Morpho-physiology of wheat genotypes under different sowing dates as affected by *Helminthosporium* leaf blight and leaf rust in Chiwan, Nepal

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Abstract

An experiment was conducted at the Agronomy farm of the Institute of Agriculture and Animal Science (IAAS), Rampur, Nepal in 2008/09. The experiment was laid out in factorial design in spit plot arrangement consisting of date of sowing as main factor and wheat genotypes as sub factor. Wheat genotypes were sown in 22 November for normal sowing and 29 December for late sowing condition. These were assessed against *Helminthosporium* leaf blight and leaf rust severity in a naturally inoculated environment. Result showed that wheat genotypes differed significantly with respect to flag leaf area, flag leaf duration and plant height. Genotype BL-3064 showed the lower decline (624.9 to 615.1) in chlorophyll content whereas RR-21 showed highest decline (471.2 to 360.4) in chlorophyll content from normal to late sowing, possibly contributing to resistant to the disease. The AUDPC value revealed that genotypes BL-3625 and BL-3623 had increased level of resistance due to lower AUDPC value and higher flag leaf duration. The results of this study suggest that genotypes BL-3623, BL-3625, BL-3063 and BL-3064 could be the option in warm and humid regions of Terai condition so far as resistant to *Helminthosporium* leaf blight and leaf rust are concerned.

Key words : wheat, variability, AUSRC, AUDPC, AURPC

Introduction

The physiological traits have caught the attention of breeders due to limitations of conventional yield-based selections, particularly for stressed environments (Reynolds *et al.*, 2001). Application of such traits in addition to other traits such as chlorophyll content (AUSRC) and disease resistance might be useful to select and develop high performing genotypes. In Nepal, HLB develops as a complex of spot blotch, caused by *Cochliobolus sativus* (Ito & Kurib.) Drechsler ex Dastur [anamorph *Bipolaris sorokiniana* (Sacc.) Shoemaker], and tan spot, caused by *P. tritici-repentis* (Died.) Drechs. [anamorph *Drechslera tritici-repentis* (Died.) Shoe-maker].

Leaf rust is common in warm humid Terai and inner Terai regions of Nepal caused by *Puccinia recondita* f.sp. *tritici*. Leaf rust epidemics is appeared in the month of March and heavy epidemic occurred in mid March where RR-21 had up to 80s rust infection recorded in farmer's field, while it was less in Farmer's Field Trial (NWRP, 2006/07).

Materials and methods

The study was conducted at the Agronomy Farm of IAAS, Rampur, Chitwan, Nepal under normal sowing (22 November) and late sowing (29 December) condition of 2008/09.There was no rainfall recorded during the growth period of the crop. The mean maximum and minimum temperatures were 27.850C and 11.940C, respectively for the crop season. The mean relative humidity was 87.38 % for the crop season. The soil was of sandy loam texture, moderately acidic having pH of 5.3.

The research was laid out in split plot design with sowing time as main plot factor and wheat genotypes as sub plot factor. The research consisting of 15 wheat genotypes among them 3 were checks of yield (Gautam), Helminthosporium leaf blight (RR 21) and leaf rust (Nepal 297) respectively. The total area of the sub plot was 2 m × 1. 5 m. The row spacing was maintained to 25 cm with continuous sowing in the row. Each plot consisted of 6 rows. The central 4 rows by excluding 25 cm on both ends were treated as net plot rows. Fertilizer was applied as recommended for the experimental site, with 100, 60, and 40 kg ha-1 of N, P2o5, and K2o, respectively. Individual plots were sown at the standard seed rate of 120 kg ha-1. Three irrigations were applied, as required in Nepal low land environments. The flag leaf area was calculated by multiplying flag leaf length and width by 0.7 (Aggarwal and Sinha, 1987). Similarly, flag leaf duration was calculated by subtracting the number of days of more than 90 % flag leaf senescence from booting stage. The plant height of ten randomly selected plants from each plot was measured from the base of the plant at soil surface to the tip of the panicle excluding the awns.

Self-Calibrating Minolta Chlorophyll Meter (SPAD-502) was used to measure the amount of total chlorophyll content in leaves after complete heading of the wheat plant. In each plot, flag leaves of ten randomly tagged main tillers were used for SPAD measurements. The three dates of observations were based on the same flag leaf of the plant. Three SPAD readings were taken on each flag leaf randomly from tip to base and average figure was recorded.

Area under SPAD value Retreat Curve (AUSRC) was calculated using the following formula-

$$\text{AUSRC}=\sum_{i=1}^{n-1}\left[\left(\frac{S_{(i+1)}+S_i}{2}\right)\right]\left(T_{(i+1)}-T_i\right)$$

Where,

Si = Chlorophyll content of flag leaves on the ith date

Ti = Days from sowing up to the date of chlorophyll measurements

n = number of dates on which chlorophyll measurements were done

The double digit disease scoring techniques as outlined by Saari and Prescott (1975) was employed to assess HLB. A total of four scores of HLB were recorded after the initiation of flag leaf at the interval of seven days. The first digit (D1) represents relative height of disease progress and measure in 0 to 9 scales. Similarly, the second digit (D2) represents the intensity of disease and also measure in 0 to 9 scales.

Percent disease severity was estimated for each score based on the following formula.

Severity (%) = (D1/9) × (D2/9) × 100

Where,

D1=Height of disease progress from the ground level to canopy

D2= Intensity of disease progress on diseased leaf area

Severity of the four scores was used to calculate the area under disease progress curve (AUDPC) by using the following formula given by Das et al. (1992).

$$\text{AUDPC} = \sum_{i=1}^{n-1}\left[\left(\frac{X_{(i+1)} + X_i}{2}\right)\right]\left(T_{(i+1)} - T_i\right)$$

Where,

Xi = Disease severity on the ith date

Ti= Days from sowing up to the date of disease score

n = number of dates on which disease was recorded

The leaf rust intensities in wheat as based upon severity (percentage of rust infection on plants) and field response (type of disease reaction) outlined by Loegering was used for disease scoring. Severity was recorded as percentage, according to the modified Cobb Scale. The recording process relies upon visual observations, and was common to use the following intervals. Trace, 5, 10,20,40,60,100 percent infection.

Field response was recorded using the following letters.

O No visible infection on plants
R Resistant; visible chlorosis or necrosis, no uredia were present
MR Moderately Resistant; small uredia were present
M Intermediate; variable size uredia were present, some with chlorosis, necrosis or both
MS Moderately Susceptible; medium size uredia were present, some with chlorosis, necrosis, or both
S Susceptible; large uredia were present, generally with little or no chlorosis or no necrosis

The Area Under Rust Progress Curve (AURPC) was calculated by the same formula as used for AUDPC of Helminthosporium Leaf Blight given by Das et al. (1992).The Average Coefficient of Infection (A.C.I.) of leaf rust disease in wheat genotypes was calculated by following method developed by Peterson et al. (1948). The disease severity and host response data were often combined into a single value called coefficient of infection (C.I.).with the different ACI readings, the area under rust progress curve (AURPC) was calculated as measure of disease resistance. The data were subjected to analysis of variance using MSTAT software. Mean separation was done by Duncan's Multiple Range Test (DMRT).

Results and discussion

Analysis of Morpho-physiology traits

The results of morpho-physiology traits of different wheat genotypes under normal and late sown condition is shown (Table 1).

Table 1. Effect of date of sowing and genotypes on Morpho-physiology traits of wheat at Rampur, Nepal during 2008/09

Treatments	Morpho-physiology traits				
	DH	DM	FLA	FLD	PHT
A. Date of sowing					
22nd November	64	126a	29.84	56a	95.35a
29th December	58	103b	27.64	43b	86.92b
LSD(0.05)	ns	2.830	ns	2.473	4.449
SEM ±	1.579	0.4651	0.4097	0.4064	0.7312
B. Genotypes					
BL2800	63	119	26.75bcd	49bcd	94.51bcde
BL2884	63	116	26.66bcd	48cd	92.06cdef
BL3264	61	115	23.77d	48d	92.50cdef
BL3063	58	112	34.37a	55a	87.43efgh
BL3064	59	113	31.52ab	54abc	
BL3235	64	113	27.49bcd	46de	101.4ab
BL3237	63	114	24.37cd	47de	98.85abc
BL3400	62	115	23.51 d	49bcd	83.58gh
BL3623	62	113	36.67a	54ab	82.46gh
BL3625	62	114	35.00a	56a	81.40h
BL2930	65	118	31.08ab	49bcd	104.9a
NL971	65	116	30.66abc	51abcd	96.93bcd
RR21(HLB Check)	59	107	22.60d	42e	86.51efgh
Nepal-297(LR Check)	56	112	25.15bcd	46de	85.37fgh
Gautam(Yield Check)	63	117	31.48ab	52abcd	90.09defg
LSD(0.05)	ns	ns	5.71	5.15	7.11
SEM ±	2.23	2.90	2.02	1.82	2.51
CV %	8.89%	6.21%	17.19%	9.01%	6.75%

Means followed by the common letter(S) are not significantly different based on DMRT at P=0.05. DH= Days to Heading (in days), DM=Days to Maturity (in days), FLA=Flag Leaf Area (cm2), FLD= Flag Leaf Duration (in days) and PHT= Plant Height (in cm)

The non significant effect of date of sowing on flag leaf area might be due to the fact that under high temperature, organ production is accelerated without any increase in net photosynthesis so there is less daily assimilates to be allocated to each organ. In late sowing condition, temperature above 250C had decreased relative growth rate of wheat through their influence on leaf growth as well as net assimilation rate and there by the flag leaf area was found non- significant on sowing date. The wheat genotypes demonstrate significantly different response to FLD because they were evolved from different population and having the different genetic base. The chlorophyll content was significantly influenced by date of sowing as well as genotype was presented (Table 2). Mercado et al. (2002) reported that correlation exists between SPAD value and chlorophyll content. In our findings significantly lower AUSRC was reported in late sowing condition because late sown wheat faces the problem of high temperature and hot winds which accelerates the developmental stages, reduces the size of the organ produced, and low biomass production (Weigand and Cueller, 1982; Fischer 1985 and Bhatta, 1992) so chlorophyll content was less.

Assessment of *Helminthosporium* leaf blight and leaf rust disease

There was significant ($p \leq 0.05$) effect of date of sowing on AUDPC. AUDPC was higher in late sowing condition (1016.0) in comparison with normal sowing condition (880.1) (Table 2). Dubin and Bimb (1994) found a higher level of conidial dispersal and blight caused by *D.tritici-repentis* compared to *C. sativus* in February while *C.sativus* became predominant later in the season with temperature increase and wheat maturity. Our finding was in line with the previous finding of Singh et al. (1998b) studied the effect of seeding date on spot blotch development and reported that the coincidence of higher foliar blight (80% blight intensity) was caused by *B. sorokiniana* under late sown conditions (December 20) as compared to lower HLB intensity (60%) under early seeding (November 30) in Utter Pradesh, India. Kandel (2003) reported that disease increased with delayed sowing was due to confounding effect and/or enhancing effect of heat stress on *Helminthosporium* leaf blight development.

There was highly significant ($p \leq 0.01$) effect of date of sowing on AURPC. AURPC as a measure of slow-rusting was higher in late sowing condition (32.55) in comparison with normal sowing condition (12.61) (Table 2). In late sowing condition, there was more conducive weather for the pathogens to cause infection and plant parts were more susceptible to disease. It might be the fact that late sowing wheat appears to be faced by warm vapors and high wind velocities which may result in the release of more spores that prevails at the late sowing condition. Losses due to leaf rust damage are normally below 10 % but can at times be as severe as 30 % under late sowing condition (Singh et al., 1988; Trench et al., 1992; Boshoff et al., 2002; Curtis et al., 2002; Singh et al., 2002).

Table 2. Effects of date of sowing and genotypes on physiological and disease assessment traits of wheat at Rampur, Nepal during 2008/09

Treatment	Physiological and disease assessment traits		
	AUSRC	AUDPC	AURPC
A. Date of Sowing			
22nd November	586.1a	880.1b	12.61b (2.36)
29th December	546.9b	1016.a	32.55a (3.72)
LSD(0.05)	7.409	127.6	0.4943
SEM ±	1.218	20.98	0.08124
B. Genotypes			
BL2800	565.0bc	809.1 gh	0.25e (0.82)
BL2884	570.9bc	1094.bc	0.96e(1.20)
BL3264	564.7bc	940.9 def	0.00e (0.71)
BL3063	620.1a	856.3fgh	0.00e (0.71)
BL3064	620.0a	884.7fg	0.00e (0.71)
BL3235	562.2bc	1009.bcde	189.0a(13.43)
BL3237	555.2bc	1051.bcd	56.23b(7.09)
BL3400	548.8c	996.9cde	5.99d (2.36)
BL3623	622.2a	598.3i	5.73d (2.26)
BL3625	617.0a	593.3i	0.00e (0.71)
BL2930	577.6b	898.8efg	49.23 b (6.87)
NL971	573.9bc	847.6fgh	0.00e (0.71)
RR21(HLB Check)	415.8e	1773.a	5.99d (2.36)
Nepal-297(LR Check)	501.9d	1116. b	25.32c(4.94)
Gautam (Yield Check)	582.4b	754.8 h	0.00e (0.71)
LSD (0.05)	24.10	102.1	0.78
SEM±	8.506	36.05	0.28
CV %	3.68%	9.31%	22.32%

Means followed by the common letter (S) are not significantly different based on DMRT at P=0.05. Values in the parenthesis are the transformed values. AUSRC=Area Under SPAD Retreat Curve, AUDPC=Area Under Disease Progress Curve, AURPC=Area Under Rust Progress Curve.

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