Libyan Agriculture Research Center Journal International 1 (1): 60-64, 2010
ISSN 2219-4304

Genetic Correlation and Path-Coefficient Analysis of Oil Yield and its Components in Castor

[1]A.O. Adeyanju, [1]A. Usman and [2]S.G. Mohammed

[1]Department of Plant Science, Faculty of Agriculture, Ahmadu Bello University. Samaru, Zaria
[2]Department of Agronomy, Faculty of Agriculture, Bayero University, Kano

Abstract: Relationship between castor oil yield and seven agronomic characters were studied in 28 selected castor genotypes. Results indicated that the genotypic correlations generally showed more significant differences between the pairs of characters than the phenotypic correlations. 100-seed weight showed significant positive genotypic and phenotypic correlations with oil yield per plant. The path analysis also revealed that 100-seed weight had a positive highly significant correlation with as well as a high direct effect on oil yield per plant. Apart from this, 100-seed weight also influenced the effects of other characters indirectly on their effects on oil yield per plant thus suggesting that 100-seed weight is undoubtedly the most reliable character to select for in castor oil yield improvement to improve oil yield of castor populations.

Key words: *Ricinus communis* % Correlation analysis % Path analysis % Breeding

INTRODUCTION

Castor is a valuable oilseed crop that provides almost the entire world's supply of hydroxy fatty acids [1]. It is used in the production of lubricants, paints, soaps and pharmaceuticals [2]. India is the largest producer of castor seed and the USA imports 44 000 megagrams of castor oil annually [3].

Castor (*Ricinus communis* L.) belongs to the family Euphorbiaceae, a diverse and economically important family of flowering plants [4]. Castor is essentially a tropical/subtropical species; it grows naturally over a wide range of geographical regions including temperate areas [5]. 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 [5].

The plant does not tolerate saline or poorly drained soils and requires 600 to 700 mm of rainfall or supplemental irrigation during the growing season [1]. Many kinds of pests and diseases have been identified on the castor plant, but only in extreme cases of infestation would chemical control be necessary [1]. Chemical fertilization in castor production is not normally recommended. High soil fertility may even be detrimental due to excessive vegetative growth which could delay flowering and fruit ripening [1].

The castor plant is an easily cultivated, adoptable cash crop when cultivated on well drained soils particularly in frost–free seasons. The crop can be successfully handled manually or mechanically at all farming system levels [1]. The castor bean plant has been cultivated for centuries for the oil produced by the seeds. The Egyptians burned castor oil in their lamps more than 4000 years ago [6]. Castor oil has been used in the production of aircraft lubricants, hydraulic fluids and in the manufacture of explosives in the United States. It has also been used in the manufacture of 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 [6].

Castor has a great potential for growth in Nigeria with its diverse usage in the military, pharmaceuticals, medical, textile, paint manufacture etc., 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 relatively new crop in Nigeria.

One of the primary objectives of Castor breeders is to increase the oil 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,

Correspondign Author: A.O. Adeyanju, Department of Plant Science, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria.

the breeder needs to identify the causes of variability in oil yield in any given environment. Since fluctuations in environment generally affects yield through its components. [7], suggested that individual yield components may contribute valuable information in breeding for yield many researchers have analyzed 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 [8]. 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 [9], 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. For instance, [10] 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 bean yield/plant were shown by all characters except days to flowering and number of nodes to primary raceme. Path-coefficient analysis indicated that both the number of capsules/primary raceme (0.74) and the number of secondary branches (0.62) have large positive direct effects on bean yield/plant. [11], in a study of fifteen hybrids obtained by crossing three lines with five testers in a line x tester mating design reported that total number of spikes per plant, total number of capsules on main spike and seed yield per plant exhibited significant positive association with oil yield. Path analysis indicated the importance of seed yield per plant, total number of spikes per plant and oil content suggesting that these traits should be given main emphasis for evolving high yielding genotypes of castor.

Although both correlation and path analysis have been extensively studied in Castor in other parts of the world, such information is virtually unavailable for castor under the Nigerian conditions.

This Study Was Therefore Undertaken to Estimate:

- The phenotypic and genotypic correlations among the oil yield components of castor.
- The direct and indirect effects of the component characters such as oil yield and their implication on selection.

MATERIALS AND METHODS

The materials used for the study consisted of twenty eight accessions of castor. The experiment was conducted under irrigation at the Research farm of the Faculty of Agriculture, Bayero University, Kano (Latitude 11°58' N and Longitude 8°26' E) between December 2006 and May 2007.

The experiment was laid out in a randomized complete block design with three replications. Each plot consisted of a basin measuring 5×17 m. The basins were manually constructed. They were later properly leveled for efficient water supply and pre-irrigated a day to planting.

The twenty eight accessions were manually sown 1×0.75 m 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. Nitrogen in the form of calcium ammonium nitrate (26% N), 50 kg of phosphorus in form of single superphosphate (18% P_2O_5) and 30 kg of potassium in form of muriate of potash (62% K_2O) were applied per hectare 5-10 cm away from the seeds at planting. Weeds were controlled manually at four and eight weeks after planting. The parameters days to 50% germination, days to 50% flowering, Peduncle length, days to 50% maturity, Plant height at harvest, Fruit yield, hundred seed weight 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 by weight [12]. 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 [8,9].

RESULTS

The summary of the genotypic and phenotypic correlations for oil yield and seven agronomic traits is

Table 1: Genotypic and phenotypic correlations among eight agronomic traits in castor

Traits		1	2	3	4	5	6	7
2	rG	0.01						
	rP	0.03						
3	rG	0.01	0.01					
	rP	0.01	0.01					
4	rG	-0.76*	0.63**	0.01				
	rP	0.58*	1.69**	0.01				
5	rG	0.58*	-0.05	0.01	2.26**			
	rP	0.77*	-0.04	0.01	0.54**			
6	rG	0.07	0.01	0.02	0.42	0.25*		
	rP	0.02	0.01	0.01	0.54*	0.24*		
7	rG	0.02	0.01	0.01	0.12	0.14	0.03	
	rP	0.01	0.01	0.01	0.08	0.12	0.81*	
8	rG	0.89*	2.62**	0.26*	0.89**	0.60**	0.51**	0.47**
	rP	0.82*	0.51**	0.11	0.72**	0.59**	0.39**	0.37**

*= significant at 0.05 level of probability

**= significant at 0.01 level of probability

1= days to 50% germination, 2= days to 50% flowering, 3= fruit yield, 4= 100- seed weight, 5= days to maturity, 6= pedicel length, 7= plant height, 8= oil yield percentage.

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

	DFG	DFF	FY	100SW	DTM	PL	PH	I
DFG	0.0472	-0.0007	0.00009	-0.2837	0.0835	0.0048	-0.0027	-0.1978
DFF	0.0005	-0.0682	0.0009	0.7578	-0.0035	0.0007	-0.0014	0.7550
FY	0.0005	0.0007	0.0920	0.0037	0.0007	0.0014	-0.0014	0.0056
100 SW	-0.0359	-0.1384	0.0009	0.3734	0.1598	0.0289	-0.0163	-0.0010
DTM	0.0557	0.0034	0.0009	0.8437	0.0708	0.0289	-0.0027	0.9299
PL	0.0033	-0.0007	0.0018	0.1568	0.0177	-0.0690	-0.0041	0.1748
PH	0.0009	-0.0007	0.0009	0.0448	0.0099	0.0021	-0.1358	0.0579

Bold figures are the direct coefficient values. DFG= days to 50% germination, DFF= days to 50% flowering, FY= fruit yield, 100SW= 100- seed weight, DTM= days to maturity, PL= pedicel length, PH= plant height, OYPP= oil yield percentage.

presented in Table 1. The highest positive genotypic correlation was found between 100 - seed weight and oil percentage (r = 0.89) while the most significant negative genotypic correlation was found between days to 50% germination and 100 - seed weight. The results showed that all the traits were significantly and positively correlated with oil yield per plant at both genotypic and phenotypic level. Association between days to 50% germination and 100-seed weight was negative and significant at genotypic level. Generally, the genotypic correlation did not show more significant differences between pairs of characters than the phenotypic correlation. 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.

Table 2, shows the combined summary of the direct and indirect effects of seven agronomic traits on castor oil yield. Figure 1 shows the diagrammatic representation of the path coefficient analysis. The results shows that days to fifty percent germination, fruit yield, 100 - seed weight, days to fifty percent germination and pedicel length had significant positive direct path coefficients with oil yield. The direct effect of days to fifty percent flowering and plant height was negatively significant. Hundred seed weight with the highest correlation coefficient with oil yield per plant also had the highest direct path coefficient with oil yield ($P_{4, 8}$ = 0.37). The highest indirect effect of 100-seed weight was through days to fifty percent flowering (0.7578). The highest total indirect effect (0.9299) was through days to fifty percent maturity. Significant positive indirect effects of 100-seed weight

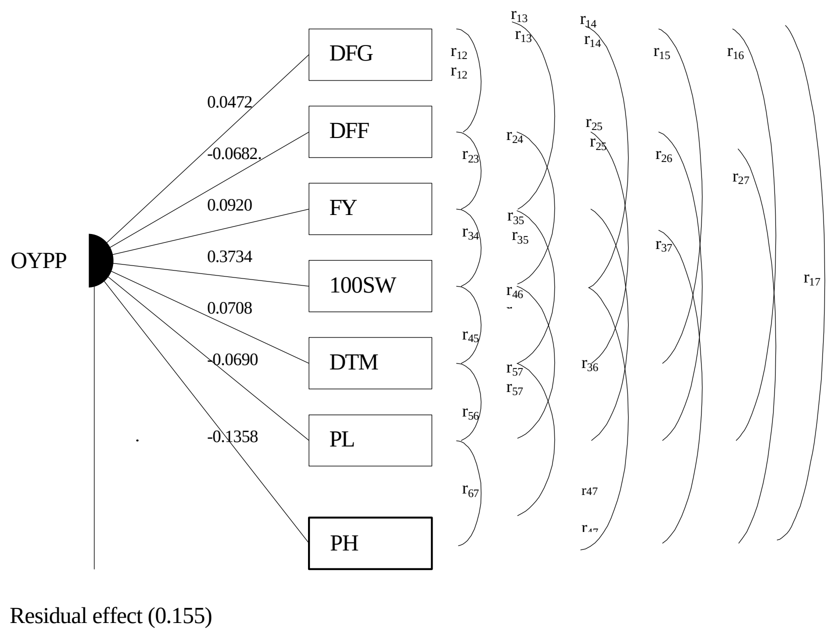

Fig. 1: A path analysis diagram of oil yield and its components in castor
DFG= days to 50% germination, DFF= days to 50% flowering, FY= fruit yield, 100SW= 100 seed -weight, DTM= days to maturity, PL= pedicel length, PH= plant height, OYPP= oil yield percentage

was recorded through days to maturity and pedicel length, while its indirect effect through days to 50% germination, fruit yield, days to maturity, pedicel length and 50% germination were positive and significant. Hundred seed weight had a total indirect effect which was negative and negligible. It is important to note that the indirect effect of 100 seed weight via days to fifty percent germination, days to 50% flowering, fruit yield, days to maturity, pedicel length and plant height were for all this traits and formed a large component of the total indirect effect for each trait.

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 oil yield per plant, 100 - seed weight, days to fifty percent germination, days to 50% flowering, fruit yield, days to maturity, pedicel length and plant height suggests that oil yield can be improved through selection for this yield components. This significant positive relationship among agronomic traits in this study at genotypic and phenotypic level is in accordance with the reports of [13, 17]. Improvement of castor oil 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 [14]. The significant positive relationship between days to 50% flower and days to maturity and oil yield suggests that earliness or lateness in maturity plays a significant role in oil yield per plant and genotypes which were later maturing tend to produce higher oil yield.

Generally, 100 - seed weight emerged as the best most important oil yield component. This is judged especially from the fact that apart from its highly significant genotypic and phenotypic correlation with oil yield, it also the highest direct effect on oil yield per plant and at the same time influenced oil yield per plant by acting as a relay route through which other characters influenced oil yield positively. However, [13] reported that oil yield and 100 - seed weight had a negative direct effect on oil yield. The residual effect was not high and most of the variability in oil yield per plant was well accounted for by the variables. It has been shown, that the most rapid improvement of economic value is expected from selection applied simultaneously to all the component characters together, with appropriate weight being given to each character according to its relative economic importance, its heritability and the genetic correlations between the different characters [15, 16].

From the results obtained, it would be reasonable to suggest that a breeder engaged in the improvement of castor oil yield should place emphasis on 100-seed weight, fruit yield and days to maturity. Selection for these traits will therefore indirectly increase oil yield.

REFERENCES

1. Atsmon, D., 1989. Castor. In Oil Crops of the World. Robbelen, G. *et al*. (Ed.). McGraw Hill Pub. Co., New York. pp: 438-447.
2. Salunkhe, D.K. and B.B. Desai, 1986. Postharvest biotechnology of oil seeds. CRC Press, Boca Raton, FL.
3. Ghandi, V.M., K.M. Cherian and M.J. Mulky, 1994. Detoxification of castor seed by interaction with sal seed meal. J. Am. Oil Chemists Soc., 71: 827-831.
4. Waynes, W., 1999. The Castor Bean: A Plant Named after a tick. htpp://waynesword.palomar. edu/ plmar99.htm
5. Marter, A.D., 1981. Castor market, utilization and prospect. Report of the tropical Institute, G152 vii +pp: 55.
6. Oplinger, E.S., E.A. Oelke, A.R. Kaminski, S.M. Combs, J.D. Doll and R.T. Schuler, 1990. Alternative Field Crops Manual (Castor beans). http:/www.hort.purdue.edu/newcrop/ afcm/castor.html.
7. Grafius, J.E., 1960. Does overdominance exist for yield in corn? Agron. J., 52: 361.
8. Wright, S., 1968. Genetic and biometric foundation (evolution and the genetics of population 1). University of Chicago press.
9. Dewey, D.R.. and K.H. Lu, 1959. A correlation and path coefficient analysis of component of crested wheat grass seed production. Agron. J., 51: 515-518.
10. Deepika, B. and P.R. Tummala, 1981. Correlations and path analysis In castor (*Ricinus communis*). Genome, 23(3): 525-531.
11. Ramu, R., N. Sreedhar and C. lavanya, 2005. Study of correlation and path analysis in castor (*Ricinus communis* L.). Res. on crops, 6(1): 109-111.
12. Pomeranz, Y. and C.E. Meolan, 1978. Food analysis theory and practice. AVI shing Co. Inc. Westport,Connecticut, pp: 607 611.
13. Yadav, Y.P., I.S. Yadav, Ravi Prakash, Ranvir Singh and J.S. Yadava, 2004. Genotypic association and path coefficient analysis in castor, (*Ricinus communis* L.) J. Oilseeds Res., 21(2): 346-348.
14. Pedroza de Azevedo, D.M.P., J.R. Crisostomo, F.C.G. Almeida and 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>.ISSN1415-4757.
15. Hazel, L.N. and J.L. Lush, 1942. The efficiency of three methods of selection. J. Heredity, 33: 393-399.
16. Hazel, L.N., 1943. The genetic basis for constructing selection indexes. 1943. Genetics, 28: 476-490.