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# Estimation of Correlation and Path Analysis between Seed Yield and Various Quantitative Traits in Black Sesame (*Sesamum indicum* L.)

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**A B S T R A C T**

Seventy genotypes of sesame were studied by correlation and path coefficient analysis for single plant yield and other yield contributing components. The association between seed yield and its contributing characters indicated that the seed yield per plant had positive and significant association with number of capsules per plant, number of primary branches per plant also thousand seed weight, harvest index and number of primary branches per plant. Based on path analysis, the number of capsules per plant, days to 50% flowering, number of primary branches per plant, number of seed per capsules and harvest index showed significant positive direct effect with seed yield per plant. Therefore, the number of capsules per plant and number of primary branches per plant should be given importance in selection programmes to get high seed yield in sesame.

## Introduction

Sesame (*Sesamum indicu*m L., 2n=26), an oleaginous seed of the family Pedaliaceae diploid species with 2n = 26 is one of the oldest oil crops and is widely cultivated in Asia and Africa, primarily for its high oil content and its distinctive flavor. The largest global producers of sesame seed are India, China and Sudan contributing approximately 60% of world production, and are highly valued for their oil. Sesame seed is commonly known as the "Queen of the Oil seeds". The seeds of sesame contain 40 to 53 percent oil, which is rich in antioxidants and has amount of oleic and linoleic acids. The seed is additionally plentiful in protein, minerals, nutrients, including niacin and lignans, for example, sesamolin and sesamin.

Considering its broad spectrum range of consumption, there is continuous need to increase the yield potential to make it a more profitable crop. Several researchers *viz*., Goudappagoudra *et al.*, (2011), Abate and Mekbib (2015), Saxena and Bisen (2016) Parameshwarappa *et al.*, (2009) Ibrahim and Khidir (2012), Gangadhara *et al.*, (2012), Bharathi *et al.*, (2015) and Abhijatha *et al.*, (2017) have employed different genetic

parameters and worked out association analysis to generate information for planned breeding programme.

Yield component and plant trait contribution on seed yield may be important for breeding strategies. Correlation analysis that relates seed yield to a single variable may not provide a complete understanding of importance of each component in determining seed yield (Dewey & Lu, 1959; Singh *et al.*, 1979). Path coefficient analysis allows an effective mean of partitioning correlation coefficients into unidirectional pathway and alternate pathway. This analysis permits a critical examination of specific factors that produce a given correlation and can be successfully employed in formulating an effective selection strategy through correlation and path coefficient analysis. Goudappagoudra *et al.,* (2011) observed that seed yield per plant, number of capsules per plant, number of seeds, number of branches per plant, plant height and 1000 seed weight are seed yielding traits. Selection for these characters may be useful in increasing seed yield in sesame.

Therefore, the plant breeder must know the relationship between different contributing and their association with yield. Keeping the above points into consideration, the present investigation was undertaken (i) to evaluate associations between yield components and plant traits with seed yield and (ii) to determine direct and indirect effects of yield components and plant traits on seed yield in black sesame genotypes.

## Materials and Methods

The experiment was conducted under Project Coordinating Unit (Sesame and Niger) Research Farm, JNKVV, Jabalpur (M.P.) during *kharif* 2017. The soil of the experimental area is medium black with uniform topography and free from water logged conditions. Jabalpur is located in the Mahakoshal region of Madhya Pradesh and has sub-tropical and semi-arid climate having hot and dry summer and cold winter with occasional showers. The experimental material consisted of 70 black sesame genotypes laid out in a Randomized Block Design in three replications with spacing of 30 x 10 cm. The crop was raised following the recommended package of practices. The observations were recorded on days to flower initiation, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, number of seeds per capsule, thousand seed weight, seed yield per plant, harvest index and oil content (%). Soxhlet apparatus was used to extract oil from sesame seed. The data were subjected to statistical analysis. Genotypic and phenotypic correlation coefficients were calculated according to the formula suggested by (Miller *et al.*, 1958). Path coefficients were estimated by following Dewey and Lu, 1959. The estimates of correlation coefficient and path coefficient analysis were calculated by analyzing data using INDOSTAT statistical package.

## Results and Discussion

Phenotypic and genotypic correlations between seed yield per plant and various yield traits *viz.*, days to flower initiation, days to 50% flowering, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, days to maturity, number of seeds per capsule, 1000 seed weight, harvest index (%) and oil content (%) are presented in Table 1. The results revealed that the estimates of genotypic correlation coefficients were higher than the phenotypic correlation coefficients.

**Table.1** Phenotypic and Genotypic correlation analysis for yield and yield related traits in sesame genotypes

| Character | | DIF | DF 50 (%) | DM | PH | NPBPP | NSBPP | NCPP | NSPC | 1000 SW | HI (%) | OC (%) | SYPP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DIF** | P | **1.0000** | 0.9789 *** | 0.0284 | -0.1732 * | -0.1746 * | -0.1048 | 0.2080 ** | -0.1242 | 0.0062 | 0.0383 | 0.0904 | 0.0576 |
| | G | **1.0000** | 0.9925 | 0.0188 | -0.1924 | -0.3191 | -0.1444 | 0.2147 | -0.1850 | -0.0009 | 0.0152 | 0.0920 | 0.0503 |
| **DF 50 (%)** | P | | **1.0000** | 0.0453 | -0.1783 ** | -0.1726 * | -0.1251 | 0.1945 ** | -0.1383 * | -0.0120 | 0.0554 | 0.1234 | 0.0547 |
| | G | | **1.0000** | 0.0357 | -0.2054 | -0.3288 | -0.1439 | 0.1991 | -0.1858 | -0.0515 | 0.0359 | 0.1305 | 0.0454 |
| **DM** | P | | | **1.0000** | -0.0151 | 0.1471 * | 0.1933 ** | -0.0094 | 0.0229 | -0.2127 ** | 0.1928 ** | 0.0168 | -0.0301 |
| | G | | | **1.0000** | -0.0270 | 0.2156 | 0.4086 | 0.0035 | 0.2720 | -0.3787 | 0.3541 | 0.0212 | -0.0180 |
| **PH** | P | | | | **1.0000** | 0.0529 | -0.1004 | -0.0802 | 0.0475 | -0.0692 | 0.0662 | -0.0320 | -0.2878*** |
| | G | | | | **1.0000** | 0.0243 | -0.0949 | -0.0863 | 0.0623 | -0.1055 | 0.0969 | -0.0377 | -0.3031 |
| **NPBPP** | P | | | | | **1.0000** | 0.0015 | 0.1700 * | 0.1530 * | 0.1852 ** | 0.0427 | 0.1173 | 0.2182** |
| | G | | | | | **1.0000** | 0.0966 | 0.2554 | 0.3448 | 0.3175 | 0.0679 | 0.1448 | 0.3296 |
| **NSBPP** | P | | | | | | **1.0000** | 0.1708 * | 0.1020 | -0.1838 ** | 0.1391 * | -0.1031 | 0.1580* |
| | G | | | | | | **1.0000** | 0.2575 | 0.1030 | -0.3581 | 0.4985 | -0.1473 | 0.1642 |
| **NCPP** | P | | | | | | | **1.0000** | -0.0315 | 0.1969 ** | 0.2557 *** | -0.0003 | 0.6555*** |
| | G | | | | | | | **1.0000** | -0.0507 | 0.2689 | 0.3120 | 0.0090 | 0.6723 |
| **NCPP** | P | | | | | | | | **1.0000** | -0.1333 | -0.0036 | -0.1217 | 0.0841 |
| | G | | | | | | | | **1.0000** | -0.1541 | 0.0913 | -0.1480 | 0.1074 |
| **1000 SW** | P | | | | | | | | | **1.0000** | -0.0613 | 0.0640 | 0.1695* |
| | G | | | | | | | | | **1.0000** | -0.1553 | 0.0979 | 0.2381 |
| **HI (%)** | P | | | | | | | | | | **1.0000** | 0.0261 | 0.1676* |
| | G | | | | | | | | | | **1.0000** | 0.0667 | 0.2189 |
| **OC (%)** | P | | | | | | | | | | | **1.0000** | -0.1371* |
| | G | | | | | | | | | | | **1.0000** | -0.1521 |

*Significant at 5% level of significance; **Significant at 1% level of significance DIF = Days to flower initiation DF 50 (%) = Days to 50% flowering DM = Days to maturity PH = Plant height NPBPP = Number of primary branches per plant NSBPP = Number. Of secondary branches per plant NCPP = Number of capsules per plant NSPC= Number of seed per capsule 1000 SW = 1000 seed weight HI (%) = Harvest index (%), OC (%) = Oil content (%), SYPP = Seed yield per plant

**Table.2** Genotypic and Phenotypic path coefficient analysis showing direct and indirect effects for yield and yield related traits in sesame genotypes

| Character | | DIF | DF 50 (%) | DM | PH | NPBPP | NSBPP | NCPP | NSPC | 1000 SW | HI (%) | OC (%) | SYPP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DIF** | **P** | **-0.2882** | -0.2821 | -0.0082 | 0.0499 | 0.0503 | 0.0302 | -0.0599 | 0.0358 | -0.0018 | -0.0110 | -0.0260 | 0.0576 |
| | **G** | **-0.6607** | -0.6558 | -0.0124 | 0.1271 | 0.2109 | 0.0954 | -0.1419 | 0.1222 | 0.0006 | -0.0100 | -0.0608 | 0.0503 |
| **DF 50 (%)** | **P** | 0.2176 | **0.2223** | 0.0101 | -0.0396 | -0.0384 | -0.0278 | 0.0432 | -0.0308 | -0.0027 | 0.0123 | 0.0274 | 0.0547 |
| | **G** | 0.6038 | **0.6084** | 0.0217 | -0.1250 | -0.2001 | -0.0876 | 0.1211 | -0.1131 | -0.0314 | 0.0219 | 0.0794 | 0.0454 |
| **DM** | **P** | -0.0014 | -0.0023 | **-0.0508** | 0.0008 | -0.0075 | -0.0098 | 0.0005 | -0.0012 | 0.0108 | -0.0098 | -0.0009 | -0.0301 |
| | **G** | -0.0019 | -0.0037 | **-0.1023** | 0.0028 | -0.0221 | -0.0418 | -0.0004 | -0.0278 | 0.0388 | -0.0362 | -0.0022 | -0.0180 |
| **PH** | **P** | 0.0458 | 0.0471 | 0.0040 | **-0.2642** | -0.0140 | 0.0265 | 0.0212 | -0.0126 | 0.0183 | -0.0175 | 0.0085 | -0.2878 |
| | **G** | 0.0579 | 0.0618 | 0.0081 | **-0.3008** | -0.0073 | 0.0285 | 0.0260 | -0.0187 | 0.0317 | -0.0291 | 0.0113 | -0.3031 |
| **NPBPP** | **P** | -0.0214 | -0.0212 | 0.0181 | 0.0065 | **0.1229** | 0.0002 | 0.0209 | 0.0188 | 0.0228 | 0.0053 | 0.0144 | 0.2182 |
| | **G** | -0.0683 | -0.0703 | 0.0461 | 0.0052 | **0.2139** | 0.0207 | 0.0546 | 0.0738 | 0.0679 | 0.0145 | 0.0310 | 0.3296 |
| **NSBPP** | **P** | -0.0010 | -0.0012 | 0.0018 | -0.0010 | 0.0000 | **0.0095** | 0.0016 | 0.0010 | -0.0017 | 0.0013 | -0.0010 | 0.1580 |
| | **G** | 0.0184 | 0.0183 | -0.0520 | 0.0121 | -0.0123 | **-0.1274** | -0.0328 | -0.0131 | 0.0456 | -0.0635 | 0.0188 | 0.1642 |
| **NCPP** | **P** | 0.1282 | 0.1199 | -0.0058 | -0.0494 | 0.1048 | 0.1053 | **0.6166** | -0.0194 | 0.1214 | 0.1576 | -0.0002 | 0.6555 |
| | **G** | 0.1323 | 0.1227 | 0.0021 | -0.0532 | 0.1574 | 0.1587 | **0.6163** | -0.0313 | 0.1657 | 0.1923 | 0.0056 | 0.6723 |
| **NCPP** | **P** | -0.0096 | -0.0107 | 0.0018 | 0.0037 | 0.0118 | 0.0079 | -0.0024 | **0.0773** | -0.0103 | -0.0003 | -0.0094 | 0.0841 |
| | **G** | -0.0120 | -0.0120 | 0.0176 | 0.0040 | 0.0223 | 0.0067 | -0.0033 | **0.0647** | -0.0100 | 0.0059 | -0.0096 | 0.1074 |
| **1000 SW** | **P** | 0.0002 | -0.0003 | -0.0053 | -0.0017 | 0.0046 | -0.0045 | 0.0049 | -0.0033 | **0.0247** | -0.0015 | 0.0016 | 0.1695 |
| | **G** | 0.0000 | 0.0014 | 0.0104 | 0.0029 | -0.0087 | 0.0098 | -0.0074 | 0.0042 | **-0.0273** | 0.0042 | -0.0027 | 0.2381 |
| **HI (%)** | **P** | 0.0013 | 0.0019 | 0.0068 | 0.0023 | 0.0015 | 0.0049 | 0.0090 | -0.0001 | -0.0022 | **0.0351** | 0.0009 | 0.1676 |
| | **G** | 0.0020 | 0.0048 | 0.0476 | 0.0130 | 0.0091 | 0.0671 | 0.0420 | 0.0123 | -0.0209 | **0.1345** | 0.0090 | 0.2189 |
| **OC (%)** | **P** | -0.0138 | -0.0188 | -0.0026 | 0.0049 | -0.0179 | 0.0157 | 0.0000 | 0.0185 | -0.0098 | -0.0040 | **-0.1524** | -0.1371 |
| | **G** | -0.0213 | -0.0303 | -0.0049 | 0.0087 | -0.0336 | 0.0342 | -0.0021 | 0.0343 | -0.0227 | -0.0155 | **-0.2319** | -0.1521 |

Residual effect = 0.619 Note: Diagonal bold figure are the direct effect and the off diagonal are indirect effects.
DIF = Days to flower initiation DF 50 (%) = Days to 50% flowering DM = Days to maturity PH = Plant height NPBPP = Number of primary branches per plant NSBPP = Number. Of secondary branches per plant NCPP = Number of capsules per plant NSPC= Number of seed per capsule 1000 SW = 1000 seed weight HI (%) = Harvest index (%), OC (%) = Oil content (%) SYPP = Seed yield per plant

**Fig.1** Correlation between plant traits

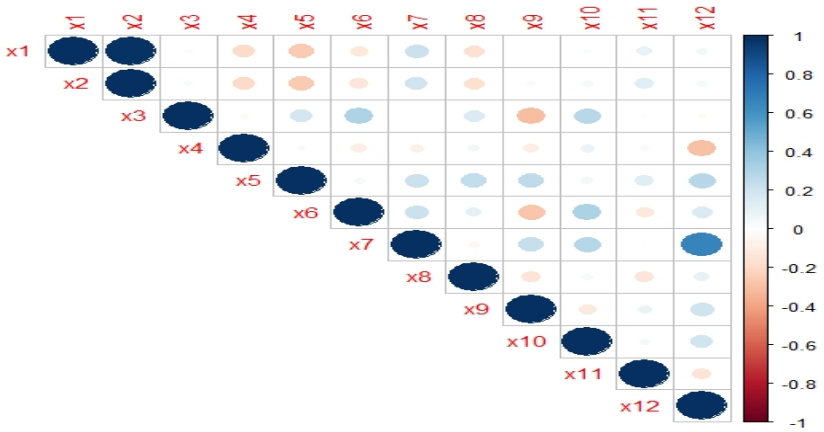



**Fig.2** Genotypic path diagram for seed yield per plant

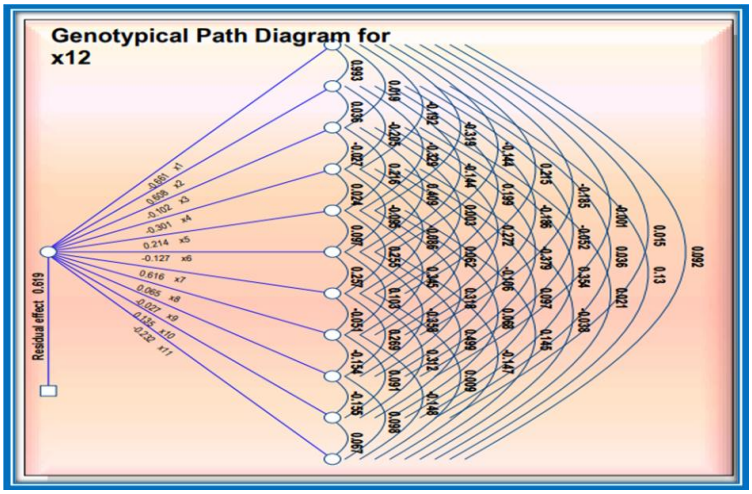
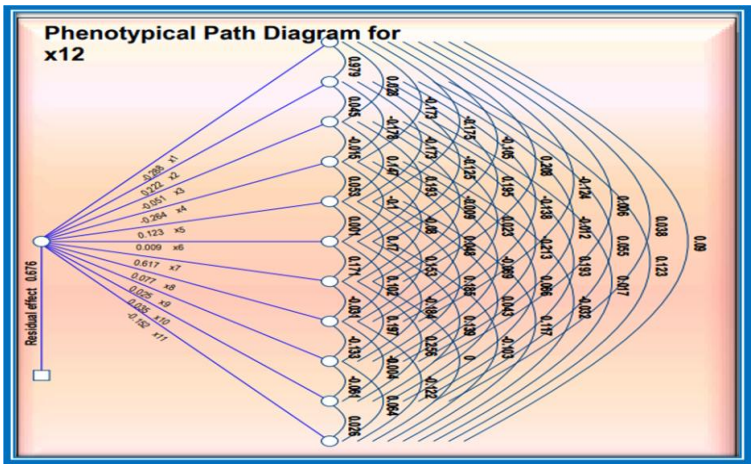



**Fig.3** Phenotypic path diagram for seed yield per plant



Study revealed that seed yield per plant showed highly positive significant correlation with number of capsules per plant and number of primary branches per plant and significant correlation with 1000 seed weight, harvest index and number of secondary branches per plant. While, significant negative correlation was exhibited with plant height and oil content %. Correlation coefficients of various traits are exhibited in Table 1 (Fig -1).

The association between seed yield and its contributing characters indicated that days to flower initiation showed positive significant association with days to 50% flowering and number of capsules per plant, while, negative association was observed with plant height and number of primary branches. Days to 50% flowering expressed high positive significant association with days to 50% flowering followed by number of capsules per plant, while, negative association was exhibited with plant height and number of primary branches per plant. Days to maturity expressed positive significant association with number of secondary branches per plant, number of primary branches per plant and harvest index (%), whereas, negative association was exhibited by 1000 seed weight (g). Plant height expressed negative significant association with days to 50% flowering and days to flower initiation. Number of primary branches per plant expressed positive association with thousand seed weight, number of capsule per plant, number of seeds per capsule and days to maturity, while, negative association was observed with days to flower initiation and days to 50% flowering. Number of secondary branches per plant expressed positive significant association with days to maturity, number of capsules per plant and harvest index (%), while, it recorded negative association with thousand seed weight (g). Number of capsules per plant expressed positive significant association with harvest index, days to flower initiation, thousand seed weight, days to 50% flowering, number of secondary branches per plant and number of primary branches per plant. Number of seeds per capsule showed significant positive correlation with primary branches per plant, while, negative association was exhibited with days to 50% flowering. 1000 seed weight showed significant positive correlation with number of capsule per plant and number of primary branches per plant while, negative association with days to maturity. Harvest index showed significant positive correlation with number of capsules per plant, days to maturity and number of secondary branches per plant. These findings are in accordance to Goudappagoudra *et al.*, (2011), Abate and Mekbib (2015), Saxena and Bisen (2016), Kordestani *et al.*, (2009) for 1000 seed weight and number of capsules per plant; Gangadhara *et al.*, (2012) for capsules per plant and branches per plant; Fazal *et al.*, (2015) for branches per plant, capsules per plant, seeds per capsule and 1000 seed weight and Singh *et al.*, (2017) for number of capsules per plant and number of secondary branches per plant. Seed yield per plant showed high significant negative correlation with plant height and oil content, which is contrast to the findings of Shekhawat *et al.*, (2013) and Singh et al (2017). Overall correlation study indicated that the traits *viz.*, number of capsules per plant, number of primary branches per plant, 1000 seed weight, harvest index and number of secondary branches per plant may play important role in the improvement of seed yield.

Path coefficient analysis (Table 2) was studied considering twelve component traits, out of which traits *viz.*, number of capsules per plant, days to 50 % flowering, number of primary branches per plant, number of seeds per capsule and harvest index showed significant positive direct effect with seed yield per plant. Similar findings have also

been obtained by Parameshwarappa *et al.,* (2009) and Ibrahim and Khidir (2012) for number of capsules per plant, Gangadhara *et al.,* (2012), Abate and Mekbib (2015) for harvest index; Bharathi *et al.,* (2015) and Abhijatha *et al.,* (2017) for number of seeds per capsule and number of capsules per plant.

While indirect effect reported in days to flower initiation exhibited positive indirect effect on seed yield per plant via number of primary branches per plant, plant height, number of seeds per capsule, number of secondary branches per plant, whereas, negative indirect effect was exhibited via days to 50% flowering, number of capsules per plant and oil content. Days to 50% flowering exhibited positive indirect effect on seed yield per plant via number of capsules per plant, oil content, harvest index (%) and days to maturity, whereas negative indirect effect was exhibited through number of primary branches per plant, plant height, number of secondary branches per plant and thousand seed weight.

Days to maturity exhibited positive indirect effect on seed yield per plant via plant height, thousand seed weight and negative indirect effect was exhibited through days to flower initiation, number of primary branches per plant, harvest index, number of seeds per capsule, oil content and number of capsules per plant. Plant height exhibited positive indirect effect on seed yield per plant via thousand seed weight, number of secondary branches per plant, number of capsules per plant, oil content, while negative indirect effect was exhibited via through harvest index, number of seeds per capsule and number of primary branches per plant. Number of primary branches per plant exhibited positive indirect effect on seed yield per plant via number of seeds per capsule, thousand seed weight, number of capsules per plant, number of secondary branches per plant, oil content and harvest index. Number of secondary branches per plant exhibited positive indirect effect on seed yield per plant via thousand seed weight and oil content; negative indirect effect via harvest index, number of capsules per plant and number of seeds per capsule.

Number of capsules per plant exhibited positive indirect effect on seed yield per plant via harvest index, thousand seed weight and oil content. These positive direct effects observed with seed yield were in accordance with the reports of Parameshwarappa *et al.,* (2009) and Ibrahim and Khidir (2012) for number of capsules per plant, Gangadhara *et al.,* (2012), Abate and Mekbib (2015) for harvest index; Bharathi *et al.,* (2015) and Abhijatha *et al.,* (2017) for number of seeds per capsule and number of capsules per plant. The path analysis of the present investigation revealed that substantial negative direct effect on seed yield was observed by days to flower initiation, plant height, oil content (%) thousand seed weight, number of secondary branches per plant, days to maturity and number of secondary branches per plant. These findings were similar with the reports of Thiyagu *et al.,* (2007) for 1000 seed weight, Gangadhara *et al.,* (2012) for oil content and days to maturity; Abate and Mekbib (2015) for days to maturity.

The path analysis of the present investigation revealed that substantial negative direct effect was observed by days to flower initiation, plant height, oil content (%), 1000 seed weight, number of secondary branches per plant, days to maturity and number of secondary branches per plant. Similar findings have also been obtained by Thiyagu *et al.,* (2007) for 1000 seed weight, Gangadhara *et al.,* (2012) for oil content and days to maturity; Abate and Mekbib (2015) for days to maturity.

In conclusion this experiment, the relationship study through path analysis and correlation revealed that characters such as number of capsules per plant, number of primary branches per plant and harvest index should be considered as the main selection parameters for formulating high yielding plant ideotype.

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## Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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