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Response of different varieties and plant geometry on seed quality parameters of ajwain *Trachyspermum ammi* L.

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Abstract
A study was carried out in the Department of Seed Science and Technology, College of Agriculture, Raichur, to assess the response of seed quality of ajwain (*Trachyspermum ammi* L.) to varieties and spacing. The seed was harvested from a split plot field experiment conducted during *Rabi* 2025-26, in which three spacings (S_1: 30 cm × 20 cm, S_2: 50 cm × 20 cm and S_3: 60 cm × 20 cm) were the main plots and four varieties (AA-01-19, Kurnool local, Bidar local and Gujarat Ajwain-1) were the sub-plots. Seed germination, shoot length, root length, seedling dry weight and seedling vigour indices were recorded. Seed from the wider spacing (S_3) recorded the highest germination (90.91%), shoot length (6.08 cm), root length (9.95 cm), seedling dry weight (9.02 mg), SVI-I (1457) and SVI-II (820), while the closer spacing (S_1) recorded the lowest values for all of them. Among the varieties, Gujarat Ajwain-1 produced the best quality seed, with 90.72% germination, SVI-I of 1463 and SVI-II of 808 andBidar local was the poorest. It is concluded that seed of Gujarat Ajwain-1 produced at 60 cm × 20 cm spacing is the most suitable for obtaining high quality seed in ajwain.

Keywords: Ajwain, seedling vigour index, seed germination, spacing, *Trachyspermum ammi*, varieties

Introduction
Ajwain (*Trachyspermum ammi* (L.), also known as carom seed or bishop's weed, is an aromatic seed spice of the family Apiaceae. Its seeds are widely used as a flavouring and digestive agent and in traditional and modern medicine (Zarshenas *et al*., 2014; Shahrajabian *et al*., 2021) [10, 15]. The crop is propagated only by seedandthe fruits are small, so good germination and strong seedling growth are needed for a uniform plant stand and a good yield (Skaria *et al*., 2007) [12].

The quality of seed is decided mainly by the genetic make-up of the variety and by the conditions under which the seed crop is raised. Varieties differ in their growth and seed characters (Ravindrababu *et al*., 2012; Meena *et al*., 2015) [6, 9]. Plant spacing affects the competition among plants for light, moisture and nutrients during seed development andso it can change how well the seed is filled and how well it later germinates and grows. Syed *et al*. (2015) [13] found that the composition of the seed volatile oil of ajwain also changed with sowing date and row spacing. Information on how the germination and seedling vigour of ajwain seed respond to variety and spacing is limited. The present study was therefore taken up with the objectives to study the effect of varieties on seed quality parameters in ajwain and to study the effect of spacing on seed quality parameters in ajwain.

Materials and Methods
Seed production
The seed was obtained from a field experiment conducted at the PG Research Block, Main Agricultural Research Station, University of Agricultural Sciences, Raichur, during *Rabi* 2025-26. The experiment followed a split plot design with three replications and 12 treatment combinations. Spacings were the main plots and varieties were the sub-plots.

Factor	Plot level	Levels
Spacing (S)	Main plot	S_1- 30 cm × 20 cm, S_2- 50 cm × 20 cm, S_3- 60 cm × 20 cm
Variety (V)	Sub-plot	V_1- AA-01-19, V_2- Kurnool local, V_3- Bidar local, V_4- Gujarat Ajwain-1 (GA-1)

All varieties were sown on 29 October 2025 with a recommended fertilizer dose of 100:50:50 kg N:P_2O_5: K_2O ha $^{-1}$ andthe crop was raised with the recommended package of practices. The soil was a medium deep black Vertisol. The seed was harvested at maturity from the net plot of each treatment, cleaned and dried to a safe moisture level before testing.

Laboratory experiment
The seed quality tests were carried out in the Department of Seed Science and Technology, College of Agriculture, Raichur. The laboratory experiment was laid out in a completely randomized design with four replications. The following observations were recorded.

- **Germination (%):** four replications of 100 seeds were germinated by the between-paper (rolled towel) method at 25 °C and 90% RH. Normal seedlings were counted at 7 and 14 days and expressed as a percentage (Anonymous, 1999) [2].

- **Shoot length (cm) and root length (cm):** ten normal seedlings were taken at random from each replication at the final count andshoot and root were measured from the collar and the average was worked out.

- **Seedling dry weight (mg):** the ten seedlings used for length were dried in a hot air oven at 70 ± 1 °C for 24 hours, cooled in a desiccator and weighed.

- **Seedling vigour index:** calculated as follows (Abdul-Baki and Anderson, 1973) [1].

SVI-I = Germination (%)/Total seedling length (cm)
SVI-II = Germination (%)/Seedling dry weight (mg)

Statistical analysis
The data were analysed by the methods for a split plot design (Panse and Sukhatme, 1985) [8]. The critical difference (CD) was calculated at the 1% level of probability where the F test was significant.

Results and Discussion
Spacing and variety had a significant effect on all the seed quality parameters studied (Tables 1 and 2). Differences between treatment means were judged at the 1% level of probability using the critical difference (CD), a difference smaller than the CD is not significant.

Effect of spacing
Seed produced at wider spacing was of better quality (Table 1). Germination was higher in S_3 (90.91%) and S_2 (89.98%), which were on par andlowest in S_1 (87.90%). Shoot length, seedling dry weight, SVI-I and SVI-II increased significantly with every increase in spacing, from S_1 to S_2 to S_3. S_3 recorded a shoot length of 6.08 cm, seedling dry weight of 9.02 mg, SVI-I of 1457 and SVI-II of 820, against 5.59 cm, 8.23 mg, 1314 and 723 in S_1. Root length was greater in S_3 (9.95 cm) and S_2 (9.75 cm) than in S_1 (9.36 cm). Compared with S_1, the seed from S_3 had 9.6% more seedling dry weight, 10.9% higher SVI-I and 13.4% higher SVI-II.

Table 1: Influence of spacing on seed quality parameters of ajwain

Spacing	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	SVI-I	SVI-II
S_1: 30 cm × 20 cm	87.90	5.59	9.36	8.23	1314	723
S_2: 50 cm × 20 cm	89.98	5.88	9.75	8.74	1406	786
S_3: 60 cm × 20 cm	90.91	6.08	9.95	9.02	1457	820
S.Em±	0.243	0.002	0.082	0.022	8.99	8.34
CD (1%)	0.955	0.009	0.324	0.088	35.34	32.73

Seed from the wider spacings germinated better and gave longer, heavier and more vigorous seedlings. Under wider spacing each plant gets lighter, moisture and nutrients andhas less competition. The plants can then supply more assimilates to the developing seed, which fills better and stores more food reserves. Seed with larger reserves germinates more uniformly and gives faster seedling growth andthis is reflected in the greater shoot and root length and seedling dry weight in S_3. The vigour indices combine germination with seedling length or dry weight, so they were higher where both were higher.
In the closer spacing (S_1) the plants were crowded and competed for resources during seed filling, which probably gave lighter seed with fewer reserves and so poorer germination and vigour. Similar improvements in seed germination and seedling vigour under wider planting geometry have been reported in sesame (Sivagamy and Rammohan, 2013) [11], dill (Bhattacharjya *et al*., 2015) [3], kabuli chickpea (Gowda *et al*., 2018) and carrot (Fufa *et al*., 2020; Noor *et al*., 2020). Syed *et al*. (2015) [4, 5, 7, 13] also found that ajwain seed composition was rich in the wider row spacing they studied (30 cm), which agrees in direction with the better quality of seed from wider spacing seen here.

Effect of varieties
Gujarat Ajwain-1 (V_4) was the best variety for all the quality parameters (Table 2). It recorded the higher germination (90.72%), shoot length (6.15 cm), root length (9.98 cm), seedling dry weight (8.91 mg), SVI-I (1463) and SVI-II (808). V_4 was significantly better than all the other varieties for germination, shoot length, seedling dry weight and the two vigour indices, except that its root length was on par with AA-01-19 and its SVI-II was significantly higher than the three other varieties, which were on par with each other. AA-01-19 was second best for most parameters, followed by Kurnool local. Bidar local recorded the lower values: germination 88.97%, shoot length 5.56 cm, root length 9.40 cm, seedling dry weight 8.49 mg, SVI-I 1331 and SVI-II 755. V_4 had 9.9% higher SVI-I and 7.0% higher SVI-II than V_3.

Table 2: Influence of varieties on seed quality parameters of ajwain

Variety	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	SVI-I	SVI-II
V_1: AA-01-19	89.47	5.95	9.78	8.70	1407	778
V_2: Kurnool local	89.22	5.75	9.58	8.56	1368	764
V_3: Bidar local	88.97	5.56	9.40	8.49	1331	755
V_4: GujaratAjwain-1	90.72	6.15	9.98	8.91	1463	808
S. Em±	0.107	0.003	0.096	0.025	10.44	9.62
CD (1%)	0.317	0.008	0.286	0.075	31.03	28.57

Gujarat Ajwain-1 produced seed of the better quality andBidar local the poor. The differences are mainly genetic, in the ability of a variety to fill seed and store reserves. Varietal differences in seed germination and seedling vigour have also been reported in coriander by Vikram (2020) [14] andajwain genotypes are known to differ widely in their seed characters (Ravindrababu *et al*., 2012; Meena *et al*., 2015) [6, 9]. Because seed of GA-1 gave the higher values for every parameter, it is a good source of planting seed among the varieties tested.

Conclusions

- Wider spacing (60 cm × 20 cm) gave the best seed quality: germination of 90.91%, SVI-I of 1457 and SVI-II of 820. The closer spacing (30 cm × 20 cm) gave the lower values.
- Gujarat Ajwain-1 gave the best quality seed, with 90.72% germination, SVI-I of 1463 and SVI-II of 808 andBidar local was the poor.
- Seed of Gujarat Ajwain-1 produced at 60 cm × 20 cm is recommended where high-quality planting seed is required.

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