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Original Research Article

Effect of Organic and Inorganic Sources of Nutrients Along with Foliar Application of Amino Acid and Potassium on Yield and Quality of Onion

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A B S T R A C T

Field experiment was conducted in *Rabi* season of 2014 at Weed Science Research Center, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani entitled "Effect of organic and inorganic sources of nutrients along with foliar application of amino acid and potassium on yield and quality of onion". The experiment was laid out in Randomized Block Design with seven treatments and replicated thrice. The yield of onion varied significantly due to application organic and inorganic sources of nutrients along with foliar application of amino acid and potassium. Application of 100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha-1 + zinc sulphate 20 kg ha-1 + foliar application of amino acid @ 150 ppm + foliar application of gluco- potash @ 3 ml per litter (T_6) recorded significantly highest TSS, Reducing sugar, non-reducing sugar, available nitrogen, phosphorus, potassium and sulphur at harvest. Similarly, the highest value of available micronutrients (Cu, Fe, Mn and Zn) were recorded with the application of 100 per cent RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150 ppm + foliar application of gluco- potash @ 3 ml per litter followed by treatment T_5.

Keywords

Amino Acid and Potassium on Yield and Quality of Onion

Introduction

Onion (*Allium Cepa* L.) is one of the most important commercial vegetable crop cultivated extensively in India and it belongs to family *Alliaceae.* Onion is liked for its flavour and pungency which is due to presence of a volatile oil "Allyl propyl disulphide" an organic compound rich in sulphur. Onion bulb is rich source of mineral like phosphorus, calcium and carbohydrates and also contains pralines and Vit C. It is also known for good medicinal value, which contains several anti-cancer agents which help to prevent the cancer. Onion is an important vegetable crop in all continents commercially cultivated over hundred countries of the world. However about three fourth of global production of vegetable crop is accounted by 18 countries, important of which are China, India, USA, USSR, Japan, Spain, Turkey, Brazil, Iran, (Anonymous, 1991). Onion falls second only to tomato in terms of annual world production.

In the world, area under onion is 4.30 million hectare with 83.35 million metric tons production in respect to 19.4 MT/ha productivity. In India, onion is grown on

1.05 million hectare accounting for 16.81 million metric tones of bulb production with 16.00 MT/ha productivity. Contribution of India in onion production in the world is around 20.2 per cent and Maharashtra is leading state in onion production in India, accounting 0.26 million hectare area and 4.66 million metric tons of total onion production and productivity of 17.9 MT/ha. (Anonymous, 2013). The contribution of Maharashtra in onion production in India is 28 per cent, and specific pocket area of onion production are Nasik (Lasalgaon), Nagar (Karjat), Pune, Solapur, Satara, Dhule and Jalgaon districts on commercial scale. Nasik is the leading district for production of onion in the country. The export of onion from India by the year 2012-13 was 1.66 million MT in the valued 0.20 million. (Anonymous, 2013).

The low productivity of onion in the world is attributed to fluctuations in climatic conditions, incidence of pest and diseases, lack of knowledge about improved technology and improved variety, frequent production on the same area of land without application of organic fertilizers, that had affect the soil health.

Agriculture production is a very intensive business and is related to better quality and better yield leading to better profitability, and every farmer's dream to achieve this goal. However to achieve this goal with advanced technology, use of fertilizer and pesticide in not adequate. Now it is the time to look at bioenergetics and biochemical aspects of plants, to achieve the goal of farmer.

The requirement of amino acids to plant in essential qualities is well known as a means to increase yield and overall quality of crop. The application of amino acids for foliar use is based on its requirement by plants in general and at critical stages of the growth period in particular. Plant absorbs amino acids through stomas and is proportional to environment temperature. Amino acids are fundamental ingredients in the process of protein synthesis and studies have proved that, it can directly or indirectly influence the physiological activities of the plants. Amino acids are also supplied to plant by incorporating them into soil. It helps in improving the micro flora of the soil thereby facilitating the assimilation of nutrients. Foliar nutrition in the form of protein hydrolysate (known as amino acids liquids) spray provide readymade building blocks for protein synthesis.

Khalil *et al.,* (2008) noticed that, the foliar spray of both amino acid and micronutrient together on onion plants could improve the onion yield and its quality components. Potassium foliar spray increases plant growth, yield and quality of onion. The fact mentioned above and considering the need of our present investigation was initiated to determine the growth, yield and quality of onion. The study was also aimed for observing the different quality characteristics like bulb size, bulb weight, yield, TSS and sugars of onion.

Materials and Methods

The experiment was carried out at Weed Science Research Center, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani during *Rabi* 2014. The experiment was laid out in Randomized Block Design with seven treatments i.e.T_1:100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer, T_2: 8 t FYM ha^{-1}, T_3: 50% RDF through chemical fertilizer + 4 t FYM ha^{-1}, T_4: 100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1}+ Zinc sulphate 20 kg ha^{-1}, T_5:100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid, T_6: RDF 100% through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per litter, T_7: Control and replicated thrice. Geographically, Parbhani district is situated at Godawari drainage basin in the Central part of the India between 76° 16' East longitude and 19° 16' North latitude having elevation of 408.46 on above the mean sea level.

The main rivers flowing in the district are Godawari, Purna and Dudhana. The Parbhani district falls under semi-arid tropical climate. The average rainfall of the district is 830 mm and mostly concentrated monsoon received particularly from June to October. Maximum rainfall occurs in the month of July and August. The annual maximum temperature ranged from 29.1 to 41.1 °C and minimum temperature ranged from 12.1 to 24.5 °C in the month of May and December respectively.

The minimum and maximum relative mean humidity varied between 25 to 63 and 85 to 96 per cent, respectively. The months July, August and September are humid and rest of the period is dry. Parbhani district grouped under assured rainfall zone.

The soil pH was 8.25, Ec 0.34 (dSm^{-1}), calcium carbonate 66.50 g kg^{-1}, organic carbon 5.40 g kg^{-1}, available N 160.00 kg ha^{-1}, available P_2o_5 14.50 kg ha^{-1}, available K_2o 325.00 kg ha^{-1}, available S 9.80 mg kg^{-1} and DTPA extractable micronutrients of soil were *viz.*, Fe, Mn, Zn and Cu 4.28, 7.14, 0.59 and 2.45 mg kg^{-1} respectively. Thus the soil was clayey in texture, moderately alkaline in reaction, low in available N, P, S and DTPA extractable Zn and sufficient in available potassium.

Results and Discussion

Bulb yield

Data reported in Table 1 indicated that, the influence of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on bulb yield of onion was significantly influenced due to variation in combination of treatments and it was ranged from 81.67 to 187.67 q ha^{-1} and highest bulb yield was recorded in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150 ppm + foliar application of gluco potash @ 3 ml per liter) and it was at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}). The lowest bulb yield was observed in control (T_7). The increased bulb yield was a direct result of improvement in yield component i.e. diameter of bulb. This might be due to organic and inorganic nutrient sources and foliar application of amino acid and potassium thereby increased in yield. The overall improvement in plant growth parameters and yield was due to application of amino acid and potassium through foliar, which provides readily source of growing substances and form the constitutes of protein in the living tissues. El-Abagy *et al.,* (2014) and Damse *et al.,* (2014) also reported that, the use of organic and inorganic nutrient sources reflects in higher yield of garlic. The increase in yield may be due to the role of nitrogen in chlorophyll formation, enzymes and proteins synthesis and the role of phosphorus on root growth development, phosphoproteins and phospho-lipids formation. The role of moderate dose of sulphur was found to be responsive in diameter and weight of bulbs which was significantly higher with the application of S up to 24 kg ha^{-1} (Ahmed *et al.,* 1988). Similar results was also reported by shafeek *et al.,* (2012) in onion crop with amino acids application.

Straw yield

The data reported in Table 1 indicated that, the dry matter yield of onion ranged between 14.07 to 23.75 q ha^{-1}. The highest dry matter yield was observed in the treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco- potash @ 3 ml per liter) and it was at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and lowest dry matter yield was recorded in treatment T_7 (control). These findings might be due to involvement of nutrients in physiological and biochemical processes culminating in more dry matter production. More than one foliar spray of different amino acid and potassium products at various growth stages improved straw yield, as reported earlier by Mohamed *et al.,* (2012).

Total soluble solid (T.S.S.)

Data furnished in Table 2 indicated that, the TSS content of bulb (B^0) was in the range of 10.84 to 13.77 B^0 and highest TSS was recorded in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco- potash @ 3 ml per liter) which was at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}). The lowest TSS value was recorded in treatment T_7 (control).

Combination of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium were found beneficial in increasing total soluble solids over no application of fertilizers and organic sources. This may be due to the known fact that, organic and inorganic nutrient sources are capable for supplying adequate macro and micro nutrients and foliar application of amino acid and potassium which plays major role in quality improvement through desirable enzymatic changes took place during entire plant growth. The results are in consequences with the findings of Singh *et al.,* (2005), Patel *et al.,* (2008), Ghoname *et al.,* (2007) and Kandil *et al.,* (2013) in onion.

Sugar content

The data on reducing sugar, non-reducing sugar and total sugar content in onion bulb as influenced by organic and inorganic nutrient sources along with foliar application of amino acid and potassium are presented in Table 3. The treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150 ppm + foliar application of gluco-potash @ 3 ml per liter) showed significantly highest (3.94, 3.80 and 7.72 %) reducing sugar, non-reducing sugar and total sugar respectively. These values were at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate

20 kg ha^{-1} + foliar application of amino acid). The lowest values were recorded with treatment T_7 (control). It could be due to readily available of major nutrients in RDF and elemental sulphur and micronutrient through $Znso_4$ and foliar application of amino acid and potassium which combinely increased metabolism activity in plant and reflected in increasing sugar content. These results are in consequence with the finding of Kandil *et al.*, (2013).

Soil pH

The data pertaining to soil pH is reported in Table 4. The initial soil pH value was 7.82. The range of soil pH at harvest of onion in different treatments were varied from 7.62 to 7.81. The soil pH value did not influenced significantly with the application of organic and inorganic nutrient sources and foliar sprays of amino acid and potassium.

Electrical conductivity

The data on electrical conductivity of soil at harvest of onion is reported in Table 4. The initial value of electrical conductivity of soil was 0.52 dSm^{-1} and it was observed that, the electrical conductivity of soil varied between 0.42 to 0.49 dSm^{-1}. The value of electrical conductivity in soil did not influenced significantly with the application of organic and inorganic sources of nutrient along with foliar sprays of amino acid and potassium and the result were statistically non-significant.

Organic carbon

Organic carbon content in soil after harvest of onion is furnished in Table 4. The organic carbon content in soil varied from 0.50 to 0.56 per cent. The highest organic carbon content at harvest (0.56 %) was observed in soil under treatment T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and lowest organic carbon (0.50 per cent) was recorded in treatment T_7 (control). The results obtained from statistical analysis were found to be non-significant.

Calcium carbonate

The data on calcium carbonate content in soil after harvest of onion is presented in Table 4. The calcium carbonate content varied from 4.10 to 4.47 per cent. The calcium carbonate content in soil was found highest in treatment T_7 (control) while lowest calcium carbonate content was recorded in treatment T_1. The results obtained from statistical analysis were found to be non-significant. Similar findings were also reported by Shinde *et al.*, (2013).

Nitrogen

The data pertaining to available nitrogen in soil is reported in Table 5. Initial status of available nitrogen in soil was 160.00 kg ha^{-1}. It was observed that, the available nitrogen content in soil at harvest stage of onion was varied in the range of 190.08 to 227.19 kg ha^{-1} and highest available nitrogen content at harvest stage was observed in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco-potash @ 3 ml per liter) followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and T_3 (50 % RDF through chemical fertilizer + 4 t FYM ha^{-1}) which were statistically at par with each other and lowest nitrogen content was noticed in treatment T_7 (control).

Table.1 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on straw and bulb yield of onion (q ha^{-1})

Tr. No.	Treatment	Bulb yield (q ha^{-1})	Straw yield (q ha^{-1})
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	118.21	15.00
T2	8 t FYM ha^{-1}	90.33	14.28
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	162.53	17.08
T4	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	170.37	21.28
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	181.44	22.79
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	187.67	23.75
T7	Control	81.67	14.07
	SE(m) ±	6.89	1.00
	CD (0.05)	20.80	3.01

Table.2 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on TSS (B^0) content of onion bulb

Tr. No.	Treatment	TSS (B^0)
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	11.68
T2	8 t FYM ha^{-1}	10.99
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	11.61
T4	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	12.99
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	13.10
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	13.77
T7	Control	10.84
	SE(m) ±	0.26
	CD (0.05)	0.80

Table.3 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on reducing sugar, non-reducing sugar and total sugar in onion bulb

Tr. No.	Treatment	Reducing sugar (%)	Non reducing sugar (%)	Total sugar (%)
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	2.44	3.58	6.02
T2	8 t FYM ha^{-1}	2.35	3.30	5.65
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	2.80	3.36	6.16
T4	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	2.80	3.72	6.52
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	3.83	3.76	7.59
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	3.94	3.80	7.72
T7	Control	2.09	2.44	4.53
	SE(m) ±	0.06	0.06	0.09
	CD (0.05)	0.19	0.18	0.27

Table.4 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on pH, EC, Organic carbon and $CaCo_3$ of soil at harvest of onion

Tr. No.	Treatment	pH	EC (dSm^{-1})	Organic carbon (%)	$CaCo_3$ (%)
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	7.63	0.42	0.54	4.10
T2	8 t FYM ha^{-1}	7.62	0.48	0.55	4.17
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	7.70	0.46	0.53	4.20
T4	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	7.81	0.49	0.56	4.47
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	7.70	0.46	0.53	4.33
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	7.71	0.44	0.51	4.37
T7	Control	7.75	0.47	0.50	4.47
	SE(m) ±	0.04	0.01	0.01	0.09
	CD (0.05)	NS	NS	NS	NS

Table.5 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on available Nitrogen, Phosphorus, Potassium and Sulphur of soil at harvest of onion

Tr. No.	Treatment	N (kg ha^{-1})	P_2o_5 (kg ha^{-1})	K_2o (kg ha^{-1})	S (mg kg^{-1})
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	223.38	13.96	680.46	12.82
T2	8 t FYM ha^{-1}	208.94	10.43	562.69	10.57
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	222.87	11.37	573.65	12.62
T4	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	225.04	14.17	682.79	15.88
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	225.21	14.37	682.69	15.62
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	227.19	14.46	683.22	15.78
T7	Control	190.08	9.77	531.38	9.25
	SE(m) ±	5.44	0.35	11.18	0.36
	CD (0.05)	16.42	1.08	33.78	1.11

Table.6 Effect of organic and inorganic sources of nutrient along with foliar application of amino acid and potassium on available Cu, Fe, Mn and Zn (mg kg^{-1}) of soil at harvest of onion

Tr. No.	Treatment	Cu (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})
T1	100% RDF (100:50:50 NPK kg ha^{-1}), through chemical fertilizer	1.82	3.95	13.05	0.66
T2	8 t FYM ha^{-1}	1.69	3.75	12.03	0.61
T3	50% RDF through chemical fertilizer + 4 t FYM ha^{-1}	1.82	3.81	13.01	0.69
T4	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1}	1.82	3.98	13.48	0.75
T5	100% RDF through chemical fertilizer + Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid	1.85	3.98	13.60	0.75
T6	100% RDF through chemical fertilizer+ Elemental sulphur 25 kg ha^{-1} + Zinc sulphate 20 kg ha^{-1} + Foliar application of amino acid @150ppm + foliar application of gluco- potash @ 3 ml per liter	1.89	4.26	13.82	0.79
T7	Control	1.63	3.73	11.31	0.60
	SE(m) ±	0.04	0.10	0.32	0.02
	CD (0.05)	0.14	0.31	0.98	0.05

This may be due to addition of N through inorganic source pool which turn leads fo availability of nitrogen in soil. Similar findings were also reported by Chauhan *et al.,* (2011).

Phosphorus

The data pertaining to available phosphorus in soil is reported in Table 5. Initial status of available phosphorus in soil was 14.50 kg ha^{-1}. It was observed that, the available phosphorus content in soil at harvest of onion was varied in the range of 9.77 to 14.46 kg ha^{-1}. The highest available phosphorus content (14.46 kg ha^{-1}) was observed in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150 ppm + foliar application of gluco-potash @ 3 ml per liter) followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and these treatments were at par with each other and lowest phosphorus (9.77 kg ha^{-1}) was noticed in treatment T_7 (control). The increase in available phosphorus content of soil was due to the direct addition of P as well as solubilization of native P through organic acids. Similar improvement in available phosphorus status was noticed due to integrated use of manures and fertilizers has been noted by Sharma *et al.,* (2009)

Potassium

The data pertaining to available potassium in soil is reported in Table 5. Initial status of available potassium in soil was 325.00 kg ha^{-1}. It was observed that, the available potassium content in soil at harvest of onion varied in the range of 531.38 to 683.22 kg ha^{-1}. The highest available potassium content (683.22 kg ha^{-1}) was observed in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco- potash @ 3 ml per liter) followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) which were at par with each other and lowest potassium (531.38 kg ha^{-1}) content was found in treatment T_7 (control). The beneficial effect of foliar spray of potassium on availability K in a soil due the plant required K is readily available through the foliar application of potassium. Similar results were reported by Ghoname *et al.,* (2007). Sharma *et al.,* (2009) also reported that, the beneficial effect of direct potassium addition on residual increase in available potassium from soil.

Sulphur

The data pertaining to available sulphur in soil is reported in Table 5. Initial status of available sulphur in soil was 9.80 mg kg^{-1} and available sulphur content in soil at harvest stage of onion ranged between of 9.25 to 15.78 mg kg^{-1}. The highest available sulphur content (15.78 mg kg^{-1}) at harvest stage was observed in treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco-potash @ 3 ml per liter) followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and these treatments were at par with each other and lowest S status (9.25 mg kg^{-1}) was found in treatment T_7 (control). Sankaran *et al.*, (2005) reported that, larger fraction of added sulphur was transformed in to extractable form resulted in an increase in available sulphur content in soil due to sulphur application.

Copper

The available Cu status in soil is presented in Table 6. The available Cu content varied from 1.63 to 1.89 mg kg^{-1} after harvest stage of onion. The treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco-potash @ 3 ml per liter) showed significantly higher available copper content (1.89 mg kg^{-1}) in soil followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}). The lowest Cu content was observed in treatment T_7 (control). This may be due to application of inorganic fertilizer with organic sources which are responsible for increasing nutrient use efficiency by the crop and availability of nutrients increased with increasing copper use efficiency. Similar results were also reported by Sharma *et al.*, (2009).

From the results presented in Table 6, it is revealed that, the treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco-potash @ 3 ml per liter) was significantly superior in available Fe content (4.26 mg kg^{-1}) of soil and it was at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}).

The minimum Fe content was noticed in treatment T_7 (control). The different sources of organic and inorganic influenced greatly in improving the available iron status of soil. Similar results are also reported by Sankarn *et al.*, (2005).

Manganese

The available Mn status in soil is presented in Table 6. The available Mn content in soil was varied from 11.31 to 13.82 mg kg^{-1} after harvest stage of onion. The treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150ppm + foliar application of gluco-potash @ 3 ml per liter) showed significantly higher available Mn content (13.82 mg kg^{-1}) followed by treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid), T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}) and T_3 (50 % RDF through chemical fertilizer + 4 t FYM ha^{-1}) and it was at par with each other and lowest Mn content was observed in treatment T_7 (control).

Sharma (2009) *et al.*, reported that, the application of inorganic fertilizer with organic sources which are responsible for increasing nutrient use efficiency by the crop and availability of nutrients increased with increasing nitrogen use efficiency.

Zinc

From the results presented in Table 6, it is revealed that, the treatment T_6 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid @ 150 ppm + foliar application of gluco-potash @ 3 ml per liter) was significantly increased the available Zn content (0.79 mg kg^{-1}) in soil after harvest stage of onion and it was at par with treatment T_5 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1} + foliar application of amino acid) and T_4 (100 % RDF through chemical fertilizer + elemental sulphur 25 kg ha^{-1} + zinc sulphate 20 kg ha^{-1}). The minimum Zn content was noticed in treatment T_7 (control). The availability of zinc was found to be increased due to application of zinc through zinc sulphate as reported by Trivedi and Dhumal (2013).

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