Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 04-08

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Performance of different wheat genotypes as influenced by dates of planting

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Abstract
A field experiment was conducted during rabi seasons of 2013-14 and 2014-15 for two consecutive years at Birsa Agricultural University, Ranchi, to study the performance of wheat varieties under different sowing dates. The experiment was conducted in split plot design with 3 replication with treatments comprising two dates of sowing viz. 15th December and 1st January in main plots and 8 different wheat cultivar viz. HD 2985, HI 1563, DBW 14, K1114, HD 3118, HD 2733, DBW 107 and NW 2036) in sub-plots. Sowing on 15th December significantly influenced different development stages, gap fraction and yielded more than 1st January. Sowing of 15th December significantly more development stages, gap fraction resulting in 20.89 % higher grain yield (33.51q/ha), straw yield (52.57 q/ha), net return (Rs. 34642/ha) and B: C ratio (1.21). Among the cultivars, HD 2733 gave significantly more development stages, heat unit requirements, chlorophyll content, min tilt angle, gap fraction grain yield (35.83 q/ha), straw yield (52.51 q/ha), net return (Rs. 37205/ha) and B: C ratio (1.34) than that of mean of the rest of the seven cultivars.

Keywords: Cultivars, chlorophyll, Sowing dates, Wheat genotypes, gap fraction, Tilt angle

Introduction
Wheat (*Triticum aestivum* L.) is the second most important food crop of India next to rice and demand for wheat in the country is increasing day by day. The greatest demand for wheat in the coming years will have to be met by increasing devotion of land to wheat or increasing yield per unit area. In India, wheat grown on an area of 30.37 million hectare with total production of 90.78 million tones making an average yield of 2.99 t/ ha, while in Jharkhand, wheat grown on an area of 1.7 million hectares with total production of 3.36 million tones, making an average yield of 1.98 t/ ha (Anonymous, 2015) [2]. Among various factors responsible for low yield of wheat crop in the country, sowing time and varietal (genotypical) selection are of primary importance. Wheat is sown in winter and it has its own definite requirements for temperature and light for emergence, growth and flowering (Dabre *et al.* 1993) [5]. Too early sowing produces weak plants with poor root system as the temperature is above optimum.

Sowing date is one of the major factors which determine the ability of the crop to stand against different environmental conditions (air, temperature and humidity). Appropriate sowing dates are important to have the crop in the field, when environmental conditions are conducive for growth and development. Proper planting date is an important factor for crop production of wheat. Different planting dates, affect seed development, quality and yield of wheat. Delay planting affect the crop performance in the field and ultimately produce low yield. Delay in planting normally reduces individual plant growth and tiller production (Nazir and Ullah, 2004) [9]. Late planted wheat grows slow because of low temperature, which impaired grain quality resulted poor germination and also crop stand. In late planting the wheat genotype (variety) should be short duration that may escape from high temperature at the grain filling stage (Phadnawis and saini, 1992) [10]. Ansary *et al.* (1989) [3] reported that delay sowing suppressed the yield, caused by reduction in the yield contributing traits like number of effective tillers, number of grains per spike and grain yield.

Many high yielding varieties have been evolved and recommended for general cultivation in the past. These varieties are loosing their yield potential due to changes in various edaphic and environmental conditions. Therefore, continuous selection of high yielding genotypes, with mid range of adaptability to edaphic and environmental conditions is very essential to increase yield per hectare. Keeping this in view, the present study was therefore, designed to determine the effect of different sowing dates and genotypes on yield and yield components of wheat.

Materials and Methods

Field experiment was conducted during the *rabi* seasons of 2012-13 and 2013-14 at Birsa Agricultural University, Ranchi (23°17' N latitude, 85° 10' E longitude and 625 m above mean sea level). The experiment was laid out in split plot design replicated three times. The treatment comprised of two dates of sowing viz. 15th December and 1st January in main plots and eight wheat cultivars viz. HD 2985, HI 1563, DBW 14, K1114, HD 3118, HD 2733, DBW 107, and NW 2036 in sub plots. The soil of the experimental field was sandy loam in texture with acidic in soil reaction (pH 5.52) low in organic carbon (0.49%) and available nitrogen (225.79 kg/ha), medium in phosphorus (12.8 kg/ha) and potassium (157.1 kg/ha). Wheat varieties were sown in rows at 18 cm apart as per treatment scheduled. The recommended basic full dose of PK and half dose of nitrogen as basel and the remaining nitrogen was applied in 2 equal doses, half at tillering and the rest half at boot stage. The sources of nutrients were urea, single super phosphate and muriate of potash for N, P and K, respectively. The crop was sown on a well prepared seedbed using a seed rate of 150 kg/ha. The crop was harvested on April 18 in 214 and April 22 in 2015. Data on development stages, heat unit requirements, chlorophyll content, min tilt angle, gap fraction and yield were recorded as per normal procedure. Soil sample were analyzed for Available nitrogen, phosphorus and potash as per standard laboratory procedures. The recommended dose of fertilizer was 120 kg N, 60 kg P_20_5 and 40 kg K_2O. The data were analyzed using appropriate analysis of variance (ANOVA).

Results and Discussion

Development phases

50 Percent flowering

The data pertaining to 50 percent flowering as influenced by date of sowing are presented in Table 1. The number of days taken to 50 per cent flowering was significantly affected due to sowing dates and Genotypes. The higher value for number of days taken to 50 per cent flowering was recorded in 15th December sown crop than 1st January sown crop. The onset of 50 per cent flowering was reduced by 3 days in very late sown (1st January) sown crop. The highest number of days taken to 50 per cent flowering was observed in Genotype HD 2733 followed by DBW 14, HD 2985, HI 1563, HD 3118,DBW 107 and NW 2036, which significantly differed from each other. The lowest number of days for 50 per cent flowering was taken by Genotype K1114. Similar finding was also observed by Ansary *et al*., (1989) [3].

Milk Stage

15th December sown crop took significantly higher number of days taken to attain milk stage than 1st January sown crop (Table 1). The onset of milk stage was reduced by 8 days in very late sown (1st January) crop. Significantly higher number of days taken to milk stage was observed in HD 2733 than all other Genotypes. It was followed by DBW 107, DBW 14, HI 1563, HD 2985, NW 2036, and HD 3118. Genotypes K 1114 attain milk stage statistically earlier than all other Genotypes. These results are in close conformity with the findings of Hem chandra (2003) [8].

Dough stage

It is evident from data (Table 1) that dough stage of wheat was also affected significantly by date of sowing and Genotypes. Late sown (15th December) wheat require more days for onset of dough stage as compared to very late (1st January) sown crop. 15th December sown crop required 101.70 days for onset of dough which is reduced by 11 days in very late (1st January) planted crop.

The highest number of days taken to dough stage was observed in Genotype HD 2733 and remains at par with DBW 107, HD 3118 and NW 2036. It was followed by HD 2985, HI 1563 and K 1114. None of these consecutive Genotypes showed significant differences for days taken to dough stage. Genotype DBW 14 requires significantly lesser number of days to attain dough stage. This result is in conformity with the result of Phadanwis and Saini (1992) [10]

Maturity stage

Number of days taken to physiological maturity was significantly affected by sowing dates and Genotypes (Table 1). 15th December sown crop took significantly higher number of days taken to attain maturity than 1st January sown crop. 1st January sown crop took lower number of days which is reduced by 9 days as compared to late sown (15th December) crop. Significantly higher number of days taken to physiological maturity was observed in HD 2733 than all other Genotypes. It was followed by HD 3118, HD 2985, DBW 107, HI 1563, DBW 14, and NW 2036. Genotype K 1114 matured statistically earlier than all other Genotypes except NW 2036. Similar findings were observed by Aslam *et al.* (2003) [4]

Heat unit requirement

Seeding time and Genotypes did not have significant impact on heat unit requirement for onset of various phenophases of growth and development of wheat crop (Table 1). However, a fixed amount of heat unit was required to shift from one stage of growth to another. Among sowing dates, 15th December sown crop required 772, 999, 1195 and 1373 heat units for 50 per cent flowering, milk, dough and maturity respectively and 795, 972, 1137 and 1381 heat units in 1st January. Delay in sowing caused reduction in heat unit requirement for each phenophases. Interaction between sowing time and Genotypes was not significant for heat unit requirement of phenophases (Table 4). Genotypes did not affect heat unit requirement at all stages. In general, wheat Genotype HD 2985 required about 781, 979, 1138 and 1443 for 50 per cent flowering, milk, dough and maturity respectively. Similarly, HI 1563 took 774, 986, 1135 and 1353 for 50 per cent flowering, milk, dough and maturity respectively. DBW 14 required about 825.68, 983.80, 1106.76 and 1317.06 for 50 per cent flowering, milk, dough and maturity respectively. K 1114 required about 726, 936, 1123 and 1208 for 50 per cent flowering, milk, dough and maturity respectively. HD 3118 required about 756, 945, 1203, 1217 and 1506. HD 2733 required about 921, 1095, 1217 and 1606 for 50 per cent flowering, milk, dough and maturity respectively. DBW 107 required about 754, 996, 1214 and 1361 for 50 per cent flowering, milk, dough and maturity respectively. And NW 2036 took 729, 964, 1189 and 1222 for 50 per cent flowering, milk, dough and maturity respectively. Similar trend was also reported by Hem chandra (2003) [8]

Chlorophyll content

Data on chlorophyll content recorded on leaves at 45, 60 and 75 days after sowing, at anthesis and two weeks after anthesis are presented in Table 2. Leaf chlorophyll content recorded in terms of SPAD values at different stages was significantly influenced by Genotypes. But, the influence of sowing dates and the interaction between sowing dates and Genotypes was non-significant at all the stages of study. In general, there was a gradual decline in leaf greenness with increase in crop age and also with delay in sowing (Table 2). December 15 sown crop produced higher chlorophyll than January 1 sown crops at 45, 60 and 75 days after sowing and at anthesis. At these stages, the difference in leaf chlorophyll content between December 15 and January 1 sowing was non-significant. However, at these stages December 15 sowing exhibited higher SPAD value than January 1 sown. At 45 days after sowing, the highest chlorophyll content was recorded in HD 2733 which was at par with HD 2985 and HD 3118. Genotypes HI 1563, DBW 14 and DBW 107 being at par with one another recorded significantly higher chlorophyll content than that of K1114 and NW 2036 which had the low value of greenness at 45 days after sowing. At 60 days after sowing, Genotype HD 2733, HD 2985 and HD 3118 being at par with each other had significantly higher chlorophyll content (SPAD Value) than all other Genotypes. Genotype DBW 107, HI 1563 and DBW 14 also had statistically similar leaf chlorophyll content (SPAD Value). Genotype NW 2036 and K 1114 with low value showed significantly lower chlorophyll content (SPAD Value) than all other Genotypes. At 75 days after sowing, the highest chlorophyll content was recorded in HD 2733 followed by HD 3118 and HD 2985. These Genotypes being at par with each other recorded significantly higher SPAD value than, HI 1563, DBW 14, K 1114, DBW 107 and NW 2036.The lowest chlorophyll content was recorded in K 1114 which was at par with NW 2036. At anthesis and at two week after anthesis, the highest leaf chlorophyll content in terms of SPAD Value was observed in HD 2985 and HD 3118. The lowest chlorophyll content (SPAD Value) was recorded in K 1114 which was at par with NW 2036. These results coincide with the ones obtained by Dabre *et al.* (1993) [5]

Mean tilt angle (MTA)

The effect of Genotypes on mean tilt angle was significant at all the stages (Table 3). The interaction of sowing dates and Genotypes was non-significant at all the stages. It can be inferred from Table (4) that of the crop declined with delay in sowings. December 15 sown crop showed significantly higher mean tilt angle than that of January 1 sown crop at 60 days after sowing. December 15 and January 1 sown crops statistically did not differ from each other at 45,75 days after sowing, at anthesis and two week after anthesis. At 45 days after sowing, Genotype HD 2733 had higher mean tilt angle than other Genotypes except HD 3118 and HD 2985 which were at par with each other. The lowest mean tilt angle was observed in K1114 which was at par with NW 2036 with each other. At 60 days after sowing, Genotype HD 2733 had significantly higher mean tilt angle than all other Genotypes except HD 3118 and HD 2985. Genotype HD 3118 and HD 2985 being at par with each other recorded significantly higher mean tilt angle than HI 1563, DBW 14, DBW 107, K114 and NW 2036. K1114 which showed the least mean tilt angle was at par with NW 2036. At 75 days after sowing, Genotype HD 2733 followed by HD 3118, HD 2985, DBW 107, HI 1563, DBW 14 and NW 2036. Genotype K1114 showed the least mean tilt angle. At anthesis, the highest canopy angle was observed in Genotype HD 2733 (46.88º) which was statistically superior to all other Genotypes except HD 3118 and HD 2985. The lowest mean tilt angle of 32.16º was observed in Genotype K1114 which was at par with NW 2036. At two week after anthesis, Genotype HD 2733 showed higher mean tilt angle than other Genotypes except HD 3118 and HD 2985. Genotypes DBW 107, HI 1563 and DBW 14 being at par with each other recorded higher mean tilt angle than K1114 which had the lowest mean tilt angle and remain at par with NW 2036. This trend was also observed by Dabre *et al.* (1993) [5]

Gap fraction

The effect of sowing dates on gap fraction was significant at all the stages. Genotypes also showed significant differences at all the stages. The interaction of Genotypes and sowing dates was non-significant at all the stages. It is evident from (Table 3) that December 15 sown crop showed less gap in its canopy than very late (1st January) sown crop at all the stages. December 15 sown crop had the lowest gap fraction followed by January 1 sown crop with the highest gap fraction. All the differences in gap fraction due to sowing dates between December 15 and January 1 were significant at all the stages. At 45 days after sowing, Genotype HD 3118 had significantly less gap than all other Genotypes. This was followed by HD 2733, HD 2985, DBW 107, HI 1563, DBW 14 and NW 2036 which statistically differed from each other. Genotype K 1114 had significantly more gap in their canopy than all other Genotypes. At 60 days after sowing, Genotype HD 3118 recorded lowest gap fraction except HD 2733 followed by DBW 107,HI 1563, and DBW 14 which was at par with each other. Genotype K 1114 had significantly higher gap fraction than all other Genotypes except DBW 14 and NW 2036. At 75 after sowing and at anthesis, Genotype HD 3118 being at par with HD 2733 exhibited the lowest gap fraction. Genotype K 1114 recorded significantly higher value of gap fraction than all other Genotypes. This was followed by NW 2036 and DBW 14 which were at par with each other. At two weeks after anthesis, Genotype HD 3118 and HD 2036 being at par with each other had significantly lower gap fraction in their canopy than rest of the Genotypes. Genotype K 1114 recorded significantly higher value of gap fraction than all other Genotypes. It was followed by NW 2036, DBW 14 and HI 1563 which were at par with each other. The result are also in conformity with Dabre *et al.* (1993) [5]**.**

Grain yield and Harvest index

Grain yield of wheat crop is the result of combined effect of various yield contributing components. It is evident from the data that sowing date affected significantly, the grain yield. Significantly maximum grain yield (33.51 q/ha) was obtained when crop was sown on 15th December with minimum grain yield (27.72 q/ha) in case of 1st January sown crop. Lower grain yield in 1st January sowing was mainly due to less number of tillers/m^2, less number of grains per spike and lower 1000-grain weight. These results are in accordance with those of Spink *et al.* (2000) [16] and Aslam *et al*. (2003) [4]. The grain yield was significantly affected by various genotypes. The same trend was also observed in the value of harvest index. 1st January sown crop recorded the lower value which was 4.62 % lower than 15th December sown crop. The cultivar HD 2733 produced significantly higher grain yield (35.83 q/ha) than all the other genotypes except HD 2985 and HD 3118. The lowest grain yield was produced in K 1114 (26.02 q/ha) which was at par with NW 2036. Higher grain yield in HD 2733 was mainly due to higher number of tillers and higher 1000-grain weight. These results are similar to Shahzad *et al*., (2002) [14]. However, the interaction between sowing time and genotypes was found to be non-significant.

Straw yield (q/ha)

The straw yield is reflected by growth parameters like total number of tillers, leaf area and plant height. The data indicated that sowing time significantly affected the straw yield. Significantly higher straw yield (52.57 q/ha) was produced when crop was sown on 15th December than 1st January sown condition (47.03 q/ha) which was 10.54 percent lower than 15th December sown crop. Higher straw yield in early sowing was mainly due to more number of effective tillers/m^2 and more plant height. These results are in line with those of Donaldson *et al*. (2001) [7], Hem chandra (2003) [8] and Ram *et al*. (2004) [11]. The straw yield was also significantly affected by various genotypes. HD 2985 produced maximum straw yield (53.80 q/ha) which was superior to all the genotypes. The lowest straw yield was produced by K 1114 (43.12 q/ha) which was at par with NW 2036. Genotypical difference in straw yield can be attributed mainly to their plant height and more number of tillers/m^2. Samra and Dhillon (2002) [12] reported that straw yield differed significantly due to genetic variation in wheat genotypes.

Economics

From the economic point of view 15th December was recorded (Rs.34642/ha) significantly higher net return and benefit: cost ratio (1.21) as compared to 1st January. Amongst all varietal treatments, maximum net return (Rs.37205/ha) and benefit: cost ratio (1.34) was recorded with cultivar HD 2733 followed by HD 2985 and HD 3118.

Conclusions

It is concluded from the results of the experiment that in order to get maximum yield wheat genotype HD 2733 was found to be more suitable genotype for late sown (upto 1st January) condition. While, HD 2985 as well as HD 3118 can also be recommended for higher yield in eastern region of Jharkhand.

Table 1: Effect of date of sowing and cultivars on development stages and heat unit requirement of wheat (data pooled over two years).

Treatment	Development stages (Days to)				Heat unit requirement (Degree Days)			
	50% Flowering	Milk stage	Dough stage	Maturity	50% Flowering	Milk stage	Dough stage	Maturity
Date of sowing								
15th December	75	91	102	110	772	999	1195	1373
1st January	72	82	90	101	795	972	1137	1381
SEm±	0.28	0.79	0.72	0.40	4.09	12.11	14.77	8.94
CD (P=0.05)	1.72	4.82	4.38	2.40	NS	NS	NS	NS
Genotypes								
HD 2985	73	86	95	109	781	979	1138	1443
HI 1563	73	86	94	105	774	986	1135	1353
DBW 14	76	86	93	103	826	986	1107	1317
K 1114	69	84	94	98	726	936	1123	1208
HD 3118	71	84	98	112	756	945	1203	1506
HD 2733	83	92	99	116	921	1095	1217	1606
DBW 107	71	87	98	105	754	996	1214	1361
NW 2036	70	85	97	99	729	964	1189	1222
SEm±	0.76	1.14	0.96	1.17	10.99	20.15	20.00	25.71
CD (P=0.05)	2.54	3.81	3.19	3.90	36.66	67.18	66.69	85.73

Table 2: Effect of date of sowing and cultivars on chlorophyll content of wheat (data pooled over two years).

Treatment	Chlorophyll content (SPAD value)				
Date of sowing	**45 DAS**	**60 DAS**	**75 DAS**	**At anthesis**	**2 weeks after anthesis**
15 th December	37.15	36.21	36.34	34.31	32.40
1st January	35.75	35.41	34.64	33.01	31.81
SEm±	0.33	0.33	0.32	0.31	0.31
CD (P=0.05)	NS	NS	NS	NS	NS
Genotypes					
HD 2985	38.67	38.00	37.63	35.72	34.12
HI 1563	36.27	35.63	35.31	33.48	31.92
DBW 14	35.61	34.98	34.67	32.88	31.35
K 1114	30.78	30.19	30.00	28.41	27.03
HD 3118	39.21	38.54	38.16	36.22	34.58
HD 2733	42.33	41.63	41.17	39.12	37.42
DBW 107	37.27	36.62	36.28	34.40	32.82
NW 2036	31.47	30.87	30.66	29.04	27.64
SEm±	1.31	1.29	1.26	1.21	1.17
CD (P=0.05)	4.36	4.31	4.21	4.04	3.91

Table 3: Effect of date of sowing and cultivars on mean tilt angle and gap fraction of wheat (data pooled over two years).

Treatment	Mean tilt angle (º)					Gap fraction				
Date of sowing	**45 DAS**	**60 DAS**	**75 DAS**	**At anthesis**	**2 weeks after anthesis**	**45 DAS**	**60 DAS**	**75 DAS**	**At anthesis**	**2 weeks after anthesis**
15th December	38.52	41.03	41.87	40.78	38.94	0.191	0.073	0.044	0.039	0.069
1st January	36.69	38.15	40.54	39.54	37.79	0.231	0.089	0.053	0.047	0.107
SEm±	0.39	0.43	0.41	0.39	0.36	0.002	0.001	0.001	0.001	0.001
CD (P=0.05)	NS	2.604	NS	NS	NS	0.012	0.003	0.002	0.002	0.004
Genotypes										
HD 2985	39.97	42.09	43.79	42.70	40.79	0.206	0.079	0.048	0.042	0.086
HI 1563	37.36	39.30	40.95	39.94	38.16	0.216	0.083	0.050	0.044	0.091
DBW 14	36.71	38.64	40.23	39.20	37.44	0.225	0.086	0.051	0.045	0.093
K 1114	31.69	33.39	34.70	33.71	32.16	0.249	0.094	0.056	0.050	0.102
HD 3118	40.47	42.58	44.36	43.30	41.38	0.175	0.067	0.041	0.036	0.073
HD 2733	43.84	46.17	48.03	46.88	44.80	0.179	0.069	0.021	0.037	0.075
DBW 107	38.40	40.39	42.09	41.07	39.25	0.210	0.081	0.048	0.043	0.089
NW 2036	32.40	34.13	35.48	34.49	32.91	0.229	0.087	0.052	0.096	0.096
SEm±	1.37	1.44	1.50	1.49	1.43	0.008	0.0031	0.002	0.002	0.003
CD (P=0.05)	4.56	4.79	5.01	4.96	4.77	0.028	0.0103	0.006	0.005	0.012

Table 4: Effect of date of sowing and cultivars on wheat yield, harvest index and economics (data pooled over two years).

	Grain yield	Straw yield	Harvest index (%)	Net return (Rs./ha)	Benefit: cost ratio
Date of sowing					
15th December	33.51	52.57	38.78	34642	1.21
1st January	27.72	47.03	36.99	24678	0.90
SEm±	0.42	0.38	0.26	708	0.02
CD (P=0.05)	2.64	2.30	1.08	4352	1.14
Cultivars					
HD 2985	32.65	53.80	38.79	33201	1.19
HI 1563	30.32	51.75	37.99	29700	1.06
DBW 14	29.91	48.50	39.22	27892	0.99
K 1114	26.02	43.12	38.53	20900	0.76
HD 3118	32.86	51.42	40.15	32706	1.17
HD 2733	35.83	52.51	41.63	37205	1.34
DBW 107	31.13	50.44	39.33	30604	1.09
NW 2036	26.56	46.69	37.07	22892	0.83
SEm±	1.12	1.62	0.51	1952	0.09
CD (P=0.05)	3.72	5.41	1.64	6509	0.24

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