Advances in Crop Science and Technology

Review Article Open Access

Correlation and Path Coefficient Analysis in Yield and Yield Related Components of Black Cumin (*Nigella Sativa L.*) Accessions, at Jimma, Southwest Ethiopia

Kenneth H. Rand*, **Kartik Cherabuddi, Michael Lauzardo, Stacy G. Beal, Neil Harris, Scott Powell, Randell L. Duggins and Forrest J Masters**

[1]*Department of Horticulture, Injibara University, Injibara, Ethiopia*
[2]*Department of Horticulture and plant science, Jimma University, Jimma, Ethiopia*

Abstract

Many research works has been done on Black Cumin focused on its nutritional and medicinal properties. But there is inadequate information on the association of yield and yield constituting traits of black cumin to improve its production. Therefore, correlation analysis was made on thirty-six Black Cumin accessions evaluated at Jimma in simple lattice design during 2016, to quantify the relationship between traits. The result of the analysis showed that seed had positive and highly significant correlation with number of effective capsule (0.88), secondary branches (0.73), plant height (0.72), total branches (0.71), steam thickness (0.58), primary branches (0.52), tertiary branches (0.52), harvesting index (0.47) and biological yield (0.43). Path coefficient analysis revealed that harvesting index, biological yield and number of effective capsule exerted high and favorable direct contribution to seed yield at phenotypic level, whereas harvesting index, biological yield, primary and tertiary branches, number of effective capsule and stem thickness showed positive direct effect at genotypic level. The favorable direct effects of these traits on grain yield indicate that, other variables kept constant, improvement of these traits will increase black cumin yield. Therefore, these traits should be kept in mind in the future breeding program of black cumin.

Keywords: Correlation; Path analysis; Black cumin; Seed yield; Yield components

Introduction

Black Cumin (*Nigella Sativa L.*) belongs to the Ranunculaceae family in the order of Ranales, which is a large family containing about 70 genera and over 300 species. It is also classified under the 14 species of annual herbs in the genus Nigella [1]. It is originated in Egypt and East Mediterranean, the cultivation of black cumin can be traced back more than 3,000 years [2]. But it is broadly cultivated in other parts of the world including sub-Saharan Africa especially Ethiopia [3,4].

The use of black cumin has been testified both in religious and scientific evidences. Importance of

N. sativa to the Muslims came from the saying of the Prophet Mohammed where he said it is the medicine for every disease except death [5]. And also mentioned in the Holy bible both in the old and the new testaments, it is said that cumin was used as a currency to pay tithe to the ancient Rome and Greece priests [6]. Researches from around the globe are also giving increasing support to black cumin's widespread healing powers. It was found out that the constituents of the seed have unique chemical properties with more than 100 different chemical components [7,8]. Due to richness in a number of chemicals, black cumin is claimed cure of all diseases except death and aging [9]. More over in Ethiopia, it is commonly used as ingredient in different homemade food items such as Berbere (local spice of stew), bread, katicala (local alcoholic beverage) and as preservative for butter. This age-old practice of using plant resources in traditional medicines is still in existence in the rural areas of Ethiopia.

Even though, production and land coverage of Black cumin have been increasing; the productivity is still less than 300 kg per hector. From several problems accoun for the continued low productivity and production of Black cumin lack of improved seed is the principal factor. Due to the increased demand of Black cumin seed for local consumption and other importance, such as oil and oleoresin for medicinal purposes, its export market improving its seed yield and genetic improvement must be undertaken.

But seed yield is a composite trait whose production is influenced by its constituent traits directly or indirectly. Breeder is certainly concerned in investigating the extent and type of relationship of such traits for they contribute valuable information in breeding for yield. Knowledge of the association of yield and its constituent traits will allowed a breeder to know how the selection pressure employed by him on one trait will cause variations in other traits. Thus, quantification of the association between yield and its constituents is critical in breeding for a certain crop. For the purpose of quantification of interactions among traits in crop plants correlation and regression analyses are used for the breeder to realize the nature and extent of the relationship between traits which are commonly used to achieve better yield of the crop. Assessing genotypic and phenotypic correlation coefficients with yield interrelated traits is, therefore, significant to utilize the available variability through selection. Correlation is logical step towards a clear sympathetic of the type of plant traits. Correlation analysis measures the relationships between any given pair of traits without regards to cause/effect association.

However, research's on the association of black cumin yield and yield component traits is unsatisfactory conducted in Ethiopia. As a result, there is no enough information on phenotypic relationship and direct and indirect effect of various characters among yield and yield components of Black Cumin to measures the relative importance of each variable. Therefore, the objective of this study was to quantify the phenotypic and genotypic relationship and to evaluate the direct and indirect effect of various traits among yield and yield constituents of Black Cumin accessions conserved in Institute of Biodiversity

***Corresponding author:** Zigyalew Gashaw, Department of Horticulture, Injibara University, Injibara, Ethiopia, E-mail: zigyalewgashaw@gmai.com

Received date: February 02, 2020; **Accepted date:** February 16, 2020; **Published date:** February 23, 2020

Citation: Gashaw Z, Gebreselassie W, Hailemichael G (2021) Correlation and Path Coefficient Analysis in Yield and Yield Related Components of Black Cumin (*Nigella Sativa L.*) Accessions, At Jimma, Southwest Ethiopia. Adv Crop Sci Tech 9:461.

Conservation (IBC), in order to gain illustrative results for efficient future selection and enhancement programs.

Methods

The experiment was conducted at Jimma, Eladale Research site; which is located 350 Km south- west of Addis Ababa, Ethiopia. The site is situated at latitude of 7o S 42' 9"N and longitude 36o 47' 6" E and an elevation of 1753 m above sea level. The area receives an average annual rainfall of 1559 mm with maximum and minimum temperatures of 26.8ºC and 13.6ºC, respectively. Average maximum and minimum relative humidity of the area are 67.5% and 37.9%, respectively. The soil of the experimental site is reddish brown clay, classified as Nitisol with pH range of 5.0 to 6.0.

Thirty six black cumin accessions were used as an experimental material, of these thirty-three accessions were kindly provided by IBC which were collected from different regions of Ethiopia. In addition, three released cultivars i.e., Dershaye, Aeden, and Darbera were provided by Gera Agricultural Research Center. Genotypes are listed in .

Experimental Design and Field Management

Twenty-four patients admitted to the UF Health Shands hospital Gainesville, FL in March- April, 2020 known to have been positive for SARS-CoV-2 were tested by both conventional and 3D printed swabs. Four of these tested negative with both swab types, leaving a final group of 20 who had at least one positive viral gene.

Data collection

Data collection was done in plot and in plant basis. So the variables were gathered from five randomly selected plants from the middle rows and from the middle row itself at each replication at the required stage. These variables are expressed below.

Data collected in plot basis

Days to 50% emergence: number of days from date of sowing to when 50% of the seedlings appeared above the ground level.

Days to blooming: days from the date of sowing to 50% bud initiation by observing the whole plants grown at each plot every morning.

Days to 50% flowering: Days when 50% of the plants in a plot get flowered.

Days to maturity: number of days from date of emergence to when the plant changed from dark green to brown-yellow colour, 90% of the capsules changed to yellow and when the capsule begun to wither.

Biological yield (Kg): It was determined by taking the total above ground whole plant parts harvested from the two central rows of each experimental plot (50cm × 2m^2) weighed in gram after dried for three days in open sun then converted to kilograms ha.

Seed yield per ha (Kg): seed yield was determined by harvesting plants from the net middle plot area 50 cm x 2 m^2 to avoid border effects. Seeds, which were obtained from the corresponding net plot, were cleaned manually. After sun dried to 8 to 10% moisture content, weighed in grams by using sensitive balance and recorded as mean values of seed yield per hectare after converted to kilograms.

Harvest index per plot (%): It was estimated by dividing grain yield per plot to biological yield per plot. It is ratio of grain yield to the above ground biomass yield.

Data collected on plant basis

Plant height (cm): Average height in centimeter measured from ground level to the tip off the plant.

Number of branches per plant: Number of primary, secondary and tertiary branches were recorded by counting branches from respective plant parts raised from main stem as primary branches, branches raised from primary branches taken as secondary and branches raised from secondary branch taken as tertiary branches which were recorded at maturity stage from five randomly taken plants .

Number of capsules per plant: Average number of seed bearing capsules from the five tagged plants.

Number of seeds per capsule: the actual total count of seeds per capsule taken from five randomly taken capsules per plant.

1000-seed weight (g): It was determined from the seed obtained from each of five tagged plants, dried in the sun to 8% to 10% moisture content by using moisture tester. Thereafter, weighed by Analytical balance and counted with a seed counter and the average weight were expressed in grams.

Data Analysis

Analysis of Variance (ANOVA)

The data collected for each quantitative trait was subjected to analysis of variance (ANOVA) for simple lattice design. Normality of each data was checked before the analysis. The result revealed that all the traits showed normality. Analysis of variance for each character was computed using the standard statistical procedure of Gomez and Gomez and using statistical software SAS 9.3. Efficiency of the lattice design relative to RCBD was checked and in most of the response variables, the lattice was found to be more efficient than that of the RCBD. After testing the ANOVA assumptions treatment means were tested for significance (LSD) at 5% probability levels.

Results

Assessment of associations among different characters revealed that some of the characters are positively correlated while others are negatively correlated indicating that improving or increasing specific character will have positive or negative influence on the other characters in such degree apparent from the correlation coefficients .

Phenotypic correlation (above diagonal) showed that seed had a highly significant correlation with number of effective capsules per plant (0.83), number of total branches (0.68), plant height (0.66), number of secondary branches (0.66), plant harvesting index (0.53) number of primary branches (0.53), steam thickness (0.52) number of tertiary branches (0.49) and biological yield (0.40).

Days to emergence highly correlated with days to harvest (0.34) and also significantly correlated with biological yield (0.28) and 50% flowering date (0.23). It also had a positive correlation with blooming (0.19), thousand seed weight (0.06), number of secondary branches (0.02), and number of seeds per capsule (0.00) and also negatively and significantly correlated with harvesting index (-0.27), negatively correlated with plant height (-0.15), number of tertiary branches (-0.13), number of effective capsules per plant (-0.08), stem thickness (-0.06), seed (-0.04) number of total branches per plant (-0.02) and number of primary branches (-0.01).

Days to blooming had highly significant correlation with 50% flowering (0.58), days to harvest (0.58), while positively correlated with number of primary branches (0.14), stem thickness (0.13). It also had highly significant negative correlation with tertiary branches (-0.45) and also negative correlation with number of total branches per plant (-0.17) number of effective capsule per plant (-0.17) and number of secondary branches (-0.13), number of seeds per capsule (-0.09), thousand seed weight (-0.09), biological yield (-0.08), plant height (-0.03), and negatively significantly correlated with seed (-0.29).

Days to 50% flowering had a highly significant correlation with harvesting date (0.64). It had positive correlation with primary branches (0.15), stem thickness (0.05), biological yield (0.01),

but highly negatively correlated with tertiary branch (-0.45) and negatively correlated other traits studied and mentioned in the . This might be due to flowers raised from tertiary branch is mostly delayed to flower once with as primary branches and secondary branches.

Number of primary branches had highly significant correlation with stem thickness (0.80), number of secondary branches (0.74), number of total branches (0.73), plant height (0.72), number of effective capsules per plant (0.63) and seed (0.53), biological yield (0.34) and number of tertiary branches (0.31). It had positive weak correlation with harvesting index (0.17) and harvesting date (0.16). But it had negatively correlated with number of seed per capsule (-0.10) and 1000 seed weight (-0.10).

Number of secondary branches had highly significant correlation with number of total branches (0.95), number of effective capsules per plant (0.70) plant height (0.69), number of tertiary branches (0.68) and stem thickness (0.68), seed (0.66) and biological yield (0.34). It had significant correlation with harvesting index (0.29) and also negatively correlated with 1000 seed weight (-0.09) harvesting date (-0.11) and number of seeds per capsule (-0.01).

Tertiary branches had highly significant correlation with total branch (0.76), seed (0.49), number of effective capsules per plant (0.46), plant height (0.40), harvesting index (0.35), it had significant correlation with stem thickness (0.29), and positively correlated with biological yield (0.11) and number of seed per capsule (0.07). While highly negatively correlated with harvesting date (-0.53) and weakly negatively correlated with thousand seed weight (-0.14).

Total branch number had highly significantly correlated with most traits studied, but negatively correlated with harvesting date (-0.18), thousand seed weight (-0.14) and number of seed per capsule (-0.02). Stem thickness also showed highly significantly correlation with plant height (0.68), number of effective capsule per plant (0.59) and seed (0.52). While significantly correlated with biological yield (0.29), and positively correlated with the rest traits except number of seed per capsule (-0.08) studied.

Plant height had highly significant correlation with number of effective capsule per plant (0.76), seed (0.66) and harvesting index (0.37). It had also positive correlation with harvesting date (0.06) and negative correlation with number of seed per capsule (-0.15) and 1000 seed weight (-0.09).

Days to harvest had a significant correlation with biological yield (0.27) and 1000 seed weight (0.02). While it had a negative correlation with seed (-0.21) and number of seed per capsule (-0.19) and number of effective capsule per plant (-0.07), but it was highly negatively correlated with harvesting date (-0.41). Biological d a highly significant correlation with number of effective capsule per plant (0.42) while positive correlation with 1000 seed weight (0.16). But highly negatively correlated with harvesting index (-0.53) and negatively correlated with number of seed per capsule (-0.09).

Number of effective capsule per plant had a highly significant correlation with seed (0.83) and also harvesting index (0.36). While it had highly negative correlation with number of seed per capsule (-0.34) and negatively correlated with1000 seed weight (-0.07). Therefore, increase in capsule number in a plant results in l000 seed weight and seed number reduction of capsule and ultimately reduction in seed yield, this result agrees with previous studies.

Number of seed per capsule had positive correlation with harvesting index (0.12) and seed (0.05). It is also negatively correlated with 1000 seed weight (-0.01). Thousand seed weight has a positive correlation with seed (0.10) but negatively correlated with harvesting index (-0.08). In addition harvesting index (0.53) has highly significant correlation with seed.

Conclusion

Seed yield was positively and highly correlated with primary branches, secondary branches, tertiary branch, total branches, stem thickness, plant height, biological yield, number of effective capsules per plant and harvesting index. Hence, selection criteria should consider all these characters for the improvement of black cumin yield.

But negatively and significantly correlated with days to blooming and days to 50% flowering and days to harvest at both genotypic and phenotypic levels. It indicates a genotype which had all those traits contributed for high seed yield.

On the basis of both genotypic and phenotypic path coefficient analysis result, harvesting index, biological yield, number of effective capsule per plant, stem thickness and number of primary branch showed positive direct effect on seed yield. The favorable direct effects of these traits on black cumin seed yield indicate that, other variables kept constant, improvement of these traits will increase grain yield. Therefore, these traits should be kept in mind in the future breeding program of black cumin.

References

1. Weiss EA (2002) Spice Crops, New York, USA: CABI.
2. Khan SH, Anjum MA, Parveen A, Khawaja T, Ashraf NM (2013) “Effects of black cumin seed (*Nigella sativa L.*) on performance and immune system in newly evolved crossbred laying hens,” Veterinary Quarterly 33:13-19.
3. Iqbal MS, Ghafoor A, Qureshi AS (2010) “Evaluation of *Nigella sativa L.* for genetic variation and ex-situ conservation,” Pak. J. Bot 42:2489-2495.
4. Shewaye L (2012) “Antifungal Substances from Essential Oils,” phdthesis.
5. Ghaznavi K (1991) “Tibbe-e-Nabvi aur Jadid Science, Al-Faisal Nasheeran wa Tajeera-e-Kutab,” Urdu Bazar Lahore, Pakistan.1:228-236.
6. Parthasarathy VA, Chempakam B, Zachariah TJ (2008) “Chemistry of Spices, (Cabi), ”International, Wallingford, Oxfordshire, Pp: 41.
7. Rabbani MA, Ghafoor A, Masood MS (2011) “NARC-kalonji: An early maturing and high yielding variety of Nigella sativa released for cultivation in Pakistan,” Pak J Bot 43:191-195.
8. Bardideh K, Kahrizi D, Ghobadi ME (2013) “Character association and path analysis of black cumin (*Nigella sativa L.*) genotypes under different irrigation regimes,” Notulae Scientia Biologicae 5:104-108.