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Influence of Sowing Dates and Varieties on Productivity of Wheat Under Mid Himalayan Region of Uttarakhand

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ABSTRACT: *The present study was conducted during* rabi *season 2013-14 to quantify the performance and variability for yield and yield contributing characters of wheat against different sowing dates (30th October, 20th November and 10th December) under rainfed conditions at Ranichauri Campus, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Bharsar. Experiment was carried out for three wheat varieties against three dates of sowing. Results revealed that wheat yield and its attributes were significantly affected by different dates of sowing and different varieties during the study period. Crop growth, yield and yield attributing characters in terms of number of effective tillers/m², number of grains/ear, number of grains/m², test weight, straw yield, biological yield and grain yields of wheat crop were recorded significantly. Among the various sowing dates, wheat variety UP-2572 sown on 20th November provided best results. The delayed sowing caused poor vegetative growth probably due to low temperature during early vegetative stage and reduced number of tillers as a result of high temperature exposure during reproductive stage; thereby reducing growing season length and causing reduction in wheat yields. Similarly early sown wheat provides poor results because of shortage of moisture due to timely onset of monsoon and also high temperature prevalence; which restricts the proper growth of wheat. In conclusion, November sown variety UP-2572 was found to be superior over UP-1109 and VL-616 for all yield and yield attributing characters of wheat in mid hill region during the study period.*

Key words: *Sowing dates, Varieties, Weather variations, Growth and Yield.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most widely cultivated cereals in hilly region of Uttarakhand. It is sown during November/December and harvested during May/June. Medium duration varieties having 180-210 days growth cycle are mostly used in hilly regions of Uttarakhand because of optimum temperature during physiological and harvest maturity and availability of good amount of monsoon rain at the time of active growth stage of crop. The total area under wheat crop in Uttarakhand is 0.4 mha, with a total production of 0.8 mt and productivity of 2.0t/ha (Datt *et al.,* 2009). Wheat is grown under rainfed conditions on undulating hilly terrains of Ranichauri because of less availability of moisture in the form of irrigation water. Most of the areas (mid hill) of wheat are confined to rainfed conditions but with the development of high yielding input responsive varieties, the crop can be cultivated under irrigated conditions also. The early and late sowing leads to reduction in the yield; however, this variation can be minimized by sowing a variety which has relatively less reduction under both conditions. The reduction in yield under delayed sowing conditions has also been reported by Siag (2003) and Sheoran *et al.,* (2008).

Among the factors influencing wheat productivity the sowing date is of particular importance. This in turn is closely correlated with soil preparation, which has a critical effect on seed germination, moisture and nutrient availability. Hussain *et al.,* (2012) reported late sowing as one of the major causes for the low wheat productivity and they found that 58% yield was reduces under late sown conditions as compared to normal sown wheat. Interaction between the sowing dates and wheat varieties remains unexplored and there is a need to investigate the influence of this interaction on the yield attributes of wheat. Therefore, the experiment was planned with the objectives to investigate the relative performance of different varieties of wheat at varying sowing dates and to estimate the maximum profitability with least input investment in mid hills of Uttarakhand under varying climatic conditions.

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MATERIALS AND METHODS

Experimental details: A field experiment was carried out during *rabi* season of 2013-14 at "B block", College of Forestry, Ranichauri Campus, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Bharsar to evaluate the crop characteristics of wheat varieties under rainfed conditions. Hill campus Ranichauri ($30^0$18′ N latitude, $78^0$24′ E longitude and 1600 to 2200 m above MSL) located in the mid hills of Himalayas falls under cool temperate climate with an annual rainfall about 1,273 mm. Soil organic matter content of the experimental plot is 0.75-0.80% with a soil pH of 5.5-6.8. The experiment was laid out in randomized block design replicated three times with recommended dose of fertilizers NPK @ 80: 60: 30 kg/ha. Depth of fertilizer application was 5-10cm. Wheat crop was sown at the seed rate of 100 kg/ha with a row to row spacing of 20 cm. The soil of the experimental plots is silty clay loam in texture having brownish black colour. Net plot size was 4m×3m. Twenty lines per plot of seed was sown using single row hand drill at 20 cm spacing.

Measurement of soil moisture: Before sowing of the crop, soil samples were collected at a depth of 0-15 cm, 15-30 cm and 30-45 cm with the help of soil auger at periodic intervals. Different weather variables (*viz*., Rainfall, maximum and minimum temperatures) were also recorded on the same day to analyze the variability of moisture status.

Observation of crop growth parameters: Experiments were conducted with three varieties *viz*., VL-616 (V1), UP-1109 (V2) and UP-2572 (V3) as influenced by three sowing dates *viz*. 30th October (D1), 20th November (D2) and 10th December (D3). The recommended standard package and practices were followed. Periodic measurements of dry matter production (tiller, spike, ear etc.) and plant height are to be taken throughout the crop season. Measurements should be started at 15 DAS (Days after Sowing) and must be taken at 15 days interval up to physiological maturity. Five randomly selected quadrate sites were chosen per plot to record yield contributing characters.

Biological yield refers to total above ground dry matter produced by a plant in a unit land area weighed in kg/plot and finally expressed in kg/ha and Harvest Index is the ratio of economic yield to total biological yield in terms of dry matter. The dry weight was determined after drying of plant parts in an oven until constant weight. After that their dry weight was measured with the help of electric balance. At the time of maturity, yield related characters like grains per spike, thousand grain weight and productive tillers were recorded. Number of effective tillers was counted at maximum vegetative stage of the crop, while, ear bearing tillers per plot was counted at harvest stage and expressed in number of tillers/m^2. The plots of 4m×3m were harvested at maturity period and manually threshed separately to calculate the grain yield. Grain yield was recorded in kg/plot and finally expressed in kg/ha at optimum moisture content of 10-12%. Total number of grains from randomly selected ears were counted after threshing and averaged to single ear. Test weight denotes the weight of 1,000 grains of field crops. The samples were collected randomly from the cleaned grains of each plot and 1,000 grains were taken using electronic balance. Weight of grains was measured in grams and expressed as test weight.

Statistical analysis: The experimental data were analyzed by using analysis of variance (ANOVA) technique for each character as prescribed for a Randomized Block Design (RBD) having with three replications. Analysis of the data was carried out by using Fisher's analysis of variance technique and critical differences (CD) at 5% level of probability were calculated for testing the significance of difference among various treatments means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

***Effects of soil moisture*:** Periodic measurements of soil moisture and weather variables recordings of same day have been portrayed in Table 1. The results revealed that soil moisture is highly dependent on the total amount of rainfall received for the period. However, high negative correlation was observed between soil moisture and temperature. It could also be seen that in the three soil layer (0-15 cm, 15-30cm and 30-45cm), the availability of soil moisture varied from 9 to 14.5%, 11.1 to 14.9% and 10.9 to 14.7% respectively. Soil water decreases rapidly with the growth of plant especially during the later stages of the crop leading to soil moisture stress.

Yield contributing characters of wheat: The effect of sowing dates on different yield attributes in terms of number of effective tillers/m^2, number of grains/m^2, test weight etc. of all three wheat varieties selected in this study have been presented in Table 2. In this experiment, dates of sowing showed significant effects on growth and yield attributing characters during crop duration. The effect of sowing dates on all yield contributing characters was found to be significant during the *rabi* season 2013-14. It is evident from the results that the effective numbers of tillers were

Table 1
Soil moisture (%) measured at fortnightly interval during different growth stages

Date of observation	Soil moisture (%) at depthWeather parameters 0-15 (cm)	15-30 (cm)	30-45 (cm)	Rainfall (mm)	Tmax (°C)	Tmin (°C)
10.02.14	14.5	14.9	14.7	93.4	13.9	4.0
25.02.14	13.7	13.6	13.0	86.5	11.1	2.0
10.03.14	11.7	12.9	12.8	50.7	12.0	3.7
25.3.2014	13.2	13.5	13.2	81.6	15.7	6.5
10.04.14	9.7	11.4	11.2	21.0	19.3	8.8
25.04.14	9.0	11.1	11.1	32.2	19.2	9.1
10.05.14	11.1	11.6	10.9	26.4	24.5	12.9
	Correlation (r)					
SM_RAIN	0.93	0.95	0.93			
SM_Tmax	-0.63	-0.71	-0.77			
SM_Tmin	-0.67	-0.75	-0.80			
	Regression (R^2)					
SM_RAIN	0.87	0.89	0.87			
SM_Tmax	0.40	0.51	0.60			
SM_Tmin	0.45	0.56	0.64			

Where,
SM = Soil moisture
T_{max} = Maximum Temperature (°C)
T_{min} = Minimum Temperature (°C)
Rain = Rainfall (cm)

Table 2
Yield contributing characters of wheat as influenced by various treatments

Treatments	No. of effective tillers/m^2	No. of grains/ear	No. of grains/m^2	Test weight (g)
Dates of sowing				
30 October	143	37	5368	38
20 November	153	39	6151	43
10 December	147	37	5695	41
SEm ±	0.57	0.46	48.62	0.59
CD at 5%	1.70	1.4	145.75	1.8
Varieties				
VL-616	148	38	5786	42
UP-1109	150	38	5876	39
UP-2572	145	37	5552	40
SEm ±	0.56	0.46	48.62	0.59
CD at 5%	1.70	ns	145.75	1.8

Table 3
Effect of different sowing environments and varieties on grain yield, straw yield, biological yield and harvest index of wheat

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
Dates of sowing				
30 October	1880	2455	4330	43.43
20 November	2194	2372	4559	48.12
10 December	2020	2312	4328	46.70
SEm ±	27.87	23.27	32.64	0.59
CD at 5%	83.55	100	97.84	1.78
Varieties				
VL-616	1890	2295	4184	44.94
UP-1109	2090	2543	4626	45.35
UP-2572	2112	2302	4406	47.95
SEm ±	27.87	33.27	32.64	0.59
CD at 5%	83.55	100	97.84	1.78

significantly superior for the crop sown on 20th November followed by 10th December sowing, whereas number of tillers was significantly lowest for the crop sown on 30th October. Effective number of tillers decreased with early and delayed sowings. Delayed emergence of seedlings caused by low temperature and early maturity due to high temperature during reproductive stage particularly the grain filling process leads to reduced number of effective tillers in case of late sown crop (Tripathi, 2003). Crop grown on 20th November recorded significantly more number of effective tiller/m^2 (153), number of grains/ear (39), number of grains/m^2 (6151), test weight (43g) and harvest index (48.12) followed by December sowing. Maximum numbers of grains/m^2 was noticed in second date of sowing followed by third (5695) and first (5368) date of sowing. Total numbers of grains per ear head was also highest in timely sown crop as compared with late and early sown crops. Cumulative effect of reduced LAI, photosynthetic rate and period of grain filling might have reduced assimilate availability to developing grains in late sown crop resulting in lower harvest index as compared to timely sown crop. The delayed sowing caused poor vegetative growth probably due to low temperature during early vegetative stage and high temperature during reproductive stage resulting in improper grain development (Patil *et al.*, 2003). The late sown crop also performed better in terms of yield attributes over the early sown crop. The least numbers of all yield attributing characters were accounted with October sowing *i.e.* early sown crop.

The effect due to varieties was found to be significant for all yield components of the crop, except for the number of grains/ear and test weight which was found to be non-significant. Data revealed that effective number of tillers was found maximum with the variety UP-1109 which was significantly at par over VL-616 and UP-2572. The variety UP-1109 also recorded significantly more number of grains/m^2 than the variety VL-616 and UP-2572 while, significantly maximum test weight were accounted in VL-616. In addition, selection of optimum dates of sowing and varieties with maximum productivity is the principal aim of wheat cultivation in this region. The total number of effective tillers recorded under different treatments revealed that treatment D2V2 recorded maximum tillers as compared to other treatments. The treatment combinations D2V1 and D2V3 were also in subsequent orders.

Yields of wheat crop: Grain yield, straw yield and biological yield were measured carefully. The yields of wheat were significantly affected due to different dates of sowing during *rabi* season 2013-14, whereas, the effect due to varieties was also found to be significant (Table 3). The significant effects of different sowing dates and varieties might be due to the changes in weather and soil moisture conditions, especially, in temperature at the time of inflorescence and pollination that are enough to cause adverse effect on the development of spikelets due to direct affect of solar radiation on sloppy experimental land. The interaction between sowing dates and varieties was found to be significant and the highest grain yield (2,194 kg/ha) was recorded in 2nd date of sowing thereafter late (2,020 kg/ha) and early (1,880 kg/ha) sown crop. The highest straw yield was recorded in October sown crop (2,455 kg/ha) and November sown wheat crop witnessed the highest biological yield (4,559 kg/ha). Grain yield, straw yield and biological yield decreased as sowing was delayed by approximately 3-4 weeks. Similar findings of reduced yield due to delayed sowing were reported by Pal *et al.*, 2012. Delay in sowings reduced number of tillers as a result of exposure to high temperature during reproductive stage, which reduces the length of growing season thereby reducing the wheat yields. Maximum yield can be obtained when crop is sown on 20th November rather than on 30th October or 10th December. In the present experiment, wheat yield decreased by 8 and 14% due to delayed and early sowing respectively. Reduction in the yield of wheat by 27 and 52% was also illustrated by Iqbal *et al.* (2001), when wheat crop was sown on 15th and 31st December, respectively. Yield of wheat under different sowing dates was studied by Kumar *et al.* (2000) and it was observed that mid-November sown wheat have higher yield as compared to early and delayed sowing. Environmental conditions during this time favour proper seed germination and thus lead to healthy crop stand that reduces the chances of insect pests attack (Mushtaq and Saleem, 2012). Productivity of the crop is directly influenced by many growth as well as yield components. Similarly, highest straw yield (2455 kg/ha) was recorded in October sown and least in December sown crop (2312 kg/ha). The maximum biological yield (4559 kg/ha) was recorded in crop sown on 20th November, which was significantly higher followed by 30th October and 10th December sowing. The lowest grain yield, straw yield and minimum harvest index were reported from the crop sown on 30th October in case of all the varieties. However, a value of dry matter partitioning was gradually increased from first observation till the end of physiological maturity of the crop.

Performance of Varieties: It was found that there is a significant relationship between different varieties among various sowing environments. Varietal variation in the yield attributes were also recorded during the study. Wheat variety UP-2572 recorded significantly higher grain yield as compared to UP-1109 and VL-616 during timely sown conditions but it was found statistically at par under early and late sown conditions (Table 3). Due to less variability of weather conditions UP-1109 produced statistically similar grain yield during December sown, whereas it produced significantly lower grain yield during October sown. The lower grain yield of UP-2572 during October sowing was due to moisture stress as compared to rest of the varieties. Even though 1000 grain weight of timely sown VL-616 indicating the bolder seed size was significantly higher, it failed to compensate the grain losses as the number of ears per plant was less. The yield loss of VL-616 may be due to seed shattering during the adverse weather conditions. The wheat varieties, VL-616 and UP-1109 produced the taller plants as compared to UP-2572. October sown wheat variety UP-1109 produced the highest straw yield, whereas November sown UP-1109 produced the highest biological yield followed by UP-2572 and VL-616. UP-1109 and UP-2572 produced the smaller size of grains as compared to VL-616. Hence, VL-616 produced significantly bolder seeds among all the varieties as is evident from significantly higher 1000 grain weight. For different varieties, timely sown UP-1109 could accumulate highest total biological yield 4626 kg/ha, followed by late sown. Timely sown variety UP-2572 produced highest biological yield 4406 kg/ha than early and late sown. The rate of biomass production was also highest in variety UP-1109 as compared with rest of the varieties.

CONCLUSION

Suitable time for sowing of wheat crop results in higher economic yield without involving extra input as it helps varieties to express their full growth potential. Due to the large variations in the climate; delayed and early sowing decreases wheat yield by 8-14%. The response of wheat crop with different growth and yield characteristics under the agro-climatic conditions of Uttarakhand (mid hills of Western Himalayas) proved to be beneficial under crop sown on 20th November with the variety UP-2572 as the farmers can keep good harvest. Date of sowing plays a crucial role in the mid hills of Uttarakhand as compared to selection of varieties therefore, in the present experiment, sowing of wheat in the month of November yields promising results in terms of enhanced productivity of wheat. Timely sown wheat variety UP-2572 recorded highest grain yield followed by UP-1109 and VL-616.

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