ESTIMATION OF SOME GENETIC PRAMETERS IN DURUM WHEAT

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ABSTRACT

To estimate genetic parameters and heritability in durum wheat (*Triticum turgidum* var. durum) genotypes, seventeen genotypes (16 exotic from ICARDA and local variety (Buhooth 7)) were included in this study. This experiment was conducted using a randomized complete block design with three replications at Field Crops Research Station, Abu-Graib, Office of Agricultural Research, during 2011-2012 and 2012-2013. The results revealed significant differences among genotypes for the studied characters at both seasons. The best genetic/environmental variance ratio attained for spike length (11.90) and no. of spikes. m^{-2} (9.22) in the first season, and grain yield (8.82) then harvest index (4.87) in the second season. High GCV observed for grain yield (15.68), no. of spikes. m^{-2} (15.18) in the first season, and harvest index (16.89) and grain yield (14.22) in the second season. High heritability estimates associated with high genetic advance for no. of spikes. m^{-2}, in the first season. While, moderate h^2_{bs} estimates associated with high GA for same trait in the second season. Expected response to selection ranged from 0.93 to 84.6, also selection index ranged from 1.23 to 106.44 for grain yield and number of spikes. m^{-2}, respectively in the first season also the same pattern was observed for value of second season. Characteristics like no. of spikes. m^{-2}, plant height, no. of grains. Spike^{-1} and grain weight showed high heritability coupled with high genetic progress. Therefore, these characters should be given top priority during selection breeding in durum wheat.

Key words: PCV, GCV, response to selection, selection index.

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تقدير بعض المعالم الوراثية في الحنطة الخشنة

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المستخلص

لتقدير بعض المعالم الوراثية في 17 تركيباً وراثياً من الحنطة الخشنة (*Triticum turgidum* var. durum) (16 تركيب وراثي مدخل من ايكاردا وصنف محلي (بحوث 7)). استخدم تصميم القطاعات الكاملة المعشاة بثلاثة مكررات في محطة ابحاث المحاصيل الحقلية في ابي غريب التابعة لدائرة البحوث الزراعية خلال 2011–2012 و2012–2013. أظهرت النتائج وجود فروقاً معنوية بين التراكيب الوراثية لجميع الصفات المدروسة خلال موسمي الزراعة. كانت أعلى نسبة تباين وراثي الى تباين بيئي لطول السنبلة (11.90) وعدد السنابل للمتر المربع (9.22) في الوسم الاول، ولحاصل الحبوب (8.82) ودليل الحصاد (4.87) في الموسم الثاني. لوحظت أعلى نسبة معامل اختلاف وراثي لحاصل الحبوب (15.68) وعدد السنابل للمتر المربع (15.18) في الموسم الاول، ولدليل الحصاد (16.89) وحاصل الحبوب (14.22) في الموسم الثاني. رافقت h^2_{bs} عالية مع تحصيل وراثي عالٍ لعدد السنابل للمتر المربع في الموسم الاول، بينما تلازمت h^2_{bs} متوسطة مع تحصيل وراثي عالٍ لنفس الصفة في الموسم الثاني. تراوحت الاستجابة المتوقعة للانتخاب 0.93–84.6 وكذلك لدليل الانتخاب من 1.23–106.44 في الموسم الاول للصفات المدروسة، كما لوحظت نسب متقاربة في الموسم الثاني. ان الصفات التي اظهرت h^2_{bs} عالية وترافقت مع تحصيل وراثي عالٍ كعدد السنابل للمتر المربع وارتفاع النبات وعدد الحبوب للسنبلة ووزن الحبة، يجب ان تكون في الاولوية خلال برامج الانتخاب في الحنطة الخشنة.

كلمات مفتاحية: PCV، GCV، الاستجابة للانتخاب، دليل الانتخاب.

INTRODUCTION

Genetic variability is an essential component of any breeding program, which use to improve the characteristics of crops. The available phenotypic variability in a population could be partitioned into heritable and non heritable variation with the aid of genetic parameters such as variance, genotypic co-efficient of variations heritability and genetic advance which serve as a basis for selection (31). So contents of genetic diversity for the trait under selection with a higher heritability is essential (9). Our understanding about nature of traits and influences of genetic and environmental factors on desire traits also has important effects on breeding programs (18, 23). Information about genetic diversity and relationships among breeding materials is essential to plant breeders for improving this crop. Wheat breeders are concentrating their efforts to improve the grain yield potential of wheat to meet the future goals by developing new cultivars with desirable genetic makeup (1). Grain yield is a complex multi genetic component character and is greatly influenced by various environmental conditions. Various morphological and physiological characters contribute to grain yield. Each of these component characters has its own genetic systems. Further these yield components are influenced by environmental fluctuations. Therefore, it is necessary to identify heritable and non heritable components (11). It is difficult to improve yield through breeding (especially in the early generations) if yield is the only factor recorded, suggesting that component traits should also be used as selection criteria for yield improvement. This is the reason why it is necessary to know the genetic architecture of yield components (22). The first application of the selection index to plant breeding was by Smith (30). The use of selection index is superior in improving complex traits. Furthermore, selection indices aimed at determining the most valuable genotypes as well as the most suitable combination of traits with the intention of indirectly improving the yield in different plants, in durum wheat, Muhe (24) concluded that direct selection for grain yield gave high genetic advance, for bringing improvement in heritable characters, estimation of genetic parameters is of prime importance in any breeding program. Heritability estimates provide information about the extent to which a particular character can be transmitted to the successive generations. Kaddem et al. (13) recorded high estimates of PCV for grain yield, but moderate PCV for harvest index, Biological yield and no. of tillers per plant, Moderate GCV was recorded for no. of tillers per plant, grain yield and spike length, high heritability along with high genetic advance for spike length and grain weight. While, Yadawad et al.(33) revealed moderate to high estimates of PCV and GCV obtained for yield per plant, indicated a good deal of variability for this character signifying the effectiveness of selection of desirable types for improvement of this trait, and high heritability assisted with high genetic advance was observed for plant height and yield per plant. Similar results were found by several researchers (7, 10, 12, 14, 15, 20, 21, 25 and 27). The objectives of the present research were to estimate genetic variability, heritability, genetic advance, expected response to selection and selection index for agronomic characters, grain yield and its components in seventeen durum wheat genotypes.

MATERIALS AND METHODS

Seventeen durum wheat (*Triticum turgidum* var. durum) genotypes (16 exotic from ICARDA and 1 local variety) were used in this study (Table 1). To estimate genetic parameters and heritability in durum wheat genotypes . This experiment was conducted using a randomized complete block design (RCBD) with three replications at Research Station of Field Crops, Abu-Graib - Office of Agricultural Research, during 2011-2012 and 2012-2013 growing seasons. Each plot consisted of a six row, 3 m length with 0.3 m between rows. Seeding rate was 140 $kg.ha^{-1}$. The soil was plowed; disc – furrowed, and the plots were prepared. Nitrogen fertilizer (Urea 46% N) was applied two times, firstly during sowing and second at tillering with average 200 kg N/ha. Phosphorus fertilizer applied of tricalcium phosphate with 100 kg/ha after tillage. Seeds were sown at 26/12/2011 and 25/11/2012 for first and second seasons, respectively. Data on plant height were recorded on ten guarded plants taken randomly from each experimental unit. Spike length (cm), number of spikelet spike^{-1}, number of spike. m^{-2}, number of grain. Spike^{-1}, grain yield, biological yield and harvest index

Table 1. Origin and pedigree of genotypes

	Genotypes	Pedigree	Origin
1	ICARDA 1	CHAM-1	ICARDA/Syria
2	ICARDA 2	Miki-2	ICARDA/Syria
3	ICARDA 3	Beltagy-2	ICARDA/Syria
4	ICARDA 4	Gen/4/D68-193A//Ruff/3/Mtl-5	ICARDA/Syria
5	ICARDA 5	Azn 1/3Stj3/Dra2//Ber	ICARDA/Syria
6	ICARDA 6	Msb-1-1//Krf/Hen	ICARDA/Syria
7	ICARDA 7	Agharass-11/3/HFN94N-8/Mbr5//Zna-1	ICARDA/Syria
8	ICARDA 8	Agharass-1/Bezaiz98-1	ICARDA/Syria
9	ICARDA 9	Anmouri-2C1115/5/F413J.s/3/Arthur 71/ Iahn/blk2/Lahn/4/Qurmal	ICARDA/Syria
10	ICARDA 10	DCD DW7/Ter-1	ICARDA/Syria
11	ICARDA 11	SU-ORDEGL3/3Ch5/20048Traikia(Mor)//STJ3	ICARDA/Syria
12	ICARDA 12	Mrfl/Stj2//Bcrch1	ICARDA/Syria
13	ICARDA 13	Ter1//Mrfl/stj2	ICARDA/Syria
14	ICARDA 14	Ter-1/3stj3//Ber/Iks4	ICARDA/Syria
15	ICARDA 15	Tarro	ICARDA/Syria
16	ICARDA 16	Nebta	ICARDA/Syria
17	Buhooth 7	Local Variety (D7)	Iraq (adapted)

The phenotypic variance, genetic variance, environmental variance, the phenotypic and genotypic coefficient of variation (PCV and GCV), broad sense heritability (h^2_{bs}) and genetic gain were estimated according to Singh and Chaudhary (29) from the components of variance as follows:

$$\sigma^2 e = MSe$$

$$\sigma^2 p = \sigma^2 g + \sigma^2 e$$

$$\sigma^2 g = (MSv - MSe) / r$$

$$GCV\% = (\sigma g / \bar{x}) \times 100$$

$$PCV\% = (\sigma p / \bar{x}) \times 100$$

$$h^2_{bs} = (\sigma^2 g / \sigma^2 p) \times 100$$

$$GA = K \, \sigma p \, h^2_{bs}$$

Where, $\sigma^2 e$ = environmental variation, MSe = error mean square, r = number of replication, σ^2 g is genetic variance, σ^2p is phenotypic variance, PCV = phenotypic coefficient of variation, GCV = genotypic coefficient of variation, h^2_{bs} = broad sense heritability, GA = genetic gain.

Expected response to selection (Re) was determined using 20% selection intensity according to the procedure outlined by Falconer and Mackay (9):

$$Re = i_x (\sigma^2 p \times h^2_{bs})^{0.5}$$

Where ix = 1.40 for trait x, σ^2p = phenotypic variance for the trait x and h^2_{bs} = heritability for the trait x.

$$SI = K \times \sigma p$$

SI = value of selection index for each character and K = 2.06 at 5% selection intensity (16).

RESULTS AND DISCUSSION

Mean squares revealed highly significant differences among genotypes for all the studied character in both seasons (Table 2). Indicating the presence of considerable amount of genetic variability among durum wheat genotypes for these traits . These results agree with the results of Khan et al. (19), Ajmal et al. (2), Baloch et al. (5), Desheva and Cholakov (7), Karimizadeh et al. (17), Rashidi et al. (25) and Tripathi et al. (31). Higher portion of phenotypic variances were attained for number of spike. m^{-2}, while lower values for spike length and grain yield in both seasons, that refer to the highest variability among genotypes of these traits. The best genetic/environmental variance ratio were with spike length (11.90) and no. of spikes. m^{-2} (9.22), follow that grain weight (6.48), grain yield (4.45) and plant height (3.16) for the first season, while grain yield revealed higher genetic/environmental variance ratio (8.82) then harvest index (4.87) in the second season, these results deals that some traits are more important than others in selection. It’s noticeable that all these distinguished traits in genetic/environmental variance ratio; it gave similar values in PCV% and GCV%. Genotypic and phenotypic coefficients of variation provided a glance of available variation in breeding material for all traits. High phenotypic coefficient of variation (PCV) (Tables 3 and 4) was observed for grain yield (17.35), no. of spikes. m^{-2} (15.98) and harvest index (14.17) in the first season, while, in the second season, harvest index (18.54) and grain yield (15.00). High genotypic coefficients of variation (GCV) observed for grain yield (15.68), no. of spikes. m^{-2} (15.18) in the first season, while, harvest index (16.89) and grain yield (14.22) in the second season. High GCV value of characters suggested the possibility of improving these traits through selection. This study shows lowest differences in genotypic and phenotypic coefficients of variability in both seasons, which indicate that large amount of variation was contribute by genetic components and lowest by environmental influence and additive gene effects indicates that genotypes can be improve and selecte for these characters. The estimated PCV higher than those of the GCV, in both seasons . Estimates of PCV and GCV were highest for grain yield and number of spikes per m^2 in first season, while harvest index and grain yield in second season, Which, were similar to previous reported by Kaddem et al. (13) and Tripathi et al. (31). Plant height had coefficient of phenotypic variability 8.28% and genotypic variability 7.28% as reported by Kahrizi et al. (14) that found lower PCV and GCV for plant height, no. of tillers and grain yield. High heritability estimates were observed for most the characters investigated in both seasons, h^2_{bs} rounded 0.53-0.92 for all traits except biological yield (0.49) in the first season, and from 0.62-0.90 except number of spikes per m^2 (0.46) in the second season. The heritability is important parameter for plant breeding programs.

Table 2. Analysis of variance for wheat traits studied during 2011-2012 and 2012-2013.

Traits	2011-2012			2012-2013		
	Replicates	Varieties	Error	Replicates	Varieties	Error
Degree of freedom	2	*16	32	2	*16	32
Plant Hight	16.21	*50.40	4.81	4.92	*55.06	9.47
Spike length	0.22	*1.45	0.04	0.16	*1.14	0.16
No. of spikes. m^{-2}	852.44	*11392.04	397.64	317.52	*2184.90	619.56
No. of grains. $Spike^{-1}$	32.33	*44.33	5.20	1.36	*101.95	17.78
Grain weight	3.84	*41.15	2.01	0.06	*18.86	2.04
Biological yield	11.75	*6.07	1.56	3.15	*8.90	1.24
Harvest Index	33.68	*35.22	7.95	2.06	*73.79	4.73
Grain Yield	0.034	*1.413	0.098	0.139	*1.173	0.042

-*Significant at 0.05 level.

Table 3. Mean, genotypic variance/environmental variance, phenotypic coefficient of variation (PCV%) and genotypic coefficient of variation (GCV) for eight characters in 17 genotypes in 2011-2012

Traits	Mean	Phenotypic variance	Genotypic variance/ Environ. Variance	Phenotypic coefficient of variability	Genotypic coefficient of variability
Plant height	78.88	20.01	3.16	5.67	4.94
Spike length	7.96	0.51	11.90	8.96	8.61
No. of spikes.m^{-2}	398.76	4062.44	9.22	15.98	15.18
No. of grains. $Spike^{-1}$	58.30	18.24	2.51	7.33	6.19
Grain weight	35.85	15.06	6.48	10.82	10.07
Biological yield	14.54	3.06	0.96	12.04	8.43
Harvest Index	29.14	17.04	1.14	14.17	10.35
Grain Yield	4.22	0.54	4.45	17.35	15.68

Table 4. Mean, genotypic/environmental variance, phenotypic variance, phenotypic coefficient of variation (PCV%) and genotypic coefficient of variation (GCV%) for eight characters in 17 genotypes in 2012-2013.

Traits	Mean	Phenotypic variance	Genotypic variance/ Environ. Variance	Phenotypic coefficient of variability	Genotypic coefficient of variability
Plant height	78.54	24.67	1.60	6.32	4.96
Spike length	7.45	0.49	1.98	9.40	7.66
No. of spikes. m^{-2}	370.13	1141.34	0.84	9.13	6.17
No. of grains. $Spike^{-1}$	59.33	45.83	1.58	11.41	8.93
Grain weight	34.97	7.64	2.75	7.91	6.77
Biological yield	14.59	3.79	2.06	13.35	10.95
Harvest Index	28.41	27.75	4.87	18.54	16.89
Grain Yield	4.32	0.42	8.82	15.00	14.22

portion of phenotypic variation in a population that is due to genetic variation within population. Thus, it can be perpetuated via selection and has been object of study by many authors, Desheva and Cholakov (7), Farshadfar and Estehghari (10), Kaleemullah et al. (15), Khan et al. (20) and Maurya et al. (21). Whereas Baloch et al. (5) observed highest heritability for plant height, tillers. $Plant^{-1}$, grain yield. $Plant^{-1}$ and harvest index, which suggested that these traits had more genetic variance and less influenced by the environmental factors, hence could be improved through selection. The heritability value alone provides no indication of the amount of genetic progress that would result in selecting the best individual, but heritability estimates along with the genetic advance is considered more useful (2). Higher heritability associate with high genetic advance for number of spikes per m^2, in the first season. Similar results were reported by Rahman et al. (26) and Ul-Haq et al. (32) that maximum heritability and genetic advance were observed in plant height, number of grains. $Spike^{-1}$ and 1000 grains weight, the result suggested that these characters are highly transferred to the next generation and improvement can be obtained by the selection. Moderate heritability estimated associated with high genetic advance for same trait in the second season. Similar results have been reported by Ajmal et al. (2) and Azam et al. (4). Such estimates of genetic advance indicated that moderate gains could be achieved with strengthening the selection. While, Aycicek and Yildirim (3) revealed lowest heritability for plant height, no. of spikes. m^{-2}, no. of grains. $Spike^{-1}$, grain weight and grain yield. Expected response to selection (Re) ranged from 0.93 for grain yield to 84.65for number of spikes. m^{-2}, also selection index ranged from 1.23 for grain yield to 106.44 for number of spikes. m^{-2} in the first season (Table 4).

Table 5. Broad sense heritability, expected genetic advance, selection Index and expected response to selection for eight characters in 17 genotypes in 2011-2012

Traits	Heritability (broad sense)	Genetic Advance	Expected response to selection	Selection Index
Plant Height	0.76	5.68	5.46	7.47
Spike length	0.92	1.10	0.96	1.19
No. of $spikes.m^{-2}$	0.90	95.80	84.65	106.44
No. of grains. $Spike^{-1}$	0.72	5.14	5.07	7.13
Grain weight	0.87	5.64	5.07	6.48
Biological yield	0.49	1.43	1.71	2.92
Harvest Index	0.53	3.65	4.21	6.89
Grain Yield	0.82	1.01	0.93	1.23

Table 6. Broad sense heritability, expected Genetic advance, selection Index and Expected response to selection for eight characters in 17 genotypes in 2012-2013.

Traits	Heritability (broad sense)	Genetic Advance	Expected response to selection	Selection Index
Plant height	0.62	5.42	5.48	8.74
Spike length	0.66	0.81	0.80	1.23
No. of spikes. m^{-2}	0.46	27.35	32.08	59.46
No. of grains. $Spike^{-1}$	0.62	7.39	7.46	11.91
Grain weight	0.73	3.55	3.31	4.86
Biological yield	0.67	2.30	2.23	3.43
Harvest Index	0.83	7.70	6.72	9.27
Grain Yield	0.90	1.03	0.86	1.14

The same pattern was observed for value of second season, that expected response to selection (Re) ranged from 0.80 for Spike length to 32.08 for number of spikes. m^{-2}, also selection index ranged from 1.19 for spike length to 106.44 for no. of spike. m^{-2} and from 1.14 for grain yield to 59.46 for number of spikes. m^{-2} in the first and second season, respectively. Generally, selection index in crops depends on more than one trait, especially if selection for grain yield only inactive due to the yield consider the quantitative trait controlled by numerous of genes, therefore it is difficult to attained of yield increasing comparison with other criterion associated with yield such as no. of spikes. m^{-2} and no. of grains. $Spike^{-1}$ in both seasons. Similar results recorded by Farshadfar and Estehghari (10) and Muhe (24). Could be conclude that characters like no. of spikes. m^{-2}, plant height, no. of grains. $Spike^{-1}$ and grain weight showed high heritability coupled with high genetic progress. Therefore, these characters should be given top priority during selection breeding in durum wheat.

REFERENCES

1-Abd El-Rahman, M. E. 2013. Estimation of some genetic parameters through generation mean analysis in three bread wheat crosses. Alex. J. Agric. Res. 58(3): 183-195.

2-Ajmal, S. U., N. Zakirm and M. Y. Mujahid. 2009. Estimation of genetic parameters and characters association in wheat. J. Agric. Biol. Sci. 1(1): 15-18.

3-Aycicek, M. and T. Yildirim. 2006. Heritability of yield and some yield components in bread wheat (*Triticum aestivum* L.) genotypes. Bangladesh J. Bot. 35(1): 17-22.

4-Azam, S. M., F. Mohammed, I. Ahmad, I. H. Khalil, S. A. Jadoon and A. Nasim. 2013. Divergence in F3 segregating bread wheat populations. International Journal of Basic and Applied Sciences. 13(3): 94-99.

5-Baloch, M. J., E. Baloch, W. A. Jatoi and N. E. Veesar. 2013. Correlations and heritability estimates of yield and yield attributing traits in wheat (*Triticum aestivum* L.). Pak. J. Agri., Agril. Engg., 29(2): 96-105.

6-Cheema, N. M., M. A. Mian, M. Ihsan, G. Rabbani and A. Mahmood. 2006. Studies on variability and some genetic parameters in spring wheat. Pak. J. Agric. Sci. 43(1-2): 32-35.

7-Desheva, G. and T. Cholakov. 2014. Cariability, heritability and genetic progress for some yield components in common winter wheat genotypes (*Triticum aestivum* L.). Genetics and Plant Physiology. 4(3-4): 191-200.

8-Ehdaie, B. and J. G. Waines. 1989. Genetic variation, heritability and path-analysis in landraces of bread wheat from southwestern Iran. Euphytica. 41(3): 183-190.

9-Falconer, D. S. and T. F. C. Mackay. 1996. Introduction to Quantitative Genetics. 4th ed. Longman Scientific and Tech. England. In Farshadfar, E. and M. R. Estehghari. Estimation of genetic archiculture for agro-morphological characters in common wheat. Int. J. Biosci. 5(6): 140-147.

10-Farshadfar, E. and M. R. Estehghari. 2014. Estimation of genetic archiculture for agro-morphological characters in common wheat. Int. J. Biosci. 5(6): 140-147.

11-Farshadfar, E., H. Romena and H. Safari. 2013. Evaluation of variability and genetic parameters in agro-physiological traits of wheat under rain-fed condition. International

Journal of Agriculture and Crop Sciences. 5(9): 1015-1021.
12-Gulnaz, S., M. Sajjad, I. Khaliq, A. S. Khan and S. H. Khan. 2011. Relationship among coleoptile length, plant height and tillering capacity for developing improved wheat varieties. International Journal of Agriculture & Biology. 13(1): 130-133.
13-Kaddem, W. K., S. Marker and G. R. Lavanya. 2014. Investigation of genetic variability and correlation analysis of wheat (*Triticum aestivum* L.) genotypes for grain yield and its component traits. European Academic Research. 2(5): 6529-6538.
14-Kahrizi, D., K. Cheghamirza, M. Kakaei, R. Mohammadi and A. Ebadi. 2010. Heritability and genetic gain of some morpho-physiological variables of durum wheat (*Triticum turgidum* var. durum). African Journal of Biotechnology. 9(30): 4687-4691.
15-Kaleemullah, I. H. Khalil, F. Subhan, F. Rabi, N. Bostan, S. Qureshi and W. Ahmad. 2015. Heritability, selection response and correlation for yield and yield components in irrigated wheat. ARPN Journal of Agricultural and Biological Science. 10(6): 217-225.
16-Kang, M. S., J. D. Mille and P. Y. P. Tai. 1983. Genetic and phenotypic path analysis and heritability in sugarcane. Crop Sci. 23, 643-647. In Farshadfar, E. and M. R. Estehghari. Estimation of genetic archiculture for agro-morphological characters in common wheat. Int. J. Biosci. 5(6): 140-147.
17-Karimizadeh, R., M. Mohammed, M. Armion, M. K. Shefazadeh and H. Chalajour. 2012. Determining heritability, reliability and stability of grain yield and yield-related components in durum wheat (*Triticum aestivum* L.). Bulgarian Journal of Agricultural Science. 18(4): 595-607.
18-Kashif, M., J. Ahmad, M. A. Chowdhry and K. Perveen. 2003. Study of genetic architecture of some important agronomic traits in durum wheat (*Triticum durum*.). Asian J. Plant Sci. 2: 708-712.
19-Khan, I., I. H. Khalil and Nasir-ud-Din. 2007. Genetic parameters for yield traits in wheat under irrigated and rainfed environments. Sarhad J. Agric. 23(4): 973-980.
20-Khan, S., F. Mohammad, K. Rahatullah, N. Ahmed, S. Ahmed, Z. Rehman, G. Ghani and M. Adnan. 2014. Genetic Divergence in bread wheat F_3 populations for morphological and yield traits. IOSR Journal of Agriculture and Veterinary Science. 7(4): 65-70.
21-Maurya, M., A. K. Chaurasia, A. Kumar, C. L. Maurya, B. M. Bara, M. kumar and P. K. Rai. 2014. Genetic variability for seed yield and its component characters in wheat (*Triticum aestivum* L.) under Allahabad Agro-climatic conditions. International Journal of Recent Development in Engineering and Technology. 2(4): 124-126.
22-Misra, S. C., V. S. Rao, R. N. Dixit, V. D. Surve and V. P. Patil. 1994. Genetic control of yield and its components in bread wheat. Indian J. of Genetics 54:77-82.
23-Mohammadi, R., M. Armion, D. Kahrizi and A. Amri. 2010. Efficiency of screening techniques for evaluating durum wheat genotypes under mild drought conditions. Int J Plant Product. 4(1): 11-24.
24-Muhe, K. 2011. Selection index in durum wheat (*Triticum turgidum* var. durum) variety development. Academic Journal of Plant Sciences. 4(3): 77-83.
25-Rashidi, V. 2011. Genetic parameters of some morphological and physiological traits in durum wheat genotypes (*Triticum durum* L.). African Journal of Agricultural Research. 6(10): 2285-2288.
26-Rahman, A., A. Mahboob, U. Khalid, A. Razaq, G. Hammad and Z. Haider. 2016. Heritability of yield and yield components in hexaploid wheat. Academic Journal of Agricultural Research. 4(5): 277-280.
27-Shankarrao, B. S., S. Mukherjee, A.K. Pal and D. K. De. 2010. Estimation of variability for yield parameters in bread wheat (*Triticum aestivum* L.) grown in Gangetic West Bengal. Electronic journal of Plant Breeding. 1(4): 764-768.
28-Singh, P. 2005. Essential of Plant Breeding. Kalyani Publishers. India. pp414.
29-Singh, R. K., and B. D. Chaudhary. 1985. Biometrical Method in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi, Ludhiana. pp. 318.
30-Smith, F, H., 1936, A discriminant function for plant selection. Ann, of Eugenics. 240-250. In Henderson, C. R. 1963. Selection Index Expected Genetic Advance. Statistical Genetics and Breeding. pp141-163.

31-Tripathi, G. P., N. S. Parde, D. K. Zate and G. M. Lal. 2015. Genetic variability and heritability studies on bread wheat (*Triticum aestivum* L.). International Journal of Plant Sciences. 10(1): 57-59.

32-Ul-Haq, W., M. F. Malik, M. Rashid, M. Munic and Z. Akram. 2008. Evaluation and estimation of heritability and genetic advancement for yield related attributes in wheat lines. Pak. J. Bot. 40(4): 1699-1702.

33-Yadawad, A., R. R. Hanchinal, H. L. Nadaf, S. A. Desal, S. Biradar and V. R. Naik. 2015. Genetic variability and heritability estimates for yield attributes and leaf rust resistance in F3 population of wheat (*Triticum aestivum* L.). An International Quarterly Journal of life Sciences, 10(2): 935-938.