COMPETITIVE ABILITY OF WHEAT CULTIVARS AGAINST COMPLEX WEED FLORA IN ZERO-TILL PLANTING

Ramesh Kumar Singh¹ and Siya Ram

ABSTRACT

Continuous and indiscriminate use of herbicides may lead to many problems such as resistance in weeds, residue in crop and soil, pollution hazards, health hazards to non-target organisms. In wheat crop, farmers can select a competitive cultivar to smoother weeds. Two year field studies were conducted at agricultural research farm of Banaras Hindu University to evaluate competitive attributes of wheat cultivars against complex weed population in wheat grown under zero-till. Variety K8027 which had taller plant and higher leaf area index was found most competitive against weed when compared with other varieties viz. K9107, HUW234, HUW468 and NW1014. Tank mix application of isoproturon + 2,4-D sodium salt at 1.0 + 0.5 kg/ha as post-emergence treatment was most effective in suppressing of weeds in all the varieties.

Keywords: Cultivars, Competitive ability, Wheat, Weeds, Zero-till

INTRODUCTION

Rice-wheat (RW) is the most important cropping system for food security in South Asia. In India, it contributes 26% of total cereal production and 60% of total calorie intake. The area under rice-wheat system is static and the productivity and sustainability of the system is threatened because of the inefficiency of current production practices, shortage of resources, such as water and labour and socioeconomic changes (Ladha et al., 2003). In recent decade, wheat establishment method has shifted from conventional multi-till to reduced zero-till system. Zero tillage minimizes the loss on account of delayed sowing as it advances the wheat sowing by 10-15 days and also saves the time and cost involved in field preparation (Sen et al., 2002). Weeds continue to be a serious threat to wheat productivity despite several decades of modern weed control practices realizing much of weed suppression through herbicides use. The development of herbicide-resistant weeds and weed population shifts continue to challenge the herbicide based weed management systems (Malik et al., 1998).

Modern wheat cultivars are nearly always evaluated for yields in weed free environments, so very little is known about their competitive interaction with weeds. The competitive ability of a crop

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against weeds can be measured in two ways: (a) the ability of the crop to maintain yield in the presence of weeds, and (b) the ability of the crops to suppress weeds and weed seed production. Several researchers (Blackshaw, 1994; Challaiah et al., 1986; Bussan et al., 1997; Wicks et al., 2004) reported that use of taller cultivars reduce weed biomass and seed production more than shorter cultivars. Similarly other crop traits (flag leaf length and orientation, overall leaf area and canopy structure) have been identified to provide competitive advantage to crop over weeds (Lemerle et al., 1996; Seavers and Wright, 1999). The objective of our research was to identify the traits associated with commonly grown wheat cultivars that confer competitiveness against complex weed flora in zero-till wheat.

**MATERIALS AND METHODS**

Two year field experiments were conducted at agricultural research farm of Banaras Hindu University, Varanasi, India during 2002-03 and 2003-04 winter seasons in sandy clay loam soil to evaluate the effect of five wheat cultivars and five weed control treatments on wheat yield and related weeds. Five wheat cultivars were K9107, HUW234, HUW468, NW1014 and K8027, while the weed control treatments were sulfosufuron @ 25 g a.i./ha, metribuzin @ 210 g a.i./ha, isoproturon 750 g a.i. + 2,4-D sodium salt 500 g a.i./ha (tank mix), weed free and unweeded check. The experimental design was a split plot design with four replication, cultivars were arranged in main plots and weed control treatments were assigned to sub-plots. All the herbicides were applied as post-emergence at 30 days after sowing (DAS) using spray volume of 500 l/ha by foot sprayer fitted with flat fan nozzle.

Wheat cultivars were sown at row space of 20 cm by opening slits with zero-till drill machine using a constant seed rate of 100 kg/ha. The crop received an uniform rate of 40 kg N, 60 kg P$_2$O$_5$ and 60 kg K$_2$O /ha at sowing and 80 kg N/ha after first irrigation. The crop was given three irrigations at 21, 75 and 90 DAS during both the years. Weeds were counted 60 days after sowing from quadrate (0.5 x 0.5 m) randomly placed at four places in each plot. Dry weight of weeds was recorded after complete drying at 70º C for 48 hours in hot air oven. At harvest, a plant sample of one square meter from each plot was taken to determine number of ear head, number of grain/ear head and 1000 grains weight. Grain yield per plot was recorded by harvesting net plot area of each treatment. For comparison between means, L.S.D. test at 5% level was used.
RESULTS AND DISCUSSION
Effect of Treatments on Weeds

The dominant weeds in the unweeded plot at 60 days after wheat sowing were *Phalaris minor* Retz., *Cyperus rotundus* L., *Rumex dentatus* L., *Anagallis arvensis* L., *Chenopodium album* L., and *Melilotus indica* (L.) All and *Cynodon dactylon* (L.) Pers. Wheat cultivars caused mark variation in relative dominance of weeds in weedy check plots (Table 1). Cultivars NW 1014, HUW 234 and HUW 468 had higher relative density of *P. minor*, *R. dentatus* and *C. rotundus*. Whereas, *C. rotundus* was dominant weed in K9107 and K8027. Concerning the effect of weed control treatments on weeds, data in Table 1 indicated that tank mix application of isoproturon + 2,4-D at post-emergence reduced population of both grass and broadleaf weeds, but none of the herbicide treatment was effective in controlling *C. rotundus*. Herbicide sulfosulfuron was most effective against *P. minor* and metribuzin was least effective against the weeds.

Table 1. Effect of wheat cultivars and weed control treatments on relative composition (%) of weeds at 60 days from sowing.

<table>
<thead>
<tr>
<th>Treatments</th>
<th><em>P. minor</em></th>
<th><em>C. dactylon</em></th>
<th><em>C. rotundus</em></th>
<th><em>R. denticulate</em></th>
<th><em>A. arvensis</em></th>
<th><em>C. album</em></th>
<th><em>M. indica</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>HUW 234</td>
<td>9.70</td>
<td>8.3</td>
<td>10.8</td>
<td>23.9</td>
<td>17.5</td>
<td>9.6</td>
<td>6.6</td>
</tr>
<tr>
<td>HUW 468</td>
<td>8.0</td>
<td>7.3</td>
<td>10.1</td>
<td>19.4</td>
<td>16.0</td>
<td>7.9</td>
<td>5.8</td>
</tr>
<tr>
<td>K 9107</td>
<td>7.2</td>
<td>6.6</td>
<td>9.5</td>
<td>17.3</td>
<td>14.7</td>
<td>7.7</td>
<td>4.9</td>
</tr>
<tr>
<td>K 8027</td>
<td>6.1</td>
<td>5.4</td>
<td>8.4</td>
<td>15.2</td>
<td>12.5</td>
<td>7.6</td>
<td>4.3</td>
</tr>
<tr>
<td>NW 1014</td>
<td>10.0</td>
<td>9.3</td>
<td>12.3</td>
<td>26.0</td>
<td>20.5</td>
<td>10.1</td>
<td>7.5</td>
</tr>
<tr>
<td>Unweeded</td>
<td>18.8</td>
<td>10.2</td>
<td>14.4</td>
<td>33.4</td>
<td>5.3</td>
<td>14.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulfosulfuron</td>
<td>6.2</td>
<td>12.8</td>
<td>14.3</td>
<td>28.7</td>
<td>23.3</td>
<td>8.9</td>
<td>7.2</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>9.2</td>
<td>10.9</td>
<td>10.9</td>
<td>20.6</td>
<td>21.8</td>
<td>9.2</td>
<td>6.8</td>
</tr>
<tr>
<td>Isoproturon+2,4-D</td>
<td>7.9</td>
<td>10.1</td>
<td>11.1</td>
<td>14.8</td>
<td>18.3</td>
<td>8.1</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Results in Table 2 revealed that different cultivars and weed control treatments significantly influenced density of different weed species at 60 days after wheat sowing. Cultivar K8027 was significantly most suppressive to different weed species, while NW 1014 was least effective in controlling weeds. Application of sulfosulfuron was significantly superior to metribuzin and isoproturon+2,4-D in reducing density of *P. minor*, whereas, the population of broad leaf weeds and *C. rotundus* was minimum in isoproturon + 2,4-D treatment. The lowest dry weight of weeds was recorded in cultivar K8027 and greatest in NW 1014. Data in Table 2 indicated that weeds dry weight was significantly less in herbicide mixture of isoproturon + 2,4-D when compared with individual herbicide sulfosulfuron and metribuzin.
Table-2. Effect of wheat cultivars and weed control treatments on weeds density (No. m\(^{-2}\)) and weeds dry weight at 60 days after sowing.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>HUW 234</td>
<td>7.20</td>
<td>5.70</td>
<td>16.50</td>
<td>15.30</td>
<td>4.33</td>
<td>3.30</td>
<td>34.90</td>
<td>31.10</td>
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<tr>
<td>HUW 468</td>
<td>6.70</td>
<td>4.20</td>
<td>17.80</td>
<td>15.90</td>
<td>4.38</td>
<td>3.34</td>
<td>35.70</td>
<td>32.70</td>
</tr>
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<td>6.40</td>
<td>3.60</td>
<td>15.80</td>
<td>13.90</td>
<td>4.10</td>
<td>3.00</td>
<td>33.30</td>
<td>29.50</td>
</tr>
<tr>
<td>K 8027</td>
<td>6.20</td>
<td>5.10</td>
<td>15.20</td>
<td>12.90</td>
<td>3.90</td>
<td>2.80</td>
<td>31.70</td>
<td>28.60</td>
</tr>
<tr>
<td>NW 1014</td>
<td>7.50</td>
<td>6.30</td>
<td>19.20</td>
<td>18.10</td>
<td>4.60</td>
<td>3.50</td>
<td>36.90</td>
<td>34.30</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>0.44</td>
<td>0.42</td>
<td>1.70</td>
<td>1.62</td>
<td>0.23</td>
<td>0.22</td>
<td>2.42</td>
<td>2.30</td>
</tr>
</tbody>
</table>

Weed control treatments

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Un weeded</td>
<td>17.28</td>
<td>15.30</td>
<td>33.40</td>
<td>30.70</td>
<td>10.30</td>
<td>7.10</td>
<td>73.90</td>
<td>68.30</td>
</tr>
<tr>
<td>Weed Free</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Sulfosulfuron</td>
<td>4.70</td>
<td>3.80</td>
<td>18.90</td>
<td>16.90</td>
<td>4.10</td>
<td>3.60</td>
<td>34.60</td>
<td>30.90</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>6.5</td>
<td>5.20</td>
<td>17.40</td>
<td>15.50</td>
<td>3.80</td>
<td>2.90</td>
<td>33.40</td>
<td>29.80</td>
</tr>
<tr>
<td>Isoproturon + 2,4-D</td>
<td>5.5</td>
<td>4.30</td>
<td>14.70</td>
<td>12.90</td>
<td>3.20</td>
<td>2.50</td>
<td>30.60</td>
<td>27.20</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>0.34</td>
<td>0.32</td>
<td>0.95</td>
<td>0.90</td>
<td>0.12</td>
<td>0.11</td>
<td>2.12</td>
<td>2.01</td>
</tr>
</tbody>
</table>

Effect of Treatments on Growth of Crop

The data on plant height, tiller number/meter row, leaf area index and crop dry weight revealed that cultivar K8027 had significantly higher values of these parameters than other cultivars of wheat (Table-3). Tank mix application of isoproturon+2,4-D recorded significantly taller plants, more number of tillers, higher leaf area index and greater dry matter accumulation by crop than individual treatment of sulfosulfuron and metribuzin.

Effect of Treatments on Grain Yield and Yield Attributes

The data pertaining to yield contributing characters viz. head/m2, grains/head and 1000, grains weight (Table-4) indicated that cultivar K8027 had significantly greater number of heads/m2, number of grains/heads and 1000-grain weight than HUW234,HUW 468 and NW1014 (Table-4).

Amongst weed control treatments, herbicide mixture of isoproturon + 2,4-D recorded significantly maximum number of heads, grains/head and 1000-grain weight of crop than individual application of herbicide sulfosulfuron and metribuzin. It is evident from the data in Table 4 that cultivars K8027 produced numerically higher grain yield than K9107 and HUW 234, but was significantly superior to HUW468 and NW1014 while NW1014 had minimum grain yield. The herbicide treatment isoproturon + 2,4-D recorded significantly higher grain yield than sulfosulfuron or metribuzin (Table 4). However, both
the herbicides produced significantly higher grain yield than unweeded treatment.

Table-3. Effect of wheat cultivars and weed control treatments on growth parameters of wheat at 60 days from sowing.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>No. of tillers per running meter</th>
<th>Late area index</th>
<th>Crop Dry Weight (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 DAS</td>
<td>60 DAS</td>
<td>60 DAS</td>
<td>60DAS</td>
</tr>
<tr>
<td>HUW 234</td>
<td>59.22 62.39</td>
<td>69.58 -71.53</td>
<td>3.15 3.46</td>
<td>364.7 411.2</td>
</tr>
<tr>
<td>HUW 468</td>
<td>55.23 58.11</td>
<td>67.11 -68.81</td>
<td>3.08 3.39</td>
<td>354.9 400.4</td>
</tr>
<tr>
<td>K 9107</td>
<td>63.62 67.03</td>
<td>72.08 -74.29</td>
<td>3.22 3.54</td>
<td>372.2 419.4</td>
</tr>
<tr>
<td>K 8027</td>
<td>66.70 70.33</td>
<td>74.09 -76.49</td>
<td>3.39 3.73</td>
<td>388.9 437.8</td>
</tr>
<tr>
<td>NW 1014</td>
<td>53.79 55.52</td>
<td>63.94 -65.30</td>
<td>3.05 3.35</td>
<td>345.6 390.1</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>5.40 5.93</td>
<td>4.29 -4.79</td>
<td>0.19 0.21</td>
<td>22.4 34.8</td>
</tr>
</tbody>
</table>

Weed control treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>No. of tillers per running meter</th>
<th>Late area index</th>
<th>Crop Dry Weight (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60 DAS</td>
<td>60 DAS</td>
<td>60 DAS</td>
<td>60DAS</td>
</tr>
<tr>
<td>Un weeded</td>
<td>50.73 52.65</td>
<td>64.67 -66.32</td>
<td>2.90 3.19</td>
<td>342.1 386.2</td>
</tr>
<tr>
<td>Weed Free</td>
<td>67.94 71.76</td>
<td>73.63 -75.17</td>
<td>3.39 3.72</td>
<td>389.7 438.7</td>
</tr>
<tr>
<td>Sulfosulfuron</td>
<td>56.56 59.26</td>
<td>67.09 -68.99</td>
<td>3.09 3.40</td>
<td>353.4 398.7</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>58.99 61.92</td>
<td>69.36 -71.49</td>
<td>3.19 3.51</td>
<td>366.7 413.4</td>
</tr>
<tr>
<td>Isoproturon</td>
<td>64.34 67.81</td>
<td>72.05 -74.45</td>
<td>3.32 3.65</td>
<td>374.4 421.8</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>3.90 4.29</td>
<td>3.68 -3.96</td>
<td>0.14 0.16</td>
<td>14.1 15.5</td>
</tr>
</tbody>
</table>

LSD (P=0.05)

Table-4. Yield and yield attributes of wheat crop as affected by cultivars and weed control treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ear head/ m²</th>
<th>Grains/ ear head</th>
<th>1000, grains weight(g)</th>
<th>Grain yield (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUW 234</td>
<td>270.70 287.60</td>
<td>43.44 43.90</td>
<td>40.10 40.90</td>
<td>3176 3548</td>
</tr>
<tr>
<td>HUW 468</td>
<td>256.30 278.86</td>
<td>42.80 43.30</td>
<td>38.30 39.02</td>
<td>2865 3220</td>
</tr>
<tr>
<td>K 9107</td>
<td>275.90 294.40</td>
<td>44.50 46.90</td>
<td>43.30 44.10</td>
<td>3281 3658</td>
</tr>
<tr>
<td>K 8027</td>
<td>278.10 305.10</td>
<td>47.50 47.90</td>
<td>44.80 45.70</td>
<td>3352 3733</td>
</tr>
<tr>
<td>NW 1014</td>
<td>245.10 272.36</td>
<td>42.20 42.60</td>
<td>37.10 37.90</td>
<td>2738 3085</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>19.87 20.56</td>
<td>3.70 3.73</td>
<td>2.70 2.64</td>
<td>233 239</td>
</tr>
</tbody>
</table>

Weed control treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ear head/ m²</th>
<th>Grains/ ear head</th>
<th>1000, grains weight(g)</th>
<th>Grain yield (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un weeded</td>
<td>243.20 264.20</td>
<td>38.80 39.10</td>
<td>38.66 39.44</td>
<td>1849 2149</td>
</tr>
<tr>
<td>Weed Free</td>
<td>276.90 307.60</td>
<td>48.20 48.70</td>
<td>42.40 43.30</td>
<td>3823 4229</td>
</tr>
<tr>
<td>Sulfosulfuron</td>
<td>261.10 284.70</td>
<td>43.70 44.10</td>
<td>40.10 40.80</td>
<td>2966 3326</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>270.10 279.30</td>
<td>45.10 45.50</td>
<td>40.50 41.30</td>
<td>3229 3604</td>
</tr>
<tr>
<td>Isoproturon</td>
<td>274.90 301.60</td>
<td>46.60 47.10</td>
<td>41.96 42.80</td>
<td>3545 3937</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>10.93 14.26</td>
<td>2.90 2.87</td>
<td>2.06 2.08</td>
<td>124 133</td>
</tr>
</tbody>
</table>
DISCUSSION

The different characteristics of a good competitive cultivars are that it must have rapid germination, initial quick growth, tillering capacity and leaf area (Lemerle et al., 1996; Challaiah et al., 1983). The difference in the ability of cultivars K8027 to suppress weed growth more than other might be due to taller plants, high leaf area index, and light interception tillering capacity and vegetative growth habit (Seavers and Wright 1999; Dhima et al. 2008). Presence of these attributes in cultivar K8027 conferred better competitiveness against most weeds infested the crop than cultivars with shorter plants, less tillers and leaf area index. An effective herbicide is one that control complex weed community. The herbicide mixture of isoproturon + 2, 4-D had ability to control dominant grass as well as broadleaf weeds, while sulfosulfuron and metribuzin could control only grass weeds. The lower weed growth in isoproturon + 2,4-D treatment was due to broad spectrum weed control than other herbicides. The significant differences in growth attributes of cultivars can be attributed to their genetic makeup. Coleman and Gill (2002) also reported significant genetic correlations for grain yield, grain yield loss and ryegrass dry matter with agronomic and morphological traits on the wheat lines.

The variation in yield and yield attributes of cultivars can be attributed to their differential weed suppression ability that led to dry matter accumulation and its translocation for the formation of yield attributes. Cultivar K8027 which had taller plants, more tillers and leaf area index also accumulated higher dry matter that was finally used for production of agronomic characters determining crop yield.

REFERENCES CITED


