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Correlation and Path Coefficient Analysis of Castor (*Ricinus communis* L.) in non-traditional area of central Uttar Pradesh

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ABSTRACT

A relationship between castor seed yield and eight agronomic characters were studied in 30 selected castor genotypes. Results indicated that the genotypic correlations generally showed more significant differences between the pairs of characters than the phenotypic correlations. Number of effective spikes plant^{-1} and number of capsules in primary raceme showed highest significant positive genotypic and phenotypic correlations with seed yield plant^{-1}. The path analysis also revealed that number of capsules in primary raceme had a positive highly significant correlation with as well as a high phenotypic direct effect on seed yield plant^{-1}. Apart from this, number of capsules in primary raceme also influenced the effects of other characters indirectly on their effects on seed yield plant^{-1} thus suggesting that number of capsules in primary raceme is undoubtedly the most reliable character to select for in castor seed yield improvement to improve seed yield of castor populations.

Key words: *Ricinus communis*, Correlation analysis, Path analysis, Raceme, Capsules

INTRODUCTION

Castor is a valuable oilseed crop that provides almost the entire world's supply of hydroxy fatty acids (Ricinoleic acid, Oleic and linoleic acids) [Atsmon

1989]. It is used in the production of lubricants, paints, soaps and pharmaceuticals [Salunkhe and Desai 1986]. World's average total production of Castor seed figures around 12.5 lakh tons and is cultivated in more than 30 countries of the world. India is the world's largest producer of castor and its derivatives contributing to almost 65% share. Likewise India is also the leading producer of castor seed oil, which has its annual world production covering around 5.5 lakh tons. Due to its end number of uses in various industries, castor oil has a high level of demand in the world that is still constantly rising at 3 to 5 % per annum and the USA imports 40000 MT of castor oil annually [Gandhi *et al.* 1994].

Castor (*Ricinus communis* L.) belongs to the family Euphorbiaceae, a diverse and economically important family of flowering plants [Waynes 1999]. Castor is essentially a tropical/subtropical species; it grows naturally over a wide range of geographical regions including temperate areas [Marter 1981]. Exploitation of castor ranges from the simple harvesting of beans from wild plants through the cultivation of hybrid varieties and use of improved cultivation methods. Wild plants are perennials, but where castor is deliberately cultivated an annual production cycle is possible [Marter 1981].

Castor oil has been used in the production of aircraft lubricants, hydraulic fluids, soaps, linoleum, printer ink, nylon, varnishes, enamels, paints and electrical insulations. Textile scientists have used sulphonated castor oil in the dyeing and finishing of fabrics and leather. The most infamous application of castor oil may have been as purgative; popular for the treatment or prevention of many ailments in the twentieth century [Oplinger *et al.*].

Castor has a great potential for growth in India with its diverse usage in the lubricants, pharmaceuticals, medical, textile and paint manufacture etc., and the country would gain a lot from its production. Considering its wide genetic background coupled with high yield potentials, great improvements can be achieved through breeding of this crop in India.

One of the primary objectives of Castor breeders is to increase the seed yield. Generally, yield represents the final character resulting from many developmental and biochemical processes which occur between germination and maturity. Before yield improvements can be realized, the breeder needs to identify the causes of variability in seed yield in any given environment. Since fluctuations in environment generally affects yield through its components. In as much as the determination of the correlation coefficient of yield and its components is undoubtedly helpful to breeders in selecting suitable plant types based on simultaneous selection of two or more characters, a better approach of character association is the path coefficient analysis [Wright 1968]. Whereas correlation is simply a measurement of mutual association, without regards to causation, path coefficient analysis specifies the cause and measures their relative importance. According to [Dewey and Lu 1959], this technique is most useful when conditions permit its application. Path coefficient analysis has been studied in castor by different workers, who reported similar but sometimes divergent findings.

MATERIALS AND METHODS

The materials used for the study consisted of thirty genotypes of castor. The experiment was conducted under irrigation at the Oilseed Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, INDIA (Latitude 26°28’ N and Longitude 80°24’ E) during *kharif* 2008 and 2009. The experiment was laid out in a complete randomized block design with three replications. Each genotype was sown in two rows. They were later properly leveled for efficient water supply.

The thirty genotypes were manually sown at 90x60 cm spacing and at 3 5cm depth. Three seeds were planted per hill and later thinned to two plants per hill twenty days after sowing. Surface irrigation was used at ten days interval. The plots were irrigated using furrow system, which conveys water from the source to the field. The plots were bounded by low bunds forming slightly sunken basins in order to retain the irrigation water. Irrigation channels were made in between two strips each of the basins while a drainage channel was provided at the end of the field to drain excess water out of the field. 50 Kg nitrogen and 30 Kg phosphorus in the form of Urea (46% N) and Di–Ammonium Phosphate (18% N and 46% P_2O_5), and 15 kg of potassium in form of Muriate of potash (60% K_2O)were applied per hectare 5 10 cm away from the seeds at planting. 50% of nitrogen and 100% phosphorus and potash were applied as basal dose and rest 50% of nitrogen applied at the time of first irrigation. Weeds were controlled manually at four and eight weeks after planting. The parameters Days of 50% flowering, No. of nodes to primary raceme, Plant height upto primary raceme (cm), Days to maturity of spike, No. of effective spikes plant^{-1}, 100 seed weight (g), No. of capsules in primary raceme, Oil content (%), Seed yield plant^{-1} (g) were recorded from the net plot area. Oil percentage was determined from samples collected from the bulk of each plot.

The oil content was determined by the Soxhlet extraction method using the Tecator HT extraction unit and expressed as percentage [Pomeranz and Meolan 1978]. Analysis of variance (ANOVA) was computed from the plot means and tests of treatment significance were done for the traits measured. Also, both phenotypic and genotypic correlations between different pairs of characters were run to determine their association. The correlation coefficients were partitioned into direct and indirect causes according to [Wright 1968., Dewey and Lu 1959].

RESULTS

The summary of the genotypic and phenotypic correlations for seed yield and eight agronomic traits is presented in Table 1. Generally, the genotypic and phenotypic both types of correlation were of comparable magnitude, the genotypic correlation were in most cases higher than the phenotypic correlation indicating that the characters were more related genotypically [Deepika and Tummala 1981].

Table 1: Genotypic and phenotypic correlations among eight agronomic traits

Traits		1	2	3	4	5	6	7	8
2	rG	0.579**							
	rP	0.469**							
3	rG	0.598**	0.402**						
	rP	0.566**	0.395**						
4	rG	0.450**	0.413**	0.225*					
	rP	0.399**	0.303**	0.196^{NS}					
5	rG	-0.211*	-0.236*	-0.020^{NS}	-0.307**				
	rP	-0.177^{NS}	-0.199^{NS}	-0.018^{NS}	-0.266*				
6	rG	0.363**	0.127^{NS}	0.130^{NS}	0.080^{NS}	0.275**			
	rP	0.314**	0.143^{NS}	0.121^{NS}	0.060^{NS}	0.185^{NS}			
7	rG	-0.226*	-0.229*	-0.125^{NS}	-0.298**	0.993**	0.371**		
	rP	-0.159^{NS}	-0.154^{NS}	-0.062^{NS}	-0.185^{NS}	0.678**	0.328**		
8	rG	0.002^{NS}	0.305**	0.336**	-0.174^{NS}	0.284**	0.558**	0.545**	
	rP	0.023^{NS}	0.235*	0.247*	-0.133^{NS}	0.177^{NS}	0.338**	0.246*	
9	rG	-0.136^{NS}	-0.274**	-0.156^{NS}	-0.319**	0.965**	0.262*	1.019**	0.287**
	rP	-0.134^{NS}	-0.247*	-0.127^{NS}	-0.232*	0.752**	0.214*	0.744**	0.141^{NS}

* = significant at 0.05 level of probability
**= significant at 0.01 level of probability
1= Days of 50% flowering, 2= No. of nodes to primary raceme, 3= Height up to primary raceme (cm), 4= Days to maturity of spike, 5= No. of effective spikes plant^{-1}, 6= 100 seed weight (g), 7= No. of capsules in primary raceme, 8= Oil Content (%), 9= Seed yield plant^{-1} (g).

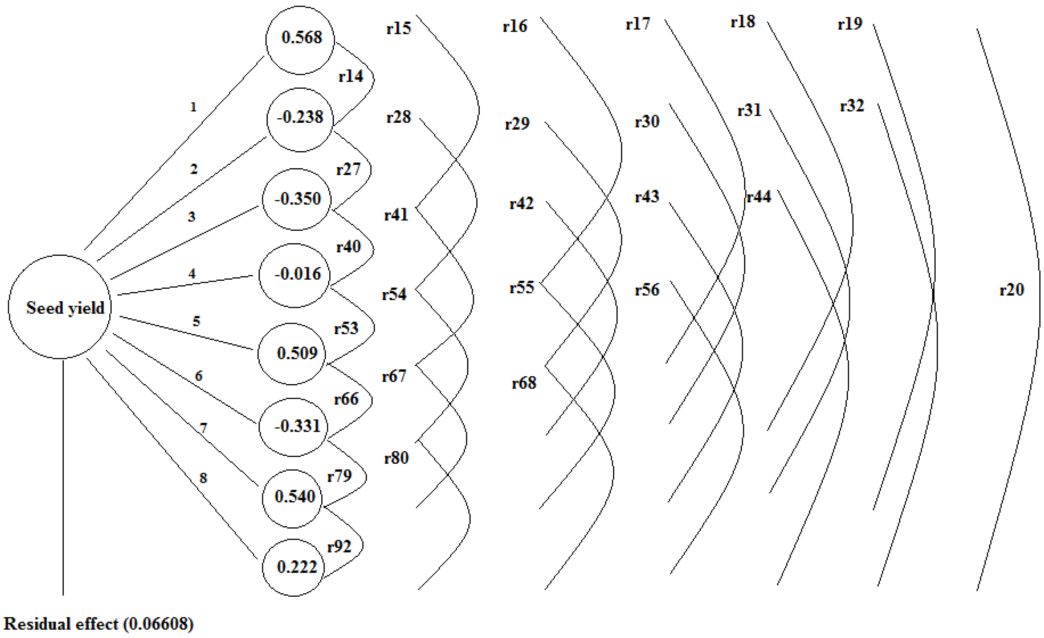
The highest positive genotypic correlation was found between seed yield and number of capsules in primary raceme (1.019**) followed by number of effective spikes plant^{-1} (0.965**). Seed yield plant^{-1} also had significant and positive association with 100 seed weight and oil content at genotypic level (0.262* and 0.287**), whereas it was negatively correlated with number of nodes to primary raceme and days to maturity (0.274** and 0.319*) respectively. Oil content showed significant and positive association with number of nodes to primary raceme, plant height, 100 seed weight and number of capsules in primary raceme at both genotypic and phenotypic levels, whereas number of effective spikes plant^{-1} at genotypic level only. Number of capsules in primary raceme indicated positive and significant association with effective spikes plant^{-1} and 100 seed weight.

Table 2, shows the combined summary of the direct and indirect effects of eight agronomic traits on castor seed yield and Figure 1 shows the diagrammatic representation of the path coefficient analysis. The results shows that, days to 50% of flowering, number of effective spikes plant^{-1}, number of capsules in primary raceme had significant positive direct path coefficients with seed yield. The direct effect of number of nodes to primary raceme, plant height up to primary raceme, days to maturity of spike and 100 seed weight were found negatively associated. Number of capsules in primary raceme with the highest genotypic correlation coefficient with seed yield plant^{-1} (0.540), and days to 50% flowering had the highest direct path coefficient with seed yield (0.568). The highest indirect effect of number of capsules in primary raceme was through number of effective spikes plant^{-1} (0.537). The highest total indirect effect (0.965) was through number of capsules in primary raceme followed by indirect effect of number of effective spikes plant^{-1} through number of capsules in primary raceme (0.505).

Table 2: Path coefficient analysis (direct, indirect) of eight agronomic traits in castor

Traits		1	2	3	4	5	6	7	8	9
1	G	**0.568**	-0.138	-0.209	-0.007	-0.108	-0.120	-0.122	0.001	0.136 ^{NS}
	P	**0.166**	-0.046	-0.078	-0.014	-0.080	-0.012	-0.070	0.001	0.134 ^{NS}
2	G	0.329	**-0.238**	-0.141	-0.007	-0.120	-0.042	-0.124	0.068	0.274**
	P	0.078	**-0.099**	-0.055	-0.010	-0.091	-0.006	-0.068	0.003	0.247*
3	G	0.340	-0.096	**-0.350**	-0.004	-0.010	-0.043	-0.068	0.074	0.156 ^{NS}
	P	0.094	-0.039	**-0.138**	-0.007	-0.008	-0.005	-0.027	0.003	0.127 ^{NS}
4	G	0.256	-0.098	-0.079	**-0.016**	-0.156	-0.027	-0.161	0.039	0.319**
	P	0.066	-0.030	-0.027	**-0.034**	-0.121	-0.002	-0.082	0.002	0.232*
5	G	-0.120	0.056	0.007	0.005	**0.509**	-0.091	0.537	0.063	0.965**
	P	-0.029	0.020	0.003	0.009	**0.455**	-0.007	0.299	0.003	0.752**
6	G	0.206	-0.030	-0.046	-0.001	0.140	**-0.331**	0.200	0.124	0.262*
	P	0.052	-0.014	-0.017	-0.002	0.084	**-0.039**	0.144	0.005	0.214*
7	G	-0.128	0.054	0.044	0.005	0.505	-0.123	**0.540**	0.121	1.019**
	P	--0.026	0.015	0.009	0.006	0.309	-0.013	**0.441**	0.003	0.744**
8	G	-0.001	-0.073	-0.117	0.003	0.144	-0.185	0.295	**0.222**	0.287**
	P	0.004	-0.023	-0.034	0.005	0.081	-0.013	0.108	**0.014**	0.141 ^{NS}

1= Days of 50% flowering, 2= No. of nodes to primary raceme, 3= Height up to primary raceme (cm), 4= Days to maturity of spike, 5= No. of effective spikes plant^{-1}, 6= 100 seed weight (g), 7= No. of capsules in primary raceme, 8= Oil Content (%), 9= Seed yield plant^{-1} (g).



1= Days of 50% flowering, 2= No. of nodes to primary Raceme, 3= Height upto primary raceme (cm), 4= Days to maturity of spike, 5= No. of effective spikes/plant, 6= 100-seed weight (g), 7= No. of capsules in primary Raceme, 8= Oil Content (%)

Fig. 1: A path analysis diagram of seed yield and its components in castor

DISCUSSION

Generally, the nature of inter trait correlations may enhance or retard the selection progress. A positive relationship indicates that the selection for improvement in one of the yield components would result in concomitant increase in one or more components. This relationship was recorded among the agronomic traits in this study. Positive and significant genotypic and phenotypic relationships among the traits seed yield per plant, 100 seed weight, days to 50% flowering, seed yield, days to maturity, pedicel length and plant height suggests that seed yield can be improved through selection for this yield components [Aswani 2003] reported that capsules in primary spike, number of spikes plant^{-1}, number of days to 50% flowering and maturity, length of primary spike and 100 seed weight were the major yield contributing characters in castor.

For instance, [Deepika and Tummala 1981] in a study of eight attributes of castor (*Ricinus communis* L.) reported that correlation and path coefficient analysis of almost all characters showed high genotypic and phenotypic coefficients. High positive phenotypic correlations on seed yield plant^{-1} were shown by number of effective spikes plant^{-1}, 100 seed weight and number of capsules in primary raceme; whereas, number of nodes to primary raceme have negatively associated. Path coefficient analysis indicated that the number of capsules in primary raceme (0.744), number of effective spikes plant^{-1} (0.752) and days to 50% flowering (0.568) have large positive direct effects on seed yield plant^{-1}, [Ramu *et al.* 2005, Uzun and Carigan 2001] observed that number of capsule plant^{-1} was highly correlated with seed yield.

Path analysis indicated the importance of seed yield plant^{-1}, total number of spikes plant^{-1} and number of capsules in primary raceme suggesting that these traits should be given main emphasis for evolving high yielding genotypes of castor. Positive correlation of seed yield with number of capsules in primary raceme and 1000 seed weight was observed by Raghuvansi *et al.* 2003.

This significant positive relationship among agronomic traits in this study at genotypic and phenotypic level is in accordance with the reports of [Yadav *et al.* 2004, Deepika *et al.* 1981]. Improvement of castor seed yield can therefore be achieved through selection of these highly correlated characters as increase in mean value of any one of the characters would significantly increase the mean of others [Pedroza *et al.* 1998]. The significant positive relationship between number of spikes plant^{-1} and number of capsules in primary raceme with seed yield suggests that these agronomic traits plays a significant role in increasing the seed yield plant^{-1} and genotypes which were having high number of capsule per raceme tends to produce higher seed yield [Sarwar 2010].

Babu *et al.* 2004 reported that oil yield plant^{-1} was positively associated with number of primaries plant^{-1}, number of capsules plant^{-1}, number of seeds capsule^{-1}, 1000 seed weight, leaf area index, harvest index and seed yield plant^{-1} both at genotypic and phenotypic level. Seed yield plant^{-1} exerted the highest positive direct effect on oil yield plant^{-1} followed by number of primaries plant^{-1}, oil content, leaf area index and harvest index.

Generally, 100 seed weight emerged as the best most important seed yield component. This is judged especially from the fact that apart from its highly significant genotypic and phenotypic correlation with seed yield, it also has direct effect on seed yield plant^{-1} and at the same time influenced seed yield plant^{-1} [Sarwar and Chaudhry 2008] by acting as a relay route through which other characters influenced seed yield positively. However, [Yadav *et al.* 2004] reported that seed yield and 100 seed weight had a negative direct effect on seed yield. The residual effect was not high and most of the variability in seed yield plant^{-1} was well accounted for by the variables. From the results obtained, it would be reasonable to suggest that a breeder engaged in the improvements of castor seed yield should place emphasis on number of spikes plant^{-1} and number of capsules in primary raceme. Selection for these traits will therefore directly become helpful in increasing the seed yield.

REFERENCES

[1] Aswani, K., R. S. Sangwan, D. S. Jatasra, 2003. Correlation and path coefficient analysis in castor (*Ricinus communis* L.) under dry land conditions. Indian J. Dry land Agric. Res. and Develop. 18: 89 91.

[2] Atsmon, D., 1989. Castor, In Oil Crops of the World. Robbelen, G. *et al*. (Ed.). McGraw Hill Pub. Co., New York. pp: 438 447.

[3] Babu, J. S., C. D. R. Reddy, N. S. Reddi, 2004. Character association and path coefficient analysis in a set of white seeded genotypes of sesame (*Sesamum indicum* L.). *Ann. Agric. Bio. Res.* 19 (1): 13 18.

[4] Deepika Bhatt, Tummala P. Reddy, 1981. Correlation and Path Coefficient Analysis in Castor (*Ricinus commumis* L.). *Canadian Journal of Genetics and Cytology,* 1981, 23(3): 525 531, 10.1139/g81 058.

[5] Deepika, B., P. R. Tummala, 1981. Correlations and path analysis in castor (*Ricinus communis* L.). Genome, 23(3): 525 531.

[6] Dewey, D. R., K.H. Lu, 1959. A correlation and path coefficient analysis of component of crested wheat grass seed production. Agron. J., 51: 515 518.

[7] Ghandi, V. M., K. M. Cherian, M.J. Mulky, 1994. Detoxification of castor seed by interaction with Sal seed meal. J. Am. Oil Chemists Soc., 71: 827 831.

[8] Marter, A. D., 1981. Castor market, utilization and prospect. Report of the tropical Institute, G152 vii +pp: 55.

[9] Oplinger, E. S., E. A. Oelke, A. R. Kaminski, S. M. Combs, J. D. Doll, R. T. Schuler, Alternative Field Crops manual (Castor beans). http:/www.hort.purdue.edu/newcrop/afcm/castor.html.

[10] Pedroza de Azevedo, D. M. P., J. R. Crisostomo, F. C. G. Almeida, A. G. Rossetti, 1998. Estimates of genetic correlations and correlated responses to selection in cashew (*Anacardium occidentale* L.). Genetics and Molecular Biology, Volume 21(3). [Online]. Available online: http://www.scielo.br/ scielo. php? Script = sci_arttext&pid=S1415 47571998000300019&lng=en&nrm=iso>.ISSN 1415 4757.

[11] Pomeranz, Y., C. E. Meolan, 1978. Food analysis theory and practice. AVI Shing Co. Inc. Westport, Connecticut, pp: 607 611.

[12] Raghuwanshi, K. M. S., S. S. Duhoon, B. R. Singh, R. B. Singh, 2003. Genetic variability and correlation, regression studies in sesame (*Sesamum indicum* L.). *J. Inter Academicia*, 7(2): 144 146.

[13] Ramu, R., N Sreedhar, C. Lavanya, 2005. Study of correlation and path analysis in castor (*Ricinus communis* L.). Res. on crops, 6(1): 109 111.

[14] Salunkhe, D. K. and B.B. Desai, 1986. Postharvest biotechnology of oil seeds. C R C Press, Boca Raton, FL.

[15] Sarwar, G., H. M. Ahmed, J. Hussain, 2010. Evaluation of castor bean (*Ricinus communis* L.) mutents for genetic parameters and cluster analysis. J. Agric. Res., 2010, 48(3): 289 302.

[16] Sarwar G, Chaudhry M. Boota, 2008. Short communication. Evaluation of castor (*Ricinus communis* L.) induced mutants for possible selection in the improvement of seed yield. Spanish Journal of Agricultural Research 2008 6(4): 629 634.
[17] Uzun, B. and M. L. Carigan, 2001. Path coefficient analysis for seed yield and related characters in a population of determinate and indeterminate types of sesame *(Sesamum indicum* L.) Turkish. *J. Field Crops,* 6(2): 76 80.
[18] Waynes, W., 1999. The Castor Bean: A Plant named after a tick. htpp://waynesword.palomar.edu/plmar99.html.
[19] Wright, S., 1968. Genetic and biometric foundation (evolution and the genetics of population 1). University of Chicago press.
[20] Yadav, Y. P., I. S. Yadav, Ravi Prakash, R. Singh, J. S. Yadava, 2004. Genotypic association and path coefficient analysis in castor (*Ricinus communis* L.) J. Oilseeds Res., 21(2): 346 348.