Journal of Crop and Weed, 15(1): 73-77 (2019)

Performance of marker assisted back cross bread wheat (*Triticum aestivum* L.) varieties in relation to sowing environment

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Received : 26-11-2018 ; Revised : 10-01-2019 ; Accepted : 26-02-2019

ABSTRACT

To study the effect of sowing conditions on yield and yield attributes of different wheat varieties, an experiment was conducted at research farm of the Punjab Agricultural University Regional Research Station, Gurdaspur during the Rabi 2015-16 and 2016-17.The treatments were consisted of two sowing conditions i.e. normal sowing (November sowing) and late sowing (December sowing) as main plots and in sub plots, five varieties viz. Unnat PBW 343, PBW 621, WH 1105, HD 2967 and PBW 343 were randomized in three replications in split plot design. Statistical analysis of the data revealed that timely sowing recorded higher yield attributes, days to heading and physiological maturity, growing degree days, biological yield as well as grain yield compared to late sowing conditions. At heading stage, variety PBW 343 and variety Unnat PBW 343 recorded significantly higher GDD as compared to other varieties during 2015-16 and 2016-17, respectively while at maturity stage, the variety PBW 621 and variety HD 2967 remained superior in GDD consumption during 2016-17. Among varieties, Unnat PBW 343 was found to be the best variety to attain maximum yield under both sowing conditions in Northwestern plains of India.

Keywords: Date of sowing, grain yield, growing degree days, wheat varieties and yield attributes

Wheat (*Triticum aestivum* L.) crop excels all other cereals both in area and production, known as king of cereals (*Costa et al*., 2013). Among various factors responsible for low yield of crop, sowing time and varietal selection are of primary importance. The sowing time of a crop is not only governed by the environmental conditions but also necessary to escape from biotic and abiotic stresses. Sowing time of a specific variety in a particular climate condition exerts a profound effect on agronomic characters and physiological behaviour of a variety under consideration. Too early sowing produces weak plants with poor root system as the temperature is above optimum which leads to poor germination, frequent death of embryo and decomposition of endosperm due to activities of bacteria and fungi (Paul,1992) and poor tillering. Late planting results in reduced duration of the crop, more chances of winter injury and expose the crop to high temperature at grain filling stage. Sowing of crop at normal time prolongs the tillering period and produces more number of tillers, earheads, grains per earhead and 1000-grain weight that ultimately helps in increased grain yield (Ram and Gupta, 2016). Sustainable increase in grain yield of wheat varieties can be achieved by sowing the wheat crop at optimum time, which may vary from time to time. Therefore, the present study was conducted to evaluate the performance of wheat varieties including marker assisted back cross bread wheat variety *Unnat* PBW 343 under timely and late sown conditions.

MATERIALS AND METHODS

A field experiment was conducted at research farm of the Punjab Agricultural University Regional Research Station, Gurdaspur during the *rabi* season of 2015-16 and 2016-17. The experimental site was sandy loam in texture. The experiment was comprised of two dates of sowing (*i.e*. timely sowing and late sowing) were kept in main plots while sub-plot treatments consisted of wheat varieties *viz*. *Unnat* PBW 343, PBW 621, WH 1105, HD 2967 and PBW 343. The crop was sown on 05.11.2015 , 15.11.2016 and 10.12.2015 , 12.12.2016 under timely sown and late sown conditions during first and second years, respectively. The seed was sown at a depth of 4-6 cm by keeping row to row distance of 20 cm by using drill. The fertilizers were applied at the rate of 150 kg N and 60 kg P_2O_5 and 30 kg K_2O per acre. Half dose of N, full dose of P & K was applied at sowing time and half dose of N was applied with first irrigation. At harvest, the data for yield components like effective tillers m^{-2}, grains per earhead and 1000- grain weight were recorded. The data for number of grains per ear head and 1000-grain weight were collected on five randomly taken plants. The biological yield and grain yield were recorded on plot basis and were converted to q ha^{-1}. Growing degree day (GDD) was calculated at earing and maturity stage of wheat (Monleith, 1984)

$$\text{GDD(day)} = \sum\left[\frac{Tmax+Tmin}{2}\right] - 4.5\right]$$

Where T_{max} and T_{min} represent the daily maximum and minimum temperature. The data were analysed in split plot design at Pd ≤ 0.05.

RESULTS AND DISCUSSION

Emergence count

Timely sown crop recorded significantly higher emergence count than late sown crop during both years

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(Table 1).The per cent increase in emergence count under timely sown conditions was 21.7 and 19.7 as compared to late sown during first year and second year, respectively. Among varieties, significant differences were observed during 2015-16. The variety HD 2967 recorded significantly higher emergence count than PBW 621 and WH 1105, but remained at par with Unnat PBW 343 and PBW343. However, during 2016-17, no significant variation observed among different varieties pertaining to emergence count.

Effective tillers

The tillering behaviour of wheat mainly depends upon the sowing time and varieties which is responsible for photosynthate assimilation, grain filling and final grain yield. Number of effective tillers was significantly affected by sowing date and varieties during both the years (Table 1). Timely sown crop produced significantly higher tillers (8.6-9.8%) as compared to late sown crop. It was due to more number of days experienced for growth and development in timely sown crop as compared late sown crop. Similar results have been reported by Ram and Gupta (2016) and Wajid *et al*. (2004). Among wheat varieties, PBW 621 and *Unnat* PBW 343 produced maximum tillers during 2015-16 and 2016-17, respectively. In 2015-16, tillers recorded in variety PBW 621 were significantly higher than WH 1105 but statistically at par with other varieties. In second year, *Unnat* PBW 343 recorded statistically similar tillers as recorded in PBW 621 and HD 2967 but significantly higher than recorded in WH 1105 and PBW 343. Shah *et al*. (2006) also observed similar observations that differences in number of tillers among varieties might be attributed to their genetic diversity.

Grains per earhead

Number of grains per earhead is an important yield attributing character and has a direct effect on grain yield of wheat. The data indicated that timely sown crop produced higher number of grains earhead^{-1} as compared to late sown crop during both the years (Table1). It may be due to longer growing period in timely sown crop, which resulted in higher production of photosynthates and favourable temperature at the time of grain setting. Similar observations of higher grains per earhead in timely sown wheat crop were reported by Tahir *et al*. (2009). In 2015-16, variety WH 1105 recorded significantly higher grains earhead^{-1}, however, in 2016-17 variety PBW 621 recorded the highest grains earhead^{-1} which was statistically at par with WH 1105. The interaction between sowing dates and varieties were found to be non-significant.

Thousand grain weight and lodging score

During first year, late sown crop recorded significantly higher 1000-grain weight as compared to timely sown crop that might be due to lodging of varieties in timely sown crop. Non-significant differences were observed during second year of the study. Among varieties, *Unnat* PBW 343 produced significantly higher 1000-grain weight as compared to all varieties during both the years. The interaction between sowing dates and varieties remained non-significant during first year of study, but found to be significant during the second year. All varieties under timely sowing conditions produced significantly higher 1000-grain weight as compared to late sowing conditions except *Unnat* PBW 343 and PBW 621 which were having similar 1000-grain weight under both the conditions (Table 2). Under timely sown conditions, 1000-grain weight recorded in PBW 343 and PBW 621 were statistically similar to new variety *Unnat* PBW 343 but under late sown conditions any of the variety was not statistically similar to *Unnat* PBW 343. Timely sowing recorded significantly higher lodging score in first year only. It might be due to winds blown after the last irrigation application. Among wheat varieties, HD 2967 recorded the highest lodging in both the years which was similar to the new variety *Unnat* PBW 343, PBW 621 in both the years.

Phenology

Days take to particular stage depends upon the prevailing temperature conditions and other environmental factors. Days taken to heading and maturity were significantly higher in timely sown conditions (Table 3). It might be due to optimum environmental conditions prevailed in timely sown conditions. In 2015-16, variety PBW 343 took maximum days for heading which was significantly higher than rest of the varieties. However, in second year, Unnat PBW 343 recorded the highest days to heading which was significantly higher than rest of the varieties. Days take to maturity were also significantly influenced by the wheat varieties. In first year PBW 621 recorded the highest days to maturity whereas in second year, PBW 343 took maximum days for maturity. Although the variation for days to phenology was significant but the magnitude was of 3 to 5 days only.

Growing degree days (GDD)

The differences in GDD were found to be significant among different genotypes under normal and late sowing environments (Table 3). Timely sown crop consumed significantly higher GDD as compared to late sown crop both at heading and maturity stages. At heading stage, the variety PBW 343 and variety *Unnat* PBW 343 recorded significantly higher GDD as compared to other varieties during 2015-16 and 2016-17, respectively. While at maturity stage, the variety PBW 621 recorded significantly highest GDD than *Unnat* PBW 343, WH 1105, HD 2967 and PBW 343 during 2015-16, whereas during 2016-17, variety HD 2967 ranked first in recording GDD, PBW 343 ranked second and PBW 621

Table 1: Effect of sowing dates and varieties on emergence count, yield attributing characters and lodging score of wheat

Treatment	Emergence count m^{-2}		Effective tillers m^{-2}		Grains per earhead		1000 grain wt. (g)		Lodging score	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Sowing dates										
Timely sown	135.5	187.6	391	391	33.06	36.31	34.45	40.24	8	4
Late sown	111.3	156.6	360	356	29.99	31.37	36.48	37.17	1	0
LSD (0.05)	**18.9**	**15.9**	**19.82**	**23.87**	**0.83**	**NS**	**1.23**	**NS**	**1.7**	**NS**
Varieties										
Unnat PBW 343	123.0	176.2	375	393	28.70	32.13	42.98	42.53	5	3
PBW 621	120.9	175.6	388	372	31.32	37.84	35.56	37.55	5	3
WH 1105	108.3	169.9	353	360	36.47	37.05	35.50	38.28	4	0
HD 2967	134.7	172.4	387	391	29.82	33.25	34.94	37.51	5	4
PBW 343	130.0	166.4	377	352	31.30	28.94	33.43	37.64	4	2
LSD (0.05)	**12.2**	**NS**	**19.33**	**24.56**	**2.99**	**3.29**	**1.28**	**1.63**	**0.6**	**1.6**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.30**	**NS**	**NS**

*Note: *: Lodging scale (0-9), 0 -9 represents no lodging to maximum lodging*

Table 2: Interactions effect of sowing dates and varieties on 1000-grain weight during 2016-17

Varieties	Timely sown	Late sown	Mean
Unnat PBW 343	42.55	42.50	42.53
PBW 621	38.51	36.58	37.55
WH 1105	40.65	35.90	38.28
HD 2967	39.08	35.95	37.51
PBW 343	40.39	34.89	37.64
LSD (0.05)	—	—	**2.30**

Table 3: Effect of sowing dates and varieties on phenology, GDD, biological yield and grain yield of wheat

Treatment	Days to heading		Days to maturity		GDD (° C day) at heading		GDD (° C day) at maturity		Biological yield (q ha^{-1})		Grain yield (qha^{-1})	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Sowing dates												
Timely	111	105	156	153	1135	1084	1891	1885	126.2	178.6	44.29	57.23
Late	93	100	134	133	914	1025	1686	1721	89.4	127.9	38.94	41.13
LSD (0.05)	**1.1**	**1.5**	**0.74**	**2.0**	**14**	**17**	**16**	**38**	**16.1**	**10.5**	**2.36**	**10.51**
Varieties												
Unnat PBW 343	102	105	144	141	1030	1083	1776	1747	107.2	160.3	42.73	53.92
PBW 621	101	104	148	144	1021	1072	1856	1823	109.0	158.6	40.76	53.29
WH 1105	100	101	145	141	1019	1034	1796	1747	102.9	150.0	42.49	51.49
HD 2967	100	104	144	146	1019	1072	1776	1868	116.5	157.7	41.55	48.72
PBW 343	103	100	143	145	1043	1016	1742	1844	103.4	139.8	40.54	38.48
LSD (0.05)	**0.90**	**0.74**	**0.49**	**0.49**	**11**	**10**	**10**	**13**	**8.6**	**6.2**	**NS**	**2.57**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**3.62**

Table 4: Grain yield (q ha^{-1}) as influenced by sowing dates and varieties during 2016-17

Varieties	Sowing time		
	Timely sown	Late sown	Mean
Unnat PBW 343	64.41	43.43	53.92
PBW 621	63.31	43.28	53.29
WH1105	60.29	42.69	51.49
HD2967	54.63	42.81	48.72
PBW 343	43.50	33.46	38.48
LSD (0.05)			**3.63**

remained third. Variety Unnat PBW 723 and WH1105 remained at par with each other in consumption of GDD. Prabhakar *et al*.(2007) and Nahar *et al.* (2010) reported that different wheat cultivars had different requirement of GDD under normal and late sowing conditions. At maturity stage, the variety PBW 621 accumulated higher GDD than *Unnat* PBW 343, WH 1105, HD 2967 and PBW 343 during 2015-16, but during the year 2016-17, variety HD 2967 proved superior in accumulating GDD than other varieties.

Biological yield

Late sown crop recorded significantly lower biological yield as compared to timely sown crop (Table 3). It might be due to less emergence count and less tiller production in late sown crop that lead to less biomass accumulation. Different varieties also showed a significant variation in biological yield during both years. The variety HD 2967 and *Unnat* PBW 343 produced maximum biological yield during 2015-16 and 2016-17, respectively. It is due to higher emergence count and higher tiller production in the respective varieties.

Grain yield

Grain yield of wheat crop is the result of combined effect of various yield attributing characters. Data revealed that sowing dates significantly affected the grain yield (Table 3). Timely sown crop recorded significantly higher grain yield as compared to late sown crop. It might be due to longer grain filling period in early sown wheat and escape from terminal heat stress, improvement in 1000-grain weight and higher accumulation of GDD. The lower yield in late sown crop may be attributed to lower production of tillers and less number of grains earhead^{-1}. These results are in accordance with Ram and Gupta (2016) and Sharma *et al.* (2006). Grain yield was significantly influenced by different varieties during the second year, however differences pertaining to yield were remained non-significant during first year (Table 4). The maximum yield was obtained from variety *Unnat* PBW 343 as compared to other varieties. The interaction between sowing dates and wheat varieties for grain yield were found to be significant during second year of study (Table 3). Significantly higher grain yield was produced under timely sown conditions as compared to late sowing conditions. In timely sown conditions, variety *Unnat* PBW 343 produced the highest grain yield which was similar to PBW 621 but significantly higher than rest of the varieties. However, under late sown conditions, the variety *Unnat* PBW 343 was only significantly superior to PBW 343. Ram and Gupta (2016) also reported the varietal variation for grain yield under timely and late sown conditions from central Punjab. The variety *Unnat* PBW 343 produced higher yield as compared to other varieties under both sowing conditions. Therefore, it can be concluded that variety *Unnat* PBW 343 can be sown to get higher yield under normal sowing conditions.

It can be concluded that wheat crop grown under normal sown conditions recorded significantly higher GDD values, yield attributes and grain yield than under late sown conditions. Among different wheat varieties, variety *Unnat* PBW 343 produced higher yield as compared to other varieties under both sowing conditions.

ACKNOWLEDGEMENT

The authors want to express sincere gratitude to Directorate of Wheat Research, Karnal for providing facilities under "All India Coordinated Research Project on Wheat and Barley" for the conduct of this research.

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