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

Vikash Kumar, Pradeep Mishra, Sidharth Shankar Bhatt, Sukhpal Singh, Rahul Kumar Singh and Chandan Kumar Singh

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, Dehradun. Testing the experiment near normal in pH and EC, Medium Organic Carbon, 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 N ha⁻¹ in main plot in combination with twelve nutrient treatments (T1: N₀+Zn₁₂, T₂: N₀+Zn₇, T₃: N₀+Zn₅, T₄: N₀+Zn₅, T₅: N₁₅₀+Zn₁₀, T₆: N₁₅₀+Zn₅, T₇: N₁₅₀+Zn₁₅, T₈: N₂₀₀+Zn₅, T₉: N₂₀₀+Zn₁₀, T₁₀: N₂₀₀+Zn₁₅, T₁₁: N₂₅₀+Zn₁₀ and T₁₂: N₂₅₀+Zn₁₅) 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, and quality of tuber colour and reducing sugar which were significantly better than 150 and 250 kg N ha⁻¹ in main plot in combination with twelve nutrient treatments (T1: N₀+Zn₁₂, T₂: N₀+Zn₇, T₃: N₀+Zn₅, T₄: N₀+Zn₅, T₅: N₁₅₀+Zn₁₀, T₆: N₁₅₀+Zn₅, T₇: N₁₅₀+Zn₁₅, T₈: N₂₀₀+Zn₅, T₉: N₂₀₀+Zn₁₀, T₁₀: N₂₀₀+Zn₁₅, T₁₁: N₂₅₀+Zn₁₀ and T₁₂: N₂₅₀+Zn₁₅) in the sub-plots with three replication. The experiment was laid out in the split-plot design with four nitrogen levels 0, 150, 200, and 250 kg N ha⁻¹ and three zinc levels 5, 10, and 15 kg Zn 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) [4]. Potato provides 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) [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, 5]. 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) [4, 10]. Nitrogen is a nutrient for which potato tuber formation is commonly considered to be 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 Zn (Zn) play several physiological roles in plants. Zinc activator enzymes which are responsible for the synthesis of certain proteins. It is in 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 and Method
A field experiment was conducted on hilly areas of plains during the 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, Dehradun, Uttar Pradesh, India for studying 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.
viz. 0, 150, 200 and 250 kg N ha⁻¹ in main plot in Combination with twelve nutrient treatments (T₁: N₀+Zn₁₀, T₂: N₀+Zn₁₀, T₃: N₀+Zn₁₀, T₄: N₁₅₀+Zn₁₀, T₅: N₁₅₀+Zn₁₀, T₆: N₁₅₀+Zn₁₀, T₇: N₂₀₀+Zn₁₀, T₈: N₂₀₀+Zn₁₀, T₉: N₂₀₀+Zn₁₀, T₁₀: N₂₅₀+Zn₁₀, T₁₁: N₂₅₀+Zn₁₀ and T₁₂: N₂₅₀+Zn₁₀) 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 N₂₀₀ (22.40 %) which was at par with N₂₅₀ (22.19 %) and significantly higher than control N₀ (20.82 %) and N₁₅₀ (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 Z₁₅ (22.1) followed by Z₁₀ (21.8 %) and Z₅ (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 N₂₅₀ (2.80) which was at par with N₂₀₀ and N₁₅₀ and significantly higher than N₀ (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 Z₁₅ (2.78) followed by Z₁₀ and Z₁₅ and Z₅ were significantly at par with each other.

Reducing Sugar

Low reducing sugar preferable for processing. Minimum reducing sugar found in control N₀ followed by N₂₀₀, N₁₅₀ and N₂₅₀ and differed significantly over control N₀. These results were according to the finding of (Kumar et al. 2004) Minimum reducing sugar found in treatment Z₁₅ followed by Z₁₀ and Z₁₅. 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 N₂₅₀ than that of N₂₀₀, N₁₅₀ and N₀ respectively. In sub treatment, Maximum Zn uptake was recorded in treatment Z₁₅ followed by Z₁₀ and Z₁₅. 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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tuber dry matter</th>
<th>Chips Colour</th>
<th>Reducing sugar</th>
<th>Nitrogen uptake</th>
<th>Processable tuber yield</th>
<th>Non-Processable tuber yield</th>
<th>Total tuber yield</th>
<th>B:C Ratio</th>
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<tr>
<td>0</td>
<td>20.82</td>
<td>1.98</td>
<td>56.8</td>
<td>60.7</td>
<td>86.1</td>
<td>108.9</td>
<td>194.0</td>
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<td>150</td>
<td>22.12</td>
<td>2.70</td>
<td>70.7</td>
<td>138.4</td>
<td>188.1</td>
<td>183.9</td>
<td>371.0</td>
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<td>200</td>
<td>22.40</td>
<td>2.60</td>
<td>66.4</td>
<td>172.4</td>
<td>216.1</td>
<td>203.2</td>
<td>418.2</td>
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<td>250</td>
<td>22.19</td>
<td>2.80</td>
<td>75.7</td>
<td>179.9</td>
<td>205.5</td>
<td>197.9</td>
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<tr>
<td>SEM±</td>
<td>0.07</td>
<td>0.12</td>
<td>2.29</td>
<td>2.24</td>
<td>6.3</td>
<td>5.36</td>
<td>6.26</td>
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<tr>
<td>CD</td>
<td>0.23</td>
<td>0.34</td>
<td>6.84</td>
<td>7.76</td>
<td>18.9</td>
<td>16.2</td>
<td>18.8</td>
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<td>5</td>
<td>21.74</td>
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<td>164.5</td>
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<td>73.1</td>
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<td>185.1</td>
<td>180.1</td>
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<tr>
<td>SEM±</td>
<td>0.06</td>
<td>0.09</td>
<td>1.78</td>
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<td>4.84</td>
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<td>NS</td>
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<td>Zn levels (kg ha⁻¹)</td>
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</table>

Tuber yield

The ultimate objective in almost all the agronomy studies is obtain the optimum yield of a crop followed by Zn₁₀ and Zn₁₅. 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 N₂₅₀. However, treatments N₂₀₀ was at par with N₂₅₀. Highest tuber yield recorded with treatment T₅ N₂₀₀ which significantly superior than other nitrogen levels in all aspects. Highest tuber yield was observed with treatment Z₁₅ which was statistically at par with Z₁₀ 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) [6] 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 N₁₅₀ and N₂₅₀. Whereas treatment N₀ was recorded minimum net return (Rs 119986) and B:C ratio of (2.93) than Z₁₀ 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 N₂₅₀ and Z₁₅ inferior as compared to the other treatment lunder prevailing condition of Dehradun region. With regards to B:C ratio N₂₀₀ and Z₁₅ recorded higher B:C ratio followed by N₁₅₀ and Z₁₅ and Z₁₀.

References

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