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Different Tillage Practices and Seed Rates Affected Phenology and Various Growth Stages of Wheat

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Abstract

To evaluate response of phenology and different growth stages to different tillage practices (i.e. 3 Times Chisel Plough + 2 Times Rotavator (40cms), 3 Times Mould Board Plough +2 Times Rotavator (30cms), 2 Times Disc harrow + 2 Times Rotavator (20cms), 1 Time Cultivator + 1 Time Rotavator (10cms) and seed rates (i.e. 70, 85,100,115,130,145,160,175 kg ha^{-1}). The research experiment was laid out in randomized complete block Design with split plot arrangement with three replications at Agronomy Research Farm, The University of Agriculture Peshawar during winter 2014-2015. Significant effect of different tillage practices on harvest index (%), straw yield were observed. Highest harvest index (%) (33.8%) was recorded from treatment of (2 Time Disc Harrow + 2 Time Cultivator 20cm). Highest straw yield (6735kg ha^{-1}) was observed from (3 Mould Board Plough +2 Times Rotavator 30cm). Seed rates showed significant effect on spike length, spikelet $spike^{-1}$, spike m^{-2}, harvest index (%), and straw yield. Maximum spike length (13.96cm), spikelet's $spike^{-1}$ (18) were recorded with application of seed rate of 70kg ha^{-1} while higher spike m^{-2} (273), straw yield (7013kg ha^{-1}) were observed with application of seed rate 175kg ha-1. Maximum harvest index (%) (35.1%) was observed with seed rate of 115kg ha^{-1}. It is concluded that tillage practices 2 Times Disc harrow + 2 Times Rotavator (20cms) and seed rate of 115kg ha^{-1} produced maximum yield of wheat.

Keywords: Tillage; Seed rate; Wheat; Growth stages

Introduction

Wheat (*Triticum aestivum L.*) belongs to family Poaceae and is known as king of the cereal. In Pakistan wheat has been the major staple food. Wheat is adapted by wide range of climatic and soil condition [1]. Wheat can be use directly or indirectly by human as diet and as feed by animals. It can be used by one –third population as feed around the globe. The low wheat yield in Pakistan might be due to improper use of tillage practices and seed rates.

Tillage is actually known as the mechanical disturbance of the soil through which the hard surface is broken down to produce a crop [2]. Tillage practices have significant effect on grain yield and kernel length of wheat [3]. Extreme tillage operation along traditional cultivation techniques enhances bulk density of soil. Fabrizzi et al. [4] observe loss of organic nutrients due excessive tillage practices [5]. Maximum tillage operation declines macro porosity and macro aggregates Chan et al. [6] and increases unavailability of nutrient's and moisture to the crop [7]. Tillage operations considerably enhanced soil water status, improved the capacity of soil moisture deposited throughout the summer and wheat growing season associated with conventional tillage [8]. Shah [9] observed that all growth and yield parameters were significantly affected by the sowing methods and seed rates. Huang et al. [10] carried out research to relate the effect of different tillage and irrigation treatments on yield of wheat grown under cotton-wheat cropping system. The results revealed that wheat yield was significantly affected in all treatments. However, effect of tillage on grain yield was non-significant at more number of tillage operations.

Maximum yield can be attained by regulating plant populations established on greater seed rates [11]. It is eminent that increase of seeding rate at early and optimal sowing time is unfavorable but the negative effect of late sowing could be compensated by increase of seed quantity [12]. Hiltbrunner et al. [13] advocated that rationale increase of the seeding density with that of sowing time is an effective to increase the grain yield. Livores et al. [14] used six seeding rates i.e. 150, 175, 250,

300, 400 and 500 seeds m^{-2} with four adapted wheat varieties including hybrid wheat. Seeding rate affected grain yield and yield components in three of the four environments, but its effect varied with the environment. Manipulation of seed rate was a more reliable factor than cultivar selection for enhancement of weed suppression Kukal & Aggarwal [15]. Wheat seed size, seeding rate and variety height had no effect on jointed goatgrass plant density. They observed that wheat reduced mature jointed goat grass biomass 46% and 16% compared with short wheat in years 1 and 2 of the experiment, respectively. Spikelet biomass was also reduced approximately 70 and 30% in same respective years [16].

Material and Methods

Experimental site

The experiment was conducted at Agronomy Research Farm, The University of Agriculture Peshawar Pakistan, during winter 2014-2015.

Experimental design

The experiment was conducted at randomized randomize complete block design with split plot arrangement having three replication with sub plot size ($9m^2$).

Variety

Wheat variety Atta-Habib was used.

Treatments

The treatment consist of two factors (1) Tillage practices (2) Seed rates. Tillage practices was allotted to main plot while seed was kept in sub plots. Tillage practices were consist of 3 Chisel Plough + 2 Times Rotavator (40cm), 3 Times Mould board Plough + 2 Times Rotavator (30cm), 2 Times Disc harrow + 2 Times Rotavator (20cm), 1 Time Cultivator + 1 Time Rotavator (10cm) while the seed rate were consist of 70 $kgha^{-1}$, 85 $kgha^{-1}$, 100 $kgha^{-1}$, 115 $kgha^{-1}$, 130 $kgha^{-1}$, 145 $kgha^{-1}$ and 160$kgha^{-1}$ respectively.

Agronomic practices

All agronomic practices were applied uniformly and at appropriate time. Irrigation was applied according to the requirement of the crop.

Data recorded

Data were recorded on spike length, number of spikelet $spike^{-1}$, spikes m^{-2}, lodging (%), harvest index (%) and straw yield (kg ha^{-1}).

Statistical analysis

The collected were evaluated statistically according to the procedure related to Randomized complete block design with split plot arrangement. Significant F-Test, (LSD) test were used for mean contrasts to identify the significance among the treatment means.

Result and Discussion

Spike length (cm)

Table 1: Spike length, Spikelet $spike^{-1}$, Spike m 2 as affected by tillage practices and seed rates.

Tillage Operations	Spike Length (Cm)	Spikelet $Spike^{-1}$	Spike m^{-2}
3 Chisel Plough+2 Rotavator (40cm)	12.53	17	231
3 MB Plough +2 Rotavator (30cm)	13.05	17	229
2 Disc harrow +2 Rotavator (20cm)	13.39	17	245
1Cultivator+1 Rotavator (10cm)	13.78	18	252
LSD(0.05)	NS	NS	NS
Seed Rates (Kg ha^{-1})			
70	13.96a	18ab	182d
85	13.55ab	18ab	209c
100	13.15bcd	17bc	224bc
115	13.40abc	18ab	235b
130	13.29abc	18a	259a
145	12.88bcd	17abc	262a
160	12.81cd	17bc	269a
175	12.47d	16c	273a
LSD(0.05)	0.72	1.12	23.61
NS = Non significant			
Means of the same category followed by different letters are not significantly different at 5% level of probability			

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Spike length of wheat as affected by tillage practices and seed rate on spike length is presented in Table 1. Statistical analysis of the data showed that spike length was not significantly ($p \geq 0.05$) affected by different tillage practices. Effect of seed rates was significant ($p \leq 0.05$) on spike length of wheat crop. All possible interactions of tillage practices and seed rates were non-significant ($p \geq 0.05$). Highest spike length (13.78cm) was produced by tillage practices (1 Time Cultivator + 1 Time Rotavator 10cm) followed by (13.19cm) and (13.05cm) from tillage practices i.e. (2 Times Disc harrow + 2 Times Rotavator 20cm), (3 Times Mould board Plough + 2 Times Rotavator 30cm) respectively. Minimum spike length (12.53cm) was recorded from treatment of tillage practices with (3 Times Chisel Plough + 2 Times Rotavator 40cm). Highest spike length (13.96cm), was recorded with application of seed rate (70kg ha^{-1}). The treatment of seed rates 85,115,130,100,145,160kg ha^{-1} ranked 2^{nd}, 3^{rd} and 4^{th}, 5^{th}, 6^{th} spike length of (13.55cm), (13.40cm), (13.29cm), (13.15cm), (12.88cm) and (12.81cm) respectively. Minimum spike length (12.47cm) was recorded from seed rate of 175kg h 1. By application of lower seed rate there will be less intra specific competition for light, water , nutrients, space etc. hence resulting highest spike length for lower seed rates. At higher seed rates there will be more competition for light, moisture, nutrients uptake etc. Hence produce short spike length. Kabir et al. [17] reported the same result that seed rate have significant effect on spike length (cm). The results are in line with Waraich et al. [18] and Shahzad et al. [19].

Spikelet spike^{-1}

Spikelet spike^{-1} of wheat as affected by tillage practices and seed rates is presented in Table 1. Perusal of data showed that spikelet spike^{-1} was not significantly ($p \geq 0.05$) affected by different tillage practices. Effect of seed rates was significant ($p \leq 0.05$) on spikelet spike^{-1} of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Greater spikelet spike^{-1} (18) was recorded by tillage practices (1 Time Cultivator + One Time Rotavator 10 cm). Minimum spikelet spike^{-1} (17) was recorded from treatment of tillage practices with 3 Times Chisel Plough + 2 Times Rotavator 40cm, 3 Times Mould board Plough + 2 Times Rotavator 30cm, 2 Times Disc harrow + 2 Times Rotavator 20cm. Highest spikelet spike^{-1} (18), was recorded with application of seed rate (70, 85,115,130 kg ha-1). Minimum spikelet spike^{-1} (16) was recorded from application of seed rate of 175kg ha 1. These result are in line with Talukder et al. [8] and Kabir et al. [17] who also reported the same result that increase of seed rate up to certain optimum level showed spikelet's spike^{-1} increases but above from optimum level of seed rate decrease in spikelet's spike^{-1} occur.

Spike m^2

Effect of tillage practices and seed rates on Spike m 2of wheat is presented in Table 1. Analysis of the data showed that Spike m 2was not significantly ($p \geq 0.05$) affected by different tillage practices. Effect of seed rates was significant ($p \leq 0.05$) on Spike m ^{2} wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Maximum number of Spike m^2 (252) was recorded from tillage practices 1 Time Cultivator + 1 Time Rotavator 10cm followed by 9245) and (229) from tillage practices i.e. (2 Times Disc harrow + 2 Times Rotavator 20cm), (3 Times Mould board Plough + 2 Times Rotavator 30cm) respectively. Minimum Spike m^2 (231) was recorded from treatment of tillage practices with (3 Times Chisel Plough + 2 Times Rotavator 40 cm). Maximum Spike m 2 (273), was recorded with application of seed rate (175kg ha^{-1}). The treatment of seed rates 160,145,130,115,100 and 85 kg ha^{-1} ranked 2^{nd}, 3^{rd} and 4^{th}, 5^{th}, 6^{th} spike m^2 of (269), (262), (259), (235), (224) and (209) respectively. Lowest Spike m^2 (182) was recorded from seed rate of 70kg ha^{1}. The results are in line with the findings of Baloch et al. [11], Longnecker et al. [20] and Shahzad et al. [19]. The possible reason might be that by using different seed rates significantly increased the number of spikes per meter square the highest seed rates will give maximum number of spikes per meter similarly the lowest seed rates will give lesser number of spike m^{-2}.

Lodging (%)

Table 2: Lodging (%), Harvest index (%), Straw yield as affected by tillage practices and seed rates.

Tillage Operations	Lodging (%)	Harvest index (%)	Straw yield (kg ha^{-1})
3 Chisel Plough+2 Rotavator (40 cm)	9.83	33.7b	6717bc
3 MB Plough +2 Rotavator (30cm)	13.04	33.6b	6735a
2 Disc harrow +2 Rotavator (20cm)	7.96	33.8a	6707c
1Cultivator+ 1 Rotavator (10cm)	8.67	33.7b	6720b
LSD(0.05)	NS	0.08	11
Seed Rates (Kg ha 1)			
70	7.58	34.0b	6515f
85	10	34.0b	6526f
100	7.92	34.1b	6564e
115	10.17	35.1a	6613d
130	10.17	34.9a	6644c

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145	10.17	32.7c	6896b
160	14	32.3d	6989a
175	9	32.2d	7013a
LSD(0.05)	NS	0.23	26
NS = Non significant			
Means of the same category followed by different letters are not significantly different at 5% level of probability			

Effect of tillage practices and seed rates on lodging (%) of wheat is presented in Table 2. Perusal of the data indicated that lodging (%) was not significantly ($p \geq 0.05$) affected by different tillage practices. Effect of seed rates was also not significant ($p \geq 0.05$) on lodging (%) of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Maximum lodging (%) (13.04 %) for (3 Times Mould board Plough + 2 Times Rotavator 30cm), (3 Times Chisel Plough + 2 Times Rotavator 40cm) and (1 Time Cultivator + One Time Rotavator 10cm) ranked 2nd and 3rd with lodging (%) of (9.83%) and (8.67%) respectively. Minimum lodging (%) (7.96%) was recorded for (2 Times Disc harrow + 2 Times Rotavator 20cm). Highest lodging (%) of (14%) was recorded for seed rate of 160 kg ha-1. Seed rate of 115, 130, 140 resulting lodging (%) of (10.17%). Seed rate of 85, 175 and 100 resulting lodging (%) of (10%), (9%) and (7.92%) respectively. Lowest lodging (%) of (7.58%) was recorded for seed rate of 70kg ha^{-1}.

Harvest index (%)

Harvest index (%) of wheat as affected by tillage practices and seed rates is presented in Table 2. Analysis data showed that harvest index (%) was significantly ($p \leq 0.05$) affected by different tillage practices. Effect of seed rates was also significant ($p \leq 0.05$) on harvest index (%) of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Highest harvest index (%) (38.8%) was produced by tillage practices (2 Time Disc harrow + 2 time rotavator 20cm) followed by (33.7%) harvest index (%) from tillage practices i.e. (1 Time Cultivator + 1 Time Rotavator 10cm), (Three Times Chisel Plough + 2 Times Rotavator 40cm) respectively. Minimum grain yield (33.6%) was recorded from treatment of tillage practices with (3 Times Mould board Plough + 2 Times Rotavator 30cm). Harvest index (%) was significantly affected by different tillage practices might be due use of 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 and hence affect harvest index (%) of crop. Our result are also in line with [21]. Shams & Rafiee [22] also reported the same trend. Our results are also in agreement with [23]. Highest harvest index (%) (35.1%) was recorded with application of seed rate (115kg ha-1). The treatment of seed rates 130, 100, 85, 70, 145 and 160kg ha^{-1} ranked 2nd, 3rd, 4th, 5th and 6th with harvest index (%) of (34.9%), (34.1%), (34%), (34%), (32.7%), and (32.3%) respectively. Minimum harvest index (%) (32.2%) was recorded from seed rate of 175kg ha^{1}. Similar results were reported by Naseem et al. [24] and Thakur et al. [25] found that wheat was quite responsive to increased seed rate; the highest seed rate produced greater plant population m^2; suggesting 115kg ha^{-1} seed rate for achieving good crop growth and higher grain yields and harvest index (%).

Straw yield (kg ha^{-1})

Straw yield of wheat as affected by tillage practices and seed rates is presented in Table 2. Mean value of the data revealed that straw yield of wheat was significantly ($p \leq 0.05$) affected by different tillage practices. Effect of seed rates was also significant ($p \leq 0.05$) on straw yield of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Maximum straw yield (6735kg ha^{-1}) was produced by tillage practices (3 Times Mould board Plough + 2 Times Rotavator 30cm) followed by (6720kg ha^{-1}), (10126kg ha^{-1}) from tillage practices i.e. (1 Time Cultivator + 1 Time Rotavator 10cm), (3 Times Chisel Plough + 2 Times Rotavator 40) cm respectively. Minimum straw yield (6707kg ha^{-1}) was recorded from treatment of tillage practices with (2 Times Disc harrow + 2 Times Rotavator 20cm). Significant effect of different tillage might be due to tillage practices preferred healthier root development and nutrient uptake by the crop and hence positive physiological and metabolic activities and reproductive development of crop were probably influenced by increased tillage practices. Tillage practice influences favourably the soil-water-plant ecosystem, there by affecting crop yields and straw yield as well. Ardell et al. [26], Ranjan et al. [27], Jabro et al. [28] stated that tillage had significant effect on crop yields. Greater straw yield (7013kg ha-1), was recorded with application of seed rate (175kg ha^{-1}). The treatment of seed rates 160, 145,130,115,100 and 85kg ha^{-1} ranked 2nd, 3rd and 4th, 5th, 6th with straw yield of (6989kg ha^{-1}), (6896kg ha^{-1}), (6644kg ha^{-1}), (6613kg ha^{-1}), (6564kg ha^{-1}), and (6526kg ha^{-1}) respectively. Minimum straw yield (6515kg ha^{-1}) was recorded from seed rate of 70kg h^{1}. These results are in agreement with Marwat et al. [29], Khan et al. [30] stated that the increase in straw yield with higher seed rate might be due to more number of plants per unit area, though with reduced tillers.

Conclusion

It was concluded that tillage practices i.e two times disc harrow plus two times rotavator with depth of 20 cm and by using seed rate of 115kg ha^{-1} resulted higher harvest index (%) and yield under for wheat crop.

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