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Effect of date of sowing and varieties on growth and yield of wheat in mid hill conditions of Himachal Pradesh

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Abstract
An experiment was conducted during *rabi* season of 2017-18 to study the effect of three dates of sowing (25th October, 25th November and 25th December) and four wheat varieties (HPW-349, HS-542, HS-490 and VL-907) on growth, yield attributes and yield at Palampur (HP), India. Wheat sown on 25th October recorded significantly highest plant height, tillers/m^2, dry matter accumulation, grains/spike, grain and straw yield. Among varieties, HPW-349 and VL-907 recorded significantly highest grains/spike, tillers/m^2 and dry matter accumulation hence recorded significantly highest grain yield.

Keywords: Dates of sowing, varieties, wheat growth, yield

Introduction
Wheat is the main source of energy and nutrition in human diet. In the realm of food crops in the world, wheat (*Triticum sp*.) ranks first. India is one of the principal wheat producing and consuming country in the world. Its importance in Indian agriculture is second to rice. India contributes 34% in world wheat production (Anonymous 2011) [3]. Being a *rabi* crop wheat crop needs cool climate. In India, wheat occupied an area 31.2 million hectares with the total production of 95.9 million tones and average productivity of 31.40 q/ha. In Himachal Pradesh, wheat was grown over an area of 338 thousand hectares with total production of 650 thousand tonnes and average productivity of 19.21 q/ha (Anonymous 2017) [2].
Date of sowing is most important factors that govern the phenological development of the crop and also efficient conversion of biomass into economic yield. It has been observed that the wheat crop sown at normal date usually have longer crop duration gets an opportunity to accumulate more biomass as compared to late sowing and thus results in higher grain yield and biological yield. Being a temperature sensitive crop, late sown crop is exposed to low temperature at the time of establishment and to high temperature at the reproductive phase that finally leads to accelerated maturity of crop and thus crops mature early in North Indian condition. This not only affects yield, but also affects the yield components and other aspects of the growth and development of this crop. Selection of proper sowing date is vital to obtain high yield due to variation among the weather conditions (Murungu and Madanzi 2010) [11]. Very early sowing, when temperature will be above the optimum could also produce poor plants, whereas, delay in crop sowing causes reduction in yield (Yajam and Madani 2013) [16]. Baloch *et al*. (2012) [4] reported that sowing of wheat on 25th October and 10th November produced the highest number of tillers, spike length, plant height, 1000-grain weight and the grain yield, which decreased with delay in sowing. Kumar (2012) [7] at Palampur revealed that early sown crop gave higher yield compared to subsequent dates of sowing. Verma *et al*. (2016) [15] concluded early sowing of wheat (15th November) had higher grains yield (54.61q ha^{-1}) than delayed sowing (51.38 q ha^{-1}).

Material and methods
A field experiment on wheat crop was conducted during 2017-18 *rabi* season (October- May) at the Experimental Farm of Department of Agronomy CSK HP Krishi Vishvavidyalaya, Palampur (32º6'N, 76º 3'E 1290.8 m elevation) in mid hill conditions of Himachal Pradesh. Field experiment comprising of three dates of sowing (25th October, 25th November and 25th

December) and four varieties (HPW-349, HS-542, HS-490 and VL-907) was conducted in split plot design with three replications. Sowing was done at spacing of 20 cm. The crop was fertilized @120:60:40 of N, P_2O_5, K_2O kg/ha, of which half dose of the nitrogen and full dose of phosphorus and potassium was applied as a basal dose and remaining half of nitrogen was applied in two equal splits, first at maximum tillering and second at earing stage. The crop was irrigated twice along with one pre sowing irrigation. During growing season (October to May), the weekly maximum and minimum temperature ranged between 16.0 to 33.6 ºC and 3.1 to 19.5 ºC, respectively. The crop experienced 362.1 mm rainfall during the crop season but it was erratically distributed during early phases of crop growth. The highest weekly rainfall of 94.6 mm was received during Meteorological Week 50. The sunshine duration and relative humidity ranged from 3.9 to10.0 hr and 20 to 84 per cent, respectively during the season.

Results and discussion

Growth

25th October sown wheat took recorded significantly taller plant height (84.5cm) followed by 25th November (81.8 cm), due to favourable weather conditions and crop growing period in optimum sowing dates (Table 1). Late sowing (25th December) also resulted in lesser growth period which forced the crop to flower earlier and also mature earlier which again resulted in lesser plant height. Baloch *et al*. (2012) [4] and Tomar *et al*. (2014) [14] also recorded similar results. Among varieties, VL-907 produced significantly taller plants over other varieties at tillering and harvesting stages. However, at these stages HS-542, HPW-349 and VL-907 were significantly at par with each other. At earing stage, HPW-349 produced significantly taller plants which were remained at par with other varieties but HS-490 produced significantly lower plant height over other varieties. Sowing date had significant effect on number of tillers. 25th October sowing produced significantly higher number of tillers compared to other dates of sowing. There was a progressive decrease in number of tillers as the sowing date was delayed from 25th November to 25th December. Decline in number of tillers with successive delay in sowing was also reported by Kumar (2012) [7] under similar agro climatic conditions. Among varieties, VL-907 and HPW-349 produced significantly higher number of tillers as compared to other varieties (Table 1). Dry matter accumulation (DMA) was significantly higher in 25th October sown crop as compared to all other sowing dates *viz*., 25th November and 25th December sown crop at harvest. The greater reduction in total dry matter and its apportioning in plant under delayed sowing were due to drop in temperature during vegetative phase and sharp rise in temperature during reproductive and maturity phases. The increased temperature during reproductive phase under delayed sowing was due to early completion of the required heat units for anthesis and maturity. These results are in conformity with earlier findings of Alam *et al*. (2013) [1] and Kumar *et al*. (2013) [8]. Among the varieties VL-907 produced significantly higher dry matter accumulation.

Table 1: Effect of sowing dates and varieties on growth attributes

Treatment	Plant height (cm) at harvest	Tillers m^{-2} at earing	Dry matter accumulation (g m^{-2})
Date of sowing			
25th Oct.	84.5	279.4	965.8
25th Nov.	81.8	260.1	905.8
25th Dec.	77.2	230.8	864.9
LSD (P=0.05)	4.6	10.9	29.8
Variety			
HPW-349	82.9	279.4	924.6
HS-542	81.7	260.1	916.4
HS-490	77.1	230.8	890.6
VL-907	83.0	10.9	917.0
LSD (P=0.05)	3.9	279.4	23.4

Yield attributes

Results presented in Table 2 indicated that ear length decreased successively and significantly with delay in date of sowing from 25th October to 25th December. Significantly higher ear length (cm) was observed in 25th November as compared to all other sowing dates at par with 25th October sowing. Jat *et al*. (2013) [6] and Kumar *et al*. (2013) [8] also found decrease in ear length with delay in sowing. No Significant difference was observed among the varieties in the spike length whereas numerically higher spike length was recorded in variety HPW-349. The reduction in spike length was in turn responsible for reduced number of grains/spike. Amongst dates of sowing, 25th October sown crop produced significantly more number of grains/spike to the tune of 44 followed by 25th November. Among varieties, HPW-349 produced significantly more number of grains/spike as compared to other varieties, however it was at par with VL-907.

Table 2: Effect of treatments on yield and yield attributes of wheat

Treatment	Grains/spike (No.)	1000-grain weight	Length of spike (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest Index
Date of sowing						
25th Oct.	44.8	46.2	10.8	3371	5698	0.37
25th Nov.	39.7	45.6	11.4	3197	5450	0.36
25th Dec.	35.0	44.8	10.0	2837	4990	0.36
LSD (P=0.05)	2.8	NS	1.0	248.1	384.6	NS
Variety						
HPW-349	42.7	45.1	11.0	3383	5599	0.37
HS-542	41.4	47.1	10.9	3016	5293	0.36

HS-490	34.1	43.6	10.8	2941	5195	0.36
VL-907	41.0	46.3	10.3	3200	5430	0.37
LSD (P=0.05)	2.0	1.3	NS	269.0	288.1	NS

Significantly more number of grains/spike may be because of timely sowing (25th November) provides sufficient period for vegetative growth to the crop, resulting in better yield attributes Tomar *et al.* (2014) [14] also observed similar findings. The data presented in Table 2 revealed that no significant difference was observed in as a result of different dates of sowing but numerically highest 1000-grain weight recoded in 25th October sown crop. Among varieties, HS-542 and VL-907 behaving statistically alike resulted in significantly higher grain weight as compared to other varieties. Significantly lowest grain weight was observed in HS-490.

The higher 1000 grain weight in early and timely sowing may be due to higher number of grains/spike (Table 2). Deshmukh *et al*. (2015) [5] also reported that earlier sowing of the crop resulted in higher 1000 grain weight than that the crop sown late in the season.

Yield

A perusal of data in Table 2 revealed that 25th October sowing, remaining at par with 25th November sowing, resulted in significantly higher grain yield. The highest yield recorded with 25th October sowing was due to significantly higher effective tillers, spike length and grains /spike as well as 1000-grain weight while lowest yield recorded during last date of sowing (25th December) was due to the lowest value of all these yield attributes which may be result of the least time taken to maturity as compared to other date of sowing. The decline in grain yield with delay in sowing may be due to forced maturity of late sown wheat, reduction in dry matter accumulation. Moreover, the yield attributes like effective tillers, grains ear-1 and 1000-grain weight were reduced (Table 2) under delayed sowing which may be responsible for lesser grain yield.

Similar results have been reported by Meena *et al.* (2016) and Mumtaz *et al*. (2015) [10]. Amongst the varieties tested HPW-349 gave significantly highest grain yield (3383 kg/ ha) though it was at par with VL-907. The sowing environments significantly influenced the straw yields, 25th October sown crop produced significantly higher straw yield (5698 kg/ha). Delayed sowing (25th December) resulted in significantly lower straw yield. The higher yields in early sown crop might be due to the reason that, 25th October sown crop received optimum environmental conditions for crop growth and get more time for attaining different phenophases. Similar findings were also reported by Sharma and Kumar (2005) [12] under similar agro climatic conditions of Palampur. Among varieties, HPW-349 and VL-907 produced significantly higher straw yield as compared to other varieties. Harvest index was not significantly affected by different. Among varieties none of variety significantly affects the harvest index (Table 2).

Conclusion

Plant height, dry matter accumulation, length of spike, number of grains/spike and 1000-grain weight were significantly higher in 25th October sown crop resulting in significantly higher grain and straw yield. However, it remained at par with 25th November sown crop. Among all varieties, HPW-349 recorded significantly higher effective tillers, number of grains/spike, length of spike and higher 1000-grain weight which was at par with VL-907 and resulted in higher grain and straw yield.

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