

INFLUENCE OF FOLIAR NUTRIENTS APPLICATION ON GROWTH AND YIELD OF ONION GROWN IN NUTRIENT DEFICIENT SOIL

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Abstract

Commercially available foliar spray labeled as 'Planto-fuel' increased significantly ($p \leq 0.05$) most of the growth traits viz., leaf length, bulb diameter (7.6 cm), bulb length (5.9 cm), leaves fresh weight/plant, neck fresh weight/plant, bulb fresh weight/plant (166.6 g) and plant fresh weight. It also produced the maximum yield (14.2 tons/ha) while the basal application of DAP significantly increased the number of leaves/plant and 2nd best results in yield whereas the lowest yield was observed through water spray. It is observed that the foliar application of micronutrients mixture in combination with nitrogen is the most suitable method to increase the onion production.

Introduction

Onion (*Allium cepa* L.) the "Queen of the Kitchen" is among the most commercially important vegetables belonging to Alliaceae. It grows best in well drained, loose and high fertile soil with pH between 6.2 and 6.8 and plenty of organic matter (Raemaekers 2001). Irrigation also plays a vital role in production of onion. From 15 to 30 cm moisture content must be kept up for maximum yield. The best climatic condition for onion growth is the dry season (Norman 1992).

Seventeen elements are required by plants for normal growth. C, H and O are taken from water and air. Other nutrients are obtained from soil (Tahir 1980). The presence of nutrients like nitrogen, phosphorus, potassium, sulfur and magnesium are essential in balanced form for major processes of development of plants and production of yield (Randhawa and Arora 2000). Plants also require the trace elements (B, Cu, Mn, Zn and Mo) for their normal growth and development (Kanwar and Randhawa 1967). In agriculture practices fertilizer is an important source to increase crop yields. Among fertilizer application methods, one of the most important methods of application is foliar nutrition because foliar nutrients facilitate easy and quick consumption of nutrients by penetrating the stomata or leaf cuticle and enters the cells (Latha and Nadanassababady 2003). The nutrients have one of the chief importance in improving quality and productivity of vegetables which require mineral nutrients in large amount. Due to continuous inorganic fertilizers consumption results in micronutrients deficiency, disproportion in physiochemical properties of soil and low production of crops. For that reason these minerals are applied as affliction foliar form (Jeyathilake *et al.* 2006). Foliar application of nutrients at proper growth phases is essential for their consumption and improved crop performance (Anadhakrishnaveni *et al.* 2004). The mineral nutrients assimilation rate by plants aerial parts is

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not only different among plant species but also among many different varieties of the same plant species (Wojcik 2004). It was found that during crop growth supplementary foliar fertilization increased plants mineral status and improved crop yields (Rahman *et al.* 2014a).

The present study was planned to conduct an experiment in farmer's field, Marghazar, Mansehra to investigate appropriate dose of foliar mineral nutrients application on growth and yield of onion (*Allium cepa* L.).

Materials and Methods

Field experiment was carried out in farmer's field, Marghazar, Mansehra in randomized complete block design RCBD with four treatments replicated three times during winter season of 2012/2013.

Soil samples were taken before sowing randomly from the experimental field from 0 to 15 cm and 15 to 30 cm in depth for physico-chemical analysis. Air dried soil (50 g) and 50 ml distilled water were added into a glass beaker. Mixture was made and allowed to stand for 1 hrs. Then, soil pH was measured by pH meter (McLean 1982). A representative random sample was analyzed for physical and chemical analysis at Land Resources Research Institute, NARC. The nitrogen was analyzed through Macro-Kjeldahl method (Paul and Berry 1921). Ammonium bicarbonate-diethylen triamin penta acetic acid (AB-DTPA) method was used to analyze both phosphorus and potassium (Soltanpour and Woekman 1979).

Table 1. Chemical analysis of soil sample pre-sowing of onion in farmer's field Marghazar showing the amount of NPK in mg/Kg in soil.

S.No	Sample Id (cm)	pH	NO ₃ -N	P	K	EC (dSm ⁻¹)
1.	0 - 15	6.6	5.5	0.87	112	0.37
2.	15 - 30	7.0	3.2	0.7	124	0.18

Table 2. Standard values of different nutrients in soil (mg/Kg).

S. No.	Elements	Low	Medium	High
1	N	≤ 10.00	11 - 20	21 - 30
2	P	≤ 03.00	04 - 07	08 - 11
3	K	≤ 60.00	61 - 120	121 - 181

In farmer's field Marghazar, the onion total number of plots was 15 and area of each plot was 1 m² and 1.5 ft path in between each plot was prepared. Onion plant to plant and row to row space was 15 cm. All the foliar applications were revised after 14 days of interval till maturity while basal placement of DAP was done single time. The applications were as follows: T₀; (H₂O spray), T₁; Planto-fuel (N + micronutrients) 6.177 liter + 1235.4 liter H₂O/ ha, T₂; DAP (Solid form) 123.5 kg /ha, T₃; Fozan (DAP foliar form and 2% N foliar form) DAP = 12.35 liter + 617.7 liter H₂O/ ha and N = 12.35 liter + 617.7 liter H₂O/ ha, T₄; K-sol (NPK 20 : 20 : 20) 6177.4 g + 1235.4 liter H₂O /ha.

Five plant samples of onion from each plot were collected after maturity to observe the following growth and yield attributes. Quantitative traits of onion were: plant height, number of leaves/plant, leaf length, neck length, bulb length, neck diameter, bulb diameter, leaves

weight/plant, neck weight/plant, bulb weight/plant, plant weight and yield. All the data were statistically analyzed by computer program SPSS 16.0. The differences among the means were calculated using LSD test ($p \leq 0.05$). Means of competition indices were separated by standard error bars.

Results and Discussion

The results of soil analysis showed the pH, EC and nitrogen, phosphorus and potassium values. In soil samples, the N and P were found deficient while K was in normal quantity. Exact values of N, P and K in the soil samples of experimental field analyzed are given in Table 1. Soil nutrients standard value is given in Table 2 (Soltanpour 1985).

The analysis of variance of recorded data for height of onion plant trait at harvest showed non-significant differences in the applications except T₁ (Table 3). The mean square values of plant height of treated applications showed that T₁ attained maximum plant height (59.8 cm), followed by T₃ (58.6 cm). Applications T₂ and T₄ had an average of plant height (56.6 and 52.7 cm, respectively) while minimum plant height (49.4 cm) was noticed in T₀ application.

Analysis of variance for number of leaves/plant attribute in T₂ application showed highly significant differences (Table 3). The mean squares data of this trait of applied applications showed that T₂ had most number of leaves/plant (13.6) which was followed by T₁ (10.6) (Fig. 1). T₃ and T₄ applications showed results for number of leaves/plant (9.6) and (8.6) while minimum number of leaves/plant (7.6) was observed through T₀ application. These findings are in agreement with that of Habba (2003) who examined the foliage application of etherel on plant height, leaves number and leaves weight of onion.

Table 3. Effects of nutrient application on plant height, no. of leaves, leaf length, neck length, bulb length and neck diameter of onion.

Treatments	Plant height (cm)	No. of leaves	Leaf length (cm)	Neck length (cm)	Bulb length (cm)	Neck diameter (cm)
T ₀	50.06 B	7.66 B	22.53 C	4.60 BC	4.20 C	11.83 B
T ₁	59.86 A	10.66 AB	36.13 A	4.40 C	5.93 A	14.83 AB
T ₂	56.60 AB	13.66 A	31.66 AB	5.60 A	5.20 AB	17.36 A
T ₃	58.66 AB	9.66 B	32.46 AB	5.33AB	4.93 BC	15.66 AB
T ₄	52.73 AB	8.66 B	29.80 B	4.73 BC	4.93 BC	16.50 A
LSD _(0.05)	3.7481	1.3166	2.2960	0.3540	0.3688	1.8779

Within each column, treatments carrying same superscript letter are not significantly different at 5% level.

Highly significant differences were observed in leaf length through T₁ application (Table 3). The mean square values of leaf length trait showed that T₁ had highest leaf length (36.1 cm), followed by T₃ (32.4 cm), whereas it was followed by T₂ and T₄ with a leaf length of 31.6 cm and 29.8 cm, respectively. The minimum leaf length (22.5 cm) was recorded in T₀. The present observations are in accordance with Singh and Chuare (1999) who reported that leaf length was significantly increased compared to that of control by nitrogen application (up to 150 Kg/ha). Contradictory results were also recorded by Tisdale *et al.* (1985) who concluded that the leaf

length increased by the application of zinc which takes part in auxin metabolism and various other enzymatic reactions.

The analysis of variance for neck length of onion plant showed non-significant differences in the applications. The mean square values of neck length character of treated applications revealed that T₂ had highest neck length (5.6 cm) which was followed by T₃ (5.3 cm) whereas T₄ and T₀ were after it and had a neck length of 4.7 and 4.6 cm, respectively. The minimum neck length (4.4 cm) was noticed in T₁ (Table 3).

The mean squares values of bulb length trait among applied applications showed that T₁ had maximum bulb length (5.9 cm) and was followed by T₂ (5.2 cm), while T₃ and T₄ showed similar values for bulb length of (4.9 cm). The minimum observation for bulb length trait (4.2 cm) was noticed in T₀.

The mean square data of this attribute among treated applications showed that T₂ had maximum neck diameter (17.3 mm) and was followed by T₄ (16.5 mm) while T₃ and T₁ revealed the values for neck diameter of 15.6 and 14.8 mm, respectively. Minimum neck diameter value (11.8 mm) was recorded in T₀. El-Bassiony (2006) reported similar findings who stated that neck diameter, bulb diameter and total yield were significantly affected by the foliar treatment of K.

The analysis of variance showed that T₁ application had highly significant difference for onion bulb diameter trait (Table 4). The mean squares data of bulb diameter of applied applications showed that T₁ had highest bulb diameter (7.6 cm) followed by T₂ (6.9 cm) while T₄ and T₃ showed the data for bulb circumference of 6.4 and 6.2 cm, respectively. The minimum value for bulb diameter (4.9 cm) was noticed in T₀. The present findings are in agreement with Shafeek *et al.* (2013) who noticed that many bulb attributes like bulb length, bulb diameter, bulb weight, yield TSS and protein content was significantly improved by the treatment of etherel (200 ppm) (Table 3).

The mean square data of this trait among treated applications showed that T₁ had highest leaves weight/plant (37.3 g), followed by T₂ (36.6 g) while T₃ and T₄ showed results for leaves weight/plant (31 and 19 g) while minimum leaves weight/plant (15 g) was observed in T₀. These results are in contradiction with Abd El-Samad (2011) who reported that in second season of experiment the micronutrients application showed non-significant differences on the attributes such as number of leaves/plant, neck length and dry weight of leaves (Table 4).

The mean square data of this trait among applied applications showed that T₁ had a maximum neck weight/plant (7.2 g) and was followed by T₂ (7.1 g) while results for neck weight/plant trait in T₃ and T₄ observed were 5.5 and 3.7 g, respectively. Minimum observations were noticed in T₀ for neck weight/plant trait (2.9 g). The present results are in accordance with Abd El-Samad *et al.* (2011) who concluded significant differences were noted on neck fresh weight and whole plant in the first season while on plant height in the second season by the combined application of different N doses and foliar micronutrients (Table 4).

The mean square values among treated applications for bulb weight/plant showed that T₁ had a highest bulb weight/plant (166.6 g) which was followed by T₂ (135.6 g). T₃ and T₄ had an average bulb weight/plant (106.6 and 89 g, respectively) and the minimum bulb weight plant⁻¹ (65.6 g) was noticed in T₀ application. Similar results were obtained by Satbir *et al.* (1989) who suggested that bulb fresh weight was significantly improved by zinc and boron application.

The mean square values of this quantitative character among applied applications showed that T₁ had maximum plant weight (212.3 g), followed by T₂ (181.3 g) while T₃ and T₄ are after it for plant weight of 140.6 and 123.3 g. The minimum recorded data for plant weight of onion (83.3 g) was scored by T₀ (Table 4). This result was supported by Kirkby and Romheld (2004) who

reported that foliar spray of the micronutrients might increase plant growth attributes and act as components of cell wall and other membranes.

The mean square data of onion yield among applied applications revealed that T₁ had highest yield (19992.6 kg) and was followed by T₂ (19200.3 kg). Applications T₄ and T₃ had an average yield (16231.0 kg) and (16001.0 kg), respectively. Whereas minimum yield of onion (13001.0 kg) was recorded through T₀ application (Table 4). Foliar application of macro and micronutrients play an important role in the production of good crop and higher yield (Rahman *et al.* 2015). These findings are in agreement with Balemi *et al.* (2007); Biesiada and Kołota, (2009) who described that bulb yield of onion significantly increased by rate of nitrogen fertilization. Similarly, Sliman *et al.* (1999) and Alam *et al.* (2010) showed that foliage treatment of zinc and then iron mostly increased the bulb yield of onion. Similar findings were found by other researchers in common bean and for cauliflower (Rahman *et al.* 2014b, c and Rahman *et al.* 2014d).

Table 4. Effects of nutrient affliction of response of neck weight, onion bulb weight, plant weight and bulb yield of onion.

Treatments	Bulb diameter (cm)	Leaves weight (g)	Neck weight (g)	Bulb weight (g)	Plant weight (g)	Bulb yield (kg/ha)
T ₀	4.98 D	15.00 B	2.93 A	65.67 E	83.33 D	13001.00 D
T ₁	7.65 A	37.33 A	7.20 A	166.67 A	212.33 A	19992.67 A
T ₂	6.95 B	36.66 A	7.10 A	135.67 B	181.33 B	19200.33 B
T ₃	6.29 BC	31.06 A	5.53 A	106.67 C	140.67 C	16001.00 C
T ₄	6.17 C	19.0B	3.70 AB	89.00 D	123.33 C	16231.00 C
LSD _(0.05)	0.2940	3.7291	0.8600	5.8376	9.1948	26.734

Within each column, treatments carrying same superscript letter are not significantly different at 5% level.

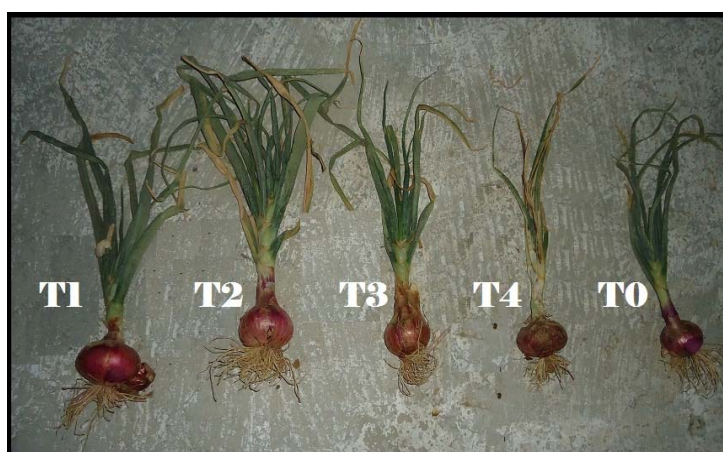


Fig. 1. Effects of different nutrients application on growth of onion.

Foliar spray with 'Planto-fuel' containing (N+ Zn, Fe, Mg, Cu, B and Mn mixture) showed highest significant results in the growth and yield attributes, leaf length, bulb diameter (7.6 cm),

bulb length (5.9 cm), leaves weight/plant, neck weight/plant, bulb weight/plant (166.6 g), yield (14.2 t/ha). The basal application of DAP + urea significantly increased the number of leaves /plant.

From the present investigations it may be concluded and recommended that the foliar application of micronutrients mixture in combination with nitrogen is the most suitable method to improve the growth and yield of onion.

References

- Abd El-Samad EH, Khalifa RKM, Lashine ZA and Shafeek MR 2011. Influence of urea fertilization and foliar application of some micronutrients on growth, yield and bulb quality of onion. *Aust. J. Basic Appl. Sci.* **5**: 96-103.
- Alam MN, Abedin MJ and Azad MAK 2010. Effect of micronutrients on growth and yield of onion under calcareous soil environment. *Int. Res. J. Plant Sci.* **1**: 056-061.
- Anadhakrishnaveni S, Palchamy A and Mahendran S 2004. Effect of foliar spray of nutrients on growth and yield of greengram (*Phaseolus radiatus*). *Legume Res.* **27**: 149-150.
- Balemi T, Pal N and Saxena AK 2007. Response of onion (*Allium cepa* L.) to combined application of biological and chemical nitrogenous fertilizers. *Acta Agric. Slovenica* **89**: 107-114.
- Biesiada A and Kolota E 2009. The effect of nitrogen fertilization on yield and nutritional value of onion grown from sets for early cropping. *Veg. Crop Res. Bulletin.* **70**: 145-151.
- El-Bassiony MA 2006. Effect of potassium fertilization on growth, yield and quality of onion plants. *J. Appl. Sci. Res.* **2**: 780-785.
- Habba 2003. Physiological studies of some growth regulators on the growth, yield and chemical constituents of onion plants. *J. Agric. Sci. Mansoura Univ.* **28**: 1645-1653.
- Jeyathilake PKS, Reddy IP Srihari D and Reddy KR 2006. Productivity and soil fertility status as influenced integrated use of N-fixing biofertilizers, organic manures and inorganic fertilizers in onion. *J. Agric. Sci.* **2**: 46-58.
- Kanwar JS and Randhawa NS 1967. Micronutrients research in soil and plants in India. A review. *Indian Council of Agric. Res. New Dehli.*
- Kirkby EA and Romheld V 2004. Micronutrients in plant physiology: functions, uptake and mobility. *Proceedings No. 543, Int. Fertilizer Society.*
- Latha MR and Nadanassababady T 2003. Foliar nutrition in crops. *Agric. Rev.* **24**: 229-234.
- McLean EO 1982. Soil pH and Lime requirement. *In: A.L. Page, R.H. Miller and D.R. Keey (eds.), Methods of Soil Analysis Part 2. Amer. Soc. Agron. No. 9 Madison, Wisconsin, USA.* 199-209.
- Norman JC 1992. *Tropical Vegetable Crops. In: Elms Court Ilfracombe, Stockwell, H. (Ed) Devon Publishers, U.K.*
- Paul AE and Berry EH 1921. The Kjeldahl method and its modifications. *J. Assoc. Agric. Chem.* **5**: 108-132.
- Raemaekers RH (ed.). 2001. *Crop production in tropical Africa. Directorate General for International Co-operation (DGIC), Brussels, Belgium.* 1540.
- Rahman IU, Afzal A, Iqbal Z and Manan S 2014a. Foliar application of plant mineral nutrients on wheat: A review. *Res. Rev: J. Agric. & Allied Sci.* **3**: 19-22.
- Rahman IU, Afzal A, Iqbal Z, Ijaz F, Manan S, Sohail, Ali A, Khan K, Karim S and Qadir G 2014b. Growth and yield of *Phaseolus vulgaris* as influenced by different nutrients treatment in Mansehra. *Int. J. Agron. Agric. Res.* **4**: 20-26.
- Rahman IU, Afzal A, Iqbal Z, Ijaz F, Sohail, Shad S, Manan S and Afzal M 2014c. Response of common bean (*Phaseolus vulgaris*) to basal applied and foliar feeding of different nutrients application. *American-Eurasian J. Agric. Environ. Sci.* **14**: 851-854.
- Rahman IU, Afzal A, Iqbal Z, Sohail, Ijaz F, Manan S, Niaz S, Shah AH, Ullah A and Waheed A 2014d. Response of cauliflower (*Brassica oleraceae* var. botrytis L.) to N, Mo and Mg fertilization under poultry manure condition. *Int. J. Biosci.* **4**: 215-221.

- Rahman IU, Afzal A, Iqbal Z, Shah AH, Khan MA, Ijaz F, Sohail, Ullah A, Nisar A, Zainab R and Manan S 2015. Review of foliar feeding in various vegetables and cereal crops boosting growth and yield attributes. *American-Eurasian J. Agric. Environ. Sci.* **15**: 74-77.
- Randhawa PS and Arora CL 2000. P-S interaction effect on dry matter yield and nutrient uptake by wheat. *J. Ind. Soc. Soil Sci.* **48**: 536-540.
- Satbir S, Tiwari RS and Sindhu SS 1989. Effect of micronutrients on the growth characters of onion (*Allium cepa* L.) cv. Pusared. Hariayana, *J. Hort. Sci.* **18**: 146-149.
- Shafeek MR, Nagwa MK, Hassan SM and EL-Greadly NHM 2013. Effect of potassium fertilizer and foliar spraying with Etherel on plant development, yield and bulb quality of onion plants (*Allium cepa* L). *J. Appl. Sci. Res.* **9**: 1140-1146.
- Singh J and Chaure NK 1999. Effect of age of seedlings and nitrogen levels on growth and yield of onion (*Allium cepa* L.). *Adv. Hort. Forest.* **6**: 73-77.
- Sliman ZT, Abdelhakim MA and Omran AA 1999. Response of onion to foliar application of some micronutrients. *Egypt J. Agric. Res.* **77**: 983-993.
- Soltanpour PN 1985. Use of ammonium bicarbonate DTPA soil test to evaluate elemental availability and toxicity. *Commun. Sci. Pl. Analy.* **16**: 323-338.
- Soltanpour PN and Woekman S 1979. Modification of the NH_4HCO_3 -DTPA soil test to omit carbon black. *Commun. Sci. Pl. Analy.* **10**: 1411-1420.
- Tahir M 1980. Wheat production manual. Pakistan Agriculture Research Council. Islamabad, 259.
- Tisdale SL, Nelson WL and JD Beaton 1985. Micronutrients and other beneficial elements in soils and fertilizers. In soil fertility and fertilizers, zinc, 387-388. Macmillan Publishing Company 866 third avenue, New York, 10022.
- Wojcik P 2004. Uptake of mineral nutrients from foliar fertilization. *J. Fruit Orn. Pl. Res. Spec. Ed.* **12**: 201-218.

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