INTRODUCTION

Berseem (Trifolium alexandrinum L.) is one of the most important winter forage crop in north, north-west, and central parts of India under irrigated conditions but it often suffers due to high crop-weed competition at initial stages of crop growth. Slow growth rate coupled with least leaf area and branching exentian allows weeds to grow fast during initial 30-40 DAS and after 1st cutting. At later cuttings, vigorous branching and faster growth of the crop plants smother the weeds. It has been estimated that the fodder yield loss in berseem may likely to recure 23 to 30 per cent (Joshi and Bhilare, 2006; Alfred, 2012) and seed yield loss upto 50 per cent. The contamination of produce with weeds and weed seeds reduces the crop quality. The problem of weeds in berseem is much severe due to lack of suitable weed control option. Current strategies for weed control in berseem include mostly application of pre-emergence herbicides. Other practices like crop rotation, mechanical weed control, hand weeding etc. are also followed. Most of the crop is grown by farmers using one and two hand weedicings which is time taking and cumbersome and timely operations are usually not applied leading to poor quality fodder and seed. Since the crop is of longer duration (October to May), the use of post emergence herbicides for season long weed control is preferred. The pre-emergence (pendimethalin) or pre-plant soil (fluchloralin) herbicides control weeds only at initial stages that too much before first cutting. Therefore an integration of pre-emergence and post-emergence herbicides is needed for season long weed management strategy. There is also possibility of using single post-emergence herbicide which may raise the farm income. Imazethapyr in the Imidazolinones class of herbicide registered in 1989 controls a wide spectrum of annual broad leaved and grassy weeds in leguminous crops (Kantar et al., 1999). Imazethapyr is compatible with pendimethalin, oxyflourfen, trifluralin etc. to formulate commercial mixture (Rao, 2000). It can be applied as pre-emergence and early post-emergence. Imazethapyr @ 125 g/ha at 20 DAS has been found to effectively reduced weed density (320/m²) and weed biomass (23.35 g/m²) of associated weeds compared to other treatments (Singh et al., 2014). Least dry weight of weeds (10.17 g/m²) has been found with post emergence (35 DAS) application of imazethapyr @ 100 g/ha (Goud et al., 2013). Since work on post-emergence herbicides for controlling weeds in berseem is meager therefore, present investigation was undertaken for effective weed control in berseem with the objective to evaluate pre & post emergence herbicides along or in combination for crop safety and bioefficacy in berseem crop under Tarai conditions of Uttarakhand.

MATERIALS AND METHODS

The field experiment was carried out in Forage Agronomy block of Instructional Dairy Farm (IDF), Nagla, G.B.Pant University of Agriculture and Technology, Pantnagar during winter seasons of 2011-2012 and 2012-2013. The soil of experiment site was silty clay loam having 7.2 pH, 0.86 % organic carbon, 278.48, 27.80 and 232 kg/ha available N, P, and K respectively as analysed following Walkley and Black method (Walkley and Black, 1934) for organic carbon, Micro Kjeldahl method (Jackson, 1973) for available nitrogen, Olsen’s method (Olsen et al., 1954) for available phosphorus and Flame photometry (Jackson, 1973) for available potassium. The experiment consisted of 10 treatments i.e.
The weed control efficiency (WCE) was calculated as suggested by Mani et al. (1973).

\[
WCE = \frac{DMC - DMT}{DMC} \times 100
\]

Where, DMC = dry matter production by weeds in control plot.

DMT = dry matter production by weeds in treated plots.

RESULTS AND DISCUSSION

Weed

The major weeds observed in the experimental plots were Polygonum spp, Medicago denticulata, Cornusus dydymus, Cyprus rotundus, Cichorium intybus, Cynadon dactylon, Celosia argentia as major weeds in berseem.

Weed dry matter

In general, all the weed control treatments caused significant reduction in dry weight of weeds compared to weedy check treatment (Table 1). One hoeing at 3 weeks after sowing + one hand weeding 5 weeks after sowing treatment was statistically at par with pendimethalin @ 1.0 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut) and imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) (Table-1). The results corroborate the finding of Pathan et al. (2012). Among herbicidal treatments, pendimethalin @ 1.0 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut) caused significant reduction in weed dry weight followed by imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) which were statistically at par with pendimethalin @ 1.0 kg a.i./ha, pendimethalin @ 1.0 kg a.i./ha, + one hand weeding at 5 weeks after sowing and Oxyfluifen @ 0.10 kg a.i./ha, PE + One hand weeding at 5 weeks after sowing. The results were in conformity with the finding of Tiwana et al. (2002). This might be due to inhibition effect of imazethapyr on acetohydroxy acid synthase and the synthesis of branched chain amino acids in legumes resulting in poor growth of weeds (Papierniks et al., 2003).

Weed control efficiency

Weed control efficiency was significantly higher due to one hoeing at 3 weeks after sowing + one hand weeding 5 weeks after sowing treatments, which was statistically at par with pendimethalin @ 1.0 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut), imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) and pendimethalin @ 1.0 kg a.i./ha + one hand weeding at 3 weeks after sowing and oxyfluifen @ 0.10 kg a.i./ha – PE + one hand weeding at 5 weeks after sowing. Higher weed control efficiency with 2HW has been reported earlier (Aggarwal et al., 2014). Among herbicidal treatments pendimethalin @ 1.0 kg ai/ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut) caused significant enhancement in weed control efficiency which was statistically at par with pendimethalin @ 1.0 kg a.i./ha/ha-PE + one hand weeding at 5 weeks after sowing, oxyfluifen @ 0.10 kg a.i./ha –PE + one hand weeding at 5 weeks after sowing and imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) (Table 1).

Crop

Among herbicidal treatments, imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) treatment, being at par with oxyfluifen @ 0.10 kg a.i./ha –PE + one hand weeding at 5 week after sowing, pendimethalin @ 1.0 kg a.i./ha-PE + one hand weeding at 5 weeks after sowing and one hoeing at 3 weeks after sowing + one hand weeding 5 weeks after sowing treatments, caused significantly more plant population compared to remaining treatments. Long lasting effects of imazethapyr in reducing weed dry matter (upto85%) might be primarily appeared due to broad-spectrum toxic activity of herbicide particularly on established plants of both narrow and broad leaf weeds and its greater efficiency to retard cell division of meristems as a result weed died rapidly (Kantar et al., 1999). Among herbicidal treatments, imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st & 2nd cut) treatment, being at par with pendimethalin @ 1.0 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut), oxyfluifen @ 0.10 kg a.i./ha – PE + one hand weeding at 5 weeks after sowing, oxyfluifen @ 0.10 kg a.i./ha –PE and one hoeing at 3 weeks after sowing + one hand weeding 5 weeks after sowing treatments, caused significantly taller plants compared to remaining treatments (Table 1). It may be due to the effective weeds control throughout the growth of the crop. The results were confirmed comparing the finding of Chandel and Saxena (2001). Among herbicidal treatments imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st and 2nd cut) treatment, being at par with oxyfluifen @ 0.10 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut) and pendimethalin @ 1.0 kg a.i./ha-PE + one hand weeding at 5 weeks after sowing treatments, caused significantly more L:S ratio compared to remaining treatments (Table 1). This may be ascribed to least competition from weeds due to their effective suppression and higher plant height by application of imazethapyr (Skrzypczak et al., 1994).

Yield

Green forage yield was significantly higher in weed free
### Table 1: Weed dry weight, weed control efficiency, growth and yield of berseem as influenced by different weed control treatments (Pooled data of 2 years)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed growth</th>
<th>Crop growth and yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean weed dry weight g/0.25 m²</td>
<td>mean weed control efficiency (%)</td>
</tr>
<tr>
<td>T1-Weedy check</td>
<td>85.82</td>
<td>0.00</td>
</tr>
<tr>
<td>T2-Weed free</td>
<td>0.00</td>
<td>100.00</td>
</tr>
<tr>
<td>T3-One hoeing at 3 week after sowing + one hand weeding 5 weeks after sowing</td>
<td>45.88</td>
<td>47.37</td>
</tr>
<tr>
<td>T4-Pendimethalin @ 1.0 kg a.i./ha-PE</td>
<td>59.07</td>
<td>21.39</td>
</tr>
<tr>
<td>T5-Pendimethalin @ 1.0 kg a.i./ha-PE + one hand weeding at 5 weeks after sowing</td>
<td>59.01</td>
<td>35.28</td>
</tr>
<tr>
<td>T6-Oxyflourfen @ 0.10 kg a.i./ha –PE</td>
<td>66.88</td>
<td>25.32</td>
</tr>
<tr>
<td>T7-Oxyflourfen @ 0.10 kg a.i./ha –PE + one hand weeding at 5 weeks after sowing</td>
<td>58.21</td>
<td>33.30</td>
</tr>
<tr>
<td>T8-Pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut)</td>
<td>48.73</td>
<td>43.53</td>
</tr>
<tr>
<td>T9-Oxyflourfen @ 0.10 kg a.i./ha + Imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut)</td>
<td>63.40</td>
<td>25.50</td>
</tr>
<tr>
<td>T10-Imazethapyr @ 0.15 kg a.i./ha  (Immediate after 1st &amp; 2nd cut)</td>
<td>52.14</td>
<td>39.34</td>
</tr>
<tr>
<td>SEm±</td>
<td>3.63</td>
<td>5.16</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>10.78</td>
<td>15.34</td>
</tr>
</tbody>
</table>

From the present investigation it may be inferred that pendimethalin @ 1.0 kg a.i./ha-PE, pendimethalin @ 1.0 kg a.i./ha-PE + One hand weeding at 5 weeks after sowing and pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st cut) caused significantly higher increase in total green and dry matter yield compared with remaining treatments (Table-1). Weed free check led to significantly less dry matter yield compared with remaining treatments except pendimethalin @ 1.0 kg a.i./ha-PE which was comparable with imazethapyr @ 0.15 kg a.i./ha-PE + one hand weeding at 5 weeks after sowing and pendimethalin @ 1.0 kg a.i./ha + Imazethapyr @ 0.15 kg a.i./ha (Immediate after 1st & 2nd cut). The results corroborate the finding of Panda et al. (2012).

### REFERENCES


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