Research Article

Yield Comparison of some Improved Wheat Varieties under Different Sowings Dates as Rainfed Crop

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Abstract | Wheat is among the staple food crops in the world. In Pakistan, it is planted on a significant cropped area (Ca. 38%) every year. In Khyber Pakhtunkhwa (KP), wheat is also a popular crop in the cropping system, however, average yield differs by 100% from the national average yield due to rainfed planting (67%). Sowing of wheat in the area starts in October subject to onset of winter rains which delays its planting in the season. This study aims to compare yield performance of newly released varieties of wheat by delay in sowing in the season under rainfed condition. Field experiment was conducted at Agriculture Research Farm, Ahmad Wala Karak, Pakistan in a randomized complete block design (RCBD); split plot arrangements in three replications during winter season 2014-15. Sowing dates were assigned to main plot and varieties to sub plot as treatments. Thirteen wheat varieties (i.e. Pak.2013, Dharabi, Tatara, Lalma, Chakwal-50, Shahkar-2013, PS-2005, Hashim-2008, Zam-2004, KT-2000, Atta-Habib, Siren-2010 and Khttakwal a local as check) were planted on five dates (i.e. 29th Oct, 10th Nov, 25th Nov, 10th Dec, and 25th Dec. 2014) using a seed rate of 130 kg ha^{-1}. Nutrients were applied as one bag urea (N 46%) and di-ammonium phosphate (N 18% and P 46%), each at sowing time during seedbed preparation and an extra bag of urea in February at stem elongation stage of the crop (each bag 50 kg ha^{-1}). Rests of the cultural practices were kept common to all plots. Both sowing dates and varieties have resulted differences in plant height (cm), spikes m^{-2}, spike weight (g), thousand grains weight (g) which affected the grain yield. Based on biomass, which contributes from plant height and grains weight, varieties Lalma, Chakwal-50 and Pak-2013 could be the best varieties for planting early to late in season in the area. Delay sowing of wheat crop due to dry weather i.e. late rainfall and/or eventuality of the previous crop of the cropping system could result higher wheat production from the variety Pak-2013 instead of growth the existing local (Khattakwal). Higher grain yield for future food security with growing population is important to be harvested with replacing the existing low yielding varieties by any of the improved available wheat varieties (e.g. Lalma, Chakwal-50, and Pak.-2013) in Karak area where almost all wheat is planted as rainfed crop.

Received | February 15, 2016; **Accepted** | May 09, 2016; **Published** | June 09, 2016
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Citation | Mukhtarullah, J. Ali and M. Akmal. 2016. Yield comparison of some improved wheat varieties under different sowings dates as rainfed crop. *Sarhad Journal of Agriculture,* 32(2): 89-95.
DOI | http://dx.doi.org/10.17582/journal.sja/2016/32.2.89.95
Keywords | Wheat, Early to late sowing, Varieties comparison, Yield and yield traits, Rainfed crop

Introduction

Wheat (*Triticum aestivum* L.) is a member of the family Poaceae. It is a dominant grain crop for staple food in Asia, where grains contributed as a major portion of the daily food requirements. Wheat is a popular grain crop in many other countries of the world. Its grain significantly contributed for human food supply and its straw for the animal's feed. Wheat has dominated in cultivation over other crops for area allocation and production in Pakistan as well as in the countries like Argentina, Australia, Morocco, Syria

and Uruguay (Ahmad and Farooq, 2013). Wheat is becoming a major commodity of world food trade in business. Acceptance of wheat grains as a basic foodstuff led its wide spread dissemination as 'food aid' to developing countries. Its fodder is also equally important due to high palatability index, crude protein and quick digestibility when compared with any other cereals (Shah et al., 2014). Spring wheat is annually cultivated on an area of 9.04 million ha in Pakistan that produces 23.86 millions tones grain per year. In Khyber Pakhtunkhwa (KP), wheat is planted on about 0.78 million ha which produces 1.2 million tones grain (MNFSR, 2014). Average yield of KP is about half of the national average yield. The reason is that around 67% wheat area is planted as rainfed crop in the province (KP). Farmers plant wheat in winter (Oct-Nov) with hope that rainfall occurs, with few to wait for rain to moist fields for wheat sowing in the season, which caused a considerable delay in wheat sowing in the season resulted in lower yield.

With recent climate change, it is expected to receive less winter rain in the future that may cause a delay of wheat sowing under rainfed condition in Pakistan and particularly in KP (Hanif and Ali, 2014; Akmal et al., 2014). Wheat under rainfed condition is planted at onset of winter rains (Oct-Nov). Weather forecast in the report of Hanif and Ali (2014) has predicted a decrease in precipitations in winter (Oct-Nov) and an increase in precipitations in summer (Jun-Aug), which may extended the duration of a standing crop in field late in the season or may delay sowing of wheat in Pakistan. Drought stress is harmful for crops and particularly at the planting time, which may lead to a famine and hunger in humanities. Sufficient availability of water for crops during growth and development is, therefore, directly correlate with future food security in the region (Aslam et al., 2003; Iqtidar et al., 2006). Crop yield (e.g. wheat) in rainfed ecologies of Pakistan is already low, which needs to enhance to ensure future food security in poor masses of the country that expected to grow at a higher rate (Akmal et al., 2011). Crop scientists are simultaneously addressing several issues related to all crops in general and wheat crop in particular in the region by releasing of good varieties having higher yield performance and could tolerate drought stress, heat shocks (Khan et al., 2014), diseases, insects pest and relatively have higher efficiency of water and nutrients uptake (Shah et al., 2014) for a micro-climate in area (Akmal and Ali, 2015). Delay in occurrence of the rainfall may postpone timely cultivation of wheat that limited its optimum growth and vegetative biomass and hence resulted in poor production (Akmal et al., 2014). Reduction in grain yield with total above ground biomass has commonly observed by late planting of wheat in the season (Akmal et al., 2011). Wheat planted on 10th Nov. in Peshawar-Pakistan has resulted higher ($p<0.05$) grain yield than that planted on Nov. 20 or late in the season (Shah and Akmal, 2002; Akmal and Ali, 2015). According to them each sequential delay in the planting date from Nov. 10 has significantly ($p<0.05$) decreased grain yield of wheat by limiting its vegetative phase of the crop development. Varieties may differ in yield by varying planting dates in the season. Early planting may favours to all genotype but wheat variety Inqlab-91 has shown better performance when planted late from its normal sowing time (Shah and Akmal, 2002).

Generally wheat is planted from late Oct. to late Nov. in Karak area in Pakistan. Undoubtedly a suitable planting time for a genotype among the new selected varieties may show better performance for the area that favours in high production for future food security of the expanded population and/or may advantageous for the area to plant wheat late in season by early drought climate change. The present research, therefore, aims to compare yield performance of the selected new varieties if planting is delay in season due to late receipt of natural precipitation or any other eventuality e.g. crop stayed longer in field or introduction of a new crop in the cropping system etc.

Materials and Methods

Field experiment was conducted at Agriculture Research Station (ARS), Ahmad Wala (Karak-Pakistan) in winter 2014-15 in a Randomized Complete Block Design (RCBD), split-plot arrangements with three replications. Sowing was done each time on a wet field by applying uniform water with known quantity in water tanks on desired area for the sowing date to ensure 38% moisture in top 6 cm soil surface of the field. Sowing interval as treatment was assigned to the main plots and wheat varieties as treatment to the subplots. Main plot was 4.0 long and 22.5 m wide accommodating 6 rows of a variety followed by a blank row between the varieties sown at 25 cm distances to adjust 13 wheat varieties in the plot. Five sowing intervals (i.e. Oct. 29, Nov. 10, Nov. 25, Dec. 10 and Dec. 25, 2014) were allotted to main plots and

Table 1: *Weather data of experiment period at Agriculture Research Station, Ahmad Wala, Karak*

Months	Temp. (°C)		Humidity (%)		Rainfall (mm)	Wind (km h^{-1})	Pan Evap. (mm d^{-1})
Jul 2014	Max.	Min.	Max.	Min.	-	-	-
Jul. 2014	36.6	27.8	90.0	62.0	74.0	3.4	4.6
Aug. 2014	35.0	26.5	81.5	60.0	185.0	2.7	8.1
Sep. 2014	32.4	23.5	79.0	47.0	40.0	3.4	5.9
Oct. 2014	31.8	20.4	90.0	52.0	Nil	1.9	5.7
Nov. 2014	24.8	10.8	87.0	49.0	9.0	1.5	3.6
Dec. 2014	21.8	5.23	82.0	44.0	1.0	1.5	3.04
Jan. 2015	19.8	5.0	75.0	36.0	0.8	1.1	3.3
Feb. 2015	19.6	7.5	90.0	60.0	26.2	1.5	3.32
Mar. 2015	20.0	11.4	99.0	70.0	96.6	4.0	8.1
Apr. 2015	30.0	18.7	96.0	58.0	63.4	3.9	6.52
May. 2015	32.0	22.0	85.0	43.0	69.5	5.28	9.8
Jun. 2015	37.0	26.0	89.0	58.0	59.0	11.4	4.9
Total rainfall					**654.5**		

the 13 wheat varieties (Pak.-2013, Dharabi, Tatara, Lalma, Chakwal-50, Shahkar-2013, Pirsabak-2005 'PS-2005', Hashim-2008, Zam-2004, KT-2000, Atta-Habib, Seren-2010 and Khattakwal 'Local check' as subplot treatment. Gram was harvested as previous crop from the field and in next season the fallow land was prepared on marked locations using a deep plough runs once followed by a cultivator runs four times and planking for all sowing dates. Seeds were graded, treated with proper fungicide and placed in rows with a hand driven drill at the rate of 130 kg ha^{-1} seed rate for all varieties. Fertilizer was applied 120-60-0 kg ha^{-1} from urea (N = 46%) and DAP (N =23% & P = 46%) sources, which were uniformly broadcast during seedbed preparation at the time of each sowing. Urea was applied in two splits: half at sowing and the rest half in 2nd week of February. Data were recorded at harvest for yield and yield traits (i.e. spike number, -weight, grain per spike and 1000 grain weight. Field was irrigated manually a day before the planting date for each sowing but, thereafter, the crop was allowed to flourish on seasonal precipitation. All agronomic practices were kept uniform to all experimental units. Crop was raised without any supplemental irrigation in the season except the seasonal natural precipitation that is shown in Table 1. At maturity of the crop, four central rows were harvested for yield and above ground biomass production. The yield traits were additionally recorded on 15 representative plants in an experimental unit randomly selected a day before the crop harvesting at maturity. At the day of harvest, all biomass of the 4 central rows were bundled and stacked in field for sun drying. The bundles were turned out on daily basis for about two weeks after the crop harvesting. Each bundle was independently weighed and threshed on a mini scale lab thresher. Before threshing the bundle weight was recorded on an electronic balance for total biomass. The grain weight after threshing was independently recorded for each bundle and data was converted to standard unit i.e. kg ha^{-1}. Fifteen samples were initially preserved in paper bags and brought to the lab for measurements of the yield traits on plant basis. Plant height data were recorded 2 days before starting the crop harvest by measuring height of the canopy on ground including spikes.

Data were statistically analysed using analysis of variance (ANOVA) techniques appropriate for the split-plot, randomized complete block deign using computer based software SAS. Significant differences among treatments were determined with least significant difference (LSD) test ($p<0.05$; SAS Computer Software).

Results and Discussion

Results pertaining to plant height (PH), spike number (SN), spike weight (SW), thousand grains weight (TGW) and grain yield (GY) are shown in Table 2 for selected high yielding wheat varieties planted on different dates in the season. The PH (cm) was reported tallest for sowing made on relatively optimum (Nov 10) date, which followed by relatively normal (Nov 25) to late (Dec 10) sowing dates in the season. The very late sowing date (Dec 25) showed the short-

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est PH of wheat canopy. It is quite logical that when sowing was delayed in the season, limitation of the total vegetative growth duration of the crop season (Akmal et al., 2011; Akmal and Ali, 2015) in addition to reduction in mean daily temperature of the season (Table 1) proceeds crop towards winter dormancy which resulted reduction in the PH. However, the SN was observed denser at a very late sowing date than any other early or in between early to late sowing dates. The too early sowing did not show any encouraging results for spike density which might be due to the reason that early sown crop faced higher drought stress in the season in addition to the low seasonal mean temperature at crop initial developmental phase (Ahmad and Farooq, 2013; Akmal and Ali, 2015). The SW remained unchanged for sowing date October 29 to November 25 with a significant reduction thereafter for the sowing made on any date in the month of December. Here we could presume that a mild reduction in climate especially the temperature does not affect the spike weight (Akmal et al., 2014) but very late sown crop of wheat has to be affected by decreasing the SW significantly ($p<0.05$) when sowing was delayed for about a month in the season (Aslam et al., 2003; Akmal and Ali, 2015). The data regarding TGW is the major yield contributor that showed variable results for the different sowing dates. As sowing was delayed from Oct. 28 onwards, a significant ($p<0.05$) reduction observed in TGW of the wheat crop. The data regarding TGW reported for the late sowing date (i.e. December 10) may be very unusual. The most interesting and economic portion of the wheat crop in rainfed cultivation is the GY, which showed a reduction ($p<0.05$) by every subsequent delay in sowing of the crop in the season (Mohammadi et al., 2011; Akmal et al., 2011). It is to point out here that wheat crop was rainfed and soil was sandy that showed a relatively big variations in stand at establishment phase of development and tillers mortality due to prolong drought stress faced by the crop started form the respective sowing date to the terminating the crop life cycle (Akmal and Ali, 2015). Disease attack as well as aphid density on spike were the reasons that observed different on different varieties which resulted variations in yield for the sowing dates when averaged over the varieties (Mustafa et al., 2004; Akmal et al., 2011).

The most interesting and significant parameter of the study was the varieties evaluation and performance under the rainfed conditions on sandy soils. We observed significant changes among varieties when compared with the traditionally cultivated variety in the area for yield and yield traits. Yield is outcome of the different traits that are both major and minor (Akmal et al., 2011; Ahmed and Farooq, 2013), the major ones significantly affects yield and vary among the varieties, the soil type and the climate (Akmal and Ali, 2015).

Table 2: *Plant height (PH), spike number (SN), spike weight (SW), thousand grain weight (TGW) and grain yield (GY) of the best wheat varieties planted on different dates as rainfed crop in Karak*

Sowing Date (SD)	PH (cm)	SN (m^{-2})	SW (g)	TGW (g)	GY (kg ha^{-1})
Oct. 29	70 d	305 c	3 a	42 b	2089 d
Nov. 10	76 a	324 b	3 a	43 a	2660 a
Nov. 25	72 b	277 e	3 a	41 c	2212 c
Dec. 10	71 c	304 d	2 b	42 b	2374 b
Dec. 25	67 e	358 a	2 b	37 d	2330 c
LSD (P<0.05)	1.13	7.83	0.07	1.00	49.82
Varieties (V)					
Pak-2013	68 f	207 l	3 c	47 a	2161 g
Daharabi	70 e	256 k	2 d	41 d	1960 k
Tatara	67 g	359 c	2 d	42 c	2114 j
Lalma	73 c	285 i	5 a	43 b	2778 a
Chakwal-50	63 j	419 b	4 b	38 g	2597 b
Shakar-2013	66 h	268 j	2 d	41 d	2495 c
PS-2005	77 b	337 e	4 b	39 f	2286 e
Hashim-08	61 k	310 f	2 d	35 h	2145 h
Zam-2004	71 d	293 h	3 c	40 e	2410 f
KT-2000	70 e	298 g	2 d	38 g	2447 d
Atta-habib	65 i	339 d	4 b	41 d	2139 i
Siren-2010	67 g	259 k	4 b	43 b	2265 f
Khattakwal	107 a	446 a	2 d	40 e	2445 de
LSD (p<0.05)	0.86	6.09	0.04	0.84	44.02
Level of significance for treatment interaction					
SD x V	**	**	**	**	**

Mean followed by same letter within a category and column not differs statistically ($p<0.05$) using least significant difference (LSD) test.

The local variety (Khattakwal), no doubt, is a good variety for the area on the basis of the canopy height, tiller production and spike density per unit area (m^2). Nonetheless, it has shown good results when compared with any other improved wheat variety in this study (Table 2). Its yield performance was incomparable with any of the improved variety in the area due to its canopy volume. In Pakistan and particularly in KP with special emphasis towards hilly and rainfed areas

there is acute shortage of fodder (Shah and Akmal, 2002) that motivates growers to grow relatively taller wheat variety (Ahmad et al., 1997). Research has proved that dwarf variety of wheat is much better for yield in dry land where there is stress of cold by low temperature and drought by no water (Naz and Akmal, 2016).

Plant that is sown early in the season emerged in time under favourable climate but have to face a prolonged stress if rainfall does not occur in the season. Their site-filling rate is also affected adversely (Akmal et al., 2014) and chances are there to lose before approaching to maturity and/or can survive if healthy enough to tolerate cold and drought (Akmal and Hirasawa, 2004). Among the group of varieties compared in this study, the variety Lalma released by Nuclear Institute for Food and Agriculture (NIFA) has shown relatively better performance in the year of the study both for grain yield with producing healthy traits i.e. spike- and thousand grains weight under rainfed condition in the area. In addition to that the variety Chakwal-50 and Shahkar-2013 also showed relatively better results on dry land agriculture in sandy soils. Interesting was treatments' interaction significant for all measured traits including the grain yield with signifi

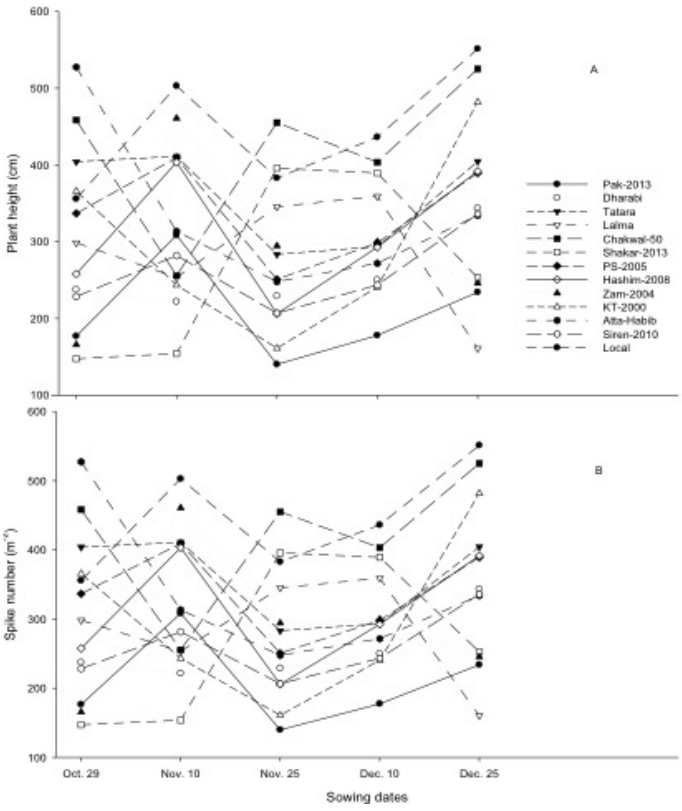

Figure 1: *Interactive effect of wheat varieties planted on different date for* **(A)** *plant height (cm);* **(B)** *spike weight (g) as rainfed crop in ARS Karak*

cant differences for varieties for the observed traits. A slight reduction was common to all varieties by delay sowing in season for PH, SN (Figure 1), SW, TGW (Figure 2) and GY (Figure 3). Contrary to that the PH, SN was fluctuated in different varieties planted on different dates in the season (Figure 1) that changed the GY (Figure 3).

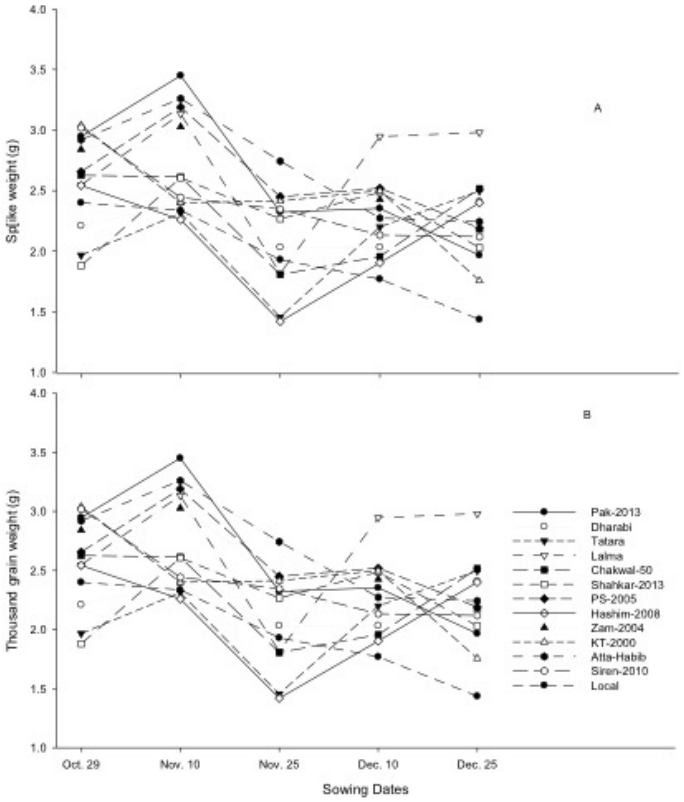

Figure 2: *Interactive effect of wheat varieties planted on different dates for (A) spike weight (g) and (B) thousand grain weight (g) as rainfed crop in ARS Karak*

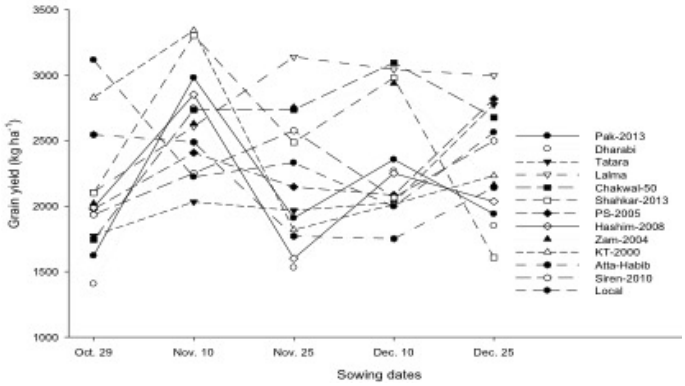

Figure 3: *Interactive effect of wheat varieties planted on different dates for grain yield (kg ha^{-1}) planted as rainfed crop at ARS Karak*

Wheat varieties (Zam-2004, Shahkar-2013 and Pak-2013) were found relatively poor at the very early sowing date (October 29) in the area as rainfed crop when compared with the rest of the wheat varieties

e.g. Dharabi from Barani Agric. Res. Institute, Chakwal; Lalma and Tatara from NIFA in the season for spike density per unit area. Interesting to note was the uniform spike density of local and Chakwal-50 at very late sowing date in the season. Based on overall yield traits, varieties KT-2000, Shahkar-2013 and Pak-2013 performed the best if wheat was planted early in season as rainfed crop. However, in case of delay rainfall in the area due to climatic changes, wheat cultivation can be postponed which is quite natural (Shah and Akmal, 2002; Aslam et al., 2003; Ahmad and Farooq, 2013). In a situation where land is not available for wheat cultivation and/or sowing is delayed by no rain fall in the season at sowing time, the varieties Lalma Chakwal-50 and seren-2010 may perform relatively better amongst the group of varieties tested as unirrigated or rainfed crop. Cultivation of the approved varieties by replacing with the existing local i.e. Khattakwal can results better wheat production to bridge the existing yield gape of over 100% between national and KP averages.

Conclusion

Based on single year study, it can be concluded that wheat planted late from mid November in season due to any eventuality i.e. delay in harvesting of a previous crop and/or in onset of the natural precipitation, replacing the existing old variety (Khattakwal) could bring a significant increase in regional productivity of wheat yield and may contribute to great extent in future food security. Wheat varieties e.g. Lalma, Chakwal-50 and Shahkar-2013 are the best varieties in the group tested for the locality if planted as rainfed or unirrigated crop in the area.

Authors' Contribution

Mukhtarullah conducted research and data compilation of the manuscript. Jawad Ali designed the experiment with financial support for research. Mohammad Akmal supervised in data collection, analysis and preparation of the manuscript.

Acknowledgements

The authors deeply acknowledge with thanks the financial support of the Climate Change Centre (CCC), University of Peshawar and the Inter-Cooperation (IC) for research work conducted off-campus.

References

Ahmad, M., and S. Farooq. 2013. Growth and physiological responses of wheat cultivars under various planting windows. J. Anim. Plant Sci. 23(5):1407-1414.

Ahmed, R., R. Munir, A. Zada and Z. Shah. 1997. Response of wheat varieties to different planting dates and seeding rate. Sarhad J. Agri. 13:323-327.

Akmal, M., and T. Hirasawa. 2004. Growth response of seminal roots of wheat seedlings to a reduction in the water potential of vermiculite. Plant Soil. 267:319-328. http://dx.doi.org/10.1007/s11104-005-0138-x

Akmal, M., N. Ahmad, A. Khan, F. Bibi and J. Ali. 2014. Climate change and adaptation – Farmer's experiences from rainfed areas' of Pakistan. Publication, Inter-cooperation Pakistan. p. 34.

Akmal, M., S.M. Shah, M. Asim and M. Arif. 2011. Causes of yield reduction by delayed planting of hexaploid wheat in Pakistan. Pak. J. Bot. 43(5):2561-2568.

Akmal, M., and N. Ali. 2015. Response of what varieties to sowing intervals as rainfed/un-irrigated crop in Khyber Pakhtunkhuwa (KP). A research project report submitted to Inter-Cooperation, SDC, Pakistan.

Aslam, M., M. Hussain, M. Akhtar, M. S. Cheema and L. Ali. 2003. Response of wheat varieties to sowing dates. Pak. J. Agron. 2(4):190-194. http://dx.doi.org/10.3923/ja.2003.190.194

Hanif, M., and J. Ali. 2014. Climate scenarios 201-20140. Districts Haripur, Sawabi, Attock and Chakwal-Pakistan. Publication, Inter-cooperation Pakistan. p. 27.

Iqtidar, H., K.M. Ayaz and K.E. Ahmad. 2006. Bread wheat varieties as influenced by different nitrogen levels. J. Zhejiang Uni. Sci. 7:70-78. http://dx.doi.org/10.1631/jzus.2006.B0070

Khan, S., M. A. Khan, M. Akaml, M. Ahmad, M. Zafar and A. Jabeen. 2014. Efficiency of wheat brassica *mixtures* with different seed rates in rainfed areas of Potohar-Pakistan. Pak. J. Bot. 46(2):759-766.

MNFSR. 2014. Ministry for Food and Agriculture. Agriculture Statistics of Pak. Government of Pakistan, Islambad.

Mohammadi, M., R. Karimizadeh and M. Abdipour. 2011. Evaluation of drought tolerance in bread wheat genotypes under dry land and sup-

plemental irrigation conditions. Aust. J. Crop Sci. 5(4):487-493.

Mustafa, Z. S., S. Yasmin, N. S. Kisana and M. Y. Mujahid. 2004. Results of the national uniform yield trials. PARC, Islamabad. p. 1-2.

Naz, G., and Mohamad Akmal. 2016. Yield and yield contributing traits of wheat varieties affected by N-rate. Sarhad J. Agri. In press.

Shah, A., M. Akmal, M. Arif,and M. J. Khan. 2014. Yield potential of spring wheat influenced by crop residue, tillage system and nitrogen rate on irrigated land. Sains Malaysiana. 43(12):1811–1819. http://dx.doi.org/10.17576/jsm-2014-4312-01

Shah, A., R. Gohar, S. Khalid and M. Akmal. 2011. Seminal root of maize varieties in relation to reduction in the substrates moisture content. Pak. J. Bot. 43(6):2897-2902.

Shah, S.M., and M. Akmal, 2002. Effect of different sowing dates on yield and yield components of wheat varieties. Sarhad J. Agri. 18(2):143-149.