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Path Coefficient Analysis Studies in Safflower Accessions (*Carthamus tinctorius* L.)

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ABSTRACT: A present research trial was carried out to study path coefficient analysis in safflower (*Carthamus tinctorius* L.). This research trial consists of 62 genotypes (accessions) alongwith 2 checks (PBNS-12, A-1) were evaluated in Randomized Block Design during *rabi* 2019-20 at All India Co-ordinated Research Project on Safflower V.N.M.K.V., Parbhani. The observations were recorded on 5 competitive fertile plants includes characters like days to 50 per-cent flowering, days to maturity, plant height (cm), number of primary branches/plant, secondary branches/plant, effective capitula/plant, number of seeds/capitulum, hundred seed weight(g), seed yield/plant(g), hull & oil content(%). Path coefficient analysis revealed that the characters like number of primary branches/plant, days to 50 per-cent flowering and number of secondary branches/plant resulted highest positive direct effect on its seed yield/plant at genotypic and phenotypic level which indicating direct selection importance for all these characters.

Keywords: Correlation Coefficients, Path Coefficient Analysis, Safflower Germplasm, Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation(GCV)

INTRODUCTION

Safflower (*Carthamus tinctorius* L.) belongs to *Compositae* or *Asteraceae* family is an oilseed crop originated in the Middle East and part of Africa, but Mediterranean has its major area of production. Safflower is a diploid (2n=24) annual herbaceous crop which grows well in hot and dry climate. Now a days, cultivation of Safflower done for its seed production. From these seeds edible oil and birdseed are made. Traditionally, Safflower grown for flowers purpose from which colouring and flavoring food done, fabric painting and for medicinal purposes. The petals of orange coloured used as a source in the preparation of carthamin dye, which is a natural colouring agent and also used for making *'saffo- tea'*.

Characters association influenced by a large number of genes is explained statistically by using correlation coefficient. The correlation coefficient partitioned into its direct and indirect effects by path coefficient analysis which is suggested by Wright in (1921). It gives useful information on its relative merit of genotypes in the selection criteria. Oil content of a seed is affected by genotype, environment and their interaction. Therefore, detailed information of genetic variability, heritability and genetic advance and path coefficient analysis studies necessary in crop improvement.

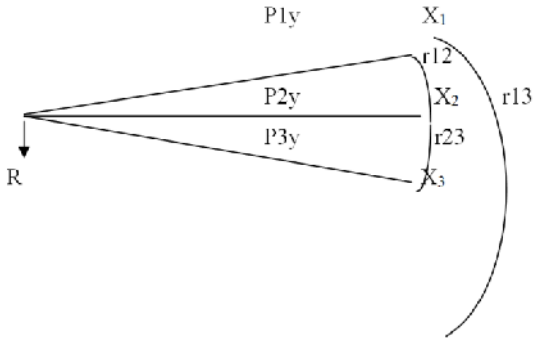
MATERIAL AND METHOD

The field trial study was conducted at All India Co-ordinated Research Project on safflower, during *Rabi* season 2019-20 under irrigated conditions,Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra). The campus geographically situated in Parbhani district of Marathwada region of North-Eastern Maharashtra. Parbhani is located at 19.27°N to 76.78°E. It has an elevation of 347 meters. The material required for present study comprised of sixty two genotypes (entries) including two check *viz*, PBNS-12 and A-1. Randomized Block Design used with 2 replication and each accession grown in single row of 5 m length with a spacing of 45 cm × 20 cm (between rows & between plants) within a row respectively.

The standard package of practices done to raise the crop. Five plants are randomly from each row and replication selected and labeled it for taking observations and the mean was recorded on the basis of that five plants data by statistical analysis. The observations were recorded for days to 50 per-cent flowering, days to maturity, plant height at maturity, number of primary branches/ plant, number of secondary branches/plant, number of effective capitula /plant, number of seeds/capitulum, hundred seed weight (g), seed yield/plant (g), hull and oil content (%).

Correlation coefficients at Genotypic level between yield and its characters were further divided into direct and indirect effects with the help of path coefficient analysis which is originally suggested by Wright , (1921) and further outlined by Dewey and Lu

(1959). In path coefficient analysis first step is preparing the path diagram based on its cause and effect relationship. In this present study, by taking yield as effect path diagram was prepared i.e. the function of various characters like X1, X2, X3 and these characters show following type of association with each other (correlation).



Path digram showing the factors influencing yield.

In the above diagram the grain safflower yield is a result of X1, X2, X3 and also some other factors designated by R. The lines indicating double arrows shown mutual association which is measured by correlation coefficient (r_{ij}) and the lines of single arrowed showing direct effect which is measured by path coefficient analysis (P_{ij}). Direct and indirect contribution of 8 variables to seed yield where calculated by solving a set of simultaneous equation of the form as per Dewey and Lu (1959).

my = pny + m2p2y + m3p3y+……

Where,

Rny = denoting correlation coefficients between one component and its seed yield

m2 = showing correlation coefficient between that character and each of other components.

pny = representing path coefficient between that characters and seed yield.

Matrix-A **Matrix -B**

$$\begin{pmatrix} r1,y \\ r2,y \\ \vdots \\ rn,y \end{pmatrix} - \begin{pmatrix} P1 \\ P2 \\ \vdots \\ Pn \end{pmatrix} \cdot \begin{pmatrix} r1,1 & r1,2\ldots\ldots r1,n \\ r2,1 & r2,2\ldots\ldots r2,n \\ \vdots & \vdots \\ rn,1 & rn,2\ldots\ldots 1 \end{pmatrix}$$

The matrix B was inverted (B^{-1}) and path coefficients (P_{ij}) obtained $P_{ij} = AxB^{-1}$

The coefficients P_1, p_2……pn were estimates of direct effects of character while i^{th} character the indirect effects on seed yield character through j^{th} character is $r_{ij}\ P_{ij}$

The residual factor i.e. yield variation unaccounted by these correlation calculated from following formula.

Residual factor (R_x) = $\sqrt{1 - R^2}$

In which,

R^2 = (P1y,r1y + P2y,r2y+……+ Pny, my)

and P1y , P2y……Pny = path values

R1y, r2y…….rny = correlation coefficients x

RESULTS AND DISCUSSION

Correlation coefficient measures the relationship between the pairs of various characters. But, an interaction production of many mutually is dependent character which is associated component of characters and whole network of cause and effect system was disturbed by change in any one character. That's why path analysis determined the appropriate direct and indirect effect without disturbing the different pairs of characters. To analyse the direct and indirect influence of different characters on yield the path analysis is an effective tool for it. It helps in giving due weightage (direct) to a particular character during selection. The path coefficient analysis indicated the resulted character primary branches/ plant (0.816), days to 50 per-cent flowering (0.589), number of secondary branches/ plant (0.202) exerted the highest direct positive effect on seed yield per plant. The characters days to 50% flowering (-0.052), days to maturity (-0.049), and plant height (-0.014) showed negative and non significant indirect effect on seed yield per plant.

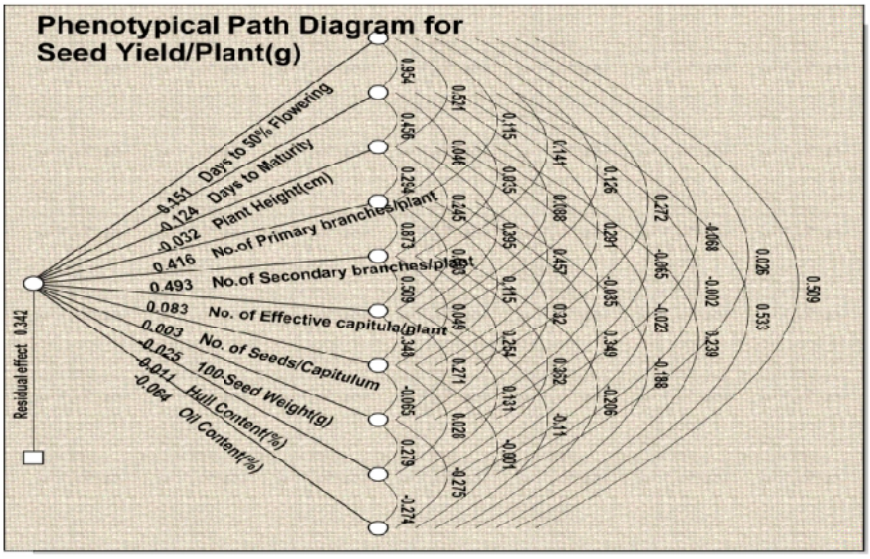
Reddy (2004) reported the character secondary branches/ plant shown highest direct effect on seed yield/ plant. These findings are also in conformity with those of Kamran and Ali (2006), Pavithra (2016). The path coefficient analysis indicated that the

character days to 50 per-cent flowering resulted the highest direct and positive effect on seed yield/ plant. These findings also found by Dambal and Patil (2016), Pavithra (2016), Tandekar and Shrivastava (2018). The character days to maturity (-0.492) shown negative but significant direct effect on seed yield/ plant. Same findings in conformity with Pavithra (2016) and Paikara and Parihar (2019).

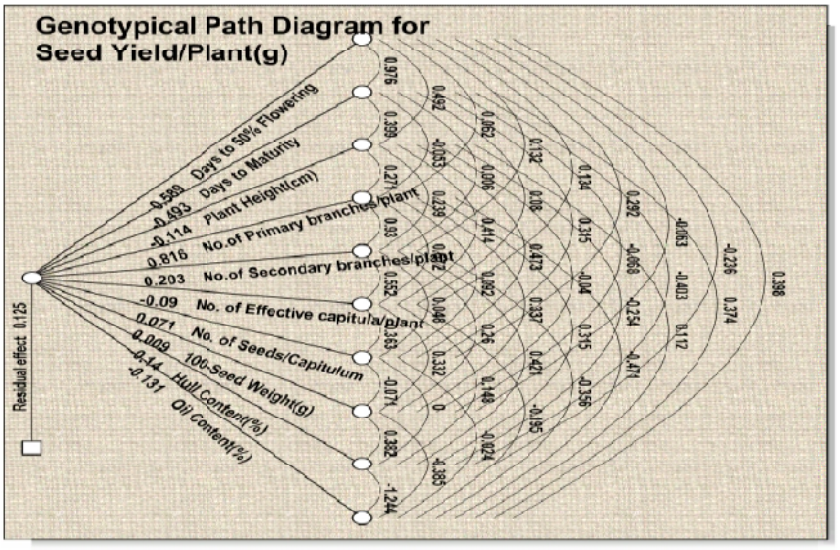
The present investigation clearly revealed as number of primary branches, days to 50% flowering, number of secondary branches exerted the highest and direct positive effect and indirect effects through other components traits. These shows the highest direct effect characters will enhance the breeding efficiency for seed yield/plant in safflower. Hence, for a plant breeder it would be necessary to take the maximum emphasis on above mentioned characters which were engaged in Safflower crop improvement. The genotypic path diagram for seed yield/plant had residual factor (0.125) and for phenotypic path diagram the residual factor (0.342) for seed yield per plant. It explains some other factors which have not been considered needs to included in this analysis to account fully for yield variation.

According to Phenotypical path diagram for seed yield/plant, the characters number of secondary branches/ plant, number of primary branches/plant, days to 50 per-cent flowering shown highest direct positive effect (0.493), (0.416) and (0.151) respectively. The character days to maturity (-0.124) shown negative and significant direct effect on seed yield/plant.

In path diagram (genotypic) the characters primary branches/plant (0.816), days to 50 per-cent flowering (0.589), number of secondary branches per plant (0.203) shown highest and positive direct effect on seed yield/plant. The above results indicated that the characters number of primary branches per plant, days to 50% flowering, number of secondary branches per plant will enhance the breeding efficiency for seed yield in Safflower. Hence, these characters will be necessary for improving yield of Safflower.



Path diagram (Phenotypical) for seed yield/plant(g) *Residual effect (0.342)



Path diagram (Genotypical) for seed yield/plant (g) *Residual effect (0.125)

Table 1 Estimates of phenotypic and genotypic level path coefficient analysis (diagonal) and (off diagonal) effects of different characters on seed yield in safflower.

S.No.	Characters		Days to 50 per-cent flowering	Days to maturity (harvesting)	Plant height	Number of primary branches per plant	Secondary branches per plant	Number of effective capitula per plant	No. of seeds per capitulum	Hundred seed weight	Hull content (%)	Oil content (%)	Seed yield per plant (g)
1.	Days to 50 per-cent flowering	**P**	**0.151**	0.144	0.078	0.017	0.021	0.019	0.041	-0.010	0.003	0.077	0.113
		G	**0.589****	0.575**	0.290**	0.036	0.078	0.079	0.172	-0.037	-0.139	0.234**	0.117
2.	Days to maturity(Harvesting)	P	-0.118	**-0.123**	-0.056	-0.005	-0.004	-0.010	-0.036	0.008	0.000	-0.066	-0.066
		G	-0.480**	**-0.492****	-0.196*	0.026	-0.002	-0.039	-0.155	0.033	0.198*	-0.184*	0.016
3.	Plant height	P	-0.016	-0.014	**-0.032**	-0.009	-0.007	-0.012	-0.014	0.001	0.0007	-0.007	0.253**
		G	-0.056	-0.045	**-0.114**	-0.030	-0.027	-0.047	-0.053	0.004	0.029	-0.012	0.265**
4.	Number of primary branches/ plant	P	0.047	0.019	0.122	**0.415****	0.363**	0.250**	0.047	0.132	0.145	-0.078	0.899**
		G	0.050	-0.043	0.221*	**0.816****	0.759**	0.549**	0.074	0.274**	0.257**	-0.384**	1.003
5.	Secondary branches/ plant	P	0.069	0.017	0.121	0.430**	**0.493****	0.251**	0.024	0.125	0.178*	-0.101	0.910**
		G	0.026	0.001	0.048	0.188*	**0.202***	0.111	0.009	0.052	0.085	-0.072	0.953**
6.	No. of effective capitula/ plant	P	0.010	0.007	0.032	0.049	0.042	**0.082**	0.028	0.022	0.010	-0.009	0.579**
		G	-0.012	-0.007	-0.037	-0.060	-0.049	**-0.089**	-0.032	-0.029	-0.013	0.017	0.596**
7.	Number of seeds/ capitulum	P	0.0009	0.0009	0.001	0.0004	0.0002	0.001	**0.003**	-0.0002	0.0001	0.0000	0.095
		G	0.020	0.022	0.033	0.006	0.003	0.025	**0.070**	-0.005	0.000	-0.001	0.087
8.	Hundred seed weight	P	0.001	0.001	0.0009	-0.007	-0.006	-0.006	0.001	**-0.024**	-0.006	0.006	0.269**
		G	-0.0006	-0.0006	-0.0004	0.003	0.002	0.003	-0.0006	**0.008**	0.003	-0.003	0.299**
9.	Hull content (%)	P	-0.0003	0.0000	0.0003	-0.003	-0.004	-0.001	-0.0003	-0.003	**-0.011**	0.003	0.339**
		G	0.033	0.056	0.035	-0.044	-0.058	-0.020	-0.0001	-0.053	**-0.139**	0.173*	0.444**
10.	Oil content (%)	P	-0.032	-0.034	-0.015	0.012	0.013	0.007	0.0000	0.017	0.017	**-0.064**	-0.240**
		G	-0.052	-0.049	-0.014	0.061	0.046	0.025	0.003	0.050	0.163	**-0.131**	-0.365**

P = Phenotypic and G = Genotypic respectively

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