Malaysian Journal of Sustainable Agriculture (MJSA)

DOI : http://doi.org/10.26480/mjsa.01.2018.07.11

ISSN: 2521-2931 (Print)
ISSN: 2521-294X (online)

CODEN : MJSAEJ

EVALUATION OF AGRONOMIC TRAITS FOR YIELD AND YIELD COMPONENTS IN WHEAT GENOTYPES WITH RESPECT TO PLANTING DATES

Farhadullah Khan[1*], Muhammad Irfaq Khan[2], Shaheedullah Khan[3], Muhammad Aftab uz Zaman[3], Haroon Rasheed[3], Abdur Rahim Khan[1]

[1] Hazara University Mansehra
[2] Nuclear Institute for food & agriculture Tarnab Peshawar
[3] University of Science and Technology Bannu
**Corresponding Author E-mail: khan.farhadullah@yahoo.com*

ARTICLE DETAILS

Article History:

Received 12 November 2017
Accepted 12 December 2017
Available online 1 January 2018

ABSTRACT

Fourteen genotypes including two checks varieties were evaluated for agronomic traits and their adaptability study on two different sowing dates at the experimental farm of Nuclear Institute for Food and Agriculture, Tarnab, Peshawar, Pakistan. The combined analysis of variance showed that there were significant variations among genotypes, dates of sowing and their interaction. Based on regression coefficient (b_i) and mean square deviation from linear regression ($\bar{S}^2_{di}$) for the individual genotypes regarding the parameters Viz. plant height, spike length, spikelets spike^{-1}, number of tillers plant^{-1} and grain yield (kg) plot^{-1} under consideration, most of the genotypes responded negatively with respect to all the traits under late planting condition. However, some of the genotypes such as CT-09117, CT-09137, CT-09141 and SRN-09111 revealed stable performance with respect to the yield assorted traits. They have been recommended for the late planting conditions where sowing is delayed due to some unavoidable circumstances than the other elite wheat genotypes.

KEYWORDS

Normal and late sowing, yield components, environmental effects, *Triticum aestivum* L.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important grass family (*Poaceae*) cereal crop throughout the world [1]. The world's leading wheat producing countries are United States, China, India, Russian Federation, Australia, France, Germany, Canada, United Kingdom, Ukraine, Turkey, Pakistan, Argentina and Kazakhstan [2]. In Pakistan wheat is grown on an area of about 8.3 million ha with average yield ranging from 2.7 to 4.2 tons ha^{-1} and total production of 23.7 million tons [3].

Stability in performance is one of the most important property of a genotype for wide cultivation. That is why multi-locational trials are conducted for number of years to estimate the performance and phenotypic stability. Sometimes the uni-locational trials can also serve the purpose provided different environments are created by planting experimental material at different sowing dates on the same location [4]. This differential yield response of genotypes in different environment is called genotype × environment (G×E) interaction [5]. Grain yield being a polygenic character and is greatly affected by different environmental conditions. Therefore, a wide research work is required to develop such varieties which could give high yield across different environments [6]. The demand for wheat is increasing, because of the rapid increase in the population growth rate. Because of urbanization and industrialization, land and water resources are being decline.

It is therefore, a great need to increase wheat production within the available resources in order to meet the increasing demand for food. Wheat breeders are engaged to improve the yield potential by developing new cultivars having desirable genetic make-up [7]. To release a new variety for wide cultivation stability in performance is one of the most desirable properties of genotypes. The present study was designed to determine environmental effects on yield and yield related agronomic traits with respect to the performance of some elite wheat genotypes.

2. MATERIALS AND METHODS

The present research work was carried out at the experimental farm of Nuclear Institute for Food and Agriculture (NIFA)in 2012-2013, Peshawar, Pakistan with two experimental sets where each set had 12 genotypes (WL-0916-2, CT-09065, CT-09117, CT-09137, CT-09141, CT-09149, SRN-09048, SRN-09063, SRN-09065, SRN-09087, SRN-09102 and SRN-09111and two check cultivars (Bathoor-08 and Pirsabak-08). Data on five randomly selected plants from each plot were recorded and average value was calculated for plant height (cm), number of productive tillers plant^{-1}, spike length (cm), number of spikelets spike^{-1} and grain yield plot^{-1} (kg).

The data collected on 5 randomly selected plants from each plot were averaged separately for each parameter and were subjected to the analysis of variance using Gen Stat 12th statistical software [8]. To detect the presence of genotype by environment (different sowing dates) interaction and to partition the variation due to genotype, date and genotype by date interaction, a pooled analysis of variance was computed. After substantiation a significant genotype by environment interaction through F-test, univariate stability parameters were performed in accordance with the coefficient of regression ($\boldsymbol{b_i}$) by using Eberhart and Russell's model as stability test [9]. Regression coefficient (***bi***) was calculated as a parameter of measuring the response of a particular genotype on varying environments (dates) with respect to each parameter.

The environmental index ($\boldsymbol{I_j}$) for each genotype was computed in order to determine the deviation of mean of all the genotypes at given date from the overall mean. Using MS Excel program for Windows, as outlined by a researchers, variance of means over different sowing dates with regard to individual genotype (σ^2_{Vi}) and mean square deviations ($\bar{S}^2_{di}$) from linear regression were also worked out as the parameter of stability [10].

3. RESULTS AND DISCUSSION

3.1 Plant Height

The combined analysis of variance (Table1) indicated highly significant difference for mean square plant height with respect to genotypes and sowing dates. However, mean square values for plant height with respect to interaction between genotypes and dates (genotype × date) were non-significant.

Table 2 presents mean plant height (cm) with respect to different dates, over all mean on the two dates, variance due to deviation from regression (σ^2_{Vi}), regression coefficient (bi) and mean square deviation from linear regression ($\bar{S}^2_{di}$) regarding the individual genotypes. It is evident from Table 2 that mean plant height of all the genotypes was reduced when their sowing was delayed. Based on bi and $\bar{S}^2_{di}$ values, CT-09149, CT-09065 and Bathoor-08 were the most stable genotypes among all the tested genotypes for plant height.

Mean plant height on both the sowing dates was recorded as 94.0, 91.1 and 89.2 cm, respectively. Both the test genotypes i. e. CT-09149 and CT-09065 exceeded in stability performance for plant height then the check varieties i.e. Bathoor-08 and Pirsabak-08. According to Table 2, the genotypes CT-09149, CT-09065, SRN-09087, SRN-09111 and Bathoor-08 have higher value of bi> 1 and are more responsive for medium plant height under highly favorable environments. Medium plant height with stout stem is desired agronomic trait in wheat because it may avoid lodging and contributes to biomass.

However, wheat varieties recommended for rainfed areas must have considerable plant height to compensate under drought response. Greater plant height is an undesirable trait under irrigated condition because the varieties with larger plant height may lodge easily due to excessive vegetative growth under irrigation [11].

The present results are in close proximity with those reported by some group researchers who also found that significant reduction in plant height is associated with delayed sowing on different locations [12]. Similar results have also been reported by others researchers who found prominent as well as significant effect on plant height of different wheat cultivars when sown under diverse environments under different sowing dates [11].

3.2 Spike length

Combined analysis of variance for spike length (cm) of 14 genotypes tested on two different sowing dates (Table 3) show that means square values for spike length were highly significant regarding to sowing dates and genotypes. However, non-significant difference in the mean square values for the interaction between genotypes and dates was observed.

Comparatively larger spike length with dense spikelets plays significant role in yield maximization as it has significant positive genotypic correlation with grain yield [13]. Very little information is available regarding the effect of sowing date on spike length. The data was subjected to Eberhart and Russel model in order to investigate the stability performance. Table 4 indicates that average spike length of almost all the genotypes decreased when sowing was delayed. Based on *bi* and S_d^2 values, Table 4 further indicates that genotypes CT-09141, SRN-09048 and SRN-09063 are highly stable.

3.3 Spikelets spike^{-1}

The analysis of variance (Table 5) reveals that the mean square values for different sowing dates were highly significant while non-significant for genotype and interaction between genotype and dates. It is evident from Table 6 that number of spikelets spike^{-1} was decreased when the genotypes were sown under late planting condition. According to ranking based on unit b_i values (b_i=1) and $\bar{S}^2_{di}$ values nearly equal to zero ($\bar{S}^2_{di}$~ 0), the genotypes SRN-09048 and SRN-09065 were found most stable in comparison to the rest of the genotypes. These genotypes have b_i values of 3.6, 3.2 and $\bar{S}^2_{di}$ values of 1.01, 0.95, respectively. No apparent reduction in the number of spikelets spike^{-1} was observed under late sowing condition (Table 6).

However, some of the genotypes i.e. WL-0916-2, CT-09065, CT-09117, CT-09149and SRN-09048 indicated reduced number of spikelets spike^{-1}under late sowing. According to unit ***bi*** values and $\bar{S}^2_{di}$values, the same genotypes were found stable with respect to the number of spikelets spike^{-1} under both normal and late planting conditions. The check Bathoor-08 was stable with respect to check Pirsabak-08. The present results are in agreement with a scientist who found that some of the genotypes might respond well even under late planting condition. This superiority of some genotypes over the other may be due to their genetic adaptive background to late planting environment. Due to the availability of such genotypes to the growers, wheat yield may be stabilized if sowing is delayed due to some circumstances.

3.4 Number of tillers plant^{-1}

Table 7 indicates high level of significance for mean squares regarding genotypes and dates. However non-significant variation was observed due to the interaction between genotypes and dates (genotypes × dates).

On the bases of b_i values (b_i =1) and $\bar{S}^2_{di}$values nearly equal to zero ($\bar{S}^2_{di}$~ 0), the genotypes SRN-09065, SRN-09102, CT-09137, SRN-09048, CT-09149 and SRN-09111 were found stable regarding the trait under consideration. Table 8 further indicates a general trend among the tested genotypes that number of tillers plant^{-1} for all the genotypes were decreased when they were sown in late planting condition. The results presented in Table 8 are comparable with some studies which advocated that number of tillers plant^{-1} have positive correlation with normal sowing [14,15]. The results forwarded in others studies which have also confirmed the present results by suggesting that delay in sowing is associated with the reduced number of productive tillers in wheat [16].

3.5 Grain yield (kg) plot^{-1}

Combined analysis of variance for grain yield (kg) plot^{-1} regarding mean squares for 14 wheat genotypes tested on two different sowing dates (Table 9) shows high level of significance for genotypes, dates and interaction due to genotype and dates (genotype × dates).

Table 10 indicates that grain yield (kg) plot^{-1} was decreased when the genotypes were sown under late planting condition. Based on unit *bi* value and value of$\bar{S}^2_{di}$ **,** Table 10 further indicates that genotypes CT-09137, CT-09141 and CT-09117 in comparison to check Pirsabak-08 were the most stable among all the genotypes. There also more studies have forwarded results quite coincident to the findings of the present investigations [11,14,17-19]. These observers have argued that late planting affects grain yield plot^{-1} negatively.

Table 1: Univariate stability parameters for plant height (cm) of 14 wheat genotypes

Genotype	Mean plant height (cm)			σ^2_{Vi}	b_i	$\bar{S}^2_{di}$	Ranking
	Date-1	Date-2	Average				
WL-0916-2	94.0	88.7	91.3	5575.4	0.67	0.8	12
CT-09065	97.2	85.0	91.1	5604.8	1.52	0.8	2
CT-09117	95.0	89.0	92.0	5660.7	0.75	0.8	10
CT-09137	94.3	87.0	90.7	5507.2	0.92	0.8	8
CT-09141	97.3	93.0	95.2	6047.2	0.54	1.0	14
CT-09149	101.0	87.0	94.0	5988.7	1.75	0.9	1
SRN-09048	99.3	92.3	95.8	6147.2	0.88	1.0	9
SRN-09063	93.7	88.0	90.8	5516.5	0.71	0.8	11
SRN-09065	88.0	83.0	85.5	4886.0	0.63	0.6	13
SRN-09087	94.0	85.0	89.5	5380.7	1.13	0.8	4
SRN-09102	98.0	89.0	93.5	5868.7	1.13	0.9	5
SRN-09111	100.0	91.0	95.5	6120.7	1.13	1.0	6
Bathoor-08	94.3	84.0	89.2	5353.9	1.29	0.7	3
Pirsabak-08	90.3	82.7	86.5	5017.6	0.96	0.7	7
Total	1336.5	1224.7	1280.6	-	14.00	-	-

σ^2_{Vi}= variance due to deviation from regression, b_i = coefficient of regression and $\bar{S}^2_{di}$ = deviation from linear regression.

Table 2: Combined analysis of variance for plant height (cm) of 14wheatgenotypes tested on two different sowing dates

Source of variation	d.f	SS	MS	v.r.	F. Pr
Genotypes	13	1083.81***	83.37***	6.17	0.001
Replication	2	247.17	123.58	9.14	-
Date	1	398.68***	398.68***	29.50	0.001
Genotypes × Date	13	319.57	24.58	1.82	0.064
Residual	54	729.83	13.52	-	-
Total	83	2779.06	-	-	-

d.f. = degrees of freedom, SS= sum of square, MS= mean square, v.r. = variance ratio = F-calculated. Pr= F probability, *= p<0.05, **= p<0.01 and ***= p<0.001

Table 3: Combined analysis of variance for spike length (cm) of 14 wheat genotypes tested on two different sowing dates

Source of variation	d. f.	S. S.	M. S.	v. r.	F. Pr
Genotype	13	77.35***	5.95***	11.92	0.001
Replication	2	4.8957	2.4479	4.90	-
Date	1	32.04***	32.04***	64.18	0.001
Genotype × Date	13	6.71	0.52	1.03	0.434
Residual	54	26.96	0.50	-	-
Total	83	147.95	-	-	-

d.f.= degrees of freedom, SS= sum of square, MS= mean square, v.r.= variance ratio = F-calculated, F. Pr= F probability, *= p< 0.05, **= p< 0.01 and ***= p< 0.001

Table 4: Univariate stability parameters for spike length (cm) of 14 wheat genotypes

Genotype	Spike length (cm)			σ^2_{Vi}	b_i	$\bar{S}^2_{di}$	Ranking
	Date-1	Date-2	Average				
WL-0916-2	13.10	12.07	12.58	106.06	0.83	1.00	9
CT-09065	11.11	10.05	10.58	75.17	0.86	0.71	8
CT-09117	14.03	13.30	13.67	124.75	0.59	1.18	10
CT-09137	10.75	10.05	10.40	72.31	0.57	0.68	12
CT-09141	11.55	9.92	10.74	78.18	1.32	0.73	4
CT-09149	13.98	12.37	13.17	116.96	1.30	1.10	5
SRN-09048	13.17	11.40	12.29	102.18	1.43	0.95	3
SRN-09063	12.17	10.17	11.17	85.16	1.62	0.79	2
SRN-09065	12.50	10.90	11.70	92.57	1.30	0.86	6
SRN-09087	13.12	12.42	12.77	108.93	0.56	1.03	13
SRN-09102	12.27	12.13	12.20	99.24	0.11	0.94	14
SRN-09111	13.32	11.77	12.55	106.13	1.26	0.99	7
Bathoor-08	11.81	11.10	11.46	87.73	0.57	0.83	11
Pirsabak-08	12.53	10.48	11.51	90.38	1.66	0.84	1
Total	175.41	158.11	166.76	-	14.00	-	-

σ^2_{Vi}= variance due to deviation from regression, b_i = coefficient of regression and $\bar{S}^2_{di}$ = deviation from linear regression.

Table 5: Combined analysis of variance for spikelets spike^{-1}of 14 wheat genotypes tested on two different sowing dates

Source of variation	d. f.	S. S.	M. S.	v. r.	F. Pr
Genotype	13	47.01	3.62	1.75	0.076
Replication	2	22.858	11.429	5.54	-
Date	1	20.01***	20.01***	9.69	0.003
Genotype × Date	13	38.41	2.96	1.43	0.176
Residual	54	111.49	2.07	-	-
Total	83		-	-	-

d.f.= degrees of freedom, SS= sum of square, MS= mean square, v.r. = variance ratio = F-calculated, F. Pr= F probability, *= p<0.05, **= p<0.01 and ***= p<0.001

Table 6: Univariate stability parameters for number of spikelets spike^{-1}of 14 wheat genotypes

Genotype	Number of spikelets spike^{-1}			σ^2_{Vi}	b_i	$\bar{S}^2_{di}$	Ranking
	Date-1	Date-2	Average				
WL-0916-2	21.80	20.53	21.17	597.37	1.3	0.99	5
CT-09065	19.53	18.73	19.13	488.11	0.8	0.85	7
CT-09117	20.73	19.00	19.87	526.25	1.8	0.92	4
CT-09137	20.17	20.80	20.48	538.42	1.6	0.27	1
CT-09141	18.23	18.53	18.38	450.60	1.3	0.18	2
CT-09149	20.30	19.47	19.88	527.13	0.3	0.02	13
SRN-09048	22.67	19.13	20.90	582.41	3.6	1.01	6
SRN-09063	19.93	19.20	19.57	510.47	0.8	0.89	8

SRN-09065	21.83	18.67	20.25	546.75	3.2	0.95	12
SRN-09087	20.63	20.33	20.48	559.42	0.3	0.97	10
SRN-09102	20.27	21.53	20.90	582.41	-1.3	1.01	14
SRN-09111	20.77	20.33	20.55	563.07	0.4	0.98	9
Bathoor-08	22.07	19.33	20.70	571.32	2.8	1.00	3
Pirsabak-08	19.73	19.40	19.57	510.47	0.3	0.89	11
Total	288.67	275.00	281.83	-	14.0	-	-

σ^2_{Vi}= variance due to deviation from regression, b_i = coefficient of regression and $\bar{S}^2_{di}$ = deviation from linear regression.

Table 7: Combined analysis of variance for number of tillers plant^{-1}of 14 wheat genotypes tested on two different sowing dates

Source of variation	d. f.	S. S.	M. S.	v. r.	F. Pr.
Genotype	13	57.54***	7.5***	2.58	0.007
Replication	2	15.070	7.535	2.59	-
Date	1	1246.63***	1246.63***	428.86	0.001
Genotype × Date	13	52.96	4.07	1.40	0.189
Residual	54	156.97	2.907	-	-
Total	83	1569.17	-	-	-

d.f.= degrees of freedom, SS= sum of square, MS= mean square, v.r. = variance ratio = F-calculated, F. Pr= F probability, *= p<0.05, **= p<0.01 and ***= p<0.001

Table 8: Univariate stability parameters for number of tillers plant^{-1} of 14 wheat genotypes

Genotype	Number of tillers plant^{-1}			σ^2_{Vi}	b_i	$\bar{S}^2_{di}$	Ranking
	Date-1	Date-2	Average				
WL-0916-2	15.90	7.20	11.55	126.78	1.13	0.82	5
CT-09065	14.40	7.40	10.90	103.71	0.91	0.73	12
CT-09117	16.60	7.33	11.97	138.40	1.20	0.88	13
CT-09137	16.53	7.80	12.17	136.82	1.13	0.91	6
CT-09141	13.60	10.07	11.83	99.59	0.46	0.86	14
CT-09149	17.67	9.00	13.33	156.07	1.12	0.10	3
SRN-09048	14.83	7.80	11.32	110.11	0.91	0.79	11
SRN-09063	16.53	7.80	12.17	136.82	1.13	0.91	8
SRN-09065	19.50	9.60	14.55	190.14	1.01	0.01	1
SRN-09087	18.83	10.47	14.65	178.08	1.09	1.34	7
SRN-09102	15.60	10.13	12.87	125.31	1.03	0.02	2
SRN-09111	16.80	9.13	12.97	141.48	1.00	0.04	4
Bathoor-08	17.00	9.47	13.23	145.12	0.98	1.08	9
Pirsabak-08	15.87	8.60	12.23	126.17	0.94	0.92	10
Total	229.67	121.80	175.73	-	14.00	-	-

σ^2_{Vi}= variance due to deviation from regression, b_i = coefficient of regression and $\bar{S}^2_{di}$ = deviation from linear regression.

Table 9: Combined analysis of variance for grain yield (kg) plot^{-1}of 14 wheat genotypes tested on two different sowing dates

Source of variation	d. f.	S. S.	M. S.	v. r.	F. Pr.
Genotype	13	1292.67***	99.44***	2.89	0.003
Replication	2	0.26454	0.13227	2.39	-
Date	1	535.05***	5.35.05***	256.79	0.001
Genotype × Date	13	97.95***	7.54***	2.76	0.004
Residual	54	147.41	2.73	-	-
Total	83	842.29	-	-	-

d.f.= degrees of freedom, SS= sum of square, MS= mean square, v.r. = variance ratio = F-calculated, F. Pr= F probability, *= p<0.05, **= p<0.01 and ***= p<0.001

Table 10: Univariate stability parameters for grain yield (kg) plot^{-1}of 14 wheat genotypes

Genotype	Grain yield (kg) plot^{-1}			σ^2_{Vi}	b_i	$\bar{S}^2_{di}$	Ranking
	Date-1	Date-2	Average				
WL-0916-2	2.28	1.15	1.71	2.60	1.38	0.6	6
CT-09065	2.02	1.49	1.76	2.20	0.65	0.7	13
CT-09117	2.02	1.85	1.94	2.04	1.17	0.5	3
CT-09137	2.30	1.94	2.12	2.03	1.05	0.7	1
CT-09141	2.11	1.98	2.05	2.12	0.79	0.7	2
CT-09149	1.77	1.10	1.43	1.59	0.81	0.4	10
SRN-09048	1.98	1.36	1.67	2.05	0.76	0.6	12
SRN-09063	2.17	1.18	1.68	2.37	1.21	0.6	5
SRN-09065	2.25	1.35	1.80	2.57	1.09	0.7	7
SRN-09087	2.00	1.17	1.59	2.02	1.01	0.5	8
SRN-09102	1.80	1.47	1.64	1.84	0.39	0.6	14
SRN-09111	2.63	1.65	2.14	3.54	1.19	1.0	11
Bathoor-08	1.99	1.29	1.64	2.03	0.84	0.6	9
Pirsabak-08	2.31	1.04	1.68	2.28	1.54	0.6	4
Total	29.63	18.10	23.87	-	14.00	-	-

σ^2_{Vi}= variance due to deviation from regression, b_i = coefficient of regression and $\bar{S}^2_{di}$ = deviation from linear regression.

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Cite the article: Farhadullah Khan, Muhammad Irfaq Khan, Shaheedullah Khan, Muhammad Aftab Uz Zaman, Haroon Rasheed (2018). Evaluation Of Agronomic Traits For Yield And Yield Components In Wheat Genotypes With Respect To Planting Dates . *Malaysian Journal of Sustainable Agriculture*, 2(1) : 07-11.