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Effect of micronutrient application on quality and shelf-life of *kharif* onion (*Allium cepa* L.)

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Abstract
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops being grown all over the country. Onion belongs to family 'Amaryllidaceae" and Locally known as Pyaj. The experiment was carried out during *Kharif* season of 2016-2017 at Tirhut College of Agriculture, Dholi kothi farm, Dholi (Muzaffarpur), a campus of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar to study the effect of micronutrient application on quality and shelf-life of kharif onion. The experiment was laid out in RBD design with ten treatments and three replications. Significant observations were recorded for maximum TSS, dry weight of leaves/plant and dry weight of bulb/plant was with treatment T_3 (NPKS + soil application of $ZnSO_4$ @ 50kg/ha). The minimum sugar contains, bulb rotting and physiological loss of weight was recorded with treatment T_5 (NPKS + soil application of Borax @ 10 kg/ha).The lowest sprouting percentage was found in treatment T_3 (NPKS + soil application of $ZnSO_4$ @ 50kg/ha).

Keywords: Onion, RDF, zinc, iron, borax, quality and shelf-life

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops being grown all over the country. It is very useful for human beings because it has several nutritional and medicinal value. Commands extensive markets and rate as an important indispensible item of every kitchen. It has diuretic properties, relieves heat sensation, hysterical faintness, insect bites and is also act as heart stimulant. Application of micronutrients to deficientsoilhas shown remarkable increase in yield of several crops. Micronutrients play an active role in the plant metabolic process from cell wall development to respiration, photosynthesis, chlorophyll formation, enzymes activity, nitrogen fixationetc. Even though, micronutrients are needed by the plants in a minor quantities and present in plant tissue in quantities measured in parts per million but it is involved in a wide variety of metabolic processesand cellular functions within the plants. Also, they work as a co-enzyme for a large number of enzymes. In addition, they play an essential role in improving quality, and highly required for better plant growth and yield of many crops (Ballabh and Rana, 2012) [7]. 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 asgastric, stimulant and promotes digestion. India ranks first in area & second in production. Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Bihar, Andhra Pradesh, Rajasthan, Haryana & Tamil Nadu are the major onion growing states. The total area under production of onion in India during 2016-2017 was 1270.4 thousand ha with 21563.9 thousand MT production and 17.0 MT/ha productivity. However, in Bihar the total area was 54.57 thousand ha with total production 1259.81 thousand MT and productivity 24.1 MT/ha (Anon, 2017). 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. Onion is widely consumed as salad and as culinary purpose for flavoring as spice in pickles & sauce. Onion is an important vegetable cum condiment crop of India. The green leaves, immature and mature bulbs are eaten raw or used in vegetable preparations.

Micronutrients are equally important like macronutrients for crop grow and the development are used in smaller quantities. The micronutrients required by plants are 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 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; in sandy soils micronutrient deficiencies is more than clay soils. Micronutrients also help to increase the efficiency of macronutrients. 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 need, local soil conditions, and the stage of crop growth growing season at which a deficiency is detected (Aske *et al., 2017)* [6]. Fertilizers can increase yield and quality of crop produce. The onion, like any other crops not only needs macronutrients but also micronutrients in adequate and balanced amount. These can be applied singly or mixed with other nutrient too. The use of micronutrients shouldbe made with great caution because of their small amounts needed and interactions with other nutrients. Improvement in onion growth and yield has been reported through micronutrient by many scientists at different types of soils. The purpose of this experiment was to study the effect of micronutrients on quality and storage of onion under calcareous soil of North Bihar In this view the experiment "Effect of Micronutrient Application on Quality and Shelf-life of *Kharif* Onion (*Allium Cepa* L.)''.

Materials and Methods

The experiment was carried out during *Kharif* season of 2016-2017 at Tirhut College of Agriculture Dholi kothi farm, Dholi (Muzaffarpur), a campus of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar. The experiment was laid out in RBD (Randomized Block Design) with ten treatments and three replication.The crop was planted in a plot size (3m × 2m) at a spacing of 15 cm × 10 cm. Before fertilizer application, random soil samples were taken from the experimental fieldand were analysed. The experimental field soil is sandy loam with alkaline pH 8.40, low in soil organic carbon (0.46%), electrical conductivity (0.36 ds m^{-1}), available nitrogen (226 kg/ha), available phosphorus (16.0.9 kg/ha), potash (115.60 kg/ha), available boron (0.26 ppm) and available zinc (0.84 ppm) & available iron (9.06 ppm). The soil is deficient in available boron. Hence the soil and foliar application of micronutrient at 30 & 45 DAT source, zinc sulphate for zinc, borax for boron and ferrous sulphate for iron was used as experimental material and its effect on the quality and shelf-lifeof *kharif* onion. The treatments includes of T_1(NPKS), T_2 (NPKS+ soil application of $ZnSO_4$ @ 25 kg/ha), T_3 (NPKS+ soil application of $ZnSO_4$ @ 50 kg/ha), T_4 (NPKS+ foliar application of $ZnSO_4$ @ 0.5% at 30 & 45 DAT), T_5 (NPKS+ soil application of Borax @ 10 kg/ha), T_6 (NPKS+ soil application of Borax @ 15 kg/ha), T_7 (NPKS+ foliar application of Borax @ 0.25 % at 30 & 45 DAT),T_8 (NPKS+ soil application of $FeSO_4$ @ 25 kg/ha),T_9 (NPKS+ soil application of $FeSO_4$ @ 50 kg/ha), T_{10} (NPKS+ foliar application of $FeSO_4$ @ 1% at 30 & 45 DAT) replicated thrice in RBD. Five plants randomly were selected for each plot taken as a unit of all observation on quality aspect and shelf-life attributes.

Results and Discussion

Qualityparameter includes TSS (%), dry weight of leaves per plant (g), dry weight of bulbs per plant (g), sugar contains (%) and bulb colour were recorded.

Total Soluble Solids (TSS) (%)

The total soluble solids differed significantly due to different treatments. The total soluble solids varied from 7.78 to 13.03 per cent. The highest TSS content (13.03 per cent) was recorded in treatment T_3(NPKS+ Soil application of soil application of $ZnSO_4$ @50 kg/ha) followed by T_2(NPKS+ soil application of $ZnSO_4$ @ 25 kg/ha), while lowest TSS content (7.78 percent) was recorded with T_1 (Control). However, all the micronutrient treatments were found significantly superior over control.The present results corroborate with those of Alam *et al.* (2010) [4], Trivedi and Dhumal (2013) [20], Manna and Maity (2016) [15] and Aske *et al.* (2017) [6] in onion. This might be due to the influence of zinc on photosynthesis, which might induce more starch and sugar production.

Dry weight of leaves (g)/plant

Dry weight of leaves (g)/plantdiffered significantly due to different treatments. The dry matter of leaves ranged from 1.83 to 3.67 g. The highest dry matter of leaves (3.67 g/plant) was observed in treatment T_3 (NPKS+ soil application of $ZnSO_4$ @50 kg/ha) and lowest (1.83 g/plant) was recorded in T_1 (Control). However, all the micronutrient treatments were found significantly superior over control.The present results corroborate with those of Alam *et al.* (2010) [4], Samad *et al.* (2011) [18], Abedin *et al.* (2012) [2], Ballabh and Rana (2012) [7] and Rizk *et al.* (2014) [17] in onion.

Table 1: Effect of micronutrients on quality of *kharif* onion

Treat. Symbol	TSS (%)	Dry weight of leaves (g)	Dry weight of Bulbs (g)	Sugar content (%)
T_1	7.78	1.83	7.33	5.29
T_2	12.54	3.33	13.33	3.14
T_3	13.03	3.67	13.60	3.70
T_4	11.02	2.72	11.33	4.60
T_5	11.81	2.83	12.33	2.82
T_6	12.40	3.07	13.00	3.43
T_7	10.97	2.53	10.83	4.31
T_8	11.43	2.73	11.83	3.29
T_9	11.70	2.75	12.17	3.97
T_{10}	10.93	2.43	10.17	5.14
S.Em±	0.27	0.09	1.09	0.07
C.D (P=0.05)	0.80	0.26	3.28	0.21

Dry weight of Bulbs (g)/plant

The dry matter of bulbs/ plantdiffered significantly due to different treatmentsexcept T_{10}. The dry matter of bulbs/ plant ranged from 7.33 to 13.60 g/bulb.The highest dry matter of bulbs/ plant (13.60 g/plant) was observed in treatment T_3(NPKS+ soil application of $ZnSO_4$ @ 50 kg/ha) followed by T_2(NPKS+ soil application of $ZnSO_4$ @ 25 kg/ha), while lowest (7.33 g/ plant) was recorded in T_1 (Control). The trend was found similar to total bulb yield. The present results corroborate with those of El-Shafie and El-Gamaily (2002), Alam *et al.* (2010) [4], Samad *et al.* (2011) [18], Abedin *et al.* (2012) [2], Ballabh and Rana (2012) [7] and Rizk *et al.* (2014) [17] in onion.

Sugar content (%)

The sugar content differed significantly due to different treatments except T_{10}. The sugar content varied from 2.82 to 5.29 per cent. The lowest sugar content (2.82 per cent)was determined in treatment T_5 (NPKS+ soil application of Borax @ 10 kg/ha) followed by T_2(NPKS+ soil application of $ZnSO_4$ @ 25 kg/ha). The highest sugar content recorded in treatment T_1 (Control).However, all the micronutrient treatments were found significantly superior over control.The some trend observed in all treatment was for TSS.

Bulb Colour

No variation in colour of bulbs due to treatments has been observed.

Shelf-life parameter includes physiological loss of weight (%), bulb rotting (%) and bulb sprouting (%) and data were recorded at 7,14 and 21 DAH.

Physiological loss of weight at 7, 14 and 21 DAH (%)

Physiological loss of weightdiffered significantly due to different treatments except $T_{10.}$ Physiological loss of weight at 7 DAH ranged from 3.29 per cent to 6.70 per cent. The maximum physiological loss of weight (6.70 per cent) was recorded in treatment T_1 (Control) and the minimum (3.29 percent) was observed in T_5 (NPKS+ soil application of Borax @ 10 kg/ha.

Physiological loss of weight differed significantly due to different treatments and loss of weight at 14 DAH ranged from 4.64 per cent to 10.31 per cent. The maximum physiological loss of weight (10.31 per cent) was found in T_1 (Control) and the minimum loss of weight (4.64 per cent) was observed in treatment T_5 (NPKS+ soil application of Borax @ 10 kg/ha). Likewise at 21 DAH ranged from 5.14 per cent to 13.12 per cent. The maximum physiological loss of weight was found in T_1 (Control) and minimum was observed in treatment T_5 (NPKS+ soil application of Borax @ 10 kg/ha) followed by treatment T_2 (NPKS+ soil application of $ZnSo_4$ @ 25 kg/ha). The results were corroborate with those of Mukesh *et al.* (1998), Abdel-Fattah *et al.* (2002) [1], Shrinath (2004) [19], El Sayed, Hameda *et al.* (2015), Aske *et al.* (2017) [6] in Onion. The effect of boron on storage quality could be associated with the micronutrient's role in improving calcium accumulation in the bulb. This might be due to effect of calcium in reducing the post-harvest transpiration and respiration in stored bulbs.

Table 2: Effect of micronutrient on shelf life of *kharif* onion

Treat. Symb.	Physiological loss of weight (%)			Bulb rotting (%)			Bulb Sprouting (%)		
	7 DAH	14 DAH	21 DAH	7 DAH	14 DAH	21 DAH	7 DAH	14 DAH	21 DAH
T_1	6.70	10.31	13.12	3.33	13.33	26.67	40.00	60.00	63.33
T_2	4.88	5.18	5.30	0.00	0.00	13.33	7.00	30.00	43.67
T_3	5.28	5.48	5.93	0.00	0.00	17.00	6.67	26.67	36.67
T_4	5.73	6.26	7.40	0.00	0.00	18.33	30.00	43.33	56.67
T_5	3.29	4.64	5.14	0.00	0.00	10.00	26.67	33.33	50.00
T_6	5.28	5.42	5.92	0.00	0.00	16.67	16.67	30.00	46.67
T_7	5.89	7.97	8.14	0.00	0.00	20.00	30.00	46.67	60.00
T_8	5.28	5.26	5.80	0.00	0.00	14.00	30.00	40.00	56.67
T_9	5.51	5.58	6.11	0.00	0.00	18.33	26.67	33.33	53.33
T_{10}	6.38	8.68	8.90	0.00	0.00	21.67	33.33	53.33	60.00
S.Em±	1.15	1.33	1.24	0.11	0.53	2.76	4.66	6.15	7.22
C.D(P=0.05)	0.38	0.44	0.42	0.37	1.58	0.92	1.56	2.05	2.41

Rotting percentage at 7, 14 and 21 DAH

The rotting percentage of bulbs at 7 DAH varied from 0.00 per cent to 3.33 per cent. The maximum rotting percentage recorded in treatment T_1 (Control) and no rotting found in micronutrient treatment.

The rotting percentage of bulbs at 14 DAH varied from 0.00 per cent to 13.33 per cent. The maximum rotting percentage recorded in treatment T_1 (Control). The rotting percent of bulbs was found nil in micronutrient treatment.

The rotting percentage of bulbsdiffered significantly due to different treatments. The rotting percentage of bulbs at 21 DAH varied from 10.00 per cent to 26.67 per cent. The maximum rotting percentage recorded in treatment T_1 (Control) and minimum in treatment T_5 (NPKS+ soil application of Borax @ 10 kg/ha).The present results corroborate with those of Jitendra and Dhankhar (1991) [12], Kumar *et al.* (1998) [14], Shrinath (2004) [19], Aske *et al.* (2017) [6] in Onion. Boron effects on improving the storage quality. The effect of boron on storage quality could be associated with the micronutrient's role in improving calcium accumulation in the bulb. This might be due to effect of calcium in reducing the post-harvest transpiration and respiration in stored bulbs.

Sprouting of bulbs (per cent)

Sprouting percentage of bulbs differed significantly due to different treatments.Sprouting percentage of bulbs at 7 DAH ranged from 6.67 per cent to 40.00 per cent. The maximum sprouting percentage (40.00 per cent) was found in treatment T_1 (Control) and the minimum sprouting percentage was observed in T_3 (NPKS+ soil application of $ZnSO_4$ @ 50 kg/ha) followed by treatmentT_3 (NPKS+ soil application of $ZnSO_4$ @50 kg/ha). Sprouting percentage at 14 DAH varied from 26.67 per cent to 60.00 per cent. The maximum sprouting percentage (60.00 per cent) was found in treatment T_1 (Control) and the minimum sprouting percentage (26.67 per cent) was observed in T_3 (NPKS+ soil application of $ZnSO_4$ @ 50 kg/ha).

Sprouting percentage of bulbs differed significantly due to different treatments.at 21 DAH varied from 36.67 per cent to 63.33 per cent. The maximum sprouting percentage (63.33 per cent) was recorded in treatment T_1 (Control) and the minimum sprouting percentage (36.67 per cent) was observed in T_2 (NPKS+ soil application of $ZnSO_4$ @ 50 kg/ha). The present results corroborate with those of Jitendra and Dhankhar (1991) [12], Mukesh *et al.* (1998) and Shrinath (2004) [19] in onion. Zinc at low concentration could reduce storage sprouting loss. The zinc might have reduced the moisture content and neck thickness and increased the ash content of onion, so that it might have reduced bulb sprouting under storage condition. Zinc might have influenced in reducing the neck thickness, increasing the percentage of dry matter, ash content and metabolite accumulation in bulbs. These improvements in quality parameter of bulb might have reduced the storage loss.

Conclusions

Analysis of variance revealed highly significant difference among the treatments for all the characters studied. Maximum TSS, dry weight of leaves/plant and dry weight of bulbs was recorded in NPKS + soil application of $ZnSO_4$ @ 50kg/ha. Minimum sugar contains, physiological loss of weight and rotting percentage was recorded in NPKS+ soil application of Borax @ 10 kg/ha. Minimum sprouting percentage was observed in NPKS + soil application of $ZnSO_4$ @ 50kg/ha.

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