fertilizers (T_2 + 2kg of organic/m^2) showed no significant increase in fruit yield /m^2.

Similar results were obtained by [18] who obtained highest fruit yield and its components (fruit weight and number /plant) with 8.0kg+3.0kg+16.0kg NPK/300m^2. [21] found that higher level of nitrogen(275ppm)affected negatively fruit yield of tomato. [22] reported that excess fertilizer gave no significant increase of tomato yield and fruit number compared to control. Moreover, [23] and [24] stated that low doses of NPK showed no significant increase in fruit yield of tomato compared to control (without fertilizer).

Table (7). Effect of chemical (N, P and K) and organic fertilizers on fruits yield (kg/m^2) of two tomato hybrids under cooled plastic tunnel

Treatments	**Fruit yield(kg/m^2) Season 2014/015**		**Mean**	**Fruit yield (kg/m^2) Season 2015/016**		**Mean**
	Athyla	**PGT107**		**Athyla**	**PGT107**	
13.4 g N + 5.0 g P+ 26.7 g of K/ m^2	22.5^{bc}	21.1^{cd}	21.8^{b}	21.0^{bc}	20.0^{bc}	20.5^{bc}
26.7 g N + 10.0 g P + 53.3 g of K/ m^2	26.0^{a}	24.0^{b}	25.0^{a}	24.5^{a}	23.1^{a}	23.5^{a}
40.1 g N + 20.0 g P + 80.0 g of K/ m^2	17.7^{e}	15.2^{fg}	16.5^{d}	18.4^{cd}	19.1^{cd}	18.8^{cd}
Organic fertilizer 2.0 kg /m^2	19.0^{d}	17.1^{ef}	18.1^{c}	21.2^{bc}	19.5^{cd}	20.4^{bc}
13.4g N + + 5.0 g P+ 26.7 g of K + 2kg organic/ m^2	21.5^{cd}	21.0^{cd}	21.3^{b}	23.0^{ab}	21.0^{bc}	22.2^{b}
26.7 g N + 10.0 g P + 53.3 g of K +2kg organic / m^2	24.5^{b}	23.0^{bc}	23.8^{ab}	24.0^{a}	22.1^{ab}	23.1^{a}
40.1 g N + 20.0 g P + 80.0 g of K +2kg organic / m^2	17.0^{ef}	15.0^{fg}	16.0^{d}	19.0^{cd}	17.0^{de}	18.0^{cd}
Control (without fertilizer)	14.2^{gh}	12.6^{i}	13.4^{e}	14.1^{e}	15.0^{e}	14.6^{d}
Mean of hybrids	20.1	18.7		20.7	19.7	
SE±		0.21			0.66	
CV %		4.50			7.60	

± Means with the same letters in the same column are not significantly different at $P \leq 0.05$.

[3] and [25] stated that moderate doses of Phosphorus and potassium were associated with optimum tomato growth and yield. Whereas low or excessive doses of both led to stunted growth and low yield.

V. CONCLUSION

The above results showed that the moderate dose (26.7 g N + 10.0 g P + 53.3 g of K/ m^2) with or without organic fertilizer significantly increased tomato growth and yield under evaporative cooling system, whereas no significant increase in both were obtained at higher doses (40.1 g N + 20.0 g P + 80.0 g K/ m^2) with or without organic fertilizer compared to control under evaporative cooling system.

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