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Performance of Wheat (*Triticum aestivum* L.*)* Varieties under Cold Stress Condition

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***Abstract*:** The present investigation was conducted during the *Rabi* season of 2020-2021 at Agricultural Research Farm of SGRR University, Dehradun, India to study the performance of wheat varieties under cold stress condition. The experiment was laid out in factorial randomize block design with three replications. The treatments comprises five sowing dates *viz*. 5th November, 15th November, 25th November, 5 December and 15th December and two varieties *i.e.* Unnat PBW 343 and PBW 502. The variety Unnat PBW 343 performs better than variety PBW 502 in yield and yield contributing traits. The plant height (101.44 cm), number of tiller per plant (10.71), spike length (14.49 cm), number of grains per spike (74.30), test weight (39.72 g) and grain yield (43.34 q/ha) was recorded maximum with 15th November sowing. The interaction of variety Unnat PBW 343 and 15th November sowing gave maximum yield (42.67 q/ha) as compared to all other treatments combinations. It can be concluded that under prevalent climatic conditions of Dehradun region, the variety Unnat PBW 343 and 15th November sowing time is best for higher yield of wheat crop as compared to all other treatments.

***Keywords*:** Sowing date, Wheat, Varieties and yield

Changing climatic conditions in recent decades is creating a major hurdle in enhancement the productivity of crops. With the changing environmental conditions, it is difficult to get higher yield and productivity by using traditional practices. It means traditional practices need to changed or modified (Xiao et al 2017). Knowledge of ideal sowing time of wheat crop as per climatic conditions is a key factor to get higher yield output without any extra economic inputs (Ali et al 2021). Wheat is playing an outstanding role in feeding the hungry people of the world and an important crop for global food security. In India, wheat is the second most important cereal crop next only to rice. It is a prime crop of the green revolution and post green revolution era. Among various factors responsible to influence the yield of wheat crop, sowing time and varietal selection are of primary importance. The environment under which crop is grown creates a tremendous impact on growth, development and yielding ability of wheat crop. It is a prime factor which affects the physiology and phenology of crop (Ahmed and Ali 2015). Wheat is sown in winter and it has its own definite requirements for temperature and light for emergence, growth and flowering. Too early sowing produces weak plants with poor root system and irregular germination. It is mainly because of the higher temperature than the required optimum temperature. Late planting results in poor tillering and slow crop growth because of low temperature. Late planting results short duration crop that may escape from high temperature at grain filling stage (Akter and Islam 2017).

Improper selection of varieties also affects crop yield because they vary with their genetic potential and adaptable environment. Thus there is scope for increasing crop yield by using climate resilient varieties (Hussain et al 2012). Many high yielding varieties have been developed and recommended for general cultivation in the past. These varieties are losing yield potential due to changes in various edaphic and environment conditions. Therefore, continuous selection of high yielding genotypes that have evolved various mechanism to cope up with heat stress which are rolling, shedding and thickening of leaves, reduction in leaf size, short duration of growth period and transpiration (Wahid et al 2007). Wheat yield can be increased 10-80 % through proper selection of sowing time and by using suitable cultivars (Conventry et al 2011). Hence, selection of optimum time of sowing and suitable variety is very essential to increase yield per hectare. Thus, the present investigation was conducted to determine the effect of date of sowing and varieties on growth and yield of wheat at the Doon valley of Uttarakhand.

MATERIAL AND METHODS

The present investigation was carried out during the rabi

season of 2020-2021 at SGRR University, Dehradun, Uttarakhand. The experimental site was situated at 30.316ºN latitude and 78.032ºE longitude with an average altitude of 450 m above the sea level under subtropical and humid region of Dehradun. The soil of the experimental station was sandy loam to clay in texture containing a pH 6.5. The treatments comprise of different sowing dates and two wheat varieties which replicated thrice in two-factorial randomize block design. The sowing of two wheat varieties *i.e.* Unnat PBW 343 (V_1) and PBW 502 (V_2) were done on 5th November (T_1), 15th November (T_2), 25th November (T_3), 5th December (T_4) and 15th December (T_5). All other agronomic practices like weeding and irrigation etc. were used as per crop's requirements. The crop growth and yield parameters were recorded in five randomly selected plants from each plot. The average value of five selected plants were calculated for each parameter in each treatment and used for statistical analysis. The experimental data were statistically analysed by using SPSS.

RESULTS AND DISCUSSION

Plant Height (cm)

Effect of varieties: Plant height is mainly controlled by its genetic makeup and also affected by environmental conditions during the production. Plant height shows non-significant variation between varieties after 60 days after sowing, while it was significant at the time of maturity. The plant height at maturity was higher in variety Unnat PBW 343 (V_1) (100.10 cm) as compare to variety PBW 502 (V_2) (97.32 cm). This significant variation might be due to the genetic constitution of varieties in prevailing environmental condition. These results are also in agreement with the finding of Mattas et al (2011).

Effect of date of sowing: The plant height was significantly affected by different dates of sowing at 60 days after sowing (DAS) and maturity. The maximum pant height was 51.10 cm at 60 days after sowing and 101.44 cm at maturity with 15th November sowing. It might be due to suitable conditions for sowing of wheat crop as compared to other dates of sowing. The plant height was decreased gradually when sowing done after 15th November. This might be due to non-availability of suitable environmental conditions for enhancing effect of vegetative growth by cell division and cell elongation. Minimum plant height at 60 days after sowing (46.88 cm) and maturity (96.73 cm) were with 15th December sowing. These findings are in close conformity with the finding of Pathania et al (2018).

Interaction effect (V×T): At 60 days after sowing, the maximum plant height was recorded (51.12 cm) with treatment combination Unnat PBW 343 and 15th November sowing (V_1T_2), which was statistically at par to the treatment combination PBW 502 and 15th November sowing date *i.e.* 51.09 cm. It was 8.45 % higher than the minimum plant height (46.80 cm) with treatment combination PBW 502 and 15th November date of sowing. At maturity the highest plant height was recorded with (103.38 cm) with treatment combination Unnat PBW 343 and 15th November sowing, which was statistically at par to treatment interaction Unnat PBW 343 and 25th November date of sowing. Minimum plant height 94.82 cm was with treatment interaction V_2T_5. These findings are also in agreement with the findings of Adam and Jahan (2019).

Number of Leaves per Plant

Effect of varieties: A non-significant variation was recorded in number of leaves per plant at 60 days after sowing (DAS) but it was significant at maturity. At maturity Unnat PBW 343 gives 22.25 per cent higher number of leaves per plant than variety PBW 502. Bachho et al (2017) found significant effects of varieties on number of leaves at all growth stages.

Effect of date of sowing: Number of leaves per plant was varies significantly at 60 days after sowing and maturity with different dates of sowing. Maximum number of leaves per plant was in 15th November sowing *i.e*. 63.87 at 60 days after sowing and 4.10 at maturity. The minimum number of leaves per plant was in 15th December sowing date at both the growth stages. It might be because of the different environmental conditions faced by crop plants. It might also be due to higher plant stand and plant height with this sowing date. The significant effect of dates of sowing on number leaves per plant was also recorded by Bachho et al (2017). Adam and Jahan (2019) observed maximum number of leaves per plant from November 15th sown crop.

Interaction effect (V×T): Both the varieties show best performance with 15th November sowing date. The variety Unnat PBW 343 gives maximum number of leaves per plant with 15th November sowing at 60 days after sowing (64.00) and maturity (4.56). At maturity the variety Unnat PBW 343 gives 19.95 per cent higher number of leaves par plant as compared to variety PBW 502 with 15th November sowing. Both the varieties give minimum number of leaves per plant with 15th December sowing date. Adam and Jahan (2019) observed maximum number of leaves per plant with combination of BARI Gom-25 and 15th November of sowing date.

Number of Tillers per Plant

Effect of varieties: The plants of variety Unnat PBW 343 (V_1) produced significantly higher number of tillers per plant (14.01 and 9.10) as compared to variety PBW 502 *i.e.* 13.05 and 8.50, at 60 days after sowing and maturity, respectively. Yusuf et al (2019) observed significant variation among the varieties for number of tillers per plant.

Effect of date of sowing: Number of tillers per plant shows decrease trend with any deviation from ideal sowing condition. The highest number of tillers per plant was recorded in crop sown on 15th November which was 16.08 and 29.97 % higher at 60 days after sowing and maturity, respectively, than lowest recorded with 15th December sowing. It might be due to less temperature during germination and initial growth results less number of tillers developed in plants. These findings are also in agreement with the finding of Tahir et al (2009).

Interaction effect (V×T): The variety Unnat PBW 343 sown on 15 November showed highest number of tillers per plant at 60 days after sowing (15.27) and maturity (10.00) then all other treatments combinations. Adam and Jahan (2019) also found significant effects of varieties and sowing time on number of tillers per plant.

Dry matter accumulation (g/plant)

Effect of varieties: Unnat PBW 343 accumulates higher amount of dry matter (71.11 and 175.79 g per plant) than variety PBW 502 (70.32 and 174.21 g per plant) at 60 days after sowing and maturity, respectively. These findings are in agreement with El-Habbal et al (2008) and El-Temsah et al (2014).

Effect of dates of sowing: The wheat plants accumulates maximum dry matter (77.63 and 186.37 g/plant) at 60 days after sowing and maturity, respectively, when sown on 15th November. The dry matter accumulation in plants decrease with early and late sowing then this optimum sowing date of crop. The minimum dry matter accumulation was with 15th December date of sowing at both the crop growth stages. El-Temsah et al (2014) recorded maximum dry matter accumulation with 1st November sowing date.

Interaction effect (V×T): The environmental conditions and genotypes of crop variety both are responsible to influence the dry weight of plants. Both the varieties accumulates maximum dry matter with 15th November sowing, but variety Unnat PBW 343 accumulates 2.30 per cent and 2.77 per cent higher dry matter at 60 days after sowing and maturity, respectively, with 15th November sowing (V_1T_2) than variety PBW 502 and 15th November sowing (V_2T_2). The minimum dry matter accumulation was recorded (66.33 and 165.80 g/plant) at 60 days after sowing and maturity, respectively, with interaction of variety PBW 502 and 15th December date of sowing (V_2T_5). These findings are also in agreement with El-Temsah et al (2014).

Spike Length (cm)

Effect of varieties: Varieties show non-significant variation with respect to spike length of wheat crop.

Effect of dates of sowing: Significant difference in spike length were with different sowing dates of crop. Crop which sown on 15th November produce maximum 22.63 per cent longer spike length than the crop sown on 15th December which produce minimum length of spike (11.21 cm). The spike length of crop gradually decreased with the delay in sowing time from 15th November to 15th December. It might be due to the crop got lower temperature and photoperiod during late growth stage and also got less time period for growth and development of plant which ultimately affect the spike length. Mattas et al (2011) revealed that the ear length is mainly controlled by genotype of the variety and by prevailing environmental conditions of the area during the crop production and thus it shows variation. Pathania et al (2018) found higher length of spike with 20th November sowing.

Interaction effect (V×T): The interaction of varieties and sowing dates shows significant effect of on length of spike. The maximum spike length (14.53 cm) was recorded with interaction of variety Unnat PBW 343 and 15th November sowing (V_1T_2), which was statistically at par to the interaction of variety PBW 502 and 15th November sowing (V_2T_2) (14.46 cm). The minimum length of spike was recorded with interaction of variety Unnat PBW 343 and 15th December sowing (11.10 cm).

Number of Grains per Spike

Effect of varieties: The variety Unnat PBW 343 (V_1) produced 2.84 per cent significantly higher number grains per spike than variety PBW 502 (V_2). This variation may be due to genetic variability of these varieties. The significant variation among varieties for number of grains per spike was also reported by Tahir et al (2009).

Effect of date of sowing: The data recorded on number of grains per ear exhibited decrease trend with early and delayed sowing than the optimum time. The maximum number of grains per spike was in plants which sown on 15thNovember (74.30) and was significantly higher than all other sowing dates. The minimum number of grains per plant was recorded in plants which sown on 15th December (T_5) (59.22). The higher number of grains per spike might be due to higher growth and development of plants of 15th November sowing, which results higher synthesis of food materials and ultimately higher number of grains per spike. It was also due to longer length of spike with this sowing date. Pathania et al (2018) also significant higher number of grains per spike with 20th November sowing.

Interaction effect (V×T): The significantly highest number of grains per spike was recorded with variety Unnat PBW 343 sown on 15th November (V_1T_2) (73.15) while, lowest with variety Unnat PBW 343 sown on 15th December (V_1T_5) (59.25). Adam and Jahan (2019) also found significant effects of varieties and sowing dates on number of grains per spike.

Test Weight (g)

Effect of varieties: The data indicated significant difference in test weight of varieties. The higher test weight was in variety Unnat PBW 343 (V_1) (37.38 g) than the variety PBW 502 (V_2) (36.07 g). The superiority of Unnat PBW 343 seems to be on account of efficient translocation of metabolites towards grain development. These results are in close conformity to the findings of Mattas et al (2011).

Effect of date of sowing: Test weight was recorded highest in the crop sown on 15th November (39.72g) which was significantly higher than all other treatments of sowing dates. This might be due to the fact that under late sown conditions after 15th November, the grains were forced to mature and dry at maturity time because of sudden rise in temperature coupled with hot wind. Thus, the grains obtained from 15th December sown crop were small and shrivelled, which results lower test weight. The timely sown crop gets an advantage of getting sufficient time for grain development and maturation. Timely sown crop also get ideal temperature and photoperiod for bold grain development. Shirpukar et al (2008) also reported that timely sowing gave higher test weight as compared to delayed sowing.

Interaction effect (V×T): The test weight of wheat crop differs significantly to the interaction of varieties and sowing dates. The interaction of Unnat PBW 343 with 15th November sowing (39.27 g) gives the highest test weight among all the interactions and was statistically at par to interaction of variety PBW 502 with 15th November sowing *i.e*. 38.82 g. The minimum test weight recorded (35.11 g) with interaction of variety PBW 502 with 15th December sowing. (V_2T_5).

Grain Yield (q/ha)

Effect of varieties: The grain yield was varied significantly with varieties. The variety Unnat PBW 343 (36.60 q/ha) produces 4.37 per cent higher grain yield than variety PBW 502 (35.00 q/ha). High yield of Unnat PBW 343 may be attributed to its higher vegetative growth and yield contributing characters like plant height, number of tillers per plant, spike length, number of grains per plant and test weight. The higher vegetative growth may results higher production of food material and ultimately higher grain

Table 1. Effect of varieties and sowing dates on vegetative characters of wheat

Treatments	Plant height (cm)		Number of leaves per plant		Number of tillers plant		Dry matter accumulation	
	60 DAS	Maturity	60 DAS	Maturity	60 DAS	Maturity	60 DAS	Maturity
Varieties								
V_1	48.74	100.20	61.83	3.55	14.01	9.10	71.11	175.79
V_2	48.63	97.32	61.84	2.76	13.05	8.50	70.32	174.21
CD (p=0.05)	NS	0.62	NS	0.27	0.28	0.47	0.78	0.76
Sowing dates								
T_1	47.73	99.05	61.61	3.16	13.47	9.68	66.61	170.70
T_2	51.10	101.44	63.87	4.10	15.36	10.71	77.63	186.37
T_3	49.75	100.99	63.20	3.40	14.72	9.91	74.31	180.01
T_4	47.97	98.09	61.64	2.79	13.63	7.96	68.68	170.22
T_5	46.88	96.73	58.86	2.32	12.89	7.50	66.32	167.70
CD (p=0.05)	0.76	0.98	1.04	0.43	0.45	0.74	1.23	1.20
Interaction effect (varieties x Sowing dates)								
V_1T_1	47.85	100.14	62.62	3.69	13.22	9.28	68.23	171.78
V_1T_2	51.12	103.38	64.00	4.56	15.27	10.00	78.54	189.00
V_1T_3	50.03	102.45	63.76	3.70	13.88	9.30	74.57	176.79
V_1T_4	47.84	100.39	62.30	3.02	12.94	7.90	67.83	171.79
V_1T_5	46.87	98.84	56.27	2.79	12.37	7.60	66.37	169.60
V_2T_1	47.61	97.96	60.61	2.64	12.97	8.87	64.99	169.60
V_2T_2	51.09	99.49	63.87	3.65	15.19	9.29	76.73	183.75
V_2T_3	49.48	98.54	63.20	3.10	13.03	8.69	74.05	183.22
V_2T_4	48.11	95.79	61.64	2.56	12.24	7.89	69.53	168.65
V_2T_5	46.89	94.82	58.86	2.04	11.84	7.82	66.33	165.80
CD (p=0.05)	1.08	1.39	4.39	0.44	0.64	1.05	1.74	1.70

development. These findings are similar to Shirpurkar et al (2008).

Effect of date of sowing: The significantly highest grain yield was obtained in crop sown on 15th November (43.34 q/ha) followed by crop sown on 25th November (40.00 q/ha) and 05th November (39.00 q/ha) November. The lowest yield was (29.67 q/ha) in crop which sown on 15th December (T_5). It might be due to suitable environmental conditions received by crop plants for their growth and yield contributing characters ultimately yield of crop. Similar results have also been reported by Shirpukar et al (2007). Pathania et al (2018) recorded significantly higher yield of wheat with 20th November sowing.

Interaction effect (V×T): The significantly higher yield was recorded (42.67 q/ha) with interaction Unnat PBW 343 sown on 15th November (V_1T_2). It was statistically at par to the interaction of variety PBW 502 and 15th November sowing (V_2T_2) (42.01 q/ha). The lowest yield was recorded (27.00 q/ha) with interaction of variety PBW 502 and 15th December sowing (V_2T_5). Adam and Jahan (2019) also found significant interaction effects of variety and sowing dates on yield of wheat.

Harvest Index (%)

Effect of varieties: The higher harvest index was recorded in PBW 502 (34.06 %) than the Unnat PBW 343 (33.78 %), however, the variation was non-significant.

Effect of dates of sowing: Harvest index significantly differs among the different dates of sowing and was maximum in crop sown on 15th November (T_2) (.93 %) followed by 05th November (T_1) sowing (35.59 %.) This maximum harvest index was 17.79 per cent higher than minimum on 15th December sowing (T_5) (30.36 %). Adam and Jahan (2019) also found maximum harvest index on 15th November sowing.

Interaction effect (V×T): The highest harvest index was r (36.73 %) with interaction of PBW 502 with 15th November sowing (V_2T_2) which was statistically at par to the combination of Unnat PBW 343 with 15th November sowing (V_1T_2) (36.24 %), PBW 502 with 05th November sowing (V_2T_1) (35.64 %) and Unnat PBW 343 with 05th November sowing (V_1T_1) (35.61 %). The lowest harvest index was with the interaction of PBW 502 and 15th December sowing (V_2T_5) (30.18 %). These finding have a close conformity with the findings of Adam and Jahan (2019).

Table 2. Effect of varieties and sowing dates on yield and yield contributing characters of wheat

Treatments	Ear length (cm)	No. of grains /ear	Test weight (g)	Grain yield (q/ ha)	Harvest index (%)
Varieties					
V_1	13.00	66.13	37.38	36.60	33.78
V_2	12.80	64.25	36.07	35.00	34.06
CD (p=0.05)	NS	0.63	0.42	1.08	NS
Sowing dates					
T_1	13.13	68.34	37.13	39.00	35.59
T_2	14.49	74.30	39.72	43.34	36.93
T_3	13.42	66.03	37.33	40.00	34.86
T_4	12.26	60.78	37.05	32.00	31.11
T_5	11.21	59.22	35.70	29.67	30.36
CD (p=0.05)	0.35	1.00	0.66	1.71	1.15
Interaction effect (varieties x Sowing dates)					
V_1T_1	13.46	67.85	36.36	37.01	35.61
V_1T_2	14.53	73.15	39.27	42.67	36.24
V_1T_3	13.06	65.22	36.38	38.01	34.07
V_1T_4	11.88	61.23	36.22	32.00	32.20
V_1T_5	11.10	59.25	35.40	28.40	30.27
V_2T_1	12.81	65.85	35.60	37.00	35.64
V_2T_2	14.46	70.01	38.82	42.01	36.73
V_2T_3	13.78	64.41	35.43	37.00	34.47
V_2T_4	12.65	61.69	35.40	32.00	33.28
V_2T_5	11.32	59.29	35.11	27.00	30.18
CD (p=0.05)	0.49	1.41	0.94	2.42	1.63

CONCLUSION

Among different dates of sowing, 15th November sowing is best for both varieties but the yield potential with variety Unnat PBW 343 is better than variety PBW 502. Hence, we can say that the variety Unnat PBW 343 sown on 15th November is best for higher yield of wheat.

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