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PERFORMANCE ANALYSIS OF SPRING WHEAT GENOTYPES UNDER RAIN-FED CONDITIONS IN WARM HUMID ENVIRONMENT OF NEPAL

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Abstract

Around 25% of total wheat area in Terai of Nepal falls under rain-fed and partially irrigated condition. A Coordinated varietal trial (CVT) was conducted during two consecutive crop cycles (2011-12 and 2012-13) under timely sown rain-fed conditions of Terai. The trial was conducted in Alpha Lattice design with two replications at Nepal Agricultural Research Council, National Wheat Research Program, Bhairahawa and Nepal Agricultural Research Council, Regional Agriculture Research Station, Nepalgunj. Observations were recorded for yield and yield traits and analyzed using statistical software Cropstat 7.2.The combined analysis of coordinated varietal trial showed that BL 3978 possessed the highest yield (2469.2 Kg ha^{-1}) followed by NL 1097 (2373.2 Kg ha^{-1}) and NL 1094 (2334.06 Kg ha^{-1}). Genotype x Environment interaction for grain yield was significant ($p<0.05$) over locations and years. BL 3978 with early maturity (111 days) escaped the heat stress environment. Among the top three genotypes, BL 3978 was consistently higher in both favorable and unfavorable conditions. Earliness was one of the major traits for heat tolerant genotypes. The three identified genotypes will be further evaluated in participatory varietal selection or coordinated farmers field trial followed by small plot seed multiplication (seed increase) and release in the future for timely sown rain-fed conditions. These lines also appear suitable for inclusion in crossing program targeted for water stress tolerance variety development.

Keywords: Spring wheat, Rain-fed conditions, Genotype× environment interaction.

Introduction

To keep pace with global population growth and food consumption patterns, future global food security will require agricultural production in 2050 to be 60% more than it was in 2010 (Alexandratos and Bruinsma, 2012). One promising pathway for increasing grain production is by bridging the gap between yields currently achieved on farms and those that can be achieved by using the best adapted crop cultivars and production practices (Van Ittersum et al., 2013).

A slight decrease in the rainfall and increase in temperature will have a negative impact in cereals yield, which is a matter of great interest (Bhandari, 2013). Rainfall is one of the most important factors for the growth of cereals. Environmental stresses affect gene expression and cellular metabolism (Lawlor, 2002). Major strategy of plants under stress conditions is decreasing the harmful effects caused by stresses (Sankar et al., 2007). Water stress affects complex of physiological/biochemical pathways, which are engaged in metabolism of proteins, carbohydrates, lipids, hormones, effective minerals, free radicals and nucleic acids and also is related with the many stresses like salinity stress and cold stress (Flexas et al., 2007).

Multienvironment yield trails (MET) are important in estimation of genotype by environment interaction (GEI) and identification of superior genotypes in the final selection cycles (Kaya et al., 2006 and Mitrovic et al., 2012).

Globally, about 37% of wheat growing areas are semi-arid in which available limited soil moisture constitutes a major problem in wheat production. Inadequate water results poor growth and reduced yield (Bhandari, 2013). Rainfed conditions provide the selection environment for drought tolerance. Around 22% of wheat area in Terai falls under rainfed and partially irrigated condition (ABPSD, 2013). Bhrikuti variety (1994), Aditya & NL 971 varieties (2009) & Vijay varieties (2010) are released as an option for rainfed conditions (Annual Report, 2012/13). This reflects the choice is limited. This research was conducted with an objective to develop superior wheat genotypes under rain-fed environment of warm humid environment of Nepal.

Materials and Methods

The experiments were conducted in two locations (Bhairahawa and Nepalgunj), as coordinated varietal trial for Terai, Tars and lower valleys, Nepal, under rainfed conditions during two consecutive years (2011/12 and 2012/13). The experiment material consisted of eight spring wheat genotypes (Table 1). In both years, the wheat genotypes were sown on 4^{th} December. The trials were set up in alpha lattice design with two replications. The plot size was 10 rows of 4 m long and 25 cm spacing. Fertilizer application with60:30:25 NPK Kg ha^{-1}. Weed management was done 35 days after sowing. Irrigation was not given as the trial was under rain-fed condition.

Table 1.The genotypes used in the study

Genotypes	Cross
NL 1140	WAXWING*2/VIVITSI
BL 3978	NL729/BL2015
NL 1094	KAUZ//ALTER84/AOS/3/PASTOR/4/TILHI
NL 1143	WHEAR/VIVITSI/3/C80.1/3*BATAVIA//2*WBLL1
NL 1093	WBLL1*2/TUKURU
NL 1097	REH/HARE//2*BCN/3/CROC-1/AE.SQU(213)
BHRIKUTI	BOW"S"/GH"S"
NL 1135	PF74354//LD/ALD/4/2*BR12*2/3/

Temperature and rainfall information of Bhairahawa and Nepalgunj during the crop period, are mentioned below in Figure 1and Figure 2, respectively.

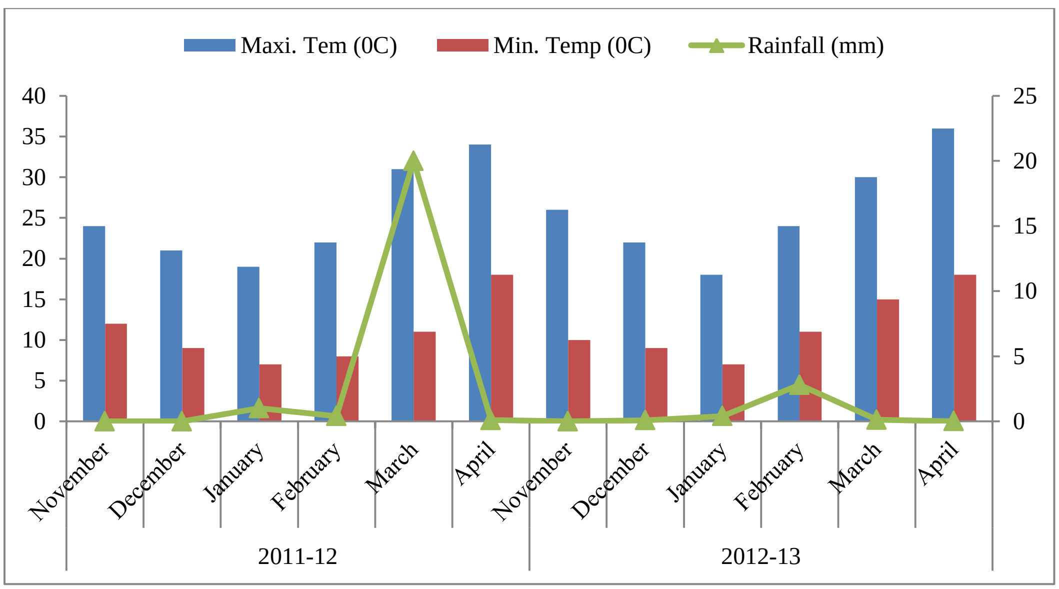

Figure 1. Meteorological information of Bhairahawa (2011-2013)

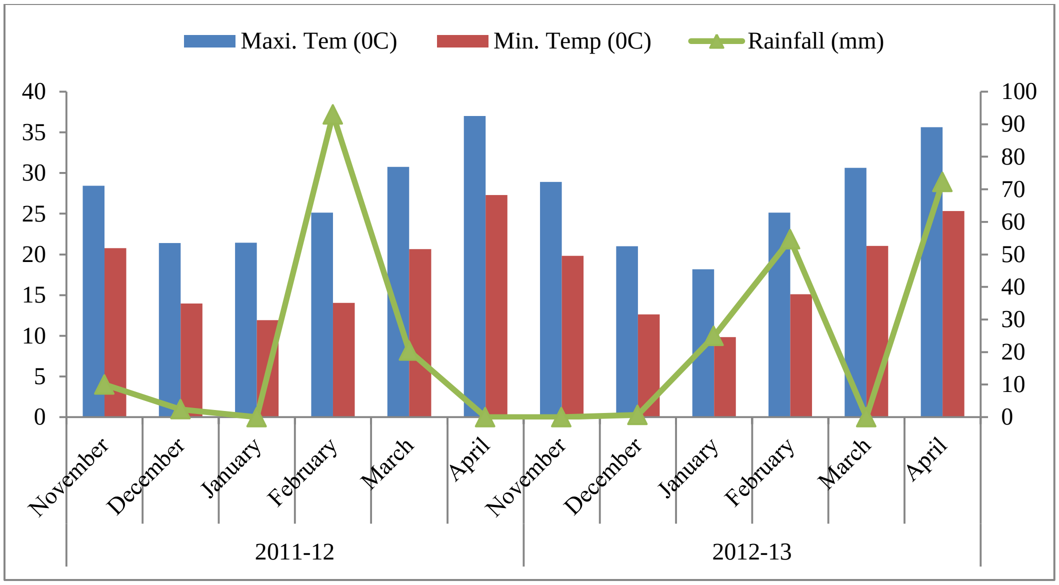

Figure 2. Meteorological information of Nepalgunj (2011-2013)

Results and discussion

The combined analysis of coordinated varietal trial (CVT) shows that BL 3978 (2469.2 Kg ha^{-1}) possessed the highest yield followed by NL 1097 (2373.2 Kg ha^{-1}) and NL 1094 (2334.06 Kg ha^{-1}). Similarly, genotype by environment interaction (GEI) was found significant ($p<0.05$) to grain yield over environment over years (Table 2). The crop duration (Days to maturity) of BL 3978 is lowest (DM=111 days) and is able to escape the heat stress environment. It can be concluded that, the grain filling duration is low for BL 3978. Early grain filling duration is reflected from the days to heading and its maturity, which is short than other tested varieties. Similarly, the rainfall was minimal in both testing sites responding the significant difference in yield (Genotype x Environment) (Table2).

Table 2. Morphological observations of wheat genotypes under rainfed conditions 2011/12-2012/13

Genotypes	Days to heading	Days to maturity	Plant height (m)	Spikesm^{-2}	Grain Yield Kg ha^{-1}
BL 3978	78	111	89	209.84	2469.22
Bhrikuti	84	114	81.78	215.37	2417.34
NL 1097	88	117	84.12	196.43	2373.28
NL 1094	87.5	114	78.46	213.37	2334.06
NL 1140	83.33	114	80.11	264.01	2305.05
NL 1135	88.75	119	81.84	201.43	2278.44
NL 1093	87.25	116	87.37	209.46	2052.34
NL 1143	85.25	115	85.40	216.03	1918.28
Grand Mean	**85.4**	**115**	**83.514**	**215.74**	**2268.50**

CV (%)	2.67	1.96	7.09	16.74	13.08
LSD (5%)	4.56	4.52	11.84	72.25	593.63
EMS	5.1	5.112	35.06	1305	8.81E+04
Year	HS	HS	HS	HS	S
Genotype x Environment	NS	NS	NS	NS	S
Genotype	HS	HS	S	S	HS
Environment	HS	HS	NS	NS	NS

HS: Highly Significant ($p<0.01$), S: Significant ($p<0.05$), NS: Non significant

There was significant variation among the tested genotypes with respect to grain yield (Table 2). The regression coefficient (b=0.82) of BL 3978 was more than the regression coefficient (b=0.72) of Bhrikuti but near to 1. Similarly, the mean grain yield of BL 3978 (2469±56.4 kg ha^{-1}) was higher than Bhrikuti (2417.3±52.5 kg ha^{-1}). It means BL 3978 is more adaptive and higher yielding than Bhrikuti both under favorable and unfavorable regime. Meanwhile, mean yield fluctuation of both varieties shows that BL 3978 can perform same level of resistance to environmental changes as Bhrikuti.

Table 3. Some stability parameters for grain yield (Kg ha^{-1}) of four wheat genotypes over 4 environments (2 locations × 2 years)

SN	Genotype	N§	Grain yield (Kg ha^{-1})		R^2 (%)	b	SE of b	t- value
			Mean ± SEM	Range				
1	BL 3978	4	2469±56.4	2181-2800	93.9	0.82**	0.079	10.4
2	NL 1094	4	2334±81.2	1980-2750	90.9	0.96**	0.11	8.4
4	Bhrikuti	4	2417.3±52.5	2100-2687	93.09	0.72**	0.07	9.7
3	NL 1097	4	2385.7±158.3	1743-2937	86.1	1.48**	0.22	6.6

§ Indicates number of trials for individual genotype; * and **, significant at 0.05 and 0.01 level of probability, respectively.

BL 3978 could be a higher yielding, suitable and adaptive genotype as of Bhrikuti for rain-fed condition of Nepal. The grain yield of four varieties plotted against mean site yield also showed that BL 3978 is consistently higher in both favorable and unfavorable growing environments (Fig. 3). It means that the BL 3978 can perform consistently better yield than Bhrikuti in a good as well as poor environment.

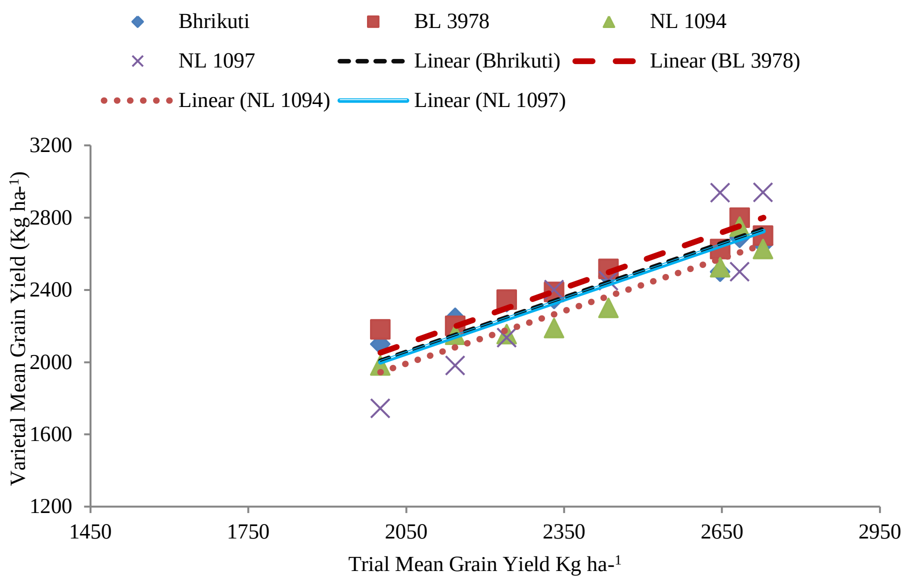

Fig. 3: Regression coefficients of four wheat genotypes across locations from Coordinated Varietal Trial (CVT) yield data over two years (2011/12-2012/13)

Conclusion

The three identified genotypes (BL 3978, NL 1097 & NL 1094), will be further evaluated in participatory varietal selection (PVS) and coordinated farmers field trial (CFFT) followed by small plot seed multiplication (seed increase) and release in the future for timely sown rain-fed conditions. These genotypes also appear suitable for inclusion in crossing program targeted for water stress tolerance.

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