Weed management approaches in transplanted rice in Mollisols of Uttarakhand

Vimal Raj Yadav*, V. Pratap Singh and S.K. Guru

Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand 263 145

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Rice (Oryza sativa L.) is one of the most important cereal crops in India cultivated in 43.9 Mha area with the total production of 106.5 Mt and a productivity of 2.4 t/ha (Economic Survey, 2014-15). Rice as staple food has tremendous influence on agrarian economy of India since it contributes 45% of the total food grain production. Infestation of weeds is one of the most important causes for low yield of rice (Pandey 2009). Transplanted rice is infested with heterogeneous group of weeds comprising of grasses, broad-leaf weeds and sedges causing yield reduction up to 76% (Singh et al. 2004). Among different weed species, grassy weeds pose greater competition as they have an extensive and fibrous root system. Similarly, sedges grow in huge number and cause serious competition for nutrients as they dominate the surface feeding zone and obstruct nutrient flow to crop roots. Broad-leaf weeds being deep rooted explore the sub-surface zone for minerals and exert less competition for nutrients with rice (Puniya et al. 2007). Manual weeding is expensive, time consuming, labour intensive, tedious, back-breaking, difficult and often limited by scarcity of laborers in time. Herbicidal weed control offers an advantage to save labour and money, as a result, regarded as cost-effective (Ahmed et al. 2000). Application of herbicide mixture or sequential application of pre- and post-emergence herbicides or its integration with other methods of weed control may be effective for broad-spectrum management of weed flora in transplanted rice. Therefore, the present study was undertaken to quantify the effect of different weed control treatments either alone or in combination on weed abundance, growth parameters and yield performance of transplanted rice.

A field study was conducted at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand during rainy season of 2012. The soil of the experimental site was silty loam with a pH of 7.3 and EC of 1.16 dS/cm, high in organic carbon content (0.86%), low in available N (226.2 kg/ha) but medium in available P (22.8 kg/ha) and K (145.4 kg/ha). The experiment was laid out in a randomized block design with three replications and twelve treatments viz. pre-emergence (PE) application of pretilachlor 750 g/ha, post-emergence application of bispyribac-Na 20 g/ha, penoxsulam 20, 22.5 and 25 g/ha, pre-emergence application of pretilachlor 750 g/ha fb one hand weeding at 45 days after transplanting (DAT), post-emergence (PoE) application of penoxsulam 22.5 g/ha fb one hand weeding at 45 DAT and one mechanical weeding through conoweeeder at 15 DAT fb one hand weeding at 45 DAT, PE application of pretilachlor with no irrigation up to one week, PE application of pretilachlor with no irrigation up to one week fb PoE application of bispyribac-Na 20 g/ha, hand weeding twice at 20 and 40 DAT and untreated (weedy check). Pre-emergence application of pretilachlor was done at 3 DAT while PoE application of bispyribac-Na and penoxsulam was done at 14 and 20 DAT, respectively. Total five irrigations were given to the crop as and when needed. To all the treatments, irrigation was applied to saturation except PE application of pretilachlor with no irrigation up to one week and pre-emergence application of pretilachlor with no irrigation up to one week fb post-emergence application of bispyribac-Na 20 g/ha. In both of these treatments, irrigation was withheld up to initial one week after transplanting to provide aerobic condition that results in emergence of weeds, which were later effectively controlled by application of post-emergence herbicide. Thereafter, irrigation application was common to all the plots. The herbicide application was done as sole or sequential at the recommended rates using 500 L of water/ha for application of pre and post-emergence herbicides through knapsack sprayer fitted with a flat fan nozzle.

*Corresponding author: vimalrajyadav31990@rediffmail.com
Twenty five days old seedlings of rice variety “Sarjoo 52” were transplanted on July 6, 2012 at 20 x 10 cm apart using two seedlings per hill. All the plots (5 x 3 m) were fertilized with 120 kg N, 60 kg P₂O₅, 40 kg K₂O and 20 kg ZnSO₄/ha in the form of urea, NPK mixture (12:32:16) and muriate of potash. Full dose of P and K and half dose of N were applied uniformly as basal dose at the time of transplanting. Remaining half dose of N was top dressed in two equal splits, one-fourth each at active tillering (30-35 DAT) and at panicle initiation (60-65 DAT) stage of the crop. Weed sampling in experimental plots was done from a sampling area of 1.0 m² by using 50 x 50 cm quadrant at 60 DAT as maximum weed density and dry matter were recorded at this stage compared to other crop growth stages. Weeds were identified, counted species-wise and then biomass was weighed after drying at 70±2°C in electric oven till constant dry weights. The dominant weed species was determined based on the sum dominance ratio (SDR) values expressed as a percentage, computed by using the following equation (Janiya and Moody 1989).

\[
SDR \text{ of a species} = \frac{\text{Relative density (RD)} + \text{Relative dry weight (RDW)}}{2}
\]

Where,

\[
RD = \frac{\text{Density of a given species}}{\text{Total density}} \times 100,
\]

\[
RDW = \frac{\text{Dry weight of a given species}}{\text{Total dry weight}} \times 100
\]

Rice crop was harvested manually on November 3, 2012 with help of sickle at height of 10-15 cm from ground level to leave rice stubbles for residue incorporation into the soil.

The untreated (weedy check) plots were infested by 8 weed species representing 5 families; 4 from Poaceae, and 1 from each of Asteraceae, Cyperaceae, Lythraceae and Amaranthaceae (Table 1). Among the weed flora, 4 were grasses, 3 were broad-leaved and 1 sedge. Based on SDR, grasses were the most dominant weeds which occupied more than 60% SDR of which *Leptochloa chinensis* (SDR 19.8%) and *Echinochloa colona* (SDR 19.1%) were the most prominent weeds. Broad-leaved weeds were next to grasses accounting for about 27.7% SDR of which *Caesalia axillaris* (SDR 13.2%) and *Ammania baccifera* (SDR 10.3%) were most dominant while Sedge was the least dominant accounting merely 12.2% SDR.

At 30 DAT and harvest, no significant difference in plant height was observed among all the treatments due to less competition between crop and weeds (Table 2). At other growth stages, shorter plants were observed in weedy check compared to other integrated and alone application of herbicides. This might be due to the inter plant competition for longer period which inhibited the plants to become taller in weedy check. At 45 and 60 DAT, the maximum plant height was recorded with PoE application of penoxsulam 22.5 g/ha fb one hand weeding at 45 DAT. This might be due to minimum crop-weed competition with application of penoxsulam due to broad spectrum control of weeds and greater weed control efficiency (91.4%) over rest of the treatments.

Number of shoots plays a vital role in determining grain yield in rice since it is closely related to number of panicles per unit ground area. At all the crop growth stages, no significant difference in number of shoots was observed among all the treatments except at 60 DAT (Table 2). In general, shoot population increased up to 45 DAT and thereafter, decreased at subsequent stages irrespective of treatments. Among weed control treatments, higher number of shoots was recorded with PE application of pretilachlor with no irrigation up to one week fb PoE application of bispyribac-Na 20 g/ha followed by PoE application of bispyribac-Na g/ha alone compared to other treatments. Higher number of shoots/m² with PE application of pretilachlor with no irrigation up to one week fb PoE application of bispyribac-Na 20 g/ha might be attributed to less crop-weed competition and better utilization of resources (nutrient, solar radiation and space) at the time of tillering due to effective control of complex weed flora. Similar result was also reported by Bhanumathy (1987). Chandra (1994) also reported that the shoot number and crop dry weight was significantly affected by various weed control treatments whereas, plant height did not reached up to the significant level.

No significant difference was observed in crop dry matter accumulation by rice at all the crop growth stages except at harvest (Table 3). At harvest,
significantly highest dry matter accumulation was observed with PE application of pretilachlor with no irrigation up to one week followed by PoE application of bispyribac-Na 20 g/ha. The dry matter accumulation was recorded with PE application of pretilachlor with no irrigation up to one week. Higher dry matter accumulation with PE application of pretilachlor with no irrigation up to one week PoE application of bispyribac-Na 20 g/ha might be due to better weed control and higher leaf area index (LAI).

The grain and straw yield of rice was influenced significantly due to various weed control treatments. All the weed control treatments registered significantly higher rice grain and straw yield over the weedy check (Table 3). Among different treatments, PE application of pretilachlor with no irrigation up to one week PoE application of bispyribac-Na 20 g/ha recorded significantly higher grain and straw yield over PE application of pretilachlor 750 g/ha alone. PE application of pretilachlor 750 g/ha with no irrigation up to one week and one mechanical weeding through conoweeder at 15 DAT supplemented with one hand weeding at 45 DAT but remained at par with rest of the treatments. Pre-emergence application of pretilachlor 750 g/ha with no irrigation up to one week and one mechanical weeding through conoweeder at 15 DAT supplemented with one hand weeding at 45 DAT recorded lower straw and grain yield, respectively. Similar results were also reported by Uma et al. (2014). The higher straw yield might be

Table 2. Effect of weed control treatments on number of shoots and plant height at different stages of crop growth

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose (g/ha)</th>
<th>Number of shoots/m²</th>
<th>Plant height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30 DAT</td>
<td>45 DAT</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>20.0</td>
<td>174.2</td>
<td>173.3</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>22.5</td>
<td>179.2</td>
<td>175.8</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>25.0</td>
<td>186.7</td>
<td>192.5</td>
</tr>
<tr>
<td>Bispyribac-Na</td>
<td>20.0</td>
<td>175.8</td>
<td>188.3</td>
</tr>
<tr>
<td>Pretiachlor</td>
<td>750</td>
<td>165.8</td>
<td>189.2</td>
</tr>
<tr>
<td>Pretiachlor fb 1 HW (45 DAT)</td>
<td>750</td>
<td>179.2</td>
<td>180.8</td>
</tr>
<tr>
<td>Penoxsulam fb 1 HW (45 DAT)</td>
<td>22.5</td>
<td>180.8</td>
<td>202.5</td>
</tr>
<tr>
<td>Pretiachlor with no irrigation up to one week fb bispyribac-Na</td>
<td>750</td>
<td>160.0</td>
<td>162.5</td>
</tr>
<tr>
<td>Pretiachlor with no irrigation up to one week fb bispyribac-Na</td>
<td>750 fb 20.0</td>
<td>200.8</td>
<td>195.0</td>
</tr>
<tr>
<td>One mechanical weeding through conoweeder fb 1 HW</td>
<td>15 fb 45 DAT</td>
<td>213.3</td>
<td>205.0</td>
</tr>
<tr>
<td>Hand weeding twice</td>
<td>20 and 40 DAT</td>
<td>164.2</td>
<td>180.0</td>
</tr>
<tr>
<td>Untreated (weedy check)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>-</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table 3. Effect of weed control treatments on crop dry matter at different stages of crop growth, yield, HI and grain/straw ratio at harvest

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose (g/ha)</th>
<th>Crop dry matter (g/m²)</th>
<th>Grain Straw Grain/Straw yield (t/ha)</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30 DAT</td>
<td>45 DAT</td>
<td>60 DAT</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>20.0</td>
<td>14.6</td>
<td>32.8</td>
<td>112.1</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>22.5</td>
<td>20.0</td>
<td>40.2</td>
<td>117.5</td>
</tr>
<tr>
<td>Penoxsulam</td>
<td>25.0</td>
<td>21.8</td>
<td>45.4</td>
<td>128.0</td>
</tr>
<tr>
<td>Bispyribac-Na</td>
<td>20.0</td>
<td>18.6</td>
<td>37.0</td>
<td>136.9</td>
</tr>
<tr>
<td>Pretiachlor</td>
<td>750</td>
<td>20.6</td>
<td>40.0</td>
<td>106.4</td>
</tr>
<tr>
<td>Pretiachlor fb 1 H.W (45 DAT)</td>
<td>750</td>
<td>24.1</td>
<td>43.7</td>
<td>140.2</td>
</tr>
<tr>
<td>Penoxsulam fb 1 H.W (45 DAT)</td>
<td>22.5</td>
<td>21.9</td>
<td>30.9</td>
<td>139.4</td>
</tr>
<tr>
<td>Pretiachlor with no irrigation up to one week fb bispyribac-Na</td>
<td>750</td>
<td>20.1</td>
<td>37.6</td>
<td>111.6</td>
</tr>
<tr>
<td>Pretiachlor with no irrigation up to one week fb bispyribac-Na</td>
<td>750 fb 20.0</td>
<td>27.6</td>
<td>59.2</td>
<td>149.6</td>
</tr>
<tr>
<td>One mechanical weeding through conoweeder fb 1 HW</td>
<td>15 fb 45 DAT</td>
<td>18.5</td>
<td>31.8</td>
<td>129.3</td>
</tr>
<tr>
<td>Hand weeding twice</td>
<td>20 and 40 DAT</td>
<td>20.5</td>
<td>40.4</td>
<td>141.7</td>
</tr>
<tr>
<td>Untreated (weedy check)</td>
<td>-</td>
<td>12.9</td>
<td>23.8</td>
<td>98.2</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>-</td>
<td>NS</td>
<td>NS</td>
<td>43.4</td>
</tr>
</tbody>
</table>

HI - Harvest index
attributed to more plant height and dry matter accumulation due to reduced crop-weed competition. Among the different doses of penoxsulam, penoxsulam 25 g/ha applied as PoE recorded higher grain yield followed by PoE application of penoxsulam 22.5 g/ha owing to higher number of panicles/m² and grains/panicle. These findings are in conformity with the results of Khare et al. (2014). Post-emergence application of penoxsulam alone 22.5 and 25 g/ha was found statistically at par with PoE application of bispyribac-Na 20 g/ha. Integration of one hand weeding with pretilachlor or penoxsulam did not improve the rice grain and straw yield significantly over their sole application. The grain/straw ratio and HI were not influenced significantly due to various weed control measures (Table 3).

SUMMARY

The present study was carried out during Kharif season of 2012 at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The dominant weed flora observed in the experimental plots were Echinochloa colona, E. crus-galli, Leptochloa chinensis, Ischaemum rugosum among grasses and Ammania baccifera, Alternanthera sessilis and Caesalia axillaris among broad-leaved weeds and Cyperus difformis among the sedges. Grasses were the most dominant weeds which occupied more than 60% of SDR followed by broad-leaved weeds (27.7%) and sedges (12.2%). Pre-emergence application of pretilachlor at 0.75 kg/ha with no irrigation up to one week fb PoE application of bispyribac-Na at 20 g/ha was the most promising treatment which recorded higher rice grain and straw yield as compared to other weed control treatments.

REFERENCES


