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Effect of zinc application on quality of potato

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Abstract
In order to investigate the response of zinc application on quality of potato tubers, field experiments were carried out during winter season of 2016-2017 at Vegetable Research Centre, G. B. Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. The experiment was laid out in randomized block design with five treatments replicated four times. The results indicated that dry matter per cent (19.9 %), starch (17.5%), specific gravity (1.04%) and available zinc content (52.64 ppm) in potato tubers were recorded maximum in treatment T_5 (Recommended dose of fertilizer of NPK + 6.0 kg zinc at the time of planting). Results also indicated that specific gravity of potato tuber did not vary significantly with the treatments. Based on present investigation, it can be concluded that basal application of zinc at 6.0 kg/ha along with recommended dose of fertilizer improved potato tuber quality under *tarai* region of Uttarakhand.

Keywords: Dry matter, starch content, specific gravity, potato, zinc

Introduction
Potato (*Solanum tuberosum* L.) is an important food and tuber crop of world as well as of India. It has ability to supplement the food requirement of high population areas of Asia because it produces more dry matter, well balanced protein and more calories per unit area of land and time than other major food crops (Shekhawat *et al*. 2001) [15]. Potato requires a balanced dose of NPK along with adequate amount of micronutrients like Zn, B and Mn. Consequently, many crops experience reduced growth, yield and tissues Zn concentrations (Cavagnaro, 2008) [3]. First time, zinc deficiency observed by Nene (1966) [12] as a problem of paddy crop under Indian alkaline soil condition. Zinc is considered as the most important micronutrient for potato and low recovery of applied Zn is the main limitation in enhancing the yield of potato (Singh *et al.* 2013) [16].
Zinc is the most deficient micronutrient in potato growing soils, followed by iron, copper, manganese, boron and molybdenum (Trehan and Sharma, 1999) [17]. Critical limit of zinc in soil is 0.55 ppm and less than 20 ppm zinc in plant, causes deficiency symptoms in plant (Jatav and Dua, 2007) [9]. The symptoms of zinc deficiency in potato plants are characterized by fern leaf and stunted plants young chlorotic leaves which are upwardly cupped and narrow. Greyish brown to bronze blotches appear first on middle leaves and later on all leaves. Other leaf symptoms are green veins; brown coloured dead tissues on older leaves. Deficiency and toxicity of zinc had a relatively greater impact than did deficient and toxic levels of phosphorous with regard to general potato plant health and appearance (Barben *et al*. 2010) [2].

Materials and Methods
The present study was carried out during the winter season of 2016-2017 at Vegetable Research Centre, G. B. Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar, Uttarakhand. Geographically, experimental site is situated at 29^0N and 79.30^0E longitudes having an altitude of 243.84 meters above mean sea level in sub- mountainous region of Shivalik, known as *Tarai*. The experimental soil was sandy loam having neutral pH 7.20, organic carbon (0.89%), medium phosphorous (21.06 kg/ha) and potassium (143.06kg/ha) contents and low available nitrogen (190.05kg/ha) and zinc (0.82ppm) contents. Field experiment was conducted under irrigated condition and laid out in randomized block design with four replication and five treatments *viz.*, T_1 (RDF of NPK), T_2 (RDF of NPK +1.5 kg zinc at the time of planting), T_3 (RDF of NPK +3.0 kg zinc at the time of planting), T_4 (RDF of NPK+ 4.5 kg zinc at the time of planting), T_5 (RDF of NPK +6.0 kg zinc at the time of planting). The recommended dose of fertilizers *i.e.* 160: 100: 120 kg N, P_2O_5 and K_2O/ha, respectively, were applied according to the treatments. Full dose of phosphorus and potassium was applied at the time of planting with half dose of nitrogen at the time of planting and remaining at 30 days after planting *i. e*. during earthing-up. Potato crop was fertilized with zinc sulphate according to different treatments of experiments.

Well-sprouted seed tubers (40-50g) of potato variety Kufri Surya were planted during last week of October with 60 × 20 cm spacing. Other agronomic practices were adopted as per recommended for potato cultivation. The crop was harvested during last week of February. The data was subjected to analysis of variance (ANOVA) through computer by using STPR-3 programme, designed and developed by Department of Mathematics and Statistics, College of Basic Sciences and Humanities, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand. Quality parameters such as dry matter per cent, starch (%), specific gravity and available zinc content of potato tuber were recorded after harvesting of tubers with following procedures:

Dry Matter

Dry matter per cent of tuber was determined on the basis of fresh weight. From each treatment, 100 g sample of fresh tubers after cutting into thin pieces was taken. Thin pieces of tuber samples (100 g) were sun-dried for 2-3 consecutive days. Further, these samples were dried into oven at $40^0 \pm 20^0$C for 48 hours and then 60^0C for 24 hours or till constant weight is obtained. After drying, the samples were weighed and dry matter content (%) was expressed based on following formula:

$$\text{Dry matter (\%)} = \frac{\text{Oven-dried weight (g) x 100}}{\text{Fresh weight (g)}}$$

Starch

Starch per cent was obtained after determining amount of total sugar of tubers. The following formula was used for determining the total sugar in tubers:

$$\text{Total sugars (\%)} = \frac{\text{Factor for Fehling solution x Dilution x 100}}{\text{Titre value x Weight of sample taken x 100}}$$

Starch content (%) = Total sugar (%) × 0.9

Where,

0.9 = factor for starch conversion

Specific Gravity

A representative sample of tubers was taken from each plot after harvesting and weighed after proper washing, cleaning and drying. The volume of tubers was determined by water displacement method. The specific gravity was determined by following formula:

Available Zinc

Available zinc concentration in potato tubers was determined by Atomic Absorption Spectrophotometer (AAS) and solution was prepared by di-acid (HNO_3 and $HClO_4$ in the v/v ratio of 4: 1) digestion method.

Results and Discussion

It is revealed from the data (Table 1) that the maximum dry matter per cent of potato tuber (19.9 %) was recorded in treatment T_5 (RDF of NPK + 6.0 kg zinc at the time of planting). Whereas, the minimum dry matter per cent (16.4%) was recorded in treatment T_1 (RDF of NPK). Critical observation of data (Table- 1) indicated that dry matter per cent of potato tuber increased with increase in the level of zinc. These findings are in agreement with the results of Sati *et al.* 2017 [14].

The maximum starch content of potato tuber (17.5%) was recorded under treatment T_5 (RDF of NPK +6.0 kg zinc at the time of planting). Whereas the minimum starch content was recorded under treatment T1 (RDF of NPK). It is evident from the data (Table 1) that starch content of potato tuber improved with increase in levels of zinc because zinc activates enzyme like aldolase and carbonic anhydrase, which helps in translocation of carbohydrates from leaves to tubers Puzina 2004 [13]. Suggested that zinc improves diameter of isodiametric cells of the perimeduallary tuber zone, these cells are characterized by most intense starch accumulation. These findings are in agreement partially with the results of E1-Hadded and Award (2007) [4], Ahmed *et al*. 2011 [1], Sati *et al.* 2017 [14].

The specific gravity of potato tuber did not vary significantly with the treatments. The maximum specific gravity of potato tuber (1.04 g/cm^3). Was recorded under treatment T_5 (RDF of NPK+ 6.0kg zinc at the time of planting). Whereas, minimum value (1.02 g/cm^3) was recorded under treatment T_1 treatment (RDF of NPK). Sati *et al.* 2017 [14] found that foliar supplementation of zinc reduced specific gravity of potato tuber relative to the soil applied zinc.

The maximum available zinc content in potato tubers (52.64 ppm) was recorded under treatment T_5 (RDF of NPK + 6.0 kg zinc at the time of planting). Whereas, the minimum value (34.75) was recorded under treatment T_1 (RDF of NPK). It was observed that available zinc content of potato tuber increased with increase in zinc levels at the time of planting. It might be due to the fact that the soil of experimental plot was low in available zinc and application of zinc improves the root biomass, which increased the zinc uptake efficiency of potato plant. White *et al.* 2012 [18] reported that zinc content of potato tubers was affected by the limited mobility of zinc in the problem. Ahmed *et al.* 2011 [1] reported that zinc content of tubers significantly varied with zinc fertilization as well as different cultivars.

Table 1. Effect of zinc application on dry matter, starch content, specific gravity and zinc content of potato tuber

Treatments	Dry matter content (%)	Starch content of tubers (%)	Specific gravity of tubers (g/cm^3)	Available zinc content in potato tubers (ppm)
T_1 (RDF of NPK)	16.4	13.7	1.02	34.5
T_2 (RDF of NPK + 1.5 kg Zn at the time of planting)	17.8	14.8	1.02	38.7
T_3 (RDF of NPK + 3.0 kg Zn at the time of planting)	18.9	15.3	1.04	44.2
T_4 (RDF of NPK+ 4.5 kg Zn at the time of planting)	19.8	15.6	1.03	46.7
T_5 (RDF of NPK+ 6.0 kg zinc at the time of planting)	19.9	17.5	1.04	52.6
S.Em±	0.1	0.3	0.01	1.1
CD at 5%	0.3	1.0	NS	3.1

Conclusion

On the basis of the findings of present experiments, the soil application of 6.0 kg zinc at the time of planting along with 160 N: 100 P_2O_5: 120 K_2O kg/ha can be recommended to improve the better get quality of potato tuber i. e. dry matter, starch and specific gravity of potato tuber.

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