Pak. J. Bot., 47(1): 83-88, 2015.

INFLUENCE OF SOWING DATES ON PHENOLOGICAL DEVELOPMENT AND YIELD OF DUAL PURPOSE WHEAT CULTIVARS

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Abstract

Dual-purpose wheat is getting recognition among community in diverse farming systems. Success of the system depends on management decisions regarding appropriate sowing dates, choice of cultivars, harvesting time and stage. A comprehensive understanding of how these factors influence the growth and phenology of dual purpose wheat is needed for comparison of grain only wheat to dual purpose system to feed the ever increasing population under this system. The existing higher yielding varieties (Saleem-2000, Bathoor-2007, Fakhre Sarhad-99, Uqab-2000, Siran-2008, and Ghaznavi-98) of wheat were sown on various planting dates from early to normal (15^{th}, 30^{th} October and 14^{th} November) and were given cut after 70 days of sowing. The experiment was arranged in randomized complete block design having split plot arrangement with three replications. Results of the study indicated that booting, heading and physiological maturity were significantly influenced by planting dates, among the cultivars and cutting imposed 70 days after sowing. Mid October sowing prolonged booting, heading, anthesis, maturity and had long stature plants and higher grain yield than sowing in mid November. Uqab-2000 booted, headed and reached to anthesis and maturity earlier followed by Ghaznavi-98, Bathoor-2007 and Saleem-2000. Uqab-2000 and Siran-2008 had higher grain yield than other cultivars. Booting, heading, anthesis and maturity were significantly delayed in cutting as compared to no cut plots. Wheat varieties Bathoor-2007, Uqab-2000 and Fakhre Sarhad-99 produced taller plants compared to Saleem-2000. It is concluded that early sowing on mid October had prolonged phenological traits and higher yield of wheat with long stature plants than later sowing (15^{th} November) and variety Fakhre Sarhad-99 unlike Uqab-2000 was late with respect to phenological development. Cutting prior to stem elongation had not delayed the maturity from three days without substantial yield reduction which revealed that wheat can be used as dual purpose crop having valuable additional fodder supply costing no or least reduction in grain yield to fill the fodder gap in the scarcity fodder months on irrigated tracts of Pakistan.

Key words: Phenology, Grain yield, Sowing dates, Variety, Dual purpose wheat.

Introduction

Wheat (*Triticum aestivum* L.) is the most important crop of the world and can be grown as dual purpose crop that provides greater benefit from both seeds/grains and fodder sown on same land (Shuja *et al*., 2010). The fodder scarcity in the harder months especially in winter is the main critical factor for the raising and production of livestock in the country, thus there is dire need for cultivation of fodder crops in the country. However the ever increasing population and food security demand cannot allow to decrease cultivation of food crops and hence system of dual purpose cropping of wheat and canola are encouraged for decreasing the competition for both types of crops. Furthermore, wheat straw as byproduct is another source of animal feed (Iqtidar *et al*., 2006).

Phenology of wheat is generally considered as the variation occurred from emergence to maturity and the influence by sowing dates and the cultivars thus the .duration and stages of phenological traits are significant indicators for potential yield of the crop. Appropriate sowing date and improved cultivars are the pre-requisite factors for optimum production and play major role especially in influencing forage and grain production under dual purpose system (Arzadun *et al*., 2006; Amrawat *et al*., 2013). Earlier cultivation prolongs the length of crop in field which may also expose the crop to some risks in open environment but on the other hand early sowing results in more biomass and the cutting may not substantially reduce the grain yield of wheat under dual purpose wheat system (Winter *et al*., 1990; Worrell *et al*., 1992). Thus greater biomass production followed by grain production, the crop might be sown early compared to the grain only wheat. As the later sowing can reduce the fodder yield due to slower growth with optimum or little reduction in grain yield (Freebairn *et al*., 2002). Thus modification in the traditional sowing dates from early to normal is needed for higher fodder accumulation with least or no considerable reduction in grain yield.

Due to the genetic disparity between different wheat cultivars for various traits, there is dire need of the selection of appropriate wheat cultivars for dual purpose wheat system as the determination of cultivars for both fodder production and then grain yield rarely results the best economic return (Krenzer *et al*., 1992; 1996). Cultivars largely vary due to the diverse genetic potential for higher fodder production (Krenzer *et al*., 1992), however its genetic potential for fodder production which may not necessarily related to grain production (Krenzer *et al*. (1996), as varieties have enormous potential and diversity for higher yield due to the improved traits. Wheat cultivars had shown considerable variation in phenological and physiological traits in dual-purpose system Khalil *et al*. (2002) while in case of others; there was no significant variation for those traits between the cultivars. The most suitable cultivars having both fodder potential and then grain recovery can be the valuable source to provide instant supply of quality forage in the harder months costing no or least substantial grain reduction under dual purpose wheat system.

Therefore keeping in view the current demand of both grain and fodder production, the present experiment was laid out for the determination of phenological performance and yield of wheat cultivars under dual purpose wheat system sown early to normal compared to the traditional grain only wheat.

Materials and Methods

The Field experiment was laid out during 2010-11 at the Research Farm of the University of Agriculture Peshawar to determine the influence of sowing dates on the phenological traits of dual purpose wheat. The wheat cultivars (Saleem-2000, Fakhre Sarhad-99, Siran-2008, Uqab-2000, Ghaznavi-98 and Bathoor-2007) were sown on the same day on three different sowing dates (15th October, 30th October and 14th November) and were given cut 70 days after cultivation. The cutting imposed prior to the stem elongation stage (Feekes and Zadoks scale 5 and 30, respectively) 70 days after sowing for each sowing dates using sickle about 4.0 cm above the surface. The experiment was arranged in RCB design with split plot arrangement having three replications. The sowing dates and cutting were placed in main plot whereas the cultivars were allotted to sub plots. The seed of each cultivar was sown in a sub plot size of 4 x 3 m^{-2} with the help of small drill four meter long and three meter wide to form ten rows having 30cm apart. The soil was well prepared by tilling with cultivator and motivator. The grains in their respective subplots were sown at rate of 120 kg ha^{-1} using hand hoe. Recommended dose of phosphorus was applied before sowing in each subplot at rate of 100 kg ha^{-1} in the form of DAP and nitrogen at rate of 120 kg ha^{-1} as basal dose in two equal splits in the form of Urea, one with first irrigation after 30 days after sowing, whereas the 2nd half dose after cutting treatments imposed in the experiment (after 70 days) to all subplots.

Data were recorded on days to emergence, heading, booting, anthesis, physiological maturity, by counting days from date of sowing to reaching 75% emergence, booting, heading, anthesis and maturity in each subplot. Plant height at maturity was measured by randomly taking five tillers in each sub plots and then was averaged. Yield was measured by weighing grains (g) obtained after harvest of three central rows, sundried in the field and then threshed. The data collected from the sample area were then converted to kg ha^{1}.

Statistical analysis: The collected data were statistically analyzed according to the procedure carried out by Jan *et al*. (2009) suitable for randomized complete block design with split plot arrangement and the means of sowing dates and cultivars were compared by the appropriate use of $LSD_{0.05}$ test in case of only significant F-values.

Results and Discussion

Days to emergence: No considerable variation among wheat cultivars were recorded regarding days to emergence, however the influence of sowing dates significantly altered days to emergence (Table 1). No significant interaction was found between sowing dates and wheat varieties. Emergence delayed (6.5 days) with the mid October sowing as compared to 30th November (7.9 days) and 14th November sowing (9.5 days). The difference in days to emergence for October sowing might be due the higher temperature compared to November month. The results are similar to Benjamin (1990) who has also reported quick emergence for early sown wheat. Delay in emergence for later sowing might be attributed to the variation in the temperature (Qasim *et al*., 2008). No significant differences among cultivars for days to emergence can be explained by the similar adaptation of all cultivars to surrounding agro-ecological conditions.

Table 1. Influence of sowing dates on days to emergence, booting and heading of dual purpose wheat cultivars.

Sowing dates	Emergence (days)	Booting (days)	Heading (days)
15th October	6.5 c	128 a	136 a
30th October	7.9 b	125 a	133 a
14th November	9.5 a	118 b	126 b
LSD	0.30	4.83	3.80
Cultivars			
Saleem-2000	8.0	124 a	132 a
Bathoor-2007	8.3	124 a	133 a
Fakhre Sarhad-97	8.4	124 a	132a
Uqab-2000	7.3	121b	130 b
Siran-2008	7.9	123 a	130 b
Ghaznavi-98	7.9	124 a	133 a
LSD	ns	1.66	1.68
Cutting			
Cut	_	125 a	136 a
No-cut	_	122 b	127 b
Significance	_	*	**
Interactions			
D x V	ns	ns	ns
D x C	_	ns	(Figure 1)
V x C	_	ns	ns
D x V x C	_	ns	ns

Means of each category followed by different letters are significantly different from each other at 5% level of probability
* = Significant at 5% level of probability
ns = Non-significant at 5% level of probability

Days to booting: Days to booting was significantly affected by sowing dates, cultivars and cutting treatments. Interaction between D x C, D x V, V x C and D x V x C were remained non significant. Booting was earlier in later sown plots during mid of November, followed by end of October, while early sowing of wheat in mid of October prolonged booting (Table 1). The increase in temperature accelerates the growth and development of crop and hastens the phenological growth compared to optimum conditions (Fischer, 1985). Later sowing hastened phenological development, thus resulting larger reduction in yield (Singh & Paul, 2003). Wheat variety Uqab-2000 booted four days earlier from Bathoor-2007, Fakhre sarhad-99, ghaznavi-98 and Saleem-2000 and three days from Siran-2008. The possible reason for difference in booting may be the differential genetic potential of the cultivars tested. Furthermore, Araus *et al*. (2007) reported that cultivars responded differently under diverse agro-climatic condition for days needed for various phenological occurrences. Cutting of wheat 70 days after sowing prolonged booting up to three days compared to no cutting. This showed that the cutting of wheat prior to stem elongation had taken three additional days to reach booting might be due to the re-initiation and re-growth of tillers compared to uncut control. Similar results were reported by Harrison *et al. (*2011) who found delay in booting due to the imposition of cutting.

Days to heading: Data regarding days to heading of wheat was shown in Table 1. Analysis of the data showed that days to heading were considerably influenced by sowing dates, cultivars and cutting. Only the interaction between sowing dates and varieties was found significant for days to heading of wheat. Sowing of wheat on 15th October headed seven days later than 30th October whereas sowing on 14th November headed two days earlier than 30th October sowing. Uqab-2000 headed two days earlier from Fakhre-Sarhad-99 which was headed five days earlier than Saleem-2000, Bathoor-2007 and Ghaznavi-98. Sowing dates and cutting interaction showed that days to heading reduced in cut plots with delay in sowing from early to normal sowing dates. Incase of no-cut, sowing till 30th October prolonged heading (Fig. 1). Similar results are reported by Kaur *et al*. (2010) and Pandey *et al*. (2010) who found early headed and lower wheat yield under later sowing compared to normal sowing.

Days to anthesis: Considerable differences were observed among varieties, sowing dates and cutting for days to anthesis. Significant D x V and D x C interactions were recorded for days to anthesis whereas the interaction between V x C and D x V x C were remained non significant. Sowing on 15th October delayed anthesis by nine days compared to 30th October sowing whereas sowing on 14th November hastens anthesis (131). Wheat cultivar Uqab-2000 had earlier anthesis (135) and was at par with Ghaznavi-98 however the remaining varieties had taken statistically similar number of days to anthesis (Table 2). Similarly, Rahman *et al*. (2009) investigated that days anthesis fluctuate widely among cultivars Anthesis delayed by seven days with cutting as compared to no cut treatments. Interaction between sowing dates and variety showed that days to anthesis hasten in Uqab-2000 for both sowing on 15th October and 14th November whereas in case of 30th October sowing, Ghazbnai-98 had the rapid anthesis (Fig. 2). Similar results were also reported by Kirby *et al*. (1999) who found that later sown wheat hasten phenological development and the crop which was sown early have enough periods for the completion of phenological development compared to later sown plots. Sowing dates and cutting revealed that anthesis hasten for later sowing in cut ploys compared to no cut plots where anthesis prolonged till sowing on 30th October (Fig. 3). Similarly, McCormick *et al*. (2008) also reported considerable delay in flowering with the cutting of the crop at vegetative stage.

Table 2. Influence of sowing dates on days to anthesis, maturity, plant height and yield of dual purpose wheat cultivars.

Planting dates	Anthesis (days)	Physiological maturity (days)	Plant height (cm)	Grain yield (kg ha^{-1})
15th October	144 a	180 a	102 a	5163 a
30th October	135 b	169 b	99 b	4906 b
14th November	131 c	159 c	97 b	4630 c
LSD	1.93	1.30	2.83	101
Cultivars				
Saleem-2000	137a	170 b	95 c	4825 b
Bathoor-2007	137a	170 b	101ab	4779 b
Fakhre Sarhad-99	137a	171 a	100b	4750 b
Uqab-2000	135 b	167 c	103 a	5113 a
Siran-2008	137a	170 b	100 b	5158 a
Ghaznavi-98	136ab	170 b	95 c	4774 b
LSD	**1.37**	**0.92**	**2.28**	**234**
Cutting				
Cut	140a	171a	97 b	4862
No-cut	133b	168b	101a	4938
Significance	**	**	**	ns
Interactions				
D x V	** (Fig. 2)	ns	Ns	ns
D x C	**(Fig. 3)	* (Fig. 4)	Ns	ns
V x C	ns	ns	Ns	ns
D x V x C	ns	ns	Ns	ns

Means of each category followed by different letters are significantly different from each other at 5% level of probability
* = significant at 5% level of probability, ns = non significant at 5% level of probability

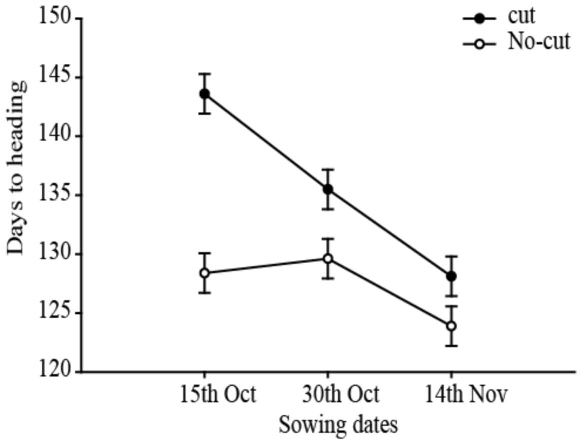

Fig. 1. Interaction between D x C for days to heading of wheat.

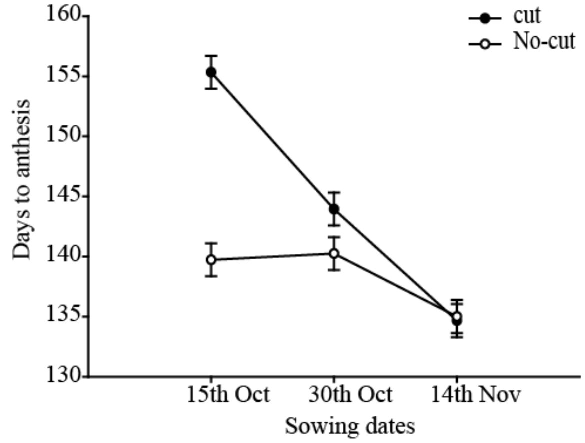

Fig. 3. Interaction between D x C for days to anthesis of wheat.

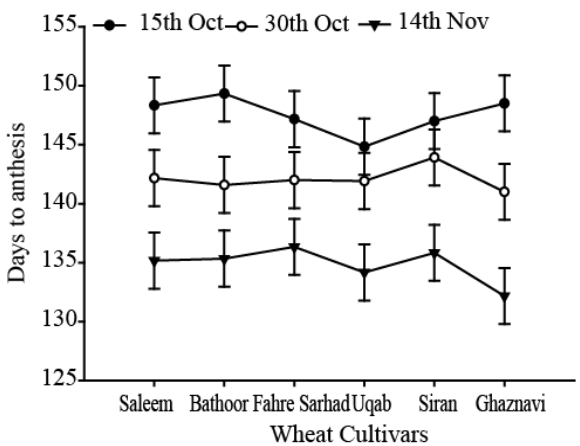

Fig 2. Interaction between D x V for days to antheis of wheat.

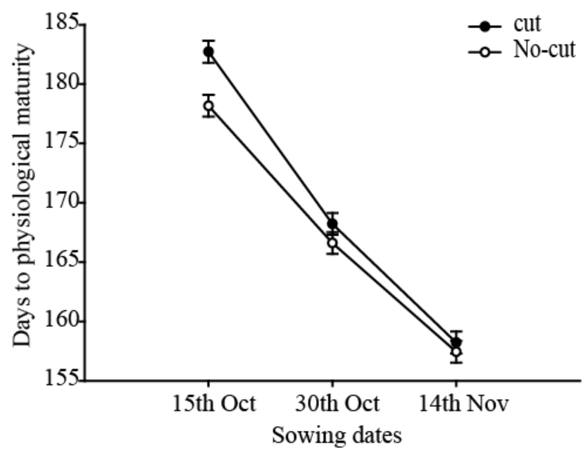

Fig. 4. Interaction between D x C for days to physiological maturity of wheat.

Days to physiological maturity: Physiological maturity of wheat was significantly influenced by sowing dates, cutting and among the cultivars (Table 2). Interaction between sowing dates and cutting was also found significant whereas the other interaction were remained non significant. Physiological maturity was earlier for later sowing on 14th November (159) followed by 30th October sowing whereas sowing of wheat on 15th October prolonged physiological maturity (180 days). The results are in line with Ouda *et al*. (2005) who reported delay in phenology of wheat i.e., anthesis, physiological maturity for early sowing in the month of October. Likewise, Singh & Dhaliwal (2000) found that increase in the temperature and velocity of wind later in April hastens physiological maturity in both early and late sown crop. Likewise, Sandhu *et al*. (1999) also found that days to physiological maturity were shortened with delay in sowing of wheat. Uqab-2000 reached four days earlier to maturity from the late matured cultivar Fakhre sarhad-99 (171 days), Cutting prolonged maturity by two days than no-cut plots. This might be ascribed to the genetic variation that expressed different to the diverse climatic condition. The results are in accordance with Khan (2004) and Abdelmula *et al*. (2010) who reported disparity among different cultivars for physiological maturity. Interaction between sowing dates and cutting revealed that greater variation in maturity was observed between cut and no-cut treatment for 15th October sowing as compared to the least variation for the same traits for same treatment under later sowing dates (Fig. 4). Delay in all phenological characters including physiological maturity of wheat in cutting treatment might be due to the removal of main stem which took more days in re-growth and recovery from the stress imposed. The probable reason for delay in maturity in cut plots might be removal of main culms and secondary tillers that needed additional days for the re-growth of the floral part (Harrison *et al.* 2011). Our results were similar to the findings of Virgona *et al.* (2006) who found that the cutting before reaching to stem elongation stage had delayed phenological development.

Plant height: Statistical analysis of the data indicated that sowing dates and cutting considerably influenced plant height of wheat. Significant variations were also recorded in the plant height of different wheat cultivars. All the interactions were found non significant for plant height. Plant height reduced with delay in sowing from early to normal sowing dates however the plant height of 30th October and 14th November were not considerably reduced. Uqab-2000 produced taller plants (103 cm) followed by Bathoor-2007 (95 cm), which were at par with each other and whereas Saleem-2000 and Ghaznavi-98 had the shorter plants heights (95 cm). Plant height of no-cut plots was higher as compared to cut plots (Table 2). Plant height has greater influence on biological yield of wheat and therefore considers an important trait for increasing the ultimate production. The reduction in plant height for later sowing may be due to favorable agro-ecological conditions during the peak growth cycle. The results were in line with Mahmoud (1992) and Salem (1999) who found taller plants under early sowing. Variation in the plant height of different varieties might be due to the inherited characters of the genotypes and thus certain variety had the tallest plants from other due to the best suits with the prevailing environmental condition (Shahzad *et al*., 2007). These results are agreed with Shahzad *et al*. (2002). Similar results were also reported by Rashid *et al*. (2004) and Al-Otayk (2010) who found considerable variation among wheat varieties for plant height. McCormick *et al*. (2009) also reported decline in plant height with imposition of cut to the crop. The results of Shuja *et al*. (2010) were similar to the present study as they concluded that there were no significant interaction between cutting and cultivars of wheat for plant height.

Grain yield: Data on grain yield of wheat was given in Table 2. Grain yield was signifiacntly influenced by sowing dates and cultivars. Cutting did not bring any significant reduction in the grain yield compared to no cut plots. All interactions were remained non signifiacnt. More grain yield was achieved for early sowing and there was signifiacant decrease with delay in sowing. The probable reason of more yield in early sowing might be due to extended growth period for both vegetative and reproductive stages of the crop and hence produced more yield as the crop growth is the increment increase in dry weight overtime due to the net photosynthesis. Furthermore, optimum resources were utilized by the early sown plots without any climatic stress during the entre growth period of crop aid to more dry matter accumulation compared to later sowing. Likewise, the shortened duration of phenological development may the other reason for lower yield in case of later sowing and the same was reported by Spink *et al*. (2000). Similar results were also presented by Munir *et al*. (2002); Tanveer *et al*. (2003) who recorded higher yield in case of early sowing due to extended growth period and flourish growth. Siran-2008 and Uqab-2000 produced higher grain yield and out yielded the remaing cultivars used in the experiment and were found similar with each others. The higher yield produced by the both Siran and Uqab might be due to their improved genetic characters and better adoptation to the prevailing sourounding compared to otther cultivars. The findings are in line with and Shah & Akmal (2002) and Kumar *et al*. (2000) who also recorded differential response in term of grain yield. Interestingly, cutting has no detrimental influence on final yield and this might be due to the early recovery and rapid re-growth of the plants after imposition of cutting at vegetative stage. Fieser *et al*. (2004) also reported least or no decline in grain yield of wheat in grazing plots compared to control plots.

Conclusion

Wheat sowing in mid November hastens phenological traits, short stature plants and lower yield as compared to early sowing of wheat in mid October aimed for dual purpose wheat. Bathoor-2007, Uqab-2000 and Fakhre Sarhad-99 produced taller plants. Fakhre Sarhad-99 was found late in most of phenological traits and remained similar for anthesis along with Bathoor-2007 and Siran-2008. Uqab-2000 earlier booted, headed and reached to anthesis and remained at par with Bathoor-2007 and Ghaznavi-98 for maturity. Wheat cultivars Siran-2008 and Uqab-2000 out yielded other cultivars studied in the experiment. Imposition of cutting 70 days after sowing did not prolong physiological maturity from three days with no significant reduction in yield indicating that wheat can be used as dual purpose for valuable additional fodder on no substantial reduction in grain yield to fill the forage gap in winter on irrigated land of the country.

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(Received for publication 20 December 2012)