Journal of AgriSearch, 8 (1): 18-20
An Open Access International Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v8i01.19557

Response of potato to zinc application in eastern Indo-Gangetic plains of India

SK YADAV[1]*, RK SINGH[2], VK DUA[3], SARALA YADAV[2], SK SINGH[4] AND VP YADAV[5]

ABSTRACT

A field experiment was conducted during two consecutive years of 2015-16 and 2016-17 at Central Potato Research Station, Patna with objective to evaluate the response of zinc on potato tuber yield. Significant effect of zinc application was not noticed on plant emergence and plant height of crop at 30 days after planting. However, higher plant height was recorded in the plot which received the zinc as compare to without zinc application. Significant difference in plant height was observed at later stages of crop due to application of zinc at the rate of 6.0 kg/ha along with recommended dose of fertilizers. Similarly, dry matter yield of potato tubers was also recorded consequently higher due to application of higher doses of zinc. Tuber grades of 0-25g and 25-50g were found non-significantirrespective of doses of zinc application in potato. Significant variation in medium and large size tuber yield were recorded due to application of zinc @ 6 kg/ha over without zinc application. About 18.1% increase in marketable tuber yield of potato was found due to application of zinc @ 6.0 kg/ha as compare to without zinc application. About11.3% and 13.7% increase in the total tuber yield of potato was observed due to application of zinc @ 4.5 and 6.0 kg/ha, respectively over without zinc application. However, no significant variation in pooled yield was found with application of zinc up to 3.0 kg/ha over without zinc application. The highest net return (Rs. 36.0×10^3/ha) and net benefit cost ratio (2.52) was recorded due to application of zinc @ 6.0 kg/ha as compare to without zinc. Application of zinc @ 6.0 kg/ha along with recommended dose of NPK may be found more beneficial for potato cultivation under Eastern Indo-Gangetic plains of India.

KEYWORDS

Fertilizer, Micronutrient, Potato, Tuber, Zinc,

ARTICLE INFO

Received on	:	07/11//2020
Accepted on	:	14/02/2021
Published online	:	19/03/2021

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the one of the most important short duration cash crop grown successfully during winter season under Indo-Gangetic plains of India. The crop has been occupied a unique position among the vegetable crops due to its high nutritional value and protein quality as compared to that of cereals (Yadav *et. al.* 2020). Commercial cultivation of potato requires more attention towards balance fertilization for higher productivity of crop. Biswaji *et al.* (2020) reported that zinc is the most deficient micronutrient in potato grown soil followed by iron, copper, and manganese. In plants, Zn deficiency reduces growth, tolerance to stress and chlorophyll synthesis (Kawachi *et al*., 2009; Lee *et al*., 2010). Lower availability of zinc in soil directly reduced the crop productivity by affecting the several vital activities of plant system (Singh and Bhatt, 2013). Zn is an essential plant nutrient to potato play important role in enzyme activation like RNA polymerases, superoxide dismutase, alcohol dehydrogenase and carbonic anhydrase for synthesis of protein and metabolism of carbohydrate, lipid and nucleic acid (Palmer and Guerinot, 2009). Majority of farmers are shifting towards cultivation of potato in rice wheat cropping system due to higher its profitability than cereal crops.

Deficiency of micronutrients from the soil especially zinc due to prevalent intensive rice wheat system is becoming a serious issue (Singh *et al*., 2013). Continuous supply of major nutrients through high analysis fertilizer without organic manure in potato also lead to great extent over exploitation of Zn from the soil by crop, resulted in deficiency of zinc was observed in many parts of rice wheat cropping system. The short duration of crops and the shallow root system of potato also hamper the utilization of zinc from deeper layer of soil. Sometimes, change in soil pH due to canal irrigation, zinc present in the soil but not available to the plants due to high pH as a result of crops grown under such soil may suffer from zinc deficiency (Singh *et al*., 2013). This deficiency is not corrected timely then a huge tuber yield loss may occur due to the sub-optimal yield of potato. Hence, keeping above facts in view a field experiment was carried out to evaluate the response of zinc in potato under irrigated ecosystem of Eastern Indo-Gangetic plains of India.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive years of 2015-16 and 2016-17 under All India Coordinated Research Project on potato at Central potato Research Station,

[1]*ICAR-Indian Institute of Sugarcane Research, Lucknow-226002, Uttar Pradesh, India
[2]ICAR-Central Potato Research Station, Patna-801506, Bihar, India
[3]ICAR-Central Potato Research Institute, Shimla-171001, Himachal Pradesh, India
[4]ICAR-Indian Institute of Vegetable Research, Varanasi-221305, Uttar Pradesh, India
[5]Research Scholar, CSAUA&T Kanpur-208002, Uttar Pradesh, India
*Corresponding author email : sanjaybhu05@rediffmail.com

Patna, Bihar. The soil of experimental field is homogenous in nature of fertility status with sandy loam in texture of Indo-Gangetic alluvial plains. The trial was conducted under randomised block design which consists of five treatment and four replications. Recommended dose of fertilizers for potato for this region were taken as 150, 60 and 80kg per hectare in the form of N, P_2O_5 and K_2O supplied through Urea, DAP and MOP, respectively to each treatment. Different doses of zinc*viz*.,0, 1.5, 3.0, 4.5 and 6.0 kg/ha were applied in the field through zinc sulphate at the time of planting through basal placement. *'Kufri Sindhuri' is* one of the most cultivated medium to late maturing variety of potato was taken for the experiment. Sprouted tuber was planting at distance of 60 cm from row to row apart from 20 cm ofplant to plant spacing. Full recommended dose of phosphorus & potassium with half dose of nitrogen were applied as basal just below the tuber in the furrows at the time of planting. Remaining half dose of nitrogen was applied at the time of earthing up at 30 days after planting. Pre-emergence herbicides were used to control the weeds during early stage of crop. Irrigation was applied as per the requirement of crop for this region.

Recommended other package and practices for disease and pest management were followed as per standard recommendation of the crop. Observations for plant emergence was recorded at 30 DAP while plant height was taken at different growth stages of the crop.The net plot area of potato in each plot was harvested for estimation of different grades of tuber yield. Grades wise tuber yield (very small <25g, small 25-50g, medium50-75g and large >75g) were separated based on the weight of individual tuber in kg per plot and further converted in t/ha. Sale price of potato was taken Rs. 8.0/kg for calculation of gross return of cultivation. The data obtained was subjected to statistical analysis for variance using statistical method given by Panse and Sukhatme (1985) at 5% level of significance.

RESULT AND DISCUSSION

Growth attributes

The data presented in Table 1 revealed that no significant difference was recorded due to different treatment for emergence of plant during both the years of study. Actually, stored nutrient and moisture in tuber is sufficient to nourish the crop for emergence of tuber during initial stage. Treatment effect of zinc application was not noticed in relation to plant height of crop at 30 days after planting. However, some differences in plant height were recorded in the plot which received the Zn at the higher doses as compare to without zinc application. Kurosh *et al.* (2004) was also reported that plant emergence was not influenced by zinc application. Significant different in plant height was observed at later stages of crop due to application of zinc at the rate of 6.0 kg/ha along with recommended dose of fertilizers. It was well established that zinc play a crucial role in development of chlorophyll and chloroplast, resulted in more assimilation of nutrient from soil due to enhanced photosynthesis activities, caused in higher plant height with application of zinc. Similar result was also reported by Hansch and Mendel (2009). Similarly, dry matter yield of potato tubers was also recorded consequently higher due to application of higher doses of zinc. However, there was no significant variation in dry matter yield of potato haulm were recorded due to zinc application. This was might be due to more partitioning of photosysnthates to wards tuber from foliage resulted in higher tuber dry matter production. Contributions of zinc were more prominent in dry matter yield of tuber as compared to foliage of potato (Vinod *et al*., 2008).

Table1: Effect of zinc application on growth attributes and dry matter yield of potato (Pooled over 2 years).

Treatment	Emergence (%)	Plant height (cm)			Dry matter (t/ha)	
	30 DAP	30 DAP	60DAP	90DAP	Tuber	Haulm
RDF of NPK	97.6	20.0	29.4	44.5	5.68	3.63
RDF of NPK + 1.5kg Zn/ha	96.1	20.5	31.6	45.4	6.10	3.46
RDF of NPK + 3.0 kg Zn/ha	95.8	21.8	32.9	49.3	6.31	3.37
RDF of NPK + 4.5 kg Zn/ha	96.3	22.4	35.1	50.3	6.78	3.58
RDF of NPK + 6.0 kg Zn/ha	95.7	22.6	36.2	54.8	7.20	3.78
SE±	0.74	1.1	1.4	2.8	0.54	0.38
CD(0.05)	NS	2.4	3.0	6.1	1·23	NS

Yield attributes

Data on different grades of tuber and marketable yield are presented in Table 2 shown that no significant difference in yield of 0-25g and 25-50g tuber were recorded irrespective of doses of zinc application in potato. However, the increasing trends were observed for different grades of tuber in all categories with gradual increase in doses of zinc. Significant variation in medium and large size tuber yield were recorded due to application of zinc @ 6.0 kg/ha over without zinc application on same level of recommended dose of fertilizers in the form of NPK. Highest marketable yield of potato was observed due to zinc application at 6.0 kg/ha followed by 4.5 kg/ha which at par to each other but found significantly superior over lower doses of zinc. Although each doses of zinc from the lowest to the highest brought out more enhancement in marketable tuber yield of potato. About 18.1% increase in marketable tuber yield of potato was found due to application of zinc @ 6.0 kg/ha as compare to without zinc application under same level of recommended does fertilizers of NPK. Increase in marketable tuber yield was directly related to the increase in medium and large size tuber yield of potato with better translocation of starch from source to sink due to zinc application (Lenka and Das, 2019).

Tuber yield

Tuber yield and economics of potato are given in Table 3. Highest tuber yield of potato was recorded with application of zinc @ 6.0 kg/ha during the both the years. Zinc response based on the pooled analysis of result revealed that consequently about 11.3% and 13.7% increase in the total

Table2: Effect of zinc application on various grades and marketable tuber yield of potato (Pooled over 2 years).

Treatments	Grade				Marketable yield (t/ha)
	0-25g	25-50g	50-75g	>75g	
RDF of NPK	4.75	6.91	10.4	11.5	28.8
RDF of NPK + 1.5kg Zn/ha	4.68	7.45	10.5	12.0	29.9
RDF of NPK + 3.0 kg Zn/ha	4.31	6.59	11.1	13.5	31.2
RDF of NPK + 4.5 kg Zn/ha	4.45	7.37	11.6	14.0	33.0
RDF of NPK + 6.0 kg Zn/ha	4.11	7.51	12.2	14.3	34.0
SE±	1.02	1.08	0.67	0.72	1.21
CD(0.05)	NS	NS	1.39	1.54	2.56

tuber yield of potato was observed due to application of zinc @ 4.5 and 6.0 kg/ha, respectively over without zinc application at the same level of recommended dose of fertilizers of NPK. However, no significant variation in pooled yield was found between application of zinc upto 3.0 kg/ha and without zinc application over the same level of RDF of NPK. Zinc play a crucial role to increase the vegetative growth of plant besides tuberization and bulking by enhancing the process of photosynthesis in potato resulted in higher yield as compared to without zinc application. Similar results were also reported by (Joshi and Raghav, 2007).

Table3: Response of zinc on total tuber yield (t/ha)

Treatments	Total tuber yield (t/ha)		
	2015-16	216-17	Pooled
RDF of NPK	32.4	34.7	33.5
RDF of NPK + 1.5kg Zn/ha	33.7	35.5	34.6
RDF of NPK + 3.0 kg Zn/ha	34.6	36.4	35.5
RDF of NPK + 4.5 kg Zn/ha	36.5	38.3	37.4
RDF of NPK + 6.0 kg Zn/ha	37.3	38.9	38.1
SE±	1.38	1.40	1.39
CD(0.05)	3.04	3.10	3.07

Economics

Profitability of zinc application becomes one of the major economic factors to decide the use of this micronutrient in potato along with recommended dose of fertilizers, hence, economics of potato are given in Table 4. The highest net return and net benefit cost ratio was recorded due to zinc application of 6.0 kg/ha as compared to other treatment. Approximately the highest increase in net return about Rs 36.0×10^3per hectare potato was recorded due to application of zinc @ 6.0kg/ha over without zinc application in potato. Similar trend was also observed for benefit cost ratio. Increase in net profit due to zinc application was found more against additional cost of zinc as compared to enhancement in productivity of potato.

Table4: Response of zinc on economics of potato ($\times10^3$Rs/ha)

Treatments	Economics (mean)		
	Total cost	Net return	B:C ratio
RDF of NPK	86.0	182.2	2.12
RDF of NPK + 1.5kg Zn/ha	86.2	190.7	2.21
RDF of NPK + 3.0 kg Zn/ha	86.4	197.5	2.29
RDF of NPK + 4.5 kg Zn/ha	86.6	212.6	2.46
RDF of NPK + 6.0 kg Zn/ha	86.7	218.2	2.52

CONCLUSION

The result may be concluded that no significant variation in total yield of potato wasfound between 4.5 or 6.0 kg/ha of zinc application. However, economic point of view, the highest net return (Rs. 36.0×10^3/ha) and net benefit cost ratio (2.52) was recorded due to application of zinc @ 6.0 kg/ha as compared to without zinc. Hence, application of zinc @ 6.0 kg/ha along with recommended dose of NPK may be found more beneficial for potato cultivation under Eastern Indo-Gangetic plains of India.

REFERENCES

Hansch R and Mendel RR. 2009. Physiological functions of mineral micronutrients (Cu, Zn, Mn, Fe, Ni, Mo, B, Cl). *Current Opinion in Plant Biology***12**(3):259-266.

Joshi N and Raghav M. 2007. Growth and yield of potato as influenced by zinc sulphate and their method of application. *Progressive Horticulture* **39**(2):189-193.

Kawachi M, Kobae Y, Mori H, Tomioka R, Lee Y and Maeshima M. 2009. A mutant strain *Arabidopsis thaliana* that lacks vacuolar membrane Zinc transporter MTP1 revealed the latent tolerance to excessive Zinc. *Plant Cell Physiology* 50(6):1156-1170.

Kourosh SN, Saeed J, Hosein AS, and Sodabeh EA. 2004. Consideration on effects of application time and rate of zinc on quantitative and qualitative characteristics of potato. *Agricultural Research Center of Khorasan*. 48 p.

Kumar Vinod, Vyakarnahal VS, Basavaraj N, Kulkarni S and Shekhargouda M. 2008. Influence of micronutrients on growth and yield of potato (*Solanumtuberosum*. L) cultivars. *Indian Journal of Agricultural Sciences* 78(9):96-97.

Lee S, Kim SA, Lee J, Guerinot ML, An G. 2010. Zinc deficiency-inducible osZIP8 encodes a plasma membrane-localized Zinc transporter in rice. *Molecules and cells*. 29(6):551-558.

Lenka Biswajit and Das Sanjib Kumar. 2019. Effect of boron and zinc application on growth and productivity of potato (*Solanum tuberosum*) at alluvial soil (Entisols) of India. *Indian Journal of Agronomy* 64(1):129-137.

Lenka Biswajit, Divya RK and Das SK. 2020. Nutrient use efficiency, yield attributes and comparative economics of potato crop (*Solanum tuberosum* L.) in response to zinc and boron nutrition in Entisols of India. *International Journal of Chemical Studies* 8(3):10-17.

Palmer CM, Guerinot ML. 2009. Facing the challenges of Cu, Fe and Zn homeostasis in plants. *Nature Chemical biology* 5(5):333-340.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research Publication, 87-89.

Singh AK and Bhatt BP. 2013. Effects of foliar application of zinc on growth and seed yield of late-sown lentil. *Indian J. Agril. Sci.* 83 (6): 622-626.

Singh AK, Meena MK, Bharati RC and Gade RM. 2013. Effect of sulphur and zinc management on yield, nutrient uptake, changes in soil fertility and economics in rice (*Oryza sativa*) – lentil (*Lens culinaris*) cropping system. *Indian J. Agril. Sci.* **83** (3):344-348.

Yadav SK, Singh RK, Singh SK, Yadav S, and Bakade RR. 2020. Site specific nutrient management in potato through nutrient omission plot technique. *Journal of AgriSearc h***7**(2):59-62.

Yadav SK,Singh RK, Dua VK, Yadav SaralaandYadav VP.2021. Evaluation of lac factory waste on flower production. Response of Potato to Zinc Application in Eastern Indo-Gangetic Plains of India.*Journal of AgriSearch* **8**(1): 18-20