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Evaluation the effect of different levels of urea and ammonia fertilizers on growth and yield of Tomato (*Lecopersicon esculentum* c.v Calji)

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ABSTRACT: In order to evaluation the effects of urea and ammonia fertilizers on growth and yield of Tomato c.v Calji, was conducted an experiment in completely randomized design with three replications. Each one of the nitrogen fertilizers was used in five concentrations consist 0, 50, 100, 150 and 200 mg/kg N soil. The evaluated characteristics were consisting fruit number, yield of one plant, vitamin C, total acid, TSS, plant height, day to flowering, fresh weight and chlorophyll index. Results indicated that the highest fruit number was observed in urea 100 and 150 mg/kg N and the lowest in control treatment. The greatest yield was relative to urea 150 mg/kg N and the least in ammonia 150 mg/kg N treatment. In most evaluated traits, application of urea 100 and 150 mg/kg N was better than ammonia. Thus, application of low levels of ammonia can be improved quantitative and qualitative characteristics of plant and fruit of tomato but its high levels had badness effects on plants. Based obtained results from this study can be concluded that urea and ammonia fertilizers are more effective on vegetative factors than generative factors and will have desirable influences on vegetative growth of tomato.

***Keywords*:** Tomato, Urea, Ammonia, Yield.

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is one of the most important fruit vegetables, which due to high nutrient value, is in the second rank in viewpoint of level under cultivation and consumption (Daneshvar, 2000). Nitrogen is one of the most principle necessary nutrient elements for plants and other living beings so that after water, the plant need to this factor more than other effective factors for plant growth. Despite nitrogen has been allocated about 79% voluminal of atmosphere but many plants involved to nitrogen deficiency due to deficit of organic matter in these soils, specially the plants that grow in dry and semi-dry regions (Rajaei, 2010). Ammonia with 82% nitrogen has the highest nitrogen amount between nitrogen fertilizers and in many countries is directly injected to soil as the fertilizer however in the central parts of Iran less is used because of soil moisture deficit as well as possibilities deficiency (Ejraei, 2007). Urea or Carbamide is an organic composition with chemical formula $CO(NH_2)_2$. More than 90% of urea in the world is produced in order to application as nitrogen chemical fertilizers. Urea with 46% nitrogen, has the greatest nitrogen amount among all nitrogen solid fertilizers and on this basis, urea has the lowest transportation cost in lieu of each nitrogen unit. Urea is presented as small pearl grains, which is called “Sugar fertilizer” (Salardini, 1987).(Flores et al., 2001) in evaluation the effect of different levels of ammonia on reduction of salinity effect on tomato plant development, nutrition, and metabolites concluded that badness influence of salinity stress can be decreased by using ammonium in medium because ammonium nutrition is relative to nitrogen absorption and apply as well as iron and chlorophyll concentration in the leaves.(Ahmed et al,. 2008) showed that application of urea and triple super phosphate and mixed Zeolite might have many advantages more than urea without additional materials. (Keeny and Nilson, 1982) in evaluation the effect of organic and chemical fertilizers on quantitative and qualitative yield of tomato c.v ‘Chief’ found that the greatest fruit yield obtained in application of 15 ton/ha hen manure and 90 kg/ha pure nitrogen and the highest fruit number in

application of 20 ton/ha hen manure and 135 kg/ha pure nitrogen.(Ahmed et al., 2006) evaluated the effect of salinity and nitrogen on distribution of nutrient elements, citric acid and vitamin C in tomato and reported that increasing nitrogen caused to increase of fruit fresh and dry weight but salinity decreased these traits and salinity had no influence on vitamin C amount. (Musavi Shalmani et al*.,* 2002) in using 15-N isotopic method to evaluate efficiency of different levels of urea under fertilizer-drip irrigation system and its comparison with furrow irrigation in tomato plant reported that despite increasing fertilizer amount in fertilizer-irrigation system, plant portion in absorption of nitrogen element almost remain constantan is consequently increasing nitrogen losing. They recommended 100 mgL^{-1} N (urea form) as suitable treatment because of 54% N absorption by plant. Also narrow irrigation system with 83% nitrogen losing had the lowest efficiency.

The main aim of present study was evaluation the effects of various nitrogen sources for nutriment of tomato plant so that assessed the reaction of this plant and its vegetative and generative characteristics to nitrogen fertilizers.

MATERIALS AND METHODS

This study was performed in order to evaluate the effects of ammonia and urea fertilizers on growth and flowering time of tomato (*Lycopersicon esculentum* c.v Calji) in a calcareous soil in completely randomized design with 9 treatments and 3 replications. The treatments were consisting 50, 100, 150 and 200 mg N in lieu of one kg soil from both nitrogen fertilizers (8 treatments) and control treatment. For supplement of potassium and phosphorus were added 80 mg K and P in lieu of one kg soil equally to the pots from potassium sulfate and triple super phosphate resources. In during growth period, consuming water amount and irrigation period was done so that did not exit from the pots and the pot moisture was in the field capacity limit. The evaluated characteristics were consisting fruit number, plant yield, vitamin C, total acid, Total soluble solid (TSS), plant height, number of days to flowering, plant fresh weight (PFW) and chlorophyll content (CI). Vitamin C and total acid amounts were measured by titration method by using iodine in potassium iodur (Logol) and NaOH respectively; TSS by refractometer and chlorophyll index by SPAD Minolta. Statistical analysis was done by MSTAT-C software and the means were compared by Duncan's multiple range test (DMRT) ($P<0.01$).

RESULTS AND DISCUSSION

Fruit number

Mean comparison by using Duncan's test ($p<0.01$) showed that the highest fruit number was in urea 100 and 150 mg/kg N (6.3 and 7.0 respectively) and the lowest in control treatment (2.0). Only urea 100 and 150 mg/kg N had significant different with control treatment. In ammonia 200 mg/kg N treatment number of fruit assessment was not possible due to drying the plants. Totally, the greatest fruit number was observed in application of urea and the lowest in control treatment. The fruit number increased by the increasing nitrogen concentration from 50 to 150 mg/kg N but from 150 to 200 mg/kg N the fruit number decreased (Table 1). The fruit number increased by increasing nitrogen level in application of ammonia but this increasing was not significant. Increasing levels of the used nitrogen fertilizers led to decreasing generative growth of the tomato plant and caused to reduction of fruit number. Obtained results in the present study are according to the findings of (Maanavifard et al., 2010).

Plant yield

The greatest plant yield was observed in urea 150 mg/kg N treatment (344.5 g/plant) and the least in ammonia 150 mg/kg N treatment (90.5 g/plant). There was no significant difference between ammonia 50 mg/kg N and urea 200 mg/kg N with control treatment in relation to plant yield. In ammonia 200 mg/kg N treatment plant yield evaluation was not possible due to drying the plants. Totally, the greatest plant yield was observed in application of urea and the lowest in ammonia treatment. Increasing concentration of nitrogen from 50 to 150 mg/kg N in application of the used fertilizers, except ammonia, caused to plant yield but from 150 to 200 mg/kg N the plant yield decreased. Reduction of the plant yield was observed in application of ammonia from levels of up to 100 mg/kg N (Table 1). Regards to reduction of the plant yield in application of nitrogen fertilizers from levels of up to 100 mg/kg N can be concluded that excessive application of nitrogen fertilizers (urea and ammonia) have

undesirable influence on generative growth of the plant and have negative effect on the yield. This subject is conforming to the findings of (Delshad et al., 2000 and Babaei et al., 2010).

Table 1. Effect of different treatments on the evaluated characteristics

Character Treatment	Fruit number	Plant yield (g)	Vitamin C (mg)	TSS (%)	Chlorophyll index (CI)
Control	2.0^{bcd}	114.2^{hi}	39.23^{fg}	4.17^{j}	33.5^{h}
Ammonia 50 mg/kg N	2.3^{bcd}	115.1^{hi}	46.93^{cde}	7.43^{a}	43.1^{def}
Ammonia 100 mg/kg N	2.7^{bc}	142.4^{fg}	45.47^{def}	7.00^{b}	47.9^{abcde}
Ammonia 150 mg/kg N	3.0^{bc}	90.5^{j}	38.13^{g}	6.33^{def}	49.1^{abc}
Ammonia 200 mg/kg N	0.0^{d}	0.0^{k}	0.00^{h}	0.00^{k}	0.0^{i}
Urea 50 mg/kg N	3.0^{bc}	176.4^{d}	46.93^{cde}	6.77^{bc}	38.7^{fg}
Urea 100 mg/kg N	6.3^{a}	311.7^{b}	48.48^{bcd}	6.33^{def}	42.6^{ef}
Urea 150 mg/kg N	7.0^{a}	344.5^{a}	49.90^{abcd}	6.00^{fg}	53.1^{a}
Urea 200 mg/kg N	2.3^{bcd}	122.8^{gh}	54.8^{ab}	4.67^{i}	43.9^{cdef}

†Means in each column having the same letter, have not significant difference (P ≤ 0.01) according to DMRT

Vitamin C

The highest vitamin C amount was observed in urea 200 mg/kg N treatment (54.80 mg) and the lowest in ammonia 150 mg/kg N treatment (38.13 mg). There was no significant difference between ammonia 100 and 150 mg/kg N with control treatment in relation to vitamin C amount. In ammonia 200 mg/kg N treatment measurement of vitamin C was not possible due to drying the plants. Totally, the greatest vitamin C was observed in application of urea and the lowest in ammonia treatment. Increasing urea concentration led to increase of vitamin C amount. Reduction of vitamin C amount was completely obvious by increasing ammonia concentration (Table 1). In fact, urea fertilizer is effective to increase of vitamin C amount in tomato fruit, which is according to the results of (Haravi et al., 2005).

Total soluble solid (TSS)

The greatest TSS was observed in ammonia 50 mg/kg N treatment (7.43%) and the lowest in control treatment (4.17%). All treatments had significant difference to control treatment. In ammonia 200 mg/kg N treatment measurement of TSS was not possible due to drying the plants. Totally, the highest TSS was observed in application of ammonia and the least in control treatment. Increasing nitrogen concentration in both the used fertilizers (urea and ammonia) led to decrease of TSS (Table 1). These results are according to the findings (Abdul-Baki et al., 1996).

Chlorophyll index (CI)

The greatest CI was observed in urea 150 mg/kg N treatment (53.1) and the lowest in control treatment (33.5). In ammonia 200 mg/kg N treatment measurement of CI was not possible due to drying the plants. Totally, the greatest CI was observed in application of urea and the lowest in control treatment. Increasing nitrogen concentration in both fertilizers led to increase of CI but CI decreased from 150 to 200 mg/kg N (Table 1). In fact, nitrogen fertilizers (urea and ammonia) are effective on vegetative growth and chlorophyll content of tomato plant. The obtained results are according to the report of (Peivast, 2007).

Increase percent of plant height (IPPH)

The highest IPPH was observed in urea 200 mg/kg N treatment (554.8%) and the lowest in ammonia 50 mg/kg N treatment (286.7%). In ammonia 200 mg/kg N treatment assessment of IPPH was not possible due to drying the plants. All treatments had significant difference to control treatment. Totally, the greatest IPPH was observed in application of urea and the lowest in ammonia treatment. Increasing ammonia concentration from 50 to 150 mg/kg N caused to increase IPPH. IPPH decreased in application of urea from 50 to 150 mg/kg N and it increased from 150 to 200 mg/kg N (continuation of Table 1). These results indicate that nitrogen fertilizers (urea and ammonia) are effective on vegetative growth of tomato plant, which is conforming to the findings of (Peivast, 2007).

Total acid

The highest total acid was observed in urea 200 mg/kg N treatment (1.010 mg) and the lowest in control treatment (0.165 mg). There was significant difference between all treatments to control treatment in relation to total acid. In ammonia 200 mg/kg N treatment measurement of total acid was not possible due to drying the plants. Totally, the greatest total acid was observed in application of ammonia and the lowest in control treatment.

Increasing nitrogen concentration in both fertilizers led to increase of total acid amount (Continuation Table 1). Therefore can be concluded various treatments of the nitrogen fertilizers are effective to increase of total acid so that increasing their levels caused to increase of total acid. These results are not according to the findings of (Delshad et al., 2000).

Continuation table 1. Effect of different treatments on the evaluated characteristics

Character Treatment	Increase percent of plant height (IPPH)	Total acid (mg)	Day to flowering	Plant fresh weight (PFW) (g)
Control	337.8^{h}	0.165^{k}	48.3^{b}	60.75^{fg}
Ammonia 50 mg/kg N	286.7^{i}	0.677^{e}	28.0^{gh}	78.33^{e}
Ammonia 100 mg/kg N	436.1^{e}	0.738^{d}	28.3^{gh}	111.90^{c}
Ammonia 150 mg/kg N	461.1^{d}	0.738^{d}	90.0^{a}	140.60^{b}
Ammonia 200 mg/kg N	0.0^{l}	0.000^{l}	0.0^{k}	0.00^{h}
Urea 50 mg/kg N	548.6^{b}	0.431^{j}	25.0^{hi}	65.41^{f}
Urea 100 mg/kg N	452.4^{d}	0.640^{f}	25.7^{h}	144.86^{b}
Urea 150 mg/kg N	407.1^{f}	0.677^{e}	26.3^{gh}	165.16^{a}
Urea 200 mg/kg N	554.8^{b}	1.01^{b}	39.3^{cd}	99.54^{d}

^{f}Means in each column having the same letter, have not significant difference (P ≤ 0.01) according to DMRT

Number of day until flowering

The highest day to flowering was observed in ammonia 150 mg/kg N treatment (60.0 days) and the lowest in urea 50 mg/kg N treatment (25.0 days). There was significant difference between all treatments to control treatment. Application of urea and ammonia fertilizers (except ammonia 150 mg/kg) accelerated the flowering than control treatment. In ammonia 200 mg/kg N treatment measurement of day to flowering was not possible due to drying the plants. Totally, the greatest number of day to flowering was observed in application of ammonia and the lowest in urea treatment. Increasing nitrogen concentration in both fertilizers led to increase the number of day to flowering i.e. by increasing nitrogen concentration the yield became late-ripening (Continuation Table 1). Using high levels of urea and ammonia fertilizers delayed generative growth of tomato plant and caused to vegetative growth, which has conformance to the report of (Neisani et al., 2003).

Plant fresh weight (PFW)

The heaviest plant was observed in urea 150 mg/kg N treatment (165.16 g) and the lightest plant in control treatment (60.75 g). In ammonia 200 mg/kg N treatment measurement of PFW was not possible due to drying the plants. Totally, the greatest PFW was observed in application of urae and the lowest in control treatment. Increasing nitrogen concentration from 50 to 150 mg/kg N in both fertilizers led to increase PFW but from 150 to 200 mg/kg N, PFW decreased (Continuation Table 1). This subject indicates that application of urea and ammonia fertilizers to 150 mg/kg N are effective to vegetative growth of tomato plant and caused to increasing plant fresh weight, which is according to the findings of (Babaei et al., 2010).

CONCULSION

Based on the total results such is deduced in more evaluated characteristics application of 100 and 150 mg/kg N as urea was better than ammonia fertilizer. Application low levels of ammonia can be improved quantitative and qualitative characteristics of plant and fruit of tomato but its high levels had destroyer influence on the plants. Thus, can be concluded that urea and ammonia fertilizers are more effective on vegetative factors and all the used nitrogen fertilizers had desirable influence on vegetative growth of tomato plant.

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