The Effect of Different Tillage Methods on Yield and Yield Components of Bread Wheat Under Rainfed Conditions

Moslem Abdipur, Nosrat Allah Heidarpur, Behroz Vaezi, Vahid Bavei, Amir Hossein Ghanbari and Sajad Talaee

Abstract: In the southwestern Iran mainly use conventional tillage (Moldboard plowing followed by two disc harrowing) to wheat production. Such a tillage system requires a high energy input and may also causes water loss and long-term soil physical degradation. This field study was conducted under dry conditions to determine whether reduced tillage systems have significant effect on wheat grain yield in rainfed conditions. For this purpose five tillage treatments (T1: Moldboard plow + disc harrow as conventional method, T2: Chisel plow + disc harrow, T3: Moldboard plow without inversion page + disk harrow, T4: Power harrow, T5: Sweep plow + disk harrow) were studied during three years (2004-2007) in Gachsaran Dryland Agricultural Research Station (GDARS), Iran. Significant differences were found among tillage treatments for thousand kernel weight, biological yield, grain yield and harvest index. T1 treatment almost had the highest amounts for above traits. Overall, Chisel plow + disc harrow treatment with 266 kg ha⁻¹ yield increase compared with conventional tillage was recognized as the best tillage treatment.

Key words: Grain yield · Rainfed condition · Tillage methods · Wheat

INTRODUCTION

Wheat crop is the most important food crop in third world countries and has a vital role in their national economies. In many parts of the world, the farms are prone to abiotic stresses especially drought and heat stress. Drought stress is an important limiting factor, especially in sensitive stage such as generative growth phase and grain filling stage which can cause major loss in wheat productivity in arid and semi arid regions [1, 2]. Therefore, keeping the soil moisture at critical stages such as grain filling stage under rainfed conditions is very important. But in the most of the undeveloped countries, the old conventional tillage methods and lake of efficient information about minimum or no tillage methods which have lower energy requirement, lower soil erosion and lower soil moisture losses, led to more abiotic stress impacts on the crops productivity. Under rainfed condition, among the approaches for maintaining soil moisture, using appropriate tillage methods according to climate and soil characteristics is very important, because the effect of different tillage methods on soil properties varies from region to region [3]. On the other hand, proper tillage practices to reduce surface runoff and increase infiltration rates can be lead to more stored soil moisture. However, many researches reported that the ability to hold water in low and no-tillage methods is higher than conventional methods [4-8]. The conventional tillage method in our experimental region is generally Moldboard plowing followed by two discs harrowing which this tillage system requires a high energy input and also causes water loss and long-term soil physical degradation [9]. Therefore, finding appropriate tillage method with minimum soil impacting and erosion, lower water losses and minimum energy requirements can cause to reducing abiotic stress impacts and reducing farming costs. However, the results of evaluation of different tillage methods on wheat yield somewhat different, as Roozbeh and Pooskani [10], Moldboard plow, Sadeghnezhad [11], shallow tillage with a disk, Hargrove [12], Shamsabadi and
Rafiee [13] and Mohammadi et al. [14], Chisel plow, as the best tillage treatment have reported. While, Kreuz [15], Shamsabadi [16], have not observed difference among tillage treatments. According to the fact that the results of different tillage practices under rainfed conditions depend on soil characteristics, climate conditions, cultivation equipment and even plant material used may be different for different regions, this study was conducted to find the effects of different soil tillage methods on wheat yield under rainfed conditions.

MATERIALS AND METHODS

To evaluation of different tillage methods in wheat-fallow rotation under dry condition a field experiment was conducted based on completely randomized block design with four replications at Gachsaran Dry land Agricultural Research Station (GDARS), Iran [50°50’N, 30°17’W, altitude 710 m] with calcareous type soil and Silty Clay Loam texture, pH: 7.3 and organic matter less than 1% during 3 years (2004-2007). Tillage treatments were included:

- **T<sub>1</sub>:** Moldboard plow+disc harrow as conventional method
- **T<sub>2</sub>:** Chisel plow+disc harrow
- **T<sub>3</sub>:** Moldboard plow without inversion page+disk harrow
- **T<sub>4</sub>:** Power harrow
- **T<sub>5</sub>:** Sweep plow+disk harrow

In this experiment, a bread wheat cultivar namely Kouhdasht (which was widely cultivated in South-West part of Iran) was planted. The experiment site had a hot climate with moderate winter and dry and warm summer. Plots were sown at a seeding rate of 300 seed per m<sup>2</sup> in December which weather is moderate and soil moisture is favorable for planting and were same for three years of study. Plot size was 13 rows, 20 m long, 9 m width and border of 17.5 cm in wide. Fertilizing was applied as 50 kg ha<sup>-1</sup> N plus 50 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> before planting. No any disease symptoms were observed during growth season and weeds control was made by hand. Metrological data during growth season (December to May) was taken in Figure 1. At maturity time, each plot individually harvested and grain yield and biological yield was calculated. Harvest index was calculated by following equation.

\[
HI = \frac{\text{Grain Yield}}{\text{Biological Yield}}
\]

Statistical Analysis and means comparison of treatments values was performed by Duncan multiple-range test (DMRT) using statistical software SAS 9.1 [17], at 5% probability level.

RESULTS

The results of combined analysis of variance for yield and yield components were taken in Table 1. For all traits significant different among years was observed. However, tillage treatments didn’t show significant difference for all traits and tillage treatments because of none significant difference for plant per square meter, tillers per square meter, spike length and grains per spike traits placed in a same class (Table 2). While tillage treatments showed significant difference for 1000-grain weight, biological yield, grain yield and harvest index traits and mean comparison of thousand kernel weight, biological yield, grain yield and harvest index traits placed tillage treatments in different classes. T<sub>1</sub> and T<sub>4</sub> treatments for 1000-grain weight, T<sub>2</sub>, T<sub>4</sub> and T<sub>5</sub> treatments for biological yield and T<sub>4</sub> treatment for harvest index had the highest amounts. While, T<sub>1</sub> treatment (conventional tillage) had the lowest biological and grain yield.

DISCUSSION

According to difference in rainfall distribution and amount during three-year and especially amount of rainfall on December (planting time), March and April months (flowering and grain filling stages) (Fig. 1), significant difference for all traits between years could be expected (Table 1). However, there was not significant difference
Table 1: Combined analysis of variance of yield and yield components

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Plants per square meter</th>
<th>Tillers per square meter</th>
<th>Spike length</th>
<th>Grains per Spike</th>
<th>1000-grain weight</th>
<th>Biological Yield</th>
<th>Grain yield</th>
<th>Harvest Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year (Y)</td>
<td>2</td>
<td>64480.650°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>115976.450°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>21.302°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>102.304°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>484.095°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>12925249.067°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>719674.850°&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Year×Replication</td>
<td>9</td>
<td>1019.744</td>
<td>14360.556°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>0.053</td>
<td>6.488</td>
<td>6.205</td>
<td>682600.356°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>172120.350°&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Treatment (T)</td>
<td>4</td>
<td>474.942</td>
<td>10747.714</td>
<td>0.276</td>
<td>25.501</td>
<td>8.845°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>753000.942°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>150510.55°&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Y×T</td>
<td>8</td>
<td>1099.567°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>4257.246</td>
<td>0.154</td>
<td>14.520</td>
<td>1.940</td>
<td>275612.942°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>51860.288°&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>Error</td>
<td>36</td>
<td>335.036</td>
<td>3901.652</td>
<td>0.230</td>
<td>11.039</td>
<td>3.020</td>
<td>182064.286°&lt;sup&gt;**&lt;/sup&gt;</td>
<td>50103.517°&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>C.V%</td>
<td>9.37</td>
<td>11.47</td>
<td>5.85</td>
<td>8.06</td>
<td>4.66</td>
<td>7.77</td>
<td>13.54</td>
<td>9.01</td>
</tr>
</tbody>
</table>

** and ° significant at 0.01 and 0.05 levels, respectively

Table 2: Mean yield and yield components for tillage treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plants per square meter</th>
<th>Tillers per square meter</th>
<th>Spike length (cm)</th>
<th>Grains per spike</th>
<th>1000-grain weight (g)</th>
<th>Biological Yield (kg ha&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Grain yield (kg ha&lt;sup&gt;-1&lt;/sup&gt;)</th>
<th>Harvest Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;1&lt;/sub&gt;</td>
<td>193.6 a</td>
<td>563.1 a</td>
<td>10.3 a</td>
<td>39.69 a</td>
<td>36.61 cd</td>
<td>5125 b</td>
<td>1582 b</td>
<td>30.87 ab</td>
</tr>
<tr>
<td>T&lt;sub&gt;2&lt;/sub&gt;</td>
<td>204.1 a</td>
<td>581 a</td>
<td>10.21 a</td>
<td>41.28 a</td>
<td>41.53 a</td>
<td>5668 a</td>
<td>1848 a</td>
<td>32.60 a</td>
</tr>
<tr>
<td>T&lt;sub&gt;3&lt;/sub&gt;</td>
<td>189.3 a</td>
<td>524.2 a</td>
<td>10.53 a</td>
<td>39.87 a</td>
<td>38.78 b</td>
<td>5381 ab</td>
<td>1700 ab</td>
<td>31.59 ab</td>
</tr>
<tr>
<td>T&lt;sub&gt;4&lt;/sub&gt;</td>
<td>190.2 a</td>
<td>506.2 a</td>
<td>10.13 a</td>
<td>42.58 a</td>
<td>35.42 d</td>
<td>5520 a</td>
<td>1674 ab</td>
<td>30.33 ab</td>
</tr>
<tr>
<td>T&lt;sub&gt;5&lt;/sub&gt;</td>
<td>199.3 a</td>
<td>549 a</td>
<td>10.27 a</td>
<td>42.80 a</td>
<td>37.38 bc</td>
<td>5761 a</td>
<td>1741 ab</td>
<td>30.22 b</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different

among tillage treatments for plant per square meter, tillers per square meter, spike length and grains per spike traits. Considering the appropriate amount of rainfall from November to February and lack of moisture and heat stress and the formation of the above traits during these months, these results can be normal. Also, Lithourgidis et al. [18], Mohammadi et al. [14], had similar results. However, for 1000-grain weight, biological yield, grain yield and harvest index traits were observed significant difference and placed tillage treatments in different classes. T<sub>2</sub> treatment almost had better position for 1000-grain weight, biological yield, grain yield and harvest index compared with other tillage treatments (Table 2). These results are conform with those reported by Ciha et al. [19], Touchton [20], Hargrove [12], Shamsabadi and Rafiee [13], Lithourgidis et al. [17] and Mohammadi et al. [14], reports. While, conventional tillage had not suitable situation in this study. Specially, T<sub>1</sub> treatment in terms of biological yield and grain yield had the lowest amounts compared with other tillage treatments. Usually, these traits can be affected by moisture and heat stress in late-stage development and greatly reduce. Many researchers, [21, 22, 14] reported that the use of moldboard is increased soil moisture loss. On the other hand, Asghari- Meidani [23], Shamsabadi and Rafiee [13] and Mohammadi et al. [14] in study on different tillage treatments under dry conditions reported that the most soil moisture at tillage with chisel obtained. So, any tillage method that can save moisture at critical development stages, especially at the grain filling stage can be effective in the stability of these traits. Enough moisture in the grain filling stage prevents to shortening grain filling during and grain weight increases.

**CONCLUSION**

Chisel plow + disc harrow treatment compared with other tillage treatments, especially conventional tillage with save soil moisture and prevent to high impact of moisture and heat stress on wheat at the end of the season has led to yield stability. Seems, this treatment with 266 kg ha<sup>-1</sup> yield increase compared with conventional tillage is suitable tillage treatment for wheat under rainfed condition.

**ACKNOWLEDGMENTS**

The authors are grateful for the support provided by the Dryland Agricultural Research Institute (DARI), Iran.

**REFERENCES**


