

Research Article

Impact of tillage and mulching levels on the yield and yield components of wheat

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Abstract

A field experiment was conducted during Rabi season 2016 at Bacha Khan Agriculture Research Farm (BARF), Bacha Khan University Charsadda, using wheat variety Pir Sabak 2013. The experiment was laid out in RCB design having two factors i.e. tillage practices (cultivator using 1 time, 3 times, and 5 times) and mulching (M₀-control, M₁-wheat straw, and M₂-sugarcane bagasse). Tillage practices were applied to the main plots while mulching to the sub plots having 3 replications with a net plot size of 1.8m x 5m (9m²) and row to row distance of 30 cm. Data were recorded for days to emergence, plant height, spike length, 1000-grain weight and grain yield. Results of the experiment showed that both tillage practice and mulching has significant effect on almost all the parameters. Tillage showed significant variation for all of the parameters recorded during the course of study except days to emergence. Maximum emergence (199 seedlings m⁻²), were attained by 1 time tillage application where maximum plant height (108 cm), maximum spike length (12 cm), maximum 1000-grain weight (45 g) and maximum grain yield (4717) were observed for 5 time tillage application. Similarly mulching application significantly affected all the parameters recorded during the course of experiment except days to emergence. Maximum plant height(110 cm), spike length (13 cm),1000-grain weight (44 g) and grain yield (5122 kg ha⁻¹) were recorded for M₁during the experiment. Overall, the combination of five times tillage and wheat mulching (M₁) provide its superiority in term of yield i.e. 4717 kg ha⁻¹ and 5122 kg ha⁻¹, respectively.

Keywords: Wheat; Tillage; Mulching; Growth; Yield

Introduction

Wheat (*Triticum aestivum* L.) belongs to the family Poaceae. It is the first grain crop around the world. In Pakistan wheat is used as a staple food because it provides daily dietary needs. Its production is generally for grain purpose, while in countries such as Argentina, Australia, Morocco, Syria and Uruguay, wheat crop is cultivated for grain

as well as for fodder purpose and it leads from all other crops regarding area and production [1]. Wheat plays a major role in the world food trade. In Pakistan wheat crop occupied about 8.9 million hectares area with total production of 25.21 million tones and average yield of 2833 kg ha⁻¹. While in Khyber Pakhtunkhwa, it occupied 0.72 million hectares area, the production was

1.15 million tones and the average yield was 1595 kg ha⁻¹ during 2010-11 [2]. It is an important food crop for Barani areas as well as for irrigated areas and plays a very important role in meeting the food requirements of both urban and rural population. It contributes 14.4 percent to agriculture and 3 percent to the gross domestic production (GDP) of Pakistan. Pakistan ranks in the top ten highly producing countries of wheat [3]. It is grown mainly under irrigated conditions and its water requirement ranges from 20-21 inches per acre.

Tillage not only improves soil tilth but also reduces soil compaction, risk of weeds, soil-borne diseases [4] and enhances soil temperature, aeration, incorporation and decomposition of crop residues [5]. However, continuous ploughing at same depth causes formation of subsurface hardpan [6] which reduces nutrient and water use efficiencies and root growth [7]. Deep tillage is done to overcome the problem of soil compaction. Deep tillage has more moisture content at 50–100 cm soil depth and reduces at 0–50 cm; however, deep ploughing is expensive in terms of fuel and time. The conventional tillage is being practiced all over Pakistan which transforms physical, chemical, biological and electrochemical properties of soil that in turn conserves soil moisture [8]. Zero tillage technology has been adopted to prevent late sowing of wheat. It facilitates sowing of wheat at proper time and good crop establishment. It also saves the cost of water and preparation of seedbed up to 30% [9]. Zero-tillage technology enhances the wheat yield as compared to the other tillage practices and facilitate less use of machinery and hence energy can be saved through less consumption of fuel [10]. Use of intensive and unnecessary conventional tillage practices is often harmful to soil. Therefore, currently there is a significant interest and

emphasis on the shift to the reduced and zero-tillage for increasing water use efficiency of summer crops, controlling erosion process and increasing crop production [11].

Mulches play a vital role for conserving the moisture in the soil profile for the success of wheat production, which totally depends on the precipitation received before and during crop growth period. Mulches reduce the evaporation losses. The practice of mulching has been widely used as a management tool in many parts of the world [12]. However, the effect varies with soils, climate, and kind of mulch material used and the rate of application. The surface mulch favorably influences the soil moisture regime by controlling evaporation from the soil surface, improves infiltration, soil water retention, decreases bulk density and facilitates condensation of soil water at night due to temperature [12]. Variation of the soil microclimate by mulching favors seedling emergence and suppress weed population [13, 14]. Many researchers [15] carried out studies to determine the effect of different mulches on the wheat production. These studies showed that the application of mulches increased grain yield of wheat in comparison with un-mulched wheat. [16] found that wheat straw mulch reduced evaporation by 50 percent under winter wheat and saved about 80 mm water during wheat growth season. Mulch increased the soil moisture in root zone and significantly decreased soil temperature, which was suitable environment for seedling establishment and growth of wheat [14]. Moreover, plastic mulch enhanced the crop yield by changing soil properties, increased nutrient and water use efficiency and soil moisture [17]. Keeping in view the increasing demand of wheat, the present study was therefore conducted to determine the effects of different tillage practices and

mulching types on growth, yield and yield components of wheat.

Materials and methods

A field experiment was conducted to find out the impact of tillage practices and mulching on the yield and yield components of wheat. The experiment was conducted at Bacha Khan Agriculture Research farm (BARF) Charsadda. The experiment was laid out in factorial experiment with randomized complete block design having 9 treatments and 3 replications. Three tillage practices (Cultivator using 1 time, 3 times and 5 times followed by planking) and three mulching levels (control, wheat straw and sugarcane bagasse) were used. A net plot size of 1.8m x 5m (9m²) was used having row to row distance of 30 cm. Data was collected on the following parameters. Days

to emergence, Plant height, Spike length, 1000-grain weight and Grain yield.

Result and discussion

Days to emergence

Tillage, mulching and their combination showed non-significant effect on days to emergence of wheat (Table 1). However, plot ploughed by five times tillage shows more days to emergence 12 as compared to cultivator 1 times and 3 times tillage. Similarly more days (12) to emergence were taken by M₀ and M₂ as compared to M₁. On days to emergence tillage and mulching showed non-significant effect this might be due the fact that at germination stage, the seedlings are mostly depends on stored food rather than on external environment. The result are in line with [18, 19] who reported that germination mostly depends on reserved food.

Table 1. Days to emergence as effected by tillage practices and mulching

Tillage practices	Mulching (kg ha ⁻¹)			Mean
	M0	M1	M2	
1 time	11	11	11	11
3 times	11	11	12	11
5 times	11	12	12	12
Mean	11	12	12	

Plant height

Plant height as affected by various levels of tillage and mulching data are presented in (Table 2). Statistical analysis of the data revealed that tillage's and mulching had significant effect on plant height while the interaction had non-significant effect. Maximum plant height (108 cm) when plot treated with tillage cultivator 1 times and

minimum 96 cm was observed. Among mulching maximum plant height 110 cm were recorded with wheat straw mulching as compared to other mulching practices. Similar result was reported by [20]. Maximum plant height was recorded in plots where wheat straw was used as mulch, as compared to sugar cane and no mulch. Similar finding was observed by [21].

Table 2. Plant height as effected by tillage's and mulching

Tillage's (cultivator times)	Mulching (kg ha ⁻¹)			Mean
	M0	M1	M2	
1 time	85	107	97	96c
3 times	89	109	99	99b
5 times	103	113	106	108a
Mean	92c	110a	101b	

LSD at P < 0.05 for tillage's = 6.29, LSD at P < 0.05 for mulching = 6.29

Spike length

Spike length as affected by tillage's and mulching data are presented in (Table 3). Statistical analysis of the data revealed that tillage's and mulching as well as T x M had significant effect on spike length of wheat. Lengthy spikes (12 cm) were produced when plot ploughed with cultivator 5 time as compared to one time and three time (10 cm) and (11cm). The results are in line with

[22] who reported that increased in tillage intensities, increase spike length. Mulch material had significant effect on spike length. Maximum (13 cm) spike length was observed when wheat straw mulch was used as compared to sugar cane mulch. While no mulch and T x M result maximum (11cm) and minimum (7 cm) maintained. These results are in agreement with the investigations of [23].

Table 3. Spike length as effected by tillage's and mulching

Tillage's (cultivator times)	Mulching (kg ha ⁻¹)			Mean
	M0	M1	M2	
1 time	7	13	11	10c
3 times	10	13	11	11b
5 times	11	13	11	12a
Mean	10c	13a	11b	

LSD at P < 0.05 for tillage's = 0.86, LSD at P < 0.05 for mulching = 0.86, LSD at P < 0.05 for T x M = 1.49

1000-grain weight

1000-grain weights as affected by tillage's and mulching data are presented in (Table 4). Statistical analysis of the data revealed that tillage's and mulching had significant effect on thousand grain weight while T x M had non-significant effect. Maximum thousand grain weight (45 g) was recorded when plot ploughed by cultivator five time and cultivator one time resulted minimum

thousand grain weight (35 g). The findings are in agreement with the result of [24], who observed that the 1000-grains weight significantly influenced by tillage practices. on other hand wheat mulch attained maximum thousand grain weight (44 g) than sugar cane mulch (39 g) while no mulch resulted minimum (36 g) thousand grain weight. The results are in agreement with that of [24].

Table 4. 1000-grain weight as effected by tillage's and mulching

Tillage's (cultivator times)	Mulching (kg ha ⁻¹)			Mean
	M0	M1	M2	
1 time	30	40	35	35c
3 times	35	43	40	39b
5 times	43	49	42	45a
Mean	36c	44a	39b	

LSD at P < 0.05 for tillage's = 2.45, LSD at P < 0.05 for mulching = 2.45

Grain Yield

Grain Yield as affected by tillage's and mulch are presented in (Table. 5). It was observed from the statistical analysis of the data that grain yield significantly affected by tillage's and mulching however the

combination of T x M was found non-significant. It was examined from the analysis that wheat mulch performs better than sugar cane mulch and resulted more grain yield (5122 kg ha⁻¹) than (4319 kg ha⁻¹) of sugar cane. The findings are in

agreement with the result of [25] who reported the significant effects of mulching on yield of wheat. Similarly cultivator five times tillage's produced maximum grain yield (4717 kg ha⁻¹) as compare to one time (4303 kg ha⁻¹) and three times (4559 kg ha⁻¹)

tillage's followed by planking. In case of T x M combination with cultivator five time tillage's produced maximum (5383 kg ha⁻¹) grain yield. Similar results were reported by [25].

Table 5. Grain yield as effected by tillage's and mulching

Tillage's (cultivator times)	Mulching (kg ha ⁻¹)			Mean
	M0	M1	M2	
1 time	3990	4800	4120	4303c
3 times	4207	5181	4289	4559b
5 times	4220	5383	4546	4717a
Mean	4139c	5122a	4319b	

LSD at P < 0.05 for tillage's = 153.6, LSD at P < 0.05 for mulching = 153.6
 Means followed by similar letters are significantly similar at p≤0.05 using LSD

Conclusions and recommendations

Based on results, it is concluded that Five times tillage followed by planking performed better and recommended for more grain yield in wheat. Wheat mulch performed better and is recommended for higher grain yield in wheat in the near future.

Authors' contributions

Conceived and designed the experiments: M Ahmad, Performed the experiments: J Ali, Analyzed the data: G Ullah, Contributed reagents/ materials/ analysis tools: Z Hussain, Wrote the paper: M Ilyas & F Begum.

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