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Effect of micronutrients on yield and quality of onion (*Allium cepa* L.)

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Abstract
An investigation was conducted at the Horticultural Research centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during *Rabi* season of 2019-2020 to find out the effect of micronutrients on yield and quality of Onion (*Allium cepa* L.). The experiment was laid out in Randomized Block Design (RBD) with three replications. The maximum yield parameters like neck thickness (1.52 cm), equatorial diameter of bulb (4.94 cm), polar diameter of bulb (5.16 cm), shell thickness of bulb (0.26 mm), fresh weight of bulb (86.83 gm), yield of bulb (12.70 kg plot^{-1}) and yield of bulb (276.08 q ha^{-1}). The quality parameters such as total soluble solids (14.46%) and acidity (12.19 mg 100 gm $^{-1}$) were reported maximum under treatment T_9 - RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1} whereas the minimum values for above parameters were recorded under T_{11} – control.

Keywords: Onion, RDF, zinc, borax, yield and quality

Introduction
Onion (*Allium cepa* L. 2n=16) is the one of the most important commercial bulbous vegetable crops which is cultivated extensively in India. It belongs to the family Alliaceae. It originated from Central Asia. Onion is the cool season vegetable crop. However, it can be grown under a wide range of agro-climatic conditions. It grows well under a mild climate without extreme heat or cold or extreme rainfall. The edible part of the onion is green leaves, immature and mature bulbs. The edible portions of the bulb are the enlarged leaf bases and compact stem. Onion has strong flavor due to the presence of sulphur containing compounds in very small quantities in the form of volatile oil allyl propyl disulphide responsible for distinctive smell and pungency. Essential amino acids like lysine and phenylalanine are present abundantly in onion bulbs. It has been cultivated for food, medicines, spices and condiments since early dates. It has medicinal and diuretic properties, relieves heat sensation, hysterical faintness, insect bites and also heart stimulation. Onion is used in the preparation of salads, pickles, spices, condiments and all types of vegetarian and non-vegetarian dishes. Fresh as well as dehydrated onions are a good source of earning foreign exchange. It is a rich source of major minerals like Calcium (180 mg 100 gm^{-1}), Phosphorus (50 mg 100 gm^{-1}), Iron (0.7 mg 100 gm^{-1}), Carbohydrates (11.0 gm 100 gm^{-1}), Protein (1.2 gm 100 gm^{-1}), Dietary fibre (0.6 gm 100 gm^{-1}) and Vitamin C (11 mg 100 gm^{-1}), (Biswas *et al.* 2020) [8].
During 2018-19 (3rd Advance Estimates), India ranked second in vegetable production after China. The area under vegetables is estimated at 10.10 million hectares with a production of 185 million tons in India. The area under onion cultivation is 1263 thousand hectares and produces 23485 thousand metric tons annually. Indian onions are very popular for their pungency and easily available round the year. The major onion producing states in India are Maharashtra, Karnataka, Madhya Pradesh, Rajasthan, Bihar, Andhra Pradesh, Gujarat, West Bengal, Haryana and Uttar Pradesh. Maharashtra is the leading onion producing state with the production of 8047.14 thousand metric tons from an area of 444.37 thousand hectares followed by Madhya Pradesh which produced 3714.79 thousand metric tons from an area of 148.71 thousand hectares and Karnataka which produced 2645.61 thousand metric tons from an area of 190.52 thousand hectares. Uttar Pradesh covers 26.90 thousand hectares area under onion cultivation with an annual production of 440.38 thousand metric tons production (Anonymous, 2019). Plant nutrients play an important role in yield and quality of bulbous vegetable crops like onion. Beside the major plant nutrients like nitrogen phosphorus and potassium, some micronutrients also play a beneficial effect in terms of plant metabolic process from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, nitrogen fixation etc.

Even though micronutrients are also needed by the onion in minor quantities and present in plant tissue in quantities measured in parts per million, it is involved in a wide range of metabolic processes and cellular functions within the plants. Also, they work as a coenzyme for a large number of enzymes. In addition to that they play an essential role in improving for better yield and quality parameters of different crops (Ballabh and Rana, 2012) [6].

The application of nitrogen increased yield and quality of onion. Similarly, phosphorus has the most beneficial effect on early root development, yield and quality of crop produce. Potassium plays an important role in crop productivity by functioning as an activator of numerous enzymes like pyruvic kinase, cytoplasmic enzymes and therefore, causes a pervasive effect on metabolic events. The judicious application of nutrient like sulphur has improved yield and quality of onion (Kumar *et al.* 2017) [10].

The functional role of Zn include auxin metabolism, influence on the activity of dehydrogenase, carbonic anhydrase enzymes, synthesis of cytochrome and stabilization of ribosomal fractions. Zinc also plays an important role in chlorophyll formation. Zinc plays an important role in chlorophyll formation. Application of Zinc increased the yield of onion (Phor *et al.* 1995) [16].

Boron is a very sensitive element and plants differ widely in their requirements but the ranges of deficiency and toxicity are narrow. It is necessary for normal cell division, nitrogen metabolism and protein formation. It is essential for proper cell wall formation. Application of boron can increase bulb size and yield of onion (Smriti *et al.* 2002) [21].

Materials and Methods

Onion variety Agrifound Light Red was used to conduct the experiment during *Rabi* season of 2019-2020 at the Horticultural Research centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). The experiment was laid out in Randomized Block Design (RBD) with eleven treatments and three replications. The crop was planted in a plot size (3.50 m x 1.25 m) at a spacing of 15 cm x 10 cm. Before fertilizer application, random soil samples were taken from the experimental field and were analyzed. The soil of the experimental plot was sandy loam in texture with pH 7.68. Nitrogen and Organic carbon content in soil were low, while the level of available phosphorus and potassium was medium. The treatments includes T_1 - RDF (100:50:50:30 Kg NPKS + 20 tones FYM ha^{-1}), T_2 - RDF + Zinc Sulphate 10 Kg ha^{-1}, T_3 - RDF + Zinc Sulphate 20 Kg ha^{-1}, T_4 - RDF + Zinc Sulphate 30 Kg ha^{-1}, T_5 - RDF + Borax 5 Kg ha^{-1}, T_6 - RDF + Borax 10 Kg ha^{-1}, T_7 - RDF + Borax 15 Kg ha^{-1}, T_8 - RDF + Zinc Sulphate 10 Kg ha^{-1} + Borax 5 Kg ha^{-1}, T_9 - RDF+ Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}, T_{10}-RDF+ Zinc Sulphate 30 Kg ha^{-1} + Borax 15 Kg ha^{-1} and T_{11} - Control. Five plants were selected from each plot randomly as a unit for observation on yield and quality parameters.

Results and Discussion

The result were found (Table-1) maximum neck thickness of bulb (1.52 cm) was recorded with the application of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}, whereas, minimum neck thickness (1.03 cm) was observed in control. In other hand the maximum equatorial diameter of bulb (4.94 cm) was observed with the application of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}.While, minimum equatorial diameter of bulb (3.15 cm) was observed in control. Similarly, maximum polar diameter of bulb (5.16 cm) was observed with the application of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}. However, minimum polar diameter of bulb (3.47 cm) was observed in control. Likewise, the maximum shell thickness of bulb (0.26 mm) was obtained from RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}, while the minimum shell thickness of bulb (0.14 mm) was obtained from control treatment. In other hand, the maximum fresh weight of bulb (86.83 gm) was obtained from RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1} presented in Table-2. Moreover, the minimum fresh weight of bulb (44.79 gm) was obtained from control treatment. Similarly, the highest bulb yield plot^{-1} (12.70 kg) was obtained with the application of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}, whereas, lowest bulb yield plot^{-1} (6.73 kg) was obtained from control. Likewise, the maximum yield of bulbs (276.08 q ha^{-1}) were obtained from RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}. However, the minimum yields of bulbs (146.37 q ha^{-1}) were obtained from control treatment. It may be due to the judicious uptake of major nutrients and micronutrients by the onion plants and therefore, it was noted that the yield and quality of onion directly improves with all yield attributing parameters.

The main function of zinc in plants is that it acts as a metal activator of several enzymes like dehydrogenase, proteinase and peptidases. Zinc enhanced the synthesis and translocation of photosynthates to the bulbs, thus higher photosynthates accumulation in the bulbs due to the formation by the leaves. More number of leaves per plant would ensure higher individual bulb weight, size of bulb and neck thickness of bulb was responsible to increase the yield of onion. Similar results were also reported by several investigators such as Ballabh and Rana (2012) [6], Ballabh *et al.* (2013) [7], Trivedi and Dhumal (2013) [22], Manna *et al.* (2014) [12].

Boron is another micronutrient which gives constructive effects on root development, formation of carbohydrates, regulation of water and translocation of photosynthates to bulbs from leaves. The higher photosynthesis accumulation in the bulbs would ensure higher individual bulb weight and size of bulb diameter which collectively increases the bulb yield of onion. Similar finding were also reported by Chattopadhyay and Mukhopadhyay (2004) [9], Paul *et al.* (2007) [17], Alam *et al.* (2010) [1], Adedin *et al.* (2012) [2], Ballabh *et al.* (2013) [7] and Acharya *et al.* (2015) [15].

Zinc and boron application with various combinations were also practiced in numerous crops and gave a beneficial effect on yield and quality of bulbous crops like onion. Combined dose of zinc and boron may be found to be most suitable in comparison with alone dose as compared to control. These findings are closely in conformity with earlier findings of Alam *et al.* (2010) [1], Manna *et al.* (2014) [12], Acharya *et al.* (2015) [15], Prusty *et al.* (2020) [19] and Mandal *et al.* (2020) [15].

The data were recorded (Table-3) total soluble solids and acidity are the indicators of quality of the onion were significantly influenced by the application of micronutrients. The maximum total soluble solids (14.46%) were measured from the RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1} application, while the minimum total soluble solids (12.18%) were measured from the control. It might be due to the use of optimum levels of micronutrients that enhanced metabolic processes involved in biosynthesis of total soluble solid such as carbohydrates, organic acid, amino acid and other inorganic constituents. Similar results were also reported by Trivedi and Dhumal (2013) [22], Manna and Maity (2016) [13], Aske *et al.* (2017) [4] and Maurya *et al.* (2018) [14].

Another quality parameter i.e., acidity (mg 100 gm^{-1}) was also influenced by the application of micronutrients. The maximum acidity (12.19 mg 100 gm^{-1}) was observed with the application of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}. However, the minimum acidity (10.34 mg 100 gm^{-1}) was observed in control treatment. The significant improvement of ascorbic acid in onion bulbs were also reported by Rao and Despandey (1971) [20], Maurya and Lal (1975) [11] and Pramanik *et al.* (2018) [18].

Table 1: Effect of micronutrients on neck thickness (cm), Equatorial diameter of bulb (cm), Equatorial diameter of bulb (cm) and Shell thickness of bulb (mm) at harvesting the bulb of onion

Treatments	Neck thickness (cm)	Equatorial diameter of bulb (cm)	Equatorial diameter of bulb (cm)	Shell thickness of bulb (mm)
T_1 - RDF (100:50:50:30 Kg NPKS + 20 tones FYM ha^{-1})	1.16	3.56	3.75	0.15
T_2 - RDF + Zinc Sulphate 10 Kg ha^{-1}	1.32	4.04	4.24	0.19
T_3 - RDF + Zinc Sulphate 20 Kg ha^{-1}	1.38	4.33	4.56	0.22
T_4 - RDF + Zinc Sulphate 30 Kg ha^{-1}	1.36	4.18	4.38	0.21
T_5 - RDF + Borax 5 Kg ha^{-1}	1.21	3.68	3.88	0.16
T_6 - RDF + Borax 10 Kg ha^{-1}	1.28	3.86	4.02	0.18
T_7 - RDF + Borax 15 Kg ha^{-1}	1.24	3.77	3.96	0.17
T_8 - RDF + Zinc Sulphate 10 Kg ha^{-1} + Borax 5 Kg ha^{-1}	1.44	4.58	4.79	0.24
T_9 - RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}	1.52	4.94	5.16	0.26
T_{10} - RDF + Zinc Sulphate 30 Kg ha^{-1} + Borax 15 Kg ha^{-1}	1.48	4.72	4.96	0.25
T_{11} - Control	1.03	3.15	3.47	0.14
SEM(+/-)	0.01	0.02	0.02	0.01
C.D.at 5% of level	0.03	0.06	0.07	0.02

Table 2: Effect of micronutrients on fresh weight of bulb (gm), Yield of bulb (kg plot^{-1}), Yield of bulb (q ha^{-1}) at harvesting the bulb of onion

Treatments	Fresh weight of bulb (gm)	Yield of bulb (kg plot^{-1})	Yield of bulb (q ha^{-1})
T_1 - RDF (100:50:50:30 Kg NPKS + 20 tones FYM ha^{-1})	54.87	8.23	178.98
T_2 - RDF + Zinc Sulphate 10 Kg ha^{-1}	76.31	10.77	234.05
T_3 - RDF + Zinc Sulphate 20 Kg ha^{-1}	80.76	11.46	249.20
T_4 - RDF + Zinc Sulphate 30 Kg ha^{-1}	78.42	11.18	242.97
T_5 - RDF + Borax 5 Kg ha^{-1}	61.29	8.77	190.57
T_6 - RDF + Borax 10 Kg ha^{-1}	72.65	10.27	223.18
T_7 - RDF + Borax 15 Kg ha^{-1}	67.48	9.70	210.86
T_8 - RDF + Zinc Sulphate 10 Kg ha^{-1} + Borax 5 Kg ha^{-1}	83.24	11.63	252.90
T_9 - RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}	86.83	12.70	276.08
T_{10} - RDF + Zinc Sulphate 30 Kg ha^{-1} + Borax 15 Kg ha^{-1}	85.19	12.33	268.11
T_{11} - Control	44.79	6.73	146.37
SEM(+/-)	0.32	0.08	1.80
C.D.at 5% of level	0.91	0.24	5.18

Table 3: Effect of micronutrients on total soluble solids (%) and Acidity (mg 100 gm^{-1}) at harvesting the bulb of onion

Treatments	Total soluble solids (%)	Acidity (mg 100 gm^{-1})
T_1 - RDF (100:50:50:30 Kg NPKS + 20 tones FYM ha^{-1})	12.67	10.76
T_2 - RDF + Zinc Sulphate 10 Kg ha^{-1}	13.56	11.67
T_3 - RDF + Zinc Sulphate 20 Kg ha^{-1}	13.88	11.95
T_4 - RDF + Zinc Sulphate 30 Kg ha^{-1}	13.78	11.89
T_5 - RDF + Borax 5 Kg ha^{-1}	13.08	11.14
T_6 - RDF + Borax 10 Kg ha^{-1}	13.38	11.53
T_7 - RDF + Borax 15 Kg ha^{-1}	13.22	11.31
T_8 - RDF + Zinc Sulphate 10 Kg ha^{-1} + Borax 5 Kg ha^{-1}	14.15	12.08
T_9 - RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1}	14.46	12.19
T_{10} - RDF + Zinc Sulphate 30 Kg ha^{-1} + Borax 15 Kg ha^{-1}	14.28	12.14
T_{11} - Control	12.18	10.34
SEM(+/-)	0.01	0.01
C.D.at 5% of level	0.04	0.03

Conclusion

It is concluded that the treatment like RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1} was found to be most superior in terms of neck thickness (cm), equatorial diameter of bulb (cm), polar diameter of bulb (cm), shell thickness of bulb (mm), fresh weight of bulb (gm), yield of bulb plot^{-1} (kg), yield of bulbs (q ha^{-1}), total soluble solids (%) and acidity (mg 100 gm^{-1}). Therefore, it is suggested that a dose of RDF + Zinc Sulphate 20 Kg ha^{-1} + Borax 10 Kg ha^{-1} recommended for onion growers of Western Uttar Pradesh.

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