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Effect of Iron, Zinc and Boron on quality parameters onion (*Allium Cepa*L.) cv. Agrifound Light Red

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ABSTRACT
An experiment was conducted to examine the effect of different micronutrient viz., iron, zinc and boron in a factorial randomized block design with three replications during the rabi season of the year 2013 and 2014. The results revealed that, the significantly maximum diameter of bulb (6.31 cm, 6.17 and 6.24 cm), (6.67 cm, 6.58 cm and 6.63 cm), total soluble solid (11.94 ^{0}Brix, 11.09 ^{0}Brix and 11.52^{0}Brix),(11.77^{0}Brix, 11.04 ^{0}Brix and 11.41^{0}Brix), protein content (0.85 %, 1.06 % and 0.95 %), (0.87 %, 1.03 % and 0.95 %) andsignificantly minimum neck thickness after curing (0.23 cm, 0.22 cm and 0.23 cm), (0.24 cm, 0.23 cm, 0.23 cm) were recorded with i_1 and $z_1$during the year 2013-14, 2014-15 and pooled data respectively. In case of boron it was found significantly maximum diameter of bulb (6.17 cm, 5.82 cm and 5.99 cm) and significantly minimum neck thickness after curing (0.24 cm, 0.23 cm, 0.23 cm)were recorded with b_2 during the year 2013-14, 2014-15 and pooled data respectively.Whereas, significantly maximum total soluble solid (11.92 ^{0}Brix, 11.00 ^{0}Brix, 11.46 ^{0}Brix) and protein content (0.77 %, 0.89 %, 0.83 %) was recorded in 2013-14 and $b_2$during the year 2014-15 and pooled data.
Key words: *Onion, Quality, Iron, Zinc, Boron*

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INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable bulbs crops grown in India from ancient time. The edible portion is a modified leaves which is known as "bulb" and develops underground. Onion is popularly used as green as well as mature bulb. It is widely used as a cooked vegetable in soups, mix vegetable and flavouring agent in many additional dishes. Because of its importance in cookery, onion is called as "Queen of the kitchen" (Selvaraj, 1976). It can be kept for a fairly long period and can safely withstand the hazards of rough handling including long distance transportation.

Onion also possesses nutritional and medicinal importance. The outstanding characteristic of onion is the pungency, which is due to volatile oil known as Allyl- propyl- disulphide, which is sulphur rich compound. It acts as gastric stimulant and promotes digestion (Yawalkar, 2004). It contains 86.6 per cent Moisture, 40 kcal Calories, 1.10 g Protein, 9.34 mg Carbohydrates, 23 mg Calcium, 2 I.U Vitamins A, 7.4 mg Vitamins C, 0.027 mg Riboflavin, 0.0116 mg Niacin per 100 g of fresh edible portion. It is used as a remedy for various diseases like dysentery, convulsions, headaches, hysterial fits, rheumatic pain, malaria, fever and as a fine demulcent to give relief in piles (Sharma, 2014).

Onion is a seasonal crop and has comparatively low storage ability and bulbs are usually stored until the harvest of next season crop or for longer period due to seasonal glut in the market. The post-harvest losses, *viz.,* sprouting, rotting and physiological loss in weight is a great problem. Annual storage losses of onion is more than 40 to 60 per cent in Indian condition (Bhagachandani*et al*. 1980). Storage methods have their own impact on post-harvest life and keeping quality of onion. Storage temperature and relative humidity have been found to be correlated with sprouting, rotting and physiological loss in weight and these are further correlated with storage periods.

Indian soil have been chronically poor in nitrogen, phosphorus, iron, zinc, boron, magnesium and sulphur and due to continuous cropping, multiple nutrient deficiencies have been noticed. Zinc deficiency in onion is fairly wide spread and is noticed also in garlic in the sandy soils. Deficiency of iron in onion, garlic, brinjal, tomato and potato is also noticed in sandy soils. Boron deficiency is also noticed in tomato, carrot, onion, garlic and radish in sandy and loamy sand soil in Gujarat and Rajasthan region.

Micronutrients can be restored, maintained and sustained by three procedures *e.g.* addition of organic residues from plant and animal sources, strengthening the soil biological process and use of synthetic micronutrients and soil amendments as per needs. The availability of the essential micronutrients to plants is often poorly related to the total quantity of the particular element in the soil. Iron and zinc are the most abundant metal to be found in living organisms, where it plays a major structural, catalytic and co-catalytic role in enzymes.

To sustain soil health and benign environment there is a need for standardization the conjunctive use of micronutrient in soil application in order to increase the productivity and alternately improving the soil health. The concept of soil application of micronutrient is gaining considerable momentum today but negligible study has been conducted so, the present investigation was planned on onion.

MATERIALS AND METHODS

The field experiments were conducted during rabi seasons of 2013 and 2014 at Department of Vegetable Science, College of Horticulture, S. D. Agricultural University, Sardarkrushinagar. Sardarkrushinagar is located at a distance of about 170 km from Ahmedabad and geographically, situated on 24^{o} 19' North latitude and 72^{o} 19' East longitude at an altitude of 154.32 meters above mean sea level. It represents the North Gujarat Agro-climatic zone (AES-IV) of Gujarat. The average rainfall of Sardarkrushinagar is 688.42 mm received in about 28 rainy days during last 15 years.The winter season starts from the end of October and continues till the end of February. The minimum temperature of the year is reached during middle December to middle January. The temperature starts rising from February and reaches maximum in the month of May. April and May are the hottest months of the summer season.

The experiment was laid out in a Factorial Randomized Block Design were employed and replicated thrice. The detail of experimental soil is loamy sand with pH 7.6, Electrical conductivity (0.16dSm^{-1}), Organic carbon (0.21%), Available N (173.76Kg ha^{-1}), Available P_2O_5 (35.76Kg ha^{-1}), Available K_2O (187Kg ha^{-1}), initial status of Fe (1.163mg/kg), Zn (0.254 mg/kg), B (0.474 mg/kg). Seeds of onion variety Agrifound light red were collected from the NHRDF, Nasik for conducting the present study. Nursery was prepared by using standard techniques and Healthyseedlings of 45 days' old were transplanted in the main field after removingupper one third portions of leaves to reduce the loss of water throughtranspiration.The experiments wereconducted during Rabi season. It was laid out in a factorial randomized block design withthree replications. There were altogether 27 treatment combinations with *viz.,* Iron (0, 20 and 40 kg/ha), Zinc (0, 25 and 50 kg/ha) and Boron (0, 2.5 and 5.0 kg/ha) from different source of $FeSo_4$, $ZnSo_4$ and borax were applied as soil application.

The crop was fertilized with recommended doses of100:50:50 NPK/ha for onion. The 20% N was added as basal and remaining 80% in four equal splits at an interval of 30, 45, 60 and 75 days after transplanting.Proper care for weeding, intercultural operations, and plant protection measures were taken from transplanting to harvesting. Observations on bulbquality parameters *viz,* diameter of bulb and neck thickness after curing of onion bulbs was measured with the help of vernier caliper and average was calculated. The Total Soluble Solids (^{0} Brix) estimated ten onion bulbs were cut into small pieces and mixed thoroughly to make a homogeneous extract. Then readings were taken with the help of hand refractometer (Erma, Japan). The mean TSS value was worked out.Protein content in the bulb after curing (%) was estimated by calculating treatmentwise total nitrogen percentage it was estimated by using micro-Kjeldahl's method as per procedure suggested by AOAC (1995). The nitrogen percentage was calculated by multiplying the nitrogen content by factor 6.25 to obtain protein content. The observations were made from the selected tagged 10 plants for eachtreatment. Statistical analysis wasdone by using standard techniques (Panse and Sukhatme, 1995).

RESULTS AND DISCUSSION

The data pertaining to diameter of bulb as influenced by various levels of iron, zinc and boron are summarized in Table.

1.Effect of iron, zinc and boron on diameter of bulb (cm)

The effects of various levels of iron on diameter of bulb were found significant during both the years of experiment and in pooled data. Significantly maximum diameter of bulb (6.31 cm, 6.17 cm and 6.24 cm during the year 2013-14, 2014-15 and in pooled data respectively) was noted withtreatment i_1. The minimum diameter of bulb (5.87 cm, 5.30 cm and 5.58 cm) was observed with treatment i_2 during the year 2013-14, 2014-15 and in pooled data. Soil application of iron which would have enhanced photosynthesis and other metabolic activities which leads to increase in cell division and cell elongation and ultimately increase in size of bulb and bulb diameter. This result are in agreement with the results reported by Ballabh*et al.* (2012), Durgude*et al.* (2013), Rizk*et al*. (2014), Singh *et al.* (2015[a]) and Singh *et al.* (2015[b]) in onion.

The effect of different levels of zinc on diameter of bulb was found significant during both the years of experimentation and in pooled data. Significantly maximum diameter of bulb (6.67 cm, 6.58 cm and 6.63 cm) was recorded withtreatment z_1 during the year 2013-14, 2014-15 and in pooled data respectively. In pooled result treatment z_1 was found statistically at par with treatment z_0.The minimum diameter of bulb (5.25 cm, 4.61 cm and 4.93 cmduring the year 2013-14, 2014-15 and in pooled data respectively) was observed with treatment z_2.

The application of zinc might have enhanced the photosynthesis and other metabolic activities, which led increase in cell division and cell elongation. These findings are in close accordance with the findings of Shrinath*et al.* (2007), Tohamy, *et al.* (2009), Abedin*et al*. (2012), Ballabh*et al.* (2012), Ballabh*et al.* (2013), Manna *et al.* (2014), Trivedi and Dhumal. (2013), Verma*et al.* (2014), Achharya*et al.* (2015), Assefa*et al*. (2015), Begum *et al.* (2015), Singh *et al.* (2015[a]) and Shukla*et al.* (2015) in onion.

Influences of different levelsof boron on diameter of bulb were found significant during both the years and in pooled data. Significantly maximum diameter of bulb (6.17 cm, 5.82 cm and 5.99 cm) was observed with treatmentb_2 during the year 2013-14, 2014-15 and in pooled data respectively which was statistically at par with treatment b_1. The minimumdiameter of bulb (5.89 cm, 5.50 cm and 5.70 cm) was observed with treatment $b_0$during the year 2013-14, 2014-15 and in pooled data respectively. This may be due to the boron application which enhances the enzyme activity which in turn triggers the physiological processes like carbohydrate metabolism in plant. Similar results were reported by Paul*et al.* (2007), Abedin*et al*. (2012), Manna *et al.* (2014), Achharya*et al.* (2015), and Singh *et al.* (2015[a]) in onion.

The interaction effect between iron, zinc and boron could not produced significant variation on diameter of bulb during both the years of experimentation and in pooled analysis.

2.Effect of iron, zinc and boron on neck thickness after curing (cm)

The effects of various levels of iron on neck thickness were found non significant during both the years of experiment and was significant in pooled data. Significantly minimum neck thickness (0.23 cm) was observed with treatment i_1 in pooled data while maximum neck thickness (0.26 cm) was found under treatment i_2 in pooled data.

The effect of different levels of zinc treatments on neck thickness after curing were found non significant during both yearsofexperimentation and in pooled data.

Influences of different levelsof boron on neck thickness after curing were found non significant during both the years of experimentation and found significant in pooled data. Significantly minimum neck thickness after curing (0.24 cm) was observed with treatment b_1 andb_2 in pooled data. The maximum neck thickness after curing (0.27 cm) was observed with treatment b_0 in pooled data.

The interaction effects between iron, zinc and boron on neck thickness after curing were found non significant during both the years of experimentation and in pooled data.

3.Effect of iron, zinc and boron on total soluble solid (^{0} Brix)

The influences of different levels of iron with respect to total soluble solid (^{0}Brix) were found non significant during both the years of experiment and found significant in pooled data. On pooled basis, significantly maximum TSS (11.52^0 Brix) was recorded with treatment i_1. It was statistically at par with treatment i_0. The minimum TSS (11.32^0 Brix) was observed under treatment i_2 in pooled data. These findings are in close accordance with the findings of Ballabh*et al.* (2012), Durgude*et al.* (2013), Singh *et al.* (2015[a]) and Singh *et al.* (2015[b]) in onion

The effect of different levels of zinc treatments on TSS (^{0}Brix) was found non significant during both the years of experimentation and in pooled data.

Influences of different levelsof boron on TSS (^{0}Brix) found non significant during both the years of experimentation though it was found significant in pooled data. Significantly higher TSS (11.47^0 Brix) was recorded with treatment b_2, which was statistically at par with treatment b_1. Minimum TSS (11.31^0 Brix) was observed with treatment b_0 in pooled data. These findings are in close accordance with the findings of Abedin*et al*. (2012), Manna *et al.* (2014), Acharya*et al.* (2015) and Singh *et al.* (2015[a]) in onion.

The interaction effect between iron and zinc with respect to TSS (^{0}Brix) was found significant in pooled data. Significantly maximum TSS was obtained with treatment combination i_1z_1 in pooled data. The interaction effect betweeniron, zinc and boron were found significant in pooled data. The maximum TSS content was observed with higher order interaction of treatment combinations $i_1z_0b_2$.

4.Effect of iron, zinc and boron on protein content (%)

The Influences of different levelsof iron, zinc, boron and its different combinations were unable to exert significant influence on protein content during both years of experimentation and pooled analysis**.**

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Table 1: Effect of iron, zinc and boron on quality parameters of onion during the two successive rabi seasons. (2013-14 and 2014-15)

Treatments	Diameter of bulb (cm)			Neck thickness after curing (cm)			TSS (^{0}Brix)			Protein content after curing (%)		
	Year 2013-14	Year 2014-15	Pooled	Year 2013-14	Year 2014-15	Pooled	Year 2013-14	Year 2014-15	Pooled	Year 2013-14	Year 2014-15	Pooled
Iron (I)												
i_0	6.01	5.67	5.84	0.25	0.24	0.24	11.87	10.96	11.41	0.72	0.83	0.78
i_1	6.31	6.17	6.24	0.23	0.22	0.23	11.94	11.09	11.52	0.85	1.06	0.95
i_2	5.87	5.30	5.58	0.27	0.24	0.26	11.78	10.87	11.32	0.56	0.85	0.70
S.Em.±	0.08	0.10	0.06	0.01	0.01	0.01	0.06	0.07	0.04	0.08	0.08	0.06
C.D. at 5%	0.24	0.28	0.18	NS	NS	0.01	NS	NS	0.12	NS	NS	NS
Zinc (Z)												
z_0	6.27	5.96	6.12	0.24	0.23	0.24	11.85	11.03	11.37	0.66	0.94	0.80
z_1	6.67	6.58	6.63	0.24	0.23	0.23	11.77	11.04	11.41	0.87	1.03	0.95
z_2	5.25	4.61	4.93	0.26	0.28	0.27	11.95	10.85	11.40	0.60	0.77	0.68
S.Em.±	0.08	0.10	0.13	0.01	0.01	0.01	0.06	0.07	0.10	0.08	0.08	0.06
C.D. at 5%	0.24	0.28	0.82	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boron (B)												
b_0	5.89	5.50	5.70	0.28	0.26	0.27	11.75	10.89	11.31	0.64	0.80	0.72
b_1	6.13	5.82	5.98	0.24	0.23	0.23	11.92	11.00	11.46	0.77	0.89	0.83
b_2	6.17	5.82	5.99	0.24	0.23	0.23	11.91	11.04	11.47	0.72	1.04	0.88
S.Em.±	0.08	0.10	0.06	0.01	0.01	0.01	0.06	0.07	0.04	0.08	0.08	0.06
C.D. at 5%	0.24	0.28	0.18	NS	NS	0.01	NS	NS	0.12	NS	NS	NS
Interaction effect												
I x Z	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
I x B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Z x B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I x Z x B	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS
CV %	7.14	8.91	8.02	11.11	13.10	12.11	2.48	3.17	2.82	9.09	8.66	8.87

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