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Effect of Micronutrients on Yield, Quality and Storability of Onion cv. Bhima Super

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ABSTRACT

An experiment was conducted to see effect of micronutrients on performance of Onion cv. Bhima Super at Horticulture Complex, Department of Horticulture, College of Agriculture, J.N.K.V.V., Jabalpur (M.P.) during the year 2015-2016. The highest plant height (27.10, 50.27 and 58.80cm at 30, 60 and 90 DAT, respectively), number of leaves (5.00, 7.80 and 14.07 at 30, 60 and 90 DAT), highest polar diameter(5.72 cm), pseudo stem diameter (1.36 cm), pseudo stem length (14.91cm), highest equatorial diameter (5.50cm), bulb weight (124.29g), total yield (276.03 q/ha), TSS (14.33 °Brix) were reported under treatment T_{11} (Soil application @ 10kg per hectare along with $ZnSO_4$ + Borax + $CuSO_4$) whereas lowest values for above parameters were recorded under T_{13} where only RDF applied. The highest bolting (1.08%) was recorded in foliar spray of 0.5% + CuSO4 + ZnSO4. However, highest rotting of bulb (0.42%) was recorded under T1 where 10 kg ha^{-1} of $ZnSO_4$ applied along with RDF.

Key word *Onion, RDF, ZnSO4, CuSO4, yield*

Onion (*Allium cepa* L.), 2n=16 is an important bulb crop, belongs to the family Alliaceae and locally known as 'Pyaj'. It is cultivated for food, medicines, religious purpose, spices and condiments since early times. Onion is one of the oldest cultivated species, and it has been in use as a food source for over 5000 year. Onion is consumed as a vegetable and condiment. The edible part of Onion is green leaves, immature and mature bulbs. It is eaten raw or used in vegetable preparations. It is an indispensable item in every kitchen and used to enhance flavour of different recipes. Onion has strong flavor due to presence of sulphur containing compound in very small quantity (about 0.005 %) in the form of volatile oil allyl propyl disulphide ($C_6H_{12}O_2$) responsible for distinctive smell and pungency acts as gastric, stimulant and promotes digestion. India ranks first in area & second in production. Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana & Tamil Nadu are the major onion growing states. The total area under production of onion in India during 2013-2014 was 1203.6 thousand ha with 19401.67 thousand MT production and 16.1 MT/ha productivity. However, in M.P. the total area was 117.3 thousand ha with total production 2628 thousand MT and productivity 24.1 MT/ha (Anon, 2014). Onion accounts for 70 percent of our total foreign exchange earnings from the export of fresh vegetables. Now a day's government of India has declared Onion as an essential commodity.

Micronutrients are used in smaller quantities. They are as important as the macronutrients in respect of their functions in plants. The micronutrients required by plants include iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), chlorine (Cl) and nickel (Ni). The availability of these nutrients in soil depends on the soil and the environment. For example, cool weather and wet soil conditions reduce the availability of Zn, resulting in a Zn deficiency. Micronutrient availability (except Mo) generally decreases as soil pH increases. Availability of Zn, Mn and Cu declines rapidly as soil pH rises. Also, sandy soils are more likely to show micronutrient deficiencies than clay soils.Although the requirement of a micronutrient is small compared to a macronutrient, nevertheless micronutrient deficiency can limit the crop growth and production. Furthermore, micronutrients help increase the efficiency of the use of macronutrients. Micronutrients have a great role in the fertilizer program to achieve higher and sustainable crop yields. Unfortunately micronutrients have received less attention in fertilizer management research, development and extension.Growers should carefully follow recommendations for micronutrients to avoid unnecessary costs and possible toxic effects or deleterious interactions with other nutrients. Selection of an effective application method depends on the micronutrient needed, local soil conditions, and the stage in the growing season at which a deficiency is detected. Micronutrient deficiencies can occur in the high pH soils. Maximizing yield without application of required fertilizers is not possible. Fertilizers can increase yield and quality of crop produce. For maximization of crop yield, all the nutrients whether macronutrients or micronutrients that are deficient in soils must be added in the form of fertilizers, either chemical, organic or both.

The research work on the effect of micronutrients on the growth, yield and storability of onion in India is very limited, although it is needed to determine micronutrient requirement of the crop. In consideration with the above situations, the present research work was undertaken "Effect of micronutrients on yield, quality and storability of Onion cv. Bhima Super".

MATERIALS AND METHODS

Treatment details

Plant height (cm), Number of leaves per plant and Leaf length (cm) was measured at 30, 60 and 90 days after transplanting.

Premature Bolting (%)

The bolting percentage was calculated by counting the number of bolted plants before harvesting.

$$\text{Bolter bulb \%} = \frac{\text{Number of bolter bulb}}{\text{Total number of bulb}} \times 100$$

Double bulbs (%)

The percentage of double bulb was calculated by counting the number of double bulbs after harvesting.

$$\text{Double bulb \%} = \frac{\text{Number of double bulb}}{\text{Total number of bulb}} \times 100$$

Average bulb weight (g)

Five randomly selected plants from each treatment and replications were weighed to determine the average weight of bulb.

Total yield (q ha^{-1})

Total yield of bulb (kg) per plot was converted in quintal per hectare multiplying with factor.

Ratio of fresh and dry weight of leaves per plant

The ratio of fresh and dry weight of leaves per plant was randomly select five plants from each plot. The fresh weight of leaves recorded at 75 days after transplanting and for the determination of dry matter content, fresh onion leaves of five sample plants of each plot were kept in an over at 70^{0}c for drying. It took 48 hours to reach the constant weight. The dry weight was recorded in mg and mean value was calculated. Ratio of fresh and dry weight of leaves was calculated by using the following formula:

$$\text{Ratio} = \frac{\text{Fresh weight of leaves}}{\text{Dry weight of leaves}}$$

Rotting (%)

The percentage of rotting bulbs was calculated by counting the number of rotted bulb after harvesting.

$$\text{Rotting \%} = \frac{\text{Number of rotted bulb}}{\text{Total number of bulb}} \times 100$$

Physiological loss in weight

The bulb weight was recorded on 20, 40 and 60 days after storage using an electronic balance. The cumulative loss in weight of bulbs was calculated and expressed as percent physiological loss in weight using the formula given below.

$$\text{PLW\%} = \frac{P_0\text{-}P_1 \text{ or } P_2 \text{ or } P_3}{P_0} \times 100$$

Where

P_o = initial weight

P_1 = weight after 20 days

P_2 = weight after 40 days

P_3 = weight after 60 days

RESULTS AND DISCUSSION

Plant height differed significantly due to different treatments at all growth stages. The plant height increased slowly during early stage of crop growth (up to 30 DAT) thereafter, increased sharply up to 60 DAT, again growth increased slowly at 60 to 90 DAT stages. At harvest plant height declined slightly in all the treatments. Highest plant height (27.10, 50.27 and 56.80 cm at 30, 60 and 90DAT, respectively) was recorded with the soil application at 10 kg ha^{-1} ($ZnSO_4$+Borax+$CuSO_4$) along with RDF which was significantly superior over all the treatments while, lowest plant height (20.83, 39.50 and 44.33 cm at 30, 60 and 90DAT, respectively) was recorded in control (No micronutrients only RDF). These finding related to plant height are in agreement with the finding of Lal and Maurya (1981), Manna *et al.* (2014) and Manna and Maity (2016) in Onion.

Number of leaves per plant differed significantly due to different treatments at 30, 60 and 90 DAT. Number of leaves per plant was observed maximum (5.00, 7.80 and 14.07 at 30, 60 and 90 DAT, respectively) in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum number of leaves per plant (4.20, 6.67 and 10.93 at 30, 60 and 90DAT, respectively) in the control (only RDF). This may be because of better growth and development of foliage under higher nutritive environment.This investigation similar result was supported by Paul et al. (2007), Ballabh&Rana (2012) and Acharya*et al.* (2015) in Onion.

Length of leaves differed significantly due to different treatments at 30, 60 and 90 DAT. Length of leaves were observed maximum (21.92cm) at 30 DAT in the control and at 60 & 90 DAT was observed maximum (46.40 and 48.80 cm, respectively) Length of leaves while, minimum (20.21) at 30 DAT in foliar application at 0.5 % of ZnSO4 and 60 & 90 DAT intervals 36.21 and 38.40 cm, respectively. These finding related to length of leaves are in agreement with the finding Ballabh*et al.* (2013) and Acharya*et al.* (2015) in Onion.

Pseudo stem length differed significantly under studies. The highest length of pseudo stem (14.91cm) was observed in treatment, soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF whereas, minimum (9.74 cm) Pseudo stem length was recorded in the control. This investigation was supported by Ballabh&Rana (2012) and Ballabh*et al.* (2013) in Onion.

Pseudo stem diameter differed significantly under studies. The highest pseudo stem diameter (1.36cm) was observed in treatment, soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF whereas, minimum (0.96 cm) Pseudo stem diameter was recorded in the control. This result was supported by Alam*et al.* (2010), Ballabh&Rana (2012) and Manna &Maity (2016) in Onion.

Polar diameter of bulb differed significantly due to different treatments. The highest polar diameter (5.72 cm) was observed in treatment, soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (4.18 cm) polar diameter of bulb was recorded in the control. The similar result was obtained by Paul et al. (2007), Tohamy*et al.* (2009), Alam et al.(2010), Ballabh&Rana (2012) and Acharya et al. (2015) in Onion.

Equatorial diameter of bulb differed significantly due

Table 1. Effect of micronutrients on onion

Treatment	Plant height (cm) at			No. of leaves per plant at		
	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT
T_1	24.80	44.77	48.20	4.53	7.13	11.53
T_2	24.07	44.67	47.47	4.53	7.07	11.40
T_3	24.00	44.63	46.87	4.47	7.07	11.40
T_4	22.30	44.60	46.67	4.47	7.07	11.33
T_5	21.67	44.20	45.50	4.33	6.93	11.20
T_6	21.13	43.80	44.67	4.20	6.73	11.00
T_7	25.77	47.63	50.13	4.80	7.15	12.33
T_8	25.60	47.00	49.87	4.80	7.13	12.00
T_9	25.27	46.76	49.27	4.73	7.14	11.73
T_{10}	24.83	45.22	48.47	4.60	7.13	11.67
T_{11}	27.10	50.27	56.80	5.00	7.80	14.07
T_{12}	25.80	49.27	54.09	4.87	7.77	13.20
T_{13}	20.83	39.50	44.33	4.20	6.67	10.93
S.Em±	1.00	1.16	1.52	0.14	0.20	0.36
C.D.5%	2.91	3.38	4.44	0.40	0.58	1.06

to different treatments. The highest Equatorial diameter (5.50 cm) was observed in treatment, soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (3.59 cm) Equatorial diameter of bulb was recorded in the control. This investigation was supported by Acharya*et al.* (2015) in Onion.

Double percentage of bulb differed significantly due to different treatments. The maximum (0.55 %) double percentage of bulb was observed in foliar application at 0.5 % of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (0.36 %) double percentage of bulb was recorded in the control and foliar application at 0.5 % of $ZnSO_4$ with RDF. The similar result was supported by Alam*et al.* (2010), Abedin*et al.* (2012) and Acharya*et al.* (2015) in onion.

Bolting percentage of bulb differed significantly due to different treatments. The maximum (1.08 %) bolting percentage of bulb was observed in foliar application at 0.5 % of $CuSO_4$+$ZnSO_4$ and soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (0.17 %) bolting percentage of bulb was recorded in soil

Table 2. Effect of micronutrients on onion

Treatment	Leaf length (cm) at			Pseudo stem length (cm)	Pseudo stem diamet (cm)
	30DAT	60DAT	90DAT		
T_1	20.31	40.00	41.00	13.61	1.31
T_2	20.21	39.90	40.60	13.33	1.30
T_3	21.86	39.67	40.53	13.22	1.24
T_4	20.98	39.63	40.20	12.91	1.24
T_5	20.72	39.57	39.40	12.77	1.20
T_6	19.68	39.50	39.11	10.93	1.13
T_7	21.28	43.30	43.40	13.76	1.34
T_8	21.23	43.17	42.83	13.76	1.32
T_9	20.52	42.30	42.47	13.75	1.32
T_{10}	20.49	40.63	41.47	13.74	1.31
T_{11}	21.54	46.40	48.80	14.91	1.36
T_{12}	21.37	43.88	46.97	13.97	1.35
T_{13}	21.92	36.21	38.40	9.74	0.96
S.Em±	0.27	1.48	0.57	0.35	0.05
C.D.5%	0.79	4.32	1.67	1.03	0.13

Table 3. Effect of micronutrients on some characters of onion

Treatment	Polar diameter of bulb (cm)	Equatorial diameter of bulb (cm)	Premature bolting (%)	Double bulb (%)	Average weight of bulb (g)	Marketable yield (q/ha)	Total yield (q/ha)
T_1	5.12	4.69	0.42	0.38	85.11	203.76	230.13
T_2	5.01	4.55	0.58	0.36	85.08	203.28	229.03
T_3	5.00	4.54	0.83	0.44	79.93	202.75	223.90
T_4	4.95	4.52	0.75	0.38	76.78	201.01	223.26
T_5	4.76	4.35	0.17	0.44	74.80	200.15	220.54
T_6	4.75	4.09	0.92	0.41	74.25	199.79	218.94
T_7	5.60	5.19	0.17	0.52	92.32	210.22	239.02
T_8	5.54	5.00	0.50	0.38	88.22	208.21	236.97
T_9	5.44	4.93	0.17	0.37	88.21	206.23	236.58
T_{10}	5.17	4.77	1.08	0.43	85.80	204.08	230.35
T_{11}	5.72	5.50	1.08	0.39	124.29	239.43	276.03
T_{12}	5.70	5.30	0.75	0.55	97.65	225.87	261.15
T_{13}	4.18	3.59	0.50	0.36	72.48	191.67	212.12
S.Em±	0.24	0.24	0.18	0.05	2.02	2.34	2.50
C.D.5%	0.70	0.70	0.54	N.S.	5.91	6.84	7.31

application at 10 kg ha^{-1} of $CuSO_4$, $ZnSO_4$+Borax and $CuSO_4$+$ZnSO_4$ with RDF. This investigation was supported by Tohamy*et al.* (2009) in onion.

Average weight of bulb differed significantly under studies. The highest weight of bulb (124.29 g) was observed in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (72.48 g) weight of bulb was recorded in control. This investigation was supported by Paul *et al.* (2007), Abedin*et al.* (2012), Manna *et al.* (2014) and Manna &Maity (2016) in onion.

Marketable yield differed significantly due to different treatments. The highest (239.43 q ha^{-1}) marketable yield was observed in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, lowest (191.67 q ha^{-1}) marketable yield was recorded in control. These finding related to marketable yields are in agreement with the finding of Manna *et al.* (2014) and Manna &Maity (2016) in onion.

Total yield differed significantly due to different. The highest (276.03 q ha^{-1}) total yield was observed in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, lowest (212.12 q ha^{-1}) total yield was recorded in control. These finding related to total yield are in agreement with the finding of Ballabh and Rana (2012), Manna *et al.* (2014), Acharya*et al.* (2015) and Manna &Maity (2016) in onion.

Ratio of fresh and dry weight of leaves per plant differed significantly due to different treatments. The maximum (6.56 g) ratio of fresh and dry weight of leaves per plant was observed in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (4.79 g) ratio of fresh and dry weight of leaves per plant was observed in control. These finding related to ratio of fresh and dry weight of leaves per plant are in agreement with the finding of Paul et al. (2007), Alam*et al.* (2010), Abedin*et al.* (2012) and Ballabh*et al.* (2013) in onion.

Rotting percentage differed significantly due to different treatments after 20, 40 and 60 days intervals after harvest. Rotting percentage was observed maximum (0.42 %) soil application at 10 kg ha^{-1} of $ZnSO_4$ along with RDF and foliar application at 0.5 % of $ZnSO_4$ along with RDF and after 40 and 60 DAH was (0.83 and 1.26 %) in foliar application at 0.5 % of $ZnSO_4$ along with RDF and foliar application at 0.5 % of $CuSO_4$ along with RDF respectively while, minimum (0.11 %) after 20 DAH in foliar application at 0.5 % of Borax along with RDF and soil application at 10 kg ha^{-1} of $CuSO_4$+$ZnSO_4$ along with RDF and after 40 and 60 DAH was minimum (0.41 and 0.73 %) respectively, in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax with RDF.

Weight loss percentage differed significantly due to different treatments after 20, 40 and 60 days intervals after harvest. Weight loss was observed maximum (3.00, 4.44 and 5.18 %, respectively) in soil application at 10 kg ha^{-1} of $ZnSO_4$ along with RDF while, minimum (2.04 %) after 20 DAH in foliar application at 0.5 % of $ZnSO_4$ along with RDF and after 40 and 60 DAH minimum was recorded (3.03 and 3.74 %) respectively, in foliar application at 0.5 % of Borax with RDF.

Total soluble solids (TSS) differed significantly due to different treatments. The maximum (14.53 ^{0}Brix) TSS was observed in soil application at 10 kg ha^{-1} of $ZnSO_4$+Borax+$CuSO_4$ along with RDF while, minimum (12.87 ^{0}Brix) TSS was observed in control. These finding related to TSS are in agreement with the finding of Ballabh and Rana (2012), Ballabh*et al.* (2013), Manna *et al.* (2014) and Manna &Maity (2016) in onion.

Table 4. Effect of micronutrients on onion

Treatment	Ratio of fresh and dry weight of leaves	TSS (%)	Rotting (%) at			Physiological weight loss (%) at		
			20DAH	40DAH	60DAH	20DAH	40DAH	60DAH
T_1	5.92	13.67	0.42	0.73	1.15	3.00	4.44	5.18
T_2	5.85	13.50	0.42	0.83	1.04	2.04	3.19	3.94
T_3	5.81	13.40	0.20	0.51	0.82	2.41	3.50	4.22
T_4	4.89	13.07	0.11	0.57	0.94	2.19	3.03	3.74
T_5	4.88	13.00	0.31	0.63	1.05	2.20	3.26	4.04
T_6	4.81	12.93	0.31	0.73	1.26	2.26	3.35	4.16
T_7	6.20	14.18	0.21	0.41	0.73	2.18	3.16	3.80
T_8	6.18	14.03	0.21	0.53	0.85	2.16	3.57	4.36
T_9	6.18	13.77	0.11	0.43	0.75	2.20	3.40	4.07
T_{10}	5.97	13.75	0.21	0.53	0.95	2.19	3.35	3.90
T_{11}	6.56	14.53	0.20	0.52	0.82	2.12	3.38	3.99
T_{12}	6.30	14.47	0.21	0.52	0.84	2.22	3.43	4.01
T_{13}	4.79	12.87	0.21	0.52	0.93	2.13	3.24	3.86
S.Em±	0.23	0.27	0.12	0.17	0.19	0.10	0.17	0.20
C.D.5%	0.69	0.80	N.S.	N.S.	N.S.	0.30	0.51	0.58

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