Value of Soil Macro- and Micro-nutrient Balances in Predicting Fertilizer Needs of Irrigated Cotton-Wheat Aridisols?

Abdul Rashid1*, Ejaz Rafique2 and M. Mahmood-ul-Hassan2

1Pakistan Atomic Energy Commission, Islamabad, PAKISTAN; 2National Agricultural Research Center, Islamabad, PAKISTAN
*Currently at: Pakistan Academy of Sciences, Islamabad, PAKISTAN (dr.rashid50@gmail.com)

Sustained productivity of >3 million ha irrigated cotton (Gossypium hirsutum L.)-wheat (Triticum aestivum L.) in alluvial, low organic matter Aridisols of Pakistan is pivotal to its food security and economy. Both crops suffer with deficiency of nitrogen (N), phosphorus (P), boron (B) and zinc (Zn) (Rafique et al. 2012a). Despite N and P fertilizer use, productivity levels are low. We investigated effectiveness of apparent soil nutrient balances in predicting crop fertilizer needs.

METHODOLOGY

A 5-year field study was conducted at Multan, Pakistan (30° 11’ N, 71° 28’ E) on two predominant cotton-wheat soil series, (i) Awagat (Coarse loamy mixed, hyperthermic Fluventic Camborthid) (ii) Shahpur (Fine silty mixed, hyperthermic Fluventic Camborthid), with following nutrient treatments:
1) Farmers’ fertilizer use (FFU);
2) Recommended fertilizer use (RFU), soil test-based;

* FFU – cotton, 110 kg N ha⁻¹; wheat, 80 kg N + 26 kg P ha⁻¹; RFU – cotton, 170 kg N + 26 kg P + 5 kg Zn + 1 kg B ha⁻¹; wheat, 140 kg N + 44 kg P ha⁻¹; INM – both crops, RFU + FYM.

The treatments were tried with and without residue recycling (cotton stalks + wheat straw) in flat-bed and raised-bed cotton systems. In split-split plot layout, cotton sowing methods were in main plots, residue recycling in sub-plots, and nutrient managements in sub-sub-plots.

Table 1. Initial topsoil properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Awagat soil</th>
<th>Shahpur soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texture</td>
<td>Coarse loamy</td>
<td>Fine silty</td>
</tr>
<tr>
<td>pH (1:1)</td>
<td>8.0</td>
<td>8.4</td>
</tr>
<tr>
<td>CaCO₃ (%)</td>
<td>2.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>0.60</td>
<td>0.85</td>
</tr>
<tr>
<td>AB-DTPA P (mg/kg)</td>
<td>2.2</td>
<td>3.5</td>
</tr>
<tr>
<td>AB-DTPA K (mg/kg)</td>
<td>150</td>
<td>204</td>
</tr>
<tr>
<td>AB-DTPA Zn (mg/kg)</td>
<td>0.48</td>
<td>0.72</td>
</tr>
<tr>
<td>HCl B (mg/kg)</td>
<td>0.28</td>
<td>0.40</td>
</tr>
</tbody>
</table>

RESULTS

- Minimum yields (Mg/ha), obtained with FFU in flat beds without residue in year-1: Coarse loamy soil – cotton, 2.04; wheat, 3.09; Fine silty soil – cotton, 2.51; wheat, 3.77.
- Productivity potential of fine silty soil was greater; conversely, yield increases with improved nutrient managements were lesser in this soil (Rafique et al. 2012a).
- Yield increases with RFU: Coarse loamy soil – cotton, 24%; wheat, 37%; Fine silty soil – cotton, 18%; wheat, 24% (P<0.05); INM resulted in slightly higher yields. Crop residue increased yields on flat beds by 3–10% and raised bed by 9–10% (Rafique et al. 2012a).
- RFU and INM enhanced SOM (P<0.05), more evidently in less SOM-having coarse loamy soil (Table 1; Rafique et al. 2012a).

CONCLUSIONS

- Unlike soil K balances, P, B & Zn balances appear to be poor indicator of fertilizer needs. High fixation in the calcareous soils appears to cause the ambiguity.
- Soil test-based N, P, K, & Zn fertilizer use, along with FYM and crop residue, is recommended for sustaining crop productivity and the soil resource.

ACKNOWLEDGEMENTS

The work was supported by Pakistan’s Ministry of Science & Technology, through Pak-Kazakh joint Research Fund Project.

REFERENCES