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Identification of phenotypic traits to improve bunch weight in *Musa* spp through genetic variability and correlation analysis

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Abstract
An experiment material comprised of 24 banana hybrids were evaluated to study genetic variability and correlation coefficient analysis for components traits associated with bunch weight in banana. The magnitude phenotypic coefficient of variation was higher than genotypic coefficient of variation for all traits. High heritability showed in all the ten characters. High heritability (98.99) with high genetic advance (124.43) was recorded for finger weight. Bunch weight has strong positive association with finger weight (0.89), pseudostem height (0.86) and total number of fingers per hand (0.81). Path coefficient analysis showed maximum positive direct effect on bunch weight was exerted by finger weight (0.553) followed by height of pseudostem (0.447), total number of fingers per hand (0.347), days to harvest (0.142) and number of hands per bunch (0.105) indicating importance of these characters and can be strategically used to improve the bunch weight of banana. The result of this study indicated height of pseudostem, finger weight, number of hands per bunch, total number of fruit per bunch and days to harvest showed high heritability coupled genetic advance, correlation and positive direct path coefficient. Hence, selecting these traits can be used as primary selection criteria for banana yield improvement program.

Keywords: Banana, correlation, genetic diversity, path analysis, phenotypic variability

Introduction
Banana and plantain (*Musa spp*.) is a family of Musaceae and origin of South East Asia. India has the second greatest diversity of indigenous banana in the world. More than 600 types of Musa germplasm comprising wild forms and cultivated species are reported world over. Banana is an important food component of human diet throughout the world, either as cooked or as fresh fruit. It is a rich source of carbohydrate, good source of fibre, vitamin B6, potassium and low in sodium and easy to digest (Chandler, 1995) [10].

Banana improvement through selection has proven difficult due to a limited understanding of the genetic organization and meiotic behaviour of species. Genetic improvement of banana has traditionally been carried out through interspecific and interploidy crosses, with the major objective of producing high yield banana hybrids (Buddenhagen, 1997) [8]. The yield of Bunch weight is a complex trait and highly influenced by many genetic factors and environmental fluctuations (Karunakaran *et al*., 2010) [18]. Knowledge on variability, heritability and correlation are estimated for phenotypic selection in crop improvements (Atta *et al.,* 2008 and Begum *et al*., 2016) [3, 7].

Analysis of variability among the phenotypic traits and association of a particular character in relation to other traits contributing to yield of a crop would be of great importance in planning a successful breeding program (Mary and Gopalan, 2006) [23]. For effective utilization of the genetic stock in crop improvement, information of mutual association between yield and yield components is necessary to know the correlation of various components characters with yield (Soares *et al*., 2012) [33]. The success of a breeding program depends largely upon the amount of genetic variability present in the population and the extent to which the desired traits are heritable (Shukla *et al.* 2006) [32].

Correlation studies help in finding out the degree of inter-relationship among various characters and in evolving selection criteria for improvement. However the correlation alone cannot explain relationship among the characters. Therefore the path coefficient analysis provides a better index for dissection of yield into its components. Path analysis permits the separation of correlation among variables into direct and indirect effects (Dewey and Lu, 1959) [11], and it has proven useful for understanding factors contributing to bunch weight in bananas by Baiyeri and Ortiz, (1995) and Faisal *et al.* (2007) [5, 13]. The selection of desirable type should not only be based on yield, the other yield components should also be consider.

Direct selection for yield is often misleading in banana because bunch weight is polygenically control. Correlation studies along with path coefficient analysis can provide a better understanding of the association of different traits with yield. Path coefficient analysis separates the direct effects from the indirect effects through other related traits by partitioning the correlation coefficient (Begum *et al.*, 2016) [7]. In this investigation, different banana hybrids were studied in order to generate information on genetic variability, correlation coefficient and path analysis, the relationship between yield and its components and the wider implications of these traits in the selection of better hybrids for the development or improvement of hybrids.

Materials and methods

Experimental site

The field experiment was conducted at the University Orchard, Department of Fruit Crops, Horticulture College and Research Institute, Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu. India. The orchard area is tropical region and site received annual rainfall of between 1.2 mm to 165.2 mm with average minimum and maximum temperature ranging between 19.0ºC to 35.3ºC during experiment conducted period. The soil of the experimental field was red laterite with pH 7.5 and 1.2% organic matter content**.**

Treatments and experimental design

The experimental material comprising 24 new synthetic banana hybrids collected from Department of Fruit Crops, TNAU, Coimbatore. The hybrids were evaluated in a randomized block design with five replication and five plants were planted for each hybrid in each replication. The details of the banana hybrids used in the experiment are given in Table 1. The hybrids were planted during second week of March 2012 in planting holes (45 x45x45 cm) with both within and between row distances of 1.8 cm. each planting hole was filled with well decomposed cattle manure mixed with topsoil. Fertilizer mixture of 110: 30: 330 recommended by the department of Fruit crops applied at the rate of 250 g per clump at 3rd, 5th and 7th month after planting. Irrigation was applied at weekly intervals in order to maintain sufficient moisture for better growth and development of plants. Harvesting was done when one fruit of the first or second hand of the bunch from the top turned yellow. After harvesting, bunches were stored and bunch were selected for further observation after getting uniform colour.

Observation recorded

The pseudostem height was measured at the time of flowering. Number of leaf per plant was counted in each plant at the time of shooting. Leaf length was measured (cm) from leaf blade base to the tip of the leaf and breadth was measured (cm) at the point where the maximum breadth exists in the leaf at the time of flowering. Shooting period measured from planting to emergence of the inflorescence while fruit maturity period from emergence of the inflorescence to harvesting of bunch. Bunch weight including 30 cm of peduncle before the first comb was taken using electronic weighing balance (kg) at ripening stage. The number of hands per bunch was recorded after counting the hand in each bunch, number of the fruit per bunch as calculated from the total number of fruits where as fruit weight (g) taken from middle fingers in the top and bottom rows of the second hand at ripening stage.

Data analysis

The mean over replication for each character was subjected to statistical analysis. The phenotypic and genotypic coefficient of variation (PCV & GCV) and genetic advance were estimated by using the formula suggested by Johnson *et al.* (1995) [16]. The heritability in broad sense and genetic advance as percentage of mean were estimated employing the methods suggested by Allard (1960) and Johanson *et al.* (1955) [1, 16] respectively. The phenotypic and genotypic coefficients of variation were estimated according to Burton (1952) [9]. Direct and indirect effects were computed by using procedure given by Dewey and Lu (1959) [11]. The phenotypic correlation coefficients and path analysis were performed using the software OPSTAT.

Result and Discussion

Variability components

Analysis of variance for characters studied during the experiment was found significantly (P<0.05) different among the 24 banana hybrids. The mean values average, minimum, maximum ranges, standard error (SE) of means, and coefficients of variation for morphological traits are shown in the Table 3. The bunch weight / plant showed large variation from 1.42kg to 31.25 kg with mean value 10.30kg. Maximum bunch weight 31.25kg was recorded in H 916 followed by H 914 (22.802 kg). Maximum finger weight was observed in H 916 (190.63g) whereas minimum finger weight in H 943 (11.30g). Total number of fingers per bunch varied from 163.00 to 11.30 with average value of 77.65. The minimum variation was recorded in number of hands per bunch varied from 4.00 to 10 with mean value of 6.98. Standard error was highest was recorded in Pseudostem height (10.90) followed by finger weight (10.81) while lowest in number of leaves /plant at shooting (0.34). The bunch weight / plant recorded the highest estimate of coefficient variation (0.81%) followed by fruit weight (0.68%) and leaf area (0.40%) and total number of finger per bunch (0.35%). Days to harvest recorded the lowest coefficient of variability of 0.07 per cent.

The mean sum of squares due to phenotypes showed significant differences among the hybrids for all the traits. The high estimates (20%) of PCV and GCV were recorded as highest for bunch weight (77.64, 76.61) followed by finger weight (61.02, 60.71), leaf area (43.34, 41.77), total number of fingers per bunch (40.34, 37.68), pseudostem girth (29.75, 29.17), number of hands per bunch (28.51, 27.64) and pseutostem height (25.43, 25.43) respectively. The high values of PCV and GCV indicated the existence of substantial variability, ensuring better scope for their improvement through selection of these traits (Karunakaran *et al.* 2010)[18]. Higher phenotypic coefficients of variation (PCV) than genetic coefficient of variation (GCV) indicated the role of environment for expression of the traits. The present findings are in agreement with the report of Uma *et al.* (2000); Karunakaran *et al*. (2010); Kavitha *et al.* (2008); Jambhale *et al.* (2014); Pandey *et al.* (2015) Sawant *et al.* (2016) and Rajamanickam and Rajmohan (2008, 2010 and 2020) [34, 18, 19, 15, 26-30] who found high value of GCV and PCV estimate on total number of finger per bunch, bunch weight and average finger size respectively.

Estimation of genetic variability components was done in order to determine the heritable potential of concerned genes as well as the influence of environment over them (Kumar *et al*., 2013) [21]. The relative values obtained for the genotypic and the phenotypic coefficient of variation indicate the magnitude of the variation present. Lower genotypic and

phenotypic coefficient of variation obtained elucidates the presence of narrow genetic base for such traits selected for their improvement (Nirmaladevi *et al*., 2015) [25]. Phenotypic correlation coefficients were the same as or higher than the genotypic correlation coefficient, indicating that both environmental and genotypic correlations in these cases acted in the same direction and finally maximized their expression at the phenotypic level (Mishra *et al*. 2015) [24].

Heritability is a valuable tools when used in conjunction with genetic advance expectations from selection in predicting genetic gain that follows in the selection for that character. The broad sense heritability estimates were higher for all the ten characters. The highest broad sense heritability was observed for finger weight (98.99) followed by bunch weight (97.37), pseudostem girth (96.11), number of hands per bunch (93.98), pseudostem height (93.47), leaf area (92.85), days taken from planting to shooting (92.16), days to harvest (89.10), total fingers per bunch (87.25) and number of leaves at shooting (79.92). The high heritability for the traits like plant height, number of fingers per bunch, weight of finger and ripe fruit weight obtained in the present studies are in agreement with the findings of Kavitha *et al.,* (2008) and Sawant *et al* (2016) [19, 30] in banana. High heritability characters also indicate that they are under influence of more number of fixable factors (Vaghela *et al.*, 2009) [35]. Therefore high heritability helps in the effective selection for phenotype of the particular characters which ultimately improves the genetic background of these traits. High heritability values for these traits indicate that variation was mainly under genetic control and less influence of the environmental that these characters could be useful basis of selection (Kumar *et al*. 2015) [20]. The high heritability of a character determines the extent to which it is transmitted from one generation to the next.

The estimates of genetic advance useful tools for understanding the type of gene action involved in the expression of various polygenic characters. Genetic advance as percentage of mean was maximum for bunch weight (155.74%) followed by finger weight (124.43%). Similarly, genetic advance was maximum for leaf area (82.90%), total fingers per bunch (72.51%). pseudostem girth (58.91%), number of hands per bunch (55.20%), pseudostem height (50.65%), number of leaves at shooting (26.20%), days taken from planting to shooting (23.02%) whereas moderate genetic advance in days to harvest (16.25%). High estimate of genetic advance in bunch weight, suggesting that there characters were governed by additive gene action whereas moderate or low value of days to harvest indicate that non additive gene action and selection pressure could profitably applied on this characters for yield improvement.

The genetic advance mean jointly with heritability is more useful tools as a selection of characters for improvement of breeding. Highest Genetic coefficient variation (76.61), heritability (97.37) coupled with higher genetic advance (155.74%) was recorded for bunch weight. High estimates of GCV coupled with high heritability for bunch weight was also reported by kavitha *et al*. (2008); Rajamanickam and Rajmohan (2010); Sawant *et al*. (2016) and Gupta and Kour (2019) [19, 28, 30, 14]. High heritability >80% had been observed for yield and associated traits would respond to selection owing to their high genetic variability and transmissibility (Bagati *et al*. 2016) [4].

These are simply inherited is due to broad sense of additive gene action and effectiveness of selection would be effective made for this characters. High GCV along with high heritability and genetic advance provided better information than single characters alone (Baye *et al.,* 2005)[6] and can be improved through simple selection while the characters showed high heritability coupled with moderate or low genetic advance can be improved by intermitting superior genotypies of segregating population developed from combination breeding (Seyoum *et al*. (2012); Dhanwani *et al*., (2013); Karuppaiyan *et al*. (2013); and Rajamanickam and Rajmohan (2020) [31, 12, 18, 29]. High heritability couple genetic advance indicating that these traits are predominantly governed by additive gene action (Assefa *et al*., 2016) [2].

Phenotypic and genotypic Correlation Coefficients

The genotypic correlation coefficients were generally higher than their corresponding phenotypic values (Table 9). The genotypic correlation values for the ten characters studied revealed that all the ten characters were positively associated with bunch weight. Bunch weight had a strong significant positive association with the traits *viz*., finger weight (0.89), height of pseudostem (0.86), total number of fingers per hand (0.81), pseudostem girth (0.79), leaf area (0.77), number of hands per bunch (0.76), days to harvest (0.64), days taken from planting to shooting (0.61) and number of leaves at shooting (0.53). The correlation between bunch weight and fruit weight was statistically significant, showing positive and higher value compared to other variable. Kavitha *et al* (2008), Soares *et al*. (2012) and Rajamanickam and Rajmohan (2020) [19, 33, 29] recorded bunch weight was positive correlation associated finger weight, pseudostem girth, number of hands per bunch, number of leaves and leaf area in banana.

Mutual relationship between bunch weight and its contributing characters in the most of the cases of genotypic correlation coefficient was found to be higher in magnitude than phenotypic correlation coefficient, indicating a strong inherent association of inherent relation among the ten characters but suppressing effect of the environment, which influence the phenotypic expression of these characters by reducing phenotypic coefficient values.

It shows that identification and selection of characters particularly the average finger weight and pseudostem height and total number of fingers per hand has significant impact on the improvement of bunch weight. Selection for number of leaves at shooting had a very low impact on the bunch improvement, but total leaf area index trait impact on improvement of bunch weight which indicate that more leaf area synthesized more photosynthesis and bunch act as source of sink for these metabolites. Selection for higher finger weight had considerable correlated response on improvement of total finger weight.

Path coefficients for direct and indirect effects

Study of relationship between bunch weight and bunch weight contributing characters were studied in details through path coefficient analysis (Table. 4). In the present investigation, among the nine characters correlated with bunch weight, the maximum positive effect on bunch weight was through finger weight (0.553) followed by pseudostem height (0.447), total number of fingers per bunch (0.347), days to harvest (0.142) and number of hands per bunch (0.105). The remaining characters, the magnitude of direct effects were negligible. This is because these characters exerted high and positive indirect effect on bunch weight *via* pseudostem height, number of hands per bunch, total number of fingers per bunch, and finger weight and days to harvest and negative

indirect traits of pseudostem girth, number of leaves, leaf area and days to shooting.

The average finger weight had very high direct effect on bunch weight. The negative direct effect of pseudostem girth on bunch weight is misleading because it has a high positive correlation coefficient with bunch weight. However, pseudostem girth had a high indirect effect with bunch weight via average fruit weight while days to harvest showed a low positive direct effect on bunch weight and number of hands per bunch was low positive direct effect on bunch weight, but very high positive indirect effect via average fruit weight. The residual value (r=0.258) indicated that nearly 70 per cent of the bunch weight influencing characters were covered for the studs and hence selection criteria banana as this study could be reliable. The relationship between bunch weight and plant height was significant and positive, which means that the weight varied directly with the size of the plant. The average fruit weight had very high direct effect on bunch weight. Thus, one can infer that the characteristics bunch weight and average fruit weight are directly correlated. This is in accordance with report of Kavitha *et al* (2008) and Soares *et al*. (2012) [19,33]. about high positive direct effect of fruit weight on bunch weight.

Conclusion

The presence of substantial variability was evident for all traits studied. A perusal of the results obtained from direct association and path coefficient analysis revealed that bunch weight was found to have significant influence on fruit weight, number of hands/bunch and total number of fruits per bunch and also have high positive direct and indirect effect through many other characters. Hence, concurrent effective selection could be practiced on the basis of these characters of pseudostem height, fruit weight, number of hands/bunch and total number of fruits per bunch contributing towards the bunch weight is ideal criteria for selection for improvement of bunch weight in *Musa* breeding. Overall, results of this study indicated average bunch weight, total number of fingers per bunch, finger weight and pseudostem height showed moderate to high heritability and genetic advance, association and direct path coefficient effect on bunch weight. Therefore, additive gene action governing the traits and improvement of any of these traits could be made for improving the bunch weight in banana breeding.

Table 1: List of hybrids used in the study

S. No.	Hybrid	Parentage	Ploidy level	Genome
1	H 901	Poovan × cv. Rose	Triploid	AAB
2	H 902	Poovan × cv.Rose	Tetraploid	AAAB
3	H 903	Poovan × cv.Rose	Triploid	AAB
4	H 904	Poovan × cv.Rose	Triploid	AAB
5	H 905	Poovan × Pisang Lilin	Triploid	AAB
6	H 906	Poovan × Pisang Lilin	Triploid	AAB
7	H 911	H 516 × cv.Rose	Diploid	AA
8	H 912	H 516 × cv.Rose	Diploid	AA
9	H 913	Poovan × Ambalakadali	Triploid	AAB
10	H 914	Poovan × Ambalakadali	Triploid	AAB
11	H 915	Poovan × Ambalakadali	Triploid	AAB
12	H 916	Poovan × Erachivazhai	Tetraploid	AAAB
13	H 921	H 516 × Yangambi km5	Diploid	AA
14	H 922	Poovan × Ambalakadali	Diploid	AA
15	H 923	Poovan × H 516	Triploid	AAA
16	H 924	H 201 × Anaikomban	Diploid	AA
17	H 925	H 201 (OP)	Diploid	AB
18	H 926	H 201 × Anaikomban	Triploid	AAB
19	H 934	Poovan × Erachivazhai	Triploid	AAB
20	H 939	H 201 × Anaikomban	Diploid	AA
21	H 940	H 201 × H 516	Diploid	AA
22	H 941	H 201 × H 516	Triploid	AAB
23	H 943	Rose × H 516	Diploid	AA
24	H 952	H 201 (OP)	Diploid	AB

Table 2: Estimate of variance and genetic parameters for morphological components in banana

S. No.	Parameters	Mean	Range		SE	CV (%)	GCV	PCV	Heritability	Genetic advance (%) mean
			Minimum	Maximum						
1	Days taken from planting to shooting	237.91	195.40	272.40	4.05	0.08	11.64	12.13	92.16	23.02
2	Pseudostem height (cm)	222.61	127.84	331.20	10.90	0.24	25.43	26.3	93.47	50.65
3	Pseudostem girth (cm)	53.46	25.44	74.86	3.09	0.28	29.17	29.75	96.11	58.91
4	Number of leaves at shooting	12.88	10.40	16.40	0.34	0.13	14.23	15.92	79.92	26.20
5	Leaf area (m^2)	7.82	3.35	12.86	0.65	0.40	41.77	43.34	92.85	82.90
6	Days to harvest	352.47	302.20	392.40	4.69	0.07	8.72	9.23	89.10	16.95
7	Number of hands per bunch	6.98	4.00	10.00	0.37	0.26	27.64	28.51	93.98	55.20
8	Total fingers per bunch	102.50	50.80	163.00	7.38	0.35	37.68	40.34	87.25	72.51
9	Finger weight (g)	77.65	11.30	190.63	10.81	0.68	60.71	61.02	98.99	124.43
10	Bunch weight (Kg)	10.30	1.42	31.25	1.71	0.81	76.61	77.64	97.37	155.74

SE: Standard error, CV: Coefficient variation, PCV: Phenotypic coefficient of variation, GCV: Genotypic coefficient of variation.

Table 3: Genotypic, phenotypic and environmental correlation coefficient among bunch weight traits in banana

Traits	PH	PG	NLS	LA	NH	TNF	FW	DS	DH	BW
PH	1.000	0.953**	0.619**	0.860**	0.750**	0.792**	0.763**	0.752**	0.777**	0.861**
PG		1.000	0.642**	0.872**	0.715**	0.789**	0.717**	0.754**	0.782**	0.792**
NLS			1.000	0.839**	0.576**	0.588**	0.490**	0.561**	0.551**	0.534**
LA				1.000	0.732**	0.799**	0.713**	0.677**	0.693**	0.773**
NH					1.000	0.844**	0.585**	0.415*	0.436**	0.763**
TNF						1.000	0.622**	0.577**	0.571**	0.816**
FW							1.000	0.536**	0.567**	0.891**
DS								1.000	0.952**	0.613**
DH									1.000	0.640**
BW										1.000

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level; PH-Pseudostem height; PG-Pseudostem girth; NLS-Number of leaves at shooting; LA-Leaf area; NH-Number of hands per bunch; TNF-Total number of fruits per bunch; FW-Finger weight; DS-Days taken from planting to shooting; DH-Days to harvest; BW-Bunch weight.

Table 4: Direct and indirect effect of morphological characters traits on bunch weight in banana hybrids

Traits	Correlation co-efficient	PH	PG	NLS	LA	NH	TNF	FW	DS	DH
PH	0.861**	0.447	-0.324	-0.008	-0.094	0.079	0.275	0.421	-0.046	0.111
PG	0.792**	0.426	-0.340	-0.008	-0.095	0.075	0.274	0.396	-0.046	0.111
NLS	0.534**	0.277	-0.218	-0.013	-0.091	0.060	0.204	0.271	-0.034	0.078
LA	0.773**	0.385	-0.296	-0.011	-0.109	0.077	0.277	0.394	-0.042	0.099
NH	0.763**	0.336	-0.243	-0.008	-0.080	0.105	0.293	0.323	-0.026	0.062
TNF	0.816**	0.354	-0.268	-0.008	-0.087	0.088	0.347	0.344	-0.035	0.081
FW	0.891**	0.341	-0.244	-0.006	-0.078	0.061	0.216	0.553	-0.033	0.081
DS	0.613**	0.336	-0.256	-0.007	-0.074	0.043	0.200	0.296	-0.061	0.135
DH	0.640**	0.348	-0.266	-0.007	-0.075	0.046	0.198	0.314	-0.059	0.142

Residue = 0.258; *Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level; Bold values indicate direct effect; PH-Pseudostemheight; PG-Pseudostem girth; NLS-Number of leaves at shooting; LA-Leaf area; NH-Number of hands per bunch; TNF-Total number of fruits per bunch; FW-fruit weight; DS-Days taken from planting to shooting; DH-Days to harvest

References

1. Allard RW. Principle of plant breeding, John Wiley and sons, Inc., New York. 1960, 320.
2. Assefa W, Ayele L, Dagnew A, Etissa E Girma Kebede, Mikiyas Damtew GKM, Ayalew M. Variability, Association and Path Coefficient Analysis of Yield and Yield Components of Dioecious Papaya Genotypes in Ethiopia. International Journal of Research in Agriculture and Forestry. 2016; 3(10):8-14.
3. Atta BM, Haq MA, Shah TM. "Variation and interrelationships of quantitative traits in chickpea (*Cicer arietinum* L.)," Pakistan Journal of Botany. 2008; 40(2):637-647.
4. Bagati1 SA, Singh K, Salgotra RK, Bhardwaj R, Sharma M, Rai SK, Bhat A. Genetic variability, heritability and correlation coefficients of yield and its component traits in basmati rice (*Oryza sativa* L.). 2016; 48(4):445-452.
5. Baiyeri KP, Ortiz R. Path analysis of yield in dessert bananas. Mus Africa 1995; 8:3-5.
6. Baye B, Ravishankar R, Singh H. Variability and association of tuber yield and related traits in potato (*Solanum tubersum* L.). Eth J Agric Sci. 2005; 18:103-121.
7. Begum S, Ahmed A, Omy SH. Genetic variability, trait association and path analysis in maize (*Zea mays* L.) Bangladesh J Agril. Res. 2016; 41(1):173-182.
8. Buddenhagen IW. Overview of global banana breeding programs and research on diseases and pests of bananas. In: P. George, P. Stewart & D.N. Vinh (Eds.), Banana Production, Biotechnology and Diversity, 1997, 1-11. Report of an International Workshop, Hanoi, Vietnam, 9-11 October The World Bank, Washington, DC, 1995.
9. Burton GW, Devane EH. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agron. J. 1953; 45(10):478-481.
10. Chandler S. The Nutritional Value of Bananas. In: Gowen, S.R., Ed., Bananas and Plantains, Chapman and Hall, London, 1995; 5:74-89.
11. Dewey DR, Lu K. A correlation and path-coefficient analysis of components of crested wheat grass kernel production. Agron. J. 1959; 51(9):515-518.
12. Dhanwani RK, Sarawgi AK, Solanki A, Tiwari JK. Genetic variability analysis for various yield attributing and quality traits in rice (*Oryza sativa* L.) The BioScan, 2013; 8(4):1403-1407.
13. Faisal M, Malik A, Ashraf M, Sharif A, Ghafoor A. Assessment of genetic variability, correlation and path analyses for yield and its components in soybean. Pak. J Bot. 2007; 39(2):405-413.
14. Gupta N, Kour A. Genetic parameters, character association and path analysis for fruit yield and its component characters in guava (*Psidium guajava* L.). Electronic Journal of Plant Breeding. 2019; 10(1):256-263
15. Jambhale VM, Kute NS, Pawar SV. Studies on genetic variability parameters, trait association and path analysis among yield and yield contributing traits in papaya carica papaya. The bioscan. 2014; 9(4):1711-1715
16. Johnson HW, Robinson JF, Comstock RE. Genotypic and phenotypic correlation in soybeans and their implications in education. Agron. J. 1955: 17:477-483.
17. Karunakaran G, Ravishankar H, Dinesh MR. Genetical studies in papaya (*Carica papaya* L.). Acta Hort. 2010; 851:103-108.
18. Karuppaiyan R, Kapoor C, Gopi R. Variability, heritability and genetic divergence in lowland rice genotypes under the midhills of Sikkim. Oryza. 2013; 50:81-84.

19. Kavitha PS, Balamohan TN, Kumar N, Veeraragavathatham D. Genetic variability studies in banana hybrids. Asian J Hortic. 2008; 3(2):265-269.
20. Kumar M, Prasad KM, Prakash S, Kumar S. Evaluation of Genetic Variability, Genetic advance, Heritability and Character association for Yield and its Contributing traits in Papaya (*Carica papaya* L.). Vegetos. 2015; 28(2):99-102.
21. Kumar R, Ameta KD, Dubey RB, Pareek S. Genetic variability, correlation and path analysis in sponge gourd (*Luffa cylindrica* Roem.) Afr. J Biotechnol. 2013; 12:539-543.
22. Lush KL. Intra-sire correlations and regression of offspring on dames as a method of estimating heritability of characters. Proc. Amer. Soc. Animal. Prodn. 1940; 33:293-301.
23. Mary SS, Gopalan A. Dissection of genetic attributes yield traits of fodder cowpea in F3 and F4. J Applied Sci. Res., 2006; 2:805-808.
24. Mishra PK, Ram Badan Ram, RB, Kumar N. Genetic variability, heritability, and genetic advance in strawberry (*Fragaria* × *ananassa* Duch.). Turkish Journal of Agriculture and Forestry. 2015;39: 451-458.
25. Nirmaladevi G, Padmavathi G, Kota S, Babu VR. Genetic variability, heritability and correlation coefficients of grain quality characters in rice (*Oryza sativa* L.). Sabrao J Breed. Genet. 2015; 47(4):424-433.
26. Pandey P, Singh R, Rawat M. Study of genetic variation, heritability and correlation in vegetable pea (able pea (*Pisum sativum* L.). The Boiscan, 2015; 10(4): 2131-2133.
27. Rajamanickam, C, Rajmohan, K. Genetic variability and correlation studies in banana (*Musa* spp.). Madras agric. J. 2008; **95**(7/12):258-265.
28. Rajamanickam C, Rajmohan K. Variability studies in Palayankodan ecotypes (AAB genomic group) of banana (*Musa* spp.). J Hortic. Sci. 2010; 5(2):109-113.
29. Rajamanickam C, Rajmohan K. Genetic variability and correlation studies of triploid ecotypes of banana (*Musa* spp.). Journal of Pharmacognosy and Phytochemistry 2020; 9(2):2425-2430
30. Sawant SB, Dalvi VV, Bhave SG, Haldankar PM, Mahadik SG. Genetic variability of banana (*Musa* spp.) in West Coastal Zone of India. Electronic Journal of Plant Breeding. 2016; 7(4):1144-1150.
31. Seyoum M, Sentayehual E. Amerew K, Bantte K. Genetic variability, heritability correlation coefficient and path analysis for yield and yield related traits in upland rice (*Oryza sativa* L.). Journal of Plant Sciences, 2012; 7(1):13-22
32. Shukla S, Bhargava A, Chatterjee A, Srivastava A, Singh SP. Genotypic variability in vegetable amaranth (*Amaranthus tricolor* L.) for foliage yield and its contributing traits over successive cuttings and years. Euphytica. 2006:151:103-110.
33. Soares TN, Diniz-filho JAF, Nabout JC., Telles MPC, Terribile LC, Chaves LJ. Patterns of genetic variability in central and peripheral populations of *Dipteryx alata* (Fabaceae) in the Brazilian Cerrado. Plant Systematic and Ecology, Heidelberg. 2015; 30(1):315-1324.
34. Uma S, Dayarani M, Singh HP, Shyam B, Sathiamoorthy S. Studies on genetic variability in banana - Silk subgroup (AAB). Indian J Hortic. 2000; 57(2):106-109.
35. Vaghela MD, Poshiya VK, Savaliya JJ, Kavani RH, Davada BK. Genetic variability studies in kabuli chickpea (*Cicer arietinum* L.). Legume Research. 2009; 32(3):191-194.