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ASSESSMENT OF GENETIC VARIABILITY AND ASSOCIATION ANALYSIS FOR YIELD AND YIELD ATTRIBUTING TRAITS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

Simerjeet Kaur[1], Harshal A. Avinashe[2]*, Nidhi Dubey[3], Swapnil Kalubarme[4] and Mandeep Kumar[5]

[1,4,5] Department of Genetics and Plant Breeding, Lovely Professional University, Phagwara, (Punjab), India.
[2*,3]Department of Genetics and Plant Breeding, Lovely Professional University, Phagwara (Punjab), India.

Abstract

The present investigation was undertaken to study the relationship between seed yield and its contributing characters by using 11 genotypes of wheat (*Triticum aestivum* L.). Experiment was conducted at the Experimental Farm, Lovely Professional University, Phagwara during *rabi* 2017-2018. Observation were recorded for the characters *i.e.* days to 50% heading, days to maturity, plant height, number of productive tillers per plant, number of spikelets per ear, ear length, ear weight, number of ears per plant, number of grains per ear, 1000-grain weight, biological yield per plant, grain yield per plant, harvest index. Analysis of variance revealed highly significant differences among the genotypes for all the characters. Indicating the existence of large variability among genotypes. High GCV was observed for number of ears per plant, number of productive tillers per plant, harvest index and grain yield per plant. PCV values were higher for number of ears per plant, grain yield per plant, number of productive tillers per plant and biological yield per plant. Both GCV and PCV were low for days to maturity. High heritability was observed in number of ears per plant, plant height and ear weight. High genetic advance as% of mean was observed in number of ears per plant, number of productive tillers per plant and harvest index. The correlation coefficient estimated positive and significant genotypic and phenotypic correlation in number of ears per plant, number of productive tillers per plant, days to maturity, biological yield per plant, harvest index with grain yield per plant. Path analysis revealed that the maximum positive direct effect was imposed by grains per ear followed by days to maturity, harvest index, biological yield per plant, days to 50% heading, 1000 grains weight, plant height and number of productive tillers per plant.

Key words : Wheat, GCV, PCV, Genetic advance, Heritability.

Introduction

Wheat (*Triticum aestivum* L.) is a hexaploid (2n=6x=42=AABBDD genomes), annual and self-pollinated cereal. It belongs to tribe "Triticeae" of the family "Poaceae". Studies indicated that the first cultivation of wheat occurred about 10,000 years ago, which is considered as part of the 'Neolithic Revolution'. The earliest cultivated forms were diploid (genome AA) einkorn and tetraploid (genome AABB) emmer wheat and their genetic relationships indicate that they originated from the south-eastern part of Turkey.

It is one of the most widely grown cereal crops, contributing to the global food supply and economic security. Globally, it is cultivated on an area of 221.61 million ha and production of 728.96 million tonnes with an average yield of 3289 kg per hectare (FAOSTAT, 2014). Wheat is also known as the "king of cereals". Wheat comes to the second position after rice which provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 developing countries (Braun *et al.,* 2010). Wheat's importance is due to physical and chemical properties of its grain, which makes bread production possible. Wheat is the staple food for over 41% of the world's population in more than 40 countries.

***Author for correspondence :** E-mail : havinashe@gmail.com

To achieve the goal of increasing productivity breeders have to find sufficient amount of variability. They have to identify superior genotypes having desirable traits and to use them to improve the cultivated varieties. It is important to divide total variability into heritable and non-heritable components *viz.,* GCV (genotypic coefficient of variation, PCV (phenotypic coefficient of variation and further, to calculate heritability and genetic advance for different traits of interest to breeder. Heritability estimation is more advantageous when expressed in terms of genetic advance. Johnson *et al.,* (1955) said that without genetic advance, heritability estimation will not be practical value and gave the importance to the concurrent use of genetic advance along with heritability.

Hanson (1963) stated that genetic advance and heritability are two complementary concepts. The present study therefore was conducted to estimate magnitude of phenotypic and genotypic variability, heritability, genetic advance, correlation coefficient and path analysis with the aim to utilize the genetic information gained in developing superior wheat genotypes and varieties.

Materials and Method

The material for the present investigation comprised of 11 genotypes (Table 1). These 11 genotypes were grown in randomized block design with 3 replications, at Experimental Farm, Lovely Professional University, Phagwara, Punjab during *rabi* 2017-2018. Each genotype was grown in five lines, each line was 3 metre long with a spacing of 20 cm row to row and plant distance 4-6 cm and one line gap was given after every genotype in order to avoid mixture of two genotypes. Recommended crop management practices were followed forraising a healthy crop. Data was recorded on whole plot basis for days to 50% heading and days to maturity whereas plant height**,** number of productive tillers per plant, number of spikelets per ear, ear length, ear weight, number of ears per plant, number of grains per ear, 1000-grain weight, biological yield per plant, grain yield per plant, harvest index from individual tagged plant.

Statistical analysis

The mean performance of each genotype was subjected for statistical analysis. The statistical analysis was done by the method given by Panse and Sukhatme (1954). Correlation coefficient and path coefficient was worked out as method suggested by Al-Jibouri et al. (1958) and Dewey and Lu (1959), respectively.

Results and Discussion

Analysis of variance

Analysis of variance (Table 2) was carried out for 13 different characters in wheat. Result revealed highly significant differences among the genotypes for all the characters. Highest values were estimated for traits biological yield/plant (318.57), plant height (117.308), harvest index (50.465), grains per ear (29.138), number of ears per plant (23.079) and days to 50% heading (20.218). This suggests that the genotypes selected were genetically variable and considerable amount of variability existed among them. Similar finding were reported by Mohsin *et al*., (2009), Nukasani *et al*., (2013), Kumar *et al*., (2014) and Avinashe *et al.,* (2017).

Variability parameters

Phenotypic and genotypic coefficient of variation

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed in the experimental material for all the characters studied (Table 3). The PCV was higher than GCV for all the characters indicating that the visible variation in the

Table 1: List of genotypes and their pedigree/sources.

Sr.No.	GENOTYPES	PEDIGREE
1	DPW-621-50	KAUZ//ALTAR84/(AOS)AWNEDONAS/3/MILAN/KAUZ/4/HUIS[4361]DBW-14/HD-2733// HUW-468 [4145]
2	JW-3211	SUPER-KAUZ/SLYCATCHER[4281]
3	DBW-14	RAJ 3765/PBW343
4	WH-1105	MILAN/S-87230//BABAX[3589]
5	DBW-17	CMH-79-A-95/3*CIANO-79//RAJ-3777 [4138][4191][4281]
6	PBW-723	INDIAN INSTITUTE OF WHEAT AND BARLEY RESEARCH, KARNAL, HARYANA
7	DBW-725	INDIAN INSTITUTE OF WHEAT AND BARLEY RESEARCH, KARNAL, HARYANA
8	PBW-550	INDIAN INSTITUTE OF WHEAT AND BARLEY RESEARCH, KARNAL,HARYANA
9	DBW-71	PRINIA/ UP 2425
10	DBW-39	ATTILA/HUI
11	CBW-38	CANDO,USA/R143/ENTE/MEXICALI2/3/AE.SQ(TR.TA)/4/WEAVER/5/2*PASTOR[4138]

Table 2: Analysis of variance for various yield and yield contributing characters in wheat.

Character	d.f	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
Replication	2	15.485^{NS}	8.212^{NS}	5.310^{NS}	0.636^{NS}	4.069^{NS}	0.477^{NS}	0.159^{NS}	0.091^{NS}	36.622^{NS}	19.757^{NS}	39.499^{NS}	2.980^{NS}	1.457^{NS}
Treatment	10	20.218*	8.872*	117.308**	9.211**	3.238*	0.751*	0.299**	23.079**	29.138*	16.523*	318.157*	50.465*	19.662**
Error	20	8.018	3.746	6.693	1.955	1.304	0.309	0.047	0.062	11.734	6.100	124.590	14.249	8.281

*,** significant at 5% and 1% level of significance

X1: Days to 50% Heading; **X2:** Days to Maturity; **X3**: Plant height; **X4**: Number of productive tillers per plant; **X5**: Number of spikelets per ear; **X6**: Ear length; **X7**: Ear weight; **X8:** Number of ears per plant; **X9**: Grains per ear; **X10**: 1000-grains weight ; **X11**: Biological yield per plant ; **X12**: Harvest index; **X13**: Grain yield per plant

expression of traits was not only due to genotype but also varying influence of environment. The highest PCV was observed for number of ears per plant (32.08%) followed by grain yield per plant (25.62%), number of productive tillers per plant (25.22%), biological yield per plant (23.60%), harvest index (21.53%), ear weight (13.84%), number of spikelets per ear (7.51%), grains per ear (7.51%), 1000-grain weight (7.50%), plant height (6.55%), ear length (6.30%), days to 50% heading (3.45%) and days to maturity (1.55%). In case of GCV, the highest estimate was observed for number of ears per plant (31.95%), number of productive tillers per plant (18.76%), harvest index (14.58%), grain yield per plant (14.36%), biological yield per plant (13.79%), ear weight (11.08%), plant height (6.02%), 1000-grain weight (4.52%), number of spikelets per ear (4.32%), grains per ear (4.32%), ear length (3.58%), days to 50% heading (2.00%) and days to maturity (0.87%). The findings were in agreement with previous study in wheat (Gollen *et al*., 2011). Similar results were also reported by Kaul and Singh, 2011; Kumar *et al*., 2013, Yadav *et al*., 2014).

Genetic advance expressed as per cent of mean

The highest genetic advance (Table 3) expressed as per cent of mean was found for number of ears per plant (65.56%), number of productive tillers per plant (28.74%), harvest index (20.34%), ear weight (18.26%), biological yield per plant (16.59%), grain yield per plant (16.58%), plant height (11.42%), 1000-grain weight (5.61%), number of spikelets per ear (5.12%), grains per ear (5.12%), ear length (4.19%), days to 50% heading (2.39%) and days to maturity (1.00%). High values of genetic advance are indicative of additive gene action whereas low values are indicative of non-additive gene action. Similar findings was observed by Nukasani *et al*., (2013) and Sharma (2016).

Heritability

The proportion of variability inherited from parents to off spring is manifested by heritability (Lush, 1949). The estimates of heritability (Table 3) varied from 31.33% for days to maturity and grain yield per plant to 99% for number of ears per plant. Among all the characters number of ears per plant (99.20%) recorded highest

Table 3 : Estimation of variability, heritability and genetics advance as percent of mean in wheat.

Characters	Range		General mean	Coefficient of variance (%)		h^2 (Broad Sense)%	Genetic Advancement 5%	Genetic Advance as % of Mean 5%
	Min	Max		PCV	GCV			
Days to 50% heading	94.67	103.00	100.88	3.45	2.00	33.65	2.41	2.39
Days to maturity	148.00	154.00	150.76	1.55	0.87	31.33	1.51	1.00
Plant height	88.53	109.60	100.79	6.55	6.02	84.64	11.51	11.42
Number of productive tillers/plant	6.20	12.53	8.29	25.22	18.76	55.30	2.38	28.74
Number of spikelts/ear	16.93	20.73	18.58	7.51	4.32	33.08	0.95	5.12
Ear length	9.90	11.60	10.72	6.30	3.58	32.28	0.45	4.19
Ear weight	2.08	3.04	2.62	13.84	11.08	64.01	0.48	18.26
Number of ears/plant	5.45	15.76	8.67	32.08	31.95	99.20	5.68	65.56
Grains per ear	50.80	62.20	55.75	7.51	4.32	33.08	2.85	5.12
1000 grain weight	38.20	44.83	41.24	7.50	4.52	36.29	2.31	5.61
Biological yield/plant	41.00	72.47	58.27	23.60	13.79	34.12	9.67	16.59
Harvest index	15.82	31.43	23.83	21.53	14.58	45.86	4.85	20.34
Grain yield per plant	10.40	19.80	13.56	25.62	14.36	31.42	2.25	16.58

Table 4 : Mean table.

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
DPW-621-50	101.67	151.00	97.13	7.80	17.93	10.27	2.72	9.05	53.80	43.93	61.20	23.21	14.08
JW-3211	102.67	152.33	102.73	6.20	19.53	10.73	2.88	6.83	58.60	42.53	52.93	23.84	12.60
DBW-14	101.67	151.00	93.47	7.40	20.73	11.60	3.04	7.60	62.20	38.20	46.00	23.19	10.40
WH-1105	94.67	151.67	104.60	7.60	19.00	10.83	3.02	7.80	57.00	39.30	57.00	23.14	13.18
DBW-17	103.00	148.33	88.53	8.00	17.73	9.90	2.08	7.62	53.20	38.27	41.00	31.43	12.84
PBW-723	102.33	149.33	100.40	7.40	18.40	10.60	2.39	5.45	55.20	44.83	72.47	15.82	11.21
PBW-725	102.67	148.00	107.33	6.93	19.33	10.57	2.65	7.96	58.00	42.03	58.00	20.42	11.78
PBW-550	98.00	151.00	97.00	8.73	18.73	11.53	2.79	7.96	56.20	40.23	60.33	26.49	15.75
DBW-71	100.33	150.67	103.53	8.33	16.93	10.53	2.61	7.81	50.80	42.10	50.67	26.26	13.03
DBW-39	103.00	151.00	109.60	10.27	18.07	10.87	2.34	11.51	54.20	43.20	69.67	20.98	14.53
CBW-38	99.67	154.00	104.40	12.53	18.00	10.43	2.25	15.76	54.00	38.97	71.67	27.35	19.80
Mean	100.88	150.76	100.79	8.29	18.58	10.72	2.62	8.67	55.75	41.24	58.27	23.83	13.56
C.V.	2.81	1.28	2.57	16.86	6.14	5.19	8.31	2.87	6.14	5.99	19.16	15.84	21.22

X1: Days to 50% Heading; **X2:** Days to Maturity; **X3**: Plant Height cm; **X4**: Number of Productive Tillers per Plant; **X5**: Number of Spikelets per Ear; **X6**: Ear Length ;**X7**: Ear weight ; **X8:**Number of Ears per Plant; **X9**: Grains per Ear; **X10**: 1000 grains weight ; **X11**: Biological yield per Plant ; **X12**: Harvest Index ; **X13**: Grain Yield per Plant.

estimates followed by plant height (84.64%), ear weight (64.01%). While in present study, low heritability was also reported for number of productive tillers per plant (55.30%), harvest index (45.86%), 1000 grain weight (36.29%), biological yield per plant (34.12%), days to 50% heading (33.65%), number of spikelets per ear (33.08%), grains per ear (33.08%), ear length (32.28%), grain yield per plant (31.42%) and days to maturity (31.33%). Similar findings were reported by Khan and Hassan (2017) and Wahidy *et al*., (2016).

In general ears per plant revealed high heritability with high genetic advance. This indicates substantial contribution of additive gene action in the expression of the characters. Hence, direct selection for such characters would be more effective. The estimates of high heritability (broad sense) and high genetic advance indicate that improvement in these traits could be possible by direct selection. High heritability coupled with moderate genetic advance was observed for plant height and ear weight suggested predominance of non- additive gene action hence; direct selection for such characters would mislead the expected results.

Correlation coefficient

The genotypic and phenotypic correlation co-efficient of component characters with seed yield were estimated (Table 5) to study how seed yield was influenced by its component characters. The correlation coefficient estimated positive and significant genotypic and phenotypic correlation in number of ears per plant (1.138, 0.628), number of productive tillers per plant (0.931, 0.830), days to maturity (0.959, 0.454), biological yield per plant (0.407, 542), harvest index (0.436, 0.429) while negative and significant genotypic correlation in days to 50% heading (-0.630), number of spikelets per ear (-1.010), ear length (-0.430), ear weight (-0.608), grains per ear (-1.010), 1000 grain weight (-0.399) with grain yield per plant.

Days to 50% heading implied positive significant at genotypic level in 1000 grain weight (0.481) and negative significant at genotypic level in ear weight (-0.701), days to maturity (-0.787), days to maturity implied positive significant at both levels in number of ears per plant (0.798, 0.440), number of productive tillers per plant (0.705, 0.383) and positive at genotypic level in biological yield per plant (0.437), ear length (0.399), plant height (0.386). Plant height implied positive significant at both levels in biological yield per plant (0.793, 0.432), 1000 grain weight (0.524, 0.344) and positive at genotypic level in number of ears per plant (0.354) and negative at genotypic level in harvest index (-0.644). Number of productive tillers per plant implied positive significant at both levels in number of ears per plant (1.039, 0.766), biological yield per plant (0.429, 0.610) positive at genotypic level in harvest index (0.375) and negative at genotypic level in ear weight (-0.649), grains per ear (-0.765), number of spikelets per ear (-0.765). Number of spikelets per ear implied positive significant at both levels in grains per ear (1.000, 1.000), ear weight (0.768, 0.581), ear length (0.648, 0.649)and negative at genotypic level in number of ears per plant (-0.359), biological yield per plant (-0.377), 1000 grain weight (-0.660), harvest index (-0.710). Ear length implied positive significant at both levels in ear weight (0.766, 0.580), grains per ear (0.648, 0.649)

Table 5: Genotypic (G) and Phenotypic (P) coefficient of correlation among different characters in wheat genotype.

Character		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
X1	G	**1.000**	-0.787**	-0.196 ^{NS}	-0.234^{NS}	-0.177^{NS}	-0.621^{NS}	-0.701**	-0.122^{NS}	-0.177^{NS}	0.481**	-0.129^{NS}	-0.329^{NS}	-0.630**
	P	**1.000**	-0.178^{NS}	-0.052^{NS}	-0.092^{NS}	0.096^{NS}	-0.116^{NS}	-0.222^{NS}	-0.067^{NS}	0.096^{NS}	0.327^{NS}	-0.034^{NS}	-0.037^{NS}	-0.114^{NS}
X2	G		**1.000**	0.386*	0.705**	0.008^{NS}	0.399*	0.157^{NS}	0.798**	0.008^{NS}	-0.291^{NS}	0.437*	0.240^{NS}	0.959**
	P		**1.000**	0.162^{NS}	0.383*	0.056^{NS}	0.151^{NS}	0.289^{NS}	0.440*	0.056^{NS}	-0.100^{NS}	0.256^{NS}	0.134^{NS}	0.454**
X3	G			**1.000**	0.252^{NS}	-0.234^{NS}	-0.052^{NS}	0.028^{NS}	0.354*	-0.234^{NS}	0.524**	0.793**	-0.644**	0.244^{NS}
	P			**1.000**	0.259^{NS}	0.043^{NS}	0.150^{NS}	0.088^{NS}	0.332^{NS}	0.043^{NS}	0.344*	0.432*	-0.294^{NS}	0.239^{NS}
X4	G				**1.000**	-0.765**	-0.183^{NS}	-0.649**	1.039**	-0.765**	-0.429^{NS}	0.429*	0.375*	0.931**
	P				**1.000**	-0.165^{NS}	0.008^{NS}	-0.402^{NS}	0.766**	-0.165^{NS}	-0.060^{NS}	0.610**	0.223^{NS}	0.830**
X5	G					**1.000**	0.648**	0.768**	-0.359*	1.000**	-0.660**	-0.377*	-0.710**	-1.010**
	P					**1.000**	0.649**	0.581**	-0.207^{NS}	1.000**	-0.005^{NS}	-0.104^{NS}	0.008^{NS}	-0.057^{NS}
X6	G						**1.000**	0.766**	-0.193^{NS}	0.648**	-0.388*	0.223^{NS}	-0.697**	-0.430*
	P						**1.000**	0.580**	-0.087^{NS}	0.649**	-0.058^{NS}	-0.113^{NS}	0.118^{NS}	0.057^{NS}
X7	G							**1.000**	-0.435*	0.768**	-0.110^{NS}	-0.265^{NS}	-0.452**	-0.608**
	P							**1.000**	-0.345*	0.581**	-0.034^{NS}	-0.257^{NS}	-0.005^{NS}	-0.172^{NS}
X8	G								**1.000**	-0.359*	-0.314^{NS}	0.597**	0.347*	1.138**
	P								**1.000**	-0.207^{NS}	-0.181^{NS}	0.327^{NS}	0.250^{NS}	0.628**
X9	G									**1.000**	-0.660**	-0.377*	-0.710**	-1.010**
	P									**1.000**	-0.005^{NS}	-0.104^{NS}	0.008^{NS}	-0.057^{NS}
X10	G										**1.000**	0.735**	-1.021**	-0.399*
	P										**1.000**	0.372*	-0.425*	-0.070^{NS}
X11	G											**1.000**	-0.639**	0.407*
	P											**1.000**	-0.495**	0.542**
X12	G												**1.000**	0.436*
	P												**1.000**	0.429*

X1: Days to 50% Heading; **X2:** Days to Maturity; **X3**: Plant Height cm; **X4**: Number of Productive Tillers per Plant; **X5**: Number of Spikelets per Ear; **X6**: Ear Length; **X7**: Ear weight ; **X8:**Number of Ears per Plant; **X9**: Grains per Ear; **X10**: 1000 grains weight; **X11**: Biological yield per Plant ; **X12**: Harvest Index ; **X13**: Grain Yield per Plant.

negative at genotypic level in 1000 grain weight (-0.388), harvest index (-0.697). Ear weight implied positive significant at both levels in grains per ear (0.768, 0.581) and negative significant at both levels in number of ears per plant (-0.435, -0.345) and negative at genotypic level in harvest index (-0.452). Number of ears per plant implied positive significant at genotypic level in biological yield per plant (0.597), grains per ear (0.359), harvest index (0.347). Grains per ear implied negative significant at genotypic level in biological yield per plant (-0.377), 1000 grain weight (-0.660), harvest index (-0.710). 1000 grain weight implied positive significant at both levels in biological yield per plant (0.735, 0.372) and implied negative significant at both levels in harvest index (-1.021, (-0.425), Biological yield per plant implied negative significant at both levels in harvest index (-0.639, -0.495). Similar finding reported by Bhushan *et al*., (2013) and Avinashe *et al.,* (2017).

Path analysis

The data (Table 6) revealed that number of grains per ear (4.526) had the highest direct positive effect towards the grain yield followed by days to maturity (1.162), harvest index (0.806), biological yield per plant (0.3142), days to 50% heading (0.304), 1000 grains weight (0.265), plant height (0.1046), number of productive tillers per plant (0.096) and ear length (-0.023), ear weight (-0.219), ears per plant (-0.352), number of spikelets per ear (-4.470) imposed negative direct effect. This result supports the findings of Ali *et al*., (2008) and Subhashchandra *et al*., (2009).

Days to maturity had high positive indirect effect *via* number of ears per plant (0.9276), number of productive tillers per plant (0.8191), biological yield per plant (0.5078), ear length (0.4635) and plant height (0.4486). Moderate indirect effect of number of spikelets per ear was positive via number of productive tillers per plant (3.4200), harvest index (3.1745), 1000 grains weight (2.9515), biological yield per plant (1.6858), number of ears per plant (1.6064), plant height (1.0478) and days to 50% heading (0.7906). Number of grains per ear exhibited high positive indirect

Table 6: Path coefficient showing direct (diagonal) and indirect effect (off diagonal) of different characters on grain yield/Plant in wheat.

Character	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
X1	**0.3043**	-0.2396	-0.0597	-0.0713	-0.0538	-0.1890	-0.2134	-0.0371	-0.0538	0.1464	-0.0393	-0.1001	-0.630
X2	-0.9149	**1.1620**	0.4486	0.8191	0.0091	0.4635	0.1823	0.9276	0.0091	-0.3380	0.5078	0.2784	0.959
X3	-0.0205	0.0404	**0.1046**	0.0264	-0.0245	-0.0054	0.0030	0.0371	-0.0245	0.0549	0.0829	-0.0673	0.244
X4	-0.0225	0.0677	0.0242	**0.0961**	-0.0735	-0.0176	-0.0624	0.0998	-0.0735	-0.0412	0.0412	0.0360	0.931
X5	0.7906	-0.0348	1.0478	3.4200	**-4.4700**	-2.8960	-3.4339	1.6064	-4.4700	2.9515	1.6858	3.1745	-1.010
X6	0.0148	-0.0095	0.0012	0.0044	-0.0154	**-0.0238**	-0.0182	0.0046	-0.0154	0.0092	-0.0053	0.0166	-0.430
X7	0.1538	-0.0344	-0.0062	0.1424	-0.1685	-0.1679	**-0.2193**	0.0953	-0.1685	0.0240	0.0581	0.0991	-0.608
X8	0.0430	-0.2815	-0.1249	-0.3662	0.1267	0.0680	0.1533	**-0.3526**	0.1267	0.1106	-0.2104	-0.1222	1.138
X9	-0.8006	0.0353	-1.0610	-3.4632	4.5266	2.9327	3.4774	-1.6267	**4.5266**	-2.9889	-1.7071	-3.2147	-1.010
X10	0.1275	-0.0771	0.1390	-0.1136	-0.1750	-0.1028	-0.0291	-0.0832	-0.1750	**0.2650**	0.1948	-0.2706	-0.399
X11	-0.0406	0.1373	0.2490	0.1347	-0.1185	0.0701	-0.0832	0.1875	-0.1185	0.2309	**0.3142**	-0.2008	0.407
X12	-0.2653	0.1933	-0.5190	0.3023	-0.5728	-0.5621	-0.3645	0.2795	-0.5728	-0.8236	-0.5155	**0.8065**	0.436
Partial R^2	-0.1918	1.1143	0.0255	0.0894	4.5133	0.0103	0.1334	-0.4013	-4.5704	-0.1058	0.1279	0.3513	

R SQUARE = 1.0960 RESIDUAL EFFECT =SQRT (1- 1.0960)

X1: Days to 50% Heading; **X2:** Days to Maturity; **X3**: Plant Height cm; **X4**: Number of Productive Tillers per Plant; **X5**: Number of Spikelets per Ear; **X6**: Ear Length; **X7**: Ear weight; **X8:**Number of Ears per Plant; **X9**: Grains per Ear; **X10**: 1000 grains weight; **X11**: Biological yield per Plant ; **X12**: Harvest Index ; **X13**: Grain Yield per Plant.

effect via number of spikelets per ear (4.5266), ear weight (3.4774) and ear length (2.9327). Biological yield per plant had moderate positive indirect effect via plant height (0.2490), 1000 grains weight (0.2309). Harvest index had high positive indirect effect via number of productive tillers per plant (0.3023). Similar findings reported by Gupta *et al.,* (2007) and Bhushan *et al*., (2013).

In the present study, the path coefficient analysis revealed that the grains per ear, days to maturity, harvest index, biological yield per plant, days to 50% heading, 1000 grains weight, plant height, no of productive tillers per plant exhibited high and positive direct effects on seed yield per plant. Thus, these characters turned-out to be the major components of seed yield and direct selection for these traits would be rewarding for yield improvement.

It can also be concluded that the characters which are most important for correlation studies are also important for path analysis. Thus, it can be suggested that correlation and path analysis study should be consider together for rapid gain for final improvement in seed yield.

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