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Effects of various rates and concentrations of N-P-K on growth 'Rio Grande 'tomato seedling

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Abstract

Tomato (*L.ycopersicon esculentum* Mill.) cv. Rio Grande seedlings were nutritionally conditioned with solutions complete fertilizer N(60% NO_3+40% NH_4)-P-K (20-20-20) , N(30%NO_3+70% NH_4)-P-K (15-5-30) , the first two week N(60% NO_3+40% NH_4)-P-K (20-20-20) and later two week N(30%NO_3+70% NH_4)-P-K (15-5-30) and vice versa were applied in completely randomized experiment with three replications to determine the effect of nutritional regimes on tomato transplant growth. As nitrate rate increased from 30% to 60%, fresh shoot weight, plant height, stem diameter, leaf number, leaf area, shoot and root dry weights, and total chlorophyll increased. in the 750 mg/lit of N(60% NO_3+40%NH_4)-P-K (20-20-20) were decreased and it is with to increasing in stem diameter and total plant growth , application of N(60%NO_3 + 40%NH_4)-P-K(20-20-20) in the first two weeks of seedling growth and N(30%NO3+70%NH4)-P-K (15-5-30) in the last two weeks in the concentration of 200 mg/liter seedling height decreased.

Key words: seedlings, complete fertilizer, Nitrate, height, tomato

Introduction

The *Lycopersicum esculentum* Mill (Solanaceae) is one of the world's most important vegetable crops with a current worldwide fresh weight production of 80 million metric Tons from a cropped area of approximately three million hectares (Johannes et. al., 2000, Anonymous, 1993). In many parts of the world, tomato (*Solanum lycopersicum* L.), are field produced from transplanted seedlings previously grown in greenhouses. Commercially, the transplants are grown in plug trays with different numbers of cells. A major problem in commercial plug production is control of plant height when seedlings are grown in small plug cells at high plant densities. Small cells increase plant density and thus, stem elongation. There are several drawbacks of excessive seedling elongation; tall seedlings with weak stems are difficult to handle and often lodge after transplanting. The goal is to produce seedlings that will withstand the physical stress of handling, shipping and transplanting, and adapt rapidly to the field environment. However, unfavorable soil and weather conditions can delay field preparation for transplanting. For these reasons, seedling height control is necessary (Kadri, 2008). Many methods are used to control seedling height, one of them is change in nutrient availability (Latimer., 1991).The nutritional status of vegetable seedlings at transplanting is an important factor influencing stand

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establishment and ultimate productivity of a crop. Melton and Dufault (199 1) reported that N fertilization of tomato seedlings with 225 mg /liter solution stimulated post transplanting shoot growth as compared with lower concentrations. Nitrogen is the only nutrient that can be supplied to plants in both anionic (NO_3^-) and cationic (NH_4^+) form (Forde and Clarkson 1999). Hence, the fraction of ammonium to the total nitrogen supply may considerably influence the total caution to anion uptake ratio (Imas et al. 1997; Savvas et al., 2006). Furthermore, the form of nitrogen supplied to the plants may influence the uptake of other macro nutrients due to ion antagonism (Marschner 1995). The N form also influences plant metabolism, due to differences in the intracellular assimilation pathways (Raab and Terry 1994; Gerendás et al., 1997). Precision control over the supply of nitrogen (N) to plants is required to maximize crop productivity. This involves not only the optimal N application rate, but also the optimal ratio between ammonium(NH_4^+), nitrate (NO_3^-) and added via the irrigation water (Bar-Yosef, 2008) Therefore, the objective of this study was to determine the effects of various rates of NO_3:NH_4 to height and growth of 'Rio Grande 'tomato seedling.

Material and methods

The experiment was conducted at the College of Agriculture of the University of shiraz, Iran, in 2011.Seeds of tomato *(Lycopersicon esculentum*,Mill.) cv. Rio Grande were sown on 11 July 2011 in 216-cell plug trays (18 X12 cell) with a 37cm^3 Cell volume filled with peat and perlite medium. Greenhouse temperatures ranged from a maximum of 32C° during the day and a minimum of 20°C at night. No supplemental lighting was provided. Two weeks after seeding, when the first true leaves were expanding treatment group include complete fertilizer N(60% NO_3+40% NH_4)-P-K (20-20-20) , N(30%NO_3+70% NH_4)-P-K (15-5-30) , the first two week N(60% NO_3+40% NH_4)-P-K (20-20-20) and later two week N(30%NO_3+70% NH_4)-P-K (15-5-30) and vice versa were applied in completely randomized experiment with three replications. Table 1 showed percent of micro, macro nutrient and ratio of nitrate :ammonium in complete fertilizers.

At the end of the experiment, the following growth variables were measured: shoot fresh weight per seedling; stem diameter (at cotyledon node); expanded true leaf number (leaves with clearly visible petioles); height per seedling (of cotyledon node to expanding younger leaf ; leaf area per seedling, including petiole, with a LI- Delta-T and shoot dry weights after drying for 24 h at 65C. Leaf segments were homogenized using a mortar and pestle in 80% (v/v) acetone and centrifuged for 15min at 23,000g. Chlorophyll content was determined spectrophotometrically model UV120-20 in the clear supernatant by measuring the absorbance at 663and 645 nm, respectively, for chlorophyll a and b, and was calculated according to Arnon (1949).

Table1: percent of micro , macro nutrient and ratio of nitrate :ammonium in complete fertilizers was used.

Nutrient source	Total N%	NO_3 N%	NH_4 N%	P_2O_5%	K_2O%	Fe%	Mn%	Zn%	Cu%	MO%
Complete fer 20-20-20 N- P- K	20	5/9	14/1	20	20	0/1	0/1	0/05	0/05	0/0005
Complete fer 15-5-30 N- P- K	15	9/1	5/9	5	30	0/2	0/05	0/05	0/05	0/0005

Result and discussion

Historically, the classical paradigm of the terrestrial N cycle has asserted that organic N must be converted into inorganic N (NO_3^--N, NH_4^+-N) by soil microorganisms prior to becoming available to plant roots. Therefore, several N researches are focused on the influence of NO_3^--N and NH_4-N on plant physiology in the past century (Ahn et al., 1998; Günes et al. 1996;Nishihara et al. 2005; Smit 2002) Nitrogen form was the major factor affecting tomato seedling growth in study. Nitrogen form influences seedling height, stem diameter, leaf number, leaf area, total chlorophyll, fresh shoot weight, and dry shoot (Table 1). As Nitrate rate increased from 30% to 60%,plant height, stem diameter, leaf number, leaf area, total chlorophyll, and shoot fresh and dry weights increased (Table 2). Usually, in hydroponic culture in a greenhouse, maximum growth tomato is obtained with an optimal NH_4^+ concentration not exceeding 30% of total N (Sandoval-Villa et al. 2001; Claussen 2002; Xu et al.2001, 2002). The superiority of mixed N forms to either form alone is related to the maintenance of nearly neutral pH (Marschner 1995), higher uptake of phosphorous, potassium, calcium and iron, etc., in mixed N forms than with either single NO_3^-or NH_4^+(Stratton et al., 2001; Zou et al., 2005). The studies has been the consistent finding that even when precautions are taken to control pH drift in the culture solution, and prevent ammonia toxicity by using frequently renewed, or continuous supply of a very dilute solution, the difference in growth rate remains (Woolhouse and Hardwick, 1966). In this study increasing in ammonium rate seedling height was decreased,it is associated with decrease in total growth of seedlings however in the 200 mg/liter(dilute solution) of N (30%NO_3+70%NH_4)-P –K(15-5-30) seedlings height were decreased. hence the total biomass of seedling including leaf number ,fresh and dry weight of shoots and leaf area and total chlorophyll were not decreased. (Table2, 3).

Table2:Effect of rates NO_3:NH_4 (60%NO_3+40%NH_4) to height and growth of 'Rio Grande 'tomato seedling.

Concentration of fertilizer(mg/l)	Plant ht (Cm)	Stem diam (mm)	Shoot wt(gr) fresh	dry	Leaf no.	Total chlorophyll ($\mu g \cdot cm^{-2}$)	Leaf area (cm^2)
100	22ab	1.9a	2.7ab	0.21ab	3.5ab	0.08b	35.6a
200	19.2bc	1.6a	2.5b	0.20ab	4a	0.13a	30.8ab
500	23a	1.7a	2.9ab	0.21ab	4a	0.16a	29ab
750	19c	2a	3.3a	0.24a	3.7a	0.16a	31.8ab
1000	20.7abc	1.8a	2.4 b	0.15b	3b	0.15a	25b

Table3:Effect of rates NO3:NH4 (30%NO3+70%NH4) to height and growth of 'Rio Grande 'tomato seedling

Concentration of fertilizer(mg/l)	Plant ht (Cm)	Stem diam (mm)	Shoot wt(gr) fresh	dry	Leaf no.	Total chlorophyll ($\mu g \cdot cm^{-2}$)	Leaf area (cm^2)

100	17a	1.5a	1.4a	0.09bc	2.7abc	0.11a	26.6b
200	19.2a	1.6a	2.1a	0.16a	3.2ab	0.16a	37a
500	19.2a	1.6a	1.9a	0.13ab	3.5a	0.11a	26.6b
750	19.2a	1.7a	2.1a	0.17a	2.5bc	0.16a	18.6b
1000	11.5b	1.1b	0.75b	0.06c	2c	0.15a	3.9c

previous experiments of Prianishnikow (1922) showed that relatively high concentrations of ammonia were toxic to seedlings, and that amide formation, at the expense of available carbohydrates, may serve as a detoxication mechanism. It has frequently been shown, however, that when ammonia is supplied at very low concentrations which do not cause toxicity by excessive utilization of carbohydrates, growth still falls short of that of nitrate-grown plants. our results shown that 750mg/liter of N (30%NO_3+70%NH_4)-P –K(15-5-30) leaf area of seedlings were decreased according to Pill et al(1979)Fertilizing tomatoes (*Lycopersicon esculentum* Mill.) NH_4-N, as compared to NO_3- N sources, in pot culture with unequal anion species and concentration and constant substrate moisture supply reduced total transpiration and transpiration rate, leaf area, and increased the calcium content of the leaves.

Table 4: Effect of application rates of NO_3:NH_4 (30%NO_3+70%NH_4) in first 2 week on growth seedling to height and total biomass of 'Rio Grande 'tomato seedling.

Concentration of fertilizer(mg/l)	Plant ht (Cm)	stem diam (mm)	Shoot wt(gr)		Leaf no.	Total chrolophyll (μg·cm^{-2})	Leaf area (cm^2)
			Fresh	dry			
100	15.27bc	1.62a	1.51a	0.16a	4b	0.15a	31.7b
200	20.17a	1.66a	1.80a	0.11b	5a	0.13a	45.3a
500	14.3c	1.72a	2.02a	0.14ab	5a	0.14a	23bc
750	17.12b	1.52a	1.93a	0.12b	3.5c	0.14a	17.29c
1000	9.25d	0.60b	0.15b	0.03c	1d	0.01b	1.2d

Table 5: Effect of application rates of NO_3:NH_4 (60%NO_3+40%NH_4) in 2 week of growth seedling to height and total biomass of 'Rio Grande 'tomato seedling.

Concentration of fertilizer(mg/l)	Plant ht (Cm)	stem diam (mm)	Shoot wt(gr)		Leaf no.	Total chrolophyll (μg·cm^{-2})	Leaf area (cm^2)
			fresh	dry			
100	16a	1.59ab	1.63b	0.18a	4ab	0.20a	23.78a
200	12b	2.03a	1.91b	0.16ab	4.5a	0.16b	27.05a
500	14.25ab	1.75a	2.38a	0.16a	4ab	0.20a	27.94a

750	13.25ab	1.64ab	1.66b	0.11bc	3.75b	0.16b	21.69ab
1000	13.25ab	1.26b	0.96c	0.07c	3.75b	0.21a	14.30b

Commercial methods of shoot control have included watering restrictions (Schnelle et al., 1993), low fertility, which mainly defined as N stress (Styer and Koranski, 1997), temperature manipulation (Berghage and Heins, 1991), and chemical growth retardants (Gaston et al., 2001; Tayama et al., 1992). The respective problems associated with these procedures are tissue desiccation and possible leaf abscission, chlorosis foliage, and high cost of growth regulators and their very limited registration for use on vegetable seedlings. Height of the seedlings in the 750 mg/lit of N (60% NO_3+40%NH_4)-P-K (20-20-20) were decreased and it is with to increasing in stem diameter and total plant growth.(Table 2) Numerous studies have demonstrated that different N forms will effect plant growth, the content of nitrogenous compound, and carbohydrate accumulations (Fan et al. 2005; Guan et al., 2000). Xu et al., (2005) reported that different ratios of N forms have an effect on carbohydrate distribution in different plant organs, and Cao and Li (2003) obtained similar results on maize seedling. In this study application of N(30%NO_3 + 70%NH_4)-P-K(15-5-30) in the first two weeks of seedling growth at high concentration (750 and 1000 mg/liter)was decreased the seedling growth and weaken seedling .however in 500 mg/liter of N(30%NO_3 + 70%NH_4) in the first two week of seedling growth the height of seedling was decreased with increasing in stem diameter , shoot fresh and dry weight and leaf number thus that can be used for the decreased of seedling height .Application of N(60%NO_3 + 40%NH_4)-P-K(20-20-20) in the first two weeks of seedling growth and N(30%NO3+70%NH4)-P-K (15-5-30) in the last two weeks in the concentration of 200 mg/liter decreased the seedling height while increased stem diameter, leaf number and leaf area (Table 4,5).

Conclusion

As nitrate rate increased from 30% to 60%, shoot fresh weight, plant height, stem diameter, leaf number, leaf area, shoot and root dry weights, and total chlorophyll increased. Form of nitrogen accounted for the major portion of variation in seedling height, stem diameter, leaf number, leaf area, total chlorophyll, fresh shoot weight, and dry shoot with increasing in ammonium rate of total nitrogen seedling height was decreased but it is associated with decrease in total growth of seedlings.

References

Ahn O, P.R.J., Harrison, P. J. (1998). Ammonium and nitrate uptake by Laminaria saccharina and Nereocystis luetkeana originating from a salmon sea cage farm. *Journal of Applied Phycology*, 10: 333-340.

Berghage, R.D., Heins ,R.D. (1991). Quantification of temperature effects on stemelongation in poinsettia. *Horticulture Science*, 116: 14–18.

Cao C L, L.S.X. (2003). Effect of N form on the accumulation of carbohydrate and nutrients of corn seedlings. *Journal of Huazhong Agricultural University*, 22: 457-461.

Claussen, W. (2002). Growth, water use efficiency, and proline content of hydroponically grown tomato plants as affected by nitrogen source and nutrient concentration. *Plant Soil*, 247: 199–209.

Fan M S, S.Y.Q., Shao, J. W., Jia, L. G. (2005). Influence of nitrogen forms on oat growth and phosphorus uptake. . *Acta Agronomic Sinica*. 31: 114-118.

Forde, B.G., Clarkson, D. (1999). Nitrate and ammonium nutrition of plants: Physiological and molecular perspectives. . *Advances in Botanical Research* ,30: 1-90.

Gaston, M.L., Konjoian, P.S. , Kunkle, L.A. and Wilt, M.F. (2001). Tips on regulating growth of floriculture crops. *O.F.A. Services, Columbus*.

Gerendás J, Z.Z., Bendixen, R., Ratcliffe, R.G., Sattelmacher, B. (1997). Physiological and biochemical processes related to ammonium toxicity in higher plants. *Zeitschrift für Pflanzeneruährung und Bodenkunde*, 160: 239-251.

Günes A, I.A., Aktas, M. (1996). Reducing nitrate content of NET grown winter onion plants by partial replacement of NO3-N with amino acid in nutrient solution. *Scientia Horticulturae*, 65: 203-208.

hrr, W.G., Llunnrn, V. N., lNo HIxcrrev, T. M. (1979). Effects of Cycocel and nitrogen form on tomato water relations, ion composition, and yield. *Plant Science*, 59: 391-397.

Imas P, B.-Y.B., Kafkafi ,U., Ganmore-Neumann ,R. (1997). Release of carboxylic anions and protons by tomato roots in response to ammonium nitrate ratio and pH in nutrient solution. *Plant and Soil*,191: 27-34.

Kadri Bozokalfa, M.(2008). Short communication. Irrigation temperature effects on seedling growth and transplant quality of tomato, pepper and eggplant. *Spanish Journal of Agricultural Research* , 6(1): 120-124.

Latimer, J.G. (1991). Mechanical conditioning for control of growth and quality of vegetable transplants. *Hort Science*. 26: 1456-1461.

Marschner, H. (1995). *Mineral Nutrition of Higher Plants* . (2nd Edn),. Academic Press, London UK, 889pp.

Melton, R.R., and, Dufault, R.J. (1991). Nitrogen, phosphoru and potassium fertility regimes affect tomato transplant growth. *Hort Science*, 26: 141-142.

Nishihara G N, T.R., Noro, T. (2005). Effect of temperature and irradiance on the uptake of ammonium and nitrate by Laurencia brongniartii (Rhodophyta Ceramiales). *Journal of Applied Phycology*,17: 371-377.

Raab , T., Terry ,N. (1994). Nitrogen source regulation of growth and photosynthesis in Beta vulgaris L. *Plant Physiology*, 105: 1159-1166.

Sandoval-Villa M, G.E., Wood, C.W. (2001). Greenhouse tomato response to low ammonium nitrogen concentrations and duration of ammonium-nitrogen supply. *Plant Nutrition*, 24(11): 1787–1798.

Schnelle, M.A., McCraw, B.D., and Dole, J.M. (1993). Height control for flowering and vegetable transplants. *Oklahoma State Univ*. Extension Facts No, 7614.

Smit, A.J. (2002). Nitrogen uptake by Gaillardia gracilis (Rhodophyta): adaptations to a temporally variable nitrogen environment. *Botanica Marina*, 45: 196-209.

Styer, R.C., and Koranski, D.S. (1997). Plug and transplant production: A grower's guide. Ball Publishing, Batavia, IL.

Tayama, H.K., Larson, R.A., Hammer, P.A., and. Roll. T.J (eds.). (1992). Tips on the use of chemical growth regulators on floriculture crops. *Ohio Florists' Assoc., Columbus.*

Xu R Y, B.Z.L., Huang ,D. F.(2005) . Effects of different nitrogen forms on the dry matter accumulation and leaf nitrogen metabolism of muskmelon. *Transactions of the CSAE*, 21: 147-150.

Bar-Yosef, B. (2008). Crops response to solution recycling in closed loop irrigation systems. In: Raviv, M., Lieth, J.H. (Eds.), Soilless Culture: Theory and Practice. Elsevier, pp. 341–424.