Effect of Drip Fertigation and Boron Foliar Spray on Growth, Seed Yield and Quality of Onion (Allium cepa L.) Cv. Palam Ilohit

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ABSTRACT

These investigations were conducted to study the influence of N and K drip fertigation along with boron foliar spray on growth, seed yield and seed quality of onion (Allium cepa L.). The experiments were carried out during two consecutive years (2014-15 and 2015-16) at experimental farm of Department of Seed Science and Technology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-173230 (H.P) using randomised block design. N and K fertilizers were applied through drip irrigation at three different levels viz; 100 %, 80 % and 60 % of RDF as twenty different combinations in 10 equal splits at 15 days interval along with boron foliar spray. The results revealed that N and K fertigation along with boron foliar spray treatments gave significant results on plant growth, seed yield and quality parameters. Among all the treatments N100K100B1 (48.34 cm) exhibited maximum plant height, minimum days to 50 % flowering (151.00), number of flowering stalks per plant (7.73), number of umbels per plant (5.72), number of umblets per umbel (992.50), number of seeds/umbel (5143.27), seed yield /hectare (862.07), 1000 seed weight (4.39 g), germination %age (96.00 %), seedling length (15.18 cm), seedling dry weight (20.42 mg) and seedling vigour index I and II (1456.99 and 1961.01).

INTRODUCTION

Onion (Allium cepa L.) is a cool season vegetable crop and well adapted to Indian sub-continent. It is one of the most important vegetable cash crop used as green leaves as well as mature bulbs. India is the second largest producer of onion in the world with an area of 12.17 lakh ha and production of 192.99 lakh MT (Anonymous 2014). As per the estimates of National Seed Corporation, India needs about 4000 tonnes of certified seed of onion per year while the yearly production of seed has been estimated to about 6000 quintals (Singh, 2003), which indicates that there is an imperative need to produce more from less arable land and water. The continuous improvement in productivity with optimum...
utilization of water, fertilizer and natural recourses is essential for sustainability of any production system. Apart from the economic considerations, it is well established that the adverse effect of injudicious use of water and fertilizers can also have adverse implications on the environment.

Application of plant nutrients by dissolving them in irrigation water particularly with the drip system is termed as fertigation, offers a vast potential for more accurate and timely crop nutrition, preventing the leaching and volatilization losses of nutrients. The major advantages of fertigation are in saving of labour, appropriate timing of application of water and nutrients and their uniform distribution (Raina; 2002). Other advantages of fertigation lies in minimum leaching and volatilization losses, fertilizer use efficiency besides higher crop yields (Raina et al., 2011). In this method, liquid fertilizers as well as water soluble fertilizers are used and fertilizer use efficiency increased from 80 – 90 %. Apart from major nutrients, micronutrients also play an important role in seed production. Foliar spraying of these nutrients may help the plant to uptake nutrients better than soil application. Generally, the plant requires a wide variety of elements to improve the growth and yield. Among these, boron is an essential element required for the development of cell wall, cell differentiation, root elongation and shoot growth. It has been involved in carbohydrate synthesis, uptake of Ca$^{2+}$ and absorption of NO$_3^-$ . Boron is essential not only for the formation of the pollen and ovary, but also for the subsequent development of the seed. Thus, good quality seed is also one of the important means to increase productivity in any seed crop. In this view, the present investigations were conducted to know the effect of drip fertigation and boron foliar spray on growth, seed yield, quality of onion (*Allium cepa* L.) in cv. Palam Lohit.

**Materials and Methods**

These investigations were carried out for two consecutive years (2014-15 and 2015-16) at the experimental farm of the Department of Seed Science and Technology, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (latitude of 35.5ºN, longitude of 77.8 º E and altitude of 1250 amsl). The soils of area belong to Typic Eutrochrept at sub – group level according to Soil Taxonomy of USDA. Salient physio- chemical properties of the experimental soil for 0-20 cm depth are presented in Table 1. Climate of the area is generally sub temperate and semi humid characterized by cold winters. Annual rainfall 0.00 to 213.6 mm, mean temperature ranges between 9.9 ºC -23.7 ºC, relative humidity 45-63 %. The soil was prepared by one round of ploughing and harrowing. Disease free, healthy, uniform sized bulbs of about 60-65 g in weight were selected and were planted in furrows covered with soil. Each experimental unit consisted of a bed of 1.5 × 1.2 m, containing two rows of plants spaced 45 × 30 cm. The drip fertigation and foliar spray treatments details are given below:

| Treatments | Details |
|------------|---------|
| $N_{RDF}K_{RDF}B_0$ | Conventional application of Nitrogen and Potassium fertilizers + distilled water spray |
| $N_{RDF}K_{RDF}B_1$ | Conventional application of Nitrogen and Potassium fertilizers + distilled water spray |
| $N_{100}K_{100}B_0$ | Fertigation of 100 % of nitrogen and 100 % of potassium + distilled water spray |
| $N_{100}K_{100}B_1$ | Fertigation of 100 % of nitrogen and 100 % of potassium + boron foliar spray |
| $N_{100}K_{80}B_0$ | Fertigation of 100 % of nitrogen and 80 % of potassium + distilled water spray |
| $N_{100}K_{80}B_1$ | Fertigation of 100 % of nitrogen and 80 % of potassium + boron foliar spray |
| $N_{100}K_{60}B_0$ | Fertigation of 100 % of nitrogen and 60 % of potassium + distilled water spray |
| $N_{100}K_{60}B_1$ | Fertigation of 100 % of nitrogen and 60 % of potassium + boron foliar spray |
nitrogen and 60 % of potassium + distilled water spray
\[ N_{100}K_{60}B_1 \] : Fertigation of 100 % of nitrogen and 60 % of potassium + boron foliar spray
\[ N_{80}K_{100}B_0 \] : Fertigation of 80 % of nitrogen and 100 % of potassium + distilled water spray
\[ N_{80}K_{100}B_1 \] : Fertigation of 80 % of nitrogen and 100 % of potassium + boron foliar spray
\[ N_{80}K_{80}B_0 \] : Fertigation of 80 % of nitrogen and 80 % of potassium + distilled water spray
\[ N_{80}K_{80}B_1 \] : Fertigation of 80 % of nitrogen and 80 % of potassium + boron foliar spray
\[ N_{60}K_{100}B_0 \] : Fertigation of 60 % of nitrogen and 100 % of potassium + distilled water spray
\[ N_{60}K_{100}B_1 \] : Fertigation of 60 % of nitrogen and 100 % of potassium + boron foliar spray
\[ N_{60}K_{80}B_0 \] : Fertigation of 60 % of nitrogen and 80 % of potassium + distilled water spray
\[ N_{60}K_{80}B_1 \] : Fertigation of 60 % of nitrogen and 80 % of potassium + boron foliar spray
\[ N_{60}K_{60}B_0 \] : Fertigation of 60 % of nitrogen and 60 % of potassium + distilled water spray
\[ N_{60}K_{60}B_1 \] : Fertigation of 60 % of nitrogen and 60 % of potassium + boron foliar spray

Results and Discussion

The analysis of variance indicated significant differences for the effect of different levels of fertigation on various plant attributed characters whereas; boron spray shows significant differences for the seed yield and quality parameters as the treatment was applied before flowering stage. Thus, the results obtained from the present investigation have been discussed in the following sub heads. Significant differences for the effect of different levels of fertigation on various plant and flowering attributed characters of onion whereas, boron foliar spray shows non-significant differences (Table 1). Among all the treatment combinations \[ N_{100}K_{100}B_1 \] gave maximum plant height (48.34 cm), flowering stalks per plant (7.73), number of umbels per plant (5.72), umblets per umbel (992.50), seeds per plant (5143.27), yield per hectare (862.07 Kg) and minimum days taken for 50 % flowering (151.00 days) which was also statistically at par with treatment \[ N_{100}K_{80}B_1 \]. The results may be attributed to the fact that nitrogen is an essential part of chlorophyll and nucleic acids, which played a major role in promoting plant growth on the other hand potassium plays an important role in translocation of photosynthesis thus the higher concentration of both nitrogen and potassium has the ability to increase the number of cells of leaves, cell size and overall vegetative and reproductive growth of the plants. The results of the present investigation in terms of plant height are in accordance with the findings reported earlier by Damaranay et al., (2016) in onion, Rahim et al., (1997) in onion, Kabir et al., (2013), Marks et al., (2006) in carrot and Jadhao et al., (1999) in radish.

The increased seed recovery % might be due to the effect of micronutrients which play a decisive role in improving the productivity of the crop. In fact, boron helps in arresting flower drop and improves the seed setting which concerned with sugar translocation from complex compounds like carbohydrates and translocated them at greater ease.
Table 1: Effect of different levels of fertigation and boron foliar spray on plant and seed yield attributes in onion

| Treatments | Plant height (cm) | Days to 50% flowering | Number of flowering stalks per plant | Number of umbels per plant | Number of seeds/umbel | Seed yield /ha (kg) |
|------------|------------------|-----------------------|--------------------------------------|-----------------------------|----------------------|---------------------|
|            | B<sub>0</sub> | B<sub>1</sub> | Mean | B<sub>0</sub> | B<sub>1</sub> | Mean | B<sub>0</sub> | B<sub>1</sub> | Mean | B<sub>0</sub> | B<sub>1</sub> | Mean | B<sub>0</sub> | B<sub>1</sub> | Mean |
| N<sub>1</sub>0<sub>D</sub>F<sub>R</sub> | 45.6 | 46.2 | 45.9 | 149 | 149 | 149 | 7.32 | 7.28 | 7.30 | 5.45 | 5.37 | 5.41 | 970.1 | 969.83 | 970 |
| N<sub>1</sub>00K<sub>1</sub>00 | 48.3 | 48.6 | 48.5 | 150 | 151 | 150 | 7.73 | 7.70 | 7.72 | 5.72 | 5.65 | 5.68 | 992.5 | 992 | 992.25 | 5143.27 | 5744.67 | 5443.97 |
| N<sub>1</sub>00K<sub>8</sub>0 | 46.7 | 47.1 | 46.9 | 151 | 150 | 150 | 7.43 | 7.44 | 7.44 | 5.60 | 5.45 | 5.53 | 977.0 | 975.83 | 976.42 | 4770.43 | 5361.07 | 5065.75 |
| N<sub>1</sub>00K<sub>6</sub>0 | 45.1 | 45.7 | 45.4 | 150 | 150 | 150 | 7.15 | 7.21 | 7.18 | 5.47 | 5.35 | 5.41 | 967.3 | 966.67 | 967.0 | 4010.41 | 4408.04 | 4209.23 |
| N<sub>8</sub>0K<sub>1</sub>00 | 44.0 | 44.5 | 44.2 | 148.33 | 149 | 148.67 | 6.82 | 6.92 | 6.87 | 5.38 | 5.18 | 5.28 | 963 | 962.50 | 962.75 | 3172.98 | 3949.34 | 3561.16 |
| N<sub>8</sub>0K<sub>8</sub>0 | 42.4 | 42.9 | 42.6 | 147 | 147 | 147.50 | 6.40 | 6.47 | 6.43 | 5.22 | 5.00 | 5.11 | 917.3 | 916.33 | 916.83 | 2440.51 | 3264.71 | 2852.61 |
| N<sub>8</sub>0K<sub>6</sub>0 | 41.5 | 41.9 | 41.7 | 148 | 147 | 147.83 | 6.42 | 6.48 | 6.45 | 5.07 | 4.82 | 4.94 | 862.6 | 861.17 | 861.92 | 1564.05 | 1564.37 | 1773.60 |
| N<sub>6</sub>0K<sub>1</sub>00 | 43.2 | 43.7 | 43.5 | 147 | 146 | 146.67 | 6.18 | 6.13 | 6.16 | 4.85 | 4.67 | 4.76 | 945.8 | 945.00 | 945.42 | 2939.02 | 3393.37 | 3166.20 |
| N<sub>6</sub>0K<sub>8</sub>0 | 42.1 | 42.6 | 42.4 | 146 | 146 | 146.33 | 5.95 | 5.92 | 5.93 | 4.42 | 4.32 | 4.37 | 891.1 | 890.33 | 890.75 | 2224.9 | 2276.25 | 2475.56 |
| N<sub>6</sub>0K<sub>6</sub>0 | 40.1 | 40.6 | 40.3 | 145 | 145 | 145.50 | 5.73 | 5.73 | 5.73 | 4.53 | 4.23 | 4.38 | 854 | 853.17 | 853.58 | 1111.99 | 1846.96 | 1479.48 |
| Mean | 43.9 | 44.4 | 44.4 | 148 | 148 | 148 | 6.71 | 6.73 | 5.17 | 5.00 | 934.1 | 933.28 | 3165.88 | 3742.93 | 760.27 | 794.53 |

CD (0.05)

| T | 1.60 | 0.85 | 0.40 | 0.34 | 16.0 | 59.31 | 6.70 |
| B | NS | NS | NS | NS | NS | 132.6 | 14.99 |
| T X B | NS | NS | NS | NS | NS | 187.5 | 21.19 |
| Treatments | 1000 seed weight (g) | Germination (%) | Seedling length (cm) | Seedling dry weight (mg) | Seedling vigour I | Seedling vigour II |
|------------|----------------------|-----------------|----------------------|-------------------------|-----------------|-------------------|
|            | B₀  | B₁  | Mean | B₀  | B₁  | Mean | B₀  | B₁  | Mean | B₀  | B₁  | Mean | B₀  | B₁  | Mean | B₀  | B₁  | Mean | B₀  | B₁  | Mean |
| N₀₀₀₁₀₀₀₀₀ | 3.24 | 4.26 | 3.75 | 91.50 | 93.92 | 92.71 | 14.86 | 15.11 | 14.99 | 20.27 | 20.34 | 20.30 | 1359.98 | 1419.36 | 1389.67 | 1855.33 | 1910.44 | 1882.89 |
| N₀₀₀₁₀₀₀₀ | 3.71 | 4.39 | 4.05 | 94.83 | 96.00 | 95.42 | 15.01 | 15.18 | 15.10 | 20.30 | 20.42 | 20.36 | 1423.55 | 1456.99 | 1440.27 | 1924.98 | 1961.01 | 1943.00 |
| N₀₀₀₁₀₀₀₀ | 3.32 | 4.34 | 3.83 | 92.33 | 94.63 | 93.48 | 14.95 | 15.17 | 15.06 | 20.22 | 20.27 | 20.24 | 1380.07 | 1436.83 | 1408.27 | 1867.14 | 1919.06 | 1893.10 |
| N₀₀₀₁₀₀₀₀ | 3.09 | 4.21 | 3.65 | 90.83 | 92.67 | 91.75 | 14.73 | 15.03 | 14.88 | 20.04 | 20.09 | 20.07 | 1337.93 | 1393.23 | 1365.58 | 1820.35 | 1863.16 | 1841.75 |
| N₀₀₀₁₀₀₀₀ | 2.79 | 4.07 | 3.53 | 89.00 | 90.42 | 89.71 | 14.48 | 14.85 | 14.67 | 19.81 | 19.99 | 19.90 | 1289.37 | 1343.07 | 1316.22 | 1764.46 | 1807.98 | 1786.22 |
| N₀₀₀₁₀₀₀₀ | 2.92 | 3.85 | 3.38 | 85.50 | 89.17 | 87.33 | 13.99 | 14.50 | 14.25 | 19.52 | 19.69 | 19.60 | 1196.78 | 1293.81 | 1245.30 | 1669.30 | 1756.40 | 1712.85 |
| N₀₀₀₁₀₀₀₀ | 2.81 | 3.63 | 3.22 | 82.33 | 86.92 | 84.63 | 13.50 | 14.15 | 13.83 | 19.20 | 19.38 | 19.29 | 1110.16 | 1230.17 | 1170.16 | 1578.60 | 1685.42 | 1632.01 |
| N₀₀₀₁₀₀₀₀ | 3.07 | 3.92 | 3.49 | 85.25 | 84.00 | 84.63 | 14.22 | 14.66 | 14.44 | 19.67 | 19.82 | 19.74 | 1213.97 | 1232.39 | 1223.18 | 1680.10 | 1666.65 | 1673.38 |
| N₀₀₀₁₀₀₀₀ | 2.86 | 3.75 | 3.30 | 82.58 | 83.00 | 82.79 | 13.73 | 14.31 | 14.02 | 19.36 | 19.50 | 19.43 | 1134.63 | 1188.43 | 1161.53 | 1600.96 | 1619.86 | 1610.41 |
| N₀₀₀₁₀₀₀₀ | 2.78 | 3.55 | 3.16 | 80.58 | 80.42 | 80.50 | 13.23 | 13.95 | 13.59 | 19.02 | 19.21 | 19.12 | 1066.49 | 1122.28 | 1094.39 | 1533.77 | 1545.66 | 1539.71 |
| Mean       | 3.08 | 4.00 | 3.54 | 87.48 | 89.11 | 88.29 | 14.27 | 14.69 | 14.48 | 19.74 | 19.87 | 19.80 | 1251.29 | 1311.65 | 1281.47 | 1729.50 | 1773.57 | 1751.53 |

**Table 2** Effect of different levels of fertigation and boron spray on quality attributes of harvested onion seed.
Chemical characteristics of the soil to a depth 0-20 cm, sampled prior to the experiment

| Properties                  | Initial values |
|-----------------------------|----------------|
| pH (1:2)                    | 6.21           |
| EC (dSm⁻¹)                  | 0.25           |
| Organic carbon (g kg⁻¹)     | 8.10           |
| Available N (kg ha⁻¹)       | 258.0          |
| Available P (kg ha⁻¹)       | 53.70          |
| Available K (kg ha⁻¹)       | 112.8          |

Boron plays a greater role in nitrogen based synthesis or utilization and involved in RNA metabolism (Deepika and Anita, 2015). Similar results were reported by Ali et al., (2007) in onion, Hamsaveni et al., (2003) in tomato. The delayed flowering by the plants fertilized with 100 % nitrogen might have been due to the influence of higher level of nitrogen in delaying initiation of flowering caused by prolonged vegetative phase (Rajangam, 1991). Similar results were found by He and Chen (1996) in tomato and Suthar et al., (2005) in eggplant.

An analysis of data presented in Table 2 significantly indicated that N₁₀₀K₁₀₀B₁ reported maximum 1000 seed weight (4.39 g), germination % (96.00 %), seedling length (15.18 cm), seedling dry weight (20.42 mg) and Seedling vigour index I and II (1456.99 and 1961.01) respectively, which was at par with N₁₀₀K₈₀B₁. The results were in consonance with Singh et al., 1994 who reported that higher germination %age in seeds is due to better mineral utilization of plants treated with drip fertigation accompanied with enhancement of photosynthesis and greater diversion of food material to seeds. The higher seed quality attributes correlating with higher level of water soluble fertilizers could be attributed to translocation of more carbohydrates due to high nitrogen levels which in turn increases the reserve food material in seed and increase 1000 seed weight. Such beneficial results are also reported with foliar application of boron which is involved in development of cell wall, cell differentiation, root and shoot elongation. It is also involved in ovary developments, seed development and maturity (Sharma; 1995, Verma et al., 1995). The results are in conformity with Chavan (1998) and Darwati et al., (1990) in sesame. This study supported the possibility that potassium plays an important role in this translocation of metabolites for the development of seed. The improvement in root and shoot length of seedling due to boron ascribed to the efficient protein synthesis and better source to sink relationship which resulted in better development of seeds giving rise to higher germination and vigour. These results were in collaborative with Dileepkumar et al., (2009) in cowpea, Arvind Kumar et al., (2012) in bitter gourd.

Thus it is concluded that N₁₀₀K₁₀₀ doses of fertilizer applied through drip irrigation and boron @0.01 % foliar spray (before flowering stage) treatment is effective in increasing the plant growth, seed yield and quality of onion as compared to conventional method of applying nutrients to soil.

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