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Integrated Application of Micronutrients to Improve Growth, Yield, Quality and Economic Yield in Potato - A Review

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A B S T R A C T

Potato (*Solanum tuberosum* L.) is a cool season vegetable, grown throughout the world. It is said to be the native of Peru in South America. It is an important tuber crops grown extensively throughout India as well as the world**.** It is an annual, herbaceous, dicotyledonous and vegetative propagated plant. Potato is high nutrient demanding crop due to underdeveloped and shallow root system. It produces much more dry matter as compared to different cereal crops Because, it removes large amount of nutrients per unit time from per unit area, so therefore, Indian soil are not in condition to fulfill the requirement of nutrients. Hence, it is essential to apply the nutrients from the external sources. High yields can only be obtained through the application of optimal doses of NPK dose in balanced proportion. The efficiency of NPK fertilizers can be further increased by the application of micronutrients. The application of inorganic fertilizers along with micronutrients is considered essential to produce high tuber yield. To improve productivity, potato plant requires a balanced dose of NPK along with adequate amount of micronutrients and macronutrients like boron, sulphur, zinc and manganese. Hence the present information explaining the importance of micronutrients is reviewed here.

Introduction

Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae, is a staple food prevailing all across the world with successful large scale production, consumption and availability. It is one of the most diverse and nutritious crops on the universe and can be grown almost all the continents (Khurana and Rana, 2008). It is an annual, herbaceous, dicotyledonous and vegetative propagated plant. The probable center of origin of potato is Peru in South America. Potato has the highest food value on a dry matter basis and it is also the most nutritious crop in proportion to its calorie value (Khurana, 1978). In potato, sulphur is required for many metabolic activities for plant growth and development. It ranks as important as nitrogen and phosphorus in the formation of protein and it is involved in different metabolic and enzymatic process of all living cells. It improves absorption of calcium and stabilizes calcium in cell wall. Boron prevent discolouration of tubers by reducing the oxidation of phenols and so. It also plays vital role in sprouting, plant growth and tuber enlargement. Both boron and sulphur not only increase the yield of potato

but also improve the quality (Taya *et al.,* 1994). In this aspect the effect of Boron Sulphur, molybdenum and zinc on growth, yield and quality of potato are reviewed here.

Effect of micronutrients on growth characters of potato

Growth is an irreversible increase in size, shape of the plant and it is affected by the complex interaction between environmental factors and physiological processes which are influenced by the application of external inputs like water and nutrients. The role of micronutrients in promoting various attributes of plant growth has been positively established. A significant number of works has been done by many authors, some of these have been reported here. El-Banna and Abd El -Salam (2005) conducted an experiment by using different foliar spraying rates of B (50 and 75 ppm) + molybdenum (25 and 50ppm) twice at 60 and 75 days after planting. Results revealed that foliar spraying of potato plants with B significantly increased plant height, number of stems per plant. Application of micronutrient showed significant effect on plant height, number of leaves and shoot weight by application of micronutrient (Jafri-Jood *et al.,* 2013.). Islam *et al.,* (2014) reported that by application of Sulphur increases plant height, stems per hill, leaves per hill and total dry mass. Singh *et al.,* (2016) conducted an experiment to study the effect of four levels of nitrogen and three levels of sulphur application on growth and yield characters of potato in split plot design with three replications and eleven treatments. The study revealed that application of Nitrogen 180 kg/ha and Sulphur 50 kg/ha significantly increased characters, namely, plant emergence, number of shoots and plant height. In addition, many authors have reported highest values for leaf area, plant height, days to maturity, fresh or dry weight of plant (Arisha *et al.,* 1999; Thakare *et al.,* 2007; Tantawy *et al.,* 2017; Mohammed *et al.,* 2018).

Micronutrients application for yield and related attributes in potato

Yield of potato is function of number of marketable tuber per plant, weight of marketable tuber per plant, size of tuber etc. These all attributes depend on nutrient level of soil and plants. A number of authors have worked on improvement of yield in potato through micronutrient application. Rahman *et al.,* (2011) in their experiment reported that application of Zn @ 4kg/ha showed highest number of tubers per hill, maximum weight of tubers per hill and the highest weight of tubers per plot and hectare. It also increases yield in comparison to control. Dissoky and Abdel kadar (2013) conducted a experiment to evaluate the foliar spray of effect of boron on potatoes. The experiment was laid in spilt plot design with three replications. Results revealed that foliar spray of B significantly increased fresh weight of plant, dry weight of plant and leaf area, total tuber yield, dry shoot yield, average weight of tubers and yield of potato. Plants showed positive response to all application rate of boron. Tuber yield and average individual tuber weight showed a linear relationship with the applied boron concentration. Application of boron showed also positive response to the contents of N, P, K and B (Tantawy *et al.,* 2017). Some additional information of work has been cited in Table 1.

Micronutrients application for quality and economic parameters in potato

Tuber dry matter is an important quality parameter in case of potato. If it is more than 20 per cent then it is good for processing purpose whereas, chips having dark colour are unacceptable to consumers due to poor aesthetic appeal and bitter taste.

Table.1 Application of micronutrients for high yield in potato

Application of micronutrient	Response/ Effect	References
Boron as boric acid	Increase tuber size and weight	Puzina (2004)
Application of Boron and manganese	Increase leaf area, number of tuber per plant, fresh weight of vegetative growth, total tuber yield, dry matter per cent.	El -Banna and Abd El -Salam (2005)
application of 0.20% boron	highest number of fruits per plant, number of fruits per plot, yield per plant, yield per plot and yield/ha	Yadav *et al.*, (2006)
Application of $ZnSo_4$	Significantly higher number and yield of seed size tuber yield per plant	Kumar *et al.*, (2008)
50% Potassium fertilizers as soil application and 50 % of that added as foliar application in combination with foliar spray of micronutrients	Recorded increased in tuber yield.	Ewais *et al.*, (2010)
Application of 45 kg/ ha sulphur	Increases yield of tuber and dry matter content	Sharma *et al.*, (2011)
Application of RDF + 18 kg borex	increased potato yield in comparison to control	Singh *et al.*, (2013)
Boron fertilization	Significantly increases yield.	Murmu *et al.*, (2014)
Combined soil application of Zn and Mn	Increase weight of potato tuber and tuber yield per plant by 94.03 g and 921.90 g respectively per tuber which was 65% higher compared to control.	Fadhly (2016)
Application of micronutrients mixture i.e. mixture of Zn, B, Fe, Mn along with NPK	Produced the highest tuber yield of 22.45 t/ha which is 32.01 per cent higher than control plot yield.	Moinuddin *et al.*, (2017)
RDF + 2 kg B + 40 kg S during both year of investigation	Significntly increases plant height number of sprouts per tuber, stem diameter and number of marketable tubers per hill, yield of marketable tubers	Muthanna *et al.*, (2017)
0.1% boric acid	Produced significantly higher number and yield of tuber of processing grade	Sarkar *et al.*, (2018)

Low reducing sugar is preferred for processing. El babky *et al.,* (2010) reported that Quality characters namely, total sugar, total carbohydrate and crude protein increases by application of Zn. Dissoky and Abdel-Kadar (2013) in their experiment revealed that by application of Boron quality parameters, namely, dry matter, protein and starch percentage increased as compared to control. It also significantly increased the uptake of N, P, and K. Singh *et al.,* (2013) in their experiment revealed that Application of RDF + 18 kg borex increased potato yield and net return in comparison to control i.e. with recommended doses of fertilizers alone. Application of 200 kg N/ ha and 15 kg Zn per hectare recorded the highest dry matter content in tuber, good quality of tuber colour and reducing sugar content. Singh *et al.,* (2016) in their study observed B: C ratio is more than 1 by all treatments that consists different concentrations of Sulphur along with NPK. Among all treatments, 180 kg/ha Nitrogen and 50 kg/ha Sulphur showed highest net income and benefit cost ratio. Sarkar *et al.,* (2018) in their experiment revealed that recommended doses of NPK and 0.1% boric acid significantly increases specific gravity, tuber hardness, total soluble solids, total acidity, Vitamin C, protein, and starch content with lowest phenol content. So it is best treatment for producing the processing grade potato. Whereas, Singh *et al.,* (2018) in their experiment revealed that foliar application of sulphur or boron significantly increased dry matter and starch level in potato tubers. Highest dry matter and starch content was recorded in treatment 9 i.e. two foliar sprays of 0.5% borovin and 0.25% sulphur. It significantly improved tuber yield, dry matter content, starch content, economic yield and net income. Sarkar *et al.,* (2018) in their experiment revealed that application of boron significantly increased quality characters, namely, specific gravity, TSS, tuber hardness, total acidity and vitamin C content. The lowest phenol content is good for chip colour and it is good for processing industry (Bandana *et al.,* 2016). Application of RDF of NPK + 0.1% boric acid spray reduces phenolic concentration and total phenol content. Whereas, same treatment gives with highest net return and cost benefit ratio.

The application of micronutrients like Boron, Sulphur, Mn and Zinc has significant and vital effect on different parameters of potato. In light of the reviews from different scientist, application of different micronutrients along with NPK is most appropriate nutrient management strategy for getting higher tuber yield, good quality of tuber and economic return.

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