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NICKEL APPLICATION RATES ON DRY BEAN CULTIVARS IAC FORMOSO AND BRS NOTÁVEL

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INTRODUCTION: Nickel (Ni) is required by crops since it is a structural component of the enzymes urease and hydrogenase, which act in assimilation of nitrogen (N) by plants. In spite of its importance, there is a lack of information in regard to use of Ni in fertilization programs for dry bean. Thus, the aim of this study was to define application rates of Ni through the soil adequate for dry bean growth.

MATERIALS AND METHODS: The experiment was carried out in a greenhouse of the Soil Science Department of the Universidade Federal de Lavras, Brazil, from December 2015 to March 2016. A randomized block statistical design was used, with three replications and a 5×2 factorial arrangement, involving five application rates of Ni (0.0, 0.25, 0.75, 1.5, and 3.0 mg dm⁻³) and two cultivars of dry bean (IAC Formoso and BRS Notável). The pots contained 3 dm³ of Latossolo Vermelho soil.

The source of Ni was hexahydrate nickel sulfate (NiSO₄.6H₂O), applied together with base fertilization according to Malavolta (1980). An inoculant with Rhizobium tropici at a rate of 10 g.kg of seed⁻¹ was used as a source of N. The inoculant contained approximately 10⁹ viable cells per gram. The cv. IAC Formoso was registered in 2010 and released on the Brazilian market in 2011. It has tolerance to lodging and resistance to bacterial blight and to bacterial wilt (Curtobacterium). The cv. BRS Notável was also released in Brazil in 2010 and is recommended for cultivation in twenty Brazilian states. Both have a semi-early cycle, type II upright growth habit, high yield potential, and resistance to anthracnose (CARBONELL et al., 2010; PEREIRA et al., 2012).

At full flowering, the following determinations were made: relative chlorophyll index (RCI), photosynthetic rate (PhR), transpiration rate (TransR), stomatal conductance (Cond), internal CO₂ concentration (ICO₂C) and internal and external CO₂ concentration (IECO₂C), and the activity of the enzyme urease, as well as plant height and shoot dry matter (SDM). All the data were subjected to analysis of variance. In the cases of significant effect of cultivars, comparison of means was performed by the F test (P≤0.05). The effects of Ni application rates were evaluated through regression analysis, selecting the equations through significance of the models.

RESULTS AND DISCUSSION: The highest RCI, PhR, Cond, and plant height were observed in cv. BRS Notável (Table 1), certainly resulting from variation in genetic material. Values similar to those of cv. IAC Formoso, however, were observed in the other variables analyzed. In relation to the effects of Ni, an increase in the application rate did not affect RCI, PhR, ICO₂C, IECO₂C, SDM, and plant height, the mean values of which were in the order of 32, 15 µmol m⁻² s⁻¹, 291 mol m⁻² s⁻¹, 0.8 mol m⁻² s⁻¹, 2.7 g plant⁻¹, and 76.0 cm, respectively. In regard to the physiological parameters TransR and Cond, as well as in regard to urease activity, an increase in the Ni application rate led to increases in the variables; rates greater than 2.0 (TransR – Fig. 1A and Cond – Fig. 1B) and 2.30 mg Ni dm⁻³ (urease activity – Fig. 1C), however, were harmful. The effect of greater application rates indicates reduction in stomatal opening, which reduced transpiration, but not the supply of CO₂ for photosynthesis. Even so, the initial rates appear to have met plant demands, not compromising the plants during the vegetative stage.

As Ni is the enzymatic activator of urease, its presence in the soil at low concentrations increased the activity of this enzyme. In contrast, high concentrations of this nutrient have a negative effect in degradation of urea into carbon dioxide and ammonia, as also reported by Sreekanth et al. (2013).
Table 1. Relative chlorophyll index (RCI), photosynthetic rate (PhR), transpiration rate (TransR), stomatal conductance (Cond), internal CO$_2$ concentration (ICO$_2$C) and internal + external CO$_2$ concentration (IECO$_2$C), urease enzyme activity, plant height, and shoot dry matter (SDM) of dry bean in the full flowering stage.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>RCI - (µmol m$^{-2}$ s$^{-1}$)</th>
<th>PhR (mmol m$^{-2}$ s$^{-1}$)</th>
<th>TransR - (mol m$^{-2}$ s$^{-1}$)</th>
<th>Cond - (µmol m$^{-2}$ s$^{-1}$)</th>
<th>ICO$_2$C</th>
<th>IECO$_2$C</th>
<th>Urease Activity - (µmol N-NH$_4^+$ g massa fresca$^{-1}$ h$^{-1}$)</th>
<th>Height (cm)</th>
<th>SDM (g planta$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAC Formoso</td>
<td>30.7 B</td>
<td>14.4 B</td>
<td>5.0 A</td>
<td>0.5 B</td>
<td>290.8 A</td>
<td>0.82 A</td>
<td>291.0 ± 0.82 A</td>
<td>14.5 A</td>
<td>68.8 B</td>
</tr>
<tr>
<td>BRS Notável</td>
<td>33.7 A</td>
<td>16.9 A</td>
<td>5.6 A</td>
<td>0.6 A</td>
<td>291.3 A</td>
<td>0.83 A</td>
<td>15.3 ± 0.83 A</td>
<td>15.3 A</td>
<td>83.3 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>32.2</strong></td>
<td><strong>15.6</strong></td>
<td><strong>6.3</strong></td>
<td><strong>0.6</strong></td>
<td><strong>291.1</strong></td>
<td><strong>0.82</strong></td>
<td><strong>14.9</strong> ± <strong>0.82</strong> A</td>
<td><strong>14.9</strong></td>
<td><strong>76.0</strong></td>
</tr>
</tbody>
</table>

Mean values followed by the same uppercase letter in the column do not differ by the F test at the level of 5% probability.

Figure 1. Transpiration rate (A), stomatal conductance (B), and urease enzyme activity (C) in dry bean (means of two cultivars, IAC Formoso and BRS Notável, two plants per cultivar) at full flowering (R6), as a function on nickel application rates on soil.

Considering these preliminary evaluations, new investigations should be carried out so as to establish the Ni application rates recommended for dry bean.

REFERENCES


