Efficacy of herbicides against weed flora in onion (*Allium cepa* L.)

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Received : 24-10-2018 ; Revised : 19-12-2018 ; Accepted : 12-02-2019

**ABSTRACT**

Field experiment was conducted to compare different weed control methods in onion during rabi 2010-11 to 2011-12. The experiment was laid out in Randomized Block Design with eight treatments and replicated thrice. The pooled results revealed that significantly highest marketable yield (187.17 q ha⁻¹) as well as total bulb yield (217.48 q ha⁻¹) was produced by the application of oxyfluorfen 23.5% EC@2 ml l⁻¹ before planting and one hand weeding at 40-60 days after transplanting (DAT) than rest of the treatments. The Weed Control Efficiency was significantly highest in T₆ (74.28) than the rest of the treatments. Thus, application of oxyfluorfen 23.5% EC@2 ml l⁻¹ before planting and one hand weeding at 40-60 DAT or combined spray of pendimethalin 30% EC@2 ml l⁻¹ and quizalofop ethyl 5% EC1.75 ml l⁻¹ at the time of planting and at 30 DAT reduces the weed infestations with higher bulb yield in onion.

**Keywords:** *Allium cepa*, economics, oxyfluorfen, pendimethalin, quizalofop ethyl and weed control efficiency

Onion (*Allium cepa* L.) is one of the major five spices crops used for the flavouring purpose in our daily dietary. It is a crop of significant economic importance with higher market demand and price due to its culinary, dietary and medicinal values (Kalhapure et al., 2014). Being an important commodity of mass consumption, it is grown commercially throughout India. Mahajan et al. (2018) reported that on the basis of an average of five years since 1976 area has increased from 2.31 lakh hectares to 12.71 lakh hectares, production from 24.44 lakh tonnes to 215.65 lakh tonnes ha⁻¹. At present India ranks 1ˢᵗ in the area, 2ⁿᵈ in production and 9ⁿᵗ in productivity in the world by producing 215.63 lakh tonnes of onion from an area of 12.71 lakh ha with an average productivity of 16.12 tonne ha⁻¹. USA ranks 1ˢᵗ in productivity with an average productivity of 55.95 tonne ha⁻¹ followed by Iran (36.93 tonne ha⁻¹), Egypt (36.58 tonne ha⁻¹), Turkey (30.70 tonne ha⁻¹), Algeria (27.95 tonne ha⁻¹), Brazil (27.82 tonne ha⁻¹), Russian federation (23.19 tonne ha⁻¹) and China (21.85 tonne ha⁻¹) as reported by Saxena et al. (2017). Even if, India stands in a superior position contributing 21.5% share in the world onion production, the productivity is mediocre as compared to other onion producing countries and remains constant since the last lustrum. Low productivity in onion crop is due to ignorance of the farmers about improved agronomic practices and appropriate protection mechanism against biotic and abiotic stresses. Weed infestation is one of the vital limiting factors for commercial cultivation of onion that causes comparatively higher losses than the losses caused by insect pests and diseases. Generally, it has been observed that continuous incorporation of undecomposed cow dung as FYM increases the weed population, as because the un-decomposed seeds of unwanted crops called “weeds” were transmitted in dormant condition through this FYM and uniformly nourished with the onion seeds. It competes with onion crop for nutrients, soil moisture, space, light and considerably reduced the bulb yield, and excellence of the crop through excess production and harvesting costs has been well documented by Hussain, (1983). Further, Appleby (1996) reported that due to smaller leaf size, slow growth and very shallow root system onion can’t compete well with weeds particularly at early stages of growth. Channapagoudar and Biradar (2007) reported that due to slow initial growth and inherent characteristic of crop short stature, non-branching habit, sparse foliage, shallow root system coupled with frequent irrigation and fertilizer application at high dose, the crop exhibits greater susceptibility to weed competition than most other crops. Without weed control, onion bulb yields reduced drastically; losses due to weed infestation were recorded to the tune of 40 to 80%. As weeds decrease the profitability of onion crops, judicious weed management practices should be adopted for better bulb yield as well as economic return. A well developed weed management programme with an appropriate defence mechanism to combat the weed population is essential to obtain higher bulb production. Keeping these views, the present study was conducted to compare the effectiveness of pre and post emergence herbicides to control the weeds density in onion crop.

**MATERIALS AND METHODS**

Field experiments were conducted during *rabi* 2010-11 to 2011-12 to compare various weed management practices in onion under All India Network Research Project on Onion and Garlic operating at College of Horticulture, Odisha University of Agriculture and Technology, Sambalpur, Odisha, India situated at...
20°21’ N latitude and 80°55’ E longitude and at an altitude of 178.8 m above mean sea level. The soil of the experimental area was sandy loam having pH of 5.89; available N of 151 kg ha⁻¹, P of 15 kg ha⁻¹ and K of 178 kg ha⁻¹ with low sulphur content (9.75ppm). The selected experimental site was a weed prone area under Western Table Land Zone of Odisha with wide diversities of monocot and dicot weeds. Among monocots *Cynodon dactylon*, *Cyperus difformis*, *Cyperus iria*, *Cyperus rotundus*, *Digitaria sangunialis*, *Echinochloa colona*, *Eleusine indica* and *Paspalum serobiculatum* are foremost whereas, *Alternanthera sesillis*, *Amaranthus viridis*, *Amaranthus spinosus*, *Cleome viscosa*, *Eclipta alba*, *Euphorbia hirta*, *Lantana camara*, *Mimosa pudica*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Physalis minima* and *Portulaca oleraceae* are the predominant dicots species found in this locality. The climate of the experimental district was warm/sub-humid with the temperature ranging from 9°C to 44.2°C. The mean maximum and the mean minimum temperatures of 40.5°C and 13°C are recorded in the months of May and December, respectively. Southwest monsoon plays an important role with a mean annual rainfall of 1426.2 mm in 93 rainy days. The station received around 6.7% rainfalls in February to May as pre-monsoon, 86.5% of in June to September as the monsoon and 6.8% in October to January as post-monsoon.

The experiment was laid out in Randomized Block Design with seven combinations of different pre and post emergences herbicides along with different straight weed management practices apart from a weedy check and replicated thrice. The treatments details are presented in the table-1.

**Table 1: Treatment details of weed management studies in onion**

<table>
<thead>
<tr>
<th>Notations</th>
<th>Treatment details</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Oxyflurofen 23.5EC @ 2ml l⁻¹ before planting and second application at 30 DAT</td>
</tr>
<tr>
<td>T2</td>
<td>Oxyflurofen 23.5EC @ 2ml l⁻¹ before planting and quizalofop ethyl 5EC @ 3.5 ml l⁻¹ at 30 DAT</td>
</tr>
<tr>
<td>T3</td>
<td>Combined spray of oxyflurofen 23.5EC @ 1ml l⁻¹ and quizalofop ethyl 5EC @ 1.75 ml l⁻¹ at the time of planting and at 30 DAT</td>
</tr>
<tr>
<td>T4</td>
<td>Pendimethalin 30EC @ 5.0 ml l⁻¹ before planting and at 30 DAT</td>
</tr>
<tr>
<td>T5</td>
<td>Pendimethalin 30EC @ 5ml l⁻¹ before planting + and quizalofop ethyl 5EC @ 3.5ml l⁻¹ at 30 DAT</td>
</tr>
<tr>
<td>T6</td>
<td>Combined spray of pendimethalin 30EC @ 2.5ml l⁻¹ and quizalofop ethyl 5EC @ 1.75ml l⁻¹ at the time of planting and at 30 DAT</td>
</tr>
<tr>
<td>T7</td>
<td>Oxyflurofen 23.5EC @ 2ml l⁻¹ before planting and one hand weeding at 40-60 DAT</td>
</tr>
<tr>
<td>T8</td>
<td>Weedy check</td>
</tr>
</tbody>
</table>

**Note: DAT – days after transplanting**

From the very beginning, the field was prepared to obtain a best possible fine tillage for the better survival of young onion seedlings. Approximately six to eight weeks old onion seedlings of variety “Agrifound Dark Red” were treated for 10minutes with a solution of bavistine @ 0.5gm li⁻¹ of water to protect the crop from the threat of various fungal diseases. Then the seedlings were manually transplanted with a spacing of 15cm in between lines and 10cm within the line in a plot size of 5 m x 2 m. Soon after transplanting, light irrigation was given for the quick seedling establishment. Before transplanting, the treatments were imposed as per the scheduled weed management practices in a well-randomized trial plot. Appropriate concentrations of herbicides were applied by using hand operated knapsack sprayer fitted with a flat fan type nozzle. For hand weeding, depending upon the weed intensity, weeds were removed manually by using the hand hoe with male manpower as per the scheduled dates in treatment details. Every possible package of practices was adapted uniformly with an utmost care to raise a high-quality crop.

The data on various vegetative growth parameters *i.e.* plant height and numbers of leaves were randomly recorded from ten selected plant. Later on, for yield and yield attributing parameters the harvested bulbs were allowed for field curing as well as shed drying for a week. Then the parameters like average bulb weight (g), marketable bulb yield (kg) and total bulb yield (kg) plot⁻¹ were recorded by using the standard digital balance and converted to q ha⁻¹. Regarding % double bulbs, % bolters %, A grade, % B grade and % C grade bulb were recorded on the basis of weight over total bulb yield, however, bulbs for different grades were selected on the basis of equatorial diameter of onion bulbs *i.e.* less than 3.5 cm “unmarketable grade”, 3.5 to 4.5 cm “C grade”, 4.5 to 5.5 cm “B grade”, 5.5 to 6.5 “A grade” and above 6.5 cm “A+ grade”.

The weed count was recorded species-wise from 1m² areas by using a quadrangle iron frame of 1 m x 1 m randomly from each and every plot. The weeds failing within the frames were collected, categorised into monocot and dicot, counted and the mean values were
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expressed in number m^{-2}. The density of total weeds was recorded and expressed in number m^{-2}.

The fresh weights of weeds m^{-2} were recorded by using the digital balance from individual plots of each replication treatment wise and values were expressed in terms of gram m^{-2}. The weeds from each category were allowed for shed drying, later on after removal of soil particles from the weeds they were kept inside the hot air oven at 80^0 C for 48 hrs by using the thick paper envelopes. The dry weights of weeds m^{-2} were recorded at 3hrs interval till the weight becomes constant and expressed in terms of g m^{-2} separately for each category.

Weed control efficiency (WCE) was calculated as per the procedure suggested by Mani et al. (1973).

\[
WCE\% = \frac{WDc - WDt}{WDc} \times 100
\]

Where,

WCE - Weed control efficiency.
WDc - Weed population in the untreated / control plot.
WDt - Weed population in the treated plot.

The observed data were then subjected to statistical analysis by following the procedure for Randomized Block Design (Sukhatme and Amble, 1995). Benefit-cost ratio was calculated by dividing net monetary returns by the cost of cultivation.

RESULTS AND DISCUSSION

Effect of weed management practices on vegetative growth of onion

The pooled results from the above experiments revealed significantly highest vegetative growth with the application of oxyfluorfen 23.5EC @ 2 ml l^{-1} before planting along with one hand weeding at 40-60 DAT i.e. T_{7}. The treatment recorded highest plant height of 58.52 cm closely followed by 57.21 cm with the combined spray of pendimethalin 30EC @ 2.5 ml l^{-1} and quizalofop ethyl 5EC @ 1.75 ml l^{-1} at the time of planting and at 30 DAT i.e. T_{5}. The same treatment i.e. T_{7} recorded highest 187.17 q ha^{-1} of marketable bulb yield and 217.48 q ha^{-1} of total bulb yield which was statistically at par with T_{6}. The highest benefit:cost of the application of oxyfluorfen 23.5% EC before planting and one hand weeding at 40 to 60 days after planting i.e. T_{7}. The combined spray of pendimethalin 30%EC and quizalofop Ethyl 5% EC at the time of planting and the second application at 30 days after planting i.e. T_{5} produced maximum 173.76 q ha^{-1} of marketable bulb yield and 203.82 q ha^{-1} of total bulb yield which was statistically at par with T_{7}. The highest benefit:cost of 3.68 was recorded in T_{5} closely followed by T_{7} (3.26) and T_{6} (3.27). The application of above said pre emergence herbicides provides maximum crop production with an optimum B:C ratio.

It indicates that the relevance of pre emergence herbicides like oxyfluorfen 23.5 EC or pendimethalin 30EC before planting or at the time of planting effectively and economically control the weed population during the critical stages of crop growth. However, another spraying of post emergence herbicide like quizalofop ethyl 5EC or one hand weeding can absolutely protect...
Fig. 1: Effect of weed management practices on fresh and dry weight of weeds

Fig. 2: Effect of weed management practices on total number of weeds and weed control efficiency

Fig. 3: Effect of weed management practices on total and marketable yield of onion
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Table 2: Effect of weed management practices on growth and yield in onion

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PH (cm)</th>
<th>NOL (g)</th>
<th>ABW (g)</th>
<th>% of A grade bulbs</th>
<th>% of B grade bulbs</th>
<th>% of C grade bulbs</th>
<th>% doubles</th>
<th>% bolters</th>
<th>TY q ha⁻¹</th>
<th>MYq ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>53.70</td>
<td>12.32</td>
<td>67.20</td>
<td>18.60</td>
<td>23.12</td>
<td>36.26</td>
<td>1.73</td>
<td>5.06</td>
<td>161.65</td>
<td>134.56</td>
</tr>
<tr>
<td>T₂</td>
<td>51.60</td>
<td>12.80</td>
<td>70.70</td>
<td>16.51</td>
<td>19.90</td>
<td>37.06</td>
<td>4.12</td>
<td>7.71</td>
<td>187.62</td>
<td>158.65</td>
</tr>
<tr>
<td>T₃</td>
<td>50.67</td>
<td>12.42</td>
<td>63.27</td>
<td>15.60</td>
<td>20.71</td>
<td>40.94</td>
<td>1.27</td>
<td>7.87</td>
<td>168.47</td>
<td>146.27</td>
</tr>
<tr>
<td>T₄</td>
<td>49.85</td>
<td>12.62</td>
<td>60.50</td>
<td>16.28</td>
<td>21.12</td>
<td>27.50</td>
<td>6.81</td>
<td>8.25</td>
<td>148.23</td>
<td>113.30</td>
</tr>
<tr>
<td>T₅</td>
<td>48.60</td>
<td>12.08</td>
<td>68.60</td>
<td>18.09</td>
<td>26.39</td>
<td>31.55</td>
<td>4.79</td>
<td>6.77</td>
<td>154.73</td>
<td>131.88</td>
</tr>
<tr>
<td>T₆</td>
<td>57.21</td>
<td>12.75</td>
<td>72.47</td>
<td>22.73</td>
<td>24.89</td>
<td>30.82</td>
<td>2.23</td>
<td>8.76</td>
<td>203.82</td>
<td>173.76</td>
</tr>
<tr>
<td>T₇</td>
<td>58.52</td>
<td>13.75</td>
<td>80.08</td>
<td>26.23</td>
<td>21.63</td>
<td>30.82</td>
<td>2.68</td>
<td>8.76</td>
<td>203.82</td>
<td>173.76</td>
</tr>
<tr>
<td>T₈</td>
<td>45.98</td>
<td>11.07</td>
<td>58.51</td>
<td>10.56</td>
<td>18.65</td>
<td>22.34</td>
<td>2.17</td>
<td>5.80</td>
<td>116.34</td>
<td>82.65</td>
</tr>
</tbody>
</table>

SEm (±) 2.26 0.47 4.56 2.82 2.68 3.66 0.74 1.35 13.01 9.34
LSD (0.05) 4.84 1.01 9.77 6.04 NS 7.84 1.60 NS 27.90 20.03

Note: PH=plant height, NOL=number of leaves, ABW=average bulb weight (gm), MY=marketable yield q ha⁻¹, TY = total yield q ha⁻¹

Table 3: Effect of weed management practices on weed population and weed control efficiency in onion

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total weeds m⁻² (MCW and DCW)</th>
<th>Total fresh weight (MC+ DC) (g m⁻²)</th>
<th>Total dry weight (MC+ DC) (g m⁻²)</th>
<th>WCE</th>
<th>B:C</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>218.50</td>
<td>112.89</td>
<td>37.37</td>
<td>67.84</td>
<td>2.09</td>
</tr>
<tr>
<td>T₂</td>
<td>227.83</td>
<td>116.67</td>
<td>41.13</td>
<td>64.61</td>
<td>3.27</td>
</tr>
<tr>
<td>T₃</td>
<td>344.50</td>
<td>130.83</td>
<td>34.59</td>
<td>49.19</td>
<td>2.58</td>
</tr>
<tr>
<td>T₄</td>
<td>188.33</td>
<td>92.73</td>
<td>24.11</td>
<td>72.34</td>
<td>1.24</td>
</tr>
<tr>
<td>T₅</td>
<td>180.67</td>
<td>93.60</td>
<td>24.28</td>
<td>73.38</td>
<td>0.96</td>
</tr>
<tr>
<td>T₆</td>
<td>174.50</td>
<td>104.44</td>
<td>22.34</td>
<td>74.28</td>
<td>3.68</td>
</tr>
<tr>
<td>T₇</td>
<td>177.17</td>
<td>86.06</td>
<td>27.59</td>
<td>73.88</td>
<td>3.26</td>
</tr>
<tr>
<td>T₈</td>
<td>678.50</td>
<td>218.40</td>
<td>55.31</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

SEm (±) 43.71 5.37 3.41
LSD (0.05) 93.75 11.52 7.32

Note: MCW= monocot weeds, DCW = dicot weeds, WCE = weed control efficiency, B: C = benefit cost ratio

The onion crop from weed competition. This is in accordance with the result of Sankar et al. (2015) in rabi season onion under western Maharashtra conditions.

Effect of weed management practices on weed population and weed control efficiency

The results on weed population and weed control efficiency showed that different herbicides had significant effects. The weed population was effectively reduced irrespective of all weed management practices except the weedy check. However, weed control efficiency was significantly highest in T₆ (74.28) followed by T₇ (74.28) along with minimum weed populations of 174.50 and 177.17, respectively than other treatments. Significantly, minimum 86.06g of fresh weight and 22.34 g of dry weight of weeds (fig 1) were also observed in T₆ & T₇ respectively as in the table- 3 and fig.- 2.

Oxyfluorfen is a nitrodiphenyl ether herbicide applied to control pre emergent and post emergent grassy and broadleaf weeds as reported by Sean May et al. (2015). Alister et al. (2009); Shaner (2014) reported, oxyfluorfen strongly adsors to soil particles and remain stable inside the soil profile. It affects terrestrial plants when directly applied as pre emergence to the soil or spray over the plants as post emergence. It causes general foliar necrosis within two days of exposure when applied as post emergence. Further, Hess (2000) reported, the leaf appears to be soaked with water and the leaf tissue turns dark green color which aggravates the necrosis and desiccation of the affected tissue. Anastoaiov (2010) reported the other sign of phytotoxicity including week chlorosis, deformation of leaf and vegetation tips and inhibition of plant growth due to reduced and ineffective functioning leaf stomata. Systematically, the application of oxyfluorfen inhibits the emergence of weedy plants, provides an encouraging ecological condition for better crop growth at the initial vegetative stage leading to enhanced bulb development and crop yield with effective weed management practice.

J. Crop and Weed, 15(1)
Likewise, Akobudu (1987) reported, pendimethalin is a dinitroaniline herbicide applied to control the weeds. It is primarily active on grass weeds and also effectively controls broad leaves as reported by Das (2011). Pendimethalin also strongly adsorbs to soil organic matter and clay particles and not easily leaches through the soil. It prevents plant cell division and elongation in some specifically vulnerable type weed and controls the weed population by preventing the weeds from the very emerging stage, particularly during the crucial development phase of the crop.

The present study exhibits that application of oxyfluorfen 23.5% EC before planting and one hand weeding at 40-60 days after planting or combined spray of pendimethalin 30%EC and quizalofop ethyl 5% EC at the time of planting and second application at 30 days after planting not only reduces the weed infestations effectively but also increases bulb yield with higher B:C in onion crop.

ACKNOWLEDGEMENT

We gratefully acknowledge the Orissa University of Agriculture and Technology, Odisha, India for the research facilities provided and to the Director, ICAR-Directorate of Onion and Garlic Research, Rajgurunagar, Pune, India for providing the financial and other facilities to carry out this experiment under All India Network Research Project on Onion and Garlic.

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