Canopy reflectance of *Phaseolus* species under saline field conditions

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Introduction

In Mexico, soils of some agricultural regions contain high levels of salts (sodium salts). High salinity in soils reduces plant growth, leaf area (low canopy), and seed yield (Subbarao and Johansen, 1994). *Phaseolus vulgaris* L. is considered as salt sensitive species; however, *Phaseolus coccineus* (ayocote) L. has been classified a tolerant to salt conditions (Subbarao and Johansen, 1994). Remote sensing (spectral reflectance) can be used to assess biomass, leaf area, absorbed radiation, and total chlorophyll with different reflectance indices such as normalized vegetative indices (NDVI and GNDVI) and a ratio analysis of reflectance spectra index for chlorophyll a (RARSa) (Araus et al., 2001). For that reason, the objective of the present work was to determine differences in NDVI, GNDVI and RARSa indices between *P. vulgaris* and *P. coccineus* under saline field conditions.

Material and Methods

The study was carried out in Montecillo, Mexico (19°19'N, 98°54' W, 2250 m of altitude) during the rainy season (June-September, 2000) and with a temperate climate. Seeds of *Phaseolus vulgaris* L. cv. Bayomex and *Phaseolus coccineus* L. cv. Ayocote were sown with a plant density of 6.25 plants m⁻². The design was a random block with four replications. The soil with high salinity has a pH 8-8.7, and an electro-conductivity of 7-14 dS m⁻¹. The soil with low salinity had a pH of 6.8-7.5 and an electro-conductivity of 2-5 dS m⁻¹. All the plots were fertilized with 100-100-00 NPK. Canopy reflectance was measured with a portable spectroradiometer (FieldSpec, USA) at pod filling stage.

Results and Discussion

Canopy reflectance of bean plants was reduced under saline conditions in *P. vulgaris* and *P. coccineus* (Figure 1). *P. coccineus* had an apparently lower canopy reflectance than did *P. vulgaris*. Indeed, *P. coccineus* had the lowest biomass and seed yield under high salinity (Table 1).

In both species, the two vegetative indices (NDVI and GNDVI) were higher in plants grown under low salinity than under high salinity. A high NDVI or GNDVI value implies high biomass and seed yield as was reported in bean plants grown under different nitrogen and phosphorous levels (Gutierrez et al., 2003a, b).

The RARSa index also was reduced under saline growth conditions in plants of *P. vulgaris* and *P. coccineus*. The RARSa index indicates an apparently low chlorophyll content on leaves due to high salt content in the soil.
Figure 1. Canopy spectral reflectance in plants of *P. vulgaris* L. and *P. coccineus* L. under low and high salinity levels. Montecillo, Mexico.

<table>
<thead>
<tr>
<th>Species</th>
<th>Salinity conditions</th>
<th>NDVI</th>
<th>GNDVI</th>
<th>RARSa</th>
<th>Biomass (g m⁻²)</th>
<th>Seed yield (g m⁻²)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Phaseolus</em></td>
<td>Low</td>
<td>0.916a</td>
<td>0.738a</td>
<td>0.069a</td>
<td>251.0 a</td>
<td>145.8 a</td>
</tr>
<tr>
<td><em>vulgaris</em></td>
<td>High</td>
<td>0.874b</td>
<td>0.666b</td>
<td>0.045b</td>
<td>210.7 b</td>
<td>114.5 b</td>
</tr>
<tr>
<td><em>Phaseolus</em></td>
<td>Low</td>
<td>0.931a</td>
<td>0.774a</td>
<td>0.095a</td>
<td>305.6 a</td>
<td>152.5 a</td>
</tr>
<tr>
<td><em>coccineus</em></td>
<td>High</td>
<td>0.833b</td>
<td>0.702b</td>
<td>0.037b</td>
<td>116.4 b</td>
<td>50.0 b</td>
</tr>
</tbody>
</table>

Conclusions

In conclusion, spectral reflectance indices, biomass and seed yield are reduced under saline field conditions. NDVI, GNDVI and RARSa indices estimated a plant growth and chlorophyll reduction under saline conditions.

Literature cited


