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Evaluation of ajwain genotypes under northern dry zone of Karnataka

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Abstract
Ajwain is seed spice which is cultivated mainly for its seed, herb and volatile oil. Analysis of variance among 28 ajwain genotypes indicated that all the genotypes were significantly different with respect to all the characters studied. Wide variability existed among the genotypes for all the morphological and yield traits. Minimum days to germination was noticed in AZ-1 (9.75), whereas the higher plant height at 150 DAS was recorded in RM (96.83 cm). AA-93 recorded the highest number of branches per plant (18.18). The minimum days taken for commencement of flower initiation (10%) was observed in AZ-1 (66.00). Minimum days taken for commencement of 50 per cent flowering was observed in AZ-1 (77.25). The highest number of flowers per umbellates was observed in HUB-8 (23.85). The minimum days taken for harvest was recorded in AZ-1 (128.50). AZ-1 showed the highest number of umbels in an individual plant is 302.25. AZ-1 showed the highest number of umbellates per umbel (14.90). HUB-8 showed the highest number of seeds per umbel (280.00). The genotype AZ-1 showed the highest seed yield per plant (11.96 g). AZ-1 recorded maximum harvest index (%) of (38.27%). The maximum test weight was observed in HUB-8 (1.83 g). The highest essential oil content was recorded in RM (2.30%) whereas the oleoresin content was recorded in DAC-5 (6.65%) and the maximum thymol content was found in the DAC-5 (49.61%).

Keywords: Thymol, ajwain, umbellates, oleoresin, essential

Introduction

Trachyspermum ammi L. Syn. *Carum copticum,* commonly known as Bishop's weed or ajwain or ajwain, cultivated as herbaceous herb belonging to the family Apiaceae and vastly grows in Egypt, Iran, Pakistan, Afghanistan, and India as well as European region (Shojaaddini *et al*., 2008) [25]. Usually greyish brown seeds or fruits of ajwain are considered for medical and nutritional purposes (Chauhan *et al*., 2012) [6]. It has been used as culinary spice worldwide and resembles thyme. Fruits were widely administered as a food flavouring agent and as a digestive stimulant (Jeet *et al.*, 2012) [11]. Ajwain fruits are used as a medicament in Unani, Ayurvedic and Arab traditional medicine for its diuretic, analgesic, antiasthmatic, anthelmintic and antispasmodic properties (Zahin *et al*., 2010) [31]. According to Pathak *et al.* (2014) [32] the thymol and carvacrol derivatives and other minor components of ajwain are responsible for its functional properties.

Rajasthan, Gujarat, Madhya Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Bihar, Telangana and Andhra Pradesh are among the Indian states, where ajwain is grown (Mohsenzadeh *et al.*, 2012) [15]. In an area of 41,134 hectare, 28,973 tonnes of ajwain seeds were produced in 2019-2020. Ajwain has a current average productivity of 704 kg/ha. Andhra pradesh is leading with respect to area (10.992 ha), whereas Gujarat is leading with respect to production (10.599 t) and Madhya Pradesh is leading with respect to productivity (1108 kg/ha) (Spice Board, 2020) [27]. Ajwain farming has extended in Bidar, Gulburga, Raichur, Vijayapura and Bagalkote districts of Karnataka in recent years (Anon., 2018) [1]. Even though India is a major producer of coriander in the world, the productivity of coriander is low. Ajwain is mainly a dryland crop which can be grown with less amount of water and least inputs. In spite of this, crop is grown in less area, so thus, there is a great scope for crop improvement in coriander for increasing yield and quality and breeding of high yielding ajwain varieties become inevitable. However India being a vast country with varied agro-climatic regions, different genotypes need to be evolved for specific regions. Hence, the present study was undertaken to evaluate different Ajwain genotypes for yield and quality.

Materials and Methods

The present investigation on "Evaluation of ajwain genotypes under northern dry zone of Karnataka" was conducted at the Department of Plantation, Spices, Medicinal and Aromatic Crops at University of Horticultural Sciences, Bagalkot. Twenty-eight germplasm were evaluated during 2020-21 and 2021-22 of *rabi* season for growth yield and quality traits. Out of 28 genotypes, 16 were released varieties and 12 were local collections. The experiment was laid out in a randomized complete block design and replicated twice. The experimental field was ploughed twice to get fine tilth and prepared flat beds size of 2.5 X 2.1m^2, spacing - 45 x 30 cm. Recommended dose of fertilizer (100: 50: 50 NPK kg ha^{-1}) was applied in the form of urea at 217.00 kg per ha, MOP at 83.00 kg per ha and SSP at the rate of 312.50 kg per ha. Full dose of potash, phosphorous and half dose of nitrogen were applied as basal dose and remaining nitrogen was given after 30 days after sowing (DAS). In each replication and in each treatment five plants were randomly selected and tagged for observation.

Observation were taken on each genotype for growth, yield and quality traits viz., days to germination, plant height, number of branches, days to 50 per cent flowering, number of flowers per umbellates, number of umbels per plant, number of seeds per umbel, number of umbellates per umbel, seed yield, test weight, harvest index, essential oil and oleoresin and thymol content. Mean data from each of the replications were used for analysis. The essential oil percentage was determined by steam distillation method by clevenger apparatus (Sadgrove and Jones, 2015) [22] and oleoresin was extracted by using soxhlet apparatus (Sontakke *et al*., 2018) [26] and the thymol content through gas chromatography.

Results and Discussion

In the current investigation significant variation was observed for all the growth parameters in ajwain cultivars during the crop growth.

The variety AZ-1 (9.75) was germinated early when compared with the other genotypes evaluated and the cultivars such as HUB-8 (10.00), AA-1 (11.00), DAC-3 (11.00), DAC-5 (11.00), AA-93 (11.50), DAC-4 (11.50) and RM (11.50) were statistically similar to the cultivar AZ-1, whereas HUB-10 (15.50) has taken maximum days to germinate. This difference in germination is due to the genetic makeup as well as the genotype interaction with the environment. Faster germination of some genotypes was mainly due to the quicker imbibitions of water by the seed tissues, but other ajwain genotypes observed late germination as a result of insufficient water intake. The results obtained on germination of genotypes are in concordance with works of Meena *et al.* (2012) [12], Giridhar *et al.* (2017) [9] and Chaitanya *et al.* (2020) [5].

Considerable amount of variation were noted for plant height at 150 DAS. Higher plant height was recorded in the genotype RM (96.83 cm). The cultivars such as HUB-8 (94.38 cm), AZ-1 (93.43 cm), HUB-1 (93.30 cm), AA-93 (91.53 cm), DAC-6 (89.55 cm), DAC-3 (88.68 cm), DAC-2 (88.33 cm), AA-2 (87.40 cm), AL-4 (86.45 cm), AA-1(85.10 cm) and HUB-3 (84.80 cm) were statistically at par with the genotype RM, whereas HUB-11 (66.23 cm) showed relatively lower plant height when compared with the other genotypes evaluated. The difference in the plant height among the ajwain genotypes were observed because of the genotype variation and its interaction with favourable agroclimatic and soil conditions. Subramaniyan *et al*. (2019), Meena *et al*. (2020) and Chaitanya *et al.* (2020) [28, 14, 5] were also reported difference in the plant height among the genotypes in their respective study material.

Remarkable differences were observed among ajwain genotypes for the total number of branches produced by each plant after 150 days of sowing. Highest number of branches per plant (18.18) were noted in the genotype AA-93 and the genotypes AZ-1 (17.38), RM (17.38), AA-2 (17.25), HUB-8 (16.85) and AA-1 (16.65) were statistically at par with the genotype AA-93. The lowest number of branches per plant was noticed in HUB-10 (10.25). The difference in the production of branches among the genotypes was mainly due to the genetic constitution of genotypes and its interaction with the environment on which it is grown. Increased production of branches resulted in the increased number of leaves and there by increases the photosynthetic activity which in turn increases the total yield. Subramaniyan *et al*. (2019) Chaitanya *et al.* (2020) and Meena *et al*. (2020) [14, 5, 14] were also noticed variation in the primary branches produced by a plant among the ajwain genotypes used in their investigation. Arif (2012) [2] reported variation with respect to number of branches among the coriander genotypes.

The genotype AZ-1 has taken minimum days (66.00) for commencement of 10% flower initiation, HUB-8 (70.00) was statistically similar to the genotype AZ-1, whereas maximum days (101.50) for the production 10% flower was noticed in the cultivar HUB-11. The variation among the ajwain genotypes for the initiation of 10% flower was due to the genetic constitution of the cultivars, shifting towards the reproductive stage from the vegetative stage might vary across the genotypes. The current results are in consonance with Chaitanya *et al.* (2020) [5]. Similar variations for days to flower initiation (10%) were also noted by earlier researchers Sarada and Giridhar (2005) [23] in coriander genotypes.

The minimum days taken for commencement of 50 per cent flowering was observed in AZ-1 (77.25), which was statistically on par with HUB-8 (81.25), RM (85.50) and AA-93 (86.50), whereas maximum days for commencement of 50 per cent flowering was recorded in HUB-11 (109.75). The variations in days to first flower appearance and 50 per cent flowering was attributed to the genetic constitution of the genotype combined with environmental interaction. Also, quick growth and accumulation of more amount of carbohydrates have resulted in early flowering. Similar reports were also reported earlier by several workers by Meena *et al*. (2017) [13] and Chaitanya *et al.* (2020) [5] in ajwain genotypes. Moniruzzaman *et al*. (2013) [16], Phurailatpam *et al*. (2016) [18] and Hongal *et al*. (2018) [10] in coriander genotypes and Telugu *et al*. (2019) [29] in fennel genotypes.

Total number of flowers in an umbellates is important seed yielding component. The highest number of flowers per umbellates was observed in HUB-8 (23.85), which was statistically on par with AZ-1 (23.43) and AA-93 (22.20), whereas lowest number of flowers per umbellates was registered in HUB-9 (11.67). Similar variation with regards to number of flowers in an umbellates was reported by Subramaniyan *et al.* (2019) [28], Chaitanya *et al.* (2020) [5] and Ranjeetha *et al.* (2020) [21].

The minimum days taken for harvest was recorded in AZ-1 (128.50), which was statistically on par with AA-93 (129.75), AA-1 (129.75), AA-2 (130.00), HUB-8 (130.75), GA-1 (133.50), RM (134.25), DAC-1 (136.00), HUB-5 (137.25), DAC-3 (137.25), LTA 26 (137.50), DAC-2 (137.75) and HUB-1 (138.00) and the maximum days taken for harvest was observed in HUB-10 (156.00). This is because of the genetic makeup and short or long-life cycle of a specific genotype and due to the interaction of the genotype with environmental factors (temperature, day length, humidity, *etc*.,) prevailed during the experiment. Also, the interaction of these factors with endogenous phytoharmones have resulted in early maturity following early flowering. Similar variations were reported reported by Moniruzzaman *et al*. (2013) [16] and Hongal *et al*. (2018) [10] in coriander genotypes and differences in crop duration in ajwain was described by Meena (2012), Chaitanya *et al.* (2020) and Ranjeetha *et al.* (2020) [12, 5, 21]

Ajwain genotypes showed differences in the seed yield. Seed yield mainly depends on variations in yield traits *viz*., number of umbellates per umbel, number of umbels per plant, number of seeds in an umbel and test weight (g).

The total number of umbels per plant differed significantly among the ajwain genotypes. AZ-1 showed the highest number of umbels in an individual plant is 302.25, which was statistically on par with HUB-8 (289.90). The lowest number of umbels in an individual plant was recorded in HUB-11 (75.68). The variation in production of umbels per plant is due to genetic makeup and response of specific genotype to environmental factors. However, increase in umbels per plant results in more number of flowers and this accompanied by higher seed set will result in higher yields. Such increase in umbels per plant may be attributed to the higher growth parameters like plant height, number of primary branches and similar results were reported by Phurailatpam *et al*. (2016) [18] and Hongal *et al*. (2018) [10] in coriander genotypes, Subramaniyan *et al*. (2019) [28], Chaitanya *et al.* (2020) [5] and Meena *et al*. (2020) [14] in ajwain genotypes and Telugu *et al*. (2019) [29] in fennel genotypes.

This experiment showed significant differences in number of umbellates per umbel. AZ-1 showed the highest number of umbellates per umbel (14.90), which was statistically on par with HUB-8 (13.85), AA-93 (13.55) and RM (13.28). The lowest number of umbellates per umbel was recorded in HUB-9 (9.38). The variation among the genotypes was due to good vegetative growth, its genotypic interaction with local environmental condition and due to better growth of primary and secondary branches as well as response of a specific genotype to a particular environment. The results are in close confirmation with the reports of Meena (2012) [12], Meena *et al*. (2017) [13], Chaitanya *et al.* (2020) [5] and Meena *et al*. (2020) [14] in ajwain genotypes, Rajamanickam *et al.* (2012) [20], Moniruzzaman *et al*. (2013) [16] and Hongal *et al*. (2018) [10] in coriander genotypes and Telugu *et al*. (2019) [29] in fennel genotypes.

The findings from the experiment showed existence of variation for the number of seeds per umbel. HUB-8 showed the highest number of seeds per umbel (280.00), which was statistically on par with AA-93 (269.80) and AZ-1 (267.95). Minimum number of seeds per umbel was recorded in HUB - 9 (67.70). The greater number of seeds in an umbel was mainly because of good pollination, more number of fertilized ovules with the retension of zygote and the response of a specific genotype to a particular environment have resulted in variations in seeds per umbel. Similar results were reported by Meena (2012) [12], Meena *et al*. (2017) [12], Subramaniyan *et al*. (2019) [28], Chaitanya *et al.* (2020) [5] and Meena *et al*. (2020) [14] in ajwain genotypes, Moniruzzaman *et al*. (2013) [16] and Hongal *et al*. (2018) [10] in coriander genotypes and Telugu *et al*. (2019) [29] in fennel genotypes.

Seed yield per plant differed significantly among different genotypes. The genotype AZ-1 showed the highest seed yield per plant (11.96 g), which was statistically on par with HUB-8 (11.62 g), AA-93 (11.03 g) and AA-1 (10.95 g), whereas HUB-9 noted less for its seed yield of a single plant (4.93 g). Seed yield is a complex biometric trait and considerable variations in seed yield are attributed to genetic character and response of a genotype to agro-climatic conditions. Increase in seed yield among ajwain genotypes could be attributed to better growth parameters which positively correlated to yield. Seed yield mainly depends on total number of branches in a plant, number of umbels in a plant, number of flowers in an umbel, number of umbellates in an umbel, number of seeds in an umbel and thousand seed weight. It is also associated with better accumulation of dry matter and storage of photosynthates. Significant differences among ajwain genotypes was reported by Awas *et al*. (2015) [3], Bajad *et al*. (2017) [4] and Chaitanya *et al.* (2020) [5] in ajwain genotypes, Moniruzzaman *et al*. (2013) [16], Phurailatpam *et al*. (2016) [18] and Hongal *et al*. (2018) [10] in coriander genotypes and Telugu *et al*. (2019) [29] in fennel genotypes. The factors mainly responsible for the differences in the seed yield among the genotypes were due to the differences in the yield attributes like umbels per plant, umbellates per umbel, seeds per umbellates, number of seeds per umbel and thousand seed weight was reported by Fikreselassie *et al.* (2012) [7]. Considerable variation in the seed yield among the genotypes of the coriander were also reported earlier by several workers by Arif (2012) [2] and Palanikumar *et al.* (2012) [17] in coriander.

The genotypes exhibited remarkable differences for most of the traits including seed yield. AZ-1 recorded the highest seed yield of 374.63 g per plot, which was statistically on par with HUB-8 (373.38 g/plot) and AA-93 (363.00 g/plot), while lowest was noted in HUB-9 (118.25 g).AZ-1 recorded the highest seed yield of 711.79 kg per ha, which was statistically on par with HUB-8 (704.17 kg/ha) and AA-93 (699.76 kg/ha), while lowest was noted in HUB-9 (220.95 kg/ha). The variation in seed yield may be because of variation in growth and yield traits *viz*., number of umbels in a plant, number of flowers in an umbel, number of umbellates per umbel, number of seeds in an umbel and test weight (g). In this experiment seed yield was less due to the stem fly incidence. Remarkable differences in seed yield among ajwain genotypes were reported prior by several researchers such as Giridhar *et al.* (2014) [8], Giridhar *et al.* (2017) [9] and Chaitanya *et al.* (2020) [5].

The substantial results with respect to harvest index was observed. AZ-1 recorded maximum harvest index (%) of (38.27%), which was statistically on par with HUB-8 (37.19%), AA-93 (33.05%), whereas the harvest index (%) was recorded minimum in HUB-9 (14.70%). Maximum harvest index (%) was noticed as a result of highest seed yield in a plant with less biological yield per plant. Similar findings was reported by Meena *et al*. (2020) [14] and Chaitanya *et al.* (2020) [5]. The variations could be attributed to production of more seed yield and dry matter. The findings of Hongal *et al*. (2018) [10] in coriander genotypes and Telugu *et al*. (2019) [29]

in fennel genotypes provides support to the present results.

Test weight (g) varied considerably among the various genotypes of ajwain. the maximum test weight was observed in HUB-8 (1.83 g) followed by AZ-1 (1.60g), AA-1 (1.56g) and DAC-1 (1.56 g). The genotype RM showed least test weight of 0.97 g. The boldness of the seeds contributed maximum test weigh in ajwain. The findings are in conformity with earlier workers by Meena (2012) [12], Chaitanya *et al.* (2020) [5] and Meena *et al*. (2020) [14] in ajwain and Rajamanickam *et al.* (2012) [20] in coriander.

The quality of ajwan seeds is a prime factor which determines its premium cost in the market. There was a significant difference was noticed for essential oil content in ajwain. The data on the essential oil content showed significant variation among the different genotypes. the highest essential oil content was recorded in RM (2.30%), which was statistically on par with HUB-8 (2.20%), AA-1 (2.15%), DAC-2 (2.15%) and AA-93 (2.15%). The lowest essential oil was found in HUB-9 (0.90%). This might be because of the genotypic interaction with the environment and maturity of the crop also determines the essential oil content. Present experimental results were in correspondence with the earlier studies by Saxena *et al*. (2016) [24], Subramaniyan *et al.* (2019) [28] and Chaitanya *et al.* (2020) [5]. Starch being a primary metabolite, may affect the accumulation of secondary metabolites like essential oil there for the genotypes with bigger seed will have low essential oil content mostly because of high starch content. The reasons for the difference in essential among the genotypes is directly related to the essential oil content and the seed yield per hectare and those with higher oil content and higher seed yield have yielded higher essential oil yield per hectare.

The data on the oleoresin content showed significant variation among the different genotypes. Significant difference was noticed for essential oil content in ajwain. The highest oleoresin content was recorded in DAC-5 (6.65%), followed by DAC-4 (6.30%) and RM (6.25%), whereas lowest oleoresin content was found in AL-3 (1.75%). This might be because of the genotypic interaction with the environment and maturity of the crop also determines the oleoresin and essential oil content. Present experimental results were in correspondence with the earlier studies by Saxena *et al*. (2016) [24] and Subramaniyan *et al.* (2019) [28] and Chaitanya *et al.* (2020) [5].

Significant difference was noticed for thymol content (%) in ajwain. The highest thymol content was recorded in DAC-5 (49.61%), which was statistically on par with DAC-3 (46.74%), whereas lowest oleoresin content was found in HUB-2 (41.10%). Similar findings were reported by Raina *et al.* (2004) and Subramaniyan *et al*. (2019) [19, 28].

Conclusion

From this study, the collection of different genotypes showed significant difference with respect to morphological, yield and quality traits. Among 28 genotypes HUB-8, AZ-1, AA-93, AA-1, AA-2, HUB-1, HUB-2, RM and DAC-5 had maximum seed yield per plant (g), harvest index (%)**,** number of umbels per plant, number of seeds per umbel, test weight (g), essential oil (%) and oleoresin (%) content under Bagalkot conditions.

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