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Relationship among Traits using Correlation and Path Coefficient Analysis in Safflower (*Carthamus tinctorius* L.)

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Abstract

In order to study the genetic variation and relationships among traits, an experiment was carried out on 40 genotypes of safflower (*Carthamus tinctorius* L.) at the Experimental Farm of College of Agriculture, Latur. The experimental designed was complete randomized block design with 2 replications in the *Rabi* 2020-2021. Analysis of Variance for ten quantitative characters indicated significant differences for all the traits it confirms presence of wide genetic variability in the experimental materials. The phenotypic and genotypic correlation among the traits and their path analysis were calculated. The characters revealed that, plant height, number of branches plant^{-1}, number of effective capitulum plant^{-1}, number of seed capitulum^{-1} and test weight is the characters which showed strong positive significant correlation with seed yield. This characters showed significant and positive correlation with seed yield. Hence, these traits could be considered as important traits for improving seed yield in safflower. The character number of branches plant^{-1}, plant height, number of effective capsules plant^{-1}, number of seed capitulum^{-1} and test weight showed that, higher direct positive effects and indirect effects via other components traits. The character number of seeds capitulum^{-1} exerted the highest direct positive effect on seed yield plant^{-1} followed by and number of branches plant^{-1} and number of capsule plant^{-1}. Hence, importance must be given to these characters because they are directly proportional to seed yield. Negative direct effects were exhibited for the characters like days to maturity and oil content.

Key words : Correlation, Path analysis and Safflower (*Carthamus tinctorius* L.).

Safflower (*Carthamus tinctorius* L.) is one of the oldest oilseed crop. It was first cultivated in Mesopotamia, with archaeological traces possibly dating as early as 2500 BC. Safflower has been grown in India since time immemorial and mentioned as kuswtiba in ancient scriptures. It is widely cultivated under the hot and dry climate of the Middle East, the Centre of its origin and diversity. Carthamus is the Latinized synonym of the Arabic word quartilum or gurtum which refers to the colour of the dye extracted from safflower flowers. In India safflower is cultivated as one of the most important Rabi oilseed crop and it is tolerant to heat, severe drought and salinity. Safflower (*Carthamus tinctorius* L.) is an important oil seed crop of the tropical countries.

Safflower belongs to family- Compositae, sub family- Asteraceae, tribe- Tubiflorae, sub-division- Angiosperm of division - Phenerogams. Safflower plant can be described as a bushy, herbaceous annual possessing several branches, which are categorized as primary, secondary, and tertiary, with each terminating into a globular structure called capitulum. There are 36 species of genus Carthamus, out of which Carthamus tinctorius L. (2n=24) is the only cultivated species of safflower which is used for oil extraction and the rest are wild species. Plants are 30-150 cm tall with globular flower heads (Capitula) and commonly it has got brilliant yellow, orange or red flowers. Safflower oil has a high quality for cooking which on average contains 75% linoleic acid, also contains tocopherols, known to have antioxidant effect and high vitamin E content. India is the largest producer of safflower 24.64 MT in the world with highest acreage 4.3 lakh

hectares but with an average productivity of only 537 kg ha^{-1} in 2018 2019. Maharashtra and Karnataka are the two most important safflower growing states accounting for 72 and 23 per cent of area and 63 and 35 per cent of production, respectively. (Ministry of Agriculture and Farmers Welfare, Govt. of India). The genotypic correlation coefficient the existence of real association, whereas, the phenotypic correlation coefficient may occur by chance. Lower phenotypic correlation may results from the modifying of environment on the association of characters at the genetic level. Genotypic correlation coefficient indicates a measure of genetic association between the characters and therefore helps in identifying the character which are important and need to consider for improvement of yield. Path coefficient analysis is a standardized partial regression analysis which permits the separation of correlation coefficient into measures of direct and indirect effect. Seed yield is the product of interaction of component traits. Apart from correlation studies, path coefficient analysis is important characters influence seed yield. This helps in giving the weightage to a particular character during the selection.

Materials and Methods

Forty genotypes including one check of safflower were evaluated during *Rabi*, 2020-21 at the Experimental Farm of College of Agriculture, Latur, under V.N.M.K.V., Parbhani. The Randomized Block Design was used with two replication and each accession was grown in single row with a spacing of 50 cm between rows and 20 cm between plants within a row. All recommended package of practices were followed to raise the good crop. Five plants at random from each row in a replication were selected and labelled for recording observations and the mean of five plants was used for statistical analysis. The data were recorded for days to 50% flowering, days to maturity, plant height at maturity (cm), number of branches $plant^{-1}$, number of effective capitula $plant^{-1}$, number of seeds $capitulum^{-1}$, 100-seed weight (g), seed yield $plant^{-1}$ (g), hull content(%), oil content(%). Analysis of variance was performed to test the significance of differences between the genotypes for all the characters. Variances were calculated far all the character and analysis of covariance was carried out by taking two character at a time to find out the simple correlation among the character. The interrelationship of different yield contributing character at genotypic level was worked out according to the Johnson (1955). The simple correlation coefficient (r) at genotype level between difference variable (character) according to the formula given by Singh and Choudhury (1977). For testing the significance of correlation coefficient, Fisher and Yates table for significant "r" value at n -2 degree of freedom was consulted (n = total number of observation). To establish a causes and effect relationship, path coefficient analysis was carried out and the simple correlation coefficients (genotypic) were partitioned into direct and indirect effect by path analysis as suggested by Dewey and Lu (1959).

Results and Discussion

Correlation coefficient analysis for seed yield per plant : Correlation coefficient is an important statistical constant which indicate the degree of association among the various characters presented in Table 1. The genotypic correlation coefficient were worked out for different characters including seed yield $plant^{-1}$. Genotypic correlation of the character seed yield $plant^{-1}$ recorded highly significant and positive association with the plant height (0.415), number of branches $plant^{-1}$ (0.834), number of effective capitulum $plant^{-1}$ (0.838), number of seed $capitulum^{-1}$ (0.207) and test weight (0.609). The character oil content (-0.086) and days to maturity (-0.033) showed the negative

and non-significant association. The character which recorded the non-significant but positive association was observed with days to 50 per cent flowering (0.174) and hull content (0.138). Similar result also found by Nair *et al*. (2006). These results are also in conformity with those of Shivani *et al*. (2010), Mohtasham *et al*. (2012), Khalili *et al*. (2013) and Pattar and Patil (2020).

It was important to note that the characters, plant height and number of seed per capitulum were positively and strongly associated with each other (g=0.710). The character number of branches per plant were positively and strongly associated with number of effective capitulum per plant, test weight and hull content. The character number of effective capitulum per plant were positively and strongly associated with test weight. Hence, these traits could be considered as important traits for improving seed yield in safflower. These results are in conformity with those of Kamran and Ali (2006) and Mohtasham *et al*. (2012).

Table 1. Genotypic correlation coefficients of yield and yield components in safflower

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches plant^{-1}	No. of capsules plant^{-1}	No. of seeds capsule^{-1}	Test weight (g)	Oil content (%)	Hull content (%)	Seed yield plant^{-1} (g)
Days to 50% flowering	1.000	0.534**	0.244*	0.116	0.166	0.130	0.029	0.233*	-0.050	0.174
Days to maturity		1.000	0.065	0.276*	0.054	-0.118	0.160	0.013	0.082	0.033
Plant height (cm)			1.000	0.189	0.148	0.710**	-0.168	-0.051	0.001	0.415**
No. of branches plant^{-1}				1.000	1.100**	-0.183	0.531**	-0.233*	0.263*	0.834**
No. of capsules plant^{-1}					1.000	-0.238*	0.456**	-0.161	0.235*	0.838**
No. of seeds capsule^{-1}						1.000	-0.592**	0.358**	-0.375**	0.207*
Test weight (g)							1.000	-0.371**	0.329**	0.609**
Oil content (%)								1.000	-1.015**	-0.139
Hull content (%)									1.000	0.138
Seed yield plant^{-1} (g)										1.000

* and ** indicates significance at 5 and 1 per cent level respectively.

Table 2. Estimates of genotypic path analysis direct and indirect effect of different characters on seed yield

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches plant^{-1}	No. of capsules plant^{-1}	No. of seeds capsule^{-1}	Test weight (g)	Oil content (%)	Hull content (%)	Seed yield plant^{-1} (g)
Days to 50% flowering	0.188	-0.149	-0.088	0.065	0.018	0.138	0.023	-0.020	-0.001	0.174
Days to maturity	0.100	-0.279	-0.023	0.155	0.005	-0.126	0.131	-0.001	0.002	-0.033
Plant height (cm)	0.045	-0.018	-0.360	0.106	0.016	0.757	-0.138	0.004	0.004	0.415**
No. of branches plant^{-1}	0.021	-0.077	-0.068	0.564	0.120	-0.195	0.438	0.020	0.009	0.834**
No. of capsules plant^{-1}	0.031	-0.015	-0.053	0.620	0.109	-0.253	0.376	0.014	0.008	0.838**
No. of seeds capsule^{-1}	0.024	0.033	-0.255	-0.103	-0.026	1.068	-0.488	-0.031	-0.013	0.207*
Test weight (g)	0.005	-0.044	0.060	0.299	0.050	-0.631	0.825	0.033	0.011	0.609**
Oil content	0.043	-0.003	0.018	-0.131	-0.017	0.381	-0.305	-0.089	-0.035	-0.139
Hull content	-0.009	-0.022	-0.004	0.148	0.025	-0.400	0.271	0.090	0.034	0.138
Seed yield plant^{-1} (g)	0.174	-0.033	0.415**	0.834**	0.838**	0.207*	0.609**	-0.139	0.138	1.000

Path coefficient analysis for seed yield plant^{-1} : Path coefficient analysis is a standardized partial regression analysis which permits the separation of correlation coefficient into measures of direct and indirect effect. Seed yield is the product of interaction of component traits. The path analysis Table 2 indicated that, the character number of seeds per capitulum exerted the highest direct positive effect (1.068) on seed yield plant^{-1} followed by test weight (0.825) and number of branches plant^{-1} (0.564) and number of capsule plant^{-1} (0.109). Jawanjal *et al*. (2006) also reported. Present findings were also in conformity with those of Ali et al. (2008), Shivani *et al*. (2010), Golkar *et al*. (2012) and Sreenivasa et al. (2011). The direct negative influence were observed for oil content (-0.089), days to maturity (-0.279), and plant height (-0.360). These findings are in conformity with Jawanjal *et al.* (2006), Shivani *et al.* (2012) and Pattar and Patil (2020).

The present investigation clearly concludes that, the character number of branches plant^{-1}, plant height, number of seed capitulum^{-1} and test weight showed that, higher direct positive effects and indirect effects via other components traits. These findings are in conformity with Pattar and Patil (2020). These indicated that, direct selection for these characters will enhance the breeding efficiency for seed yield in safflower. Hence, for a plant breeder engaged in the improvement of safflower yield, it would be necessary to lay the maximum emphasis on above mentioned characters.

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