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

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Abstract
A field experiment was conducted to evaluate the efficacy of micronutrients on the performances of onion (*allium cepa* L. var. Arka Kalyan) with respect to quality attributes of bulbs during 2014-15 at College of Horticulture (OUAT), Sambalpur, Odisha under All India Network Research Project on Onion and Garlic India. The experiment was laid out in RBD having four replication with following treatments: T_1 (recommended 150:50:80:30 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + soil application of Zinc Sulphate @ 10.0 kg ha-1), T_2 (recommended 150:50:80:30 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + foliar application of Zinc Sulphate @ 0.5% at 30 & 45 days after planting (DAP)), T_3 (recommended 150:50:80:30 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + soil application of Borax @ 10.0 kg ha-1), T_4 (recommended 150:50:80:30 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + foliar application of Borax @ 0.25% at 30 & 45 DAP), T_5 (recommended 150:50:80:30 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + Foliar application of Micronutrient Mixture i.e. iron-2.5%,boron-0.5%,zinc -3%,copper -1%and manganese-1% @ 0.5% at 30 & 45 DAP) and T_6 (control). The result revealed significantly better bulb quality in terms of TSS (12.40-13.^{0}Brix), ascorbic acid (11.58-12.03 mg100g-1), protein (10.63-12.53%) and total sugar (4.34-6.12%), was recorded in T_5 followed by T_4. Hence, it may be concluded foliar application of micronutrient mixture @ 0.25% followed by borax @ 0.5% at 30 and 45 DAP not only increase the quality attributing parameters but also enhance the consumer preference.

Keywords: micronutrients, foliar application, TSS, total sugar, ascorbic acid

1. Introduction
Onion (*Allium cepa* L.), the "Queen of Kitchen" is one of the most important commercial crop not only in India but also in the world. India ranks second in position both in area (12.04 lakhs ha) and production (194.02 lakh tones) in the world (NHB, 2014). In India, it is treated as most important export oriented vegetable, exporting to the tune of 13, 58,193.00 MT of Rupees 2, 87,713.00 lakhs during 2013 – 2014 (NHB, 2014). In India, onion is cultivated for vegetable as well as medicinal purposes. Its medicinal properties are steadily gaining more importance in the world. It has benefits in lowering total plasma cholesterol, reducing blood pressure, regulating blood sugar, acts as blood purifier etc. Most of the medicinal effects of onion are preferable to a sulphur compound known as allicin (Schulz, 1998) [13], which is influenced by both genetic and agronomical practices. Deficiency of micronutrients during the last three decades has grown in both, magnitude and extent. This has become a major constraint to production and productivity of vegetables in general and onion in particular. Indian soils are exposed to multi-micronutrient deficiencies that closely associated with the yield and quality of crops. Proper plant nutrition is one of the most important factors in improving the quality as well as quantity of plant products. Even though, micronutrients are needed by the plants in a minor quantities but it is involved in a wide variety of metabolic processes as well as cellular functions within the plants. In general, micronutrients play an active role in the plant metabolic process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, nitrogen fixation etc. (Ballabh *et al*., 2013) [3]. Bhonde *et al*. (1995) [4] evaluated the effect of zinc, copper and boron on onion crop. Bulb size and yield as well as quality of bulb enhanced when micronutrients were applied in combinations instead of their single application. Foliar application of micronutrients during active crop growth stage was successfully used for correcting their deficits and improving the mineral status of the plants as well as increasing the crop yield and quality (Kolota and Osinska, 2001) [5]. Producing of good quality onion bulbs is an important target by onion growers whom have an for

Inadequate knowledge about beneficial role of micronutrients in increasing yield and quality of onion local and foreign markets. Hence, its cultivation has been expanded in the newly reclaimed areas which characterized with low fertility, high pH value and low organic matter content, consequently low available of micronutrients in the soil. Keeping this in view, a field experiment was conducted at College of Horticulture (OUAT), Sambalpur, and Odisha, India during *Rabi* 2014-15 to study about the effect of micronutrient on bulb quality of onion.

2. Materials and Methods

A field experiment was conducted during *Rabi* 2014-15 under AINRP on Onion and Garlic at College of Horticulture, Chiplima, Sambalpur, Orissa University of Agriculture and Technology (OUAT), Odisha, India. Soil of the experiment area was sandy loam having pH of 5.89; available NPK151.25:15.78:178.75 kg ha^{-1}. The field trial was laid out by adopting RBD replicated four with six treatments. The details of treatment are presented in Table no.1. Onion seeds variety Arka Kalyan obtained from the IIHR, Bangalore were sown in the nursery beds (1 m width, 3 m length and 15 cm height) on 22.10.2014at a distance of 5 cm and at a depth of 2 cm. Nursery beds were prepared by mixing FYM @ 20 kg and NPK mixture @ 20 g bed-1.About 55 days old seedling of 10-15 cm, height were transplanted in the field on 01.12.2014 and 02.12.2014 at a spacing of 15 x 10cm. All the recommended package of practices was adapted uniformly to all the treatments except the application of micronutrients. The recommended dose of fertilizer (RDF) used for onion crop was150:50:80:30 NPK kg ha-1 along with FYM @ 20 t ha-1, applied uniformly in all the treatments. The sources of NPKS for the present study were Urea, Di Ammonium phosphate (DAP), Muriate of Potash (MOP) and Gypsum, respectively. The nutrient content of FYM used in the study was estimated as 1.04:0.59:0.97:0.25% NPKS, respectively. The whole FYM was applied 15 days prior to planting. The full dose of P, K, S and half dose of N was applied as basal at the time of planting. The remaining 50% of Nwas applied in two equal splits during 30 and 45 days after transplanting of onion seedlings. As per the treatment schedule (Table no. 2), micronutrients were applied to the experiment. The data recorded on various parameters were subjected to statistical analysis as per the procedure suggested by Sukhatme and Amble (1995).

3. Results and Discussion

3.1 Effect of micronutrient on Total Soluble Solids (TSS, ^{0}Brix)

The Total Soluble Solids (Table no.3) of harvested bulbs varied from minimum of 10.73^{0}Brix in T_6 to maximum of 13.00^{0}Brix in T_5, i.e. foliar spray of micronutrient mixture (iron - 2.5%, boron - 0.5%, zinc - 3%, copper -1% and manganese – 1%) @ 0.5% at 30 and 45DAP. Significantly highest TSS was recorded in bulbs obtained from T_5 than rest of the treatments, except T_2, T_3 and T_4 which were *statistically at par* (11.69^{0}Brix to 12.40^{0}Brix). Interestingly, foliar application of micronutrients as zinc sulphate (11.69^{0}Brix),borax (12.40^{0}Brix) and micronutrient mixture (13.00^{0}Brix) recorded higher TSS as compared to soil application of micronutrients such as zinc sulphate (11.37^{0}Brix) and borax (11.83^{0}Brix).The improvement in TSS content onion bulbs with application of micronutrients might be attributed to enhanced metabolic processes involved in biosynthesis of total soluble solid, such as carbohydrates, organic acid, amino acid and other inorganic constituents (Acharya *et al*., 2015) [1]. This might be due to increased carbohydrates production during the process of photosynthesis. Both zinc and boron plays a vital role in photosynthetic activity of plant (Lal and Maurya, 1981) [6].

3.2 Effect of Micronutrient on Ascorbic acid (mg 100g^{-1})

Regarding ascorbic acid (mg 100g^{-1}) content of onion bulbs, the results indicated significant variations, ranging from 9.15 in T_6 to 12.03 in T_5(Table no.3). Significantly highest ascorbic acid (mg 100g^{-1}) content was observed in T_5 (12.03) than rest of the treatments. However, *statistical parity* were observed with T_2, i.e. foliar application of zinc sulphate @ 0.5%at 30 and 45 DAP (11.48) and T_4, i.e. foliar application of borax @ 0.25% at 30 and45 DAP (11.58) for highest value. Similar trends of better efficacy of foliar application of micronutrients than soil application was also observed. The significant improvement of ascorbic acid in onion bulb was also reported by Rao and Despandey (1971) [11] as well as Maurya and Lal (1975) [7].

3.3 Effect of micronutrient on total protein content (%)

A perusal of Table no. 3 indicated significant variations were also observed among different micronutrient application including control for protein content of onion bulbs. The protein content of bulbs varied from 6.38% (T_6) to 12.53% (T_5). The results also showed that significantly lowest protein content of 6.38% was recorded in plots received without any micronutrient than plots received micronutrients. However, *statistical parity* was observed in T_3, i.e. soil application of borax @ 10 kg ha^{-1} with T_6, the control plot. The results indicated significant increase in protein content of bulbs as foliar application than the soil application. Bonde *et al.* (1995) observed the increased bulb quality with combined application of micronutrients than their sole application in onion variety Agrifound Dark Red. Increased in bulb quality by application of zinc in onion were reported by Alam *et al*. (2010) [2] and Samad *et al*. (2011) [12] while better efficacy of boron on better quality parameters in onion were reported by Shafie *et al*. (2002) [14].

3.4 Effect of Micronutrient on Sugar content (%)

The results indicated significant variations which varied from 1.78% (T_6) to 2.27% (T_1) for reducing sugar, 2.41% (T_6) to 4.02% (T_5) for non-reducing sugar as well as 4.20% (T_6) to 6.12% (T_5) for total sugar content of the bulbs (Table no.4). Significantly highest reducing sugar content was observed in the bulbs produced with soil application of zinc sulphate @ 10 kg ha^{-1} (2.27%), closely followed by either borax @ 0.25% (2.10%) or micronutrient mixture (iron - 2.5%, boron - 0.5%, zinc -3%, copper -1% and manganese – 1%) @ 0.5% (2.10%) as foliar application at 30and 45 DAP as compared to the other treatment concentrations. The overall results indicated that use of micronutrients increased the sugar content of onion bulbs to a considerable extent. The increased sugar content by use of micronutrients might be due to increased photo synthates more specifically by the role of zinc and boron (Lal and Maurya, 1981 [6] as well as Jawarlal and Veeraraghavathatham, 1988) [9]. Similar report of increased sugar content of onion by use of micronutrients was reported by Ballab *et al*. (2013) [3]. Maurya and Lal (1975) [7] observed increased content of reducing, non-reducing and total sugar by zinc nutrition while Samad *et al*. (2011) [12] mentioned that foliar spraying of zinc and iron could give the best result of quality of onion bulbs.

Table 1: Experimental techniques details

Crop	Onion (*Allium Cepa L.*)
Variety	ArkaKalyan
Season	*Rabi* season (2014-15)
No. of Treatments	6 (Six)
Design and Experiments	Randomized Block Design (RBD)
No. of Replication	4 (Four)
Net plot area	6m X 2m
No. of plots	24
Spacing	15cm X 10cm

Table 2: Time of application of different micronutrients on different treatments

Treatments	Treatment details	Source
T_1	Soil application of Zinc Sulphate @ 10.0 kg ha-1	Zinc Sulphate
T_2	Foliar application of Zinc Sulphate @ 0.5% at 30 & 45 days after planting (DAP)	
T_3	Soil application of Borax @ 10.0 kg ha-1	Borax
T_4	Foliar application of Borax @ 0.25% at 30 & 45 DAP	
T_5	Foliar application of Micronutrient Mixture 0.5% at 30 & 45 DAP	Composition:Fe-2.5%,B – 0.50%,Zn– 3.0%,Cu – 1.0% and Mn – 1.0%
T_6	Control (Without application of any micronutrients)	

Table 3: Effect of micronutrients on TSS, Ascorbic acid and Total Protein content of onion bulbs var. ArkaKalyan

Treatments	TSS (^{0}Brix)	Ascorbic acid (mg 100g^{-1})	Total Protein content (%)
T_1	11.37	10.57	9.19
T_2	11.69	11.48	10.75
T_3	11.83	10.20	7.48
T_4	12.40	11.58	1.063
T_5	13.00	12.03	12.53
T_6	10.73	9.15	6.38
Mean	11.84	10.83	9.49
SE (m) +	0.63	0.32	0.75
CD (5%)	1.34	0.68	1.60
CV (%)	7.53	4.18	11.19

Table 4: Effect of micronutrients on sugar content (%) of onion bulbs var. ArkaKalyan

Treatments	Reducing sugar (%)	Nonreducing sugar (%)	Total sugar (%)
T_1	2.17	3.18	5.46
T_2	1.70	3.03	4.73
T_3	1.83	3.17	5.00
T_4	2.10	2.24	4.3
T_5	2.10	4.02	6.12
T_6	1.78	2.41	4.20
Mean	1.96	3.01	4.97
SE (m) +	0.10	0.09	0.17
CD (5%)	0.21	0.19	0.35
CV (%)	7.06	4.72	4.72

4. Conclusion/ Recommendation

From the present study it is concluded that application of micronutrients to onion crop have significant impact on production of better bulb quality in terms of TSS, total sugar, protein and ascorbic acid content.

Among all the micronutrient treatment schedule, it was observed that the treatment schedule, T5 i.e., foliar spray of micronutrients mixture (iron- 2.5%, boron- 0.5%, zinc- 3%, copper-1% and manganese- 1%) @ 0.5% at 30 and 45 DAP significantly recorded better results on almost all parameters under study than rest of the treatments. The second best treatment identified was foliar application of boron as borax @ 0.25% at 30 and 45 DAP.

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