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Zinc Nutrition of Potato

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SUMMARY

The yield and quality of potato is highly influenced by zinc nutrition. Zinc plays a major role in nitrogen metabolism and hence the deficient crops will posses lower levels of protein. Zinc is necessary for auxin formation, cell division and elongation. The starch content in potato is also influenced by zinc nutrition. Zinc fertilization in potato as basal soil application or through foliar application increases Zn concentration in potato tuber by 3 to 4 times over the unfertilized crops. Zinc fertilization also improves the chip colour of potato chips. Zn-fortified potato is a better option for alleviating malnutrition in the Asian countries as it is much better accumulator of zinc than the cereals.

INTRODUCTION

Micronutrient application in cultivated crops has received great attention from the researchers to overcome their wide-spread deficiencies observed all over the country. Significant response has been found in many crops to the application of micronutrients indicating their deficiency in soils. The key reasons for such deficiency are intensification of cropping system, adoption of high yielding varieties and hybrids of crops and low or no use of much needed organic manures. Potato is a staple food for more than a billion people of the world. It is considered as the most promising crop for food security. Hence, improvement of its productivity and quality is of utmost importance for the economy and human health. In potato cultivation some minor plant nutrients like Zn, B can help in increasing the foliage at initial stage of growth and in the later stages, the translocation of assimilates is responsible for higher yield (Trehan and Grewal, 1981). Zn plays an important role in carbohydrate metabolism, photosynthesis, sucrose and starch formation, protein metabolism, flowering and seed production and defense mechanism of the potato plant. Growing of HYVs in intensive cropping system and minimum or no use of organic manures lead to deficiency of micronutrients especially Zn in different potato growing soils of India.

Deficiency symptoms of Zn in potato:

- Leaves of affected crops are smaller in size and their upper internodes are shorter. This is known ad little leaf symptom. Youngest leaves are cupped upward and rolled.
- Bronzing or yellowing around the leaf margin and also develop tip burn.
- Green veins, spotting with dead tissue and sometimes leaves become thick, brittle and puckered.
- Retards photosynthesis and nitrogen metabolism of the crop.
- Delayed maturity as a result of prolonged growth periods, ultimately resulting yield reduction and inferior quality of the tubers.

Correction of Zn deficiency:

Zn deficiency is found in 49% of Indian soils, wherein response of most crops to Zn fertilization has been reported (Shukla and Behera, 2012). Ferti-fortification i.e. fertilizing the crops with Zn at appropriate time and dose is the corrective measure against zinc deficiency. Many researchers recorded that application of zinc sulphate @ 15 kg/ ha in potato resulted in highest per cent of yield increase (upto 25%) compared to other crops. Potato is one of the highest Zn accumulators compared to the rice. Rice can accumulate upto 18.6 to 28.1 mg Zn/kg of dry matter where most of the Zn got removed during processing (milling, polishing and cooking) (Hazra *et al.*, 2015). In contradictory to rice, Zn accumulation in potato takes places in the tuber, which remains till consumption. Most of the Zn ferti-fortification programme carried out in the world, showed that Zn application in potato through foliar as well as soil-applied Zn, increases Zn concentration in potato tuber upto 3-4 times (30-40 mg Zn /kg of dry matter) which is quite higher than most of the commonly known fruit crops (White *et al.*, 2012). Hence, Zn-fortified potato can be strategy to alleviate the Zn driven malnutrition in the Asian countries.

Management options for correcting zinc deficiency:

To meet the demand of the potato crop and ameliorate the Zn deficiency in soils, the application of Zn-fertilizer is necessary. Moreover, the choice of an appropriate Zn-fertilizer with proper dose and application method is very much important (Das, 2011). Breeding of crop with high capacity to absorb zinc from soil is another option. The application of zinc solubilizing bacteria for improving the zinc nutrition of crop has been also receiving due attention from the researchers all over the world.

Fertilizer sources:

Different sources of zinc fertilizers are inorganic compounds, synthetic chelates and natural organic complexes; they vary considerably with respect to zinc content, effectiveness for crops on different types of soils and price. However, sulphate salt is the common source of Zn. Zinc sulphate monohydrate and zinc sulphate heptahydrate are the most widely marketed Zn fertilizers in India.

Application methods: Generally three methods are followed for Zn fertilization in potato.

Soil application:

The deficiency of Zn may be corrected by soil application of inorganic fertilizers like zinc sulphate @ 25 kg /ha. Soil application through broadcasting followed by mixing, drilling, band placement and top dressing were found to be effective (Das, 2011). The application of Zn in soils not only increases the yield of crops, but also decreases the concentration of cadmium (Cd) in soils, thereby decrease the content and uptake of Cd by the plants.

Foliar application:

Foliar sprays with 0.02% zinc solution (200 g in 100 litres of water) on the standing crop at 40 and 60 days after planting (DAP) in the plains, and 60 and 80 DAP in hills were found effective. Foliar spray should be avoided between 11.00 am to 3.00 pm to prevent scorching of leaves.

Seed treatment:

In this method, seed tubers are soaked in 0.05% zinc sulphate solution (50 g per 100 litres of water) for 3 hours. The soaked tubers are dried in shade for 24 hours and then planted in the field (Mondal *et al.*, 2015).

A number of studies were conducted to compare the relative effectiveness of different application methods and found to be equally effective for increasing the tuber yield of potato (Mondal *et al.*, 2015). Further, the application of Zn either as soil application or foliar spray triggers several metabolic pathways in the plants like translocation of Zn within the plant, enzyme activities etc. which finally influences growth and yield of crops (Das, 2011).

Yield of potato as affected by Zn fertilization:

Zinc fertilization in potato showed significant increase in tuber numbers, tuber weight, tuber yield, quality and post–harvest properties. The increased tuber yield of potato might be attributed to the beneficial effect on tuberization as a result of Zn application and Zn content in tubers. All India coordinated study on potato to micronutrient response showed that yield response of potato to applied Zn fertilizers varies with the soil type, variety, quantity of other major nutrients applied to the soil and finally method of application (Mondal *et al.*, 2015). Zinc application through soil (20 kg $ZnSO_4$/ ha), foliar spray (0.02 % zinc sulphate solution at 40 and 60 days after planting) and soaking of tuber (0.05 % zinc sulphate solution for three hours) significantly increased the tuber yield of potato (Sharma and Grewal, 1988).

Quality of potato as influenced by Zn fertilization:

Zn fertilization has a great impact on the quality parameters of potato. Zinc fertilization improves the chip colour of potato. This may be due to less production of phenol substances in tuber influenced by Zn^{++} ion thus few chances of enzymatic discolouration of potato chips during frying. Mondy and Chandra (1981) revealed that Zn fertilization significantly reduce the total phenol content of tuber which improves chip colour while frying.

Singh *et al.*, (2018) concluded that for commercial cultivation of potato cv. Kufri Pukhraj, foliar application of Zn @ 30 ppm is very effective for getting the higher yield and quality (**Table.** 1) .

Table 1: Effect of foliar application of Zinc on growth, yield and quality

Treatment	Tuber yield per plant (g)	Yield (t ha^{-1})	Carbohydrate (g/100g)	Protein (g/100g)	TSS (%)
T1: control	182.39	13.13	13.56	6.16	4.82
T2: Zn @5ppm	200.00	14.40	14.78	6.59	5.94
T3 : Zn @10ppm	221.38	15.94	16.38	6.80	6.19
T4 : Zn @15ppm	212.58	15.31	15.77	7.21	5.41
T5- Zn @20ppm	206.92	14.90	14.28	6.99	6.34
T6: Zn @25ppm	261.97	18.86	19.09	7.70	7.05
T7: Zn @30ppm	262.32	18.89	19.52	7.70	7.55
T8 : Zn @35ppm	232.13	16.72	18.62	7.62	6.78
SE(m)	2.42	0.02	0.21	0.18	0.10
CD	7.41	0.06	0.64	0.56	0.30

CONCLUSION

Application of zinc in potato for correcting the Zn deficiency in deficient soils is of paramount importance for obtaining high yield and better quality. Location specific research has been conducted to standardize the dose, time and method of zinc application in potato. Adoption of such recommendation will not only sustain productivity and improve the quality of potato but also reduce the Zn induced malnutrition in the developing countries.

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