Effects of weed control methods on yield and yield components of Iranian rice

H. Yousefnia pasha, R. Tabatabae koloor*, S.J. Hashemi

Department of Agricultural Machinery, Sari Agricultural Sciences and Natural Resources University, Sari, Mazandaran, Iran

*Corresponding author: r.tabatabaei@sanru.ac.ir

Abstract

In order to study the effects of several weed control methods on yield and yield components of rice, a field experiment was carried out in Northern part of Iran during 2011. The experiments were set up as randomized complete block design with three replications and seven treatments including hand weeding twice (T1), powered weeding twice (T2), powered weeding + hand weeding once (T3), cono-weeder weeding twice (T4), herbicide application + hand weeding once (T5), control treatment (T6) and herbicide application once (T7). Results showed that all the treatments had significant effect (P<0.01) on the grain yield, biological yield, fertile tillers, panicle number per square meter, grain number per panicle, filled grain number per panicle and unfilled grain number per panicle, while the treatments effect on weight of thousand seeds was not significant. In general, among treatments, herbicide application + hand weeding once (T5) had the highest grain yield (4584 kg ha⁻¹), while control treatment (T6) because of the high unfilled grain per panicle and less panicle number per square meter had the lowest grain yield (2505 kg ha⁻¹). Among the mentioned traits, unfilled grain number per panicle had negative and significant correlation (-0.47*) with grain yield. Panicle number per square meter had very high and positive correlation (0.94**) with grain and biological yield. As a result, panicle number per square meter is considered as the most important and the most effective trait in increasing grain yield.

Keywords: Rice, weed control, yield, yield components.

Introduction

Rice is grown on approximately 600,000 ha in Iran (FAO, 2010) and more than 75% of paddy fields are located in northern provinces of Mazandaran and Guilan (Ministry of Agriculture, 2011). The weeds instead of harbouring insects, compete with crop for water, light and plant nutrients and adversely affect the micro-climate around the plant (Behera et al., 1996; Nojavan, 2001 and Yaghobi et al., 2008). Loss of production due to weed on transplanted rice in Guilan province in Iran was reported about 46-67 percent and loss due to barnyard grass weed itself was reported 8-53 percent and according to this report loss due to weeds in transplanting rice was 44-96 percent at the global level in the case of non-controlling (Mohamad Sharifi, 1994). DeDatta (1981) reported that the loss of yield due to weeds are 11.8% in Asia. Losses in grain due to weeds in upland rice vary from 40 to 80% and in many cases complete crop failure (Singh and Ram, 1990). Vakili (2000) reported that about 35 to 80 percent of rice in South East Asia has been reduced due to the presence of weeds. These statistics demonstrate the importance of losses due to weed in agriculture especially barnyard grass in cultivation of rice. Hence, one of the key elements of agricultural systems such as rice cultivating is weed management and control. Weed control in paddy fields is accomplished with chemical, mechanical, cultural practice and hand labor (Abdollahi and Ghadiri, 2004). Reliance on herbicide weed management systems can be costly and can lead to herbicide-resistance concerns, whereas herbicide use is often recommended and required for maximum economic returns (Wilcut et al., 1995). Low-input weed management must include a multitactic approach. These approaches include optimal row spacing and plant population, mechanical weed control, hand weeding and cultivar selection (Liebman and Gallandt, 1997). Several workers reported about the possibility of weed control by using herbicide alone or in combination with other methods (Sharma et al., 1977; Singh and Puran, 1982 and Singh and Reddy, 1983). Many herbicides are effective against many weeds but some weeds which are not affected by herbicides must be eliminated mechanically as the weeds which survive or emerge after the herbicide treatment may grow vigorously due to less competition from other weeds (Singh et al., 1994). Studies showed that not using herbicides and controlling weeds by other methods causes 31 percent reduction in product and there upon about 13 million dollars loss (Rashed et al., 2006). The aim of this study was to investigation the effects of different weed control methods on the grain yield, biological yield, fertile tillers, panicle number per square meter, grain number per panicle, filled and unfilled grain number per panicle and weight of thousand seeds of Iranian rice variety of Tarom.

Results and discussion

Grain yield and biological yield

The effect of weed control method on grain yield and biological yield was significant at 1% level of probability (Table 1).
Figure 1 indicates that the highest grain yield in different treatments was related to treatment T5 (4584 kg ha\(^{-1}\)), while the least value was related to treatment T6 (2505 kg ha\(^{-1}\)). Some researchers also have reported that application of herbicides increased the performance of rice yield (Adigun et al., 2005; Ishaya et al., 2007 and Eskandari et al., 2011). Singh et al. (1994) reported that combined application of herbicide + two mechanical weedings was more effective in reducing weed growth and maximizing grain yield. Rice yield can be affected by different genetic and environmental factors such as plant density, water management, pests, diseases, weeds and feeding (Gheisari, 2007). Based on the correlation coefficient (Table 2) the grain yield had positive and significant correlation with fertile tiller (0.94**), panicle number per m\(^2\) (0.94**), filled grain number per panicle (0.51*), grain number per panicle (0.47*), while the correlation with unfilled grain number per panicle was negative (-0.47*). The mean comparison of treatments (Fig 2) showed that treatments T5 and T7 had the highest biological yield, while the least value was for treatment T6. Mirzaei et al. (2006) reported that panicle length, tiller number and biological yield traits had the most direct effects on biological yield and these traits can be used as indirect selection criteria on yield. Biological yield had positive and significant correlation with yield (0.91**), panicle number per m\(^2\) (0.88**), filled grains per panicle (0.54*), grain number per panicle (0.51*), and negative correlation with unfilled grain per panicle (-0.43*).

### Fertile tillers

The results of variance analysis for effect of treatments on the rice yield and it's components have been shown in the Table 1. The effect of all treatments except weight of thousand seeds were significant (p<0.01). All weed control methods had significant effect on fertile tiller at 1% level of probability (Table 1). The highest and lowest number of fertile tillers in treatments T5 (12.6) and T6 (8.9) were observed, respectively (Fig 3). The difference between treatments T1 and T4, also T3 and T7, was not statistically significant. According to the attribute correlation (Table 2), rice yield and biological yield had positive significant correlation (0.94** and 0.88**, respectively) with fertile tiller. Moreover, this character had negative correlation (-0.45*) with unfilled grain number per panicle. Pass analysis of grain yield and some agronomic characteristics in both groups of local and improved varieties showed an increase in yield that is more influenced by the number of fertile tillers (Ebadi et al., 2002). Miller et al. (1991) reported that the number of fertile tillers is the most important yield components, which includes 86% of yield changes.

### Panicle number per square meter

Table 1 showed that the panicle number per m\(^2\) at the 1% probability level was influenced by different weed control methods. Among treatments, the T5 had the highest panicle number per m\(^2\) (234), while T6 had the lowest number (165) (Fig 4). The panicle number per m\(^2\) at the 1% level of probability had positive and significant correlation with grain yield and biological yield (Table 2). Studies showed that panicle number per square meter is the most important factor in increasing grain yield of rice and 89% of yield changes is due to the effect of this factor (Sonia et al., 1990; Grovois and Helms, 1992).

### Filled grain number per panicle

Analysis of variance showed that the filled grain number per panicle significantly affected by different weed control methods (Table1). The minimum filled grain number per panicle was observed in T6 (73), while in treatment T4 it was the maximum (110) with 7.6% more than T5 (Fig 5). The most direct effect of filled and unfilled grain number per panicle was observed on grain yield. Therefore, increasing filled grain number and reducing unfilled grain number per panicle increases grain yield (Norbakhshian and Razaei, 1999). Based on the correlation coefficient (Table 2) the field grain number per panicle had positive and significant correlation with yield (0.5*) and biological yield (0.54*). Eskandari et al. (2011) also reported positive correlation (0.62) for filled grain number per panicle with yield.

### Unfilled grain number per panicle

The effect of weed control method on unfilled grain number per panicle was significant (p<0.01) (Table 1). Mean comparison of treatments showed that average unfilled grain number per panicle in T6 was the highest, while in T7 was the least (Fig 6). According to the Table 2, the unfilled grain number per panicle had negative and significant correlation with grain yield (-0.47*) and biological yield (-0.43*).

### Grain number per panicle

Analysis of variance indicated that grain number per panicle under different weed control methods was significantly different at the 5% level of probability (Table 1). Mean comparison results showed that the least grain number per panicle achieved in T6 and the highest was observed in T4 (Fig 7). Application of cono-weeder weeding twice (T4) is one of the main reasons of increasing grain number per panicle, in which weeds are controlled in a better way. The grain number per panicle had positive and significant correlation with grain yield (0.47*) and grain bioyield (0.51*). Rahimian et al (1998) reported that increase in grain number per square meter is achieved either through increasing panicle number per m\(^2\) or through higher grain number per panicle.

### One thousand seeds weight

Table 1 showed that 1000-seed weight was not influenced by different weed control methods and all of the treatments were placed in the same level. Weight of 1000-seeds is one of the major yield components and stable properties of cultivars are due to higher genetic stability than other yield components. It is not affected by environmental factors (Rafiee, 2008). In general, it seems that the different methods of weed management can not be much effective on the 1000-seeds weight and this trait is more influenced by cultivar.

### Materials and methods

### Field preparation

Field experiments were conducted during summer 2011 at a local paddy field in Babol, north of Iran. The soil of the experimental field was sandy clay loam with PH 7.2. The average of air temperature was 22.7 ºC, with the average rainfall of 36 mm at the first six months, relative humidity of air 77.5%, sunshine 174 hours and evaporation 129.4 mm.
Table 1. Analysis of variance for yield and yield components at different weed control methods.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>df</th>
<th>Fertile tiller</th>
<th>Panicle number per m²</th>
<th>Filled grain number per panicle</th>
<th>Unfilled grain number per panicle</th>
<th>Grain number per panicle</th>
<th>Weight of 1000-seed grain</th>
<th>Yield (kg ha⁻¹)</th>
<th>Biological yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rep</td>
<td>2</td>
<td>0.02**</td>
<td>7.4**</td>
<td>204.7**</td>
<td>0.08**</td>
<td>204.6**</td>
<td>0.36**</td>
<td>21365.8**</td>
<td>1636681.9**</td>
</tr>
<tr>
<td>Treat</td>
<td>6</td>
<td>4.9**</td>
<td>1674.3**</td>
<td>458.1**</td>
<td>2.6**</td>
<td>446.1*</td>
<td>0.28**</td>
<td>144819**</td>
<td>6261284.3**</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>0.04</td>
<td>12.3</td>
<td>77.5</td>
<td>0.3</td>
<td>82.4</td>
<td>0.18</td>
<td>54807.7</td>
<td>488587.3</td>
</tr>
<tr>
<td>C.V.%</td>
<td></td>
<td>1.7</td>
<td>1.7</td>
<td>9.6</td>
<td>15.3</td>
<td>9.5</td>
<td>1.6</td>
<td>6.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>11.3</td>
<td>209.9</td>
<td>92</td>
<td>3.7</td>
<td>95.7</td>
<td>26.6</td>
<td>3850.5</td>
<td>9164.8</td>
</tr>
</tbody>
</table>

** : significant at 1% level of probability  * : significant at 5% level of probability  ns : non-significant

Table 2. Correlation coefficients.

<table>
<thead>
<tr>
<th>traits</th>
<th>Fertile tiller</th>
<th>Panicle number per m²</th>
<th>Filled grain number per panicle</th>
<th>Unfilled grain number per panicle</th>
<th>Grain number per panicle</th>
<th>1000-seed grain weight</th>
<th>Yield</th>
<th>Biological yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertile tiller</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panicle number per m²</td>
<td>1**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filled grain number per panicle</td>
<td>48*</td>
<td>0.48*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfilled grain number per panicle</td>
<td>-0.45*</td>
<td>-0.45*</td>
<td>-0.06</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain number per panicle</td>
<td>0.45*</td>
<td>0.45*</td>
<td>0.1</td>
<td>0.01</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000-seed grain weight</td>
<td>0.33</td>
<td>0.33</td>
<td>-0.014</td>
<td>-0.38</td>
<td>-0.012</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yield</td>
<td>0.94**</td>
<td>0.94**</td>
<td>0.5*</td>
<td>-0.47*</td>
<td>0.47*</td>
<td>0.27</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Biological yield</td>
<td>0.88**</td>
<td>0.88**</td>
<td>0.54*</td>
<td>-0.43*</td>
<td>0.51*</td>
<td>0.27</td>
<td>0.91**</td>
<td>1</td>
</tr>
</tbody>
</table>

* : significant at 1% level of probability  ** : significant at 5% level of probability  ns: non-significant
The paddy field was transformed into flooding state and prepared by rototiller and flatered by trowel. Rice (cv. Tarom) was transplanted by hand with in-row and inter-row spacing of 18 and 30 cm, respectively.

**Treatments**

The treatments were as follow:
- a) Hand weeding twice, 20th day and 35th day after transplanting (T1)
- b) Powered weeding twice, 20th day and 35th day after transplanting (T2)
- c) Powered weeding, 20th day after transplanting + hand weeding once, 35th day after transplanting (T3)
- d) Cono-weeder weeding twice, 20th day and 35th day after transplanting (T4)
- e) Herbicide application (Butachlor), 5th day after transplantation and 3-4 Liter in each hectare + hand weeding once, 35th day after transplanting (T5)
- f) Control treatment (weedy check) (T6)
- g) Herbicide application once, 5th day after transplanting and 3-4 Liter in each hectare (T7)

The average number of fertile tillers at 15 plants in each plot was calculated. The panicle number per square meter was counted. Total, filled and unfilled grain number per panicle were obtained from average of 15 panicles in each plot. In order to calculate weight of thousands seeds, 500 seeds per plot was randomly selected according to 14% moisture content. Grain yield and bioyield were determined after complete ripening. Each plot was harvested with elimination of marginal effects and after threshing total grain weight and straw were separately recorded. Grain yield and bioyield (grain+straw) were estimated in kg per ha with 14% moisture content.

**Statistical analysis**

The experiments were set up as randomized complete block design with seven treatments and three replications in 2100 m² in 21 plots and the size of each plot was 5x20 m. The data were analysed using the standard procedure of randomized block design. An analysis of variance was carried out, and means were analysed by Duncan's multiple range tests at the 5% probability level. Statistical software of SPSS and MSTATC were used.

**Conclusion**

Based on the results of weed control methods effect on rice yield and yield components it was concluded that all the treatments had significant effect (P<0.01) on the fertile tillers, panicle number per square meter, grain yield, biological yield, grain number per panicle, filled grain number per panicle and unfilled grain number per panicle, while the treatments effect on weight of thousand seeds was not significant. The highest grain yield (4584 kg ha⁻¹) and the lowest grain yield (2505 kg ha⁻¹) were observed in herbicide application + hand weeding once (T5) and control treatment (T6), respectively. Fertile tillers and panicle number per square meter had the highest correlation (0.94**) and unfilled grain number per panicle had negative correlation (-0.47*) with grain yield. In general, herbicide application + hand weeding once (T5) due to high grain yield, grain number per panicle, filled grain number per panicle, panicle number per m² and fertile tiller was the best among treatments. Panicl
Fig 5. Effect of weed control methods on the filled grain number per panicle

Fig 6. Effect of weed control methods on the unfilled grain number per panicle

Fig 7. Effect of weed control methods on the grain number per panicle

number per square meter had very high and positive correlation with grain and biological yield. As a result, panicle number per square meter is considered as the most important and the most effective trait in increasing grain yield.

References


De Datta SK (1981) Principal and practices of rice production. John Willey and Sons, New Jersey, USA.


