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Full Length Research Paper

Control of nitrogen and potassium fertilizer rates on pepper and tomato yield and nutrient uptake under field conditions

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The influence of nitrogen (N) and potassium (K) fertilizers on pepper (*Capsicum annuum* L.) and tomato (*Lycopersicon esculentum Mill*) growth, fruit production and nutrient uptake was determined under field conditions for two successive years. The aim of the experiment was to determine the optimum N and K fertilizer rate for yield and quality parameters. Experiments were carried out during the two consecutive growing seasons of 1997-1998 at the Agricultural Research Station of Çukurova University, Adana, Turkey. A split plot design with three replications was used with each block containing three treatments 0, 100 and 200 Kg ha-^{1} of N and K_2O. Nitrogen was used as NH_4NO_3 and K used as K_2SO_4. Results revealed that the pepper and tomato plants have responded significantly ($P< 0.001$) to the nitrogen fertilizer (100 and 200 kg N ha^{-1}) by increasing plant length, yield and nutrient content. However, potassium fertilizers have less effect on both plant parameters. Increasing N addition increased tomato and pepper plant yield, however increasing K addition did not make a significant ($P< 0.277$, 827 respectively) difference on the yield of either plant. Under high nitrogen and potassium fertilizer application, flowering time was earlier than that of the control plants. Nitrogen treatments increased the plant N, P and K concentration. The study showed that K fertilizer has no significant influence on nutrient concentration. Results have shown that pepper plants have a higher K content than tomato plants.

Key words: Pepper, tomato, nitrogen, potassium, fertilizer, nutrient uptake.

INTRODUCTION

Pepper and tomato are considered to be the most important vegetable crops in the Mediterranean region. Golcz et al. (2012) have reported that the total yield, marketable yield, commercial fruit yield and total average yield per plant were increased by increasing application rates of nitrogen (N) and potassium (K) fertilizers on pepper plant. Previously, Golcz et al. (2012) stated that chilli pepper has the greatest requirement for potassium (40%) and nitrogen (31%) in relation to the total amount of absorbed nutrients.

Increasing the productivity of horticultural fruits with good yield and quality is an important goal for the growers to market and export. The study of Huang and Snapp (2009) and Liu et al. (2008) showed the high amount of quality which was influenced by high amount of K or the greatest amount of K fertilizer application which was associated with increased cracbioassaytibility as indicated by a fruit bioassay. It is currently a common agricultural practice by farmers to use an excess amount of K fertilizers especially for horticultural cash crops

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(El-Bassiony, 2006). In vegetable crops, the yield response to nitrogen and potassium is also important for plant quality. Most of the time farmers use too much or too less fertilizer and as a consequence the yield and quality of the plant are affected.Horticultural crop species such as pepper and tomato are grown in the field and greenhouse and traditionally fertilized with high levels of chemicals. The solanaceas vegetable crops of pepper and tomato generally take up large amounts of nutrients from the soil (Mengel and Kirkby, 1980). In recent years, because of increased levels of nitrate in groundwater associated with high rates of N applied to crops, improved nitrogen management has become an important issue for safe agriculture. The application of N and K fertilizer are important for better nutrient management. Growers and farmers need to manage the fertilizer for better quality of fruit production.

Many studies have shown that there is a linear relationship between relative growth rate and plant nitrogen concentration. Nitrogen is especially important for horticultural plants. Also, since potassium is very important for horticultural crop quality, it is important to use N and K applications for major horticultural plant species in the Mediterranean region (El-Bassiony, 2006; Savvas et al., 2008). It has been reported that potassium fertilizer increases plant growth (Al-Karaki, 2000; Gupta and Sengar, 2000) yield, quality (Nanadal et al., 1998) and the chemical composition of the tomato (Al-Karaki, 2000; Gupta and Sengar, 2000).

Potassium is considered to be one of the most essential elements for the growth and development of plants (Ortas et al., 1999). Zhen et al. (1996) and Renner et al. (1995) studies have proved that K plays a major role in many physiological and biochemical processes such as enzyme activation; metabolism of carbohydrates and protein compounds. Potassium is the most prominent inorganic chemical influencing plant physiology (Marschner, 1995). Also potassium has a significant role to play in the plant energy status for storage of assimilates and tissue water relation. K plays a key role in crop quality (El-Bassiony, 2006; Mengel and Kirkby, 1980, 1987). K also improves the size of the fruit and stimulates root growth (Marschner, 1995; Mengel and Kirkby, 1980). Zhen et al. (1996) reported that the N, P and K uptake of eggplant seedlings increased with increasing application rates of N, P, K fertilizers. Johnson and Decoteau (1996) indicated that biomass, fruit count, and fruit weight per plant increased linearly with increasing K rate.

In general, although several varieties of pepper and tomato are used under filed conditions with high levels of fertilizer application, it is still not known exactly how much N and K need to be used under semi-arid Mediterranean soil conditions. Farmers decide to use high K because of high quality and use N because of high yield. So it is necessary to determine the N and K fertilizer requirements. Previously, Altunlu et al. (1999) tested nine different nutrient solutions containing 100, 200 and 300 $mg.kg^{-1}$ of N and K in various combinations on cucumbers (cv. Alara) grown in a greenhouse and they found that N influenced plant growth, yield and fruit quality. They also concluded that the N concentration of the nutrient solution should not be more than 200 $mgkg^{-1}$. Guertal (2000) used a slow release fertilizer for pepper plants and found that for pepper yield the maximum recommended rate of nitrogen is 135 kg N ha^{-1}.

Also very recently, fertigation is becoming a popular fertilization and water management practice. However, it is necessary to know how much fertilizer is needed for optimum yield for pepper and tomato plants. Since chemical nitrogen and potassium fertilizers are imported from outside they are very expensive fertilizers in developing countries. The aim of the study was to determine the influence of nitrogen and potassium fertilizer rates on pepper and tomato yield and nutrient uptake under field conditions.

MATERIALS AND METHODS

The experiment was carried out during the two successive growing seasons of 1997 and 1998 on the Arık soil series (*Entic Chromoxerert*), located at the Agriculture Faculty Research Farm, University of Çukurova, in the Eastern Mediterranean region of Turkey (37°00.47.75 N latitude and 35°21′.31.92 E altitude longitude 33 m.a.s.l.). Chemical and physical properties of soil are presented in Table 1.

Seedling production

Pepper seedling (*Capsicum annuum* L.) and tomato (*Lycopersicon esculentum Mill*), seedlings were produced under greenhouse conditions. For tomatoes (CV. SC2121) and peppers, (CV. Local Kahramanmaras) bred in the eastern Mediterranean region of Turkey seeds were sown in a sand: soil: organic matter (7:2:1 v/v) growth medium. The seedlings were grown in a greenhouse for 38 days before being transferred to the main field plots. In the early spring time, seedlings were produced and at the beginning of May were transplanted to the field.

Field experiment

The experimental design was arranged in split plots design with three replicates. Pepper seedlings were grown in plots 4 m long and 2.5 m wide and spaced at a distance of 50 cm. Tomato seedlings were planted on 4 m long and 3 m wide and ridges of 60 cm. Each plot for pepper in the plot area was 10 m^2 and for tomato 12 m^2. Treatments of N and K were applied at three rates 0, 100 and 200 Kg ha^{-1} of N and K_2O. Nitrogen was used as NH_4NO_3 and K used as K_2SO_4. In each block, 60 kg P_2O_5 kg ha^{-1} were applied as Triple superphosphate (TSP). N and K fertilizer levels were applied to the soil three times at equal and constant levels (the first portion was applied at sowing stages, the second one after transplanting and the third one was applied as top-dressing at the flowering stage.

Harvest and measurement

At harvest, fruits at the mature stage were harvested. Vegetative

Table 1. Selected physical, chemical and biological properties of Menzilat soil series.

Properties	Unit	Depth (cm)
		0-20
Sand	%	12.9
Loam		33.0
Clay		54.1
$CaCO_3$		17.1
Organic matter		1.32
Total salt (soluble)		0.058
pH (H_2O)		7.40
CEC	$Cmol^+$/kg	30.4
P_2O_5 (1)	kg/ha	80.6
K (2)	(mg^{-1} kg)	850
N (total)	(%)	0.11
Zn (3)	(mg^{-1} kg)	0.30
Fe (3)		1.58
Cu (3)		0.20
Mn (3)		3.0

0.5 N $NaHCO_3$ extractable Mans (three replicates); 1 N HNO_3 extractable; DTPA extractable.

growth parameters, plant length (cm), early flowering time, and numbers of fruit were measured and total yield was recorded.

Plant analysis

At flowering stages, samples of leaves were collected and oven dried at 65°C then fine ground and wet digested. Plant materials were ashed at about 550°C, and the residues were dissolved in 3.3% HCl. After the digestion of the plant material, the concentration of P in this solution was determined by spectrophotometer, micronutrients were analyzed by atomic absorption spectrophotometer (Perkin Elmer Corp.,), and total N was analyzed by Kjeldahl apparatus. The content of K was determined using a flamephotometer (Ortas et al., 1999). The concentration of Zn, Fe, Cu, and Mn were determined by an atomic absorption spectrophotometer.

Statistical analysis

The results were expressed as mean values. All data were subjected to analysis of variance (ANOVA) for a completely randomized split design. Statistical Analysis System (SAS, 2009) software programs were used to conduct the ANOVA. Significances of treatment means were determined at P<0.05 with Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Two field experiments were carried out during the two successive seasons of 1997-1998 at the Agricultural Research Station of Çukuroava University. In this study, ammonium sulphate and potassium sulphate were used in the levels of 0, 100 and 200 Kg ha^{-1} of N and K_2O.

Statistical analysis showed that in both years, N treatments were significantly effective for yield of tomato and pepper plant (P>0.001) (Table 2). Statistical analysis of growth parameters showed no significant influence of K treatment on shoot dry weight (Table 2).

The response of pepper and tomato plants to mineral N and K fertilization are presented in Figures 1 and 2. In the two seasons, data presented in Figure 1 clearly showed that N application had a significant effect on plant length. In N0 treatment, increased K application increased plant length for all measurements. K has a significant effect on photosynthesis which is related with number of leaf size. Oseni et al. (2010) reported that the number and leaf size, which plays an important role in tomato seedling growth and development.

Data presented in Figure 1 shows that for both plant species of pepper and tomato, increasing N addition increased yield. Results in Figure 2 indicate that there were no significant differences between both years in the pepper plant's yield. However, for tomato plants the second year's yield was higher than the first. For pepper plants, although N addition increased yield, also the highest values were recorded when using 100 and 200 Kg NH_4NO_3. The highest values of total yield (29181 Kg ha^{-1}) were recorded with N_2K_2 nitrogen and potassium application in pepper plants in the year 1997. Such results were in agreement with the results reported by Guertal (2000) who found that in a three-year experiment under Alabaman conditions maximum pepper yields were obtained with 135 kg/ha N addition. Under eggplant and

Table 2. Significance of P-values (probability) from analysis of variance for plant yield and nutrient parameters (in shoot).

Nutrient parameter	S.D	N	P	K	Zn	Fe	Cu	Mn	Yield
1997					**Pepper**				
N	2	0.001	0.008	0.001	0.071	0.533	0.484	0.308	0.001
K	2	0.571	0.852	0.001	0.392	0.466	0.968	0.479	0.277
NxK	4	0.886	0.964	0.868	0.632	0.975	0.888	0.797	0.632
1998									
N	2	0.019	0.027	0.005	0.275	0.690	0.085	0.586	0.001
K	2	0.988	0.857	0.073	0.870	0.551	0.833	0.676	0.172
NxK	4	0.127	0.930	0.982	0.980	0.984	0.656	0.836	0.769
1997					**Tomato**				
N	2	0.008	0.001	0.090	0.295	0.060	0.108	0.497	0.001
K	2	0.510	0.233	0.001	0.814	0.810	0.957	0.832	0.798
NxK	4	0.948	0.634	0.740	0.839	0.494	0.664	0.981	0.996
1998									
N	2	0.001	0.179	0.001	0.001	0.060	0.100	0.600	0.001
K	2	0.974	0.697	0.007	0.971	0.810	0.775	0.868	0.827
NxK	4	0.835	0.811	0.972	0.722	0.494	0.640	0.716	0.995

***, **, *; 0.001, 0.01, 0.05 ad > 0.05 respectively.

pepper intercropping system, Aminifard et al. (2010) observed that fertilization with 0 Kg N ha^{-1} resulted in the best fruit weight and plant yield. Liu et al (2008) suggested that the application of N fertilizer did not have any effect upon tomato yield, whereas application of K fertilizer did increase the yield.

The results showed that the N applied to soil in 100 and 200 kg N ha^{-1} treatments gave the highest vegetative growth and total yield for tomato plants for both years. Lara et al. (2008) reported that nitrogen fertilization significantly increased plant growth and fruit yield. Nitrogen supply is crucial for tomato yield and quality (Savvas et al., 2008). In both years, for both plants, in N0 treatment increasing K application slightly increased the yield.

Also although K fertilizer has no significant effect on plant yield, obtained data showed that the highest yields were observed with soil application of 200 Kg/ha potassium sulphate. Melton and Dufault (1991) found that K did not significantly influence any of the growth variables of tomato plants.

The effect of nitrogen and potassium fertilizers on N, P and K percentage in the leaves of plants were determined. The results reported in Table 3 show that there were significant differences with N and K application on plant tissue N, P and K content. Increasing N application increased plant tissue N concentration in both years for pepper and tomato plants. Plant P concentration also increased with increasing N application. Plant K concentration also slightly increased with N level addition. However, there was no significant effect between 100 and 200 K kg ha^{-1} on nitrogen concentration. Since the initial soil had available K content, and consequence most probably both plants accumulated high K in their tissue without any influence on plant growth. These results have coincided with those by Johnson and Decoteau (1996) who found that plant tissues have high K content without any toxic affect.

Nitrogen treatment statistically increased pepper plant P concentration for both years. However, tomato plants in the 1997 N treatment significantly increased P concentration, but in 1998 the response was low (Table 3).

In general, according to data presented in Table 3, pepper plant nutrient content is higher than tomato plants. The K:N ratio varied between N and K treatments and with values greater than > 1.0 in the K treatments. The obtained results coincided with those of found by Lara et al. (2008). Huang and Snapp (2009) reported that moderate K rates were associated with the greatest marketable yield, and the 1N:1.7K ratio plus foliar B nutrient regime produced the greatest quality fruit.

Especially Fe, Cu, Mn and Zn content in pepper plants compared to tomato plant are higher (Table 4). In the second year's experiment for both plants, plant tissue Mn content is higher and increasing N level increased Mn content. Also in pepper plant, Zn uptake increased with N addition. However, increasing K level did not make any significant contribution to micronutrients. Although statistically there is no significant contribution of N application on microelements uptake, in tomato plants for the year 1998, N treatment significantly increased Zn uptake. The data in Table 2 reports that the interaction between N and K application had no statistically significant effect on Mn, Fe and Cu content for either plant. The results were true in the two years. Plant

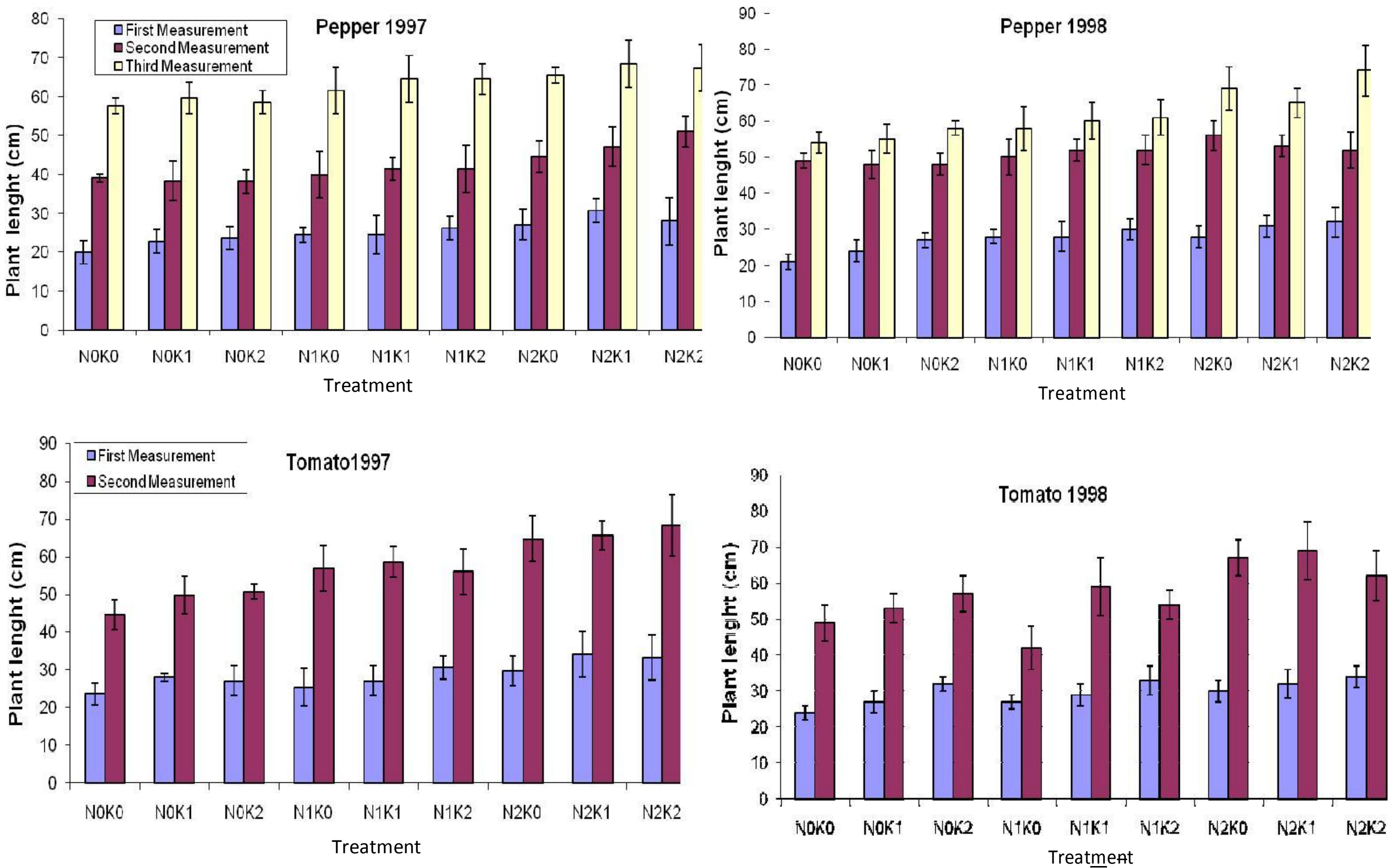

Figure 1. Nitrogen and potassium doses application on pepper and tomato plant length (cm) at several time measurements.

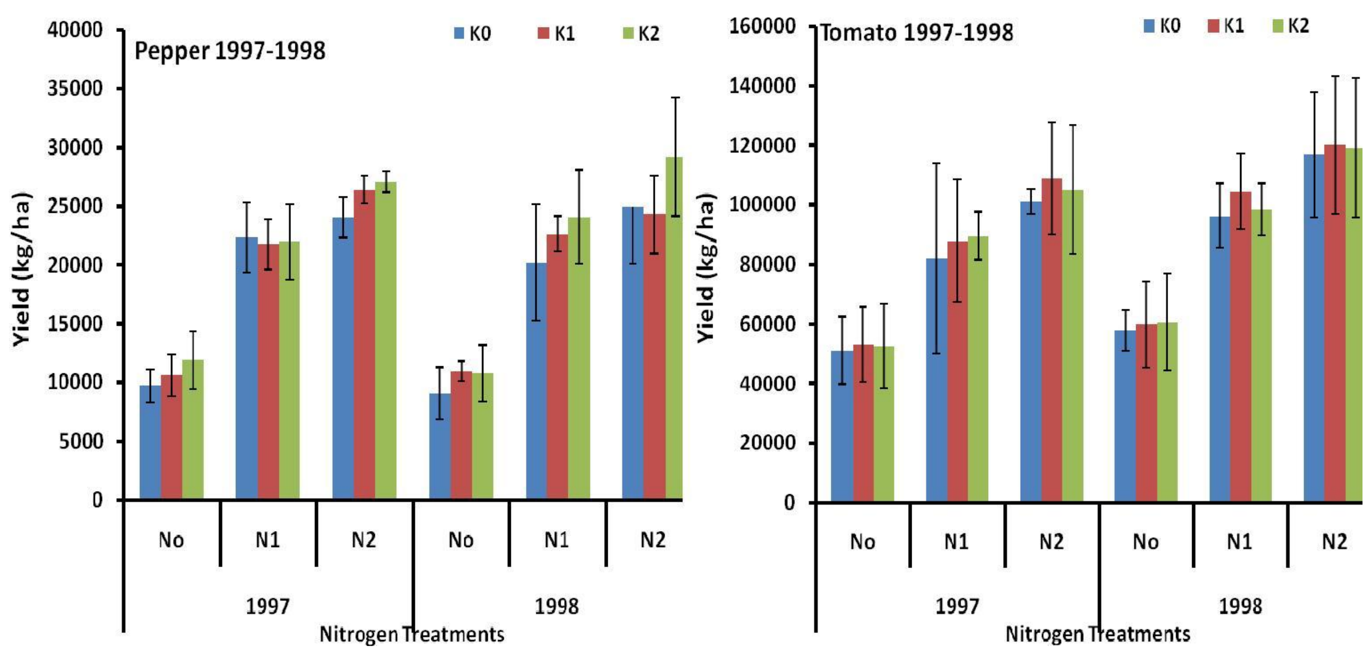

Figure 2. Nitrogen and potassium doses application on pepper and tomato yield.

Table 3. The effect of nitrogen and potassium doses on pepper and tomato N, P and K concentration.

	Year 1997						Year 1998					
Treatment	**%N**		**%P**		**%K**		**%N**		**%P**		**%K**	
Pepper												
N0K0	2.59	0.3± b	0.20	0.0±a	2.43	0.2±d	3.29	0.3±b	0.22	0.0±a	3.30	1.0±b
N0K1	2.78	0.4± b	0.21	0.0±a	3.01	0.5±b-d	3.70	0.3±ab	0.22	0.0±a	3.97	0.4±ab
N0K2	2.66	0.2± b	0.21	0.0±a	3.14	0.4±a-d	3.67	0.6±ab	0.22	0.0±a	4.13	0.6±ab
N1K0	3.67	0.4± a	0.24	0.0±a	2.94	0.2±cd	3.92	0.1±ab	0.25	0.0±a	3.70	0.6±ab
N1K1	3.74	0.0± a	0.26	0.0±a	3.88	0.4±a-d	4.11	0.4±ab	0.25	0.0±a	4.17	0.6±ab
N1K2	3.88	0.1± a	0.26	0.0±a	4.12	0.9±b	3.94	0.5±ab	0.27	0.0±a	4.30	0.5±ab
N2K0	4.20	0.1± a	0.27	0.0±a	3.66	0.2±a-d	4.41	0.3±a	0.26	0.0±a	4.43	0.9±ab
N2K1	4.16	0.3± a	0.27	0.1±a	4.55	0.3±a	3.73	0.1±ab	0.27	0.1±a	5.37	0.6±ab
N2K2	4.23	0.2± a	0.27	0.0±a	4.47	0.7±ab	3.99	0.3±ab	0.26	0.0±a	5.53	1.3±a
Tomato												
N0K0	2.77	0.5±a	0.19	0.0±b	2.67	0.3±b	2.70	0.4±b	0.21	0.0±a	2.83	0.5±c
N0K1	2.96	0.3±a	0.22	0.0±ab	3.23	0.3±ab	2.90	0.2±ab	0.22	0.0±a	3.23	0.5±a-c
N0K2	3.06	0.1±a	0.21	0.0±ab	3.34	0.1±ab	2.87	0.2±ab	0.24	0.0±a	3.40	0.3±a-c
N1K0	3.19	0.1±a	0.23	0.0±ab	2.97	0.1±ab	3.44	0.2±ab	0.22	0.1±a	3.17	0.3±bc
N1K1	3.37	0.3±a	0.28	0.1±ab	3.34	0.2±ab	3.32	0.3±ab	0.26	0.1±a	3.57	0.2±a-c
N1K2	3.21	0.3±a	0.27	0.0±ab	3.52	0.4±ab	3.40	0.2±ab	0.26	0.0±a	3.67	0.4±a-c
N2K0	3.39	0.4±a	0.28	0.0±a	2.84	0.3±b	3.50	0.2±a	0.27	0.0±a	3.57	0.5±a-c
N2K1	3.49	0.5±a	0.28	0.0±a	3.65	0.5±ab	3.42	0.2±ab	0.27	0.0±a	4.20	0.1±a
N2K2	3.55	0.3±a	0.28	0.0±ab	3.92	0.6±a	3.45	0.3±ab	0.25	0.0±a	4.17	0.3±ab

Mean (three replicates) Bracket is SE (Standard error); N0= 0 kg N/ha; N1= 100 kg N/ha; N2= 200 kg N/ha; K0= 0 kg K_2O/ha; K1= 100 kg K_2O/ha, K2= 200 kg K_2O/ha.

Table 4. The effect of nitrogen and potassium doses on pepper and tomato Zn, Fe, Cu and Mn concentration (mg kg^{-1}).

	Year 1997								Year 1998							
Treatment	**Zn**		**Fe**		**Cu**		**Mn**		**Zn**		**Fe**		**Cu**		**Mn**	
Pepper																
N0K0	19.6	1.2±a	141.5	47.3±a	14.7	0.8±a	98.1	14.5±a	18.7	3.7±a	111.9	32.7±a	18.9	1.1±a	126.3	27.1±a
N0K1	19.1	3.9±a	142.2	28.4±a	15.3	1.3±a	96.1	21.3±a	18.8	5.4±a	126.1	14.5±a	19.6	1.7±a	116.7	30.3±a
N0K2	20.2	3.7±a	129.9	26.2±a	14.8	0.9±a	92.9	14.5±a	20.0	4.7±a	119.8	19.9±a	19.0	1.1±a	114.5	23.0±a
N1K0	20.2	2.9±a	141.7	25.2±a	14.5	0.6±a	96.3	10.1±a	19.8	2.9±a	124.5	6.7±a	18.5	0.7±a	114.7	17.6±a
N1K1	22.8	2.2±a	146.0	12.5±a	15.1	1.1±a	95.7	9.1±a	20.2	1.7±a	129.1	14.4±a	19.3	1.4±a	118.7	5.0±a
N1K2	25.0	5.2±a	132.7	11.1±a	15.0	1.3±a	87.1	9.0±a	19.4	0.9±a	123.5	7.2±a	19.3	1.7±a	104.7	18.3±a
N2K0	22.0	2.9±a	121.2	3.8±a	14.6	2.0±a	96.7	20.3±a	21.0	4.5±a	118.4	3.7±a	17.8	2.1±a	115.2	26.7±a

Table 4. Contd.

N2K1	24.5	2.8±a	140.1	26.5±a	13.9	0.7±a	112.1	9.3±a	22.1	3.5±a	124.8	15.2±a	16.4	1.7±a	132.1	10.0±a
N2K2	22.6	1.9±a	121.3	15.7±a	14.3	2.0±a	99.9	5.6±a	22.9	4.1±a	118.5	15.3±a	18.3	2.6±a	121.7	17.7±a
Tomato																
N0K0	16.7	1.6±a	84.4	3.5±a	13.1	1.4±a	82.3	1.9±a	16.3	1.5±a	82.4	3.5±a	16.7	1.8±a	96.4	4.2±a
N0K1	18.8	3.2±a	83.0	29.4±a	13.6	1.2±a	79.9	8.3±a	16.3	1.7±a	81.1	28.7±a	17.4	1.5±a	94.8	13.1±a
N0K2	19.8	4.3±a	64.3	7.4±a	12.7	2.1±a	83.3	4.8±a	16.8	1.2±a	62.9	7.3±a	15.7	3.5±a	100.0	11.8±a
N1K0	19.9	3.8±a	83.2	21.9±a	11.8	0.8±a	84.7	5.9±a	17.8	1.2±a	81.3	21.4±a	17.6	3.3±a	102.0	13.3±a
N1K1	19.7	2.2±a	86.8	11.5±a	12.2	0.7±a	89.5	18.9±a	17.4	1.0±a	84.8	11.3±a	17.8	2.8±a	111.7	27.5±a
N1K2	20.1	2.3±a	89.2	9.8±a	13.1	1.0±a	88.8	16.7±a	18.9	1.4±a	87.1	9.5±a	18.2	2.7±a	108.0	26.4±a
N2K0	21.2	2.5±a	90.5	19.6±a	14.0	1.5±a	85.1	10.7±a	21.7	1.6±a	88.4	19.1±a	18.0	1.9±a	114.3	39.7±a
N2K1	20.4	4.2±a	97.7	3.8±a	13.4	0.5±a	85.1	7.8±a	21.5	4.5±a	95.5	3.7±a	18.9	2.0±a	104.7	18.8±a
N2K2	20.6	1.4±a	99.9	11.4±a	13.7	1.6±a	89.0	9.3±a	20.1	1.7±a	97.6	11.1±a	20.9	1.4±a	90.2	11.1±a

Mean (three replicates) Bracket is SE (Standard error).

Table 5. The effect of nitrogen and potassium doses on pepper and tomato flowering time.

	Pepper		Tomato	
Treatment	**Year 1997**	**Year 1998**	**Year 1997**	**Year 1998**
N0K0	21 June 1997	27 June 1998	01 July 1997	09 July 1998
N0K1	21 June 1997	29 June 1998	27 June 1997	09 July 1998
N0K2	19 June 1997	27 June 1998	29 June 1997	07 July 1998
N1K0	17 June 1997	25 June 1998	27 June 1997	02 July 1998
N1K1	18 June 1997	24 June 1998	26 June 1997	05 July 1998
N1K2	17 June 1997	24 June 1998	28 June 1997	05 July 1998
N2K0	17 June 1997	24 June 1998	24 June 1997	03 July 1998
N2K1	16 June 1997	22 June 1998	26 June 1997	04 July 1998
N2K2	16 June 1997	24 June 1998	25 June 1997	05 July 1998

flowering data were recorded for both plants in two years. It has been found that increasing N and K fertilizer application caused the plants to flower between 5 - 9 days earlier than before NOKO treatments.

In general, there is a marginal Zn deficiency in the soils of the Mediterranean region (Cakmak et al., 1999). Since there is Zn deficiency in area and also N fertilizer have influence on Zn uptake, therefore it is important to concentrate on management of N fertilizer on Zn uptake as well. Previously in the same soil solanaceas crops such as tomato, eggplant and pepper were grown under field conditions with and without mycorrhizal inoculation (Ortas et al., 2003). It has been found that pepper and tomato plants have a high response to nutrient uptake. Under greenhouse conditions, also tomato plants respond to nutrient uptake (Dasgan et al., 2008).

Under high nitrogen and potassium fertilizer application, flowering time was earlier than control plants (Table 5). In general, flowering was more pronounced for N treatments rather than P treatments. Aminifard et al. (2010) reported that under field conditions nitrogen fertilizer treated pepper plants flowered earlier than control. There were 5 to 6 days earlier flowering times in high N2 treatment than the N0 treatment. Since in the market fresh vegetable make double price, it is important to have early get yield for growers.

Conclusion

Data presented in Figure 1 demonstrated clearly that levels of nitrogen had a significant effect on the total yield of both pepper and tomato plants. It could be concluded that the highest yield was obtained by 200 N kg/ha. K addition had less of an effect on plant yield. Increasing the N level addition statistically increased the yield and N, P and K concentration. N, P and Zn content were affected by N addition. Also plant tissue P and Zn concentration was affected significantly by the N addition rather than K addition. The potassium treatment did not show a significant difference (P>0.05) on yield and nutrient uptake. K addition increased plant K concentration. Results have also indicated that pepper plants have more K content than tomato plants. K addition did not have a significant effect on P and Zn content. Also other micronutrients were not been significantly affected by N and K application.

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