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Response of wheat (*Triticum aestivum*) genotypes under varying fertility levels in alpine climate of lahaul valley in western Himalaya

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Abstract

A field experiment was conducted at Research Farm of Directorate of Wheat Research, Regional Station, Dalang Maidan (Wheat Summer Nursery) Lahaul & Spiti, Himachal Pradesh during the summer seasons (May to October) of year 2009 and 2010 to identify the most suitable genotypes for cultivation in alpine climate of Western Himalyas with two levels of fertility and seventeen wheat genotypes in a split plot design. Application of recommended dose of fertilizers (RDF) recorded significantly higher values of yield attributes and yield compared to application of half dose of the recommended fertilizers. Wheat genotype 'HPW 89' was superior to other 16 genotypes with significantly high grain yield 47.17 and 45.87 q/ha during the year 2009 and 2010 respectively, at recommended dose whereas 31.60 & 31.73 q/ha in the first and the second year respectively at half of the recommended dose. The other superior genotypes were 'VL 892', 'HPW 251', 'VL 829' under RDF and 'HS 295', 'HPW 211', 'HPW 236' under half of the RDF.

Keywords: Alpine climate, wheat genotypes, fertility level, growth and grain attributes, productivity

Introduction

Due to peculiar geographical and agro-ecological nature of the Western Himalayan region, food security at local level is utmost important for the region, particularly during winter months. There is only one cropping season (April to October) and crops cannot be grown from November to March as the whole area remains covered with snow and experiences temperatures below 0°C. In this region, a number of crops are cultivated but there is limited previous documentation available on the performance of wheat genotypes. The irrigated fields of Lahaul Valley provide a yielding and relatively stable environment for wheat production during the summer season. Farmers in the region were growing wheat until the early 1980s before switching to potato, off season pea and other exotic vegetables like lettuce, broccoli etc. The shift from wheat to other crops might have been due to non availability of high yielding wheat cultivars. Moreover the cultivation of wheat crop in Lahaul & Spiti valley is mainly done using traditional local wheat varieties which are low yielding and susceptible to rust diseases. This could also be one of the reasons which contributed to significant reduction in the area under wheat cultivation. Hence, identification and introduction of improved high yielding varieties is the need of hour to meet the local demand of the wheat, which is otherwise imported from plains at substantial cost to the environment in terms of green house gas emission during the transport. Studies investigated that wheat yield was influenced by cultivar diversity, fertilizers, soil quality and varied weather conditions (Barkley and Nalley, 2007). An increase in yield for spring wheat over the last five decades has been attributed to a combination of genetic changes, agronomic management and climatic conditions (McCaig and DePauw, 1995). Wheat cultivars often show highly significant genotype by environment interaction for yield, even when comparing different years within a relatively stable location. Wheat is one of the most widely adapted crop tolerate extremes of temperature from –35 °C (Haji and Hunt, 1999) to over 40 °C (Elahmadi, 1994). Fischer (1985) showed that bread wheat yield is most sensitive to environmental conditions during the rapid spike growth stage. Such adaptability reflects the diversity of the wheat genome, and it follows that when comparing different genotypes, their interaction with environment is often highly significant. Therefore, the investigation was undertaken with the objective to evaluate the response of wheat genotypes to identify the suitable wheat varieties for cultivation under low and high fertility conditions of Western Himalyas.

Materials and Methods

Field experiment was conducted at the Research Farm of Directorate of Wheat Research, Regional Station, Dalang Maidan (Wheat Summer Nursery) Lahaul and Spiti, Himachal Pradesh during summer seasons of 2009 and 2010 (May to October) in split plot design with three replications. Main plots had two fertility levels (recommended NPK fertilizer dose 125 kg N/ha, 60 kg P_2O_5/ha, 30 kg K_2O/ha and half of the recommended dose of N:P:K *i.e* 62.5:30:15 kg/ha) and sub-plots with seventeen wheat genotypes (HPW 42, HPW 89, HPW 251, HPW 249, HPW 147, HPW 184, HPW 155, HPW 211, HPW 236, VL 616, VL 829, VL 892, HS 240, HS 295, HS 420, HS 490 and PBW 343) recommended for northern hill zone of India. The station is located at latitude of approximately 32° 21' N and 77° 14' longitude and at an altitude of about 3300 m (10000 ft) above from the mean sea level. For laboratory analysis, a composite soil sample was taken by mixing of ten sub-samples which were drawn randomly from the experimental field before sowing. The soil samples were analyzed for various physico-chemical characteristics. The soil of the experimental area was sandy loam in texture, rich in organic carbon (0.97%) and neutral

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in reaction (pH 7.36). EC of the soil was 0.25 dS/m. The soil had available nitrogen 530 kg/ha, phosphorus 40 kg/ha and potassium 180 kg/ha. The mean temperature in the valley varies from 8.2 to 22.7°C during the season (Fig. 1). The maximum mean temperature during the season was recorded in the month of August, whereas minimum in the months of April and October during both the years of experiment. The relative humidity was varying from 43.3 to 56.2 per cent. The tested genotypes were evaluated for growth, yield attributing characters and yield. The trial was conducted under irrigated conditions and all the agronomic practices and plant protection measures were followed as per standard recommendations. The data for the two years were statistically analyzed using analysis of variance. Significance levels were calculated at 0.05 level of probability unless otherwise stated.

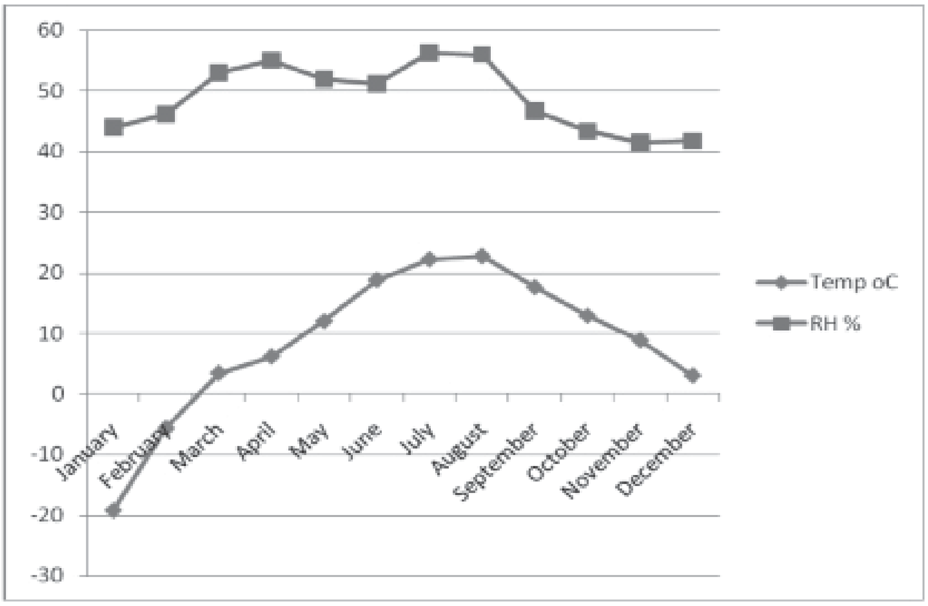

Fig. 1. Climatic pattern of Lahaul Valley as recorded at station (Mean of year 2009 and 2010)

Results and Discussion

Effect on growth and yield attributes

Plant height of the wheat genotypes remained statistically similar under both the fertility levels for both the years of study. The different genotypes did not differ significantly among themselves for plant height during both the years (Table 1). Perusal of data pertaining to earhead per square meter revealed that there was significant improvement in earhead per square meter under recommended dose of fertilizers as compared to half of recommended dose of fertilizers. Genotypes also differ significantly for their tillering behavior. Genotype HPW 89 in year 2009 and HS 295 in year 2010 recorded the highest number of earheads per square meter and were significantly higher than genotypes HPW 42, PBW 343, HPW 155 and VL 829 but at par with rest of genotypes. Verma and Pandey (2007) also recorded similar observations while working on fertility levels and spring wheat genotypes.

Significantly higher grains per earhead were recorded with recommended dose of fertilizers compared to 50 per cent of recommended dose during the year 2010 but during cropping season 2009, the increase in grains per earhead could not reach to the level of significance. The improvement in grains per earhead due to increase in fertility levels might be attributed to better growth and development of crop plants which led to more efficient source and sink relation, resulting in setting of more grains and their better filling. Among the genotypes HPW 89 recorded the highest grains per earhead during both the years of study (Table 1) and was found significantly superior to rest of the genotypes except VL829 being at par. The findings are in corroboration with the findings of Pandey *et al.,* (2007).

Grain weight showed significant improvement with higher fertility levels compared to lower fertility levels in the year 2009 but during year 2010, remained statistically similar under both the fertility levels. Higher fertility level might have led to better grain filling resulting in bolder grains as also reported by Verma and Pandey (2007). Majority of the genotypes showed higher 1000 grain weight and were at par among themselves during both the years of study (Table 1). Except genotype HPW 236 which recorded significantly lower 1000 grain weight. This may be attributed to its genetic characters (Pandey *et al.,* 2007).

Effect on yield

The grain yield of wheat genotypes was significantly influenced by the fertility levels in the prevailing climate (Table 2). Grain yield was recorded significantly higher with recommended fertilizer doses compared to half of recommended fertilizer dose in both the years of study as well as on pooled basis. This might be attributed to better growth and yield attributing character under higher fertility level. These findings are in corroboration with the findings of Frant and Bujak (2007) and Pardeshi *et al.* (2009).

As far as genotypes are concerned 'HPW 89' produced the highest (39.26 q/ha) grain yield during both the years of study as well as on pooled basis. This genotype was found significantly superior to rest of the genotypes. The other superior varieties were 'HPW 257', 'VL 829', 'HS 490' and 'HPW 249' which gave significantly higher grain yield than rest of the genotypes. The interaction effect for yield between genotypes and fertility levels was found significant during both the years of study (Table 2). During the year 2009, genotype 'HS 295' produced statistically similar yield under both the fertility levels and during the year 2010 genotype 'HPW 211' and 'HPW 236' recorded statistically similar yield under both the fertility levels indicating their lower nutrient requirement as compared to rest of the genotypes. Pandey *et al.* (2007) and Verma and Pandey (2007) also reported differential yield potential of the spring wheat genotypes under varying fertility levels.

Table 1. Effect of fertility levels on growth and yield attributes of different wheat genotypes in alpine conditions of high altitude Western Himalaya

Treatments	Plant height		Earhead/M^2		Grains/earhead		1000 grain weight	
	2009	2010	2009	2010	2009	2010	2009	2010
Recommended dose of N, P &K	72	73	216	210	38	40	39.61	38.77
50 % of Recommended dose of N, P & K	71	73	177	171	35	38	38.32	38.77
S.Em	1	1	2	2	1	1	0.14	0.08
CD (P=0.05)	NS	NS	14	13	NS	2	0.87	NS
Genotypes								
HPW 42	70	74	181	178	30	29	39.40	38.03
HPW89	70	74	210	191	46	48	40.28	40.52
HPW251	70	72	205	199	43	43	38.52	40.48
HPW249	73	71	204	199	40	45	39.63	39.80
HPW147	72	72	201	193	37	41	37.28	37.65
HPW184	72	74	196	194	38	39	38.33	38.75
HPW155	71	73	193	190	33	38	37.27	36.98
HPW211	73	72	195	183	32	37	37.85	37.17
HPW236	73	73	193	193	34	33	34.82	36.55
VL616	73	72	204	199	35	37	38.27	38.72
VL829	73	73	201	187	43	45	39.35	39.80
VL892	73	74	205	181	36	46	41.75	39.45
HS240	73	74	206	197	39	39	38.20	39.93
HS295	70	73	200	201	39	40	38.42	36.49
HS420	72	75	199	192	28	32	40.65	40.36
HS490	73	74	194	189	39	45	41.28	39.03
PBW343	69	74	165	178	27	30	41.05	39.38
SE(m)	1	1	2	5	1	1	0.60	0.46
CD (P=0.05)	NS	NS	6	13	3	3	1.70	1.29

Table 2. Interaction effect of fertility levels and genotypes on productivity (q/ha) of wheat in alpine climate of Western Himalaya

Treatments	Fertility Levels								
	2009			2010			Pooled		
Genotypes	Rec	50% of Rec	Mean	Rec	50% of Rec	Mean	Rec	50% of Rec	Mean
HPW 42	23.85	18.95	21.40	24.19	18.14	21.17	24.02	18.55	21.28
HPW89	47.17	31.60	39.39	45.87	31.73	38.80	46.52	31.67	39.09
HPW251	36.62	30.94	33.78	36.89	32.65	34.77	36.76	31.79	34.27
HPW249	36.42	28.21	32.32	38.49	29.40	33.95	37.46	28.81	33.13
HPW147	34.64	21.60	28.12	36.18	24.82	30.50	35.41	23.21	29.31
HPW184	32.39	24.88	28.64	33.05	25.92	29.49	32.72	25.40	29.06
HPW155	27.79	19.51	23.65	28.13	24.56	26.35	27.96	22.03	25.00
HPW211	24.62	21.98	23.30	25.62	24.25	24.94	25.12	23.12	24.12
HPW236	24.76	20.50	22.63	23.96	21.68	22.82	24.36	21.09	22.73
VL616	34.26	21.64	27.95	34.80	21.90	28.35	34.53	21.77	28.15
VL829	37.64	30.49	34.06	37.95	30.03	33.99	37.79	30.26	34.03
VL892	37.55	25.10	31.33	39.05	27.57	33.31	38.30	26.34	32.32
HS240	40.53	22.29	31.41	39.01	22.76	30.88	39.77	22.53	31.15
HS295	29.76	29.47	29.62	32.30	26.38	29.34	31.03	27.93	29.48
HS420	27.11	18.90	23.00	27.87	22.32	25.10	27.49	20.61	24.05
HS490	36.78	26.84	31.81	39.45	27.29	33.37	38.12	27.07	32.59
PBW343	20.15	16.98	18.57	23.82	17.91	20.87	21.99	17.44	19.72
Mean	32.47	24.11	28.29	33.33	25.26	29.30	32.90	24.68	28.79
	Fertility levels (A)	Genotypes (B)	AxB	Fertility levels (A)	Genotypes (B)	AxB	Fertility levels (A)	Genotypes (B)	AxB
SE(m)	0.30	0.69	0.90	0.21	0.70	0.91	0.10	0.46	0.60
CD (P=0.05)	1.82	1.94	2.74	1.28	1.97	2.78	0.63	1.29	1.82

* Rec. = Recommended dose of N, P & K (125 kg N/ha, 60 kg P_2O_5/ha, 30 kg K_2O/ha)

On the basis of two years study it can be concluded that improved genotypes respond the applied fertilizers and higher yield potential of wheat genotypes can be realized with application of 125 kg N/ha, 60 kg P_2O_5/ha and 30 kg K_2O/ha. The best suited genotype was found 'HPW 89' followed by 'VL 892', 'HPW 251' and 'VL 829'. Under low fertility conditions genotypes 'HS 295', 'HPW 211' and 'HPW 236' can be grown in alpine conditions of Lahaul & Spiti Valley of Himalyan region.

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