Effect of nickel with different sources of nitrogen on rice (*Oryza sativa* L.)

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Abstract

A field experiment consisting of 6 treatment combinations of two levels of Ni (@ 1 and 2 kg ha\(^{-1}\)) with two nitrogen sources and three replications was conducted under randomized block design at research plot of Udai Pratap (Autonomous) College, Varanasi (U.P.). The main objective of study was to find out the effect of Ni with different sources of nitrogen on growth and yield of rice (*Oryza sativa* L.). The experiment was laid out in a randomized block design (RBD) having 6 treatments and 3 replications. Treatments were T\(_0\) = control, T\(_1\) = nitrogen through ammonium sulphate + Ni @ 1 kg ha\(^{-1}\), T\(_2\) = nitrogen through ammonium sulphate + Ni @ 2 kg ha\(^{-1}\), T\(_3\) = nitrogen through urea + Ni @ 1 kg ha\(^{-1}\), T\(_4\) = nitrogen through urea + Ni @ 2 kg ha\(^{-1}\) and T\(_5\) = 50% nitrogen through Urea and 50% nitrogen through ammonium sulphate + Ni @ 2 kg ha\(^{-1}\). The results revealed that the growth, yield, organic carbon and available N, P and K status of soil was significantly increased by application of Ni @ 1 and 2 kg ha\(^{-1}\) with different nitrogen sources (urea and ammonium sulphate) as compared to control. Similar results were also observed with nutrients (N, P and K) content and uptake by the rice.

Keywords: Nickel, nitrogen, urea, ammonium sulphate, rice

1. Introduction

Ni is the most recent candidate to be added in the list of essential nutrient for higher plant. Ni is considered as an essential element primarily because of its function as an irreplaceable component of urease which is responsible for the hydrolysis of urea N. Urea N acquired by plant is not available for plant N metabolism unless hydrolyzed to CO\(_2\) and NH\(_3\). Consequently, urea grown plants are highly sensitive to inadequate Ni supply (Gerendas and Sattelmacher, 1999a) \[8\]. Additionally, seed treatment together with Ni fertilization of soybean might improve the efficiency of biological nitrogen fixation (BNF), boosting grain dry matter yield and N content (Lavres et al., 2016) \[13\]. Among the nitrogenous fertilizer sources, urea is most popular than other nitrogenous fertilizer like, ammonium sulphate, ammonium nitrate etc. However, urea N requires conversion of nitrogen into inorganic form it is hydrolyzed by urease enzyme before its utilization by plant roots. (Gerendas et al., 1998) \[8\] found that in plants supplied with urea and Ni, the growth was impaired at the lower levels of Ni, whereas, in plants supplied with NH\(_4\)NO\(_3\) and Ni, growth was not affected by micronutrient.

2. Materials and Methods

The field experiment was conducted in the *kharif* season of 2016 at research plot of Udai Pratap (Autonomous) College, Varanasi (U.P.). The soil (0-15 cm) of the experimental plot was of alluvial origin, sandy loam in texture, having electrical conductivity (EC) of 0.51 dS m\(^{-1}\), pH 7.62 with 0.61% organic carbon (OC). The soil was low in available N (131.2 kg ha\(^{-1}\)), available P (14.2 kg ha\(^{-1}\)), and available K (182.3 kg ha\(^{-1}\)). The experiment was laid out in a randomized block design (RBD) having 6 treatments and 3 replications. Treatments were T\(_0\) = control, T\(_1\) = nitrogen through ammonium sulphate + Ni @ 1 kg ha\(^{-1}\), T\(_2\) = nitrogen through ammonium sulphate + Ni @ 2 kg ha\(^{-1}\), T\(_3\) = nitrogen through urea + Ni @ 1 kg ha\(^{-1}\), T\(_4\) = nitrogen through urea + Ni @ 2 kg ha\(^{-1}\) and T\(_5\) = 50% nitrogen through Urea and 50% nitrogen through ammonium sulphate + Ni @ 2 kg ha\(^{-1}\). The crop was fertilized with recommended dose of 120 kg N, 60 kg of P\(_2\)O\(_5\) and 60 kg of K\(_2\)O ha\(^{-1}\). Half dose of N and full doses of P\(_2\)O\(_5\) and K\(_2\)O were applied as basal application. The remaining N was applied at tillering and panicle initiation stages. Ni was applied in the form of NiSO\(_4\) as basal application. The crop was irrigated as per recommended schedule and harvested at maturity. Growth and yield attributes were recorded.
2.1 Soil and plant analysis

Soil samples were collected at 0-15 cm depth after harvest of the crop and analyzed by standard method of analysis. Soil reaction (pH) was determined using soil: water suspension (1:2.5) with the help of glass electrode digital pH meter (Jackson, 1973) [11], EC by TDS meter (Chopra and Kanwar, 1991) [10], Organic Carbon by Walkley and Black’s rapid titration method (Walkley and Black, 1934) [20], available P:O (Olsen’s et al., 1954) [15], available K:O by neutral normal ammonium acetate extraction method (Jackson, 1973) [11], available N by alkaline permanganate method (Subbiah and Asija, 1956) [19] and available Ni by A.A.S. method using DTPA extract (Laurent and Sylvie, 1996) [12]. Plant samples were dried at 70°C for 12 hours. 0.5 gram ground plant sample was digested in sulphuric acid and perchloric acid with the ratio of 9:1 and digested samples were used to determine the content of nitrogen by micro kjeldahl’s method, phosphorus by spectrophotometer, potassium by flame-photometer and nickel by AAS method.

3. Results and Discussion

The growth parameters (plant height and number of tillers) were significantly increased by the application of nitrogen through ammonium sulphate and urea with nickel @1 and 2 kg ha⁻¹ as compared to and control (table 1). Maximum plant height and number of tillers were recorded with the treatment containing urea + Ni @ 2 kg ha⁻¹. The findings are in accordance with the results obtained by (Gheibi et al., 2011) [10] who reported that both plant growth and leaf chlorophyll content of the urea fed plants increased significantly with the increase in nickel content up to a certain level. They further reported that the plants received urea plus nickel gave better response than those that received ammonium nitrate plus nickel. Increase in chlorophyll content due to nickel application is also documented by (Lavres et al., 1998) [13], (Dalton et al., 1988) [6] stated that Ni enhances the urease activity in plants. Urease plays an essential role in mobilization of nitrogenous compounds in plants, a process that is especially important during seed germination and fruit formation when protein reserves are degraded into amino acids. Arginine, an abundant amino acid in plants when degraded, produces urea as a product and urease is needed for this reaction (pH) was determined using soil: water suspension (1:2.5) with the help of glass electrode digital pH meter [4].

Table 1: Effect of treatments on growth attributes of rice

<table>
<thead>
<tr>
<th>Treatment</th>
<th>30 DAT</th>
<th>45 DAT</th>
<th>60 DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant height (cm)</td>
<td>Tillers plant⁻¹</td>
<td>Plant height (cm)</td>
</tr>
<tr>
<td>T₀</td>
<td>60.20</td>
<td>3.83</td>
<td>75.10</td>
</tr>
<tr>
<td>T₁</td>
<td>71.10</td>
<td>5.08</td>
<td>92.33</td>
</tr>
<tr>
<td>T₂</td>
<td>77.50</td>
<td>6.00</td>
<td>95.20</td>
</tr>
<tr>
<td>T₃</td>
<td>81.30</td>
<td>6.50</td>
<td>97.20</td>
</tr>
<tr>
<td>T₄</td>
<td>89.40</td>
<td>8.83</td>
<td>113.13</td>
</tr>
<tr>
<td>T₅</td>
<td>85.20</td>
<td>7.17</td>
<td>100.50</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>3.370</td>
<td>0.561</td>
<td>4.263</td>
</tr>
</tbody>
</table>

DAT = Days after transplanting

3.2 Nutrient content and uptake

Ni application @ 1 and 2 kg ha⁻¹ in combination of two sources of nitrogen viz, urea and ammonium sulphate registered significantly higher nutrients (N,P,K) content in grain and straw as compared to without nickel application. Maximum content were recorded with nitrogen @120 kg ha⁻¹ through urea + Ni @ 2 kg ha⁻¹ (T₅). Uptake of N, P and K by straw and grain followed similar trend as in case of their content (table 2). Similar results were also reported by (Dahdoh, 1995) [5], (Palacios, 1998) [16] and (Gad et al., 2007) [7], (Dahdoh et al., 1995) [5] observed that the plant N content and uptake were increased by the addition of Ni. According to (Palacios et al., 1998) [16], the nitrogen content in the plant increased significantly with increasing Ni treatments, showing a synergetic effect between Ni and N. A positive interaction between Ni and potassium (K) content and uptake was also found. (Gad et al., 2007) [7] Also reported a significant promotive effect on nitrogen, phosphorus and potassium content as compared to control by the application of Ni.

Table 2: Effect of treatments on N, P and K content and uptake by rice

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen content (%)</th>
<th>Nitrogen uptake (kg ha⁻¹)</th>
<th>Phosphorus content (%)</th>
<th>Phosphorus uptake (kg ha⁻¹)</th>
<th>Potassium content (%)</th>
<th>Potassium uptake (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Straw</td>
<td>Grain</td>
<td>Straw</td>
<td>Grain</td>
<td>Straw</td>
<td>Grain</td>
</tr>
<tr>
<td>T₀</td>
<td>0.249</td>
<td>1.12</td>
<td>7.25</td>
<td>21.36</td>
<td>0.10</td>
<td>0.32</td>
</tr>
<tr>
<td>T₁</td>
<td>0.433</td>
<td>1.52</td>
<td>26.16</td>
<td>56.24</td>
<td>0.16</td>
<td>0.47</td>
</tr>
<tr>
<td>T₂</td>
<td>0.446</td>
<td>1.62</td>
<td>27.79</td>
<td>61.44</td>
<td>0.18</td>
<td>0.49</td>
</tr>
<tr>
<td>T₃</td>
<td>0.465</td>
<td>1.71</td>
<td>30.29</td>
<td>70.50</td>
<td>0.21</td>
<td>0.50</td>
</tr>
</tbody>
</table>
4. Conclusion
The present study thus concluded that the application of nickel with two sources of nitrogen viz; urea and ammonium sulphate significantly affected the growth, yield and nutrient uptake by rice. The application of nitrogen @ 120 kg ha\(^{-1}\) through urea + Ni @ 2 kg ha\(^{-1}\) was found to be the best treatment regarding growth, yield and nutrients (N, P, K) uptake.

5. References