International Journal of Agricultural and Environmental Research
FREE AND OPEN ACCESS
Available online at www.ijaaer.com
ISSN 2414-8245 (Online)
ISSN 2518-6116 (Print)

YIELD AND YIELD COMPONENTS OF WHEAT AS INFLUENCED BY VARIOUS TILLAGE OPERATIONS AND SEED RATES

SAJJAD AHMAD[1], MUHAMMAD SHAFI[1], INAMULLAH[1], HAFEEZ UR RAHIM[1], ZAID KHAN[1], MUHAMMAD AYOUB KHAN[2], LAIQ ZADA[3], USMAN[4]

[1]Department of Agronomy, The University of Agriculture Peshawar
[2] Department of Plant Breeding and genetics, The University of Agriculture Peshawar
[3]Department of Soil & Environmental sciences, The University of Agriculture Peshawar
[4] Department of Agricultural Chemistry, The University of Agriculture Peshawar
Corresponding Author email: sajjad@aup.edu.pk

Abstract

Various tillage operation and seed rate could be operated to optimize spatial distribution and plant growth. Thereby enhancing WUE, Sunlight, soil available nutrients and yield of wheat on sustainable basis. To evaluate response of wheat yield and yield components 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 conducted 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 spike weight, grains spike^{-1}, biological and grain yield were recorded. Highest spike weight (2.92 g), grains spike^{-1}(41), grain yield (3418 kg ha^{-1}), were recorded from treatment of Two Time Disc Harrow + Two Time Cultivator (20 cm). Highest biological yield (10141 kg ha^{-1}) was observed from 3 Times Mould Board Plough + 2 Times Rotavator (30cms). Maximum weeds dry weight m^{-2} (32.8 g) was recorded with tillage practices 3 Chisel Plough+2 Rotavator (40 cm). Seed rates also showed significant effect on spike weight, grains weight spike^{-1}, grains per spike, weeds dry weight m^{-2}, grain yield and biological yield. Maximum spike weight (2.88 g),grains weight spike^{-1}(1.26 g), grains per spike (42), grain yield(3573 kg ha^{-1}),were observed with seed rate of 115 kg ha^{-1}. Highest biological yield (10348 kg ha^{-1}) were recorded from seed rate 175 kg ha^{-1}. Maximum weeds dry weight m^{-2} (30.8 g) was observed with seed rate 70 kg 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

Key words: Tillage, Seed rate, Wheat, Weeds, Yield and Yield Components.

INTRODUCTION

Wheat (*Triticum aestivum* L.) rank first among the cereal crops. It cover about 66% of the agriculture land in Pakistan (Ali et al., 2010). In the third world countries wheat is consider one of the important crop, and play an important role in their national economies (Vaezi et al., 2010). Wheat yield in Pakistan is low as compare to developed countries like USA, China, and France (Ozpinar, 2006). The main reason of low wheat yield in Pakistan are the mismanagement of agronomic practices such as tillage, optimum seed rate (Chhokar et al., 2007). Pakistan rank high position and consider one of the important wheat producing country in the world. Reduction in yield of wheat greatly affect our economy. Population of Pakistan is increasing very rapidly. Therefore it is important to strengthen wheat production by efficient use of tillage practices, and by using optimum seed rate at the time of sowing. Wheat occupies 8549.8 thousand ha land in Pakistan. Which produced 24033 thousand tones wheat. With an average production of 2657 kg ha^{-1}. While in KPK wheat covers an area of 769.5 thousand ha, by producing 1204.5 thousand tones with mean production 0f 1556 kg ha^{-1}. Wheat area and production increases by 5.8% and 14.7% respectively as compare to the previous year (MNFSR, 2014). Wheat production of our county is very low as compare to other wheat producing countries. Wheat low yield is due to certain factor like agronomic, environmental and genetic factors. Under such condition maximum grain yield can be obtain by using proper tillage practices and

seed rate. One of the main reason of low wheat yield is tillage practices and weeds occurrence that can reduce wheat yield by 50 to 58% (Chhokar and Malik, 2002). Now a days, conventional tillage is not beneficial and economical because of the energy shortage and rising of fuel prices (Kumar et al., 2002). Conventional tillage have long term effect on soil nitrogen capacity to retain nitrogen in the soil (Patra et al., 2004). The effect of tillage practices on soil properties rises from countries to countries and from region to region (Mujdeci et al., 2010). Proper tillage practices decrease surface runoff and increase water infiltration which enhance soil moisture condition (Erenstein et al., 2008). Conventional tillage generally include i.e Mouldboard plough, followed by two disc harrow, which need high amount of energy, causes land degradation and soil water loss (Barzegar et al., 2004). Different tillage implements and practices have different effect on wheat yield (Roozbeh et al., 2003). Therefore for obtaining maximum yield of wheat it is needed to find proper tillage practices that have minimum impact on soil, reduce water losses, cost production and require low energy (Sadeghnezhad, 2006).

Different seed rate significantly affect growth and yield of wheat crop (Chan et al., 2005). Arif et al., (2002) study the effect of different sowing on yield and yield component on two wheat cultivars. So maximum number of spikes m^{-2}, plant height and grain yield were observed at sowing rate 150 kg/ha. Handling of seed rate was a more reliable factor than cultivar selection for enhancement of weed suppression (Williams, 2002). Use of maximum seed rate for growing wheat would decrease the influence of jointed goat grass on winter wheat (Joseph and young, 2004). Seed rate affect growth and yield parameter of wheat crop (Stewart, 2003). On base of plant population higher yield can be obtain by using maximum seed (Nazir, 1990). The late sowing of crop can also be compensated by maximum seed rate (Pan et al., 1994). Proper increase of seed rate in combination with time of sowing is more affective to enhance the grain yield of wheat (Hiltbrunner et al., 2007). It is reported 100 kg ha^{-1} was the most effective by producing taller plants and maximum wheat yield as compared to low seed rate (Blue et al. 1990). Optimum seeding rate very important that can increase yield by 15 to 20%.

Keeping in view the significance of tillage operations and seeding rates the research was design to study the effect of different tillage operations and seed rates on growth and yield performance of wheat.

MATERIAL AND METHODS

The experiment was conducted at Agronomy Research Farm, The University of Agriculture Peshawar Pakistan, during winter 2014-2015. The experiment was conducted at randomized RCB design with split plot arrangement having 3 replication with sub plot size (9 m^2). Wheat variety Atta-Habib was used. 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 (40 cm), 3 Times Mould board Plough + 2 Times Rotavator (30 cm), 2 Times Disc harrow + 2 Times Rotavator (20 cm), 1 Time Cultivator + 1 Time Rotavator (10 cm) 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. Irrigation was applied according to the requirement of the crop. All other agronomic practices were applied uniformly and at appropriate time. Data were recorded on spike weight, grain $spike^{-1}$, grain weight $spike^{-1}$, spikelet $spike^{-1}$. The data of the above parameters were recorded by selecting 10 randomly spikes from each experimental plot after physiological maturity. The spike was sundried and weighed for spike weight, weeds dry weight m^{-2} was recorded after sun drying of fresh weeds. For grain $spike^{-1}$ number of grain were counted of each spike and then grain were weighted for grain weight $spike^{-1}$. After harvesting and sun drying, biological yield was recorded and then threshed for grain yield.

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 (Jan et al., 2009).

RESULT AND DISCUSSION

Spike weight (g): Wheat spike weight was significantly ($p \leq 0.05$) affected by tillage operations and seed rates is presented in (Table 1). All interactions were found non-significant. Maximum spike weight (2.92 g) was recorded from tillage practices, 2 Times Disc harrow + 2 Times Rotavator 20 cm followed by 2.54 g, 2.27 g by tillage i.e, 1 Time Cultivator + One Time Rotavator 10 cm, 3 Times Mould board Plough + 2 Times Rotavator 30 cm respectively. Minimum spike weight (2.21 g) was recorded from treatment of tillage practices with 3 Times Chisel Plough + Two Times Rotavator 40 cm. Tillage practices (2 Times Disc harrow + 2 Times Rotavator 30 cm) has showed improvement in soil physical properties by pulverizing the field and eradicate weeds hence providing suitable condition for plant growth as a result maximum spike weight occur. Our result are in line with (Gangwar et al., 2004) reported that tillage practices have significant effect on spike weight. The results are in agreement with (Shams et al., 2007) who reported with the application of tillage practices the soil surface soft and it became very easy

plant to uptake nutrients from the soil to form maximum assimilates that in turn increase the spike weight. (Lithourgidis et al., 2006) that tillage practices have significant effect on spike weight. Greatest spike weight (2.88 g), was observed with 115 kg ha^{-1} seed rate. The treatment of seed rates 70,85,160,130,100,145, kg ha^{-1}ranked 2nd, 3rd and 4th,5th,6thspike weight of 2.63 g,2.58 g, 2.58 g, 2.5 g,2.29 g, and 2.25 g respectively. Smallest spike weight2.16 g was recorded from seed rate of 175 kg h^{-1}. Using of seed rate 115 kg ha^{-1} has provided optimum condition for plant growth, high availability of plants nutrients and less competition and maximum assimilates transfer towards grain and as a result spike weight increases. The result are in line with (Longnecker et al., 1993), (Bahrani et al., 2002) and (Talukder et al., 2004) stated if seed rate increases from their optimum level so decrease in spike weight occur.

Weeds dry weight m^{-2} (g): Weeds dry weight m^{-2} as affected by tillage operations and seed rates is presented in Table 1. Perusal of data presented that weeds dry weight m^{-2} was significantly ($p \leq 0.05$) affected by different tillage practices and seed rates. All possible interactions of tillage × seed rates were non-significant ($p \geq 0.05$). . Highest weeds dry weight m^{-2} (32.8 g) was recorded with tillage practices 3 Chisel Plough+2 Rotavator (40 cm) followed by (28.9 g) and (26.6 g) weeds dry weight m^{-2} were obtained from tillage operations 3 MB Plough +2 Rotavator (30 cm), 1 Cultivator + 1 Rotavator (10 cm) respectively. Lowest weeds dry weight m^{-2} (24.7 g) was observed with tillage practices 2 Disc harrow + 2 Rotavator (20 cm). Our results are in line with (Wright et al., 2007), who reported that tillage operations have significant effect on weed dry weight. Our results are also in line with (Aikins et al., 2012) showed that weeds density can reduce by using different tillage practices. It might be due to tillage operation inversion of soil occur as result the weeds and weeds present in the soil surface are deeply in the soil and it becomes very difficult for the weeds seeds to germinate easily. Our results are also in agreement with (Tow et al., 2011). Maximum weeds dry weight m^{-2} (30 g), were recorded with application of seed rate (70 and 85 kg ha^{-1}). The treatment of seed rates 100, 115, 130, 145, 160 kg ha^{-1} ranked 2nd, 3rd and 4th, 5th, 6th with weeds dry weight m^{-2} e of 29 g, 28.8 g, 27.5 g, 27.3 g, and 27.2 g respectively. Minimum weeds dry weight m^{-2} (26.3 g) was recorded from seed rate (175kg h^{-1}). These results correlates with the findings of (Hussain et al., 2011) and in line with (Hussain et al., 2011) who reported that number of weeds dry weight m^{-2} decreased linearly with increasing in seed rates. It might be due to maximum seed rate maximum plant population occur thus it becomes very difficult for to compete for nutrients and due to high plant density less sunlight will reach to the weeds to grow properly. Our results are also in line with (Bunting et al., 2005).

Grains $spike^{-1}$: Grains $spike^{-1}$ of wheat as affected by different tillage practices and seed rates is presented in Table 1. Mean of data showed that grains $spike^{-1}$ was significantly ($p \leq 0.05$) affected by different tillage practices. Effect of seed rates was also significant ($p \leq 0.05$) on grains $spike^{-1}$ of wheat crop. The interaction of tillage practices and seed rates were not significant ($p \geq 0.05$). Highest grains $spike^{-1}$ (41) was recorded by tillage practices Two Times Disc harrow + Two Times Rotavator 20 cm followed (40), (38) was recorded from tillage practices One Time Cultivator + One Time Rotavator 10 cm, Three Times Chisel Plough + Two Times Rotavator 40 cm respectively. Minimum grains $spike^{-1}$ (38) was recorded from treatment of tillage practices Three Times Chisel Plough + Two Times Rotavator 40 cm. Our finding are in agreement with the findings of (Liovers et al. 2004), (Bahrani et al. 2002) and (Jug et al. 2004) has showed that impact of tillage practices on grain $spike^{-1}$might be due to healthier root system and nutrient absorption and hence tillage practices shows significant effect on grain $spike^{-1}$.Maximum grain $spike^{-1}$ (42), was recorded with application of seed rate (115 kg ha^{-1}). The treatment of seed rates 130, 145, 70, 85, 100,160 kg ha^{-1} ranked 2nd, 3rd and 4th, 5th, 6th with grains per spike of 40, 40,39,39,39 and 37 respectively. Minimum grains $spike^{-1}$ 36 was recorded from seed rate (175kg h^{-1}). These results correlates with the findings of (Hussain et al., 2011) and in line with (Hussain et al., 2011) who reported that number of grain $spike^{-1}$ decreased linearly with increasing in seed rates.

Table 1. Spike weight, Spikelet $spike^{-1}$, Grains $spike^{-1}$ as affected by tillage operations and seed rates

Tillage Operations	**Spike Weight (g)**	**Weeds dry weight m^{-2} (g)**	**Grains $spike^{-1}$**
3 Chisel Plough+2 Rotavator (40 cm)	2.21 b	32.8 a	38 bc
3 MB Plough +2 Rotavator (30 cm)	2.27 b	28.9 b	38 b
2 Disc harrow + 2 Rotavator (20 cm)	2.92 a	24.7 bc	41 a
1Cultivator+ 1 Rotavator (10 cm)	2.54 ab	26.6 c	40 ab
$LSD_{(0.05)}$	0.47	3.52	1.91
Seed Rates (Kg ha^{-1})			
70	2.63 ab	30.0 a	39 bc
85	2.58 abc	30.0 a	39 bcd

Continued Table 1

100	2.29 bc	29.0 ab	39 bcd
115	2.88 a	28.8 abc	42 a
130	2.5 abc	27.5 bcd	40 ab
145	2.25 bc	27.3 cd	40 ab
160	2.58 abc	27.2 cd	37 cd
175	2.16 c	26.3 d	36 d
$LSD_{(0.05)}$	0.44	2.00	2.40

NS = Non significant

Means of the same category followed by different letters are not significantly different at 5% level of probability

Grain weight spike^{-1} (g): Effect of tillage practices and seed rate on grain weight spike^{-1} of wheat is presented in Table 2. Analysis of the data showed that grain weight spike^{-1} was not significantly ($p \geq 0.05$) affected by different tillage practices. Effect of seed rate were significant ($p \leq 0.05$) on grain weight spike^{-1} of wheat crop. All possible interactions of tillage practices and seed rates were non-significant ($p \geq 0.05$). Highest grain weight per spike (1.26 g), was recorded with application of seed rate (115 kg ha^{-1}).The treatment of seed rates 100,70,85,145,130,160 kg ha^{-1} ranked 2nd, 3rd and 4th,5th,6thgrain weight spike^{-1} of 1.23 g,1.13 g,1.1.15 g,1.11 g,1.10 g, and 1.09 g respectively. Smallest grain weight spike^{-1} 1.08 g was recorded from seed rate of 175 kg ha^{-1}. The possible reason might be that increase in seed rate did not show any positive effect on grain weight. This might be due to bulk planting density on account of higher seed rates used that eventually declined the seed weight. The results are in accordance with the findings of (Shahzad et al., 2007) and (Baloch, 2010) who reported that by using optimum level of seed rate grain weight spike^{-1} increases.

Grain yield (kg ha^{-1}): Grain yield as affected by different tillage practices and seed rates is presented in Table 2.Statistical analysis data showed that grain yield was significantly ($p \leq 0.05$) affected by different tillage practices. Effect of seed rates was also significant ($p \leq 0.05$) on grain yield of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Highest grain yield (3418 kg ha^{-1}) was produced by tillage practices Two Time Disc harrow + Two time rotavator 20 cm followed by 3409kg ha^{-1}, 3405 kg ha^{-1} from tillage practices i.e. One Time Cultivator +One Time Rotavator 10 cm, Three Times Mould board Plough +Two Times Rotavator 30 cm respectively. Minimum grain yield (3405 kg ha^{-1}) was recorded from treatment of tillage practices with Three Times Chisel Plough +Two Times Rotavator 40 cm. Tillage practice Two Times Disc harrow + Two Times Rotavator 20 cm has led improvement in soil physical properties i.e. favorable environment for root morphology through conservation soil moisture ,enhanced soil aeration and low weed infestation ..The results are in line with (Shah, 2011), who reported that tillage practices enhanced root morphology has led desire level of nutrients and moisture uptake from soil and as result grain yield increases. Highest grain production (3573 kg ha^{-1}), was recorded with application of seed rate (115 kg ha^{-1}). The treatment of seed rates 130,100,85,70,145,160, kg ha^{-1} ranked 2nd, 3rd and 4th,5th,6th with grain yield of 3554 kg ha^{-1} ,3401 kg ha^{-1},3365 kg ha^{-1},3363 kg ha^{-1},3346 kg ha^{-1}, and 3337 kg ha^{-1}, respectively. Minimum grain yield 3335 kg ha^{-1} was recorded from seed rate of 175kg ha^{-1}. Application of 115 kg ha^{-1} seed rate has resulted desired level of plant population which ensured maximum tillers from plants, longest spike and more number of spikelet's spike^{-1}, highest grain production from wheat crop .The result are in agreement with findings of (Sayre and Moreno Ramos, 1997), Talukder et al., 2004) and (Waraich et al., 2011) reported highest grain yield by using optimum seed rate produce longest spike and more number of spikelet's spike^{-1}, highest grain production from wheat crop.

Biological yield (kg ha^{-1}): Biological yield of wheat as affected by tillage practices and seed rates is presented in Table 2.Mean value of the data revealed that biological yield was significantly ($p \leq 0.05$) affected by different tillage practices. Effect of seed rates was also significant ($p \leq 0.05$) on biological yield of wheat crop. All possible interactions of tillage and seed rates were non-significant ($p \geq 0.05$). Maximum biological yield (10141 kg ha^{-1}) was produced by tillage practices (Three Times Mould board Plough + Two Times Rotavator 30 cm) followed by 10129 kg ha^{-1}, 10126 kg ha^{-1} from tillage practices i.e. One Time Cultivator + One Time Rotavator 10 cm, Two Times Disc harrow + Two Times Rotavator 20 cm respectively. Minimum biological yield (10122 kg ha^{-1}) was recorded from treatment of tillage practices with Three Times Chisel Plough + Two Times Rotavator 40 cm. Biological yield indicates overall growth performance of the crop. The results are in accordance with the findings of (Ali, 1982) and (Imran et al., 2013) and (Hussain et al., 2011) who conducted an experiment to show the effect of different tillage system on wheat crop (Triticum aestivum L.) and concluded that highest biological

yield was found in different tillage treatment. Greater biological yield (10348 kg ha^{-1}), was recorded with application of seed rate (175 kg ha^{-1}). The treatment of seed rates 160, 145,130,115,100,85 kg ha^{-1}ranked 2nd, 3rd and 4th,5th,6th with biological yield of 10326 kg ha^{-1},10242 kg ha^{-1},10199 kg ha^{-1},10185 kg ha^{-1},9965 kg ha^{-1}, and 9890 kg ha^{-1}, respectively. Minimum biological yield 9877 kg ha^{-1} was recorded from seed rate of 70 kg h^{-1}. These results are in agreement with (Huang et al., 2012), and (Hiltbrunner et al., 2007) stated that the increase in biological yield with higher seed rate might be due to more number of plants per unit area, though with reduced tillers.

Table 2. Grain weight spike^{-1}, Biological yield, Grain yield as affected by tillage operations and seed rates

Tillage Operations	**Grain weight spike^{-1}**	**Biological yield (kg ha^{-1})**	**Grain yield (kg ha^{-1})**
3 Chisel Plough+2 Rotavator (40 cm)	1.14	10122 b	3405 b
3 MB Plough +2 Rotavator (30 cm)	1.19	10141 a	3405 b
2 Disc harrow + 2 Rotavator (20 cm)	1.14	10126 b	3418 a
1Cultivator+ 1 Rotavator (10 cm)	1.12	10129 ab	3409 ab
$LSD_{(0.05)}$	NS	12.41	9.34
Seed Rates (Kg ha^{-1})			
70	1.15 bc	9877 f	3363c
85	1.13 bc	9890 f	3365bc
100	1.23 ab	9965 e	3401b
115	1.26 a	10185 d	3573 a
130	1.10 c	10199 d	3554 a
145	1.11 c	10242 c	3346 c
160	1.09 c	10326 b	3337 c
175	1.08 c	10348 a	3335 c
$LSD_{(0.05)}$	0.11	13.60	24.0

NS = Non significant

Means of the same category followed by different letters are not significantly different at 5% level of probability

CONCLUSION

It was concluded that tillage operation i.e two times disc harrow plus two times rotavator with depth of 20 cm and by using seed rate of 115 kg ha^{-1} resulted higher crop yield under agro-ecological condition of Peshawar for wheat crop.

REFERENCES

Aikins, S., J. Afuakwa, O.O. Akuoko. 2012. Effect of four different tillage practices on maize performance under rain fed conditions. Agriculture and Biology J. North America. 3(1):125-131.

Ali, F. M. 1982. Annual Report, Gezira Research Station – Sudan

Ali, M., L. Ali, M. Sattar and M.A. Ali. 2010. Improvement in wheat (*Triticum aestivum* L.) yield manipulating seed rate and row spacing in vehari zone. The J. Animal & Pla. Sci., 20(4):225-230.

Arif, M., F.H. Taj., K.M. Kakar and K. Nawab. 2002. Seed rates effects on wheat varieties. Sarhad. J. Agric.18 (3): 259-261.

Bahrani, M.J., M. Kheradnam, Y. Emam, H. Ghadiri, and M.T Assad. 2002. Effects of tillage methods on wheat yield and yield components in continuous wheat cropping. Experimental agriculture. Cambridge University Press 38:389-395.

Baloch, M.S. 2010. Effect of seeding density and planting time on growth and yield attributes of wheat. The J. Animal and Pla. Sci., 20(4):239-240.

Barzegar, A.R., M.A. Asoodar, A.R. Eftekhar and S.J. Herbert. 2004. Tillage effects on soil physical properties and performance of irrigated wheat and clover in semi-arid region. Asian J. Agron., 3(4):237-242.

Blue, E. N., S.C. Mason and D. H. Sander. 1990. Influence of planting date, seeding rate and phosphorous rate on wheat yield phosphorus rate on wheat yield. Agro. J. 82(4):762-768.

Bunting, J.A., C.L. Sprague and D.E. Riechers. 2005. Incorporating foram sulfuron into annual weed control systems for Corn. Weed Tech., 19(1):160-167.

Chan, K.Y., D.P. Heenan. 2005. The effects of stubble burning and tillage on soil Carbon sequestration

and crop productivity in southeastern Australia. Soil Use Manage 21, 427–431.

Chhokar, R.S., R.K. Sharma, G.R. Jat, A.K. Pundir and M.K. Gathala. 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice-wheat growing system. Crop Protection, 26:1689-1696.

Chhokar. R.S. and R.K. Malik. 2002. Isoproturon resistant Phalaris minor and its response to alternate herbicides. Weed Tech., 16:116-123.

Erenstein, O., U. Farooq, R.K. Malik and M. Sharif. 2008. On-farm impacts of zero tillage wheat in south Asia's rice-wheat systems. Field Crops Res., 105:240-252.

Gangwar, K.S., K.K. Singh, S.K. Sharma, .2004. Effect of tillage on growth, yield and nutrient uptake in wheat after rice in the Indo-Gangetic Plains of India, Journal of Agricultural Science. Vol. 142, 453–459.

Hiltbrunner, J., B. Streit and M. Liedgens. 2007. Are seeding densities an opportunity to increase grain yield of winter wheat in a living mulch of white clover. Field Crop Res., 102(3):163-171.

Huang, G.B., C. Qiang, F. Fu-xue and Y. Aizhong. 2012. Effects of different tillage systems on soil properties, root growth, grain yield, and water use efficiency of winter wheat. J. Integrative Agric., 11(8):1286-1296.

Hussain, I. and M. Ayaz. 2011. Response of wheat (*Triticum Aestivum* L.) to row spacing, nitrogen, seed rate and sowing technique under climatic conditions of Dera Ismail Khan. J. Bangladesh Agril. Univ., 11(2):80–82.

Imran, A., J. Shaf, N. Akbar, W. Ahmad, M. Ali, S. Tariq. 2013. Response of wheat (*Triticum aestivum*) cultivars to different tillage practices grown under rice-wheat cropping system. Universal J. Pla. Sci., 1(4):125-131.

Joseph, P. Y. and F. L. Young. 2004. Winter wheat completion against jointed goatgrass as influenced by wheat plant height, Seeding rate, and seed size. J. Bioone, 52 (6): 996-1001.

Jug, M.E., D. Jug, M. Sabo, B. Stipesevic, M. Stosic. 2011. Winter wheat yield and yield components as affected by soil tillage systems. Turkish J. Agric. and Forestry 35:1-7.

Kumar, P., D. Jha, A. Kumar, M.K. Chaudhary, R.K. Grover, R.K. Singh, A. Mitra, P.K. Joshi, A. Singh and P.S. Badal. 2002. Economic analysis of total factor productivity of crop sector in Indo-Gangetic Plain of India by district and region. In: Agricultural Economics Research Report 2. Indian Agricultural Research Institute, New Delhi, India.

Liovers, J., J. Manent, J. Viudas, A. L. Pez and P. Scantier. 2004. Seeding rate influence on yield and yield components of irrigated winter wheat in Mediterranean climate. J. Agron. 96: 1258-1265.

Lithourgidis, A.S., K.V. Dhima, C.A. Damalas, I.B. Vasilakoglou and I.G. Eleftherohorinos, 2006. Tillage effects on wheat emergence and yield at varying seeding rates and on labor and fuel consumption. Crop Sci., 46:1187-1192.

Longnecker, N., E. J.M. Kirby and A. Robson. 1993. Leaf emergence, tiller growth, and apical development of nitrogen-deficient spring wheat. Crop Sci., 33:154-160.

MNFSR. 2013-14. Agric. Statistics of Pakistan. Ministry of National Food Security and Research, Agric. Div. (Econ. Wing) Govt. of Pakistan.

Mujdeci, M., B. Kara and A.A. ISiIdar, 2010. The effects of different soil tillage methods on soil 5(21):3345-3350.

Nazir, A. 1990. Crops for profit: *In* proceedings of Symposium on Maximum Yield Research August 1990. 892[En ref. Satellite Symposium of 14th International Congress of Soil Science August 12-18. Kyoto Japan National Fertiliser Marketing Ltd; Lahore.

Ozpinar S. 2006. Effects of tillage on productivity of a winter wheat-vetch rotation under dry land Mediterranean conditions. Soil and Tillage Research, 89:258-265.

Pan, Q. Y., D. J. Sammons and R. J. Kratochil. 1994. Optimizing seeding rate for late-seed winter wheat in the Middle Atlantic Region. J. Prod. Agri. 7 (2): 221-224.

Patra, A.K, P.K. Chhonkar, M.A. Khan. 2004. Nitrogen loss and wheat (*Triticum aestivum* L.) yields in response to zero-tillage and sowing time in a semi-arid tropical environment. Journal of Agronomy and Crop Science. 190:324-331.

Roozbeh, M. and M.A. Pooskani. 2003. The effect of different tillage methods on wheat yield when in rotation with corn. Iranian J. Agric. Sci., 34(1):29-38.

Sadeghnezhad, H.R. 2006. The comparison of wheat yield under different tillage methods. Iranian J. Agric. Sci., 12(1):103-112.

Sayre, K.D. and R.O.H. Moreno. 1997. Application of raised bed planting system to wheat. Wheat Program Special Report No. 31. CIMMYT. Mexico. D.F.

Shah, W.A. 2011. Yield and yield components of wheat as affected by different seed rates and nitrogen level. Sarhad J. Agric. 27(1).

Shahzad, M A., W. U. Din, S. T. Sahi, M. M. Khan, Ehsanullah and M. Ahmad. 2007. Effect of sowing dates and seed treatment on grain

yield and quality of wheat. Pakistan J. Agri. Sci., 44(4):581-583.

Shams Abadi, H.A. and S. Rafiee, 2007. Study on the effect of tillage practices and different seed densities on yield of rainfed wheat. J. Agric. Sci. and Natural Resources, 13:95-102.

Stewart, B.A. 2003. Fire in the soil. Enable Newsletter of the Association for Better Land The southern Pampas of Argentina. Soil Tillage Res. 81.57–69.

Talukder, A. S. M. H. M., A. Sufian, J.M. Dxbury, J.G. Lauren and C.A. Meinser. 2004. Effect of tillage options and seed rate on grain yield of wheat. J. Sub trop. Agric. Res. Dev. 2: 57-62.

Tow, P., I. Cooper, I. Partridge and C. Birch. 2011. Rainfed farming systems: Springer.

Vaezi, B., V. Bavei and B. Shiran, 2010. Screening of barley genotypes for drought tolerance by agro-physiological traits in field condition. African J. Agric. Res., 5(9):881-892.

Waraich, S. A., S. Yasmin and S. Ashraf. 2011. Genetic parameters influenced by seeding dates in wheat. Pakistan J. Agric. Res., 3:273-276.

Wright, A.L, F.M. Hons, R.G. Lemon, M.L. McFarland and R.L. Nichols. 2007. Stratification of nutrients in soil for different tillage regimes and cotton rotations. Soil and Tillage Research, 96(1):19-27.