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Effect of Micronutrient Application on Vegetative Growth and Bulb Yield Attributes of *Rabi* Onion (*Allium cepa* L.)

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A B S T R A C T

An experiment was conducted to evaluate the efficacy of micronutrients on performance of Onion cv. Sukhsagar at Nadia, West Bengal during 2017-2018.The experiment was laid out in RBD having four replication with six treatments each having FYM @ 20 t ha^{-1}, *viz*. T_1 (RDF + soil application of Zinc Sulphate @ 10.0 kg ha^{-1}), T_2 (RDF+ foliar application of Zinc Sulphate @ 0.5% at 30 & 45 days after planting (DAP), T_3 (RDF+ soil application of Borax @ 10.0 kg ha^{-1}), T_4 (RDF+ foliar application of Borax @ 0.25% at 30 & 45 DAP), T_5 (RDF+ 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). Highest plant height (63.72 cm), number of leaves/plant (12.71), polar diameter (58.62 mm), equatorial diameter (46.88 mm), average weight (61.72 g) of bulb, yield ha^{-1} (266.80 q) and highest % (29.82) of A grade bulbs, were recorded with T_5 followed by T_4.Hence, it is concluded foliar application of micronutrient mixture @ 0.25% followed by borax @ 0.5% at 30 and 45 DAP is better in respect of bulb growth and yield.

Introduction

Onion (*Allium cepa* L.) belonging to the family Alliaceae, is one of the most important and popular vegetable and spice crops cultivated worldwide (Mishra *et al.*, 2013). It is famous for its characteristics flavour and it is widely used to increase the taste of foods like gravies, soups, stew stuffing, fried fish and meat (Rashid *et al.*, 2016). 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. It is hence known as “Queen of Kitchen”. It is a rich source of major minerals like calcium (180 mg/100 g), phosphorus (50mg/100 g), iron (0.7mg), carbohydrates (11.0 g), protein (1.2 g), dietary fibre (0.6 g),vitamin C (11 mg) and minerals (0.4 g).Onion has strong flavour 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 (Pramanik *et al.,* 2018).In West Bengal, onion is grown mostly in Hooghly, Murshidabad, Nadia and North 24 Parganas districts. The total area under onion in West Bengal was 29 thousand ha with production and productivity of 465.45 thousand MT and 16.05 MT/ha, respectively (Anon, 2017). In the foreign exchange point of view, onion ranks first among the vegetables.

Proper plant nutrition is one of the most important factors in improving the as quantity well as quality of plant products. Micronutrients are needed by the plants in minor quantities but they are involved indifferent 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). Boron and zinc are the most important micro-nutrients which are essential for cell division, nitrogen and carbohydrate metabolism and water relation in plant growth (Brady, 1990). The functional role of Zn includes auxin metabolism, influence on the activities of dehydrogenase, carbonic anhydrate enzymes, synthesis of cytochrome and stabilization or ribosomal fractions (Tisdale *et al.,* 1985). Boron is an essential micronutrient required for normal plant growth and development. It 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).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. Bhonde *et al.,* (1995) 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).Keeping this background, a field experiment was conducted at new alluvial soils of West Bengal during Rabi season of 2017-2018to study about the effect of micronutrients on vegetative growth and bulb yield attributes in onion.

Materials and Methods

Site description

The field experiment was conducted at “C” Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India during the period between November 2017 and March2018. The farm is situated at 23.5ºN latitude and 89ºE longitude with an average altitude of 9.75 m above the mean sea level. Topographic situation of the experimental site belongs to Gangetic new alluvial plains of West Bengal. All laboratory experiments had been conducted in the laboratories of Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur and Department of Agricultural Chemistry and Soil Science, Kalyani, Nadia, West Bengal.

Experimental details

The experiment was laid out in a RBD (Randomized Block Design) with six treatments and four replication. Experimental field was divided into four blocks and each of them was further subdivided into six plots. There were total 24 plots in the experiment. The crop was planted in a plot (size 2m × 1.5m) at a spacing of 15 cm × 10cm. Before fertilizer application, random soil samples were taken from the experimental field and were analysed.

The soils were non-saline (EC 0.11 dS/m), sandy-loam in texture, slightly acidic in reaction (pH 6.6) and medium to low in organic carbon (0.66 %) with good drainage facilities. The treatments includesT_1 (recommended 100:60:80:40 NPKS kg ha^{-1} + FYM @ 20 t ha^{-1} + soil application of Zinc Sulphate @ 10.0 kg ha^{-1}), T_2 (recommended 100:60:80:40 NPKS 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 100:60:80:40 NPK kg ha^{-1} + FYM @ 20 t ha^{-1} + soil application of Borax @ 10.0 kg ha^{-1}), T_4 (recommended 100:60:80:40 NPK kg ha^{-1}+ FYM @ 20 t ha^{-1} + foliar application of Borax @ 0.25% at 30 & 45 DAP), T_5 (recommended 100:60:80:40 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). Ten plants were selected from each plot randomly as a unit for observation on growth aspect and yield attributes.

Soil analysis

Representative soil samples of the experimental field were collected randomly up to the depth of 0 - 15 cm. The soil samples were air dried, ground well in wooden mortar and pestle and sieved through 2 mm sieve. The soil samples were analyzed from each treatment separately for soil available N, P, K, S, Zn and B before planting and after harvest of crop according to standard methods as mentioned in Table 1.

Results and Discussion

Plant growth parameters

In the present field experiment, foliar application of micronutrients exerted a significant influence on plant growth parameters in onion *viz*. plant height and number of leaves/plant.

Plant height

The results show that at 30 DAT, the significant highest plant height (35.99 cm) was recorded with soil application of Zinc sulphate @ 10 kg/ha (T_1). Foliar application of Borax @ 0.25 % (T_4)(30.96 cm) was statistically at *par* with (30.19 cm) foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5). At 60 DAT, foliar application of Borax @ 0.25 % (T_4) had recorded significantly highest plant height (60.17 cm) and it was at *par* (59.46 cm) with $T_{5,}$ *i.e.* foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 %and Mn - 1 %).At 90 DAT, the highest plant height of 63.72 cm was recorded with $T_{5,}$ *i.e.* foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) followed by (60.45 cm) foliar application of Borax @ 0.25 % (T_4). However, T_6 (control) had recorded the lowest plant height of 27.02 cm, 50.26 cm and 51.41 cm at 30, 60 and 90 DAT respectively (Table 2).

The increase in plant height due to application of micronutrient mixture; zinc as well as boron alone observed in the present investigation attributed to their role in cell division and auxin synthesis in the active sinks which would have led to higher transport and accumulation of photosynthates in foliage. Similar findings of better efficacy of boron has been reported by Dake *et al.,* (2011) while by zinc application reported by Maurya *et al.,* (2018) and Aske *et al.,* (2017) in onion. Similarly, better efficacy of micronutrient mixture was reported by Goyal *et al.,* (2017) in onion.

Number of leaves per plant

The results show that at 30 DAT, soil application of Borax (T_3) had produced significantly maximum number of leaves/plant (4.34), which was closely followed by (4.25 leaves/plant) soil application of Zinc sulphate @ 10 kg/ha (T_1) and was statistically at *par*. Foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 %and Mn - 1 %) (T_5) (3.49 leaves/plant) was at *par* with foliar application of Zinc sulphate@ 0.5 % (T_1) (3.37 leaves/plant) and Borax @ 0.25 % (T_4) (3.61).At 60 DAT, foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B -0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5) had recorded significantly maximum number of leaves/plant (9.19).At 90 DAT, foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B -0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5) had recorded significantly maximum number of leaves/plant (12.71). However, T_6 (control) had recorded the lowest numbers of leaves/plant of 3.2, 6.46and 10.70 at 30, 60 and 90 DAT respectively (Table 2).

The application of micronutrients in onion increased the production of more leaves/plant than control. This might be due to their role in cell division, meristematic activity of plant tissue and expansion of cell (Patil *et al.,* 2009). Similar result was reported by Paul *et al.,* (2007) and Acharya *et al.,* (2015) in onion crop. Similarly, better efficacy of micronutrient mixture was reported by Smriti *et al.,* (2002); Ballabh *et al.,* (2013) and Goyal *et al.,* (2017) in onion crop.

Bulb parameters

Neck Thickness of Bulb

The result revealed that foliar application of Zinc sulphate @ 0.5 % (T_2) produced bulbs with relatively thin neck thickness of 0.60 cm closely followed (0.66 cm) by foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5). However, T_6 (control) produced bulbs with maximum neck thickness of 0.92 cm (Table 3).Thin and compact neck is ideal for onion, which improve the storage life of bulbs. Mean neck thickness of the plants increased slowly in first month, rapidly in 30-60 days period and slowly reduced between 60-90 days and rapidly reduced after 90 days because of maturity. The application of zinc might have reduced the moisture content and reduced the bulb neck thickness (Maurya *et al.,* 2018) in onion. Manna (2013) also observed significant improvement in bulb neck thickness in onion by application of boron.

Polar diameter of bulbs

Polar diameter of bulb differed significantly due to different treatments (Table 3). The maximum polar diameter (58.62 mm) was observed with foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 %and Mn - 1 %)

(T_5). The result also showed that foliar application of micronutrient both alone (T_2 and T_4) or in combinations (T_5) significantly increased the polar diameter of onion bulbs as compared to soil application of micronutrients @ 10 kg/ha (T_1 and T_3) or without micronutrient (T_6).Rapidly increased photosynthetic activities and translocation of more photosynthates in growing bulb with the application of micronutrients (B + Zn) might be the reason behind the increased length of the bulb. Application of Zn and B more or less increased the bulb diameter. The present findings were in agreement with the results of Samad *et al.,* (2011), Trivedi and Dhumal (2013) and Manna (2013) in onion crop.

Equatorial diameter of bulbs

The result of equatorial diameter of bulbs revealed significant variations which ranged from minimum of 42.18 mm in T_6 to maximum of 46.88 mm in T_5 (Table 3). The marked improvement in size and diameter might be due to the translocation and storage of food materials from leaf to bulb for which micronutrients were the responsible factors. Zinc helped in translocation of constituents from one part to another part and boron also helped in the absorption of nitrogen and acted as a regulator of Ca:K ratio in the plant. The micronutrient application especially boron which enhanced the enzyme activity which in turn triggered the physiological processes like protein and carbohydrate metabolism in plants. Similar findings were also reported by Shukla *et al.,* (2015), Aske *et al.,* (2017) in onion.

Average bulb weight

The maximum average weight (61.72 g) of bulb was significantly recorded in T_5 , *i.e.* foliar spray of micronutrients mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu-1 % and Mn - 1 %). The minimum average weight (50.73 g) of bulb was observed in control plot (T_6) (Table 3).The supply of food is directly proportional to the rate of growth and development of bulb. Zinc rapidly increases the photosynthetic activity and translocation of photosynthates for growing onion bulbs and it influenced the bulb weight positively. Similar findings were also recorded by Mandal *et al.,* (2003) in onion. Better efficacy of foliar application micronutrients *viz.,* zinc and boron in onion was also reported by Acharya *et al.,* (2015).

Number of bulbs/kg

The lowest number of bulbs (16.19)/kg was found in $T_{5,}$ *i.e.* foliar application of micronutrients mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) and it was at *par* with $T_{3,}$ *i.e.* soil application of Borax @ 10 kg/ha, while the highest number of bulbs (19.61)/kg was found in T_6 (control) (Table 3). The less number of bulbs/kg was due to bigger size of bulbs.

Yield parameters

Total Bulb yield/hectare

Significant variation among the treatments for yield/hectare have been observed and varied from 214.78 q/ha in T_6 to maximum of 266.80 q/ha in T_5. Significantly highest yield/hectare (266.80 q/ha) was recorded in T_5 *i.e*. foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) followed by(250.18 q/ha) $T_{4,}$ *i.e.* foliar application of Borax @ 0.25 %. On the other hand, significantly the lowest bulb yield of 214.78 q/ha was recorded in control plot $T_{6,}$ *i.e.,* without micronutrients application (Table 4).The higher photosynthesis accumulation in the bulbs would ensure higher individual bulb weight and large bulb diameter which collectively increases the bulb yield in onion. Similar reports of increased bulb yield was observed by several workers in onion (Abedin *et al.,* 2012). The better efficacy of boron towards enhanced bulb yield was also observed by several research workers in onion (Manna, 2013). Similarly, the better efficiency of zinc towards increased bulb yield of onion were obtained by Alam *et al.*, (2010) and Trivedi and Dhumal (2013).

Marketable bulb yield/hectare

The treatment $T_{5,}$ *i.e.* foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %,B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) recorded maximum marketable bulb yield (260.45 q) per hectare followed by $T_{4,}$ *i.e.* foliar application of Borax @ 0.25 % and $T_{2,}$ *i.e.* foliar application of Zinc sulphate @ 0.5 %, where the marketable bulb yield were 242.95 and 233.88 q/ha, respectively. However, significantly lowest bulb yield of 203.50q/ha was recorded in control plot $T_{6,}$ *i.e.* without micronutrients application (Table 4).

Table.1 Methods adopted for determination of soil fertility status and total nutrient uptake by onion crop

Sl. No.	Property	Method adopted	Reference
	A. Soil analysis		
1.	Available N (kgha^{-1})	Modified alkaline permagnate	Subbiah and Asija (1956)
2.	Available P (kg ha^{-1})	0.5 M NaHCO3 at (pH 8.5)	Olsen *et al.*, (1954)
3.	Available K (kg ha^{-1})	Flame photometry	Brown and Warncke (1988)
4.	Available sulphur (mg ha^{-1})	Turbidimetric	Tabatabai (1982)
5.	Available boron (mg ha^{-1})	Hot water extractable method	Berger and Trough (1939)
6.	Available zinc (mg ha^{-1})	DTPA extractable method	Lindsay and Norvell (1978)

Table.2 Effect of micronutrient on plant height (cm) and number of leaves/plant of *rabi* onion

Treatments	**Plant height (cm)**			**Number of leaves/plant**		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	35.99	55.20	57.70	4.25	7.54	11.25
T_2	31.71	51.45	52.27	3.37	7.21	11.50
T_3	34.32	56.17	59.96	4.34	8.15	11.81
T_4	30.96	60.17	60.45	3.61	8.77	12.46
T_5	30.19	59.46	63.72	3.49	9.19	12.71
T_6	27.02	50.26	51.41	3.2	6.46	10.70
SE(d)	0.338	0.599	0.612	0.072	0.098	0.084
CD at 5%	1.028	1.821	1.862	0.219	0.298	0.257

T_1:Soil application of Zinc sulphate @ 10.0 kg/ha,T_2: Foliar application of Zinc sulphate @ 0.5 % at 30 and 45 days after transplanting (DAT), T_3: Soil application of Borax @ 10.0 kg/ha, T_4: Foliar application of Borax @ 0.25 % at 30 and 45 DAT, T_5: Foliar application of micronutrient mixture @ 0.5 % at 30 and 45 DAT, T_6: Control

Table.3 Effect of micronutrients on neck thickness (cm), polar and equatorial bulb diameter (mm), average bulb weight (g) and number of bulbs/kg

Treatments	Neck thickness (cm)	Polar diameter of bulb (mm)	Equatorial diameter of bulb (mm)	Average bulb weight (g)	Number of bulb/kg
T_1	0.81	52.22	45.53	54.56	18.29
T_2	0.60	55.05	46.63	56.35	17.74
T_3	0.68	53.75	45.44	55.69	17.93
T_4	0.71	55.25	46.73	59.38	16.87
T_5	0.66	58.62	46.88	61.72	16.19
T_6	0.92	48.67	42.18	50.73	19.61
SE(d)	0.009	1.217	0.447	0.633	0.192
CD at 5%	0.026	3.702	1.359	1.927	0.584

T_1:Soil application of Zinc sulphate @ 10.0 kg/ha,T_2: Foliar application of Zinc sulphate @ 0.5 % at 30 and 45 days after transplanting (DAT), T_3: Soil application of Borax @ 10.0 kg/ha, T_4: Foliar application of Borax @ 0.25 % at 30 and 45 DAT, T_5: Foliar application of micronutrient mixture @ 0.5 % at 30 and 45 DAT, T_6: Control

Table 4. Effect of foliar application of micronutrients on yield and marketable bulb yield in onion and B:C ratio

Treatments	Bulb yield/hectare (q/ha)	Marketable bulb yield/hectare (q/ha)	B:C ratio
T_1	228.30	218.06	3.49
T_2	233.30	223.88	3.42
T_3	219.27	207.69	2.93
T_4	250.18	242.95	3.92
T_5	266.80	260.45	4.61
T_6	214.78	203.50	4.08
SE(d)	1.830	2.009	-
CD at 5%	5.568	6.111	-

T_1:Soil application of Zinc sulphate @ 10.0 kg/ha,T_2: Foliar application of Zinc sulphate @ 0.5 % at 30 and 45 days after transplanting (DAT), T_3: Soil application of Borax @ 10.0 kg/ha, T_4: Foliar application of Borax @ 0.25 % at 30 and 45 DAT, T_5: Foliar application of micronutrient mixture @ 0.5 % at 30 and 45 DAT, T_6: Control

Table 5. Effect of micronutrients on production of A, B and C grade bulbs in onion cv. Sukhsagar

Treatments	A grade bulb(%)	B grade bulb (%)	C grade bulb (%)
T_1	14.57	25.39	23.24
T_2	20.01	28.07	25.69
T_3	15.54	23.955	27.77
T_4	23.03	25.403	21.07
T_5	29.82	27.64	18.99
T_6	8.27	16.208	35.1
SE(d)	0.256	0.472	0.387
CD at 5%	0.78	1.177	1.177

T_1:Soil application of Zinc sulphate @ 10.0 kg/ha,T_2: Foliar application of Zinc sulphate @ 0.5 % at 30 and 45 days after transplanting (DAT), T_3: Soil application of Borax @ 10.0 kg/ha, T_4: Foliar application of Borax @ 0.25 % at 30 and 45 DAT, T_5: Foliar application of micronutrient mixture @ 0.5 % at 30 and 45 DAT, T_6: Control

The higher yield might be due to increase in plant height, number of leaves, and yield attributes *viz.*, polar and equatorial diameter of bulb, higher individual average bulb weight. The result also showed significantly better efficacy of foliar application of micronutrients over soil application, which might be due to better utilization of applied nutrients which required in minute quantities by foliar spray rather than soil application. A similar result of better efficacy of foliar sprays over soil application of micronutrient was reported by Acharya *et al.*, (2015) in multiplier onion.

Production of A, B and C grade bulbs

The % of production of A grade bulbs varied significantly among different treatments ranging from minimum of 8.27 in control (T_6) to maximum of 29.82 in T_5.Significantly highest % of A grade bulbs were obtained by plot of treatment T_5*i.e.* foliar application of micronutrient mixture @ 0.5 % (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu - 1 % and Mn - 1%) closely followed by T_4 (foliar application of Borax @ 0.25 %). Similarly, the % of production of B grade bulbs varied from 16.20 (T_6) to 28.07 (T_2).Foliar application of Zinc sulphate @ 0.5 % recorded significantly highest % of B grade bulbs (28.07).The % of production of C grade bulbs, varied from minimum of 18.99 (T_5) to maximum 35.10 (T_6). Foliar application of micronutrient mixture (T_5) recorded minimum % of C grade bulbs. The overall results on production of A and B grade bulbs indicate that application of micronutrients (both soil and foliar) increased the % of superior graded bulbs as compared to control treatment. Significantly maximum % of A and B grade bulbs were produced in the promising treatments might be due to significantly higher polar and equatorial diameter due to application of micronutrients.

In conclusion, the highest values for plant growth characters *viz.* Plant height (63.72 cm), number of leaves/plant (12.71) were recorded with the foliar application of 0.5 % micronutrient mixture (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 %and Mn - 1 %) (T_5). However, among the micronutrient treatments the next best values with respect to plant height (60.45 cm) and number of leaves/plant (12.46)were recorded with the foliar application of 0.25 % borax (T_4). The bulb characters *viz.* neck thickness (0.60 cm) *i.e.* relatively thin was observed in soil application of zinc sulphate @ 10 kg/ha (T_1) closely followed by foliar application of 0.5 % micronutrient mixture (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5) (0.66 cm). The maximum polar diameter (58.62 mm), equatorial diameter of bulb (46.88 mm) and average weight of bulb (61.72 g) were recorded with the foliar application of 0.5 % micronutrient mixture (Fe - 2.5 %, B - 0.5 %, Zn - 3 %, Cu -1 % and Mn - 1 %) (T_5). The lowest number of bulbs/ kg (17.74) was found in T_2 *i.e.* foliar application of zinc sulphate. The yield characters *viz.*, maximum yield/plot (8.01 kg), yield/hectare (266.80q/ha), highest % of A grade bulbs (29.82 %), minimum % of C grade bulbs (18.99 %)were recorded with the foliar application of 0.5 % micronutrient mixture (Fe - 2.5 %,B - 0.5 %, Zn - 3 %, Cu - 1 % and Mn - 1 %) (T_5). However, foliar application of zinc sulphate recorded significantly highest % of B grade bulbs (28.07 %). Hence, from the present study it can be concluded that among all the micronutrient treatment schedule, it was observed that the treatment schedule, T_5*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.

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