Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(6): 1641-1643
Received: 12-09-2017
Accepted: 14-10-2017

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Impact of nitrogen and zinc on quality, yield and economics of potato (*Solanum tuberosum* L.) cultivar Kufri Himsona

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Abstract
A field experiment was conducted during the winter (*rabi*) season of 2015-16 to study the Impact of nitrogen and zinc on quality, yield and economics of potato (Solanum tuberosum L.) cultivar Kufri Himsona at selaqui, Deharadun. Testing the experiment near normal in pH and EC, Medium Organic Carban, low in available N, high in available P and medium available K, low in available Zn. The experiment was laid out in Randomized block design with four Nitrogen levels viz. 0, 150, 200 and 250 kg ha^{-1} in main plot in Combination with twelve nutrient treatments (T_1: N_0+Zn_5, T_2: N_0+ Zn_{10}, T_3: N_0 + Zn_{15}, T_4: N_{150} + Zn_5, T_5: N_{150} + Zn_{10}, T_6: N_{150} + Zn_{15}, T_7: N_{200} + Zn_5, T_8: N_{200} + Zn_{10}, T_9: N_{200} + Zn_{15}, T_{10}: N_{250} + Zn_5, T_{11}: N_{250} + Zn_{10} and T_{12}: N_{250} + Zn_{15}) in the sub-plots with three replication. Result show that 200 kg N ha^{-1} and 15 kg Zn ha^{-1} recorded the highest tuber yield, Dry matter content in tuber, good quality of tuber colour and reducing sugar which were significantly better than 150 and 250 kg nitrogen and 5, 10 kg Zinc accept 0 kg nitrogen kg ha^{-1}. Highest nitrogen content and zinc content in potato plant recorded with application of 250 kg ha^{-1} which was at par with 200 kg N ha^{-1}.

Keywords: Kufri Himsona, nitrogen, zinc, potato, quality, yield

Introduction
Potato (*Solanum tuberosum* L.) is a leading staple food in the diet of the world's population which is also used as animal feed (Eleiwa *et al.*, 2012; Levy *et al.*, 2013) [3]. Potato provides a part of daily caloric needs of human and delivers many essential nutrients and vitamins including potassium, phosphorus, manganese, magnesium, folate, vitamin C and vitamine B-6 (Haynes *et al.*, 2012) [4]. Potatoes provide a bulk dry matter and yield per unit area in comparison with other crops such as cereals, therefore Potato is considered as a heavy nutrient requiring crop (Haynes *et al.*, 2012; Bari *et al.*, 2001) [4, 1]. Nitrogen (N) is an important nutrient influencing the quality and yield of potato tubers and vegetative growth of the plant (Westerman and Kleinkopf, 1985; Vos, 1997; Eleiwa *et al.*, 2012) [3, 10, 9]. Potato is highly responsive to N fertilization and N is generally the most limiting nutrient in potato production (Belanger *et al.*, 2000) [2]. On the other hand excess nitrogen application may delay tuber initiation and reduce the yield and quality of tubers (Marschner, 1995; Crozier *et al.*, 2000) [5].
Micronutrients are essential elements for plant growth and development which are utilized in trace amounts by plants. Among Zinc (Zn) play several physiological roles in plants. Zinc activator enzymes which are responsible for the synthesis of certain proteins. It is use in the formation of chlorophyll and some carbohydrates, conversion of starches to sugars and its presence in plant tissue helps the plant to withstand cold temperature. Zinc is essential in the formation of auxin, which help with growth regulation and stem elongation. (Hafeez *et al*. 2013). In spite of knowing the importance of nitrogen and physiological roles of zinc in plants, thus this trial was aimed to study the Impact of nitrogen and zinc on quality, yield and economics of potato (*Solanum tuberosum* L.) Cultivar Kufri Himsona.

Material Method
A field experiment was conducted on hilly areas of plains during rabi season of 2015-16 on sandy loamy soil of Main Agronomy Research Station, Doon (P.G.) Collage of Agriculture Science and Technology, Rampur, Selaqui, Deharadun, Uttrakhand to study the response of nitrogen and zinc on growth and yield of potato (*Solanum tuberosum* L.) cultivar Kufri Himsona. The important soil properties of the field were: pH 6.5, organic carbon 0.52 % soil, available N 220.9 kg ha^{-1}, available P 27.3 kg ha^{-1} and available K 195.6 kg ha^{-1} and available zinc (0.44 ppm). The experiment was laid out in the split-plot design with four Nitrogen levels

viz. 0, 150, 200 and 250 kg N ha^{-1} in main plot in Combination with twelve nutrient treatments (T_1: N_0+Zn_5, T_2: N_0+ Zn_{10}, T_3: N_0 + Zn_{15}, T_4: N_{150} + Zn_5, T_5: N_{150} + Zn_{10}, T_6: N_{150} + Zn_{15}, T_7: N_{200} + Zn_5, T_8: N_{200} + Zn_{10}, T_9: N_{200} + Zn_{15}, T_{10}: N_{250} + Zn_5, T_{11}: N_{250} + Zn_{10} and T_{12}: N_{250} + Zn_{15}) in the sub-plots with three replication. Kufri Himsona varieties were sown on 7 October, 2015. Fertilizers (Urea, Single Super Phosphate, Murate of Potash, and Zinc sulphate) were applied according to treatment. Half dose of the N and full dose of P, K and Zn was applied at planting and other half at the time of earthing up (30 DAS) according to treatment.

Result and Discussion

Quality Parameter

Tuber dry matter is an important quality parameter. Tuber dry matter content more than 20 per cent is acceptable for processing (sandhu *et al.* 2010) maximum dry matter conten was observed in treatment N_{200} (22.40 %) which was at par with N_{250} (22.19 %) and significantly higher than control N_0 (20.82 %) and N_{150} (22.12 %). Decrease in tuber dry matter content with higher fertilizer dose could be related with relative maturity of tubers. Maximum dry matter was observed in treatment Z_{15} (22.1) followed by Z_{10} (21.8 %) and Z_5 (21.7 %).

Chips colour of fried chips is most important visual character for determining the suitability of potatoes for processing. Chips having dark colour are unacceptable to consumers due to poor aesthetic apperal and bitter taste. Higher chip colour was observed in treatment N_{250} (2.80) which was at par with N_{200} and N_{150} and significantly higher than N_0 (1.98). (kumar *et al.* 2004) observed slight increase in chip colour at higher fertilizer N dose. Chip show significantly variation with Zn application. Higher chip colour was observed in Zn_{15} (2.78) followed by Zn_{10} and Z_{15} and Zn_5 were significantly at par with each other.

Reducing Sugar

Low reducing sugar preferable for processing. Minimum reducing sugar found in control N_0 followed by N_{200}, N_{150} and N_{250} and differed significantly over control N_0. These results were according to the finding of (Kumar *et al.* 2004) Minimum reducing sugar found in treatment Zn_{15} followed by Zn_5 and Zn_{10}.

The Interaction for all quality parameter between Nitrogen and zinc was found non-significant to each other.

Chemical analysis

Availability of fertilizers increased the N and Zn uptake by tuber yields significant over control treatment, which might be because of better growth and development of the plant and adequate N and Zn availability in the soil. However, higher values of N uptake by the crop were noted with N_{250} than that of N_{200}, N_{150} and N_0 respectively**.** In sub treatment, Maximum Zn uptake was recorded in treatment Zn_{15} followed by Zn_{10} and Zn_5. Taya *et al*. (1994) [7] also started that zinc uptake was highest in soil application 8 kg Zn ha^{-1}.

The interaction between nitrogen and zinc was found non-significant to each other.

Table 1: Impact of nitrogen and zinc on quality, yield and economics of potato

Treatment	Tuber dry matter	Chips Colour	Reducing sugar	Nitrogen uptake	Processable tuber yield	Non-Processable tuber yield	Total tuber yield	B:C Ratio
0	20.82	1.98	56.8	60.7	86.1	108.9	194.0	1.59
150	22.12	2.70	70.7	138.4	188.1	183.9	371.0	3.01
200	22.40	2.60	66.4	172.4	216.1	203.2	418.2	3.27
250	22.19	2.80	75.7	179.9	205.5	197.9	402.3	2.98
SEm±	0.07	0.12	2.29	2.24	6.3	5.36	6.26	
CD	0.23	0.34	6.84	7.76	18.9	16.2	18.8	
Zinc levels (kg ha^{-1})								
5	21.74	2.37	65.0	0.06	156.4	164.5	319.9	2.68
10	22.12	2.43	73.1	0.26	180.3	175.3	354.6	2.72
15	22.40	2.7	64.0	0.33	185.1	180.1	364.2	2.93
SEm±	0.06	0.09	1.78	0.03	4.84	4.1	5.8	
CD	0.17	0.29	5.58	NS	14.9	12.5	17.8	

Tuber yield

The ultimate objective in almost all the agronomy studies is obtain the optimum yield of a cr followed by Zn_{10} and Zn_5. Taya *et al*. (1994) [7] also started that zinc uptake was highest in soil application 8 kg Zn ha^{-1}. op. Tuber yield increased significantly up to treatment N_{200}. However, treatments N_{200} was at par with N_{250}. Highest tuber yield recorded with treatment T_9 N_{200} which significantly superior than other nitrogen levels in all aspects. Highest tuber yield was observed with treatment Z_{15} which was statistically at par with Z_{10} and significantly higher than control. Tuber yield might have increased due to better nitrogen and zinc availability. Whereas the interaction effect on tuber yield of potato plants were not significant. (Rajanna *et al.* 1987) [8] also reported application of different levels of nitrogen increase the yield significantly over control. Similar result reported by (Barghi *et al*. 2012).

Economics

The economic evaluation of different treatments (Table.1) indicated that application of urea at the rate of 200 kg N ha^{-1} fetched maximum net monetary return (145746.41 Rs/ha) with B:C ratio (3.27) followed by N_{150} and N_{250}.Whereas treatment N_0 was recorded minimum net return (Rs 119986) and B:C ratio of (2.93) than Z_{10} and control.

Conclusion

It is inferred that application of 200 kg N ha^{-1} incubated with 15 kg Zn ha^{-1} to potato crop is the most appropriate nutrient management strategy for getting higher tuber yield, good quality of tuber. However, looking into the net return, due to high production was found by N_{200} and Zn_{15} inferior as compared to the other treatment 1under prevailing condition of Dehradun region. With regards to B:C ratio N_{200} and Zn_{15} recorded higher B:C ratio followed by N_{150} and N_{250} and Zn_5 and Zn_{10}.

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