**Annals of Plant and Soil Research 20(2): 214–217 (2018)**

# Effect of zinc and boron nutrition on productivity and uptake of nutrients in onion (*Allium cepa*)

**V.P.S. SOLANKI, JAGPAL SINGH AND VINAY SINGH**

Department of Agricultural Chemistry and Soil Science, Raja Balwant Singh College, Bichpuri, Agra (U.P.) 283 105

Received: January, 2018; Revised accepted: May, 2018

## ABSTRACT

*A field experiment was conducted at research farm of R. B.S. College, Bichpuri, Agra, (Uttar Pradesh) to study the effect of Zn and B levels on the yield and nutrients uptake in onion (Alluim cepa). The experiment was laid out in randomized design with four levels each of Zn (0, 2, 4 and 6 kg ha$^{-1}$) and B (0, 0.5, 1.0 and 2.0 kg ha$^{-1}$) and three replications. The results revealed that the bulb yield of onion increased significantly up to 4 kg Zn ha$^{-1}$ and 1 kg B ha$^{-1}$. The dry matter production also increased significantly with Zn and B levels over respective controls. The highest bulb yield (32.54t ha$^{-1}$) at 4 kg Zn ha$^{-1}$ was 18.2% higher in comparison to the yield at control (27.54t ha$^{-1}$). Similarly 1 kg B ha$^{-1}$ produced highest yield (31.83t ha$^{-1}$), which was 16.4% higher compared to control. Thus, zinc application was more effective in enhancing the yield of onion than boron application. Application of B increased the uptake of all the nutrients while the application of Zn especially at higher level (6 kg ha$^{-1}$) decreased the uptake of P. The content and yield of protein in onion bulbs increased significantly with the application of B and Zn. The use efficiency of zinc and boron decreased with their increasing levels and maximum values were recorded at lower levels of zinc and boron.*

**Keywords:** Boron, zinc, quality, uptake of nutrients, yield, onion

## INTRODUCTION

With the introduction of high yielding crop cultivars and use of high analysis chemical fertilizers, soils are showing a rapid decline in their ability to supply the essential micronutrients in required quantities. Accelerated depletion of these trace elements from the finite soil reserves have restrained and constrained sustainable growth in productivity of several crops including vegetables. However, several aspects like micronutrient fertilization of vegetables, especially bulb crops have not received due attention. Onion is the most popular vegetable grown in Uttar Pradesh. Onion requires substantial amount of plant nutrients and responds very well to the added nutrients. Boron and zinc deficiencies and neglect to give equal importance to these nutrients in fertilization programme has resulted in low productivity of onion. Boron plays a vital role in transport of carbohydrates as well as in cell wall metabolism, permeability and stability of cell membranes and phenol metabolism with primary role in lignin synthesis. Zinc plays a significant role in various enzymatic and physiological activities of the plant body. Zinc catalyses the process of oxidation in plant cells and plays a vital role in the transformation of carbohydrates, regulates the consumption of sugar, increases the sources of energy for the production of chlorophyll, adds in the formation of auxins and promotes absorption of water. Response of applied zinc for better growth and yield of vegetable crops has also been reported by Solanki *et al.* (2010) and Pal *et al.* (2016). Zinc deficiencies occur in varied category of soils to the extent of 50 to 65 per cent in the state. Onion has higher requirement for trace elements like B, the deficiency of which may induce crippling reduction in terms of yield and quality. Hence, a field experiment was conducted to study the effect of zinc and boron application on onion crop.

## MATERIALS AND METHODS

Afield experiment was conducted with onion at Raja Balwant Singh College, Research Farm, Bichpuri (Agra) during rabi season on a sandy loam soil with four levels each of Zn (0, 2, 4 and 6 kg Zn ha$^{-1}$) and boron (0, 0.5, 1.0 and 2.0 kg B ha$^{-1}$). A total of 16 treatment combinations were replicated thrice in randomized block design. The climate of the study area is semi-arid with an average rainfall of about 650 mm per annum,

about 80% of which is received during June to September. The soil was alkaline in reaction. (pH: 7.8), free from salinity (0.20 $dSm^{-1}$), DTPA-Zn (0.55 mg $kg^{-1}$) and deficient in HWS-B (0.50 mg $kg^{-1}$), while low in available N (160 kg $ha^{-1}$), in P (9.0 kg $ha^{-1}$) and medium in K (130 kg $ha^{-1}$). Six weeks old seedling of onion (var. Nasik red) were transplanted at the spacing of 15 cm between rows and 10 cm between plants. A basal application of 200 kg N, 100 kg $P_2O_5$, 100 $K_2O$ and 40 kg S $ha^{-1}$ through urea, DAP, muriate of potash and elemental sulphur, respectively was applied at transplantation. Boron and zinc were applied as borax and zinc oxide, respectively at the time of transplanting. The crop was harvested at maturity and bulb yield was recorded. Processed bulb samples were analysed for their nutrients by digesting the samples using di-acid mixture ($HNO_3$ : $HCl_4$, 10:4) followed by estimation of zinc on an atomic absorption spectrophotometer. Phosphorus, K and S were determined by vanadomolybdo phosphoric yellow colour method, flame photometer (Jackson 1973) and turbidimetric method (Chesnin and Yien 1951), respectively. Boron content in acid digest was determined by carmine method (Hatcher and Wilcox, 1950). Nitrogen content in bulb was determined following micro Kjeldahl method. The uptake of nutrients was then computed from their concentration in bulb and yield of bulb.

## RESULTS AND DISCUSSION

### Yield

Both the elements exerted positive and significant influence on the bulb yield of onion (Table 1). Application of zinc significantly enhanced the yield of bulbs ranging from 18.2 to 12.8 per cent over control due to 4 and 6 kg Zn $ha^{-1}$, respectively. The higher Zn levels did not vary among themselves in influencing the yield (32.54 and 31.07 t $ha^{-1}$). Increase in bulb yield on addition of zinc might be due to its deficiency in experimental soil. Similar findings were reported by Pal *et al.* (2016). The favourable influence of zinc on the bulb yield of onion may be attributed to its role in various enzymic reactions, growth processes, hormone production and protein synthesis and also the transformation of photosynthates to reproductive parts, thereby leading to higher yield of the crop.

Table 1: Effect of zinc and boron levels on yield, dry matter and quality of onion bulbs (mean of 2 years)

| Treatments | Bulb yield (t $ha^{-1}$) | Dry matter yield (t $ha^{-1}$) | Protein (%) | Protein yield (q $ha^{-1}$) |
|---|---|---|---|---|
| Zn (kg $ha^{-1}$) | | | | |
| 0 | 27.54 | 4.31 | 6.86 | 3.1 |
| 2.0 | 31.10 | 4.96 | 7.23 | 3.6 |
| 4 | 32.54 | 5.18 | 7.61 | 4.0 |
| 6.0 | 31.07 | 4.95 | 7.27 | 3.6 |
| SEm± | 0.41 | 0.06 | 0.07 | 0.06 |
| CD (P = 0.05) | 1.20 | 0.17 | 0.21 | 0.17 |
| Boron (kg $ha^{-1}$) | | | | |
| 0 | 27.34 | 4.60 | 6.78 | 3.1 |
| 0.5 | 30.51 | 4.87 | 7.06 | 3.5 |
| 1.0 | 31.83 | 5.08 | 7.45 | 3.8 |
| 2.0 | 31.15 | 4.94 | 7.62 | 3.9 |
| SEm± | 0.41 | 0.06 | 0.07 | 0.06 |
| CD (P = 0.05) | 1.20 | 0.17 | 0.21 | 0.17 |

Solanki *et al.* (2010) and Singh and Singh (2017) reported similar results in onion. Application of 1 kg B $ha^{-1}$ produced significantly higher bulb yield in comparison to control. The higher bulb (31.83t $ha^{-1}$) yield was recorded with the application of 1 kg B $ha^{-1}$, which was 16.4% higher than control. Increase in bulb yield due to boron addition may be ascribed to low status of available B in soil. Rajni and Meitei (2004) and Ali (2017) reported similar results. At higher dose of boron (2 kg $ha^{-}$

$^{1}$), a significant reduction in bulb yield was recorded over 1 kg B ha$^{-1}$. This reduction in yield may be attributed to nutrient imbalance and toxic effect of boron as reported by Varghese and Duraisamy (2005).

The dry matter yield of onion bulbs increased significantly by various treatments and the highest value was recorded at 4 kg Zn ha$^{-1}$ (5.18 t ha$^{-1}$) and lowest in control (4.31 t ha$^{-1}$). A spectacular increase in dry matter production was observed up to 1 kg B ha$^{-1}$, which was 10.4 per cent higher in comparison to control. Like bulb yield, dry matter yield also decreased significantly with 2 kg B ha$^{-1}$ over 1 kg B ha$^{-1}$. However, the effect was more pronounced for Zn than B application. The increased dry matter yield is probably the result of these nutrients favouring carbohydrate metabolism and hormone activity especially IAA. Similar trend of increase in dry matter yield due to Zn and B application was reported by Pal *et al.* (2016) Varghese and Duraisamy (2005), respectively.

**Quality**

Protein content in onion bulbs increased significantly with the application of Zn, being lowest at control (6.86%) and highest (7.61%) at 4 kg Zn ha$^{-1}$ (Table 1). Application of boron tended to increase the protein content significantly up to 2 kg B ha$^{-1}$ over control. However, the values of protein content at 1 and 2 kg B ha$^{-1}$ were statistically at par. The imcrease in protein content on boron application might be attributed to increase in the activity of enzymes involved in protein synthesis on its addition. The protein yield increased significantly up to the level of 4 kg Zn and 2 kg B ha$^{-1}$ over control. This increase in protein yield may be attributed to higher production of bulbs and improvement in protein percentage with Zn and B addition. Rajni and Maitel (2004) and Pal *et al.* (2016) also reported similar results.

**Uptake of nutrients**

The uptake of N, P and K increased due to application of Zn and B (Table 2). Uptake of N and K by bulbs increased significantly up to application of 4 kg Zn ha$^{-1}$. Boron application significantly increased the uptake of N up to 1 kg B ha$^{-1}$ and K uptake increased up to 1 kg B ha$^{-1}$. Phosphorus uptake also increased significantly up to 2 kg Zn ha$^{-1}$, and thereafter decreased significantly at 6 kg Zn ha$^{-1}$.

Table 2: Effect of zinc and boron levels on uptake of N, P, K and S (kg ha$^{-1}$) and Zn and B (g ha$^{-1}$) in onion bulbs (mean of two years)

| Treatments | Nitrogen | Phosphorus | Potassium | Sulphur | Zinc | Boron |
|---|---|---|---|---|---|---|
| Zn (kg ha$^{-1}$) | | | | | | |
| 0 | 47.8 | 13.2 | 32.7 | 13.7 | 148.8 | 321.2 |
| 2 | 55.8 | 15.7 | 36.2 | 16.1 | 194.2 | 377.0 |
| 4 | 61.4 | 15.3 | 40.5 | 16.0 | 239.3 | 383.5 |
| 6 | 56.4 | 13.7 | 38.1 | 14.7 | 274.6 | 357.8 |
| SEm± | 0.96 | 0.38 | 0.61 | 0.42 | 6.45 | 6.12 |
| CD (P = 0.05) | 2.78 | 1.13 | 1.78 | 1.21 | 18.63 | 17.69 |
| Boron (kg ha$^{-1}$) | | | | | | |
| 0 | 48.4 | 13.2 | 34.7 | 14.4 | 209.1 | 227.2 |
| 0.5 | 53.9 | 14.2 | 37.7 | 15.8 | 224.2 | 314.6 |
| 1.0 | 60.3 | 15.3 | 38.3 | 15.2 | 220.6 | 426.7 |
| 2.0 | 58.8 | 15.1 | 36.7 | 14.6 | 203.2 | 470.9 |
| SEm± | 0.96 | 0.38 | 0.61 | 0.42 | 6.45 | 6.43 |
| CD (P = 0.05) | 2.78 | 1.13 | 1.78 | 1.21 | NS | 18.59 |

Boron addition up to 1 kg ha$^{-1}$ increased significantly the P uptake by onion bulbs over control. Uptake of sulphur increased significantly up to 4 kg Zn ha$^{-1}$ whereas, boron application increased up to 0.5 kg ha$^{-1}$ thereafter a declining trend was observed at 2 kg B ha$^{-1}$. There was an obvious increase in Zn uptake by the crop as a result of its addition up to 6 kg Zn ha$^{-1}$ (Pal *et al.* 2016, Singh and Singh 2017). Application of 0.5 kg B ha$^{-1}$ recorded the highest Zn uptake (224.2 g ha$^{-1}$) followed by a reduction at higher levels of boron. The boron uptake increased up

to the application of 4 kg Zn and 2 kg B $ha^{-1}$. This may be attributed to increase in their availability in soil and increased dry matter production as a result of B and Zn addition. These results are in agreement with the findings of Varghese and Duraisami (2005) in respect of boron and zinc uptake by onion bulbs.

**Efficiency indices**

Data on apparent recovery and nutrient use efficiency of Zn and B are presented in Table 3. Mean values of recovery of Zn on added Zn and B varied from 0.91 to 1.32% and from 1.04 to 2.67%, respectively. The apparent recovery of B on Zn addition varied from 0.26 to 3.23% and on B addition from 11.08 to 18.14%. The data show that fertilizer Zn and B use efficiencies were higher with lower rates of their application. The response varied from 58.91 to 237.66 kg bulb $ha^{-1}$ Zn applied, whereas in the case of B it varied from 190.50 to 635.00 kg bulb $kg^{-1}$ B applied.

Table 3: Effect of Zn and B levels on apparent recovery and fertilizer use of Zn and B in onion (mean of two years)

| Treatments | Apparent Zn recovery (%) | Apparent B recovery (%) | Nutrient use efficiency (kg bulb $kg^{-1}$ nutrient) |
|---|---|---|---|
| Zn kg $ha^{-1}$ | | | |
| 0 | - | - | -237.66 |
| 2 | 1.32 | 3.23 | 165.67 |
| 4 | 1.31 | 1.74 | 58.91 |
| 6 | 0.91 | 0.26 | |
| Boron kg $ha_{-1}$ | | | |
| 0 | - | - | - |
| 0.5 | 2.67 | 15.89 | 635.00 |
| 1.5 | 1.04 | 18.14 | 449.50 |
| 2.0 | - | 11.08 | 190.50 |

On the basis of the experimental findings it may be concluded that the application of 4 kg Zn $ha^{-1}$ and 1 kg B $ha^{-1}$ can be recommended for onion in alluvial soil. Application of 4 kg Zn and 1 kg B $ha^{-1}$ gave highest bulb yield, quality and uptake of nutrients by the crop.

**REFERENCES**

Ali, J. (2017) Effect of boron, zinc and sulphur on soil fertility and yield of fababean (*Vicia faba* L.). *Annals of Plant and Soil Research* **19** (3): 329-333.

Chesnin, L. and Yien, C.H. (1951) Turbidimetric determination of available sulphate Soil Science Society of America Proceedings **15**: 149-151.

Hatcher, J.T. and Wilcox, L.V. (1950) Colorimetric determination of boron using carmine. Analytical Chemistry **22**: 567-569.

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Pal, A.K., Lal, M.,Singh, A.P. and Singh, C.P. (2016) Response of onion to iron and zinc nutrition in an alluvial soil. *Annals of Plant and Soil Research* **18**(3): 241-245.

Rajani, K. and Meitei, W.I. (2004) Effect of boron and zinc on growth and yield of French-bean (*Phaseolus vulgaris* L.). Environment and Ecology **22** (1): 83-85.

Singh, V. and Singh, R. (2017) Effect of zinc nutrition on yield, quality and uptake of nutrients in cabbage (*Brassica oleracea*). *Annals of Plant and Soil Research* **19** (3): 299-302.

Solanki. V.P.S., Singh, S.P., Singh, O.V. and Singh, V. (2010) Differential response of vegetable crops in zinc fertilization in alluvial soil. *Indian Journal of Agricultural Sciences* **80** (12): 1054-1057.

Varghese, Annie and Durainsami, V.P. (2005) Effect of boron and zinc on yield, uptake and availability of micronutrients on cauliflower, *Madras Agriculture Journal* **92** (10-12): 618-628.