

Original Research Article

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**Effect of Micronutrients, Growth Regulators and Organic Manures on Yield, Biochemical and Mineral Component of Onion (*Allium cepa* L.) Grown in Vertisols**

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There is a need of in depth studies for increasing the efficiency of applied micronutrients and bio-regulators, owing to their high cost. However, to ensure higher economic productivity correct dose of fertilizers, micronutrients and bio regulators is essential. Considering the importance of micronutrients and bio regulators in determining quality production of onion, the present investigation was undertaken. The experiment laid out in RBD with twenty-seven treatments in three replications. Micronutrients like Fe and Zn added in to the soil through alone and combination with FYM and cow dung slurry as per treatment. Fe and Zn also applied through foliar spraying alone and combination with amino acid, GA<sub>3</sub> and 2-4-D. Soil application of zinc with cow dung slurry emerged as the best treatment for number of leaves per plant, polar diameter of bulb, bulb weight, yield, TSS and mineral components of bulb.

**Introduction**

Onion (*Allium cepa* L) is the most important conventional vegetable crop commercially grown in India. 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 the good source of earning foreign exchange. It is originated from the region comprising North West India, Afghanistan, Tasik and Uzbek. It was reported that onion was a very popular food in Egypt. Some of the important testimonials of Bible give good account of onion used as food in ancient Egypt. Onion had been grown in India from ancient times as it is mentioned in *Charka Samhita*.

Onions have received considerable attention for their healthful, functional benefits. Phytochemicals in onions include the organosulfur compounds such as cepaenes and thiosulfinates (Dorsch and Wagner, 1991; Goldman *et al.*, 1996). Onion has different medicinal values. It is a stimulant, vitalizing, pungent, promoters of virility, heavy refreshing, stimulative of gastric enzymes and lubricous. It reduces cough and induces sleep. It is the best remedy for tuberculosis, cardiac troubles, dyspepsia, leprosy, piles, swelling and blood imparities. It saves one from sunstroke. Eating onion in the morning and a bedtime is beneficial in jaundice. Onion juice is a very effective vermifuse. It dislodges mucous and prevents its formation.

It is also beneficial for intestinal disorders. It stimulates the process of peristalsis of the intestine and removes intestinal putrefaction and flatulence. It is also useful during indigestion and bleeding of piles. The onion has effective germicidal properties. On account of presence of volatile oil, it is very useful in respiratory disorders. White onion has more demand for medicinal uses as compared to the other varieties. Onion is widely used in all parts of the world as a flavoring agent in vegetables.

The importance of micronutrients in agriculture can be defined as the product of the magnitude of impacts per unit area, and the area of impact. Impact is most commonly measured as crop yield. Zinc is involved in enzyme systems and metabolic reactions, and is necessary for production of chlorophyll and carbohydrates. Zinc deficiencies may occur on calcareous, high pH, sandy texture, high P, and eroded soils. Zinc deficiencies usually show up under cool, wet conditions in early spring when root growth is slow. Poorly drained soils may also be deficient. Badly eroded soils and eroded knolls may be low in Zn. Iron is a catalyst to chlorophyll formation, acts as an oxygen carrier, and aids in respiratory enzyme systems. Iron is not translocated within the plant, so deficiency symptoms first show up on the younger leaves. The classic Fe symptom is interveinal chlorosis, a pale green to yellow leaf with sharp distinction between green veins and yellow interveinal tissue. The best practice has been to broadcast and incorporate micronutrients as a pre-plant application. This should provide several years effectiveness.

Plant growth regulators (PGR's) are known to improve physiological efficiency including photosynthetic ability of plants and offer a significant role in realizing higher crop yields. Various plant growth regulators are responsible for stimulate cell division, cell

elongation, auxin metabolism altering, cell wall plasticity. They are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby increasing the productivity. Though, the plant growth regulators have great potential, its application and accrual assessments etc. have to be judiciously planned in terms of optimal concentration, stage of application, species specificity and seasons. The organic manure seems to act directly in increasing crop yields either by acceleration of respiration process by increasing cell permeability or by hormone growth action, or by increased combination of all these processes. It supplies N, P, K and S in available forms to the plants through biological decomposition. Indirectly it improves physical properties of soil such as aggregation, aeration, permeability and water holding capacity.

For the profitable cultivation, it is highly desirable to find ways and means to enhance the productivity of vegetables by using techniques that are within the reach of farmers. To achieve this, one of the options is to use balanced nutrient supply of macro and micronutrients along with bio regulators and combination of organic and inorganic fertilizers. This will highly improve the yield as well as nutritive, market and export qualities life of different vegetables including onion. There are favorable reports on various crops regarding the response of added micronutrients and bio-regulators for improving the growth and yield, however, such type of studies are lacking in onion crop. Therefore, there is an urgent need to work out application methodology of micronutrients and bio-regulators during the life cycle of onion crop for getting desired yield and bulb quality. Further there is also a need of in depth studies for increasing the efficiency of applied micronutrients and bio-regulators, owing to their high cost. However, to ensure

higher economic productivity and to sustain the available soil nutrient status at desirable level correct dose of fertilizers, micronutrients and bio regulators is essential. Considering the importance of micronutrients and bio regulators in determining production and quality of onion, the present investigation was undertaken.

## **Materials and Methods**

The field experiments were conducted during the *late kharif* seasons of at the experimental farm of Directorate of Onion and Garlic Research, Manjari, Pune, following RBD design with 27 treatments including control in three replications with different combinations of micronutrients with bio regulators and organic manures at latitude 18.32° N and longitude 73.51° E and at an altitude of 553.8 m above the mean sea level. The average annual rainfall during the period of investigation was 669 mm and was fairly distributed from June to October. The maximum and minimum temperature during the experimental period was 17.6°C and 31.8 °C respectively. The experiments were conducted on medium black, clay loam soil. Composite soil samples were collected from the experimental site before sowing and were analyzed for various physical and chemical properties by using standard methods. The data on soil characteristic is given in table 1.

Micronutrients like Fe @10 kg/ha and Zn@10 kg/ha were added in to the soil through alone and combination with FYM@ 20 t/ha and fresh cow dung slurry @5t/ha as per treatment. Similarly Fe @1g/l and Zn @1g/l were also applied through foliar spraying alone and combination with amino acid@1g/l, GA<sub>3</sub> @50 ppm and 2-4-D @ 3 ppm. Multiplex @2.5 ml/l (commercial micronutrient mixture) was used as foliar spray to find out its efficiency in onion. Zinc and iron were applied as zinc sulphate and iron sulphate in the treatment of soil and foliar application

respectively.

The raised beds were prepared and basal application of fertilizers was given according to the treatments designed. The drip laterals having discharge of 4 liter per hour were placed on raised beds. The distance between two drip lateral was 50 cm and the distance between two dripper was 40 cm. Healthy seedlings of onion cv. Baswant -780 were transplanted at 45 DAS. At the time of transplanting, upper one third portions of leaves was removed to reduce the rate of transpiration. The crop was fertilized with 19:19:19 NPK and urea was applied as per recommended dose of fertilizer 150:50:50 NPK / ha. The 50 percent dose of nitrogen was applied as basal and remaining was applied in the form of urea in two equal splits at an interval of 30 and 45 DAT. The harvesting of bulbs was done in October when the leaves turned yellow and there was 50 % neck fall. The bulbs were cured in field within a week. The harvested bulbs were cleaned and tops were cut carefully. The bulbs were then cured again under shade for 3-4 days. The foliar applications were given at 30,45,60 DAT while soil application was given at 15 DAT. Observations regarding growth, development of bulb, quality of the bulb, nutrient status of bulb were assessed from the selected tagged 10 plants from each treatment. The bulb parameters were recorded after harvesting and curing.

Alcoholic extracts of bulbs of each treatment were prepared according to AOAC (1990) method. This alcoholic extract was used for the estimation of reducing, non-reducing, and total sugars, phenols and amino acids. All bio chemical analysis was done as per AOAC (1990) method.

The soluble reducing sugars were quantitatively estimated by dinitrosalicylic acid (DNS) method and total soluble sugars were estimated by anthrone method. The

absorbance of the colour developed was measured at 575 nm in a spectrophotometer (Biomate-3, Thermo Electron Corporation, Madison, USA). Amount of reducing sugars present in the sample was calculated by using a standard curve prepared from variable quantity of glucose.

The quantity of total phenols was estimated by using Folin-phenol reagent (E-Merck India Absorbance of the blue coloured solution was recorded at 650 nm in the spectrophotometer (Biomate-3, Thermo Electron Corporation, Madison, USA). Total soluble phenols in the sample were calculated from a standard curve developed using catechol as the standard.

Total free amino acids were estimated by ninhydrin method. Absorbance of the purple colour solution was measured at 570 nm in a spectrophotometer (Biomate-3, Thermo Electron Corporation, Madison, USA). Total free amino acids in the sample were calculated from a standard curve drawn by using variable amount of glycine.

Samples of onion bulbs were collected, processed as per the standard procedure and analyzed for their nutritional contents. The fresh tissues were washed in sequence in detergent solution, dilute HCl and de ionized water and finally with distilled water. The extra moisture was wiped out; the sample was placed in butter paper bags and dried in oven at 70 °C.

Total nitrogen in bulb samples was determined by micro Kjeldahl method. For the analysis of nutrients other than nitrogen, the bulbs samples were digested in a di-acid 9:4 mixture of HNO<sub>3</sub>: HClO<sub>4</sub>. The samples were predigested with 25ml HNO<sub>3</sub> per gram sample to avoid explosion and the aliquots of this solution were used for the determination of P, K, Ca, S, Fe, Mn, Zn and Cu.

Phosphorus contained in the extracts was estimated by reacting with vanadomolybdate forming yellow colour complex in HNO<sub>3</sub> medium. For estimation of K, the extract was diluted to appropriate concentration and it was directly atomized in to the flame photometer.

The sulphate content in the digest was determined by barium sulphate turbidimetry method by reading the absorbance or transmittance of solution on colorimeter using blue filter. Iron, manganese, copper and zinc contents in di-acid extract were determined by using Atomic Absorption Spectrophotometer.

All the data were statistically analyzed by ANOVA as per method suggested by Panse and Sukhatme (1995) and considering the treatment as the independent variable. The means were separated by the Tukey's test, considering a significant level of  $P < 0.05$  throughout the study.

## **Results and Discussion**

The data on the growth parameters and yield attributes as influenced by various treatments of micronutrients, organic manure and growth regulators presented in table 2.

### **Effect on growth characters**

Foliar application of Zn with 2,4-D resulted in highest value in growth character. The treatment T<sub>19</sub> (72.64 cm) showed significantly higher plant height. The treatments T<sub>13</sub> (72.04cm), T<sub>20</sub> (71.64cm), T<sub>21</sub> (71.42cm), T<sub>12</sub> (70.87cm) and T<sub>2</sub> (69.60cm) followed this, which were at par.

The treatments T<sub>19</sub> (15.70 cm) recorded higher number of leaves per plant than any other treatments. The treatments T<sub>1</sub> (15.44), T<sub>2</sub> (15.40), T<sub>3</sub> (15.05), T<sub>20</sub> (14.99) and T<sub>4</sub> (13.92) were at par.

### **Effect on yield and yield attributes**

The parameters polar and equatorial diameter of bulb, average weight of bulb and yield was found the highest in treatment zinc with cow dung slurry. It was revealed that the treatment T<sub>1</sub> (46.32 cm) recorded significantly maximum polar diameter in late *Kharif* season, followed by the treatments T<sub>19</sub> (45.32 cm), T<sub>2</sub> (45.16 cm), T<sub>24</sub> (44.88cm) and T<sub>5</sub> (44.35 cm), which were at par.

The treatment T<sub>3</sub> (60.63 cm) found to be significantly higher in equatorial diameter of bulb amongst the all treatments. The treatments T<sub>16</sub> (57.92 cm), T<sub>18</sub> (57.30cm), T<sub>24</sub> (56.56cm), T<sub>2</sub> (55.57 cm) and T<sub>9</sub> (55.38cm) were at par and superior to control (46.12 cm).

There was significant increase in bulb weight was recorded in the treatment T<sub>1</sub> (77.80 g) followed by the treatments T<sub>12</sub> (77.15g), T<sub>16</sub> (75.50g), T<sub>2</sub> (72.51g) and T<sub>24</sub> (72.16g) as compared to control.

The significantly higher bulb yield was observed in the treatment T<sub>1</sub> (48.20T/ha) followed by the treatments T<sub>12</sub> (46.27 T/ha), T<sub>16</sub> (45.85T/ha), T<sub>2</sub> (44.72 T/ha) and T<sub>24</sub> (43.91 T/ha.) as compared to control (25.18 T/ha).

### **Mineral contents of bulbs**

The results pertaining to the mineral contents of the onion bulbs as influenced by application of micronutrients, organic manures and growth regulators presented in table 3.

#### **Nitrogen (%)**

The effect of micronutrients and bio regulators applications on nitrogen content of bulbs was a significant increase in nitrogen content of bulbs in late *Kharif* season. The

maximum nitrogen content in the treatment T<sub>14</sub> (5.40%) was at par with treatments T<sub>12</sub> (3.56%), T<sub>8</sub> (3.08%), T<sub>24</sub> (2.64%), T<sub>18</sub> (2.66%) and T<sub>9</sub> (2.58%).

#### **Phosphorus**

Significantly maximum phosphorus content was recorded in the treatment T<sub>2</sub> (0.33%). The treatments T<sub>3</sub> (0.30%), T<sub>1</sub> (0.27%), T<sub>10</sub>(0.24%) and T<sub>4</sub> (0.21%) were at par. The lowest phosphorus content was observed in the control bulbs (0.07%).

Increase in P content of onion bulbs due to different treatments of chemical fertilizers, bio fertilizer, bio regulators, organic manures and micronutrients.

#### **Potassium**

The maximum potassium content was recorded in the treatment T<sub>8</sub> (1.98%) and T<sub>7</sub> (1.95 %). The next best treatments were T<sub>9</sub> (1.92%), T<sub>10</sub> (1.88%), T<sub>19</sub> (1.78%) and T<sub>12</sub> (1.76%)

#### **Sulphur**

The sulphur content of the treatment T<sub>3</sub> (0.88%) was significantly higher than the treatments T<sub>2</sub> (0.87%), T<sub>8</sub> (0.80 %), T<sub>9</sub> (0.80%) and T<sub>1</sub> (0.77%). The combination of bio fertilizers and micronutrients were effective to enhance the mineral content of bulbs.

#### **Iron**

The data on iron content as influenced by application micronutrients and bio regulators in treatment T<sub>22</sub> (99.5ppm) showed significantly higher content of iron, followed by the treatments T<sub>15</sub> (95.4ppm), T<sub>3</sub> (95.20 ppm), T<sub>23</sub> (94.5ppm) and T<sub>2</sub> (94.3ppm).



## **Manganese**

The maximum increase in manganese content was recorded in the treatment T<sub>9</sub> (23.5ppm) followed by T<sub>21</sub> (22.5ppm) which was at par with the treatments T<sub>14</sub> (21.6ppm), T<sub>22</sub> (18.6ppm) and T<sub>8</sub>(18.3ppm).

## **Zinc**

The treatment, T<sub>12</sub> (58.6 ppm) caused significantly higher increase zinc content amongst all the treatments. The remaining treatments like T<sub>6</sub> (58.40 ppm), T<sub>16</sub> (54.2 ppm), T<sub>1</sub> (53.9 ppm), T<sub>7</sub> (48.9ppm) and T<sub>13</sub> (48.8 ppm) were at par.

## **Copper**

The copper content of bulbs in treatment T<sub>16</sub> (25.00) was significantly higher. It was followed by treatments T<sub>1</sub> (23.00), T<sub>17</sub> (19.00 ppm), T<sub>3</sub> (18.20 ppm) T<sub>10</sub> (17.30 ppm) and T<sub>23</sub> (17.20 ppm).

## **Biochemical constituents of bulbs**

The sugar percentage in onion was found significantly increased by application of micronutrients with growth regulators and organic manure. All the chemical constituents studied were increased by combined application of micronutrients as compared to control (Table 4).

## **Sugars**

The total sugar content in onion bulb was significantly higher in treatment T<sub>17</sub> (29.66%) and It was followed by the treatment T<sub>22</sub> (23.35%), T<sub>13</sub> (21.43%), T<sub>24</sub> (19.12%), T<sub>6</sub> (17.81%) and T<sub>7</sub> (17.44%). The treatment T<sub>15</sub> (11.61%) showed significantly higher content of reducing sugar followed by the treatments T<sub>20</sub> (10.03%), T<sub>19</sub> (9.88%), T<sub>22</sub> (9.68%) and T<sub>10</sub> (9.67%), which were at par. The non reducing sugar content in the treatment, T<sub>17</sub>

(20.85%) showed highest content as compared to treatments T<sub>13</sub> (13.63 %), T<sub>24</sub> (9.80%), T<sub>6</sub> (9.56%), T<sub>7</sub> (8.37%) and T<sub>26</sub> (7.33%).

## **Amino acids**

The treatment T<sub>22</sub> (3.89%) was found to be significant in the amino acids content of bulbs. The treatments T<sub>5</sub> (2.85%), T<sub>10</sub> (2.84%), T<sub>11</sub> (2.73%), T<sub>24</sub> (2.70%) and T<sub>6</sub> (2.66%) were at par and better than control (0.89%).

## **Phenols**

The highest phenolic content was recorded in the treatment T<sub>17</sub> (26.44%) which was followed by T<sub>22</sub> (15.57%), T<sub>13</sub> (14.29%), T<sub>24</sub> (12.75%) and T<sub>6</sub>(11.87%).

## **Effect on growth characters**

The treatments containing Zn +2, 4-D, Fe+2, 4-D and Zn +Fe+2, 4-D might have caused synergistic effect on the activity of cell division and cell elongation at cellular level causing enhanced height in treated plants. Similarly the treatment of Zn +Fe+GA<sub>3</sub> had also shown similar trend for increasing the plant height. All these positive results may be the outcome of growth regulators like GA<sub>3</sub> and auxin, as their role in cell division, elongation and growth (Singh and Tiwari, 1995; Singh *et al.*, 1995).

The experimental results clearly indicated that application of GA<sub>3</sub> at different concentrations was very effective to enhance all the growth parameters like plant height, number of leaves per plant, number and height of scapes etc. (Mandal *et al.*, 2003; Thapa *et al.*, 2005).

## **Effect on yield and yield attributes**

The soil application of Zn with organic manure emerged as superior treatment. The

previous studies have reported increase in bulb weight by the application of combination with FYM, NPK and micronutrients, the influence of IAA, IBA and GA<sub>3</sub> on yield and bulb weight in onion (Bahadur and Maurya, 2001).

Micronutrients like zinc requires for activation of different enzymes. It plays important role in biosynthesis of hormones and chlorophyll. The action of micronutrients and bio regulators might be involved in various metabolic processes leading to improved growth, yield attributes and bulb yield in onion (Attia, 2001; Singh *et al.*, 2002 and Yadav and Yadav, 2002). Auxin and gibberellins both are involved in signal transduction pathways (Venis *et al.*, 1996; Steffens *et al.*, 2001), which then initiate the gene expression leading to stimulation in various activities involved in improvement of yield attributes and yield. The treatments of micronutrients, bio regulators along with FYM might be responsible for increasing the chlorophyll content and thereby photosynthetic rate, which usually cause increase in the yield. Manipulation of source (leaf) and sink (bulb) relationship through the above treatments may be the principal reason for yield improvement. Higher yield in many crops has so far been achieved mainly through the judicious applications of various plant growth regulators (Raghava, 2003). The beneficial impact of micronutrients, bio regulators, bio fertilizers, vermicompost and organic manures showed when applied separately or in combinations.

### **Mineral contents of bulbs**

The all treatments showed mixed response on mineral contain of bulbs. The overall improvement in mineral content of onion bulbs recorded in the present investigation might be due to favorable soil, water and

other conditions prevailing after the application of FYM, micronutrients and bio regulators etc. (Bhonde *et al.*, 1995; Mukesh Kumar and Das, 1999) The application of FYM, cow dung slurry might be responsible for maintaining the soil fertility, micro flora, water, PH, EC and other physical as well as physiological characters. All such favorable condition might have helped to stimulate the uptake and availability of various mineral nutrients for the plant. This was reflected in to improved mineral contents of onion bulbs. The application of bio regulators and micronutrients might have caused healthy and vigorous root growth in onion throughout out the life cycle of plant. These mineral nutrients during leaf senescence and neck fall at might be translocated very effectively from leaves in to the bulbs during bulb curing. The foliar application of PGRs thus stimulates the downward translocation of mineral constituents in to bulbs. Improvement in mineral nutrient status of bulbs concomitantly improves their nutrient value and TSS as well as dry matter and yield (Jayathilake *et al.*, 2003 and Yadav *et al.*, 2005).

The improvement in nitrogen content may directly or indirectly cause increase in protein and amino acid content of bulbs. Improvement in P might be contributing to towards significant enhancement in total sugars; carbohydrates etc. increased potassium content in bulbs may play a major role in providing disease resistant to bulb during storage. It is also claimed that K stimulate phenol synthesis and accumulation. These phenol act as defiance compound as they have anti fungal and anti bacterial activity. Sulphur as essential role in governing the bulb pungency, which is correlated with bulb quality. Similarly the other mineral nutrients like zinc, copper, manganese and iron are involved in several enzymatic reactions, which control many biosynthetic pathways. Thus the overall increase in macro

and micronutrients of bulbs had multifarious and diversified benefits related to bulb yield quality and storage ability.

**Biochemical constituents of bulbs**

Significantly increase in total reducing and non-reducing sugars in onion bulbs with the application of different types of organic manures, bio regulators and recommended doses of NPK along with micronutrients. These parameters contribute to TSS and dry matter content as well as storage potential of the bulbs (Parmar, 2003; Ghorbanli and Sar, 2003).

The accumulation of total reducing and non reducing sugars in bulbs due to the treatments of GA<sub>3</sub>, 2,4-D, cow dung, FYM, Zn and Fe clearly indicated the stimulated synthesis of carbohydrates due to application of all above treatments. The auxin as well as gibberellins along with micronutrients applications might have initially stimulated the activities of sucrose syntheses, sucrose phosphate syntheses resulting in to higher accumulation of carbohydrates in the bulbs. The other possible reason for enhance carbohydrates in the bulbs may be due to efficient, effective and stimulated translocation of carbohydrates reducing and non reducing sugars from leaves to the bulb. After harvest the bulbs undergo curing in the field for one week, during this time the carbohydrates as well as mineral nutrients and other chemical constituents,

which are locked in the leaves, are released or translocated in onion bulbs resulting in to their accumulation. The sugars in the bulbs undergo degradation producing reducing sugars due to stimulated activity of enzyme invertase.

**Amino acids**

The overall results on amino acids in bulbs indicated that the treatments of PGRs along with micronutrients might have stimulated the bio synthetic path ways and overall process of amino acids synthesis. The increase in amino acid contain in the bulbs will favour protein synthesis and its accumulation in the bulbs.

**Phenols**

The phenolic content are important in onion bulbs which provide disease resistance to the bulb during storage, she had reported increase in protein, sugars and phenols in the bulbs of variety N-2-4-1(Parmar, 2003, Yadav *et al.*, 2004). Phenolic compounds bound to cell walls could be indirectly responsible for the resistance to pathogenic fungi, since they result in increased resistance by the cell wall to the action of digestive enzymes. The stimulated synthesis of phenols which are the important defense compounds might be providing very high resistance to fungal pathogen during storage; this will avoid rotting and storage losses of bulbs.

**Table.1** Soil property of experimental plot

Sr, No.	Particular	Value	Sr, No.	Particular	Value
01	PH	8.75	09	Magnesium (ppm)	1350
02	E.C ( DSm <sup>-1</sup> )	0.12	10	Sulfur (ppm)	410
03	CaCO <sub>3</sub> (%)	14	11	Iron (ppm)	1.30
04	Organic carbon (%)	0.70	12	Manganese (ppm)	4.02
05	Nitrogen (ppm)	114	13	Zinc (ppm)	1.10
06	Phosphorus (ppm)	53	14	Copper (ppm)	4.52
07	Potassium (ppm)	280	15	Sodium (ppm)	650
08	Calcium (ppm)	7450			



**Table.2** Effect of micronutrients, growth regulators and organic manures on growth and yield parameters of onion (*Allium cepa* L.) (Pooled value of two years)

Treatments	Plant Height(cm)	Number of Leaves	Polar Diameter (cm)	Equatorial Diameter (cm)	Weight of Bulb (gm)	Yield T/ha
T <sub>1</sub> Zn+CD	64.57	15.44	46.32	55.37	77.80	48.20
T <sub>2</sub> Fe+CD	69.60	15.40	45.16	55.57	72.51	44.72
T <sub>3</sub> Zn+Fe+CD	66.34	15.05	42.04	60.63	71.10	40.21
T <sub>4</sub> Zn-Soil	65.70	13.92	40.06	52.03	66.61	34.14
T <sub>5</sub> Fe-Soil	66.57	14.24	44.35	54.19	68.57	39.36
T <sub>6</sub> Zn+Fe+Soil	65.44	14.17	41.68	54.16	66.49	39.05
T <sub>7</sub> Zn+FYM	67.24	13.90	40.93	54.02	63.85	38.20
T <sub>8</sub> Fe+FYM	67.37	13.37	42.74	54.65	58.07	34.35
T <sub>9</sub> Zn+Fe+FYM	66.60	13.34	40.49	55.38	65.44	38.78
T <sub>10</sub> Zn	67.50	13.34	41.22	51.97	68.84	38.09
T <sub>11</sub> Fe	64.97	13.50	42.54	54.62	71.11	41.24
T <sub>12</sub> Zn+Fe	70.87	12.99	43.67	50.27	77.15	46.27
T <sub>13</sub> Zn +GA <sub>3</sub>	72.04	14.14	41.09	51.34	61.63	33.93
T <sub>14</sub> Fe +GA <sub>3</sub>	64.27	13.64	42.87	51.21	61.19	34.67
T <sub>15</sub> Zn +Fe +GA <sub>3</sub>	66.30	13.34	41.98	54.84	58.73	35.08
T <sub>16</sub> Zn+ Amino acids	64.74	12.45	43.99	57.92	75.50	45.85
T <sub>17</sub> Fe+ Amino acids	66.87	13.37	41.76	54.29	63.96	36.00
T <sub>18</sub> Zn+Fe+ Amino acids	65.12	12.97	43.02	57.30	68.52	38.07
T <sub>19</sub> Zn+2-4-D	72.64	15.70	45.35	52.05	58.03	32.34
T <sub>20</sub> Fe+2-4-D	71.64	14.99	42.67	53.65	60.87	32.00
T <sub>21</sub> Zn+Fe+2-4-D	71.42	13.40	43.49	50.57	71.53	40.76
T <sub>22</sub> Zn+FAS	64.57	12.44	43.14	51.08	68.63	38.14
T <sub>23</sub> FAS	65.70	13.00	43.58	52.28	63.59	36.48
T <sub>24</sub> Multiplex	68.60	13.30	44.88	56.56	72.16	43.91
T <sub>25</sub> NPK	63.90	13.06	42.80	52.56	62.56	29.85
T <sub>26</sub> Only FYM	67.55	13.40	40.81	52.37	63.61	36.91
T <sub>27</sub> Control	52.50	6.93	38.97	46.13	40.37	25.18
S.Em ±	0.86	0.43	0.93	1.27	1.03	2.49
C.D. (P=0.05)	2.48	1.20	2.71	3.56	2.89	7.24

C.V.%	3.26	8.00	3.59	5.81	3.61	4.89
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**Table.3** Effect of micronutrients, growth regulators and organic manures on mineral components of onion (*Allium cepa* L.) (Pooled value of two years)

Treatments	N (%)	P (%)	K (%)	S (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
T <sub>1</sub> Zn+CD	2.56	0.27	1.57	0.77	48.80	8.80	53.90	23.00
T <sub>2</sub> Fe+CD	2.08	0.33	1.52	0.87	94.30	14.30	23.40	9.00
T <sub>3</sub> Zn+Fe+CD	2.50	0.30	1.53	0.88	95.20	14.50	29.20	18.20
T <sub>4</sub> Zn-Soil	2.01	0.21	1.33	0.59	35.20	13.50	36.80	15.00
T <sub>5</sub> Fe-Soil	1.84	0.14	1.75	0.66	68.90	13.60	28.80	12.30
T <sub>6</sub> Zn+Fe+Soil	2.50	0.10	1.72	0.74	93.00	14.30	58.40	14.70
T <sub>7</sub> Zn+FYM	2.84	0.21	1.95	0.67	28.80	10.20	48.90	15.00
T <sub>8</sub> Fe+FYM	3.08	0.16	1.98	0.80	32.80	18.30	23.70	14.30
T <sub>9</sub> Zn+Fe+FYM	2.58	0.11	1.92	0.80	57.80	23.50	23.90	15.80
T <sub>10</sub> Zn	2.08	0.24	1.88	0.54	38.90	14.30	43.50	17.30
T <sub>11</sub> Fe	1.90	0.15	1.54	0.65	85.00	13.60	22.50	16.50
T <sub>12</sub> Zn+Fe	3.56	0.12	1.76	0.62	63.50	12.80	58.60	17.00
T <sub>13</sub> Zn +GA <sub>3</sub>	2.56	0.16	1.41	0.53	68.40	12.07	48.80	6.30
T <sub>14</sub> Fe +GA <sub>3</sub>	5.40	0.10	1.57	0.57	84.00	21.60	28.90	14.30
T <sub>15</sub> Zn +Fe +GA <sub>3</sub>	2.46	0.08	1.33	0.62	95.40	11.50	22.20	12.00
T <sub>16</sub> Zn+ Amino acids	2.23	0.17	1.75	0.63	34.80	14.00	54.20	25.00
T <sub>17</sub> Fe+ Amino acids	2.15	0.13	1.54	0.56	45.10	13.00	25.60	19.00
T <sub>18</sub> Zn+Fe+ Amino acids	2.60	0.19	1.43	0.67	75.00	14.50	24.30	5.00
T <sub>19</sub> Zn+2-4-D	1.96	0.15	1.78	0.48	32.50	14.00	47.60	14.00
T <sub>20</sub> Fe+2-4-D	1.96	0.19	1.38	0.53	56.40	17.30	23.10	17.00
T <sub>21</sub> Zn+Fe+2-4-D	1.99	0.19	1.25	0.53	85.50	22.50	35.50	14.85
T <sub>22</sub> Zn+FAS	1.95	0.12	1.52	0.66	99.50	18.60	45.00	16.50
T <sub>23</sub> FAS	1.95	0.15	1.59	0.66	94.50	17.50	28.50	17.20
T <sub>24</sub> Multiplex	2.64	0.08	1.64	0.65	80.80	12.30	28.40	9.10
T <sub>25</sub> NPK	1.75	0.12	1.60	0.58	30.50	18.30	28.00	15.00
T <sub>26</sub> Only FYM	1.56	0.14	1.51	0.54	39.70	10.00	23.60	7.00
T <sub>27</sub> Control	1.10	0.07	1.14	0.47	28.50	5.80	13.50	4.80
S.Em ±	0.18	0.02	0.05	0.04	6.111	0.70	0.74	0.58
C.D. (P=0.05)	0.54	0.053	0.14	0.12	17.085	2.04	2.06	1.69
C.V.%	10.99	14.24	5.53	11.31	23.84	7.48	5.05	6.50

**Table.4** Effect of micronutrients, growth regulators and organic manures on biochemical components of onion (*Allium cepa* L.) (Pooled value of two years)

Treatments	Total Sugar (%)	Reducing Sugar (%)	Non Reducing Sugar (%)	Total Amino Acid (%)	Phenol (%)
T <sub>1</sub> Zn+CD	8.39	5.04	3.35	2.62	5.59
T <sub>2</sub> Fe+CD	9.31	8.81	0.50	1.39	7.02
T <sub>3</sub> Zn+Fe+CD	10.63	7.40	3.23	1.39	7.08
T <sub>4</sub> Zn-Soil	10.53	8.68	3.61	2.60	4.90
T <sub>5</sub> Fe-Soil	9.41	7.97	1.44	3.02	6.27
T <sub>6</sub> Zn+Fe+Soil	17.81	8.25	9.56	2.49	11.87
T <sub>7</sub> Zn+FYM	17.44	9.13	8.31	2.57	11.63
T <sub>8</sub> Fe+FYM	11.30	8.38	2.92	1.33	7.53
T <sub>9</sub> Zn+Fe+FYM	10.60	7.73	2.87	2.59	5.73
T <sub>10</sub> Zn	15.62	9.67	5.95	2.84	10.41
T <sub>11</sub> Fe	9.50	7.43	2.07	2.73	9.40
T <sub>12</sub> Zn+Fe	8.65	5.87	2.78	1.38	5.77
T <sub>13</sub> Zn +GA <sub>3</sub>	21.43	7.81	13.63	1.31	14.29
T <sub>14</sub> Fe +GA <sub>3</sub>	10.89	8.81	2.08	1.38	7.26
T <sub>15</sub> Zn +Fe +GA <sub>3</sub>	15.22	11.61	3.61	2.55	10.15
T <sub>16</sub> Zn+ Amino acids	9.32	7.46	1.86	2.51	6.22
T <sub>17</sub> Fe+ Amino acids	29.66	8.81	20.85	1.31	26.44
T <sub>18</sub> Zn+Fe+ Amino acids	8.90	6.31	2.59	1.50	5.93
T <sub>19</sub> Zn+2-4-D	11.96	9.88	2.09	1.48	7.98
T <sub>20</sub> Fe+2-4-D	11.29	10.03	1.26	1.32	6.86
T <sub>21</sub> Zn+Fe+2-4-D	14.03	9.32	4.71	1.41	9.35
T <sub>22</sub> Zn+FAS	23.35	9.68	13.67	3.89	15.57
T <sub>23</sub> FAS	10.48	8.52	1.96	2.30	6.99
T <sub>24</sub> Multiplex	19.12	9.33	9.80	2.70	12.75
T <sub>25</sub> NPK	9.50	8.95	0.55	1.39	6.07
T <sub>26</sub> Only FYM	14.69	7.35	7.33	1.41	9.79
T <sub>27</sub> Control	7.35	3.73	1.85	1.28	4.87
S.Em ±	0.582	0.281	0.71	0.15	0.52
C.D. (P=0.05)	1.692	0.791	2.05	0.44	1.51
C.V.%	6.075	8.19	22.41	18.07	6.90

The phenolic compounds are derived from primary metabolites like carbohydrates and sugars through different path ways like shikimic acid, malonic acid and acetyl CoA path ways (Taiz and Zeiger, 2003). In the present investigation accumulation of carbohydrates and sugar is recorded which might be contributing to enhance synthesis of phenols, which might be involved in defense mechanism.

The overall improvement in inorganic and bio chemical constituents like total, reducing and non reducing sugars, amino acids will finally improve the nutrient quality of bulb, storage quality along with export quality.

In conclusion, micronutrients, Bio regulators are of growing importance in crop nutrition because of: increased demand from higher yielding crops and intensive cropping; continued expansion of cropping onto marginal land with low levels of micronutrients. In addition there is an emerging shift in emphasis from the role of micronutrients in crop production, The treatment soil application of zinc with cow dung slurry emerged as the best one for number of leaves per plant, polar diameter of bulb, bulb weight, yield, TSS and mineral components of bulb. Amongst the micronutrients zinc in combination with organic manure and PGRs proved to be highly effective for overall improvement in onion.

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