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Direct and indirect effects of yield and its related traits in RIL population of safflower (*Carthamus tinctorius* L.)

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Abstract
The present study was aimed to analyse the cause and effect relation between the yield related traits in RIL population developed from the cross CO-1 x EC-523368-2 during rabi 2020-21. The path analysis resulted with traits number of seeds per primary capitulum, number of primary capitula per plant showing positive direct effect while days to 50% flowering has shown negative direct effect. The indirect effect on seed yield was attributed by days to 50% flowering via days to maturity, number of primary capitula per plant via number of seeds per primary capitulum. However, the traits showing strong direct effect were strongly correlated with the seed yield. Hence, selection of genotypes based on these traits would be reliable in the crop improvement programmes.

Keywords: Path analysis, Direct and Indirect effects, RILs, Safflower, R Studio

1. Introduction
Safflower (*Carthamus tinctorius* L.), 2n = 24, is one of the important and highly nutritious oilseeds at India and global level. It is mainly grown for its petals in dyeing industries (culinary and textiles) and later used for edible oil. The oil of safflower is rich in unsaturated fatty acids like linoleic and oleic acids (75%). It is grown in an area of 0.82 million ha, productivity of 800 kg/ha and production of 0.65 million tonnes. Its acreage, productivity and production in India in 2020 was 0.85 lakh ha, 515 kg/ha and 0.44 lakh tonnes, respectively (FAOSTAT, 2020) [4]. Because of its deep tap-root system, it is primarily grown in arid and semi-arid regions with residual moisture. It is predominantly a self-pollinated crop, herbaceous with primary and secondary branches that bear capitulum (flower head) with 20 to 250 florets (Golkar and Karimi, 2019) [6]. Two natural pigments, carthamin and carthamidin (Golkar., 2018) [5] were responsible to have different petal colours like yellow, red, orange and white in safflower. These coloured florets attract pollinators and allow cross pollination upto 5–40% (Kumari and Pandey, 2005) [10]. The seed is known as an achene, and each flower head typically contains 15-50 seeds; however, the number of seeds can exceed 100. The crop is mostly spiny, but there are commercial varieties that are not (Singh and Nimbkar, 2018) [15]. Despite of many advantages, safflower yield is less in India and global countries. This is due to different yield related traits either genetic or non-genetic characters influence on the dependent character, yield (Dhage *et al*., 2020) [3]. Correlation gives a perspective about a set of characters improving the yield. While, path analysis dissects the correlation between the characters and yield into direct and indirect effects (Dewey and Lu, 1959) [2]. This helps the breeder to identify relatively important variable on the basis of direct and indirect effects. The aim of the study was to establish the cause-and-effect relationships through direct and indirect effects of the path analysis.

2. Materials and Methods
2.1 Plant material
The material used in the present consists of RIL population developed from the cross between CO-1 and EC-523368-2. CO-1 is the female parent, which is a non- spiny safflower variety developed at Tamil Nadu Agricultural University, Coimbatore, India. EC-523368-2 is the male parent, which is a line selected from an exotic accession received from United States Agricultural Department (USDA), USA. Details of the development of the RIL population was provided by Jegadeeswaran *et al*. (2021) [9]. In this study, a set of 147 F_{10} RILs were used.

2.2 Phenotyping
The F_{10} RILs were sown during rabi 2021 (last week of November) in augmented design. Each RIL was grown in a single row following a of spacing of 45 cm x 20 cm with 20 plants/row. Observations were recorded on randomly selected three plants, for seven quantitative characters namely, days to 50% flowering (days), days to maturity (days), plant height (cm), number of primary capitula/ plant, number of seeds/ primary capitulum, 100 seed weight (g) and seed yield (g).

2.3 Statistical analysis
The cause and effect estimations with coefficients on seed yield was analysed using path analysis. It permits the separation of the correlation coefficients into components of direct and indirect effects (Dewey and Lu, 1959) [2]. This was done using R software. R software (RStudio) is a command/code based statistical tool runs under graphical user interface. The following steps were followed to derive the path coefficients from unreplicated data by giving different commands/codes in the source tab

1. Import the data files
```
data <-read.csv(choose.files())
View(data)
attach(my_data)
```

2. Install required packages
```
require(agricolae)
```

3. Analysis
```
x<-path[,c(1,2,3,4,5,6,7,8)] #here we have to define independent variables#
y<-path[,9] #here we have to define dependent variable#
cor.y<-correlation(y,x)$correlation
cor.x<-correlation(x)$correlation
pathresult<-path.analysis(cor.x,cor.y)
```

4. Output
```
write.table(pathresult,file = "pathresults.csv", sep=",",col.names = NA,qmethod = "double")
```

3. Results and Discussion

Table 1: Direct and Indirect effects of seed yield related traits using path analysis

	DFF	DM	PH	NPCP	NSP	HSW
DFF	-0.126	0.146	-0.028	-0.035	-0.032	-0.043
DM	-0.123	0.150	-0.030	-0.035	-0.032	-0.041
PH	0.033	-0.041	0.109	0.089	0.037	0.022
NPCP	0.014	-0.017	0.031	0.317	0.130	0.025
NSP	0.009	-0.011	0.009	0.089	0.464	0.000
HSW	0.039	-0.044	0.018	0.057	0.000	0.140

Residual effect R= 0.526

3.1 Direct effects
The highest positive direct effect on seed yield was observed with number of seeds per primary capitulum (0.464) followed by number of primary capitula per plant (0.317) while days to 50% flowering has shown negative direct effect (-0.126). The traits number of seeds per primary capitulum and number of primary capitula per plant showing direct effect on seed yield was also reported by Mahasi *et al*. (2006) [11], Gopal *et al*. (2014) [7], Pushpavalli *et al*. (2016) [12], Pushpavalli *et al*. (2017) [13] and Jadhav *et al*. (2018) [8]. Negative direct effect on seed yield by days to 50% flowering was also supported by other researchers like Gopal *et al*. (2014) [7] and Jadhav *et al*. (2018) [8].

3.2 Indirect effects
The highest positive indirect effect on seed yield was observed with traits, days to 50% flowering via days to maturity (0.146), number of primary capitula per plant via number of seeds per primary capitulum (0.130) followed by plant height via number of primary capitula per plant (0.089) and number of seeds per primary capitulum via number of primary capitula per plant (0.089). The lowest positive indirect effect was observed with traits, number of seeds per primary capitulum via days to 50% flowering (0.009) and via plant height (0.009). The highest negative indirect effect on seed yield was observed with traits, days to maturity via days to 50% flowering (-0.123) followed by 100 seed weight via days to maturity (-0.044) and days to 50% flowering via 100 seed weight (-0.043). The lowest negative indirect effects were observed with traits, number of seeds per primary capitula via days to maturity (-0.011) and number of primary capitula per plant via days to maturity (-0.017). The results portrayed that there was no indirect effect relationship on seed yield with traits number of seeds per primary capitulum and 100 seed weight (0.000).

Days to 50% flowering via days to maturity showing positive indirect effect was reported by Gopal *et al*. (2014) [7] and Pushpavalli *et al*. (2016) [12]. Plant height via number of primary capitula per plant was in line with the reports by Bahmankar *et al*. (2014) [1] and Jadhav *et al*. (2018) [8] similarly, number of seeds per primary capitulum via number of primary capitula per plant was observed by Pushpavalli *et al*. (2017) [13]. The trait number of primary capitula per plant via plant height reported by Gopal *et al*. (2014) [7] in negative direction. The negative indirect effects observed in traits days to maturity via days to 50% flowering was observed by Gopal *et al*. (2014) [7] and Pushpavalli *et al*. (2016) [12]. Likewise, 100 seed weight via days to maturity by Pushpavalli *et al*. (2017) [13]; days to 50% flowering via 100 seed weight was reported by Pushpavalli *et al*. (2016) [12]; number of seeds per primary capitula via days to maturity was also reported by Pushpavalli *et al*. (2016) [12] and number of primary capitula per plant via days to maturity was reported by Gopal *et al*. (2014) [7].

4. Conclusion
The results of path analysis of yield components revealed that components with highest correlation to yield also had strong direct effect to yield showing the traits number of primary capitula per plant and number of seeds per primary capitula having highest strong correlation and direct effect to yield. Hence, selection of genotypes based on these traits can be done and is reliable. The residual effect R = 0.526 indicates that there were some other characters which were not included in the study accounting for the variation in the yield and should be included in the study.

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6. References

1. Bahmankar M, Nabati DA, Dehdari M. Correlation, multiple regression and path analysis for some yield-related traits in safflower. Journal of Biodiversity and Environmental Sciences. 2014;4(2):111-118.
2. Dewey JR, Lu KH. Correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal. 1959;51:515-518.
3. Dhage P, Ratnaparkhi RD, Sonone M, Fatak S. Correlation studies in safflower (*Carthamus tinctorius* L.) for seed yield and yield related traits. International Journal of Chemical Studies. 2020;8(4):2515-2517.
4. FAOSTAT 2020. *https://www.fao.org/faostat/en/#data/QCL*
5. Golkar P. Inheritance of carthamin and carthamidin in safflower (*Carthamus tinctorius* L.). Journal of Genetics. 2018;97(1):331-336.
6. Golkar P, Karimi S. Safflower (*Carthamus tinctorius* L.) Breeding. In: Al-Khayri, J., Jain S., Johnson D. (eds) Advances in Plant Breeding Strategies: Industrial and Food Crops. Springer, Cham. 2019, 537-575.
7. Gopal GR, Bagade AB, Doijad SB, Jawale LN. Path analysis studies in Safflower germplasm (*Carthamus tinctorius* L.). International Journal of Current Microbiology and Applied Sciences. 2014;3(12):347-351.
8. Jadhav SA, Dhuppe MV, Salunke PM. Correlation Coefficient and Path Analysis in Safflower (*Carthamus tincorius* L.). International Journal of Current Microbiology and Applied Sciences. 2018;6:1234-1241.
9. Jegadeeswaran M, Kadirvel P, Srinivas PS, Senthilvel S, Selvaraj VM, Mobeen S, *et al*. Genetic mapping reveals a major QTL associated with tolerance to the aphid, *Uroleucon compositae* (Theobald) in safflower (*Carthamus tinctorius*). Plant Breeding. 2021;140:320-330.
10. Kumari A, Pandey AK. Pollination mechanism and behaviour of pollinators in safflower (*Carthamus tinctorius* L.). The Journal of Indian Botanical Society. 2005;(84):57-61.
11. Mahasi MJ, Pathak RS, Wachira FN, Riungu TC, Kinyua MG, Kamundia JW. Correlation and path coefficient analysis in exotic safflower (*Carthamus tinctorius* L.) genotypes tested in the arid and semi arid lands (Asals) of kenya. Asian Journal of Plant sciences. 2006;5(6):1035-1038.
12. Pushpavalli SNCVL, Sudhakar C, Jyothi R, Raja RR. Correlation and path coefficient analysis for the yield components of safflower germplasm (*Carthamus tinctorius* L.). Electronic Journal of Plant Breeding. 2016;7(2):420-426.
13. Pushpavalli SNCVL, Kumar G. Study of Genetic Variability, Correlation and Path Analysis of Safflower Genotypes. Research Journal of Agricultural Sciences. 2017;8(3):706-709.
14. R Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria. *https://www.R-project.org/* 2021.
15. Singh V, Nimbkar N. Safflower Research at the Nimbkar Agricultural Research Institute (NARI), Phaltan. Published By: The Director. Nimbkar Agricultural Research Institute (NARI), Phaltan-415523, Maharashtra, India, 2018, 2-39.