RESPONSE OF TOMATO TO NITROGEN LEVELS WITH OR WITHOUT HUMIC ACID

SHER AMAN and ABDUR RAB*

Department of Horticulture, The University of Agriculture, Peshawar – Pakistan
**Email: abdurrabaup@gmail.com*

ABSTRACT

An experiment was conducted to study the response of tomato to nitrogen levels with or without Humic acid on yield and yield components of tomato `Advanta-1209` sown at New Developmental Farm (Horticulture section),The University of Agriculture, Peshawar Pakistan, during summer 2011. The experiment was laid out in Randomized Complete Block Design with spilt plot arrangements having three replications. The experiment involved two factors, Humic acid (0 and 5 kg ha^{-1}) allotted to main plot and nitrogen (0, 25, 50, 75, 100, 125 and 150 kg ha^{-1}) kept in sub plots. . The results showed that leaf length (cm), plant height (cm), fruit weight (g), and yield (t ha^{-1}) were significantly affected, whereas survival percentage and blossom end rot to fruits were not significantly affected by Humic acid and nitrogen levels and interaction of both. High leaf length (6.43 cm), plant height (82.92 cm), fruit weight (75.27 gm) and yield (28.49 t ha^{-1}) were produced by Humic acid applied at the rate of 5 kg ha^{-1}and maximum leaf length (6.88 cm), plant height (89.16 cm), fruit weight (78.82 gm) and yield (32.43 t ha^{-1}) were recorded by nitrogen applied at the rate of 125 kg ha^{-1}. From this study it can be concluded that tomato plants should be treated with fertilizers, Humic acid and nitrogen at the rate of 5 kg and 125 kg ha^{-1}, respectively to obtain maximum and quality yield.

Keywords*: Tomato (Lycopersicon esculentum* Mill.), **Humic acid, Nitrogen levels**

Citation: Aman. S and A. Rab. 201 3. Response of tomato to nitrogen levels with or without humic acid. Sarhad J. Agric. 29(2): 181- 186

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to family *Solanaceae*. Andean region of South America is the native land of tomato (Dorais *et al.,* 2008; Olaniyi *et al.,* 2010). Tomatoes are produced over 0.03 million hectares area in Pakistan. In Khyber Pakhtunkhwa tomato crops are grown in two seasons. The summer crops are grown in plain areas, whereas the winter crops are grown in some frost free zones as Bara killey in Peshawar, Malakand Agency and Dargai. In 2008-09 tomatoes were cultivated in Khyber Pakhtunkhwa over 16500 hectares area with a total production was 16800 tones (MINFA, 2009). In Pakistan, the average yield of tomato is 27.43 t ha^{-1}, which is very low as compared to the major producing countries (MINFA, 2005-06). It is a major horticultural crop with an estimated global production of over 120 million metric tons (FAO, 2007).

The tomato crop is economically attractive due to its good yielding capacity in a short duration and high minerals especially iron, lycopene and phosphorus (Bagal *et al*., 1989) and vitamins especially B and C. Hence, the area under tomato cultivation is increasing with time. The yield potential of tomato crop is affected due to many biotic and abiotic problems. Several bacterial, viral and fungal diseases may seriously damage the tomato crop. In Pakistan bacterial wilt is one of the diseases which results huge losses in tomato production every year (Ruben, 1999).

Fertilizers application is essential for better yield of tomato, is very important. Nitrogen and potassium have a key role in the plant growth and development and is better to apply during the growing stage of the crop and especially phosphorous is needed after transplanting the tomato plant (Arya *et al.,* 1999). The amount of nitrogen required by the plants is comparatively larger than other elements (Marschner, 1995). Nitrogen deficiency results in stunted growth of the plant, which leads to premature flowering and short growth cycle. This nutrient promotes plant organs development and result in abundant chlorophyll except root growth that is relatively poor (Lincoln and Edvardo, 2006). Nitrogen has a key role in plant physiological processes and development due to which it is one of the major nutrients. To achieve the improved nitrogen management it is necessary to supply it according to crop need. Similarly, timing of fertilizers application and appropriate source is also necessary for improved nitrogen management (Hochmuth *et al.,* 1987). Depending on plant species nitrogen is taken up from different sources in different forms but usually take up as nitrate and ammonium (Marchner, 1995).

Humic acid is a commercial product of organic fertilizers containing most elements that improve soil fertility and increase nutrients availability, thus enhances plant growth and yield as well as decreases the harmful effect of stresses (Doran *et al*., 2003). Humic acid is believed to increase helps in nitrogen use efficiency and therefore stimulates the shoot and root growth (Adani *et al.,* 1998). Humic acid constitute a stable fraction of carbon that improve some of the soil characteristics such as improve water holding capacity, pH buffering and thermal insulation (McDonnell *et al*., 2001). Humic acid assimilates minor and major elements, activates or inhibits

enzyme, causes changes in membrane permeability resulting in protein synthesis and activating biomass production which stimulates plant growth (El-Ghamry *et al*., 2009).

MATERIASLS AND METHODS

The study on response of tomato to nitrogen levels with or without Humic acid was conducted at New Developmental Farm (Horticulture section) The University of Agriculture, Peshawar Pakistan during the year 2011.

Seedlings of tomato Advanta-1209` were transplanted to well prepared soil in April, 2011. After a week, Humic acid in granule form (Favour brand, Exin Chemical Company) was applied at the rate of 5 kg ha^{-1} in different rows of each replication, while nitrogen in different levels (0, 25, 50, 75, 100, 125 and 150 kg ha^{-1}) was applied in split doses as half of the dose was applied with Humic acid and half after 25 days of the first application. For the application of phosphorous and potassium, DAP (46% P and 18% N), SOP (50% K), respectively was applied as a basal dose to all plots. In addition, all the farm practices as irrigation, hoeing, weeding etc were done regularly.

Parameters studied

The data was recorded on following parameters regarding the growth and production of tomato.

Survival percentage

The number of plants survived after transplanting were counted in each treatment and the percentage was calculated by the following formula.

$$Survival\ Percentage = \frac{Number\ of\ \ plants\ \ planted - Number\ of\ \ plants\ survived}{Number\ of\ \ plants\ \ planted}\ x100$$

Leaf length (cm)

The leaf length was measured in centimeters by placing the lower end of the measuring tape touching the joint of the leaf through the tip of the leaf by taking five randomly selected plants from each plot.

Plant height (cm)

The plant height was recorded in centimeters at the end of the growing season i.e. at harvest by measuring the plant from soil surface to the tip of the main stem by taking five randomly selected plants from each plot and after that means were estimated.

Fruit weight (g)

Single tomato fruit weight was measured with the help of electric balance by weighing five randomly selected plants from each plot for all treatments in each replication and the average was calculated.

Yield ha^{-1} (tons)

Yield $hectare^{-1}$ of tomato fruits in tons was calculated through the following formula.

$$Yield\ \ \text{per}\ hectare\ (\text{ton/ha}) = \frac{Yield\ per\ \ plot\ \ (kg) \times\ 10{,}000}{Plot\ area\ \ (m^2) \times 1{,}000}$$

Blossom End Rot

This was recorded during the growing season by counting the BER affected and healthy fruits $plot^{-1}$. The blossom end rot incidence was converted and presented as percent of total fruits showing BER symptoms.

Statistical procedure

The recorded data were subjected to analysis of variance technique following the procedure of Steel *et al.* (1997). Least significant differences (LSD) test was applied for separation of treatments and their interaction means in which differences were noticed using computer program, M STAT-C (Michigan State University, USA).

RESULTS AND DISCUSSION

Survival percentage

The data related to survival percentage (%) is mentioned in Table 1. Analysis of variance showed that survival percentage was not significantly affected by Humic acid and nitrogen levels and their interaction. It might be due to no effect of Humic acid and nitrogen on survival of tomato plant. Since the survival of tomato seedlings is

Table 1. ***Survival percentage of tomato as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	77.99	74.44	76.21
25	90.48	76.77	83.63
50	70.58	81.47	76.03
75	85.89	72.21	79.05
100	78.51	63.89	71.20
125	75.22	80.55	77.89
150	78.99	74.62	76.81
Mean	**79.67**	**74.85**	

Leaf length (cm)

The mean data regarding leaf length is mentioned in Table 2. There were significant differences for different levels of Humic acid and nitrogen as well as its interaction.

The means regarding leaf length revealed that the high leaf length (6.43 cm) was obtained with application of 5 kg Humic acid ha^{-1} while lesser leaf length (6.16 cm) with control treatment.

Table 2. ***Leaf length (cm) of tomato as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	5.59	5.65	5.62 c
25	5.70	5.87	5.79 c
50	6.01	6.13	6.07 b
75	6.20	6.25	6.22 b
100	6.55	6.96	6.75 a
125	6.66	7.11	6.88 a
150	6.44	7.06	6.75 a
Mean	**6.16 b**	**6.43 a**	

LSD value for Nitrogen at 5% level of probability = 0.19
LSD value for interaction at 5% level of probability = 0.27
Means followed by same letter are statistically non significant at 5% level of probability.

The maximum leaf length (6.88 cm) was observed with the application of 125 kg N ha^{-1} which was statistically similar to the leaf length (6.75 cm) obtained with the application of 150 and 100 kg nitrogen ha^{-1} while minimum leaf length (5.65 cm) was observed with control nitrogen which was statistically similar to the leaf length (5.79 cm) obtained at the rate of 25 kg ha^{-1} nitrogen application.

In case of interaction maximum leaf length (7.11 cm) was obtained from those plots having 5 kg Humic acid and 125 kg nitrogen ha^{-1} while minimum leaf length (5.59 cm) was recorded in plots untreated with Humic acid and nitrogen.

The maximum leaf length was due to photosynthetic pigments content which increased by Humic acid and the synthesis of carotenoids activated which protect chlorophyll from oxidation resulting in increase in number of cells per leaf, chloroplasts per cell and gradually leaf area (Yildirim, 2007). Azarpour *et al.* (2012) also reported that foliar application of Humic acids with nitrogen fertilizers had significant effect on leaf length.

Plant height (cm)

The mean data regarding plant height is given in Table 3. The results showed significant differences among nitrogen and Humic acid levels and its interaction. Mean data showed that high plant height (82.92 cm) was recorded with application of 5 kg Humic acid ha^{-1} whereas less plant height (80.46 cm) in control treatment.

The plant height (89.16 cm) was more in plants applied with nitrogen at the rate of 125 kg ha^{-1} which was statistically similar to the plant heights (88.30 cm & 88.26 cm) obtained at the rate of 150 kg and 100 kg ha^{-1} nitrogen application, whereas lower plant height (68.50 cm) was noted in control treatment.

The interaction of both fertilizers showed that maximum plant height (90.56 cm) was obtained from those plots where 5 kg Humic acid and 125 kg nitrogen ha^{-1} was applied, whereas plots supplied with 5 kg Humic acid and 0 kg nitrogen ha^{-1} showed less plant height (67.10 cm).

Table 3. ***Plant height (cm) of tomato as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	69.90	67.10	68.50 d
25	72.6	74.00	73.31 c
50	77.63	84.62	81.12 b
75	81.62	84.77	83.19 b
100	86.51	90.02	88.26 a
125	87.76	90.56	89.16 a
150	87.20	89.40	88.30 a
Mean	**80.46 a**	**82.92 b**	

LSD value for Nitrogen at 5% level of probability = 2.40
LSD value for interaction at 5% level of probability = 3.40
Means followed by same letter are statistically non significant at 5% level of probability.

Nitrogen is important for formation of amino acids in DNA and RNA because of photosynthetic reaction and further increased cell division results in plant growth (Haque *et al.,* 2001). On the other hand Humic acid assimilates minor and major elements, activates or inhibits enzyme, carry changes in membrane permeability, results in protein synthesis and activate biomass production which stimulates plant growth and ultimately increase plant growth (Stevenson, 1994). These are the reasons due to which tomato plant height were maximum at optimum nitrogen level. These observations are in comparison with some of the field experiments conducted by some of the researchers as El-Ghamry *et al.* (2009) and Atiyeh *et al.* (2002) reported that application of Humic acid increased tomato plant height significantly. Azarpour *et al.* (2012) also reported that the fertilizer Humic acid and nitrogen result in the highest plant height.

Fruit weight (g)

The data regarding fruit weight (g) is given in table 4. Significant differences were recorded for Humic acid and nitrogen levels as well as interaction between Humic acid and nitrogen.

Table 4. ***Fruit weight (gm) of tomato as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	67.09	68.75	67.92 e
25	69.33	71.08	70.20 d
50	71.27	72.56	71.91 cd
75	72.42	73.95	73.19 c
100	74.94	79.48	77.21 ab
125	75.54	82.09	78.82 a
150	74.43	79.01	76.72 b
Mean	**72.15 b**	**75.27 a**	

LSD value for Nitrogen at 5% level of probability = 1.80
LSD value for interaction at 5% level of probability = 2.55
Means followed by same letter are statistically non significant at 5% level of probality.

The mean data showed that the mean fruit weight (75.27 g) was obtained with the application of 5 kg Humic acid ha^{-1} as compared to 72.15 g in untreated plants with Humic acid.

Application of nitrogen also influenced the fruit weight which was the maximum (78.82 g) with application of 125 kg nitrogen ha^{-1} closely followed by (77.21 g) with application of 100 kg N ha^{-1} while the minimum fruit weight (67.29 g) was recorded with control treatment.

The interaction of Humic acid and Nitrogen levels showed the maximum fruit weight (82.09 g) with 5 kg Humic acid and 125 kg N ha^{-1} application, while minimum fruit weight (67.09 g) was recorded in plots untreated with Humic acid.

Humic acid and nitrogen leads to good plant vigor and growth and whenever there is nitrogen deficiency there will be stunted growth of the plant, which leads to premature flowering and short growth cycle (Grundon, 1987, Lincoln and Edvardo, 2006). It may due to vigorous growth and emhaned plant canopy establishment and better inception of light and uptake of nutrients (Kasperbauer, 1987), that resulted in higher fruit weight with Humic acid and nitrogen application (Aminifard *et al*., 2010).

Fresh Yield (tons ha^{-1})

The mean data regarding fresh yield (t ha^{-1}) is given in Table 5, which shows significant differences among Humic acid and nitrogen levels and their interaction. The highest mean yield (28.49 t ha^{-1}) was recorded with application of 5 kg Humic acid ha^{-1} as compared to 27.22 t ha^{-1} in control treatment. The yield was the maximum (32.43 t ha^{-1}) with application of 125 Kg N ha^{-1} which significantly higher than the rest of the nitrogen treatments followed by (29.95 t ha^{-1}) with application of 100 kg N ha^{-1}, whereas the minimum yield (24.22 t ha^{-1}) was recorded in plants untreated with nitrogen. The interaction of Humic acid and nitrogen application revealed the highest yield (32.57 t ha^{-1}) with 125 kg N and 5 kg Humic acid ha^{-1}, whereas the least yield (23.96 t ha^{-1}) was recorded in plots having 0 kg ha^{-1} Humic acid and nitrogen, respectively. Nitrogen (Lincoln and Edvardo, 2006) and Humic acid (Yildirim, 2007) have been reported to improve plant physiological processes by enhancing the availability of major and minor nutrients as well as enhancing the vitamins, amino acids, and also auxine, cytokinine and ABA contents of the plants. Thus, it enhances the uptake of essential nutrients and increases plant resistance to pests and diseases. Rehman *et al.* (2007) also reported that yield of tomato had been significantly affected by nitrogen. Similarly Martin and Senn (1967) also reported that application of nitrogen and Humic acids had a significant effect on yield of tomato grown in green house

Table 5. ***Yield ha^{-1} (tons) of tomato as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	23.96	24.47	24.22 f
25	24.22	27.07	25.65 e
50	27.13	27.79	27.46 d
75	28.07	29.00	28.53 c
100	28.61	31.29	29.95 b
125	32.30	32.57	32.43 a
150	26.27	27.22	26.74 d
Mean	**27.22 b**	**28.49 a**	

LSD value for Nitrogen at 5% level of probability = 0.93
LSD value for interaction at 5% level of probability = 1.31
Means followed by same letter are statistically non significant at 5% level of probability.

Blossom End Rot

The data regarding blossom end rot disease caused to tomato fruits is given in Table 6. The analysis of the results showed that blossom end rot incidence was not significantly affected by Humic acid, nitrogen levels and their interaction.

Table 6. ***Blossom end rot disease caused to tomato fruit as affected by Humic acid and nitrogen levels.***

Nitrogen levels (kg ha^{-1})	Humic acid levels (kg ha^{-1})		Mean
	0	5	
0	8.89	10.15	9.52
25	9.27	8.89	9.08
50	8.86	9.08	8.97
75	8.78	8.29	8.53
100	7.09	8.38	7.74
125	6.80	7.57	7.18
150	9.44	7.59	8.51
Mean	**8.45**	**8.56**	

CONCLUSIONS AND RECOMMENDATIONS

According to the results of the experiment, it is concluded that compared to control treatment Humic acid at the rate of 5 kg ha^{-1} showed better results. Nitrogen applied at the rate of 125 kg ha^{-1} gave high yield and yield components of tomato plant followed by 100 and 150 kg ha^{-1} whereas control treatments showed minimum results. Tomato plant should be treated with fertilizers Humic acid and nitrogen at the rate of 5 kg and 125 kg ha^{-1} to obtain maximum and quality yield under the prevailing agro-climatic condition of Peshawar.

REFERENCES

Adani, F., P. Gerevini and G. Zocchi. 1998. The effect of commercial Humic acid on tomato plant growth and mineral nutrition. J. Plant Nutr. 21: 561-575.

Aminifard, M.H., H. Aroiee, H. Fatemi, A. Ameri and S. Karimpour. 2010. Responses of eggplant (*Solanum melongena* L.) to different rates of nitrogen under field conditions. J. Central Eur. Agric. 11: 453-458.

Arya., P.S., Vidyasagar and S.R. Singh. 1999. Effect of N, P and K on tomato seed production. Sci. Hort. 6: 89-91.

Atiyeh, R.M., S. Lee, C.A. Edwards, N.Q. Arancon and J.D. Metzger. 2002. The influence of Humic acids derived from earthworm-processed organic wastes on plant growth. Soil Ecology Laboratory, 105 Botany and Zoology Building, The Ohio State University, 1735 Neil Avenue, Columbus, OH 43210, USA.

Azarpour, E. A., M. Karim, Motamed, M. Maral and H. R. Bozorgi1. 2012. Effects of bio, mineral nitrogen fertilizer management, under Humic acid foliar spraying on fruit yield and several traits of eggplant (Solanum melongena L.) Afr. Agric. 7: 1104-1109.

Bagal, S.D., G.A. Sheikh and R.N. Adsule. 1989. Influence of different levels of N, P and K fertilizers on the yield and quality of tomato. J. Maharashtra Agric. Univ. 14: 158-160.

Doran, I., C. Akinci and M. Yildirim. 2003. Effects of delta humate applied with different doses and methods on yield and yield components of diyarbakir-81 wheat cultivar. 5th Field Crops Congress. Diyarbakir. Turkey. 2: 530-534 (in Turkish with English abstracts).

Dorais M., D.L. Ehret and A.P. Papadopoulos. 2008. Tomato (*Solanum lycopersicum*) health components: from the seed to the consumer. Phytochem. Rev. 7:231-250.

El-Ghamry, A.M., K.M.A., E. Hai and K.M. Ghoneem. 2009. Amino and Humic acids promote growth, yield and disease resistance of faba bean cultivated in clayey soil. Aust. J. Basic Applied Sci. 3: 731-739.

FAO. (2007). Food and Agricultural Organization Stat, core production 2005. Available online: http://faostat.fao.org/site/340/default.aspx.

Grundon, N.J. 1987. Hungry crops: A guide to nutrient deficiencies in field crops. Brisbane, Australia: Queensland Govt. 246 p.

Haque, M.M., A. Hamid and N.I. Bhuiyan, 2001. Nutrient uptake and productivity as affected nitrogen and potassium application levels n maize/sweet potato intercropping system. Korean J. Crop Sci. 46: 1-5.

Hochmuth, G.J., K.D. Shuler, R.L. Mitchell and P.R. Gilreath. 1987. Nitrogen crop nutrient requirement demonstrations for mulched pepper in Florida. Proceedings of the Florida State. Hort. Soc. 100: 205-209.

Kasperbauer, M.J. 1987. Far-red light reflection from green leaves and effects on phytochrome mediated assimilate partitioning under field conditions. Plant Physiol. 85:350-354.

Lincoln, T and Z. Edvardo. 2006. Assimilation of mineral nutrition. In: Plant physiology (4th ed.), Sinaur Associates, Inc. Pub. P. O. Box. 407. Sunderland. 705p.

Marchner, H. 1995. Mineral nutrition in higher plants. Acad. Inc. London. UK. pp: 887.

Martin, J.A. and T.L. Senn. 1967. The Influence of Various Rates of Nitrogen and Humic Acid Derivatives on the growth and yield of greenhouse tomatoes. S. Carolina Ag. Exp. Sta. Res. Series No. 95.

McDonnell, R., N.M. Holden, S.M. Ward, J.F. Collins, E.P. Farrell and M.H.B. Hayes. 2001. Characteristics of Humic substances in healthland and forested peat soils of the Wicklow mountains. Bio. Environ. 101: 187-197.

MINFA. 2009. Department of Agriculture Statistics Govt of Khyber Pakhtunkhwa.

MINFA. 2005. Agricultural statistics of Pakistan. Ministry of Food, Agriculture, and Livestock. Food and Agric (Economic Wing), Islamabad.

Olaniyi J.O., W.B. Akanbi, T.A. Adejumo, O.G. Akande. 2010. Growth, fruit yield and nutritional quality of tomato varieties. Afr. J. Food Sci. 4:398-402.

Rehman, M.J., Mondol, M.N. Rahman, R.A. Begum, and M.K. Alam. 2007. Effect of irrigation and nitrogen on tomato yield in the grey terrace soil of Bangladesh. J. Soil Nature.1: 01-04.

Ruben, I.V. 1999. Tomatoes in the tropics. Western Press/Boulder. Colorado. p. 5.

Senn, T.L. 1991. Humates in Agriculture. Principles and procedures of statistics. 2nd ed. Mc Graw Hill international book company, New York, USA.

Stevenson, F.J. 1994. Humus Chemistry: Genesis, Composition, Reaction (Second ed.), Wiley, New York

Yildirim, E. 2007. Foliar and soil fertilization of Humic acid affect productivity and quality of tomato. Acta Agriculturae Scandinavica. (Section B). Soil Plant Sci. 57: 182-186.