Journal of Cereal Research

14(1): 89-96

Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Research Article

Genetic Variability, Relationship among the yield components and selection criteria for yield improvement in diverse genotypes of durum wheat (*Triticum durum Desf.*)

Ramraj Sen*, Akshay Talukar, Narendra Singh Sipani and Mukesh Birla

ICAR-IARI-Sipani Krishi Anusandhan Farm, Collaborative Outstation Research Centre, Mandsaur – 458001, M.P., India

Article history:
Received: 09, Jan., 2022
Revised: 18, Mar., 2022
Accepted: 07, Apr., 2022

Citation:
Thapa S, Baral D, Shivakoty P. Das S. 2022. Culture condition and variation in the pathogenicity of *Ustilagonoidea virens* isolates causing false smut disease of rice. *Journal of Cereal Research* ***14(1):*** *89-96.* *http://doi.org/10.25174/2582-2675/2022/120861*

****Corresponding author:***
E-mail: corcsipani@gmail.com

Abstract

Estimates of genetic parameters for twenty three entries of durum wheat [*Triticum durum* (L.)] revealed significant variability for all the traits under study, indicated wide spectrum of variability among the genotypes. The estimates of genotypic and phenotypic coefficient of variation were high for plant height, number of seeds per ear and seed yield per plant. High heritability coupled with high genetic advance was observed for plant height, number of seeds per ear and grain yield per m^2. Improvement in yield can be made by selecting these yield contributed traits having high heritability coupled with high genetic advance. Genotypic correlations were of higher magnitude as compared to their corresponding phenotypic correlation in most of the character combination, indicating the existence of strong influenced of inherent association for the various attributes. Grain yield per m^2 exhibited significant stable and positive correlation with number of tillers per plant and flag leaf area at genotypic and phenotypic level. Thus, it can be inferred that selection based on any one of these traits either alone or in combination, will result in identifying high yielding genotypes. Path coefficient analysis of genotypic and phenotypic level exhibited high positive and direct effect of flag leaf area, leaf length, number of tillers per plant and plant height on grain yield per m^2. Thus any selection based on these characters will enhance performance and improvement grain yield in durum wheat (*Triticum durum* Desf.).

Key words: *Triticum durum,* Heritability, Genetic variability, Correlation and Path coefficient analysis.

1. Introduction

Wheat is the world's largest famous energy rich cereal crop. It has been described as the "King of Cereals" because of the acreage it occupies, high productivity and the prominent position it holds in the international food grain trade. Wheat is the world's most important crop that excels all other cereal crops both in area and production, thereby providing about 20.0 per cent of total food calories for the people of the world. The extent of genetic variability has been considered as an important factor which is an essential pre-requisite for a successful hybridization aimed at producing high yielding progenies. The selection of parents becomes more difficult if the improvement is made for a polygenetically controlled complex character like grain yield (V. Nukasani *et. al.*,2013). The ultimate goal of most of the breeding programmes is to increase the production per unit area in per unit time (Gaur, 2019). Both tetraploid (*Triticum durum* Desf.) and hexaploid (*Triticum aestivum* L.) wheats, are important cereals in Ethiopia, ranking third in total production (17%) after rice next to maize (*Zea mays*

L.), ((FAOSTAT, 2019). Ethiopia is the largest wheat-producing country in Sub-Saharan Africa, with annual production of about 4.83 million tons of grain on 1.72 million hectares of land which accounted for 13.38% of total land allotted to cereals in 2017 cropping season with national average productivity of 2.8 t/ha (FAOSTAT, 2019). It covers a total arable land of 110,434 ha with an average productivity of about 8.4 qt ha-1, which is below the national average (14.4 qt ha-1). Most of the tetraploid wheat varieties, grown in Ethiopia are landraces consisting of a large number of different genetic lines. Purseglove (1975) reported the presence of genetic diversity of durum wheat in Ethiopia and Zohary (1970) identified Ethiopia as the centre of origin for tetraploid wheat. However, the absence of ancestral forms and wild relatives ruled-out Ethiopia as the centre of origin of cultivated wheat (Pecetti *et al.*, 1992). Durum wheat (*Triticum durum* Desf.) is one of the important cereal crops in many countries in the world (Kahrizi et al., 2010a, b and Mohammadi et al., 2010). Also, this crop plant is the most important *Triticum* species constituting 10 to 11% of the world wheat crop and accounting for 8% of the total wheat production in the world, and grows in most countries except in the hot and humid tropical regions (Peña et al., 2002 and Ganeva et al., 2011). It has various traits of interest such as resistance to yellow rust (Beharav et al., 1997), environmental stability and high quality of its end products. The crop is widely grown in the Middle East, North Africa, the Indian subcontinent and Mediterranean Europe and part of Ethiopia, Argentina, Chile, Mexico, the United States and Canada (Abdalla et al., 1992). According to Central Statistics Authority (CSA, 2008), the average productivity of durum wheat in Ethiopia is estimated to be 17.46 q/ha, which is lower than the average world productivity (25 q/ha). The presence of genetic diversity and genetic relation-ships among genotypes is a prerequisite and paramount important for successful durum wheat breeding programme. Developing durum wheat varieties with desirable traits require a thorough knowledge about the existing genetic variability (Maniee et al., 2009; Kahrizi et al., 2010a, b and Tsegaye *et al.*, 2012). More genetically diverse parents have the greater the chances of obtaining higher heterotic expression in F_1's and broad spectrum of variability in segregating population (Shekhawat et al., 2001). Clear information on the nature, pattern and degree of genetic diversity assists breeders in choosing the diverse parents for purpose of hybridization and crossing programme. Several genetic diversity studies have been conducted on different crop species based on quantitative and qualitative attributes in order to select genetically distant parents for hybridization (Ahmadizadeh *et al.*, 2011; Daniel et al., 2011 and Tsegaye *et al.*, 2012).

2. Material And Methods

In this investigation twenty (*Triticcum durum* viz.SKAF-WD-7003, SKAF-WD-5/12, SKAF-WD-2/19, SKAF-WD-52, SKAF-WD-57, SKAF-WD-59, SKAF-WD-620, SKAF-WD-58, SKAF-WD-510, SKAF-WD-64, SKAF-WD-626, SKAF-WD-655, SKAF-WD-639/1, SKAF-WD-532, SKAF-WD-6156, SKAF-WD-6146, SKAF-WD-8498 (source- developed SKAF) , HI-8777, HI-8759 (from Indore) and SKAF-WD-6077 diverse accessions of durum wheat with three check (*Triticcum aestivum* viz. HI-1605, HI-1544 and LOK- 1(local checks)) were evaluated for grain yield and its component attributes in randomized block design with three replications during *rabi* 2018-19 at ICAR-IARI- Sipani Krishi Anusandhan Farm (SKAF), Collaborative Outstation Research Centre, Mandsaur (M.P.). Each plot consisted of six rows of six meter length with row to row and plant to plant spacing of 22.5 cm and 5 cm, respectively. Observations were recorded on five competitive plants for days to 50% ear emergence, number of tillers per plant, ear length, number of spikelet per ear, plant height, leaf length, leaf breadth, flag leaf area, days to maturity and grain yield. The coefficients of variation, heritability in broad sense and expected genetic advance were estimated as suggested by Allard (1960), Lush (1949) and Johnson *et al.* (1955). Correlation coefficients were calculated as per the methods suggested by Searle (1961) and path coefficient were worked out as per the method of Dewey and Lu (1959).

3. Results And Discussion

Analysis of variance revealed highly significant differences among genotypes for all the ten traits, indicating wide spectrum of variation among the genotypes (Table 1). High amount of genetic variability for many of these traits has also been reported earlier by Sharma et al., 2006, Singh et al., 2012, Gaur, 2019 and Saini et al, 2020. In general estimates of phenotypic coefficient of variation (PCV) were higher comparable with genotypic coefficient of variation (GCV) for all characters (Table 2), indicating that all these traits were little influenced by environment. These findings are similar in agreement with earlier reported by Singh et al., 2012, Kumar et al., 2017, Gaur, 2019 and Saini *et al.*, 2020. The GCV was found maximum (>25%) for number of tillers (45.33), whereas minimum (<10%) being for number of spikletes per ear (7.39), 50% ear emergence (3.48) and days to maturity (2.18). The highest phenotypic coefficient of variation (PCV) (>25%) was observed for number of tillers (50.68), whereas minimum (<10%) being for days to maturity (2.84). These findings are similar in agreement with earlier reported by Singh et al., 2012, Kumar et al., 2017, Gaur, 2019 and Saini et al., 2020. The efficiency of selection not only depends on the magnitude of genetic variability but also on the heritability of the desirable characters. Heritability is the ratio of genetic variance to total variance for a plant trait and is related with progress from selection. It expresses the extent to which phenotypes are determined by the genes transmitted from parents to the offsprings. The high heritability (>60%) in broad sense was recorded for five characters viz. grain yield, plant height, number of tillers per plant, ear length and leaf breadth in table 2. This is in conformity with the findings of Singh et al., 2012, Kumar et al., 2017, Gaur, 2019 and Saini et al., 2020. It is necessary to identify the components that create the phenotypical difference in order to calculate the genetic variability and heritability based on that variation. Yield performance continues to be of importance in wheat breeding, though it will be necessary to improve traits involved in yield stability, if further yield increases are to be achieved by Das and Rehman, 1984. The high heritability refers high proportion of genetic effects in the determination of these observations and can be adopted for improving grain yield in durum wheat. The genetic advance as percent of mean recorded maximum (20%) for number of tillers per plant, grain yield and plant height whereas, it was minimum (10%) for days to 50% Ear emergence and days to maturity. In the present investigation, high heritability coupled with high genetic advance recorded for grain yield. This indicates that substantial contribution of additive genetic variance in the expression of this attribute and can be more useful in hybridization and selection for higher grain yield (Table-2). These results are in confirmation with earlier reports of Singh et al., 2012, Rajput *et al.*, 2018, Gaur, 2019 and Saini et al., 2020. The phenotypic correlation coefficient were in general, observed to be higher than that of genotypic correlation coefficients, indicates that the phenotypic expression of the correlation was influenced by the environmental factors, the various traits studied as also observed earlier by Ahmed et al., 2010, Rangare et al., 2010, Sakhare et al., 2011, Saini *et al.*, 2018 and Rajput *et al.*, 2018. However, the phenotypic expression of the correlation was influenced by the environmental factors. Grain yield per m^2 exhibited significant stable and positive association with number of tillers per plant (0.263, 0.233), flag leaf area (0.254, 0.155) and leaf length (0.243, 0.152) at genotypic and phenotypic level in table- 3. Thus, it can be concluded that selection based on any one of these characters either alone or in combination, will result in identifying high yielding genotypes. These results are in general agreement with the finding of Rangare et al., 2010, Sakhare et al., 2011, Saini *et al.*, 2018 and Rajput *et al.*, 2018. Results on the genotypic and phenotypic path coefficient revealed high positive direct contribution of flag leaf area (19.797, 1.952) followed by ear length (0.885, 1.629), number of tillers per plant (0.143, 0.051) and plant height (0.048, 0.152) towards grain yield (Table-4). The direct contribution of above traits with seed yield per plant observed in this study is also in confirmation with the findings of Sakhare et al., 2011, Saini *et al.*, 2018 and Rajput *et al.*, 2018. High indirect positive contribution of grain yield mainly via days to 50% ear emergence, number of tillers per plant and ear length mainly via leaf breadth, number of spikletes per ear, plant height, leaf length, leaf breadth, flag leaf area and days to maturity mainly via; leaf breadth were responsible for their positive association with grain yield per m^2. On contrary, days to 50% ear emergence, ear length and leaf breadth had indirect but negative effects on grain yield per m2. The results thus indicate that effective tillers per plant and flag leaf area should be criteria of selection for increasing grain yield in durum wheat. These results are in general agreement with findings Saini *et al.*, 2018, Rajput *et al.*, 2018, Nukasani et at., 2019 and Baye et al., 2020. The contribution of residual effects that influenced grain yield was very low at both genotypic and phenotypic levels indicating that the traits included in the present investigation were sufficient enough to account for the variability in the dependent traits i.e. grain yield per m^2.

Table 1: Analysis of variance for different characters in durum wheat (*Triticum durum* Desf.)

Source of Variation	D.F.	50% Ear emergence	No. of Tillers	Ear length (Cm.)	No. of spikletes per ear	Plant height	Leaf length	Leaf breadth	Flag Leaf area	Days to maturity	Grain Yield/ m2 (g.).
Rep.	2	313.35	0.04	0.30	0.75	19.80	5.02	0.00	1.63	191.84	110.56
Treatment	22	29.50**	24.00**	5.44**	8.47**	576.15**	22.80**	0.11**	61.42**	31.65**	15042.91**
Error	44	5.42	1.84	0.49	1.71	12.29	8.10	0.01	22.48	5.96	3.99

*,** Significant at 5% and 1% probability level respectively

Table 2: Mean performance and parameters of variability for various traits studied in durum wheat

Sl. No.	Characters	Range Min-Max		Heritability (%)	GA	GA as %	GCV (%)	PCV (%)	% contribution
1.	50% Ear emergence	77.67	88.33	59.68	4.51	5.54	3.48	4.51	11.99
2.	No. of Tillers	2.67	14.33	80.02	5.01	83.54	45.33	50.68	10.66
3.	Ear length(cm.)	6.33	10.67	77.26	2.33	28.32	15.64	17.80	10.51
4.	No. of spikletes per ear	17.33	25.00	56.88	2.33	11.48	7.39	9.80	12.39
5.	Plant Height (cm)	85.00	129.00	93.86	27.36	26.79	13.82	13.85	7.31
6.	Leaf length (cm)	16.75	28.75	37.70	2.80	12.79	10.11	16.46	11.64
7.	Leaf breadth (cm)	1.55	2.30	70.30	0.31	16.19	9.37	11.18	9.15
8.	Flag Leaf area (cm2)	17.95	39.28	36.61	4.49	16.50	13.24	13.80	13.04
9.	Days to maturity	130.00	140.33	58.95	4.63	3.45	2.18	2.84	11.05
10.	Yield g/m2	355.33	656.52	99.92	145.80	30.63	14.87	14.88	2.26

Table 3: Estimates of correlation coefficient for genotypic (G) and phenotypic (P) levels among different traits in durum wheat

Character		50% Ear emergence	No. of Tillers	Ear length (cm.)	No. of spikletes per ear	Plant Height (cm)	Leaf Length (cm)	Leaf Breadth (cm)	Flag Leaf Area (cm2)	Days to maturity	Correlation with grain yield/m^2
50% Ear emergence	G	1.000	-0.461**	0.459**	0.281*	-0.296*	0.013	-0.348**	-0.218	0.231	-0.542**
	P	1.000	-0.347**	0.307*	0.171	-0.193	0.005	-0.254*	-0.121	0.128	-0.418**
No. of Tillers	G			-0.233	-0.154	0.271*	0.153	-0.227	-0.059	-0.170	0.263*
	P			-0.196	-0.149	0.239*	0.103	-0.162	-0.014	-0.109	0.233
Ear length (cm.)	G				0.673**	-0.220	-0.030	-0.086	-0.117	-0.222	-0.445**
	P				0.444**	-0.193	-0.031	-0.080	-0.084	-0.125	-0.390**
No. of spikletes per ear	G					-0.279*	0.083	0.122	0.135	-0.097	-0.427**
	P					-0.226	0.011	0.066	0.036	-0.084	-0.317**
Plant Height (cm)	G						0.287*	0.038	0.247*	0.375**	0.052
	P						0.130	0.021	0.110	0.284*	0.049
Leaf length (cm)	G							-0.091	0.711**	0.061	0.243*
	P							0.226	0.863**	-0.042	0.152
Leaf breadth (cm)	G								0.634**	0.032	0.112
	P								0.682**	-0.046	0.092
Flag Leaf area (cm^2)	G									0.128	0.254*
	P									0.152	0.155
Days to maturity	G										-0.008
	P										-0.009

* Significant at 5% level of significant.

Table 4: Path coefficient analysis showing the direct and indirect effect of ten traits on the grain yield at G and P level of durum wheat

Characters		50% Ear emergence	No. of Tillers	Ear length (cm.)	No. of spikletes per ear	Plant Height (cm)	Leaf length (cm)	Leaf breadth (cm)	Flag Leaf area (cm^2)	Days to maturity	correlation with yield
50% Ear emergence	G	-0.846	-0.066	0.407	-0.163	-0.014	-0.193	4.832	-4.307	-0.193	-0.542**
	P	-0.322	-0.018	-0.079	-0.031	0.029	0.008	-0.249	0.236	0.008	-0.418**
No. of Tillers	G	0.390	0.143	-0.206	0.090	0.013	-2.294	3.153	-1.167	0.142	0.263*
	P	0.112	0.051	0.051	0.027	-0.036	0.167	-0.159	0.027	-0.007	0.233
Ear length (cm)	G	-0.389	-0.033	0.885	-0.391	-0.010	0.443	1.189	-2.324	0.185	-0.445**
	P	-0.099	-0.010	-0.258	-0.081	0.029	-0.050	-0.079	0.165	-0.008	-0.390**
No. of spikletes per ear	G	-0.238	-0.022	0.595	-0.581	-0.013	-1.239	-1.689	2.679	0.081	-0.427**
	P	-0.055	-0.008	-0.115	-0.182	0.034	0.019	0.065	-0.071	-0.005	-0.317**
Plant Height (cm)	G	0.250	0.039	-0.195	0.162	0.048	-4.295	-0.534	4.889	-0.312	0.052
	P	0.062	0.012	0.050	0.041	-0.152	0.212	0.020	-0.214	0.018	0.049
Leaf length (cm)	G	-0.011	0.022	-0.026	-0.048	0.014	-14.981	1.256	14.068	-0.051	0.243*
	P	-0.001	0.005	0.008	-0.002	-0.020	1.629	0.221	-1.686	-0.003	0.152
Leaf breadth (cm)	G	0.295	-0.032	-0.076	-0.071	0.002	1.356	13.879	12.544	-0.027	0.112
	P	0.082	-0.008	0.021	-0.012	-0.003	0.368	0.978	-1.331	-0.003	0.092
Flag Leaf area (cm^2)	G	0.184	-0.008	-0.104	-0.079	0.012	-10.646	-8.795	19.797	-0.106	0.254*
	P	0.039	-0.001	0.022	-0.007	-0.017	1.406	0.667	-1.952	-0.003	0.155
Days to maturity	G	-0.196	-0.024	-0.197	0.056	0.018	-0.908	-0.450	2.525	-0.834	-0.008
	P	-0.041	-0.006	0.032	0.015	-0.043	-0.068	-0.045	0.082	0.065	-0.009

Residual values (G) = 0.7996, Residual values (P) = 0.6686

Bold values indicate direct effects

G= Genotypic, P= Phenotypic

** Significant at 1% and 5% level respectively

4. References

1. Ahmadizadeh, M, Shahbazi, H, Valizadeh, M, Zaefizadeh, M (2011). Genetic diversity of durum wheat landraces using multivariate analysis under normal irrigation and drought stress conditions. Afr. J. Agric. Res., 6(10): 2294-2302.
2. Ahmed B, Iftikhar RH Khalil, Muhammad Iqbal and Hidayat-Ur-Rahman(2010). Genotypic and phenotypic correlation among yield components in bread wheat under normal and late plantings. Sarhad Journal of Agriculturem.; 26(2):259-265.
3. Akanksha, Anil Sirohi, Sanjiv Kumar, Shashi Kant, Krishan pal, Anil Kumar and Manender Singh (2012). The traits with high heritability and high genetic advance may be subjected to mass or progeny.
4. Ali, IH and Shakor EF, 2012. Heritability, Variability, Genetic correlation and Path analysis for quantitative traits in durum and bread wheat under dry farming conditions. Mesoptamia J. of Agri: 40 (4):27-39.
5. Al-Jibouri HA, Miller PA, Robinson HP, (1958). Genotypic and phenotypic co-variances in an upland cotton cross of interspecific origin. Agronomy Journal; 50:633-636.
6. Allard, RW (1960). Principle of Plant Breeding. *John Wiley and sons, New York.* p.185.
7. Baye, A, Berihun, B, Bantayehu, M & Derebe, B (2020). Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (*Triticum aestivum* L.) lines. Cogent Food & Agriculture. 6(1): 2331-1932(online).
8. CSA (2008). Report on Area and Production of Crops. Statistical Bulletin No 446. Addis Ababa, Ethiopia.
9. CSA, 2002. Central Statistics Authority (CSA). 2002. Statistical Abstract. 96pp.
10. Das, MK and Rehman, L, Estimates of genotypic variability, heritability and genetic gain in common wheat. *Bangladesh Journal of Agriculture Science* 9: 15-18 (1984).
11. Dewey, DR and Lu, KH (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Argon. J.,* 51: 515-518.
12. Falconer, DS and Trudy, FC, Mackay, 1996. Introduction to Quantitative Genetics 4th ed. Longman Group Limited Malaysia.
13. FAOSTAT (2019). Crop production.
14. Fisher, RA, (1954). Statistical methods for research workers, Oliver and Boyd. Ltd. London.
15. Ganeva G, Korzun, V, Landjeva, S, Popova Z and Christov, NK (2011) Genetic diversity assessment of Bulgarian durum wheat (*Triticum durum* Desf.) landraces and modern cultivars using microsatellite markers. *Gene. Res. and Crop Evol.* 57: 273-285.
16. Gaur, SC, 2019. Genetic Improvement through Variability, Heritability and Genetic Advance for Grain Yield and its contributing traits in Wheat (*Triticum aestivum* L. em Thell). *Int. J. Pure App. Biosci.* 7 (1): 368-373.
17. Ibrahim, AU (2019). Genetic variability, Correlation and Path analysis for Yield and yield components in F_6 generation of Wheat (Triticum aestivum Em. Thell.). (IOSR-JAVS. 12(1):17-23.
18. Indal, Y, Soni, SK Jain, R, Vimal, SC, Yadav, VK (2011). Path coefficient analysis was analyzed in which vigor index was kept as dependant character. Environment and Ecology. 29 (4): 1866-1870.
19. Johnson, HW, Robinson, H F and Comstock, RE (1955). Estimates of genetics and environmental variability in soybean. *Journal of Agronomy,* 47: 314-318.
20. Kahrizi D, Maniee M, Mohammadi R, Cheghamirza K (2010b). Estimation of genetic parameters related to morpho-agronomic traits of Durum wheat (*Triticum turgidum* var. durum). Biharean Biologist., 4(2): 93-97.
21. Kumar D, Srivastava RK, Yadav PK, Kumar A and Yadav RS, (2017). Studies on Variability, Heritability and Genetic Advance in Some Quantitative Characters in Bread Wheat (*Triticum aestivum* L.). Int.J.Curr.Microbiol.App.Sci, 6(7): 873-877.
22. Maniee M, Kahrizi D, Mohammadi R (2009). Genetic variability of some morpho-physiological

traits in Durum wheat (*Triticum turgidum* var. durum). J. Appl. Sci., 9(7): 1383-1387.

23. Mengistu, DK, Kidane, YG, Fadda C and Pè, ME, 2016. Genetic diversity in Ethiopian Durum Wheat (Triticum turgidum var durum) inferred from phenotypic variations. Plant Genetic Resources; 1–11.
24. Mohammadi R, Armion M, Kahrizi D, Amri A (2010). Efficiency of screening techniques for evaluating durum wheat genotypes under mild drought conditions. Int. J. Plant Prod., 4(1): 11-24.
25. Nukasani V., Potdukhe N. R., Bharad S., Deshmukh S. and Shinde S. M. (2013). Genetic ariability, correlation and path analysis in wheat. J. Wheat Res. 5 (2) : 48-51
26. Nukasani, V, Potdukhe, NR, Bharad, S, Deshmukh, S and Shinde, SM (2019). Genetic variability, correlation and path analysis in wheat. J. Wheat Res. 5(2): 48-51.
27. Pecetti, L, Damania, A and Kashour, G 1922. Geographic variation for spike and grain characteristics in durum wheat germplasm adapted to dry land conditions. *Genetic Resources and Crop Evolution* 39:97-105.
28. Peña RJ, Trethowan R, Pfeiffer WH, Ginkel MV (2002). Quality (end-use) improvement in wheat: compositional, genetic, and environmental factors. In: Basra AS, Randhawa LS (eds.). Quality improvement in field crops. Food products press, Binghampton, USA, pp. 1-39.
29. Purseglove, JW 1975. Tropical Crops; monocotyledons. John Wiley & Sons, Inc., New York, Pp. 287-291.
30. Rajput RS, 2018. Correlation, path analysis, heritability and genetic advance for morpho-physiological character on bread wheat (*Triticum aestivum* L.). Journal of Pharmacognosy and Phytochemistry. 7(2):107-112.
31. Rangare, NR, Krupakar, A, Kumar, A and Singh, S, 2010.Character association and component analysis in wheat (Triticum aestivum L.) Electronic Journal of Plant Breeding, 1(3): 231-238.
32. Saini, RK, Kerkhi, SA, Khilari, K, Chand, P, Singh, SK and Yadav, MK, 2018. Study of indirect selection parameter in bread wheat (*Triticum aestivum* L.). Journal of Pharmacognosy and Phytochemistry. 7(4): 2265-2269.
33. Saini, RK, Sen, R, Tomer, P, Kumar, A and Kerkhi, SA (2020). Genetic variability, Heritability and Genetic advance study in bread wheat (Triticum aestivumL.) Progressive Agriculture, 20(1):61-65.
34. Sakhare SB and Ghawat NP (2011). Correlation and path analysis in durum wheat. PKV. Research Journal; 35(1):23-25.
35. Salahuddin W, Suresh BG and Lavanya GR, 2016. Genetic variability, correlation and path analysis in wheat germplasm (*Triticum aestivum* L.) 3 (7): 24-27.
36. Searle, SR (1961). Phenotypic, Genotypic and environmental correlations. *Biometrics,* 47: 474-480.
37. Sharma V, Pawar, IS, Munjal R,(2006). Variability parameters, correlation and path coefficients for yield, its components and quality traits in bread wheat. National Journal of Plant Improvement; 8(2):153-155.
38. Singh AK, Singh SB, Singh AP, Sharma AK (2012). Genetic variability, character association and path analysis for seed yield and its component characters in wheat (Triticum aestivum L.) under rainfed environment. Indian Journal of Agricultural Research.; 46(1):48-53.
39. Singh BN, Vishwakarma SR, Singh VK (2010). Character association and path analysis in elite lines of wheat (T. aestivum L.) Plant Achieves.; 10(2):845-847.
40. Tsegaya D, Dessalegn T, Dessalegn Y, Share G (2012). Genetic variability, correlation and path analysis in durum wheat germplasm (Triticum durum Desf.). Agricultural Research and Review; 1(4):107-112.
41. Zohary, D (1970). Centres of Diversity and centers of Origin: In: O.H. Frankel and E. Bennett (Eds.) Genetic Resources in Plants. Their Exploration and Conservation. I.B.P. Handbook 11: 33-42.