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EFFECT OF DATE OF SOWING ON THE PERFORMANCE OF DROUGHT TOLERANT WHEAT GENOTYPES TO SPOT BLOTCH AT RAMPUR, CHITWAN, NEPAL

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Abstract

A research was conducted in field to elucidate the response of twenty drought tolerant wheat genotypes to spot blotch. Field experiment was carried out in Agronomy block of IAAS, Rampur, Chitwan in split plot design with three replications, considering 25 November as normal sowing and 15 December as late sowing dates taking them as main factors and genotypes as sub factors. Grain yield was 2.50 t ha^{-1} on 25 November sowing and 2.03 t ha^{-1} on 15 December sowing. Similarly thousand kernel weight was 37.50 g on 25 November sowing and 32.82 g on 15 December sowing. Aditya, CSISA DRYT 5204 and CSISA DRYT 5205 had less than 13% grain yield and TKW reduction when sown in late condition also. From the experiment it is concluded that these three genotypes can be sown in late condition as they were resistant to spot blotch and heat stress.

Key words: Spot blotch, Heat stress, AUDPC, TKW, Grain yield.

Introduction

Wheat (*Triticum aestivum* L.) cultivation in the warmer region of South Asia is constrained by several biotic and abiotic factors (Sharma and Duveiller, 2003). Among them, Helminthosporium leaf blight complex which is caused by association of spot blotch and tan spot is the most important biotic factor and terminal heat stress during the latter stage of the crop growth is another abiotic factor causing significant yield loss and covering more than twenty five million hectares of land worldwide (Van Ginkel and Rajaram, 1998).

The pathogen has a worldwide distribution, but is particularly aggressive under conditions of high relative humidity and temperature associated with imbalanced soil fertility. Epidemiological factor is very important for the development of spot blotch and tan spot in the wheat growing season. The combined effects of high temperature, high relative humidity and long period >12 hours leaf wetness caused by rainfall, and dew are conducive to foliar blight development in the Indo-gangetic Plains where wheat is grown from November to April (Duveiller, 2004). In Asian context, spot blotch is more rapid and severe at 28ºC than at lower temperature (Nema and Joshi, 1973 and Singh *et al.*, 1998). Disease development becomes high after heading stage when temperature slowly increases.

The average yield loss due to spot blotch in South Asia and India has been estimated to be 19.6% and 15.5% respectively (Dubin and Van Ginkel, 1991). Average grain yield losses due to HLB associated with the 26 November, 11 December and 26 December seedling dates were 20%, 30% and 32% respectively in Nepalese situation (Duveiller *et al.,* 2005). Spot blotch causes 100% yield loss under severe infection conditions (Mehta, 1994). Higher yield loss at late sowing date is due to combined effect of higher temperature which favored spot blotch severity and terminal heat stress. *B. sorokiniana* is a seed borne disease. Saari (1984) reported if severe leaf infection is present and some rain occurs after heading, the percentage of grain infection may exceed 50% and becomes seed borne in nature.

Terminal heat stress has been shown to increase severity of spot blotch (Sharma and Duveiller, 2004). Drought is an expanding and creeping threat of world slowly taking hold of an area and tightening its grip with time (Mishra *et al*., 2002). About 60% wheat area in developing world (75 million hectare) is subjected to various abiotic stresses, of which 45 million hectare is affected by moisture stress (Parry *et al*., 2005). The shift of rice -wheat cropping pattern from the normal date to delayed condition due to impact of climate change has made wheat growing farmers of Nepal reluctant to sow the seed in the late season which are surely to be attacked by combined effect of spot blotch and terminal heat stress at severe level. Bhandari (2001) stated that combined resistance to seed infection, root rot and spot blotch was not identified in any one genotype, which indicated that the resistance in different parts of wheat plant may be governed by different genes. Therefore the present study was carried out to identify the best disease resistant and heat tolerant genotypes with the following objectives.

- To find out the incidence and severity of spot blotch at different dates of sowing
- To find out the yield response of the genotypes under disease and heat tolerant conditions

Materials and Methods

Seed collection

Twenty released as well as pre- released drought tolerant wheat genotypes seed differing in genetic background, yield potential, maturity and level of HLB resistance were included in the study which were collected from National Wheat Research Program (NWRP), Bhairahawa. Aditya and Bhrikuti were taken as spot blotch resistant and RR-21 as spot blotch susceptible.

Experimental site

The experiment was conducted in the research farm of Agronomy at the Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal during November 2011 to April 2012. The site was situated at 27°31' North latitude and 84°25' east longitude with an elevation of 256m above mean sea level. Climate of the location was subtropical and humid type. The maximum and minimum temperature recorded for the day of November 25th sowing was 27°C and 11°C respectively with 90% relative humidity. For second sowing i.e. 15th December, the maximum and minimum temperature recorded for the day was 20°C and 8°C respectively with 88% relative humidity. November 25 sowing genotypes received total 171.6 mm rainfall while December 15 sowing genotype received total 306.7 mm rainfall water during the entire growth period.

Design of the experiment plot and sowing

The field experiment was laid out in split- plot design with three replications. Main factor (Date) and sub factor (genotypes) were assigned in each split. Length of each strip was 20 m which occupied 4 rows in every 1 sq. m plot. Breadth of each strip was 1 m. Distance between each replication was 1m. Distance between the main factors that is two date of sowing was 0.5 m. Border distance from all four sides was1m. Total gross area of the field was 22x11.5= 253m^2.Chemical fertilizer @ 120:60:40 NPK Kg ha^{-1} was applied as recommended by NWRP.The seed was sown manually @ 120 kg ha^{-1}(3g/1m row) at the spacing of 25 cm from row to row.Crop was grown as rainfed.

Disease assessment

Both single and double digit scoring were done for the disease assessment at both date of sowing. Single digit scoring was done visually on flag leaf (F) and penultimate leaf (F-1) from 10 randomly selected single tillers per genotype in each replication by using standard diagram developed by CIMMYT (Muzeeb-Kaazi A *et al*., 1996). Three scoring at the interval of 6 days was done when the disease development started in penultimate and flag leaf respectively.

Double digit scoring after anthesis was evaluated using the double-digit scale (00 to 99) developed as a modification of Saari and Prescott's scale for assessing severity of foliar disease of wheat (Saari *et al*., 1975). The first digit (D_1) indicates disease progress in canopy height from the ground level and the second digit (D_2) refers to severity measured based on diseased leaf area. Both D_1 and D_2 are scored on a scale of 1 to 9. Five scoring were done at the interval of 6 days in both the seeding dates. For each evaluation, percent disease severity was estimated based on the formula.

Disease severity (%) = $(D_1/9) \times (D_2/9) \times 100$

The area under disease progress curve (AUDPC) was calculated by summarizing the progress of disease severity. AUDPC values from double digit and AUDPC from flag leaf (F) and penultimate leaf (F-1) were separately calculated by using the following formula given by Das *et al*. (1992).

$$\text{AUDPC} = \sum_{i=1}^{n} (Y_{i+1} + Y_i) 0.5 (T_{i+1} - T_i)$$

Agronomic traits

After all the plants in the plot reached to maturity, they were hand harvested, threshed and grain weight and thousand kernels weight were recorded at 12% moisture level.

Data analysis

MS excel was used for data entry. The recorded data were subjected to analysis of variance and DMRT for the mean separations from the reference of Gomez and

Gomez (1984). ANOVA was done at 1% and 5% level of significance to test the significance difference for each parameter

Results and Discussion

Disease assessment

Whole plant or double digit scoring

Analysis of variance (ANOVA) revealed highly significant difference ($p \leq 0.01$) on AUDPC value at two dates of sowing. Mean AUDPC value on 25 November sowing was 540.4 and 15 December sowing was 635.8 (Table 1). Interaction between the date of sowing and genotypes was also highly significant ($p \leq 0.01$) for AUDPC value. AUDPC value ranged from 394.1 to 1073. RR-21 had highest AUDPC value of 1073 on 15 December sowing but the same variety had AUDPC value 752.8 when sown on 25 November. Similarly CSISA DRYT 5217 had 733.5 and CSISA DRYT 5202 had 728.5 when sown on 15 December. Aditya had lowest AUDPC value 394.1 followed by CSISA DRYT 5205 (401.4), CSISA DRYT 5229 (402.1) and CSISA DRYT 5228 (403.5) respectively when sown on 25 November (Table 2).

Table 1: Effect of date of sowing in AUDPC and yield characters at Rampur, Chitwan, Nepal, 2011- 012

Treatment	AUDPC(DD)	AUDPC F	AUDPC F-1	EY (t ha-^{1})	TKW(g)
25 NOV	540.40^b	339.20^b	780.40^b	2.50^a	37.50^a
15 DEC	635.80^a	449.90^a	965.10^a	2.03^b	32.82^b
LSD	9.38	12.44	13.96	0.18	0.34
SEm(±)	1.542	2.04	2.29	0.30	0.056
CV%	4.41	10.6	8.26	10.81	3.13
Probability	0.00	0.00	0.00	0.00	0.00

AUDPC DD: Area Under Disease Progress Curve Double Digit; AUDPC FL: Area Under Disease Progress Curve of Flag leaf; AUDPC F-1: Area Under Disease Progress Curve of penultimate leaf; EY: Economic yield (t ha^{-1}); TKW: Thousand kernel weight (g). Treatment means are separated by Duncan's Multiple Range Test (DMRT) and the columns represented by same letter (s) are not significantly different among each other at 5% level of significance.

AUDPC on flag leaf

Analysis of variance (ANOVA) revealed highly significant difference ($p \leq 0.01$) between the date of sowing and AUDPC on flag leaf. Mean Flag leaf AUDPC value was 339.2 and 449.9 when sown on 25 November and 15 December respectively (Table 1). Interaction between the date of sowing and genotypes was also highly significant ($p \leq 0.01$). The range of flag leaf AUDPC was from 146 to 815.7. RR-21 had highest flag leaf AUDPC value 815.7 followed by CSISA DRYT 5217(796.3), CSISA DRYT 5202(763.7) and CSISA DRYT 5211 (752) respectively when sown on 15 December sowing. Lowest flag leaf AUDPC was recorded 146 and 161 in Aditya when sown on 25 November and 15 December respectively. Similarly CSISA DRYT 5205 had 165 and CSISA DRYT 5228 had 167.7 flag leaf AUDPC value next to Aditya (Table 2).

Penultimate leaf (F-1)

Analysis of variance (ANOVA) revealed highly significant difference ($p \leq 0.01$) between the date of sowing and penultimate leaf AUDPC. Mean F-1 AUDPC value sowing on 25 November and 15 December were 780.4 and 965.1 respectively (Table 1). The interaction of date and genotypes for penultimate leaf was highly significant ($p \leq 0.01$). The range of F-1 AUDPC was from 431.3 to 1446. RR-21 (1446) had highest F-1 AUDPC value followed by CSISA DRYT 5202 (1398), CSISA DRYT 5203 (1392), CSISA DRYT 5219 (1365) and CSISA DRYT 5220 (1323) respectively when sown on 15 December. Aditya (431.3) had lowest F-1 AUDPC value followed by CSISA DRYT 5205(491.3), CSISA DRYT 5229 (506), CSISA DRYT 5228 (508.7) and CSISA DRYT 5204 (510) respectively when sown on 25 November (Table 2).

Table 2: Interaction effect of dates of sowing and genotypes on AUDPC value at Rampur, Chitwan, Nepal, 2011- 2012

Genotypes	AUDPC DD 25 NOV	AUDPC DD 15 DEC	AUDPC FL 25 NOV	AUDPC FL 15 DEC	AUDPC F-1 25 NOV	AUDPC F-1 15 DEC
CSISADRYT5202	615.9ghi	728.5bc	482.0gh	763.7c	940.7gh	1398b
CSISADRYT5203	595.4ghijk	688.6cde	451.0j	736.3de	946.3gh	1392b
CSISADRYT5204	412.9o	506.3mn	181.7uvw	185.0uv	510.0p	596.7o
CSISADRYT5205	401.4o	534.1lmn	165.0wx	194.0u	491.3p	604.7o
CSISADRYT5207	499.0n	631.7fgh	249.7st	275.3qr	748.7n	758.7n
CSISADRYT5210	503.7mn	523.5lmn	241.7t	284.7q	756.0n	754.3n
CSISADRYT5211	618.6fgh	721.9bcd	491.3g	752.0cd	962.0g	1402b
CSISADRYT5217	666.1ef	733.5bc	498.3g	796.3b	958.0g	1404b
CSISADRYT5218	492.4n	582.1hijk	252.7st	265.3rs	738.0n	759.3n
CSISADRYT5219	621.9fgh	680.8de	488.3gh	743.0d	951.0gh	1365c
CSISADRYT5220	606.7ghij	679.7de	471.0hi	721.0e	927.7h	1323d
CSISADRYT5223	550.0klm	614.6ghi	332.0o	362.3m	805.7klm	848.3ij
CSISADRYT5224	549.1klm	622.1fgh	343.0no	357.3mn	795.0m	872.3i
CSISADRYT5226	568.2ijkl	605.0ghij	303.3p	358.0mn	822.0kl	826.3jk
CSISADRYT5227	561.9jkl	614.9ghi	373.3m	391.0l	799.3lm	853.7i
CSISADRYT5228	403.5o	520.8lmn	167.7vwx	184.3uv	508.7p	581.3o
CSISADRYT5229	402.1o	524.5lmn	168.3vwx	191.3u	506.0p	603.3o
Aditya	394.1o	489.2n	146.0y	161.0xy	431.3q	516.7p
Bhrikuti	591.9ghijk	642.3efg	409.0k	459.3ij	862.7i	996.7f
RR-21	752.8 b	1073.a	569.0f	815.7a	1147.0e	1446a
LSD	42.19		16.69		23.60	
SEm(±)	14.98		5.92		8.38	
CV%	4.41		10.6		8.26	
Probability	0.00		0.00		0.00	

Treatment means are separated by Duncan's Multiple Range Test (DMRT) and the columns represented by same letter (s) are not significantly different among each other at 5% level of significance.

This result was in line with Rosyara *et al*. (2008) and Gurung *et al*. (2012) who found increased AUDPC in late sowing condition. AUDPC value of resistant genotypes also increased in delayed sowing condition. Similar results were obtained by Duveiller *et al*. (2005). Increase in AUDPC value of even resistant genotype might be due to combined effect of heat stress and easily available inoculums (spores) from the first date sowing field. Moreover the epidemiological condition might have favored for the high disease in second date of sowing.

Economic yield

There was highly significant difference between the dates of sowing and economic yield ($p \leq 0.01$). Economic yield sowing on 25 November was 2.50 t ha^{-1} whereas 2.03 t ha^{-1}on 15 December (Table 1). Interaction of dates of sowing and genotypes for grain yield was not significant. The range of economic yield was from 1.38 t ha^{-1} to 3.20 t ha^{-1}. Highest economic yield was obtained in Aditya (3.20 t ha^{-1}) followed by CSISA DRYT 5229 (3.1t ha^{-1}), Bhrikuti (2.93 t ha^{-1}), CSISA DRYT 5228 (2.91 t ha^{-1}) when sown on 25 November. Aditya when sown on 15 December had also 2.90 t ha^{-1}. Lowest economic yield was recorded in CSISA DRYT 5211(1.38 t ha^{-1}) followed by CSISA DRYT 5220 (1.40 t ha^{-1}), CSISA DRYT 5202 (1.43 t ha^{-1}) and CSISA DRYT 5223(1.50 t ha^{-1}) when these genotypes were sown on 15 December. RR-21 which was highly susceptible in both date of sowing had 2.49 t ha^{-1} yield with 752.8 AUDPC value in first date and 1.98 t $ha^{-1}$with 1073 AUDPC value in second date (Table 3).

Higher yield was also obtained by Duveiller *et al*.(2005) when the genotypes were sown in normal planting date than late planting. Aditya with AUDPC value of 394.1 had higher yield 3.20 (t ha^{-1}) and in second date also it had 2.90 (t ha^{-1}) with 489.2 AUDPC value which suggests as resistant genotype in both date of sowing. Different genotypes have different level of yield potential; however the level of disease might also have influenced the yield. RR-21 being the highly susceptible among others genotypes had higher yield than susceptible genotypes in first date but yield was reduced in second date. This might be due to high disease severity as RR-21 was used as the susceptible check.

Thousand Kernel Weight (TKW)

Analysis of variance (ANOVA) showed highly significant difference between the dates of sowing and thousand kernel weight (p≤0.01). Mean TKW was 37.50 g and 32.82 g sown on 25 November and 15 December (Table 1).There was highly significant interaction between the date of sowing and the genotypes for TKW. The range of TKW was from 22.33 g to 52.07 g. Highest TKW of 52.07 g was recorded in Aditya when it was sown on 25 November and was 47.61 gm on 15 December. CSISA DRYT 5204 had (43.3g) sown on 25 November. Lowest TKW was recorded in CSISA DRYT 5217 (22.33g) in second date of sowing followed by CSISA DRYT 5211 (24.91g) and CSISA DRYT521 (25.87g) respectively when sown on 15 December (Table 3).

Decrease in TKW with increse in disease severity was recorded by Sharma *et al.* (2007). Higher temperature combined with high disease severity in the late planting condition affects the grain filling period that prevails the reduction in TKW (Duveiller *et al* 2005).

Table 3: Mean value of AUDPC, grain yield and thousand kernel weight at Rampur, Chitwan, Nepal, 2011- 2012

Genotypes	AUDPC DD 25 NOV	AUDPC DD 15 DEC	EY(t ha^{-1}) 25 NOV	EY(t ha^{-1}) 15 DEC	TKW(g) 25 NOV	TKW(g) 15 DEC
CSISA DRYT 5202	615.90ghi	728.50bc	1.81	1.45	40.03ef	30.63o
CSISA DRYT 5203	595.40ghijk	688.60cde	1.96	1.50	33.20lmn	27.50pq
CSISA DRYT 5204	412.90o	506.3mn	2.80	2.64	43.03c	40.67e
CSISA DRYT 5205	401.40o	534.10lmn	2.84	2.50	38.05ghi	34.70kl
CSISA DRYT 5207	499.00n	631.70fgh	2.67	2.30	41.07de	37.87ghi
CSISA DRYT 5210	503.70mn	523.50lmn	2.86	2.49	28.07p	25.87qr
CSISA DRYT 5211	618.60fgh	721.90bcd	1.77	1.38	32.40mno	24.91r
CSISA DRYT 5217	666.10ef	733.50bc	2.18	1.69	25.40r	22.33s
CSISA DRYT 5218	492.40n	582.10hijk	2.77	2.09	37.54ghi	35.07kl
CSISA DRYT 5219	621.90fgh	680.80de	2.20	1.61	42.93cd	31.32no
CSISA DRYT 5220	606.70ghij	679.70de	1.89	1.40	35.17kl	28.15p
CSISA DRYT 5223	550.00klm	614.60ghi	2.23	1.50	38.61fgh	31.08o
CSISA DRYT 5224	549.10klm	622.10fgh	2.79	1.70	37.37hij	32.53mno
CSISA DRYT 5226	568.20ijkl	605.00ghij	2.39	2.23	37.83ghi	35.50jk
CSISA DRYT 5227	561.90jkl	614.90ghi	2.23	2.20	34.07klm	32.13mno
CSISA DRYT 5228	403.50o	520.80lmn	2.91	2.29	41.23cde	39.54efg
CSISA DRYT 5229	402.10o	524.50lmn	3.10	2.60	36.10ijk	34.60kl
Aditya	394.10o	489.20n	3.20	2.90	52.07a	47.61b
Bhrikuti	591.90ghijk	642.30efg	2.93	2.13	35.00kl	32.00no
RR-21	752.8 0b	1073.00a	2.49	1.98	40.93e	32.47mno
LSD	42.19		0.39		1.79	
SEm(±)	14.98		1.14		0.63	
CV%	4.41		10.81		3.13	
Probability	0.00		Ns		0.00	

Ns: Non-significance; EY: Economic yield: TKW: Thousand Kernel Weight. Treatment means are separated by Duncan's Multiple Range Test (DMRT) and the columns represented by same letter (s) are not significantly different among each other at 5% level of significance.

Conclusion

Disease severity is increased and yield is reduced as sowing is delayed. However Aditya, CSISA DRYT 5204, CSISA DRYT 5205 had low AUDPC value and high yield in both normal and late sowing condition with high tolerance to heat stress so, these genotypes could be recommended also for late sowing condition. Also these genotypes may be used as resistant check in future research work on genotypes/ varietal screening against spot blotch.

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