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Effect of different sowing dates on growth and yield of wheat (*Triticum aestivum*) cultivars under mid hill situation of West Bengal

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ABSTRACT

A field experiment was conducted during the *rabi* 2008-09 and 2009-2010 at the Regional Research Station (Hill Zone) of Uttar Banga Krishi Viswavidyalaya, Kalimpong (1250 m amsl), to elucidate the effect of different sowing dates and cultivars on yield of wheat (*Triticum aestivum* (L.) emend Fiori & Paol.). The experiment was conducted in split plot design with 3 replications with treatments comprising five dates of sowing viz. Nov. 1, Nov. 15, Nov. 30, Dec. 15 and Dec. 30 in main plots and 6 different wheat cultivar viz. 'HS 473', HPW 236, 'VL 875', 'HS 365', 'VL 832', 'PBW 343' and 'SKW 196' in sub-plots. Sowing on November 15, significantly influenced most yield attributes and was at par with November 30 sowing, but significantly superior to later sowings. The highest grain yield was obtained with November 15 sowing (2.79 and 2.49 t/ha), which was at par with November 30, and November 1 sowings in first year and in second year this was statistically similar with all date of sowing except extreme late sown condition. Sowing in mid November gave 14.9 and 26.2% more grain yield over December 30 sowing. Amongst the cultivars, 'HS 473' was found to be best and gave significantly more grain yield than 'HS 365' (2.93 and 2.74 t/ha) and was at par with 'VL 875' (2.86 and 2.50 t/ha) and 'PBW 343' (2.89 and 2.61 t/ha). More biomass production was recorded with early November 15 sowing, which was at par with November 30 sowing. Within the cultivars, maximum biomass production was recorded with 'HS 473' (7.78 and 7.28 t/ha) and was statistically at par with 'VL 875', ''SKW 196'' and 'PBW 343'. Uptake of NPK was most with 'PBW 343', which was at par with 'HS 473'. Maximum net return (₹ 24,926 and 23,192/ha, respectively) recorded with November 15 sowing, followed by November 30 sowing. This treatment also recorded higher B: C ratio (2.11 and 2.03, respectively). Amongst cultivars, maximum net return (26,986 and 24,368/ha) and B: **C** ratio (2.21 and 2.08) was recorded with cultivar 'HS 473' followed by 'PBW 343' and ''SKW 196''.

Key words : Economics, N-uptake, Productivity, Sowing date, Wheat genotypes

Wheat is cultivated under diverse agro-climatic situations (500 m to 2,200 m amsl) in eastern Himalaya during the *rabi* season in the low to high hill regions and during summer in the dry, temperate areas. Yield potential of wheat in north eastern Himalaya is not being exploited fully due to many factors, among which use of improper sowing date and low yielding varieties are the most important ones. The north eastern hills contribute about 1.9% of the total production of wheat in the country. The productivity of wheat in the region is around 1.3 t/ha, as compared to the national average of 2.7 t/ha (Mukherjee, 2008). Around 90 % of the wheat in the region is cultivated under rainfed condition, while irrigated area is only 4%. Comparatively cooler season and long crop duration in this zone provides congenial condition to achieve fairly good yield. Despite this, wheat productivity in the region, is quite low as compared with the national average. Most of the wheat, which is sown in this region, is late sown. Date of planting plays an important role in productivity of wheat. Drastic reduction in yield of wheat has been recorded with the delay of sowing beyond optimum time. It has been estimated that delay in sowing of wheat beyond 15 December, resulted in yield reduction of 50 kg grain/day/ha (Singh *et al*., 2001). Late sown wheat is exposed to both the extreme of temperature *i.e.* low temperature during early growth period, which restrict the vegetative phase and high temperature during post anthesis period, which reduce the duration of grain development and consequently the grain yield. Therefore, an experiment was planned to find out optimum date of sowing for different varieties of wheat for the condition prevailing in eastern Himalaya.

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MATERIALS AND METHODS

The experiment was conducted during the winter season of 2008-09 and 2009-10 at Regional Research Station (Hill Zone) under the aegis of Uttar Banga Krishi Viswavidyalay, Kalimpong with an altitude of 1250 m amsl. The soil was sandy loam in texture, high in organic carbon (0.73%), available N (221.5 kg/ha), but low in available P (9.9 kg/ha) and available K (79 kg/ha) and had pH 5.2. The total rainfall recorded during crop growth period was 16.3 and 12.5 mm, minimum temperature ranged from 1.3 to 12.6 and 2.7 to 14.3, and maximum temperature 19.2 to 29.3 and 17.8 to 32.6^0 C during winter 2008-09 and 2009-10, respectively. The experiment was laid out in split plot design with three replications with treatments, comprising five dates of sowing *viz.* November 1, November 15, November 30, Decemberm15 and December 30 in main plots and 6 wheat cultivar *viz.* 'HS 473', HPW 236, 'VL 875', 'HS 365', 'VL 832', 'PBW 343' and 'SKW 196' in sub-plots. Wheat varieties were sown in rows 20 cm apart as per treatment scheduled. The crop received full dose of P (25.8 kg/ha) and K (33.3 kg/ha) and half dose of nitrogen (60 kg/ha) as basal 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. Pre-emergence application of isoproturon was given 2 days after sowing followed by one hand weeding at 30 DAS for complete check of weed during critical period of crop-weed competition. Other management practices were adopted as per recommendations of the crop under irrigated condition. The crop was harvested on April 19 in 2009 and April 26 in 2010. Data on growth, yield components and yield were recorded as per normal procedure. Crop sample were analyzed for uptake of nitrogen, phosphorus and potash as per standard laboratory procedures. For working out the economics, prevailing market prices for wheat (11.50/kg), urea (8.75/kg), SSP (12.60/kg), MOP (6.75/kg) and cost of labour (82.50 /day) were considered.

RESULTS AND DISCUSSION

Growth characters

Significant differences were exhibited with date of sowing and cultivars on growth characters (Table 1). Date of sowing significantly influenced the growth characters viz. plant height and dry matter accumulation at harvesting stage. Plant height was significantly more with mid November sowing than rest of the sowing dates, and was followed by late November sowing. This corroborates the findings of Tahir *et al*., 2009. Dry matter accumulation varied significantly. Maximum dry matter was recorded with November 15, and was at par with November 30, sowing. Further, December 15, sowing also produced significant response in dry matter production than November 1, and December 30, in first year only, and showed parity with November 30, sowing. Dry matter accumulation was 33.2 and 62.4 % less over November 15, with extreme late sowing (December 30). Decrease in plant height and dry matter accumulation in late sowing was due to shorter growing period. These results are in line with those reported by Shahzad *et al*., (2002).

Wheat cultivars showed significant difference for plant height and dry matter accumulation. In the first year tallest plants was recorded with HPW 236 and was at par with 'VL 875'. However, in the second year 'HS 473' produced tallest plants, significantly superior than all other tested cultivars. Differences in plant height among varieties might be attributed to their genetic diversity. These results are similar to those of Mishra (2006). Maximum dry matter accumulation (g/plant) at harvest was recorded in 'HS 473' during first year, while in second year 'HS 365' produced more dry weight, and significantly superior to rest of the tested cultivars under mid hill condition.

Yield attributes and yield

All yield attributes were significantly affected by the date of sowing. Delayed sowing decreased grains/ear, effective tiller /m^2 and 1,000-grain weight. Effective tillers, considered as the most important yield determinant varied significantly under different date of sowing. Sowing at November 15, significantly influenced the entire yield attributing character and was statistically at par with November 30 sowing, and significantly better to other dates of sowing. Analysis revealed that 49.2 and 41.6 % more effective tiller/m^2 with November 15 sowing in the first and second year, respectively, over December, 30 sowing. Late sowing of wheat significantly produced poor yield attributes during both the years. This might be due to decrease in temperature in late sown condition which reduces cell division and cell expansion. Reduced cell expansion also carries a primary effect on meristematic development of yield components, such as the inflorescence or the tiller initials in the wheat leading to potentially small reproductive organs and reduced yield (Akhthar *et al*., 2002). Further, data revealed that grains/ear, ear length and grain weight/spike was maximum with November 15 sowing and was at par with November 30 sowing. Less number of grains/spike in late sowing was due to less production of photosynthates due to shorter growing period. These results are in line with those of Shahzad *et al*., 2002. Date of sowing significantly affected the test weight only in first year of experiment, when delay in sowing gave least test weight compared to early sowings. The reduction

Table 1. Effect of date of sowing and cultivars on growth and yield attributing characters of wheat (2008-09 and 2009-10).

Treatment	Plant height (cm)		Dry matter (g/plant)		Effective tillers/m² (No)		Grain/ear (No)		Ear length (cm)		Grain weight/ spike (g)		1,000-grain weight (g)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Date of Sowing														
November 1	72.8	77.6	3.43	4.64	243	258	44.3	35.6	8.3	8.7	1.50	1.32	41.2	40.2
November 15	84.3	89.4	5.45	6.92	310	301	46.0	49.6	9.2	8.9	1.92	1.81	42.9	41.7
November 30	78.6	81.0	4.21	4.94	287	286	44.4	48.0	9.0	9.8	1.70	1.59	42.1	41.3
December 15	68.9	78.3	4.90	2.62	290	256	42.0	39.4	8.6	8.2	1.62	1.22	41.1	40.2
December 30	58.9	55.6	3.62	2.31	208	214	36.7	38.9	8.1	7.6	0.96	1.28	39.9	40.3
SEm±	1.5	0.8	0.4	0.8	8.7	10.7	0.8	1.8	0.2	0.4	0.06	0.12	0.4	0.2
CD (P=0.05)	4.5	2.2	1.2	2.0	26	30	2.1	4.9	0.7	1.3	0.21	0.36	1.0	NS
Cultivars														
'HS 473'	81.2	89.5	5.01	3.93	311	305	56.1	45.1	9.4	8.6	1.80	1.80	43.3	43.1
HPW 236	87.9	82.9	4.25	3.91	288	302	45.5	46.7	8.9	9.0	1.71	1.45	41.9	40.4
'VL 875'	84.2	81.1	4.61	4.65	262	283	45.3	43.2	8.7	9.5	1.68	1.78	41.3	42.3
'HS 365'	81.3	79.6	3.75	5.9	219	246	39.1	42.6	8.5	7.2	1.42	1.56	40.3	41.4
'VL 832'	78.6	83.1	4.31	4.04	254	216	44.1	39.8	9.2	8.3	1.66	1.48	42.6	40.7
'SKW 196'	73.6	82.6	4.18	3.91	249	286	47.1	44.1	9.1	8.5	1.69	1.72	42.9	43.0
'PBW 343'	80.3	79.0	4.66	4.94	290	291	51.3	41.3	9.6	9.2	1.37	1.54	40.2	39.6
SEm±	1.5	0.9	0.1	0.1	7.4	9.4	0.6	1.0	0.2	0.3	0.08	0.04	0.9	0.6
CD (P=0.05)	4.6	2.3	0.3	0.4	21.0	27	1.6	2.8	0.5	1.0	0.26	0.13	2.6	2.0

in test weight due to delay in sowing was mainly due to reduction in growth period and shriveling of grain due to winds prevailed during milk and grain filling stage. Sharma and Chakor (1993) also recorded similar results.

Various cultivars showed significant variation for different yield attributes characters. Effective tillers/m² was the highest with 'HS 473' and was at par with 'PBW 343' and 'SKW 196', during both the years of experiment, but significantly higher compared to 'VL 875', 'HS 365' and 'VL 832'. Differences in number of tillers/m² among varieties might be attributed to their genetic diversity (Akhthar *et al*., 2002)

The grains/ear was more with 'HS 473' and was significantly superior to all other tested cultivars. However, the ear length was maximum with 'PBW 343' and significantly better compared to other variety except 'HS 473' and 'SKW 196' in first year of experiment only. The grain weight/spike was the highest in 'HS 473' and showed distinct parity with 'SKW 196'. The test weight was the highest with 'HS 473' but was at par with other cultivers.

The significant difference in grain as well as biological yield was recorded with the different date of sowing and varieties in mid hill situation (Table 2). Grain yield is a function of various yields attributing factor and maximum grain yield was obtained with November 15 sowing, which was at par with November 30 sowing in first year and in second year this was statistically similar with all date of sowing except extreme late sown condition *i.e.* December, 30. This accrued mainly because of more dry matter accumulation and yield attributing characters. Sowing in mid November gave 27.6 and 26.2 % more grain yield over the December 30 sowing. This corroborate with the finding of Akhtar *et al* (2002). Cultivar performance in wheat varies with time of sowing, which is contingent on the time of seasonal break in rainfed agriculture. Among the cultivar, 'HS 473' was found to be best because of maximum value of yield attributing characters and gave significantly more grain yield (2.93 and 2.74 t/ha), and was at par with 'VL 875' (2.86 and 2.50 t/ha) and 'PBW 343' (2.89 and 2.61 t/ha) in first year and in second year its showed parity with 'PBW 343', 'SKW 196' and 'VL 875', whereas, 'HS 365' produced significantly lower grain yield than all other cultivars under trial. 'HS 473' recorded 31.7 and 20.9 % more grain yield over the genotype 'HS 365', which produced lowest grain yield amongst all tested cultivars.

Biomass production showed significant variation

with date of sowing and cultivars (Table 2). All the date of sowing had showed its impact on total biomass production. The maximum biomass production recorded with November 15 and was at par with November 30 sowing in the second year only. Within the cultivars, maximum biomass production was recorded with 'HS 473' (7.78 and 7.28 t/ha) and was at par with 'VL 875', 'SKW 196' and 'PBW 343' and significantly better to other varieties. Lowest biomass amongst the variety was recorded with 'HS 365' (2.00 and 2.17 t/ha) which was followed by 'HPW 236' (2.28 and 2.09 t/ha).

Harvest index was significant only in the first year of experiment. Maximum harvest index was recorded with November 15 sowing, and was at par with November 30 and November 1 sowing, and significantly superior to other date of sowing. Among the cultivars, maximum harvest index was recorded with 'VL 832' and was at par with all the cultivars except 'HS 365' in the first year, however in second year no significant difference was found. Deswal *et al.* (1996) also reported similar genotypic variation in yield and harvest index.

Economics

Net returns of 24,926 and 23,192 was maximum with November, 15 sowing followed by late November sowing 22,699 and 21,681/ha for two years respectively. This treatment also recorded higher benefit:cost ratio of 2.11 and 2.03, respectively for the year 2009 and 2010 compared to all other treatments (Table 2). Amongst all varietal treatments, maximum net return (26,986 and 24,368/ha) and benefit:cost ratio (2.21 and 2.08) was recorded with cultivar 'HS 473' followed by 'PBW 343' and 'SKW 196'.

Nutrient uptake

Total nutrient uptake pattern is directly related to growth and yield pattern of plant. Nutrient uptake pattern varied distinctly with various treatments and produced significant response with date of sowing and cultivars (Table 3). Among all sowing date, maximum uptake of nitrogen was with mid November sowing in first year and in second year this was at statistically similar with November 30 sowing. This was might be due to higher biomass production per unit area (Deswal *et al.,* 1996). Uptake of phosphorus and potassium was highest with mid sowing and showed parity in response with end of November sowing. Further, observation showed that maximum potassium mining was recorded by mid November sowing and significantly superior to rest of sowing dates during both the years of observation.

Amongst cultivars, maximum uptake of nitrogen was recorded with 'HS 473' and was at par with 'PBW 343', 'SKW 196' in first year, and in second year this was at par with 'HPW 236', 'VL 875' and 'PBW 343'. Phosphorus uptake was more with 'HS 473' and was statistically similar with 'PBW 343', 'VL 875', 'HPW 236' in first year and in second year this was at par with 'SKW 196', 'VL 832' and 'PBW 343', and significantly superior to other cultivars. Further studied reveled that maximum potassium

Table 2. Effect of date of sowing and cultivars on wheat yield, biological yield, harvest index and economics (2008-09 and 2009-10).

Treatment	Grain yield (t/ha)		Biological yield (t/ha)		Harvest index (%)		Net return (× 10^3₹/ha)		Benefit : cost ratio	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Date of Sowing										
November 1	2.35	2.19	6.02	5.57	40.1	39.3	20.1	18.3	1.89	1.81
November 15	2.79	2.49	6.81	6.35	41.0	39.3	24.9	23.1	2.11	2.03
November 30	2.50	2.40	6.41	6.00	40.3	36.4	22.6	21.6	2.01	1.96
December 15	2.28	2.13	6.01	5.49	38.1	39.2	21.3	19.8	1.94	1.88
December 30	2.02	1.84	5.93	5.03	35.1	36.9	17.1	15.3	1.76	1.68
SEm±	0.13	0.15	0.38	0.18	0.4	1.3				
CD (P=0.05)	0.40	0.41	NS*	0.50	1.1	NS				
Cultivars										
'HS 473'	2.93	2.74	7.77	7.28	38.0	37.8	26.9	24.3	2.21	2.08
HPW 236	2.28	2.09	5.92	5.69	38.1	36.8	21.4	19.3	1.95	1.86
'VL 875'	2.86	2.50	7.40	6.89	38.8	36.3	23.1	22.1	2.03	1.94
'HS 365'	2.00	2.17	5.86	6.03	34.1	36.0	17.9	19.1	1.80	1.85
'VL 832'	2.59	2.30	6.39	6.14	41.1	37.5	23.0	20.1	2.03	1.90
'SKW 196'	2.51	2.46	7.16	6.44	35.8	38.9	22.6	21.9	2.00	1.98
'PBW 343'	2.89	2.61	7.63	6.99	38.0	37.8	24.8	22.8	2.10	2.01
SEm±	0.10	0.14	0.39	0.28	0.8	1.0				
CD (P=0.05)	0.31	0.42	1.06	0.81	2.1	NS				

NS* = Non significant

Table 3. Nutrient uptake pattern as influenced by different treatments (2009 and 2010)

Treatment	Nutrient uptake (kg/ha)					
	N		P		K	
	2009	2010	2009	2010	2009	2010
Date of Sowing						
November, 1	135.0	124.5	18.1	20.9	145.1	139.8
November, 15	153.9	149.2	24.6	23.1	181.3	164.8
November, 30	142.8	135.4	23.8	21.8	154.9	145.6
December, 15	132.9	113.3	21.3	18.4	136.9	121.3
December, 30	109.3	102.9	19.9	16.1	138.4	119.8
SEm±	4.7	6.0	1.2	1.0	7.9	6.0
CD (P=0.05)	14.8	18.7	3.9	3.1	22.8	16.9
Cultivars						
'HS 473'	168.1	142.0	23.0	22.4	256.4	271.3
HPW 236	139.7	128.9	21.0	18.5	256.3	241.9
'VL 875'	142.9	136.4	22.9	20.1	223.0	259.9
'HS 365'	119.2	122.0	18.3	21.1	206.3	213.6
'VL 832'	158.6	121.5	20.8	19.9	230.3	242.3
'SKW 196'	149.9	123.6	20.0	21.9	214.3	261.6
PBW 343	165.8	159.1	23.5	22.4	265.3	287.1
SEm±	6.9	6.3	0.7	0.4	12.0	10.2
CD (P=0.05)	21.3	17.1	2.1	1.9	36.9	31.3

uptake was with PBW 343 and was significant with 'HPW 236', 'HS 473', 'VL 832' in first year and with 'HS 473', 'VL 875', 'SKW 196' in second year.

Based on the study of wheat November 25, sowing and cultivar 'HS 473' recommended for mid-hill situation of West Bengal.

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