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Correlation and path analysis of seed yield and its contributing traits in safflower (*Carthamus tinctorius* L.) genotypes

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Abstract
The present experiment was conducted at the Research cum Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during *rabi* 2020-21 with a view to study the phenotypic correlation and path analysis studies for yield and yield contributing traits in safflower. 16 safflower genotypes along with 3 checks *viz*., A1 (NC), DSH-185(HC), PBNS-12(VC**)** were evaluated. Association studies indicating positive association of harvest index and biological yield for seed yield as dependent trait, and shows negative association for traits like number of branches per plant and oil content. The oil content had significant negative correlation with harvest index and seed yield. Thus these characters are the key yield contributing characters to be given selection pressure for improving yield. The result of path analysis indicated that the characters biological yield, number of capitulum per plant and 100 seed weight showing direct effect on yield. Highest positive direct effect on oil content was recorded for traits like number of capitulum per plant and biological yield.

Keywords: *Carthamus tinctorius* L., correlation, path analysis

Introduction
Safflower is most commonly known as 'Kusum' (India, Pakistan), derived from the Sanskrit, 'Kusumbha' (Chavan, 1961) [4]. Safflower or wild saffron (*Carthamus tinctorius* L.) is an annual plant native to Mediterranean region. It belongs to the family of *Compositae* or *Asteraceae*, genus-*Carthamus*, tribe-*Tubiflorae*, order- *Asteracae*, sub-division *Angiosperm* of division- *Phanerogams*. Safflower containing the chromosome number 2n=24 (Singh, 2007) [15]. One of the oldest oilseed crops, it is grown in India primarily for the oil produced by the seeds and the scarlet colour produced by the blooms. Safflower florets have been employed in the creation of ayurvedic medicines in India and are worthy of mention in European and Japanese pharmacopoeias, but in recent years, the therapeutic use of these flowers has reignited interest in this crop Safflower oil is extracted from safflower seeds, and it is often considered as best option than others oils due to its reduced amount of unsaturated fatty acids, sunflower oil (Dajue and Mündel, 1996) [7], olive and canola oils (Bergman, 1997; Corleto *et al*., 1997), as well as other oils, are recommended. The monounsaturated fatty acid oleic acid, which is present in safflower oil, and the polyunsaturated fatty acid linoleic acid are both present (polyunsaturated fatty acids). Linoleic acid has been shown to lower blood cholesterol levels, and oleic acid is extremely beneficial in the prevention of coronary artery disease (Dajue and Mündel, 1996) [7]. Safflower oil has more linoleic acid than other oils, according to Arslan *et al*. (2003).

Materials and Methods
The present research work entitled Study of yield and contributing traits in safflower (*Carthamus tinctorius* L.) was carried out during *rabi* 2020-2021. The research work was accomplished at the Research cum Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during *rabi* 2020-2021 and post-harvest observations were conducted at Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur. The experimental materials for current study comprise 16 genotypes of safflower from AICRP of Safflower, Indian Institute of Oilseeds Research (IIOR), Hyderabad. The research work was configured in Randomized Block Design (RBD) with three replications. Correlation coefficient is used to estimate interrelationship between each character. It is proposed by Miller *et al.*, (1958) [12]. Path analysis has been pioneered by Wright (1921) [16], Dewey and Lu

(1959) [8]. The results of the path coefficient analysis are represented according to the following levels recommended by Lenka and Mishra (1973) [11].

Result and Discussion

The association between yield and the qualities that contribute to it was found to be significant in predicting the effectiveness of parent selection as a breeding strategy to improve both plants and economic output. The degree of association affects the primary goal of crop breeding efforts, which is to produce higher yields. Days to maturity shows positive association with days to 50% flowering (0.151) indicated delayed flowering also increases days to maturity. Harvest index has significant positive correlation with days to 50% flowering (0.405**), which indicated that prolong period of flowering gives more time to accumulate source as a result of photosynthesis in form of sink (seed/economic yield). The oil content shows negative significant negative association with harvest index (-0.352**). Seed yield per plant shows positive correlation with days to maturity (0.437), number of capitulum per plant (0.041), harvest index (0.355**) and biological yield/plant (0.396**) where as significant negative correlation with oil percentage (0.460**) and number of seeds per capitulum (-0.407). These findings were reported by Kotecha (1981) [10], Reddy *et al*., (2003) [14], Pahalvani *et al*., (2004), Bidgoli *et al*., (2006) [3], Purkhyastha and Shrivastav (2020).

The positive direct effect on yield per plant was estimated via biological yield (0.116), number of capitulum per plant (0.052), whereas negative direct effect on yield were estimated for days to 50% flowering (-0.296), days to maturity(-0.487), number of seeds per capitulum (-0.222), 100 seed weight (0.088), harvest index (-0.284), plant height (0.234), number of branches per capitulum (-0.116) and oil content (-0.704). Results revealed that increase in number of capitulum per plant increase the number of primary branches, which contributed in increasing the seed yield in safflower. Highest positive direct effect on oil content was recorded for traits like number of capitulum per plant (0.053) and biological yield per plant (0.174), 100 seed weight (0.143) whereas negative direct effect on oil content were estimated for days to 50% flowering (-0.473), days to maturity (-0.946), number of seeds/capitulum (-0.643), harvest index (0.389), plant height (0.375), number of branches per plant (-0.368) and seed yield (-1.977). Residual effect -0.33178 indicated this trait is highly dependent on its contributing traits and all the traits takes influence much in enhancing the quantity of this trait. Results of present study confirms the finding of Patil *et al*., (1990), Chavan *et al*., (1999) [5], Reddy *et al*., (2003) [14], Hussain *et al*., (2014) [9] and Patil and Dambal (2016) [6].

Table 1: Correlation studies of various yield and yield contributing traits in safflower (Rabi 2020-21)

		Days to 50% flowering	Days to maturity	Number of capitulum /plant	Number of seeds /capitulum	100 seeds per weight(g)	Harvest index (%)	Biologic al yield (kg/ha)	Plant height (cm)	Number of branche s/plant	Oil Content (%)
Days to maturity	G	-0.016									
	P	0.151									
Number of capitulum /plant	G	0.435**	0.206								
	P	0.202	-0.151								
Number of seeds/capitulum	G	0.135	0.267	-0.259							
	P	0.049	-0.051	-0.164							
100 seeds per weight(g)	G	-0.185	0.111	-0.128							
	P	-0.091	0.104	-0.135	0.155						
Harvest index (%)	G	0.538**	0.369**	-0.250	-0.078	-0.310*					
	P	0.405**	-0.250	0.016	-0.070	-0.233					
Biological yield(kg/ha)	G	-0.180	-0.347**	0.835**	0.339*	0.707**	-0.468**				
	P	0.066	0.032	-0.061	-0.174	0.175	-0.145				
Plant height(cm)	G	0.136	-0.411**	-0.089	-0.124	-0.046	-0.182	-0.090			
	P	0.068	-0.271	-0.065	-0.022	-0.063	-0.160	-0.105			
Number of branches /plant	G	-0.081	0.362**	-0.084	-0.404**	0.403**	-0.626**	-0.786**	0.037		
	P	-0.139	0.103	-0.194	-0.034	0.139	-0.195	-0.139	0.010		
Oil percentage (%)	G	0.121	0.215	0.128	0.222	0.034	-0.372**	-0.064	-0.205	-0.264	
	P	0.045	0.060	0.052	0.170	0.050	-0.352**	0.052	-0.170	-0.071	
Seed yield(kg/ha)	G	-0.181	0.859	-0.010	-0.430**	0.033	0.399**	0.029**	0.135	-0.477	-0.662**
	P	-0.220	0.437	0,041	-0.407**	0.034	0.355**	0.396**	0.077	-0.065	-0.460**

Table 2: Path analysis of yield contributing traits on seed yield (dependent characters) in safflower (Rabi 2020-21)

	Days to 50% flowering	Days to maturity	No. of capitulum/ plant	Number of seeds/ capitulum	100 seed weight (g)	Harvest index (%)	Biological yield (kg/ha)	Plant height (cm)	Number of branches/capitulum	Oil %
Days to 50% flowering	-0.296	0.008	0.023	-0.030	0.016	0.153	-0.030	-0.032	0.009	0.020
Days to maturity	0.005	-0.487	0.011	-0.059	-0.010	0.105	-0.224	0.096	-0.158	-0.127
Number of capitulum/plant	-0.129	-0.100	0.052	0.057	0.011	0.071	0.139	0.021	0.010	-0.090
Number of seeds/capitulum	-0.040	-0.130	-0.014	-0.222	-0.036	0.022	0.056	0.029	0.047	-0.156
100 seed weight(g)	0.055	-0.054	-0.007	-0.091	-0.088	0.088	0.118	0.011	-0.047	-0.024
Harvest index (%)	0.159	0.180	-0.013	0.017	0.027	-0.284	-0.078	0.042	0.072	0.262
Biological yield(kg/ha)	0.053	0.657	0.044	-0.075	-0.062	0.133	0.166	0.021	0.091	0.045
Plant height(cm)	-0.040	0.200	-0.005	0.028	0.004	0.052	-0.015	-0.234	-0.004	0.144
Number of branches/capitulum	0.024	-0.664	-0.004	0.090	-0.036	0.178	-0.131	-0.009	-0.116	0.186
Oil %	0.008	-0.087	0.007	-0.049	-0.002	0.105	-0.010	0.048	0.030	-0.704

Residual effect -0.11815

Table 3: Path analysis of yield contributing traits on oil content dependent characters in safflower (Rabi 2020-21)

	Days to 50% flowering	Days to maturity	Number of captitulum/ plant	Number of seeds/capitulum	100 seed weight (g)	Harvest Index (%)	Biological yield (kg/ha)	Plant height (cm)	Number of branches /plant	Seed Yiel (kg/h)
Days to 50% flowering	-0.473	0.015	0.023	-0.087	-0.026	0.214	-0.031	-0.051	0.030	0.35
Days to maturity	0.007	-0.946	0.011	-0.172	0.016	0.147	-0.234	0.154	-0.502	1.69
Number of capitulum/plant	-0.206	-0.195	0.053	0.166	-0.018	0.099	0.145	0.034	0.031	0.01
Number of seeds/capitulum	-0.064	-0.252	-0.014	-0.643	0.059	0.031	0.059	0.047	0.149	0.85
100 seeds weight	0.088	-0.105	-0.007	-0.265	0.143	0.123	0.123	0.017	-0.149	0.06
Harvest index (%)	0.254	0.349	-0.013	0.050	-0.044	-0.398	-0.081	0.068	0.231	-0.78
Biological yield(kg/ha)	0.085	1.275	0.044	-0.218	0.101	0.186	0.174	0.034	0.290	-2.03
Plant height(cm)	-0.064	0.389	-0.005	0.080	-0.007	0.072	-0.016	-0.375	-0.014	-0.26
Number of branches/plant	0.038	-1.289	-0.004	0.260	0.058	0.249	-0.137	-0.014	-0.368	0.94
Seed yield (kg/ha)	0.086	0.813	-0.001	0.277	-0.005	-0.159	0.179	-0.051	0.176	-1.97

Residual effect -0.331

Conclusion

From the present investigation it is clear that correlation studies indicating positive association of harvest index and biological yield for seed yield as dependent trait, and shows negative association for traits like number of branches per plant and oil content. The oil content had significant negative correlation with harvest index and seed yield. The positive direct effect on yield per plant was estimated via biological yield, number of capitulum per plant and 100 seed weight, whereas negative direct effect on yield were estimated for days to 50% flowering, days to maturity, number of seeds per capitulum, harvest index, plant height, number of branches per capitulum and oil content.

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