

Electronic Journal of Plant Breeding

Research Article



Genetic variability and correlation in maize inbred lines under irrigated and moisture stress condition

P. Bharathi^{1*}, R. Ravikesavan¹, A. Yuvaraja², N. Manikanda Boopathi³ and K. Iyanar¹

¹ Department of Millets, Centre for Plant Breeding and Genetics, TNAU, Coimbatore, Tamil Nadu, India.

² Department of Plant Breeding and Genetics, AC&RI, TNAU, Madurai, Tamil Nadu, India.

³ Department of Plant Molecular Biology and Bioinformatics, TNAU, Coimbatore, Tamil Nadu, India.

*E-Mail: bharathiagriento4@gmail.com

Abstract

Maize, one of the most widely grown cereals in the world and is called as queen of cereal due to its productivity. The experiment was conducted to assess the extent of genetic variability and correlation for yield and its attributing traits under irrigated and moisture stress conditions (stress imposed during flowering stage) at two locations *viz.*, Department of Millets, TNAU, Coimbatore and Maize Research Station, Vagarai. A total of thirteen biometrical parameters were recorded. High values of GCV, heritability and genetic advance per cent, respectively was noted for the traits Anthesis Silking Interval (ASI) (36.51, 78.51 & 66.63%), number of kernels per row (29.08, 80.50 & 53.75%), hundred grain weight (28.54, 82.16 & 53.29%) and yield (21.37, 73.85 & 37.83%) under irrigated condition, and the traits cob yield (29.78, 71.49 & 51.87%), ASI (29.03, 72.52 & 50.93%), hundred grain weight (26.86, 80.76 & 49.73%) and cob placement height (21.34, 78.75 & 39.01%) under stress condition. This indicates that the selection based on these traits may be influenced by additive gene action and would be quite effective. The correlation analysis revealed a positive association of the traits hundred grain weight (0.592, 0.536), number of kernels per row (0.430, 0.397), number of kernel rows per cob (0.415, 0.382) and plant height (0.303, 0.316) with grain yield under both ecosystems (irrigated and moisture stress) and these traits can be given importance while the selection of promising individuals for grain yield. Days to 50% per cent tasseling (-0.496, -0.240) and silking (-0.565, -0.358) recorded significant negative association with yield and it can be used for the development of early duration lines. Further the significant negative ASI could be exploited to develop drought tolerant inbred lines in maize.

Key words: *Zea mays*, water stress, ASI, GCV, heritability, genotypic correlation.

INTRODUCTION

Maize (*Zea mays* L.), the wonder crop, is the third most important crop in the world. Being a multipurpose crop, it plays an important role in cropping systems throughout the world. Worldwide, the most significant environmental stress in agriculture is Drought. Improving yield under drought is a major goal of maize breeding since it serves as major food and feed for semi-arid and tropics. Critical evaluation of breeding material through genetic variability, broad sense heritability, correlation and interrelationship among grain yield and its components is a pre-requisite

for a consolidated breeding programme (Venugopa *et al.*, 2003; Bartaula *et al.*, 2019 and Izzam *et al.*, 2017). The existence of resistance to biotic and abiotic factors and wide adaptability in the genotypes depends on the variability among the genotypes. Selection is effective when there is genetic variability among the individuals in a population. Hence, understanding the magnitude of genetic variability present in a population is most essential for a plant breeder to a judicious breeding programme. Knowledge of heritability and genetic advance of

character indicates the scope for improvement of the crop through selection. Correlation studies are an effective tool for determining the relationship among the agronomic traits of genetically diverse populations. Besides that, correlations among the traits of importance will pave the way for effective selections in breeding programmes and analysis of correlation coefficient is the most widely used to understand the relationship between the characters (Yagdi and Sozen, 2009).

MATERIALS AND METHODS

A total of sixty two drought tolerant inbred lines which was screened previously at MRS Vagarai and were found to poses varying degrees of drought tolerant and were evaluated in two locations viz., Department of Millets, Tamil Nadu Agricultural University, Coimbatore and Maize Research Station, Vagarai. The experiment was conducted in randomized block design at a spacing of 60 x 20 cm with two rows of each entry and was subjected to irrigated and moisture stress conditions in both locations. Moisture stress was given at the flowering stage by withholding irrigation. Observations for 13 traits viz., days to 50 per cent tasseling, days to 50 per cent silking, Anthesis Silking Interval (ASI), plant height, tassel height, number of tassel branches, cob placement height, cob length, cob girth, number of kernel rows per cob, number of kernels per row, hundred grain weight and cob yield were recorded in five randomly selected plants.

The mean values of irrigated and water stress condition, (both the locations) data were subjected to pooled and analysed separately. These pooled values were used to calculate the genotypic coefficient of variance (Burton, 1952), Broad sense heritability (Lush, 1940), Genetic advance, Genetic advance as per cent of mean and genotypic correlation coefficient (Johnson *et al.*, 1955).

RESULTS AND DISCUSSION

The pooled analysis of variance was done to find the significant difference among the inbred lines. It revealed that the inbred lines tested differed significantly even at one per cent level of probability for all characters studied. The mean sum of squares for all the characters is presented in **Tables 1 and 2**.

The basic information about the genetic properties of the population can be known through genetic variability studies. With this information, the a suitable breeding method can be formulated for crop improvement. In addition, this provides knowledge about the nature and extent of variability that can be attributed to different causes, crop sensitivity to environmental influences, the heritability of the characters and genetic advances that can be understood in practical breeding.

The estimates on variability parameters are presented in **Tables 3** for irrigated and moisture stress condition. It was detected that the traits showed high phenotypic

Table 1. Pooled ANOVA for various characters under irrigated condition

Source	DF	Mean square												
		50%T	50%S	ASI	PH	TL	NTB	CH	CL	CG	NR/C	NK/R	100SW	Y
Genotype	61	68.05**	66.59**	6.09**	1650.92**	85.39**	6.98**	577.74**	25.58**	8.07**	9.32**	113.24**	155.56**	842985**
Location	1	10.90**	33.39**	5.82**	3904.29**	601.98**	0.29**	1887.09**	30.73**	122.92**	222.68**	248.0**	30.73**	10798647**
G X L	61	2.12**	1.81**	1.49**	414.58**	28.04**	3.90**	127.45**	2.18**	1.72**	3.18**	2.14**	2.17**	263684**
Error	122	8.86	7.59	0.39	109.50	13.20	0.53	33.4	2.20	0.86	0.43	7.61	8.01	68543

** Significant at P=0.01

Table 2. Pooled ANOVA for various characters under moisture stress condition

Source	DF	Mean square												
		50%T	50%S	ASI	PH	TL	NTB	CH	CL	CG	NR/C	NK/R	100SW	Y
Genotype	61	147.70**	85.46**	13.87**	133.39**	80.21**	5.08**	422.58**	14.96**	7.44**	9.40**	11.01**	72.98**	797285**
Location	1	45.30**	158.08**	47.03**	3837**	421.66**	4.66**	1269**	30.75**	30.78**	90.72**	3.62**	30.73**	11546310**
G X L	61	3.26**	2.83**	1.81**	467.83**	36.33**	3.88**	148.45**	1.57**	2.17**	2.25**	1.34*	1.87**	183785**
Error	122	17.60	10.70	1.20	14.20	14.10	0.46	26.7	1.40	0.89	0.51	0.67	4.10	69542

** Significant at P=0.01

50% T - Days to 50% tasseling

50% S - Days to 50% silking

ASI - Anthesis silking interval

PH - Plant height

TL - Tassel length

NTB - Number of tassel branches

CH - Cob height

CL - Cob length

CG - Cob girth

NR/C - Number of kernel rows per ear

NK/R - Number of kernels per row

100SW - 100 seed weight

Y - Yield

coefficients of variation than genotypic coefficients of variation under irrigated as well as moisture stress conditions. In an irrigated ecosystem, high GCV and PCV were recorded for an anthesis-silking interval, a number of kernels per row, hundred grain weight and yield, while cob placement height and cob length recorded high PCV and moderate GCV. Similar results were obtained by Bhusal *et al.* (2017) and Bisen *et al.* (2018) and Islam *et al.* (2020) for grain yield per plant and ear height. Bartaula *et al.* (2019) reported high PCV and GCV for ASI and kernel per cob. Similarly Gazal *et al.* (2017) and Dar *et al.* (2018) reported high GCV and PCV for ASI and cob height. The traits *viz.*, plant height, tassel length, number of tassel branches, cob girth and number of kernel rows per cob recorded moderate GCV and PCV under irrigated conditions. These results were in line with the results obtained by Belay (2018) and Varalakshmi *et al.* (2018) for grain yield and kernel row per cob. Days to 50 per cent tasseling and days to 50 per cent silking exhibited low GCV and PCV under irrigated conditions.

In moisture stress conditions, the traits cob yield, anthesis-silking interval, hundred grain weight and cob placement height recorded high GCV and PCV, suggesting that selection can be made for these traits to get higher yield

in maize genotypes. Low GCV and PCV were observed for days to 50 per cent tasseling and days to 50 per cent silking under both irrigated and moisture stress condition. Belay (2018) and Islam *et al.* (2020) reported low PCV and GCV for days to 50 per cent tasseling and days to 50 per cent silking.

In the present investigation, high heritability was recorded in both irrigated and moisture stress conditions for all traits except tassel height. Although the basic knowledge on selection based on phenotypic performance can be gained through heritability estimates, the heritability estimate together with genetic advance should always be considered simultaneously for the selection of the best lines. Johnson *et al.* (1955) pointed out high heritability will not always be accompanied by high genetic advances. Heritability gives the information on the magnitude of quantitative characters, while genetic advance would be helpful in calculating suitable selection procedures. High heritability accompanied with high genetic advance as per cent of mean was observed for the traits *viz.*, ASI, number of tassel branches, cob placement height, cob length, cob girth, number of kernel rows per cob, number of kernels per row, hundred grain weight and yield under both irrigated and moisture stress condition. Hence, selection

Table 3. Variability parameters for grain yield and yield attributing traits in maize in irrigated condition (Pooled mean)

S. No.	Traits		Mean	Range		GCV %	PCV %	h ² % (broad sense)	GA as per cent of mean
				Maximum	Minimum				
1	Days to 50% tasseling	IR	60.95	71.00	53.75	6.27	7.93	62.55	10.21
		WS	62.49	77.50	53.75	9.13	11.33	64.89	15.14
2	Days to 50% silking	IR	64.04	72.00	55.25	5.95	7.32	66.03	9.96
		WS	68.48	80.50	57.25	6.33	7.93	63.72	10.41
3	Anthesis-silking interval	IR	3.08	5.50	1.00	36.51	41.20	78.51	66.63
		WS	6.13	9.50	2.75	29.03	34.09	72.52	50.93
4	Plant height (cm)	IR	123.99	167.88	81.55	15.83	17.94	77.86	28.77
		WS	98.31	144.80	64.55	5.55	6.75	67.73	9.41
5	Tassel length (cm)	IR	31.72	45.28	22.05	13.39	17.62	57.76	20.97
		WS	28.46	39.70	19.10	14.28	19.45	53.96	21.62
6	Number of tassel branches	IR	9.74	13.25	7.00	13.04	15.03	75.26	23.30
		WS	8.72	11.25	6.00	12.32	14.57	71.52	21.47
7	Cob placement height (cm)	IR	58.92	90.45	33.83	19.80	22.10	80.29	36.55
		WS	46.62	72.03	25.55	21.34	24.05	78.75	39.01
8	Cob length (cm)	IR	13.73	22.43	9.23	17.96	21.07	72.65	31.54
		WS	11.54	17.78	8.18	15.95	18.97	70.77	27.65
9	Cob girth (cm)	IR	11.05	15.35	8.85	12.15	14.77	67.70	20.59
		WS	9.91	15.55	6.28	12.91	16.04	64.79	21.41
10	Number of kernel rows/cob	IR	11.53	16.00	9.00	12.84	14.03	83.79	24.21
		WS	10.19	13.25	7.50	14.63	16.22	81.33	27.18
11	Number of kernels per row	IR	18.98	33.00	9.50	29.08	32.42	80.50	53.75
		WS	11.62	18.50	8.75	13.84	15.53	79.71	25.40
12	100-grain weight (g)	IR	22.00	41.13	11.83	28.54	31.49	82.16	53.29
		WS	15.45	26.78	9.53	26.86	29.89	80.76	49.73
13	Yield (kg/ha)	IR	2059.18	3262.06	752.67	21.37	24.86	73.85	37.83
		WS	1402.55	2745.08	617.10	29.78	35.22	71.49	51.87

GCV - Genotypic coefficient of variance; PCV - Phenotypic coefficient of variance; h² - Heritability; GA - Genetic Advance; IR - irrigated; WS - Water stress

for these traits would prove quite effective. These results were in agreement with the results obtained by Bartaula *et al.* (2019) for plant height, ear height, ASI and kernel row per cob, Ahmed *et al.* (2020) for cob yield, Islam *et al.* (2020) for ASI, cob height, cob diameter cob length and plant height, Kumar *et al.* (2017) and Wali (2019) for plant height and grain yield. In the same way Devi (2020) also reported high heritability with high genetic advance for the traits seeds yield per plant, seed yield per cob, total seeds per cob.

The combination of high GCV, high heritability and genetic advance will provide much more information than a single parameter alone (Sahao *et al.*, 1990). In this study, the traits ASI, number of kernels per row, hundred grain weight and yield under irrigated condition, and the traits cob yield, ASI, hundred grain weight and cob placement height under stress condition recorded high values of GCV, heritability and genetic advance. Hence, these traits can be looked upon for yield improvement.

In plant breeding, the mutual relationship between various plant characters can be studied through correlation

coefficient analysis which determines the component characters on which selection can be made for genetic improvement in yield. Yield is a complex character that depends upon a number of independent characters that would contribute directly or indirectly. The knowledge on correlation helps in determining the components of complexity. As this investigation would be useful to formulate selection criteria, the correlation was studied. In the present investigation, the genotypic correlation between pairs of characters had been studied to identify the component traits that were closely related to grain yield.

A genotypic pooled correlation coefficient of inbred lines under irrigated condition and moisture stress condition is given in **Table 4** (Data were pooled separately for irrigated condition and moisture stress condition). Days to 50 per cent tasseling and silking recorded a negative and significant correlation with grain yield under irrigated conditions. In stress conditions, days to 50 per cent silking (-0.358) had a significant negative correlation and days to 50 per cent tasseling (-0.240) had a non-significant negative correlation with yield (**Table 4**). These findings

Table 4. Genotypic correlation coefficient (pooled) of inbred lines under irrigated and water stress condition.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 IR	1.000	0.958**	-0.197	-0.456**	-0.355**	-0.155	-0.429**	-0.290*	-0.297*	0.033	-0.257*	-0.208	-0.496**
1 WS	1.000	0.922**	-0.109	-0.467**	-0.447**	-0.167	-0.354**	0.217	-0.231	0.101	-0.354**	0.011	-0.240
2 IR		1.000	0.491**	-0.486**	-0.393**	-0.106	-0.468**	-0.373**	-0.391**	0.026	-0.323*	-0.319*	-0.565**
2 WS		1.000	0.299**	-0.455**	-0.423**	-0.168	-0.327**	-0.317*	-0.338**	0.088	-0.438**	-0.081	-0.358**
3 IR			1.000	-0.076	-0.112	0.181	-0.111	-0.266*	-0.303*	-0.024	-0.212	-0.365**	-0.277*
3 WS			1.000	-0.009	-0.020	-0.026	0.019	-0.263*	-0.291*	-0.015	-0.248*	-0.245	-0.338*
4 IR				1.000	0.765**	0.572**	0.876**	0.547**	0.478**	0.297*	0.399**	0.380**	0.303*
4 WS				1.000	0.632**	0.415**	0.780**	0.423**	0.358**	0.292*	0.275*	0.149	0.316*
5 IR					1.000	0.469**	0.644**	0.531**	0.467**	0.362**	0.350**	0.364**	0.182
5 WS					1.000	0.399**	0.675**	0.324*	0.220	0.177	0.329**	0.129	0.362**
6 IR						1.000	0.595**	0.226	0.091	0.150	0.413**	0.149	0.211
6 WS						1.000	0.544**	0.214	0.183	0.060	0.230	-0.015	-0.016
7 IR							1.000	0.462**	0.422**	0.153	0.342**	0.328**	0.332**
7 WS							1.000	0.344**	0.244	0.097	0.347**	0.229	0.089
8 IR								1.000	0.685**	0.459**	0.591**	0.678**	0.378**
8 WS								1.000	0.596**	0.366**	0.647**	0.394**	0.200
9 IR									1.000	0.603**	0.456**	0.793**	0.337**
9 WS									1.000	0.686**	0.553**	0.526**	0.135
10 IR										1.000	0.413**	0.219	0.415**
10 WS										1.000	0.195	0.197	0.382**
11 IR											1.000	0.321*	0.430**
11 WS											1.000	0.466**	0.397**
12 IR												1.000	0.592**
12 WS												1.000	0.536**
13 IR													1.000
13 WS													1.000

1. Days to 50% tasseling
2. Days to 50% silking
3. Anthesis silking interval

4. Plant height
5. Tassel length
6. Number of tassel branches

7. Cob placement height
8. Cob length
9. Cob girth

10. Number of kernel rows per ear
11. Number of kernels per row
12. 100 seed weight
13. Yield

** Significant at 1% level

* Significant at 5% level

IR – Irrigated condition

WS – Water Stress condition

are in accordance with Soumya and Kamatar (2017) and Devasree *et al.* (2020)

Anthesis-silking interval, the important criteria for drought tolerance showed significant negative association under irrigated and moisture stress conditions with grain yield. This result was in line with the findings of Bartaula *et al.* (2019). Plant height was positively correlated with grain yield under both irrigated and moisture stress ecosystems. These results were in agreement with Kumar *et al.* (2017), Chandana *et al.* (2018) Aman *et al.* (2020) and Devasree *et al.* (2020) for plant height. Tassel length and number of tassel branches exhibited non-significant positive correlation with grain yield under irrigated condition, whereas under moisture stress conditions, the number of tassel branches showed a negative correlation with grain yield. Chandana *et al.* (2018) reported a non-significant negative correlation for, tassel length and the number of tassel branches over grain yield. Cob length (0.378) and cob girth (0.337) was positively and significantly associated with grain yield under irrigated condition. The results of Sesay *et al.* (2017) matches with the present study where they reported positive influence on ear height, ear diameter and ear length on grain yield. Correspondingly, Devasree *et al.* (2020) and Ahmed *et al.* (2020) also reported a positive association of cob length and girth with grain yield. Under moisture stress conditions, cob length and girth recorded a non-significant positive correlation with grain yield. The number of kernel rows per cob, the number of kernels per row and hundred grain weight registered significant positive correlation with grain yield in both irrigated and moisture stress conditions, respectively. Belay (2018) and Bartaula *et al.* (2019) reported a significant positive association with grain yield for these traits. In the studies conducted by Devasree *et al.* (2020) hundred grain weight was found to have a significant positive association with grain yield. Similarly, Varalakshmi *et al.* (2018) and Sesay *et al.* (2017) also observed a direct positive effect of a number of kernels per row and days to maturity on the grain yield of single cross hybrids in maize. Khalili *et al.* (2013) recorded the highest correlation for the total number of grains per ear, number of grains per row under severe drought stress condition. Khodarahmpour (2013) reported that grain filling period, grain number per ear, grain number per row and grain width had a positive and significant correlation with grain yield under drought stress conditions.

Finally, the results concluded that in the selection process, the traits exhibiting positive and significant association with grain yield under both irrigated and moisture stress ecosystems can be given importance while selecting individuals for grain yield. The traits *viz.*, hundred grain weight, number of kernel rows per cob, number of kernels per row and plant height recorded positive association with grain yield under both ecosystems. Contrarily, the yield had significant negative genotypic correlations with characters *viz.*, days to 50 per cent tasseling, days

to 50 per cent silking and anthesis-silking interval (ASI) indicating that selection for early tasseling and silking and short ASI is desirable to increase grain yield.

From the variability studies it is concluded that all the characters studied, except tassel length exhibited high heritability under both irrigated and moisture stress conditions indicating the high influence of genetic components. High values of genotypic coefficient of variation, heritability and genetic advance were observed for the traits anthesis-silking interval, hundred grain weight and yield under both irrigated and moisture stress conditions in both the environments (Coimbatore and Vagarai) -indicating that selection based on these characters would be more effective.

ACKNOWLEDGEMENT

The authors are acknowledging the financial assistance in the form of research grant DBT-RGYI scheme (No. BT/PR15026/GBD/27/285/2010), New Delhi for conducting the trials.

REFERENCES

- Ahmed, N., Chowdhury, A. K., Uddin, M. S. and Rashad, M. M. I. 2020. Genetic variability, correlation and path analysis of exotic and local hybrid maize (*Zea mays* L.) genotypes. *Asian Journal of Medical and Biological Research*, **6**(1): 8-15. [[Cross Ref](#)]
- Aman, J., Bantte, K., Alamerew, S. and Sbhatu, D. B. 2020. Correlation and path coefficient analysis of yield and yield components of quality protein maize (*Zea mays* L.) hybrids at Jimma, western Ethiopia. *International Journal of Agronomy*, **2020**: 1-7. [[Cross Ref](#)]
- Bartaula, S., Panthi, U., Timilsena, K., Acharya, S. S. and Shrestha, J. 2019. Variability, heritability and genetic advance of maize (*Zea mays* L.) genotypes. *Research in Agriculture Livestock and Fisheries*, **6**(2): 163-169. [[Cross Ref](#)]
- Belay, N. 2018. Genetic variability, heritability, correlation and path coefficient analysis for grain yield and yield component in maize (*Zea mays* L.) Hybrids. *Advance in Crop Science and Technology*, **6**: 399. [[Cross Ref](#)]
- Bhusal, T., Lal, G. M., Marker, S. and Synrem, G. J. 2017. Genetic variability and traits association in maize (*Zea mays* L.) genotypes. *Annals of Plants and Soil Research*, **19**(1): 59-65
- Bisen, N., Rahangdale, C.P. and Sahu, R.P. 2018. Genetic variability and correlation studies of yield and yield component in maize hybrids (*Zea mays* L.) under kymore plateau and satpura hill region of Madhya

- Pradesh. *International Journal of Agriculture, Environment and Biotechnology*, **11**: 71-77.
- Burton, G.W. 1952. Quantitative inheritance in grasses. Proc. 6th Int. Grassland Cong., **1**: 277 - 283.
- Chandana, A.S., John Joel, A., Ravikesavan, R. and Uma, D. 2018. Genetic variability and correlation studies of yield and phytic acid in F2 populations of maize (*Zea mays* L.). *Electronic Journal of Plant Breeding*, **9**(4): 1469-1475. [Cross Ref]
- Dar, I.A., Sofi, P.A., Dar, Z.A. and Kamaluddin, Lone A. 2018. A Screening of maize genotypes for drought tolerance related trait variability. *International Journal of Current Microbiology and Applied Sciences*, **7**(4):668-682. [Cross Ref]
- Devasree, S., Ganesan, K. N., Ravikesavan, R., Senthil, N. and Paranidharan, V. 2020. Relationship between yield and its component traits for enhancing grain yield in single cross hybrids of maize (*Zea mays* L.). *Electronic Journal of Plant Breeding*, **11**(3): 796-802. [Cross Ref]
- Devi, B. 2020. Appraisal of genetic variability for different quantitative traits in *kharif* maize (*Zea mays* L.) genotypes. *Electronic Journal of Plant Breeding*, **11**(2): 713-715. [Cross Ref]
- Gazal, A., Dar, Z.A., Lone, A.A., Yasin, A., Ali, Y. and Habib, M. 2017. Breeding climate change resilient maize and wheat for food security. *Archives of Agriculture and Environmental Science*, **2**(2):129-133.
- Islam, N. U., Ali, G., Dar, Z. A., Maqbool, S., Baghel, S. and Bhat, A. 2020. Genetic variability studies involving drought tolerance related traits in maize (*Zea mays* L.) in breds. *International Journal of Chemical Studies*, **8**(1): 414-419. [Cross Ref]
- Izzam, A., Sohail, H. R. A., Shahzad Ali, M. and Hussain, Q. 2017. Genetic variability and correlation studies for morphological and yield traits in maize (*Zea mays* L.). *Pure and Applied Biology*, **6**(4): 1234-1243. [Cross Ref]
- Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.*, **47**(7): 314-318. [Cross Ref]
- Khalili, M., Naghavi, M.R., Aboughadareh, A.P. and Rad, H.N. 2013. Evaluation of relationships among grain yield and related traits in Maize (*Zea mays* L.) cultivars under drought stress. *International Journal of Agronomy and Plant Production*, **4** (6): 1251-1255.
- Khodarahmpour, Z. 2013. Study of Some quantitative traits in maize (*Zea mays* L.) inbred lines under the drought stress using multivariate analysis. *International Journal of Agriculture and Crop Science*, **5**(14): 1547-1552.
- Kumar, R, Dubey, R.B., Ameta, K.D., Kunwar, R., Verma, R. and Bisen, P. 2017. Correlation and path coefficient analysis for yield contributing and quality traits in quality protein maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences*, **6**: 2139-2146. [Cross Ref]
- Lush, J.L. 1940. Intra - sire correlation and regression of offspring on dams as a method of estimating heritability of characters. *Proc. Journal of animal science*, **33**: 293 – 301.
- Sahao, S.C., Mishira, S.N. and Mishia, R.S. 1990. Genetic variation in F2 generation of chilli capsicum. *Newsletter* **8**: 29-30.
- Sesay, S., Ojo, D. K., Ariyo, O. J., Meseka, S., Fayeun, L. S., Omikunle, A. O. and Oyetunde, A. O. 2017. Correlation and path coefficient analysis of top-cross and three-way cross hybrid maize populations. *African Journal of Agricultural Research*, **12**(10): 780-789. [Cross Ref]
- Soumya, H. and Kamatar, M. 2017. Correlation and path analysis for yield and yield components in single cross maize hybrids (*Zea mays* L.). *J. Farm Sci.*, **30**(2):153-156.
- Varalakshmi S, Wali M.C., Deshpande S.K. and Harlapur, S.I. 2018. Correlation and path coefficient analysis of single cross hybrids in maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences*, **7**: 1840-1843. [Cross Ref]
- Venugopal, M., Ansari, N.A. and Rajanikanth, T. 2003. Correlation and path analysis in maize (*Zea mays* L.). *Crop Resarch*, **25**(3): 524 – 525.
- Wali, M. C. 2019. Genetic variability and divergence studies in maize (*Zea mays* L.). *EC Agriculture*, **5**: 2014-15.
- Yagdi, K. and E. Sozen. 2009. Heritability, variance components and correlations of yield and quality traits in durum wheat (*Triticum durum* Desf.). *Pakistan Journal of Botany*, **41**(2): 753-759.