International Journal of Chemical Studies

**P-ISSN: 2349–8528**
**E-ISSN: 2321–4902**
IJCS 2017; 5(4): 1762-1765

Received: 21-05-2017
Accepted: 22-06-2017

**Manjunath RP**
Department of Vegetable Science, College of Horticulture, UHS Campus, GKVK Post, University of Horticultural Sciences Bagalkot, Karnataka, India

**Vishnuvardhana**
ADRE, Regional Horticultural Research and Extension Centre, UHS Campus, GKVK Post, Bengaluru, Karnataka, India

**Anjanappa M**
Professor and Head Department of Vegetable Science, College of Horticulture, Bengaluru

**Ramegowda GK**
Asst. Prof. of Agril. Entomology, Regional Horticultural Research and Extension Centre, Bengaluru, Karnataka, India

**Anilkumar S**
Asst. Prof. of Soil Science, Regional Horticultural Research and Extension Centre, Karnataka, India

**Prasad PS**
Asst. Prof. of Plant Pathology, Regional Horticultural Research and Extension Centre, Hassan, Karnataka, India

**Correspondence**
**Manjunath RP**
Department of vegetable Science, College of Horticulture, UHS Campus, GKVK Post, University of Horticultural

# Studies on influence of specific micronutrient formulation on grade wise tuber yield and quality in potato (*Solanum tuberosum* L.)

**Manjunath RP, Vishnuvardhana, Anjanappa M, Ramegowda GK, Anilkumar S and Prasad PS**

**Abstract**
A field experiment was conducted at Horticulture Research and Extension Centre (HREC), Somanahallikaval, Hassan during 2016 to study the effect different micronutrients and their formulation on growth, yield and quality of potato (*Solanum tuberosum* L.) Cv Kufri Jyoti. The experiment was conducted with Randomized Complete Block Design with twelve treatments and three replication. In each formulation different concentration of micronutrients were used. The micronutrients and their formulation were sprayed at 30, 45 and 60 days after sprouting of tubers. Among the different formulations, foliar spray of UHSB-3 micronutrient formulation along with RDF recorded significantly highest A grade (>75g) tuber yield per plant (532.15 g), total yield per plant (687.87 g), A grade tuber yield per hectare (16.65 t/ha), total tuber yield per ha (25.18 t/ha), dry matter content (19.76%) and total sugar (0.43%).

**Keywords:** Micronutrients, *Solanum tuberosum*, Dry matter, sugars

## Introduction

Potato is a very popular vegetable grown all over the world and is an important food crop grown in more than 150 countries in the world. Potato *(Solanum tuberosum* L.) is an important food crop after wheat, maize and rice, contributing to food and nutritional security in the world. It is also called as poor man's strength or king of vegetables (Mustafa, 1997) [12].

Potato developed as a temperate crop and was later distributed throughout the world. It was introduced to India by early 17th century probably through British missionaries or Portuguese traders. India is now producing 43.77 million tonnes of potato tubers in an area about 2.13 million hectare. (Anon., 2016) [1].

Nutrient management in potato is very important to achieve optimum yield and quality of tubers. Potato is a plant with high nutrient demands because of forming abundant vegetative mass and a high quantity of tubers per unit area. It is a great consumer of nitrogen, phosphorus, potassium, magnesium and calcium, as well as micro nutrients. High potato yields can only be obtained through the application of optimal nutrient doses in balanced proportions (Poljak *et al*., 2007) [14]. But Indian agricultural production heavily depends on fertilizer application which results in greater rate of nutrient collapse and soil health problems. Regular depletion of nutrient resources from soils has led to emergence of several nutrient deficiencies. Most of the Indian soils are widely deficient in micronutrients especially Zn, Mn, B and Fe. The efficiency of applied inorganic micronutrients is rather low due to their fixation in the soil. However, soil mineral reserves and soil fertilization are not always sufficient to satisfy the needs of crops. Nutritional disorders in potato occur in acidic and alkaline soils. In acidic soils, there is a lack of calcium, magnesium and phosphorus for growing crop and in alkaline soil there is lack of boron, manganese and zinc. The alternative approach is the application of these nutrients to plant leaves and stems through foliar fertilization.

Micronutrients play a very important role in vital processes of plants. They increase the chlorophyll content of leaves, improve photosynthesis which intensify the assimilating activity of the whole plants (Marschner, 1995) [9]. Spray of micro-element solution (B, Cu, Mn, Zn and Mo) on potato leaves increased the uptake of N, P, K; chlorophyll content and photosynthesis in leaves, promoted the tuber expansion and increase potato yield (Meng *et al*., 2004) [10].

Thus micronutrients are important key elements which stimulates the uptake of other primary and secondary nutrients when applied in optimal concentration because of their interaction effect like zinc associated with uptake of phosphorous, iron associated with uptake of copper, copper associated with uptake of zinc and iron associated with uptake of magnesium *etc*. And foliar application of micronutrients readily available to plants moreover easy to apply compared to soil application.

**Material and methods**

The soil of the experimental area was sandy loam having good physical and chemical properties and pH of the soil was 6.2. This experiment was undertaken to find out the best micronutrient formulation to obtain good growth, yield and yield attributes in potato. The design followed was RCBD (Randomized Complete Block Design) with 12 treatments replicated thrice in a plots of 4.2 x 4 m size with 60 x 20 cm spacing during Kharif 2016. The treatments included under the study were, $T_1$ (control)- RDF (FYM 25 t/ha + N:P:K at 75:75:100 kg/ha), $T_2$ - RDF+ Foliar spray of boron at 50 ppm, $T_3$ - RDF+ Foliar spray of zinc 150 ppm, $T_4$ - RDF + Foliar spray of zinc 150 ppm + boron 50 ppm, $T_5$ - RDF + Foliar spray of IIHR vegetable special (5g/l), $T_6$ -RDF + Foliar spray of IIHR potato specific nutrient formulation (4g/l), $T_7$ - RDF + Foliar spray of UHSB 1 potato micronutrient formulation (3g/l), $T_8$ - RDF + Foliar spray of UHSB 2 potato micronutrient formulation (3g/l), $T_9$ - RDF + Foliar spray of UHSB 3 potato micronutrient formulation (3g/l), $T_{10}$ - RDF + Foliar spray of UHSB 4 potato micronutrient formulation (3 g/l), $T_{11}$ - RDF + Foliar spray of UHSB 5 potato micronutrient formulation (3 g/l) and $T_{12}$ - Only recommended dose of N:P:K without FYM. Composition of nutrient formulation are presented in Table 1 and were applied at 30, 45 and 60 days after sprouting of tubers.

**Table 1:** composition of nutrient formulation

| Sl. No. | Nutrient formulation | Composition |
|---|---|---|
| 1 | IIHR Vegetable Special | Zinc (225 ppm), Boron (50ppm), Manganese (42.5 ppm), Iron (105 ppm), Copper (5 ppm) |
| 2 | UHSB-1 formulation | Zinc (50 ppm), Boron (50 ppm), Copper (20 ppm) |
| 3 | UHSB-2 formulation | Zinc (200 ppm), Manganese (100 ppm), Boron (50 ppm), Iron (75 ppm), Copper (20 ppm) |
| 4 | UHSB-3 formulation | Zinc (200 ppm), Manganese (75 ppm), Iron (100 ppm), Boron (75 ppm), Copper (25ppm) |
| 5 | UHSB-4 formulation | Zinc (150 ppm), Manganese (150 ppm), Iron (100 ppm), Boron (75 ppm), Copper (10 ppm) |
| 6 | UHSB-5 formulation | Zinc (50 ppm), manganese (150 ppm), Iron (75 ppm), Boron (75 pm), Copper (25 ppm) |

Water soluble micronutrients were mixed by using pulverizer and composition of nutrient formulation are presented in Table 2 and were applied at 30, 45 and 60 days after sprouting of tubers. TSS of tubers was estimated by digital hand refractrometer. Sugar estimation was done by Eynon and Lane method explained by Ranganna (1986) [15]. Tubers were stored under ambient condition up to 75 days weight loss and potato tuber moth (PTM) infestation during storage at regular intervals were recorded.

**Results and Discussion**

**Yield parameters**

Significantly highest A grade (>75 g), tuber yield per plant (532.15 g/plant), total tuber yield per plant (687.87 g), A grade tuber yield per hectare (16.66 t/ha), total tuber yield per hectare (25.18 t $ha^{-1}$was recorded with foliar spray of UHSB-3 micronutrient formulation along with soil application of RDF (Table 2 and 3). Whereas, C grade and D grade tuber yield was significantly less in micronutrients sprayed treatments compared to control. These results are in conformity with Mousavi *et al*. (2007) [11]; Vinod Kumar *et al.* (2008) [17]; Jobori and Hadithy (2014) [8] and Parmar *et al.* (2016) [13] and Shah *et al.* (2016) [16].

Increase in tuber yield was due to micronutrient application which may be attributed to the enhanced photosynthesis activity, resulting into the increased production and accumulation of carbohydrates and favorable effect on vegetative growth (Davis *et al.*, 2003; and Basavarajeswari *et al.* 2008; Parmar *et al.,* 2016) [5, 3, 13] in different vegetable crops.

Increase in tuber size was may be due to improved physiological activity like photosynthesis and translocation of food materials. Applied micronutrients helped in increasing the average weight of individual tuber thereby transferring the tubers from small to medium grade and medium to large grade. Application of micronutrients significantly increased the yield of large and medium grade tubers and decrease proportionately small tubers (Vinod Kumar *et al.*, 2008 and Bari *et al*., 2001) [17, 2].

In potato, the biomass and tuber yield were highest at adequate (0.55 mg/l) manganese which appears to be optimum for improved crop yield. Both low and excess Mn resulted in low concentration of chlorophyll a and b as well as reduced Hill reaction activity in potato leaves (Gopal *et al.,* 2006) [7]. The decline in biomass at both low and high Mn (< > 0.55 mg/l) might be due to lower photosynthetic efficiency of potato, because low as well as excess Mn decrease the rate of photosynthesis as Mn is directly related to biological and economic yield (Marschner, 1995) [9].

**Quality parameters**

There was no significant difference in the TSS content of tubers with the foliar application of micronutrients (Table 4). Significantly highest dry matter (19.76%) was recorded in $T_9$ (RDF + FYM + UHSB-3) compared to control (16.86%) and was on par with $T_8$ (19.44%). Similar results were also reported by Bari *et al*. (2001) [2]; Mouasavi *et al.* (2007) [11]; Vinod Kumar *et al.* (2008) [17]; Dissoky and Khader, 2013 [6]. The enhanced dry matter production may be attributed to greater accumulation of photosynthates by vegetative parts. Zinc helps in synthesis of food material and their translocation to developing tubers and thereby increasing size of tubers (Vinod Kumar *et al.*, 2008) [17]

Application of micronutrients through IIHR Vegetable Special along with FYM and RDF recorded significantly highest reducing sugar (0.40%) and was on par with $T_9$, $T_{10}$, $T_8$ and $T_2$. Total sugar in potato tubers measured by Lane and Eynon method differed significantly due to foliar application of micronutrient mixture during crop growth period. Four treatments *viz*., $T_9$, $T_8$, $T_{10}$, and $T_5$ recorded significantly highest total sugar (0.43%) compared to that of 0.41 per cent in $T_{12}$, $T_1$ (control) and $T_2$. %). This results are in accordance with Gopal *et al*. (2006) [7]; Chandra and Singh (2015) [4]. Zn and Mn have main role in synthesis of proteins, enzyme activation, oxidation, revival reactions and metabolism of carbohydrates and increased total sugar, reducing sugar and non-reducing sugar (Parmer *et al*., 2016)

**Table 2:** Influence of foliar spray of micronutrients on grade wise yield and total yield per plant

| Treatments | Grade wise yield/ plant (g) | | | | Yield/ plant (g) |
|---|---|---|---|---|---|
| | A Grade (>75 g) | B Grade (50-75 g) | C Grade (25-50 g) | D Grade (0-25 g) | |
| $T_1$: FYM (25 t/ha) + Recommended dose of N:P:K (75:75:100 Kg/ha). | 276.43 | 53.17 | 56.37 | 32.37 | 418.33 |
| $T_2$: $T_1$ + Foliar spray of boron at 30, 45 and 60 DAS | 376.33 | 34.17 | 47.50 | 16.37 | 474.37 |
| $T_3$: $T_1$ + Foliar spray of zinc at 30, 45 and 60 DAS | 335.57 | 90.77 | 36.57 | 13.03 | 475.93 |
| $T_4$: $T_1$ + Foliar spray of zinc + boron at 30, 45 and 60 DAS | 359.57 | 68.68 | 29.84 | 32.20 | 490.29 |
| $T_5$: $T_1$ + Foliar spray of IIHR vegetable special at 30, 45 and 60 DAS. | 351.73 | 77.33 | 29.16 | 16.23 | 474.45 |
| $T_6$: $T_1$ + Foliar spray of IIHR potato specific nutrient formulation at 30, 45 and 60 DAS. | 364.67 | 78.38 | 30.19 | 11.23 | 484.47 |
| $T_7$: $T_1$ + Foliar spray of UHSB 1 Potato micronutrient formulation at 30, 45 and 60 DAS | 396.16 | 96.21 | 28.27 | 11.99 | 532.63 |
| $T_8$: $T_1$ + Foliar spray of UHSB 2 potato micronutrient formulation at 30, 45 and 60 DAS | 532.00 | 72.41 | 31.09 | 1.39 | 636.88 |
| $T_9$: $T_1$ + Foliar spray of UHSB 3 potato micronutrient formulation at 30, 45 and 60 DAS | 532.15 | 89.27 | 51.84 | 14.62 | 687.87 |
| $T_{10}$: $T_1$ + Foliar spray of UHSB 4 potato micronutrient formulation at 30, 45 and 60 DAS | 342.33 | 89.73 | 38.05 | 16.77 | 486.89 |
| $T_{11}$: $T_1$ + Foliar spray of UHSB 5 potato micronutrient formulation at 30, 45 and 60 DAS | 474.53 | 89.45 | 54.66 | 6.49 | 625.14 |
| $T_{12}$: Recommended dose of N:P:K without FYM | 251.43 | 38.57 | 45.65 | 22.8 | 358.44 |
| S Em± | 11.71 | 1.87 | 2.28 | 1.78 | 11.00 |
| CD 5% | 34.34 | 5.47 | 6.69 | 5.21 | 32.27 |

**Table 3:** Influence of foliar spray of micronutrients on grade wise yield and total yield per hectare

| Treatments | Grade wise tuber yield/ha (t/ha) | | | | | Tuber yield (t/ha) |
|---|---|---|---|---|---|---|
| | A Grade (>75 g) | B Grade (50-75 g) | C Grade (25-50 g) | D Grade (0-25 g) | Rotten tuber weight | |
| $T_1$: FYM (25 t/ha) + RDF of N:P:K (75:75:100 Kg/ha). | 12.12 | 2.77 | 1.55 | 1.21 | 1.68 | 19.18 |
| $T_2$: $T_1$ + Foliar spray of boron at 30, 45 and 60 DAS | 14.63 | 3.16 | 1.38 | 1.00 | 1.46 | 21.63 |
| $T_3$: $T_1$ + Foliar spray of zinc at 30, 45 and 60 DAS | 13.68 | 3.69 | 1.89 | 0.94 | 1.59 | 21.79 |
| $T_4$: $T_1$ + Foliar spray of zinc + boron at 30, 45 and 60 DAS | 14.15 | 3.4 | 1.72 | 0.94 | 1.66 | 21.88 |
| $T_5$: $T_1$ + Foliar spray of IIHR vegetable special at 30, 45 and 60 DAS. | 13.42 | 2.77 | 1.67 | 0.98 | 1.69 | 20.53 |
| $T_6$: $T_1$ + Foliar spray of IIHR potato specific nutrient formulation at 30, 45 and 60 DAS. | 14.73 | 3.84 | 1.47 | 0.97 | 1.59 | 23.12 |
| $T_7$: $T_1$ + UHSB 1 potato micronutrient formulation at 30, 45 and 60 DAS | 15.01 | 3.22 | 1.49 | 0.88 | 1.5 | 22.11 |
| $T_8$: $T_1$ + Foliar spray of UHSB 2 potato micronutrient formulation at 30, 45 and 60 DAS | 16.28 | 3.92 | 1.51 | 0.95 | 1.57 | 24.23 |
| $T_9$: $T_1$ + Foliar spray of UHSB 3 potato micronutrient formulation at 30, 45 and 60 DAS | 16.65 | 4.11 | 1.8 | 1.05 | 1.57 | 25.18 |
| $T_{10}$: $T_1$ + Foliar spray of UHSB 4 potato micronutrient formulation at 30, 45 and 60 DAS | 13.65 | 3.34 | 1.47 | 0.98 | 1.38 | 20.75 |
| $T_{11}$: $T_1$ + Foliar spray of UHSB 5 potato micronutrient formulation at 30, 45 and 60 DAS | 13.96 | 5.54 | 2.95 | 0.99 | 1.44 | 24.88 |
| $T_{12}$: Recommended dose of N:P:K without FYM | 10.39 | 2.61 | 1.55 | 0.91 | 1.71 | 17.18 |
| S Em± | 0.6 | 0.44 | 0.23 | 0.12 | 0.23 | 0.79 |
| CD 5% | 1.75 | 1.3 | 0.67 | NS | NS | 2.22 |

DAS – Days After Sprouting

**Table 4:** Influence of foliar spray of micronutrients dry matter, TSS, reducing sugar, non-reducing sugar and total sugar in potato

| Treatment | Dry matter content of tuber (%) | TSS ($^0$Brix) | Reducing sugar (%)** | Non reducing sugar (%)** | Total sugar (%)** |
|---|---|---|---|---|---|
| $T_1$: FYM (25 t/ha) + Recommended dose of N:P:K (75:75:100 Kg/ha). | 16.86 (48.23) | 4.33 | 0.38 (3.54) | 0.03 (0.93) | 0.41 (3.67) |
| $T_2$: $T_1$ + Foliar spray of boron at 30, 45 and 60 DAS | 17.38 (40.66) | 4.47 | 0.39 (3.57) | 0.02 (0.85) | 0.41 (3.68) |
| $T_3$: $T_1$ + Foliar spray of zinc at 30, 45 and 60 DAS | 18.40 (46.49) | 4.57 | 0.38 (3.54) | 0.04 (1.09) | 0.42 (3.71) |
| $T_4$: $T_1$ + Foliar spray of zinc + boron at 30, 45 and 60 DAS | 18.34 (41.11) | 4.57 | 0.38 (3.51) | 0.05 (1.10) | 0.42 (3.73) |
| $T_5$: $T_1$ + Foliar spray of IIHR vegetable special at 30, 45 and 60 DAS. | 19.35 (44.48) | 4.59 | 0.40 (3.61) | 0.03 (0.98) | 0.43 (3.75) |
| $T_6$: $T_1$ + Foliar spray of IIHR potato specific nutrient formulation at 30, 45 and 60 DAS. | 18.75 (43.79) | 4.47 | 0.37 (3.51) | 0.04 (1.12) | 0.42 (3.69) |
| $T_7$: $T_1$ + Foliar spray of UHSB 1 potato micronutrient formulation at 30, 45 and 60 DAS | 18.20 (36.42) | 4.37 | 0.38 (3.51) | 0.04 (1.16) | 0.42 (3.71) |
| $T_8$: $T_1$ + Foliar spray of UHSB 2 potato micronutrient formulation at 30, 45 and 60 DAS | 19.44 (44.46) | 4.68 | 0.40 (3.61) | 0.03 (1.02) | 0.43 (3.75) |
| $T_9$: $T_1$ + Foliar spray of UHSB 3 potato micronutrient formulation at 30, 45 and 60 DAS | 19.76 (34.09) | 4.44 | 0.39 (3.59) | 0.04 (1.26) | 0.43 (3.75) |
| $T_{10}$: $T_1$ + Foliar spray of UHSB 4 potato micronutrient formulation at 30, 45 and 60 DAS | 18.02 (39.01) | 4.87 | 0.39 (3.56) | 0.05 (1.23) | 0.43 (3.77) |
| $T_{11}$: $T_1$ + Foliar spray of UHSB 5 potato micronutrient formulation at 30, 45 and 60 DAS | 18.85 30.82) | 4.57 | 0.37 (3.50) | 0.05 (1.25) | 0.42 (3.73) |
| $T_{12}$: Recommended dose of N:P:K without FYM | 16.33 (52.99) | 4.20 | 0.38 (3.55) | 0.03 (0.95) | 0.41 (3.68) |
| S Em± | 0.13 | 0.13 | 0.02 | 0.09 | 0.02 |
| CD 5% | 0.39 | NS | 0.05 | 0.25 | 0.06 |

**arc sin values

DAS – Days After Sprouting

## Conclusion
By this experiment we can conclude that foliar application of UHSB-3 micronutrient formulation (3 g/l) along with soil application of RDF (75:75:100 kg/ha of N:P:K) and FYM (25 t/ha) was found more economical in terms of large size tuber yield, total tuber yield, dry matter of tubers and total sugar content in the tubers.

## Reference

1. Annonymous. 3rd advanced estimates for 2015-16. National Horticulture Board, Gurgaon, 2016, 1.
2. Bari MS, Rabbani MG, Rahman MS, Islam MJ, Hoque MR. Effect of zinc, boron, sulphar and magnesium on growth and yield of potato. Pakisthan Journal Biological Sciences. 2001; 4(9):1090-1093.
3. Basavarajeshwari CP, Hosamani RM, Ajjappalavara PS, Naik BH. Effect of foliar application of micronutrients on growth and yield components of tomato (*Lycopersicon esculentum* Mill.). Karnataka Journal of Agricultural Sciences. 2008; 21(3):428-430.
4. Chandra R, Singh KK. Foliar application of zinc sulphate, magnesium sulphate and copper sulphate on yield and quality of aonla (*Emblica officinalis* Gaerth L.) cv. NA-47 under Garhwal Himalaya. Journal of Medicinal Plant Studies. 2015; 3(5):42-45.
5. Davis TM, Sanders DC, Nelson PV, Lengnick L, Sperry WJ. Boron improves growth, yield, quality and nutrient content of tomato. Journal of American. Society. for Hortcultural. Sciences. 2003; 128(3):441-446.
6. Dissoky RAE, Kadar AES. Effect of boron as a foliar application on some potatoes cultivars under Egyptian alluvial soil conditions. Research Journal of Agriculture and Biological Sciences. 2013; 9(5):232-240.
7. Gopal R, Dube BK, Chatterjee C. Effect of manganese stress on yield, productivity and metabolism of potato. Indian Journal of Horticulture. 2006; 63(2):174-177.
8. Jobori MM, Hadithy SA. Response of potato (*Solanum tuberosum*) to foliar application of iron, manganese, copper and zinc. International Journal of Agriculture and Crop Sciences. 2014; 7(7):358-363.
9. Marschner H. Mineral nutrition of higher plants. 2nd Ed. Academic Press, London 1995, 889.
10. Meng ML, Yic MF, Jun Y, Lin YZ. Research Progress on cultivation Physiology of potato in China 5th world Potato Congress, 2004, 16.
11. Mousavi SR, Galavi M, Ahmadavand G. Effect of zinc and manganese foliar application on yield quality and enrichment on potato (*Solanum tuberosum* L.), Asian Journal of Plant. Sciences. 2007; 6(8):1256-1260.
12. Mustafa G. Input management of potato crop in Northern areas of Pakistan. *M. Sc. thesis*, Uni. of Reading. UK. 1997, 14.
13. Parmar M, Nandre BM, Pawar Y. Influence of foliar supplementation of zinc and manganese on yield and quality of potato, *Solanum tuberosum* LInternational Journal of Farm Sciences. 2016; 6(1):69-73.
14. Poljak M, Herak-custic M, Horvat T, Coga L, Magic A. Effects of nitrogen nutrition on potato tuber composition and yield. Cereal Research. Communications 2007; 35:937-940.
15. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1986, 190-210.
16. Shah SA, Mohammad W, Shahzadi SR, Elahi R, Ali A, Basir A *et al*. The effect of foliar application of urea, humic acid and micronutrients on potato crop**.** Iran Agriculture Research. 2016; 35(1):89-94.
17. Vinod kumar, Vyakarnahal BS, Basavaraj N, Srikant K, Gouda SM. Influence of micronutrients on growth and yield of potato (*Solanum tuberosum*) cultivars. Indian Journal of Agricultural Sciences. 2008; 78(9):752-6.