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GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION COEFFICIENT AND PATH ANALYSIS IN AJOWAN (*Trachyspermum ammi* L.)

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ABSTRACT

A field experiment was conducted to study the growth and yield performance of ajowan genotypes (*Trachyspermum ammi* L.) at the Department of Spices and Plantation Crops, Horticultural College and Research Institute, TNAU, Periyakulam during 2012- 2013. Totally twenty genotypes of ajowan collected from different parts of India were evaluated under field condition. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Higher phenotypic and genotypic variation was recorded by the traits *viz.,* number of flowers per umbel, number of umbels per plant, number of seeds per umbel. Phenotypic and genotypic coefficient of variations were found to be high for seed yield per plant. The lowest GCV was observed by the plant height, days taken for first flowering, days taken for 50 per cent flowering, number of primary branches per plant, number of flowers per umbellet, percentage of fruit set, number of seeds per umbellet, 1000 seed weight. The lowest PCV was recorded by days taken for first flowering, days taken for 50 per cent flowering, number of flowers per umbellet and 1000 seed weight. High heritability coupled with high genetic advance was recorded by 1000 seed weight, seed yield per plant, seed yield per hectare, number of umbels per plant, number of flowers per umbel, number of umbellets per umbel, number of secondary branches per plant, percentage of fruit set, plant height and days taken for 50 per cent flowering. Correlation study showed that there is a positive correlation between the traits *viz.,* number of umbellets per umbel, number of flowers per umbel, number of seeds per umbel and seed yield per plant at both genotypic and phenotypic levels. The path analysis enlightened that the traits *viz.*, seed yield per plant, number of secondary branches per plant, number of seeds per umbellet and percentage of fruit set had positive direct effect on the seed yield per hectare, suggesting that such traits could be selected in further breeding programmes. Among the genotypes evaluated, the genotypes Acc. No.3, LTa-26, LS-1 and GA-1 recorded higher seed yield per plant.

KEYWORDS: Ajowan, *Trachyspermum ammi* L, h^2, GA, Correlation, Path Analysis

Ajowan (*Trachyspermum ammi* L.) is a herbaceous annual plant belonging to the family Apiaceae. It is a minor seed spice with medicinal value. In India it is cultivated in the states of Rajasthan and Gujarat in a large scale and to a limited extent in Uttar Pradesh, Bihar, Madhya Pradesh, Punjab, Tamil Nadu, West Bengal and Andhra Pradesh. India is the largest producer and exporter of the ajowan seed in the world exporting to around 46 countries. In India during 2002-03, 1,630 tonnes of ajowan seeds were produced from 10380 hectare area out of which 935 tonnes of ajowan seeds worth Rs. 400 lakhs was exported. India exported 1047 tonnes of ajowan valued Rs.7.16 crores during 2009 (Anoop *et al.,* 2012). The ajowan seeds are hot, pungent, stomachic, appetizer, aphrodisiac, carminative, laxative and diuretic. Ajowan is traditionally used as remedy for gastric disturbances and as a digestive aid. The thymol and carvacrol derivatives and other minor components of ajowan are responsible for its functional properties (Anilkumar *et al*., 2009 and Pathak *et al*., 2010). Ajowan is a cross pollinated crop and is an important seed spice. Its use as a medicine and industrial raw material shows its immense potential to be a main crop. So further research should orient towards developing high yielding varieties and standardization of production technology. Indian farming community has to be informed of the scope of ajowan cultivation and its export potential. Meanwhile emphasis is to be given towards motivating farmers to take up commercial ajowan cultivation (Anoop *et al*., 2012). The primary objective in any crop improvement programme is the identification of promising genotypes for which knowledge on variability existing in a population is imperative. Ajowan is a cross-pollinated crop exhibiting high variability for the economic characters and attempts were made to assess the extent of variability present in the population and distinguish the heritable part of the variation from the non-heritable variation. This would enable the breeder to formulate selection indices for crop improvement. The primary objective of this evaluation is to identify the genotypes capable of producing higher growth, yield and quality in ajowan. Studies on variability helps in locating the desirable plant type either for direct introduction or for use in the further breeding programme. The seed yield and thymol content is a complex character. Therefore, the knowledge on the optimal plant characteristics, the extent of variability available and character association with seed yields is essential to improve the yield in ajowan. Systematic assessment of variability using biometrical methods helps in understanding the breeding behaviour of ajowan. Besides variability analysis, correlation and path

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analyses helps the breeder to decide on crop improvement strategy.

MATERIALS AND METHODS

The present investigation was conducted to study the "Genetic variability, heritability, genetic advance, correlation coefficient and path analysis in ajowan (*Trachyspermum ammi* L.)". The experiment was carried out at the Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam during August 2012 to May 2013. The experimental materials includes twenty ajowan genotypes obtained from Tamil Nadu (6 Nos.), Gujarat (12 Nos.) and Andhra Pradesh (2 Nos.). The experiment was laid out in a randomized block design and replicated thrice. The experimental field was ploughed thrice to get fine tilth. The seeds are sown in the raised bed of 7m X 1m at spacing of 45 cm X 30 cm. All the recommended cultural operations were carried out uniformly and a separate fertilizer dose at the rate of 80: 30: 30 kg of NPK ha^{-1}, 5 kg of Sulphur was applied to the field. Biometrical observations *viz.*, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Days taken for first flowering, Days taken for 50 (%) flowering, Number of umbellets per umbel, Number of umbels per plant, Number of flowers per umbel, Number of seeds per umbellet, Number of seeds per umbel, Fruit setting (%), Seed yield per plant (g), 1000 seed weight (g) and Seed yield per hectare(t) were taken from randomly selected ten plants from each genotypes and the mean data were used for statistical analysis. The statistical parameters like mean, standard error coefficient of variation, correlation and path co efficient analysis were calculated for all the characters by the procedure as suggested by Panse and Sukatme (1985). PCV and GCV were computed based on the methods given by Burton (1952). Heritability in broad sense was calculated according to Lush (1940) and expressed in percentage. The genetic advance was worked out based on the formula given by Johnson *et al.* (1955).

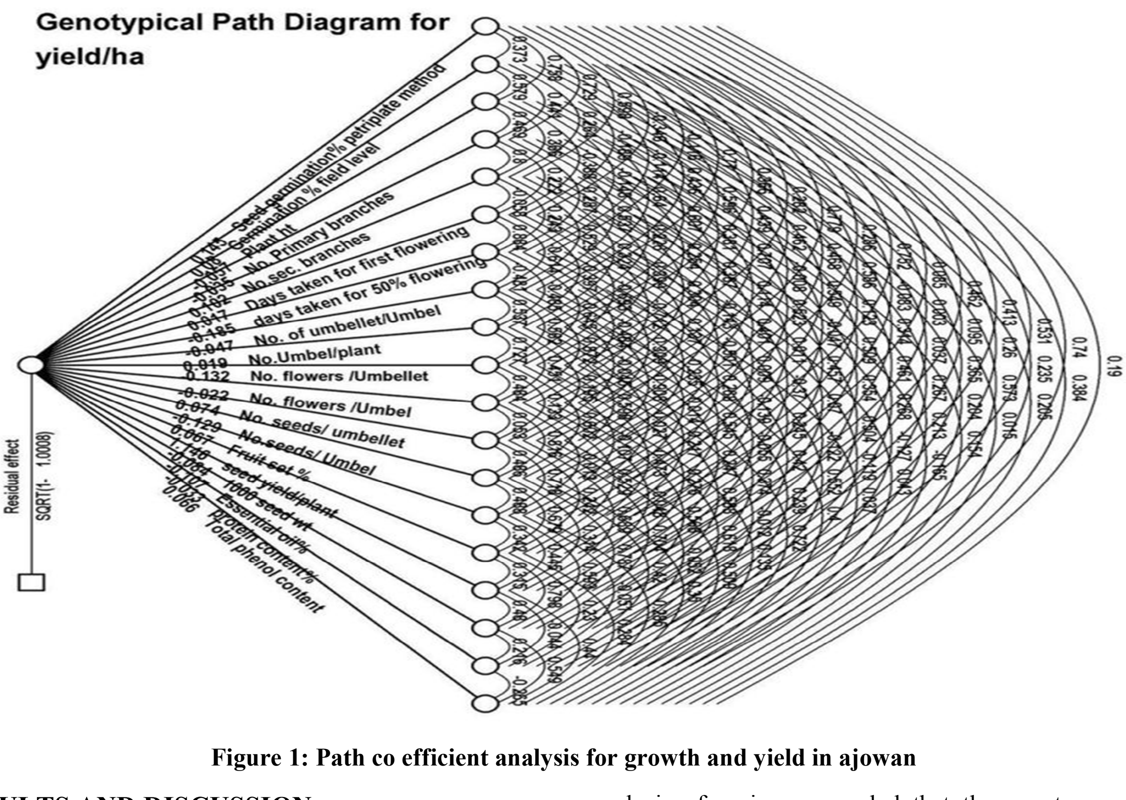

Figure 1: Path co efficient analysis for growth and yield in ajowan

RESULTS AND DISCUSSION

Analysis of variance showed that the variance due to genotype was greater in magnitude for all the growth and yield parameters studied. It was also noticed that the analysis of variance for genotypes was highly significant and the result are present in the Table 1.The results of analysis of variance revealed that the genotypes of the present study showed significant amount of variability for all the growth and yield characters studied indicating the presence of genetic variability among the genotypes. This is in agreement with those of Agnihotri *et al*. (1997) and Singh and Choudhary (2008) in fennel and Dhirendra

Singh and Choudhary (2008) in ajowan. This suggested that the response to selection may be expected in the breeding programme for seed yield or its related traits. These findings are in association with the findings of Datta and Jana, (2012) in chilli and Zeinab Chaghakaboodi *et al.* (2012) in rapeseed.

Table 1: ANOVA for growth, yield and quality traits in ajowan genotypes

Source of variation	Df	Mean sum of square														
		x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
Replication	2	19.52	0.297	112.4	0.467	31.40	0.767	970.3	0.642	937.2	0.530	424.1	63.39	7.501	0.001	0.040
Treatment	19	370.2	4.653	740.4	49.14	111.7	8.033	5538.3	4.114	5651.9	7.726	4556.2	197.3	123.3	0.021	0.065
Error	38	51.13	1.558	76.83	16.12	18.75	0.722	428.9	1.062	449.4	2.790	912.9	20.77	4.385	0.001	0.024
Mean		107.1	14.17	78.40	75.87	86.00	12.67	251.2	19.28	243.8	17.18	219.6	80.93	24.95	0.802	1.844
S. Ed.		4.128	0.729	5.061	2.318	2.500	0.491	11.96	0.595	12.24	0.964	17.44	2.631	1.209	0.016	0.089
C.D. 5%		11.82	2.088	14.49	6.636	7.158	1.405	34.23	1.704	35.04	2.761	49.94	7.533	3.461	0.045	0.255
C.V.		06.678	8.914	11.18	5.292	5.035	6.711	8.244	5.345	8.696	9.725	13.76	5.631	8.393	3.375	8.351

X_1	Plant height (cm)	X_9	Number of flowers per umbel
X_2	Number primary branches per plant	X_{10}	Number of seeds per umbellet
X_3	Number of secondary branches per plant	X_{11}	Number of seeds per umbel
X_4	Days taken for first flowering	X_{12}	Fruit setting (%)
X_5	Days taken for 50 (%) flowering	X_{13}	Seed yield per plant (g)
X_6	Number of umbellets per umbel	X_{14}	1000 seed weight (g)
X_7	Number of umbels per plant	X_{15}	Seed yield per hectare(t)
X_8	Number of flowers per umbellet	X_{11}	Number of seeds per umbel

The genotypic and phenotypic variation gives an idea about the variability existing in the germplasm, exclusively due to the genetic nature of a genotype and permit identification of component characters for selection. The highest phenotypic variance value of 2183.6 was observed by the number of flowers per umbel. It was followed by number of umbels per plant (2132.0) and number of seeds per umbel (2127.3). Whereas, the lowest phenotypic variance value of 0.007, 0.234, and 0.397 were observed by 1000 seed weight and seed yield per hectare respectively (Table.2). Analysis of genotypic variance showed that the higher genotypic variance value of 1734.1, 1703.1 and 1214.5 were registered by number of flowers per umbel, number of umbel per plant and number of seeds per umbel . Whereas, the traits 1000 seed weight (0.007) and seed yield per hectare (0.210) registered lower genotypic variance (Table.2). The results revealed that the relative magnitude of phenotypic variation was higher than the corresponding genotypic variation for all the traits, which indicated the influence of environmental factors on the expression of characters. Similar trend was noticed in case of phenotypic and genotypic variance. Genotypic variance and genotypic coefficient of variation explains major portion of phenotypic variance and phenotypic coefficient of variation. Hence the traits *viz.,* growth, yield and quality characters express the true genetic potential found in both genotypic and phenotypic level of a genotype and hence are highly dependable for exercising selection. This is in confirmity with the findings of Kohli *et al.* (1986) and Hariharan (1996) in fenugreek and Umanath *et al.* (1998) in coriander and Singh and Singh (1993) in french bean.

The estimates of variability on the basis of genotypic coefficient of variation, phenotypic coefficient of variation and environmental coefficient of variation were analysed and are presented in table 2. Genotypic coefficient of variation (GCV) for growth and yield traits ranged from 4.37 (days taken for first flowering) to 25.23 (seed yield per plant). Higher GCV observed by seed yield per plant (25.23) and seed yield per hectare (24.85). The moderate GCV value were found in number of secondary branch per plant (18.97), number of flowers per umbel (17.08), number of umbel per plant (16.43), number of seeds per umbel (15.87) and number of umbellet per umbel (12.33). Whereas, the lowest GCV were found in 1000 seed weight (10.24), plant height (9.631), fruit setting percentage (9.479), number of seeds per umbellet (7.467), number of primary branch per plant (7.123), days taken for 50 per cent flowering (6.473), number of flowers per umbellet (5.231) and days taken for first flowering (4.37). (Table 2)

The result of the estimates of variability revealed that the phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all the characters studied indicating that the environment plays a major role in the expression of the character. However, in general the results showed that for most of the characters studied in the present experiment, the magnitude of GCV was closer to the PCV. High PCV and GCV values were noticed by the trait total phenol content (38.37 and 37.89), essential oil (33.11 and 32.14), protein content (31.36 and 30.57) respectively and seed yield per plant (26.59 as PCV and 25.23 as GCV). For the other traits *viz.,* days taken to first flowering, days taken to 50 per cent flowering, number of flowers per umbellet, fruit setting percentage and 1000 seed weight , the estimates of PCV and GCV were close to each other. This indicated the role was played by genotype rather than environment and the characters having high genotypic co-efficient of variation have better scope of improvement through selection. These findings agree with the findings of Sarada *et al*. (2009) in fenugreek and Magari *et al.* (2009) in radish. Similarly, Mahender Singh *et al*. (2001) reported relatively high estimates of phenotypic and genotypic coefficient of variation for number of grains per umbel, umbels per plant and grain yield in fennel indicating that these traits may be effective. Rawat *et al.* (2013) noticed high GCV and PCV for the characters like yield per plant and seed yield per hectare in fennel. Patel *et al.* (2008) reported the highest genotypic and phenotypic coefficient of variations was recorded by volatile oil content in seed, total branches per plant and number of seeds per umbel in fennel. Similarly high genotypic and phenotypic coefficient of variation for umbels per plant and seed yield per plant was observed by Rajput *et al*. (2004) in fennel. According to Abhay and Sastry (2011) PCV and GCV indicated the existence of fairly high degree of variabilty for seed yield per plant in fennel. High magnitude of PCV and GCV for seed yield per plant of fennel was observed by Singh and Mittal (2002). Meena *et al.* (2013) reported that PCV was slightly higher than corresponding GCV for umbels per plant and seed yield per plant in fennel.

In the present study, the moderate GCV was found for the number of secondary branch per plant (18.97 as GCV), number of flowers per umbel (17.08 as GCV and 19.17 as PCV), number of umbels per plant (16.43 as GCV and 18.38 as PCV), germination per cent in field level (16.02 as GCV and 17.63 as PCV), number of seeds per umbel (15.87 as GCV) and number of umbellet per umbel (12.33 and 14. 03) and PCV level for the traits *viz*., number of seeds per umbellet (12.26), plant height (11.72), number of primary branches per plant (11.41) and fruit set percentage (11.03). Singh and Singh (2013) reported that moderate PCV was found in number of flowers per umbel, number of umbel per plant, germination per cent in field level, number of umbellet per umbel, number of seeds per umbellet, plant height, number of primary branch per plant and fruit setting percentage in coriander. Dhirendra Singh *et al.* (2006) reported that the high genotypic and phenotypic coefficient of variation was found in seeds per umbel in coriander. Similar findings have also been reported by Rao *et al.* (1981) and Jain *et al.* (2002) in coriander.

Estimates of heritability appreciate the proportion of variation. Heritability was in reality a measure of the efficiency in the selection system. The heritability estimates for different traits ranged from 37.10 (number of seeds per umbellet) to 90.20 (1000 seed weight). Among the different characters considered for genetic analysis the traits *viz.,*1000 seed weight (90.20), seed yield per plant (90.00), seed yield per hectare (89.90), germination per cent at field level (82.50), number of umbel per plant (79.90), number of flowers per umbel (79.40), number of umbellet per umbel (77.10), number of secondary branches per plant (74.20), fruit setting percentage (73.90), plant height (67.50) and days taken for 50 per cent flowering (62.30) registered high heritability. This is in accordance with the early works of Mishra and Rawat (2004), who stated a high heritability for all the characters studied except the number of seeds per umbel and 50 per cent flowering. Megeji and Korla (2002) also reported similar results for 1000 seed weight in coriander. These results indicate that these traits are greatly governed by additive genes and therefore these characters can be readily fixed by selection. Similar reports also made by Mahender Singh *et al*. (2001) in cumin and Patel *et al*. (2008) and Rawat *et al*. (2013) in fennel.

Heritability estimates when used in conjunction with genetic advance would give better information than the heritability alone. The reports of Johnson *et al. (*1955) indicated that the estimate of heritability and genetic advance should always be considered simultaneously as high heritability is not always associated with high genetic gain. The utility of heritability estimates increased when they are used in conjunction with genetic advance expressed as percentage of mean (Johnson *et al*., 1955; Allard, 1960). The genetic advance for growth, yield and quality ranged from 0.161(1000 seed weight) to 76.45 (number of flowers per umbel). Estimates of high genetic advance were noticed by number of flowers per umbel (76.45), number of umbels per plant (75.98), number of seeds per umbel (54.24), number of secondary branches per plant (26.40). The moderate genetic advance estimates were noticed by plant height (17.46), fruit setting percentage (13.59) and seed yield per plant (12.30). Whereas, the lowest genetic advance estimates were noticed by days taken for 50 per cent flowering (9.052), days taken for first flowering (4.354), number of umbellet per umbel (2.824), number of seeds per umbellet (1.609), number of flower per umbellet (1.453), number of primary branches per plant (1.298), essential oil content (1.223), yield per hectare (0.895) and 1000 seed weight (0.161). (Table 2)

The genetic advancement as 5% over mean of growth, yield and quality ranged from 5.74 (days taken for first flowering) to 49.38 (seed yield per plant). In present study, high genetic advance as percentage of mean was noticed for seed yield per plant (49.38), seed yield per hectare (48.53), number of secondary branch per plant (33.67), number of flowers per umbel (31.35), number of umbels per plant (30.25), number of seeds per umbel (24.70) and number of umbellets per umbel (22.30). Similar findings were observed by Radjamany (1995); Rao *et al*. (1981) for 1000 grain weight and Jindla *et al.* (1985) for days to flowering, Agnihotri *et al*. (1997) and Singh and Mittal (2002) in coriander. The result showed that these traits are primarily governed by additive genes. Hence, these traits can be exploited for selection procedure as reported by Panse (1957).

The goal of any crop improvement programme is to achieve a high level of yield, which is a complex trait influenced by the component characters either in combination or individually. Besides the background information on the genetics of various traits and adequate knowledge of the inter relationship that exists between these traits with the yield and also the *inter* relation among themselves is required to enable the right of selection of characters for improvement. In the present investigation, significant to highly significant and positive association with yield was exhibited by number of umbellets per umbel, number of seeds per umbellet, number of seeds per umbel and seed yield per plant. The results suggested that these traits can be utilized as selection indices for yield improvement in ajowan. These findings are in line with those of Sanker and Khader (1991), Shah *et al.* (2003) and Datta *et al.* (2006) in coriander.

In this study, the genotypic and phenotypic correlation of all the traits studied except seed germination in petriplate method (-0.009), (-0.025), days taken for 50 per cent flowering (-0.152), (-0.161) and days taken for first flowering (-0.381), (-0.239) had negative association with seed yield per hectare and positive association with number of umbellets per umbel (0.540), (0.510), number of flowers per umbel (0.521), (0.570), number of seeds per umbel (0.669), (0.478), seed yield per plant (0.999), (0.999) and essential oil content (0.792), (0.765). These had significant correlation towards yield and all are considered as major yield contributing characters in ajowan. Jindla *et al*. (1985) reported positive association for number of umbels, number of umbellets, days to flowering and number of grains with seed yield in coriander. Similar result was observed by Sharma and Sharma (1989), Sharma and Sharma (1989), Ali *et al.* (1993), Mandal and Hazra (1993), Choubey *et al*. (1991) in coriander. Miheretu Fufa (2013) reported that the correlation coefficient analysis and revealed that seed yield was positively correlated with all traits except the number of umbels per plant and oil content in coriander. The seed yield had moderate positive correlation with days to flower, plant height and primary branches per plant. The present result is in agreement with Bahandari and Gupta (1991) and Tripathi *et al.* (2000), who reported positive association of plant height, days to flowering, days to maturity and umbels with seed yield in coriander. Singh *et al.* (2006) reported that seed yield was positively correlated with branches per plant and umbels per plant at genotypic level whereas negative correlation was observed with days to 50 per cent flowering in coriander. Meena *et al.* (2010) reported that yield per plant had positive and significant correlation with the number of umbels per plant, number of umbellets per umbel at genotypic and phenotypic level in coriander indicating that fruit yield could be improved by making selection on the basis of number of umbels per plant, number of secondary branches per plant, number of seeds per plant and number of umbellets per umbel. These findings are in line with those of Sanker and Khader (1991), Shah *et al.* (2003) and Datta *et al.* (2006) in coriander.

Dhirendra Singh *et al.* (2006) reported that seed yield was positively correlated with branches per plant and umbels per plant at genotypic level and negatively associated with days to 50 per cent flowering in coriander. Arul Sankar (2007) reported that the grain yield was positively correlated with the number of primary branches, number of productive branches, number of umbels per plant, number of umbellets per umbel, number of seeds per umbel, 1000 seed weight and except for days to first flowering all traits was found to be in positive correlation with seed yield in fennel. Belgin Cosge *et al*. (2009) reported that the highest positive correlation was recorded between single plant yield, number of umbels and umbellets in sweet fennel. According to Yadav *et al.* (2013) seed yield was positively correlated with number of umbellets per umbel in fennel. Kaosar Bardideh *et al.(*2013) reported that the essential oil percent and its components had high positive significant correlation for seed yield of black cumin. In cumin Kahrizi *et al.* (2011) reported positive significant correlation for essence and its components. Topal *et at.* (2010) reported that the seed yield and oil content had higher positive correlation with seed yield per hectare. Similar results were observed in Tunçtürk and Çiftçi (2004). As per the report of Savita *et al*. (2011) the correlation among yield and yield components indicated that seed yield per plant was positively and significantly associated both at genotypic and phenotypic levels with oil yield per plant, number of capsules per plant and seeds per capsule in contrary with Mishra and Yadav (1999) and Mohammed Akbar *et al.* (2003).

The knowledge on correlation helps to determine the component characters of a complex trait such as yield. It has been generally accepted that correlation between pairs of characters represent a coordination of physiological process, which are often achieved through favorable gene linkages (Mather and Harrison, 1949; Mather and Jinks, 1971). Graffius (1964) reported that knowledge of the correlation between yield and yield components is upon which selection pressure is to be exercised to get higher yield.

The path analysis revealed that the traits seed yield per plant (1.146), number of secondary branches per plant (0.102), number of seeds per umbellet (0.074) and fruit set percentage (0.067) had the high positive direct effect on seed yield per hectare. Further, the seed yield per plant had positive indirect effect on seed yield per hectare *viz.,* number of seeds per umbel (0.778), number of umbellet per umbel (0.625), number of flowers per umbel (0.606), number of primary branches per plant (0.583), number of flowers per umbellet (0.542), and number of secondary branches per plant (0.524) and high negative indirect effect *viz.,* days taken for first flowering (-0.424). The fruit set percentage had high positive indirect effect *viz*., number of seeds per umbellet (0.048). The results suggest that the above characters play a major role influencing the seed yield per hectare both directly as well as indirectly through other yield parameters also. Hence, selection based on such characters would be effective in ajowan. This is in agreement with Beemnet Mengesh Kassahun *et al*. (2013) who reported that seed yield per plant is an important character in making selection for seed yield per hectare in coriander. Similarly the result is also in conformity with the findings of Peter *et al.* (1989), Ali *et al.* (1993), Rao *et al.* (1981), Bhandari and Gupta (1993), and Gayathri e*t al*. (2004) in coriander.

Table 2: Genetic parameters for growth, yield and quality traits in ajowan genotypes

	Mean	GV	PV	EV	GCV	PCV	ECV	Herita bility (h^2)	GA at 5%	GA at Mean 5%
x_1	107.1	106.3	157.5	51.13	9.631	11.72	6.678	67.50	17.46	16.30
x_2	14.17	1.019	2.615	1.596	7.123	11.41	8.914	39.00	1.298	9.161
x_3	78.40	221.2	298.0	76.83	18.97	22.02	11.18	74.20	26.40	33.67
x_4	75.87	11.01	27.12	16.12	4.373	6.865	5.291	40.60	4.354	5.739
x_5	86.00	30.99	49.74	18.75	6.473	8.201	5.035	62.30	9.052	10.53
x_6	12.67	2.437	3.159	0.722	12.33	14.03	6.711	77.10	2.824	22.30
x_7	251.2	1703.1	2132.0	428.9	16.43	18.38	8.244	79.90	75.98	30.25
x_8	19.28	1.017	2.080	1.062	5.231	7.478	5.345	48.90	1.453	7.537
x_9	243.8	1734.1	2183.6	449.5	17.08	19.17	8.695	79.40	76.45	31.35
x_{10}	17.18	1.645	4.436	2.790	7.467	12.26	9.725	37.10	1.609	9.369
x_{11}	219.6	1214.5	2127.3	912.9	15.87	21.00	13.76	57.10	54.24	24.70
x_{12}	80.93	58.85	79.62	20.77	9.479	11.03	5.631	73.90	13.59	16.79
x_{13}	24.95	39.62	44.01	4.385	25.23	26.59	8.392	90.00	12.30	49.31
x_{14}	0.802	0.007	0.007	0.001	10.24	10.78	3.375	90.20	0.161	20.04
x_{15}	1.844	0.210	0.234	0.024	24.85	26.22	8.351	89.90	0.895	48.53

Table 3: Genotypic correlation for growth, yield and quality traits in ajowan genotypes

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15
x1	1.000	0.469*	0.366	-0.388	-0.148	0.640**	0.607**	0.381	0.707**	-0.008	0.549*	0.123	0.314	0.037	0.304
x2		1.000	0.801**	0.222	0.287	0.537*	0.227	0.254	0.387	0.114	0.523*	-0.047	0.509*	0.461	0.496
x3			1.000	-0.058	0.243	0.529*	0.324	0.399	0.304	-0.143	0.401	0.011	0.457	0.354	0.444
x4				1.000	0.884**	-0.614**	-0.397	-0.693**	-0.712**	0.137	-0.501*	0.009	-0.370	0.070	-0.381
x5					1.000	-0.481*	-0.485*	-0.645**	-0.484*	0.309	-0.235	0.268	-0.139	0.245	-0.152
x6						1.000	0.537*	0.562*	0.872**	-0.045	0.908**	-0.014	0.545*	-0.055	0.540*
x7							1.000	0.727**	0.451	0.195	0.598**	0.027	0.217	0.247	0.207
x8								1.000	0.484*	0.133	0.602**	-0.107	0.473*	0.276	0.466
x9									1.000	0.053	0.816**	-0.013	0.529*	-0.048	0.521*
x10										1.000	0.486*	0.718**	0.243	0.689*	0.232
x11											1.000	0.488*	0.679**	0.314	0.669**
x12												1.000	0.342	0.445	0.335
x13													1.000	0.315	0.996**
x14														1.000	0.310
x15															1.000

****- Significant at 1% level**

***- Significant at 5% level**

X_1	Plant height (cm)	X_9	Number of flowers per umbel
X_2	Number primary branches per plant	X_{10}	Number of seeds per umbellet
X_3	Number of secondary branches per plant	X_{11}	Number of seeds per umbel
X_4	Days taken for first flowering	X_{12}	Fruit setting (%)
X_5	Days taken for 50 (%) flowering	X_{13}	Seed yield per plant (g)
X_6	Number of umbellets per umbel	X_{14}	1000 seed weight (g)
X_7	Number of umbels per plant	X_{15}	Seed yield per hectare(t)
X_8	Number of flowers per umbellet		

Table 4: Path analysis for growth, yield and quality traits in ajowan genotypes

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
x_1	**-0.057**	-0.027	-0.021	0.022	0.009	-0.037	-0.035	-0.022	-0.041	0.001	-0.031	-0.007	-0.018	-0.002	0.304
x_2	-0.017	**-0.035**	-0.028	-0.008	-0.010	-0.019	-0.008	-0.009	-0.014	-0.004	-0.018	0.002	-0.018	-0.016	0.496
x_3	0.037	0.081	**0.102**	-0.006	0.025	0.054	0.033	0.041	0.031	-0.015	0.041	0.001	0.047	0.036	0.444
x_4	-0.007	0.004	-0.001	**0.017**	0.015	-0.010	-0.007	-0.012	-0.012	0.002	-0.008	0.000	-0.006	0.001	-0.381
x_5	0.027	-0.053	-0.045	-0.163	**-0.185**	0.089	0.090	0.119	0.089	-0.057	0.043	-0.049	0.026	-0.045	-0.152
x_6	-0.030	-0.025	-0.025	0.029	0.023	**-0.047**	-0.025	-0.027	-0.041	0.002	-0.043	0.001	-0.026	0.003	0.540
x_7	0.011	0.004	0.006	-0.007	-0.009	0.010	**0.019**	0.014	0.008	0.004	0.011	0.001	0.004	0.005	0.207
x_8	-0.050	-0.034	-0.053	0.091	0.085	-0.074	-0.096	**-0.132**	-0.064	-0.018	-0.079	0.014	-0.062	-0.036	0.466
x_9	-	-	-	0.016	0.011	-	-	-	-	-	-	0.000	-	0.001	0.521

	0.016	0.009	0.007			0.019	0.010	0.011	**0.022**	0.001	0.018		0.012		
x_{10}	-0.001	0.008	-0.011	0.010	0.023	-0.003	0.014	0.010	0.004	**0.074**	0.036	0.053	0.018	0.051	0.232
x_{11}	-0.071	-0.068	-0.052	0.065	0.030	-0.117	-0.077	-0.078	-0.106	-0.063	**-0.129**	-0.063	-0.088	-0.041	0.668
x_{12}	0.008	-0.003	0.001	0.001	0.018	-0.001	0.002	-0.007	-0.001	0.048	0.033	**0.067**	0.023	0.030	0.335
x_{13}	0.359	0.583	0.524	-0.424	-0.160	0.625	0.249	0.542	0.606	0.278	0.778	0.391	**1.146**	0.361	1.000
x_{14}	-0.003	-0.039	-0.030	-0.006	-0.021	0.005	-0.021	-0.023	0.004	-0.058	-0.026	-0.037	-0.026	**-0.084**	0.310
x_{15}															**0.066**
						R SQUARE = 1.0008 RESIDUAL EFFECT =SQRT(1- 1.0008)									

X_1	Plant height (cm)	**X_9**	Number of flowers per umbel
X_2	Number primary branches per plant	**X_{10}**	Number of seeds per umbellet
X_3	Number of secondary branches per plant	**X_{11}**	Number of seeds per umbel
X_4	Days taken for first flowering	**X_{12}**	Fruit setting (%)
X_5	Days taken for 50 (%) flowering	**X_{13}**	Seed yield per plant (g)
X_6	Number of umbellets per umbel	**X_{14}**	1000 seed weight (g)
X_7	Number of umbels per plant	**X_{15}**	Seed yield per hectare(t)
X_8	Number of flowers per umbellet		

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