Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 1652-1655
Received: 25-11-2019
Accepted: 27-12-2019

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Study on correlation and path analysis in F_2 population in safflower

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Abstract
The study was conducted during *rabi* 2015-16 at research cum instructional farm of IGKV, Raipur. Number of seeds per capitulam has significant positive correlation with seed yield. Similarly, number of branches per plant shows significant correlation with number of capitulam per plant. Number of seeds per capitulam also showed significant positive correlation with plant height and number of capitulam per plant. Days to 50% flowering has significant negative correlation with number of branches per plant, seed yield per plant (g) and number of capitulam per plant, respectively. Number of capitulam per plant has maximum positive direct effect on seed yield per plant followed by number of seeds per capitulam, number of branches per plant and plant height, indicated maximum contribution of these traits in seed yield.

Keywords: Variable N doses, Maize+legume intercropping, maize equivalent yield

Introduction
Safflower (*Carthamus tinctorius* L.) is an important dry land oilseed crop, a member of the family Asteraceae, genus- *Carthamus*, tribe- *Tubiflorae*, sub division-*Angiosperm* of division-*Phanerogams.* It is the only cultivated type of safflower that contains 2n=24 chromosomes (Singh, 2007) [7]. It is an important multipurpose oilseed crop, since ancient times both for a dye as well as for quality oil in a wide range of geographical regions (Knowles, 1976) [3]. Less costly substitute for saffron is indicated by the names false saffron, bastard saffron, thistle saffron and dyers saffron (Weiss, 1983) [10]. Safflower is mainly valued for its seed oil, which includes the traditional high linoleic acid type (typically 64–79% of the total fatty acids) and the high oleic acid type (10–81%). The major bottle necks with this crop are less seed yield, shininess of the plants and maturity duration. To increase the seed yield of the crop there is need to study the association of the important traits, which contributes more for seed yield. Hence, information on correlation coefficient and path analysis between seed yield and yield contributing traits in safflower is pre-requisite for further crop improvement.

Material and methods
The Present study was carried out at Research cum Instructional Farm, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur (M.P.) during *rabi* of 2015-16. In present study two genetically diverse parents GMU 224 and GMU 1303 (exotic collection) were used to make cross. These parents were diverse for many traits such as petal colour, spininess, leaf shape and oil content etc. In present study F_2 population was used to record the segregation pattern of different traits. Observations were recorded in individual plant basis separately for each trait in parents, $F_1$and F_2 plants. The recommended packages of practices were followed to raise good crop. The major features of parents which showed diversity is presented below:

Table 1: Distinguishing traits of parents:

S. No.	Parents	Leaf characters	Petal colour	Oil content
1	GMU 224	Spiny leaves and bracts	Yellow petals	33%
2	GMU 1303	Non spiny leaves and bracts	Orange petals	24%

Parents, F_1 and F_2 populations were grown during the year 2015-16. In F_1 10 plants were raised along with the parents. F_2 population of cross (GMU 244 X GMU 1303) were raised in bulk. Observations of all individual plants of F_2 population were recorded, separately. The study observations for contrasting traits were recorded on 500 plants in F_2 population. In F_2 population each plant was tagged with a number and different observations i.e. plant height, number of capitulam per plant, number of branches per plant, number of seeds per capitulam,

seed yield per plant (gm), days to flowering and oil (%) were recorded for each individual plants. The association relation between seed yield and its contributing characters in safflower was worked out as described by Panse and Sukhatme (1957) while path coefficient analysis was carried out according to methods suggested by Dew and Lu (1959) [1]. The oil content (%) was measured on whole seeds (~ 20 g of sample) using nuclear magnetic resonance (NMR) spectroscopy as described by Yadav and Murthy (2016). SPSS software used for analysis of phenotypic correlation and path analysis were done with the help of DOSBOX0.74 software. Analysis of variation within the F_2 population were also done in order to know the variability for different traits. Dandrogram of F_2 generation were generated through SPSS.

Results and discussion

Table 2: ANOVA in F2 population in safflower

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	16443847	7	2349121	1170.343	0.03	2.012235
Within Groups	6920854	3448	2007.208			
Total	23364701	3455				

ANOVA of all the characters chosen for analysis in F_2 generation plants between cross GMU224 and GMU1303 shows that there is significant variation present in the population both within and between the characters. The different characters are correlated and are responsible towards yield improvement *via*, direct and indirect pathway. The morphological diversity analysis of F_2 generation between cross GMU224 and GMU1303 shows the variation of 432 lines of F_2. Maximum numbers of lines are of GMU 224 type.

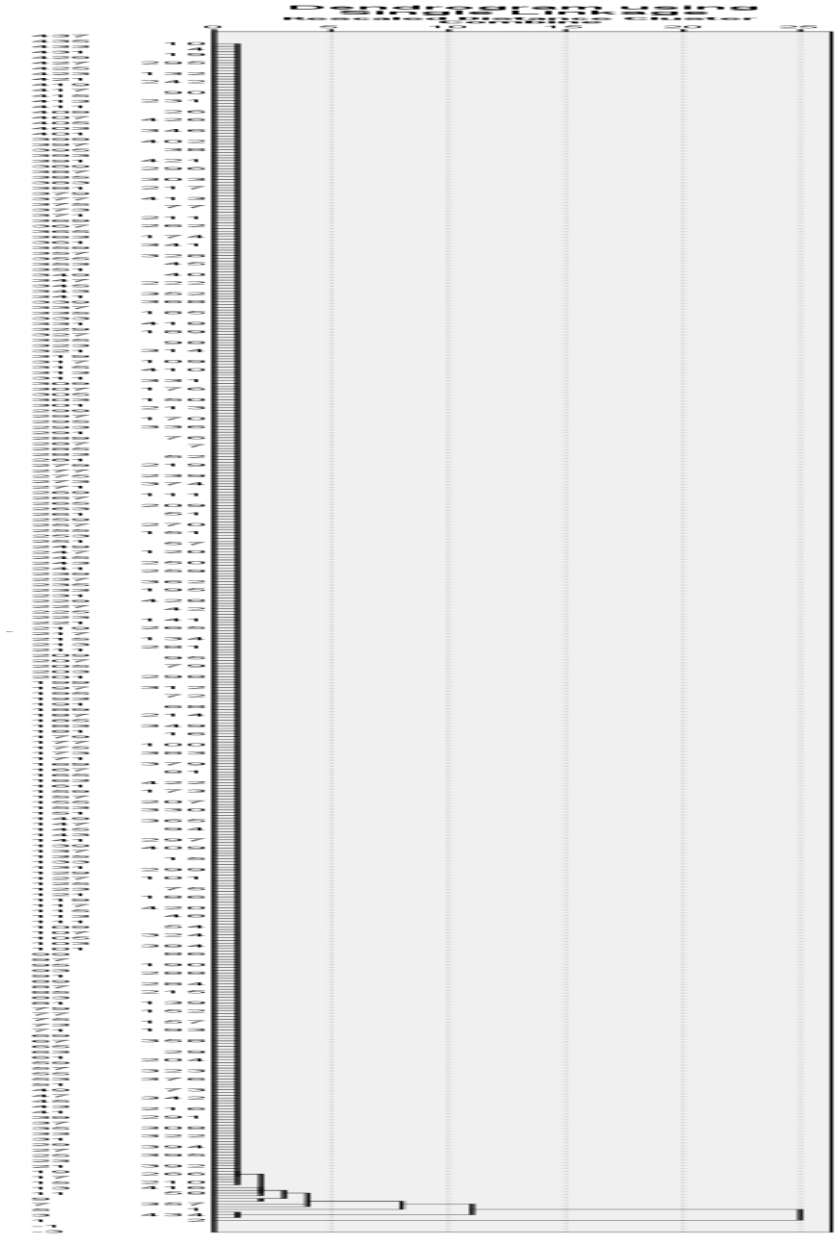

Fig 1: Morphological dendogram of F_2 lines between parents GMU 224 and GMU1303. Line number 1 and 2 number denotes GMU 224 and GMU 1303 respectively.

Correlation analysis among seed yield and its contributing traits

Table 3: Heat map of Correlation matrix for variables studied in F2 population in safflower

Characters	Plant height	No. of capitulam /plant	No. of branches /plants	Seeds per capitulam	Seed yield /plant(gm)	Days to 50% flowering	Oil (%)
Plant height	1	0.027	-0.03	0.09	0.042	0.064	-0.04
No. of capitulam	0.027	1	0.403	0.143**	0.338**	-0.112*	-0.018
No. of branches	-0.03	0.403**	1	0.159**	0.441**	-0.128**	0.005
Seeds per capitulam	0.09	0.143**	0.159**	1	0.323**	-0.023	0.053
Seed yield/plant (gm)	0.042	0.338**	0.441**	0.323**	1	-0.111*	0.07
Days to 50% flowering	0.064	-0.112*	-0.128**	-0.023	-0.111*	1	0.009
Oil (%)	-0.04	-0.018	0.005	0.053	0.07	0.009	1

**Critical values of correlation coefficients at 1 % level of significance, *Critical values of correlation coefficients at 5 % level of significance

Correlation analysis among seven traits reveals that number of capitulam per plant, number of branches per plants and number of seeds per capitulam has significant positive correlation with yield. Maximum effect on seed yield is of number of branches (0.441**) followed by number. of capitulam (0.338**), seeds per capitulam (0.323**) they were significantly positively correlated, indicating that if number of capitulam per plant, number of branches per plants and number of seeds per capitulam can be increased, it will directly increase the seed yield per plant. Similarly, number of branches per plant shows significant correlation with number of capitulam per plant. Number of seeds per capitulam also showed significant positive correlation with plant height and number of capitulam per plant. Days to 50% flowering has significant negative correlation with number of branches, seed yield per plant (g) and number of capitulamper plant respectively. This indicates that number of capitulam per plant, number of branches per plants and number of seeds per capitulam (Table 3) has a significant positive correlation with seed yield and seed yield can directly increased by increasing these traits. These results confirm the findings of previous workers Ghongade *et al*. (1993) [2], Mahasi *et al*. (2006) [4], Sarang *et al*. (2004) [6], Thombre and Joshi, (1981) [9] and Topal *et al.* (2010).

Path analysis among seed yield and its contributing traits.

Table 4: Heat map of Path analysis matrix for variables studied in F2 population in safflower

Characters	Plant height	No. of capitulam /plant	No. of branches /plant	Seeds per capitulam	Days to 50% flowering	Oil %
Plant height	0.06170	0.01210	-0.00350	0.05260	0.00050	-0.00060
No. of capitulam	0.00220	0.34310	0.05650	0.04850	0.00080	0.00080
No. of branches	-0.00250	0.22430	0.08630	0.01700	0.00030	0.00150
Seeds per capitulam	0.01080	0.05540	0.00490	0.29990	0.00020	0.00100
Days to flowering	-0.00250	-0.02120	-0.00180	-0.00470	-0.01300	0.00130
Oil %	-0.00090	0.00690	0.00330	0.00730	-0.00040	0.03930
Residual = 0.6948						

Bold: Direct effects

The path analysis indicates various direct and indirect effects of quantitative characters on seed yield per plant (Table 4) seed yield per plant taken as the dependant character and six other characters taken as independent characters, whose direct and indirect effects will affects the seed yield per plant. Number of capitulam per plant (0.34) has maximum positive direct effect followed by number of seeds per capitulam (0.29), number of branches per plant (0.09) and plant height (0.061). Days to flowering has direct negative effect on seed yield per plant. It was also reported by many scientist Subbalakshmi and Sivasubramanian (1995) [8] and Sarang *et al.* (2004) [6] also reported that the number of capitulum/plant exerted highest positive direct effect on seed yield while it`s positive indirect effect through primary branches/plant (0.395). Number of capitulam per plant has maximum indirect effect (0.22) through number of branch per plant but the residual effect is very high i.e 0.61 which shows that the characters under study only contribute just 31% to the seed yield per plant. Hence, some other characters are also present which literally affects the seed yield per plant. These characters are needed to be identified and must included in the further analysis to know the full variation on seed yield per plant of cross GMU224 and GMU1303.

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