Control of different weeds through various weed control methods for improving growth and yield of hybrid maize Pioneer-1543

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Abstract
This study was conducted, the effects of various weed control methods to suppress the growth and development of weeds for enhancing growth and yield of maize, at the experimental area of Agronomy section, Agriculture Research Institute, Tandojam, during winter season 2011-12. The experiment was comprised of five treatments viz; T1= Weedy check, T2= Hand hoeing, T3= Mechanical, T4= Cultural and T5= Chemical weed control in randomized complete block design (RCBD) with four replications. Different weed species were found in the experimental field viz; 1.Chenopodium album L., 2.Rumex dentatus L., 3.Phalaris minor, 4.Anagallis arvensis, 5.Convolvulus arvensis, 6.Chenopodium morale L., 7.Cynodon dactylon, 8.Cyperus rotundus. Results indicated that the Leaves plant-1, Cobs plant-1, Plant height (cm) and Grain yield kg ha-1 of maize were significant (p<0.05) and days to tasseling and silking were non-significant (p>0.05) in all treatments except weedy check. Hand hoeing weed control method effectively reduced weeds as compared to other weed control methods. On the other hand, when weeds frequency increased significantly decreased parameters of maize. It was concluded that the hand hoeing weed control method was found suitable and effective to suppress weeds and improved grain yield of hybrid maize crop as compare to other weed control methods.

Keywords: Grain yield kg ha-1; Hybrid corn (Zea mays L.); Weeds; Weed control methods

Introduction
Maize (Zea mays L.) is the third ranked an essential cereal crop after wheat and rice of Pakistan and getting valuable position in agriculture sector because it has possessed more potential for grain yield and having short-term growth crop. Maize is the main resource of food and fodder which has been using for the making of corn sugar, corn oil, corn protein, corn-flacks and corn syrup.
Maize contributes 2.7 percent to the value added in agriculture and 0.5 percent to GDP. The under area during (2016-17) 1334 (000) hectares cultivated, production 6.130 million tonnes and 3458 kg ha\(^{-1}\) average yield of maize in Pakistan (Pakistan Economic Survey, 2016-17). The grain yield kg ha\(^{-1}\) of maize is very low of Pakistan as compared to other corn growing countries such as, Italy, USA, Canada, Argentina and China (9530, 8600, 6630, 5650, 4570 kg ha\(^{-1}\) reported by [1]. The available favorable condition for high yielding cultivars of maize, still that average yield is very of Pakistan. The highly reduction of 66–80% in crop yields due to more growth of weeds density. Among the considering factors, main responsible factor for low yield as weed competition which competes with plants for available growth resources. Weeds are fighting with the crop plants for space, light, dampness, supplements and carbon dioxide, which decreased not just the yield, grain quality and prevent harvest activities yet additionally increment the cost of production. Different weed control practices have resulted about around 77-96% higher yield [2, 3]. Today, integrated weed management (IWM) program is a mean combined (hand hoeing, Mechanical, cultural and chemical control) techniques and under attention, after environmental and health damages of herbicides were revealed to the public and weeds become resistant to herbicides. Researchers are working on alternative methods to replace them instead of the chemical method and reduce the need for herbicide application [4, 5]. Herbicide dose can be decreased by 15-30% without significant reduction in yield reported by [6, 8]. While the authentic mechanical and cultural methods they are parts of IWM and can be used integrated farming practice [9, 10]. Among the integrated weed management practices the hoeing with the hand is a best historical weed control method in agriculture before activation of technology and it has been continually used in crop production for maximum crop yield [11]. This practice is effective for all crops, sometime when crops and weeds, both become mature in the standing crop due to less attention of farmers then they cannot be controlled completely using chemicals and famous weedicides products provides failure results [12, 13]. Secondary the cultural control measures include winter tillage and good seedbed preparation, optimizing planting date, seeding rate and depth, fertility management, understanding of the crop, field sanitation and the use of adapted varieties [14]. In this regard before sowing the tillage with mould board (MB) reduce weeds through the damaged of the germinated weeds after harvested of previous crop [15, 16]. On other hand, the mechanical weed control method manages the excessive growth of weed by mean various physical practices and it makes their growing conditions unfavorable, therefore these methods almost completely remove weeds and causing lethal injury as compared to chemical control [17]. The chemical weed control is considered to be effective in modern agriculture, but it has also certain drawbacks like pollution development of weedicides etc [18]. Chemicals cause harm to the user and to millions of microorganisms in the soil-crop ecosystem. Herbicides are expensive, and, in some cases, they are not available at the market [19]. Keeping in view all these limitations, chemical weed control is the main alternative due to the shortage manpower and high labour price [20]. Poor weed control methods are responsible for the gap between the potential and actual grain yield of maize All field crops in Sindh are heavily infested with weeds. The traditional weed controls practices including tillage, hand hoeing and hand hoeing are effectively have been used for weeds control practices. Use of herbicides has not become a common control for the poor farmers Therefore, at that time hoeing plays an important role for weed control and effectively controls the weeds. Hoeing is the most suitable method of weed control
and it is recommended for getting maximum yields and Hand hoeing practice was done at pre-emergence weeds in the crop [21].

The present study was targeted, the effect of different weed control methods to suppress the growth and development of weeds for improving growth and yield of hybrid maize.

**Materials and methods**

This study was performed at Agronomy section, Agriculture Research Institute, Tandojam, Sindh, Pakistan (Figure 1) “the effect of different weed control methods to suppress growth and development of weeds for improving growth and yield of hybrid maize”. The experiment was comprised of five weed control methods viz; \( T_1 \) = Weedy check, \( T_2 \) = Hand hoeing, \( T_3 \) = mechanical, \( T_4 \) = Cultural and \( T_5 \) = Chemical control (Mark @ 1000 ml ha\(^{-1}\)) with randomized complete block design having net plot size 3 x 5m with three replications. Maize (Pioneer-1543) was sown on during in Winter Season 2011-12 year. The recommended seed rate of maize 25 kg ha\(^{-1}\) (two seeds per hill) with the row to row 75 cm and plant to plant distance of 20 cm was applied. Land preparation was done properly at recommended depth plough for better root penetration and equal distribution of irrigation and fertilizers. Initially disc plough was used to break the hardpan, followed by leveling and planking. After soaking dose, when the land came in proper moisture condition, the seedbed was prepared by using disc harrow, followed by motivator. Entire phosphates (DAP) and potassium (MOP) and \( \frac{1}{4} \) of Nitrogen (Urea) fertilizers were applied at the time of sowing and remaining \( \frac{1}{4} \) reach at knee height stage, \( \frac{1}{4} \) at pollination stage and remaining \( \frac{1}{4} \) was applied at grain filling stage.

**Observations were recorded**

The observations on Weeds frequency m\(^{-2}\) 15,30,45 DAS, leaves plant\(^{-1}\), days to tasseling and silking (50%), cobs plant\(^{-1}\), plant height (cm), grain yield kg ha\(^{-1}\) were recorded. The different weed flora species were found in the experimental field and noted their Local, English and Technical names as shown in (Table 1) as well as their images are displayed in (Figure 2). Weeds frequency m\(^{-2}\) was counted at 15, 30 and 45 days after sowing by using the wooden frame in all plots. The leaves plant\(^{-1}\) were counted of five randomly selected plants from each treatment. Days to tasseling and silking (50%) was recorded by counting the number of days from sowing to 50% of a plant developed tassels and silking. Cobs plan\(^{-1}\) were obtained at the time of maturity of maize from selected plants. Plant height (cm) was recorded at physiological maturity of the maize crop in five randomly selected plants, using measuring tape from ground to tip of the tassel. The grain yield kg ha\(^{-1}\) received from each plot then weighed based on grain yield kg ha\(^{-1}\) per plot according to formula:

\[ \text{Grain yield (kg ha}^{-1}\) = Yield plot \( ^{-1} \) of given treatment (kg)/Plot area (m\(^2\)) x 10000. \]

**Statistical analysis**

The data statistical analysis was analyzed the variances in treatment means. L.S.D (Least significant difference) test was applied for the statistical differences within treatments, following the method developed by [22].

**Results and discussion**

In Pakistan, the production of maize very low due to various factors, weeds infestation is one of the key factors among them [23], reported that the weeds caused, decreasing of growth and yield parameters of maize crop. The statistical analysis of variance indicated that the all growth, and yield contributing parameters of maize such as, leaves plant\(^{-1}\), days to tasseling and silking (50%), cobs plant\(^{-1}\), plant height (cm) and grain yield kg ha\(^{-1}\), as well as total weeds frequency m\(^{-2}\) 15, 30 and 45 DAS, were significantly (P>0.05) influenced by various weed control methods. The analysis of variance indicated that the all traits of maize crop among the different weed control methods was statistically significant
(p<0.05) except days to tasseling and silking (50%) as indicated in (Table 2).

1st weeds frequency 15 DAS
The data of weeds frequency of 15 days after sowing revealed that the minimum reduction of weeds frequency (11.0 m²) was recorded in hand hoeing, followed by (28.0, 34.0 and 52.0 m²) observed in mechanical, cultural and chemical weed control method respectively. However, maximum weeds frequency (105.0 m²) was observed in weedy check plot presented in (Figure 3).

2nd weeds frequency 30 DAS
The results of weeds frequency of 30 days after sowing was difference. The lowest weeds frequency (16.0 m²) was noticed in hand hoeing, followed by (35.0, 44.0 and 61.0 m²) recorded in mechanical, cultural and chemical control methods respectively [24]. While, highest weeds frequency (118.0 m²) obtained from weedy check plot as shown in (Figure 3).

3rd weeds frequency 45 DAS
According to the data of 45 days after sowing, the lower weeds frequency (13.7 m²) was recorded in hand hoeing and higher (118.0 m²) was observed in the weedy check plot. Moreover, the weeds frequency (33.0, 41.0 and 59.0 m²) were noted in mechanical, cultural and chemical weed control methods respectively as displayed in (Figure 3). In this regard, the chemical weed control was not effective as compared to hand hoeing, mechanical and cultural weed control methods. This result indicated that the hand hoeing weed control was more effective to reduced weeds as compared to other weed control methods. These results are agreed with [25], who observed that the significantly variations in weeds frequency of various weeding methods and had negatively affected the weed growth. According to this the hoeing with hand produced maximum grain yield and appropriately eradicates the weeds reported [26].

Leaves plant⁻¹
The results of leaves plant⁻¹ in maize was significantly affected by different weed control methods are given in (Table 3). The results showed that maximum leaves plant⁻¹ (14.0 and 12.3) obtained in hand hoeing and mechanical weed control methods respectively, followed by (9.0 and 7.0) leaves plant⁻¹ observed in cultural and chemical weed control method respectively. However, more reduction in leaves plant⁻¹ (4.5) noted in weedy check plot. This might be attributed to severe competition of high weed densities for resources viz; sunlight, moisture and nutrients thereby making maize plants weaker. These results are in accordance with findings of reported by [27], higher leaves plant⁻¹ due to lesser weed competition during early and critical stages of crop leads to better resource use efficiency. Increasing LAI due to an increased competition and increased leaves plant⁻¹ of maize crop.

Days to tasseling and silking (50%)
The days to tasseling and silking of maize are playing an important role in maize grain production due to male and female part of maize plant, this may influence on grain production. The data of analysis of variance indicated that the days to tasseling and silking was non-significantly (p>0.05) influenced by various weed control methods which showed in (Table 3). The minimum days to tasseling (65.0) recorded in hand hoeing weed control method. The bar data of days to tasseling (66.0) was observed in mechanical, cultural and chemical weed control methods respectively. However, maximum days to tasseling (70.0) were noted by weedy check plot. On the other hand, lower days to silking 50% (68.0 and 69.0) observed in hand hoeing and mechanical weed control methods, followed by (71.0 and 72.0) were noted in cultural and chemical weed control methods. Moreover, higher days to silking (70.0) recorded in weedy check plot. The results of this study revealed the lower days to tasseling and silking (50%) were noted in hand hoeing weed control method and higher days were observed in weedy check plot. These results are occurrence similar
with [28], who observed that the better weed control method could be effectively control of weeds in early growth stages of the maize crop, therefore, that crop plants will be provided better environment to utilize by crop for growth and development. The higher days of tasseling and silking could be long-term duration and take more days to physiological maturity.

Cobs plant\(^1\)

Cobs plant\(^1\) of maize are a main of major yield component and with linear affected on grain yield of maize. The data of cobs plant\(^1\) was significantly influenced by different weed control methods as given in (Table 3). The higher cobs plant\(^1\) (1.8) was recorded in hand hoeing weed control method, followed by (1.3, 1.2 and 1.1) were obtained from mechanical, cultural and chemical control methods. However, the lower cobs plant\(^1\) (1.0) recorded in the weedy check. These results of our study are agreed with [29], observed that the numbers of cobs plant\(^1\) were significantly affected by various weed control methods.

Plant height (cm)

Tallness in maize plant is mostly associated with the better growth and development of maize plant that could be due to effective weeds control method. Plant height has been reported to be positively correlated with the productivity of plants reported by [30]. The results showed that the tallest plant height (179.0 cm) was noted in hand hoeing weed control method and shortest (79.0 cm) recorded in weedy check plot. However, different plant heights (155,115 and 103 cm) were observed mechanical, cultural and chemical weed control methods respectively which demonstrated in (Table 3). Although, this study revealed that chemical weed control method had not effectively to reduce weeds for production of taller plant. These results are confirmed to findings of the higher plants were observed due to effective weed control method. Whereas, shorter plants were found when weed control method was delayed reported by [31].

Grain yield (kg ha\(^{-1}\))

The grain yield of maize is the ultimate objective of all research such as cobs plant\(^1\) and number grain cob\(^{-1}\). The data revealed that the different weed control methods significantly affect on grain yield of maize crop as mentioned in (Table 3). The highest grain yield of maize (6400.0 kg ha\(^{-1}\)) was recorded in hand hoeing weed control method, followed by (6032.0, 5900.0 and 5700.0 kg ha\(^{-1}\)) observed in mechanical, cultural and chemical weed control methods respectively. Moreover, lowest grain yield (5520.0 kg ha\(^{-1}\)) was obtained by weedy check plot. These results occurrence with those of other researchers [32], suggested that the nonchemical weed control practice resulted in higher grain yield than that of chemically weed control method.

Table 1. Different weeds flora in the experimental field of maize.

<table>
<thead>
<tr>
<th>Local Name</th>
<th>English Name</th>
<th>Botanical Name</th>
<th>Life of Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naro</td>
<td>Bind weed</td>
<td>Convolvulus arvensis</td>
<td>Biennials</td>
</tr>
<tr>
<td>Nalibuti</td>
<td>Pimpernel</td>
<td>Anagallis arvensis</td>
<td>Annual</td>
</tr>
<tr>
<td>Danak</td>
<td>Bunch grass</td>
<td>Phalaris minor</td>
<td>Annual</td>
</tr>
<tr>
<td>Jhunli palak</td>
<td>Sheep clock sorrel</td>
<td>Rumex dentatus L.</td>
<td>Biennial</td>
</tr>
<tr>
<td>Jhill</td>
<td>Lambs quartes</td>
<td>Chenopodium album L.</td>
<td>Annual</td>
</tr>
<tr>
<td>Kurund</td>
<td>Nattleaf goosefoot</td>
<td>Chenopodium morale L.</td>
<td>Biennial</td>
</tr>
<tr>
<td>Chabbar</td>
<td>Lawn grass</td>
<td>Cynodon dactylon</td>
<td>Perennials</td>
</tr>
<tr>
<td>Kabbah</td>
<td>Nut grass</td>
<td>Cyperus rotundus</td>
<td>Perennials</td>
</tr>
</tbody>
</table>
Figure 1. The map of experimental site

Figure 2. Weeds were found in the experimental field of maize
Figure 3. Effect of different weed control methods on weeds frequency m² of 15, 30 and 45 days after sowing

Table 2. Mean square ANOVA of weed frequency m² 15,30,45 DAS, leaves plant⁻¹, days to tasseling and silking (50%), cobs plant⁻¹, plant height (cm) and grain yield kg ha⁻¹

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>DF</th>
<th>WF/15 DAS</th>
<th>WF/30 DAS</th>
<th>WF/45 DAS</th>
<th>LP</th>
<th>DT 50%</th>
<th>DS 50%</th>
<th>CP</th>
<th>PH (cm)</th>
<th>GY (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rep</td>
<td>3</td>
<td>145.43</td>
<td>132.05</td>
<td>170.32</td>
<td>0.5107</td>
<td>104.721</td>
<td>4.0267</td>
<td>0.08390</td>
<td>119.05</td>
<td>61811</td>
</tr>
<tr>
<td>Weeding</td>
<td>4</td>
<td>5156.20&lt;NS&gt;</td>
<td>6142.05&lt;NS&gt;</td>
<td>7254.25</td>
<td>59.1367</td>
<td>14.859</td>
<td>38.8593</td>
<td>0.39550</td>
<td>6418.66</td>
<td>451405</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>93.74</td>
<td>180.72</td>
<td>157.15</td>
<td>4.0078</td>
<td>13.071</td>
<td>5.7446</td>
<td>0.04056</td>
<td>60.87</td>
<td>132335</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>93.74</td>
<td>180.72</td>
<td>157.15</td>
<td>4.0078</td>
<td>13.071</td>
<td>5.7446</td>
<td>0.04056</td>
<td>60.87</td>
<td>132335</td>
</tr>
</tbody>
</table>

Whereas. Df= degree of freedom, WF= weed frequency, LP= leaves plant⁻¹, DT= days to tasseling, DS= days to silking, CP= cobs plant⁻¹, PL= plant height (cm), GY= grain yield kg ha⁻¹

Table 3. Effects of different weed control methods on leaves plant⁻¹, days to tasseling and silking (50%), cobs plant⁻¹, plant height (cm) and grain yield kg ha⁻¹ of maize

<table>
<thead>
<tr>
<th>Weed control methods</th>
<th>Leaves plant⁻¹</th>
<th>Days to tasseling (50%)</th>
<th>Days to silking (50%)</th>
<th>Cobs plant⁻¹</th>
<th>Plant height (cm)</th>
<th>Grain yield kg ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weedy check</td>
<td>4.5 c</td>
<td>70.0 a</td>
<td>76.0 a</td>
<td>1.0 c</td>
<td>79.9 d</td>
<td>5520.0 b</td>
</tr>
<tr>
<td>Chemical</td>
<td>7.0 bc</td>
<td>66.0 a</td>
<td>72.0 ab</td>
<td>1.1 bc</td>
<td>103.1 c</td>
<td>5700.0 b</td>
</tr>
<tr>
<td>Cultural</td>
<td>9.0 b</td>
<td>66.0 a</td>
<td>71.0 bc</td>
<td>1.2 bc</td>
<td>115.0 c</td>
<td>5900.0 b</td>
</tr>
<tr>
<td>Mechanical</td>
<td>12.3 a</td>
<td>66.0 a</td>
<td>69.0 c</td>
<td>1.3 b</td>
<td>155.0 b</td>
<td>6032.0 b</td>
</tr>
<tr>
<td>Hand hoeing</td>
<td>14.0 a</td>
<td>65.0 a</td>
<td>68.0 c</td>
<td>1.8 a</td>
<td>179.0 a</td>
<td>6400.0 a</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>3.0843 NS(5.5701)</td>
<td>NS(3.6926)</td>
<td>0.3103</td>
<td>12.020</td>
<td>5604.6 b</td>
<td></td>
</tr>
<tr>
<td>SE:±</td>
<td>1.4156</td>
<td>2.5565</td>
<td>1.6948</td>
<td>5.5168</td>
<td>0.1424</td>
<td>257.23</td>
</tr>
<tr>
<td>CV</td>
<td>21.34</td>
<td>5.42</td>
<td>3.36</td>
<td>15.52</td>
<td>6.17</td>
<td>6.15</td>
</tr>
</tbody>
</table>
Conclusion
It was concluded that the hand hoeing weed control method was found suitable and effective to suppress weeds and improved grain yield of hybrid maize crop as compared to other weed control methods, because this method effectively controls weeds at the early growth stage and when weeds become mature in standing crop of maize.

Authors’ contributions

References


