

Impact of Temperature Regimes on Germination and Seed Quality Attributes in Ajwain (*Trachyspermum ammi* L.)

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ABSTRACT: The present investigation was carried out to study the effect of different temperature on seed germination and seed quality parameters of ajwain. The laboratory experiment was laid out in Completely Randomized Design with two genotypes of Ajwain variety i.e Local and AA-1-19, four temperature treatments T₁: 10°C, T₂: 20°C, T₃: 30°C and T₄: 40°C and three replications. Observations were recorded on following characters viz first count (%), germination (%), root length (cm), shoot length (cm), seedling length (cm), seedling fresh weight (mg), seedling dry weight (mg), seedling vigour index-I, seedling vigour index-II. It was observed in the present study that the seeds should be tested at the temperature ranging around 20°C to 30°C. As all the parameters were maximum at this temperature range and among two varieties the variety AA-1-19 showed better response for above objectives as compared to Local.

Keywords: Ajwain, temperature, seed germination, seed quality parameters

INTRODUCTION

Ajwain (*Trachyspermum ammi* L.), known by various names such as owa, omum, or carom, is an annual herbaceous plant belonging to the family Apiaceae (Umbelliferae) with a chromosome number of 2n = 18. It is a cross-pollinated, aromatic, and annual herbaceous plant. Typically reaching a height of 60–90 cm, it features a straight stem, inflorescence, and a compound umbel with 16 umbellates, each hosting up to 16 white flowers and small brownish seeds. The protandrous flowers undergo cross-pollination facilitated by insects [1,2].

Ajwain seeds are prized for their essential oil content, comprising 3–4% of the seed. Thymol is a predominant constituent, making up 35–60% of the essential oil, although variations exist among genotypes [3, 4]. Additionally, carvone, limonene, and dillapiol have been identified as principal oil constituents. Ajwain seeds boast a nutritional profile, containing moisture (8.9%), protein (15.4%), fat (18.1%), carbohydrates (38.6%), crude fiber (11.9%), and minerals (7.1%). The seeds are a source of vital minerals (calcium, phosphorus, iron, sodium, potassium) and vitamins (thiamine, riboflavin, nicotinic acid, and carotene) [2].

Ajwain, a cold-loving crop primarily cultivated during the *Rabi* season in India, displays adaptability to a range of climatic conditions. Although it thrives in moderately cool

and dry climates, it can also be grown as a *Kharif* crop in certain regions. The crop prefers temperatures between 15 and 27°C, with a relative humidity of 60 to 70% during its growth period, and it benefits from relatively warm weather during seed development. Ajwain exhibits moderate drought tolerance, contributing to its wide climatic adaptability. Well-drained loamy soils, particularly those rich in organic matter, are ideal for ajwain cultivation. Heavy soils with good moisture retention capabilities, such as clay-loam, are suitable for rainfed agriculture. While ajwain displays salt resistance, it attains a higher yield in soils with a pH range of 6.5 to 7.5. Farmers often practice effective crop rotations, such as intercropping with tall-growing plants or incorporating green gram, black gram, cluster bean, cowpea, maize, or pearl millet in *Kharif* seasons followed by ajwain in *Rabi* seasons, to enhance soil fertility and ensure sustainable production.

Temperature is a critical factor influencing seed germination and vigor. Sub-optimal temperatures often lead to poor germination, posing challenges for seed farmers. Intermediate temperatures, around 20°C, allow diverse genotypes to emerge. Germination occurs within specific temperature limits, and the optimal temperature ensures the most effective combination of germination percentage and speed, facilitating maximal germination in the shortest time possible [5]. Hence, the present

investigation was carried out with the objectives to study the effect of different temperature on seed germination and quality parameters of ajwain.

MATERIAL AND METHODS

The experiment was conducted at Seed Technology Research Unit, Vasantao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, during *Rabi*, 2022–2023. The laboratory experiment was laid out in Completely Randomized Design with two genotypes of Ajwain variety i.e. Local and AA-1-19, four temperature treatments and three replications. Factor I - V_1 - Local and V_2 - AA-1-19 and Factor II - Temperature T_1 : 10°C, T_2 : 20°C, T_3 : 30°C and T_4 : 40°C. Observations were recorded on following characters viz., First count (%), Germination (%), Root length (cm), Shoot length (cm), Seedling length (cm), Seedling fresh weight (mg), Seedling dry weight (mg), Seedling vigour index-I and Seedling vigour index-II.

Table 1. Treatment details

S.N.	Treatments combinations	Variety	Temperature
1	V_1T_1	Local	10°C
2	V_1T_2	Local	20°C
3	V_1T_3	Local	30°C
4	V_1T_4	Local	40°C
5	V_2T_1	AA-1-19	10°C
6	V_2T_2	AA-1-19	20°C
7	V_2T_3	AA-1-19	30°C
8	V_2T_4	AA-1-19	40°C

RESULTS AND DISCUSSION

First Count

The initial count was obtained on 7th day of the germination test and was impacted by the different temperature treatments on variety which were found to be significant. When the data was compared, the treatments had a significant effect on the varieties AA-1-19 (49.66%) and Local (38.33%). However, the maximum first count was observed in variety AA-1-19 with treatment T_3 (49.66%) followed by T_4 (32.66%) and T_2 (26.66%) whereas the minimum first count was in T_1 (20.33%). In Local variety T_3 treatment also had the maximum first count (38.33%) followed by T_4 (24.66%) and T_2 (19.66%) and T_1 had the minimum (10.33%). The data in the table showed that the influence of varied temperature treatments had a substantial effect on variety. Significantly the maximum first count percentage was noticed in V_2T_3

(49.66%) and minimum first count percentage was recorded in V_1T_1 (10.33%). Temperature has a pronounced effect on rate and percentage of germination. For most crop species, seed germination rate increases as temperature rises. Temperature is an important environmental factor for seed germination. Under optimal conditions it shows maximum first count per cent unless innate dormancy is present in seeds. The results confirmed the reports of [6] in Ajwain and [7] in cumin.

Germination

The final germination count was considered as germination per cent and was recorded on the 14th day and was significantly influenced by the different temperature treatment on variety. The data pertaining to different temperature treatment on variety was highly significant. The treatments had a significant effect on the varieties AA-1-19 (93.33%) and Local (82.00%). However, the maximum germination per cent was observed in variety AA-1-19 with treatment T_3 (93.33%) followed by T_2 (86.00%) and T_1 (76.00%) whereas the minimum was in T_4 (74.00%). In Local variety T_3 treatment also had the maximum germination per cent (82.00%) followed by T_2 (78.33%) and T_1 (70.00%) and T_4 had the minimum (67.33%). Significantly the maximum germination percentage was recorded between the variety and treatment V_2T_3 (93.33%) and minimum in V_1T_4 (67.33%). Seed germination increases as temperature rises for most crop species. Optimum ajwain seed germination occurs at relatively high temperatures (20–30°C). Poor germination is a common phenomenon at sub-optimal temperatures. The results confirmed the reports of [8] in carrot and [9] in wheat and [5] in fennel.

Root length

The seedling root length was measured at the final count of the germination test i.e., on the 14th day. Root length was affected by temperature treatment on variety. In results, when compared significant difference in root length was recorded in AA-1-19 (4.81cm) and Local (3.10cm). However, the maximum root length was observed in variety AA-1-19 with treatment T_3 (4.81cm) followed by T_2 (3.93cm) and T_1 (2.62cm) whereas the minimum was in T_4 (2.38cm). In Local variety T_3 treatment had the maximum root length (3.10cm) followed by T_2 (2.64cm) and T_4 (2.22cm) and T_1 had the minimum (1.99cm). The temperature treatment and variety showed significant influence on root length. Among the treatment and variety combinations, maximum root length was

recorded with V_2T_3 (4.81cm). While minimum values were recorded with V_1T_1 (1.99 cm). The data revealed that maximum root length was observed in V_2T_3 due to higher vigour of seed. While minimum root length was observed in V_1T_1 due to the poor seed vigour and unfavorable environmental condition (extreme low temperature). This result was agreement with the findings of [8] in carrot, [9, 10] in wheat and [11, 12] in cotton.

Shoot length

The seedling shoot length was measured at the final count of the germination test i.e on the 14th day. The result confirms that there was significant influence of temperature treatment on variety. The significantly maximum shoot length was recorded in AA-1-19 (3.83cm) and Local (2.67cm), when shoot lengths were compared. However, the maximum shoot length was observed in variety AA-1-19 with treatment T_3 (3.83cm) followed by T_2 (3.17cm) and T_4 (2.33cm) whereas the minimum was in T_4 (2.33cm). In Local variety T_3 treatment had the maximum shoot length (2.67cm) followed by T_2 (2.42cm) and T_4 (1.82cm) and T_1 had the minimum (1.61cm). The temperature treatment and variety showed significant effect on shoot length. Among the treatment combinations, maximum shoot length was recorded with V_2T_3 (3.83cm) minimum shoot length values were recorded with V_1T_1 (1.61cm). The data showed that maximum shoot length was observed in V_2T_3 due to maximum speed of germination, higher vigour of seed and favourable germination temperature. While minimum seedling length was observed in V_1T_1 due to the poor seed vigour and unfavorable temperature. This result was in agreement with [10] in wheat, [13] in *Piper nigrum*, [9] in wheat and [11,12] in cotton.

Seedling length

The seedling length was measured at the final count of the germination test. The results pertaining to seedling length was influenced by temperature treatment on variety. In results, significantly maximum seedling length was recorded in AA-1-19 (8.64cm) and Local (5.78cm), when seedling lengths were compared. However, the maximum seedling length was observed in variety AA-1-19 with treatment T_3 (8.64cm) followed by T_2 (7.10cm) and T_1 (4.82cm) whereas, the minimum was in T_4 (4.71cm). In Local variety T_3 treatment had the maximum seedling lengths (5.78cm) followed by T_2 (5.06cm) and T_4 (4.03cm) and T_1 had the minimum (3.59cm). Among the treatment combinations, maximum seedling length

was recorded with V_2T_3 (8.64cm) and the minimum seedling length values were recorded with V_1T_1 (3.59cm). The data showed that maximum seedling length was observed in V_2T_3 due to maximum speed of germination, higher vigour of seed and favorable germination temperature. While minimum seedling length was observed in V_1T_1 due to poor seed vigour and unfavorable germination temperature. This result was in agreement with [9, 10] in wheat, [13] in *Piper nigrum* and [11, 12] in cotton.

Seedling fresh weight

The seedling fresh weight was measured at the final count of the germination test i.e., on the 14th day, the ten normal seedlings were selected and fresh weight was recorded. The results pertaining to seedling fresh weight was influenced by different temperature treatment on variety. In results, significantly maximum seedling fresh weight was recorded in AA-1-19 (215.67mg) and Local (204.33mg), when seedling fresh weight was compared. However, the maximum seedling fresh weight was observed in variety AA-1-19 with treatment T_2 (215.67mg) followed by T_3 (120.67mg) and T_4 (115.33mg) whereas, the minimum was in T_1 (98.33mg). In Local variety T_2 treatment had the maximum seedling fresh weight (204.33 mg) followed by T_3 (108.67mg) and T_4 (103.67mg) and T_1 had the minimum (99.33 mg). Among the treatment combinations, maximum seedling fresh weight was recorded with V_2T_2 (215.67 mg) and the minimum seedling fresh weight values were recorded with V_2T_1 (98.33 mg). In present study the data revealed that maximum seedling fresh weight was observed in V_2T_2 due to maximum seedling length, speed of germination and seedling vigour. This result conformed with [9] in wheat, [11,12] and [14] in rice.

Seedling dry weight

The seedling dry weight was measured at the final count of the germination test i.e on the 14th day, 10 seedlings were selected and oven dried result was recorded. The results related to seedling dry weight was influenced by different temperature treatment on variety. Data pertaining to ten normal seedling dry weights showed that significantly maximum seedling dry weight was noticed in AA-1-19 (9.89 mg) and Local (8.11 mg), when seedling dry weight were compared. However, the maximum seedling dry weight was observed in variety AA-1-19 with treatment T_2 (9.89 mg) followed by T_3 (8.92mg) and T_1 (7.94mg) whereas, the minimum was in T_4 (7.89 mg). In

Table 2. Effect of different temperature treatments and variety on seed germination and quality parameters of Ajwain

SN.	Treatments	First Count (%)	Germination Per cent	Seedling Root Length (cm)	Seedling Shoot Length (cm)	Seedling Length (cm)	Seedling Fresh Weight (mg)	Seedling Dry Weight (mg)	Seedling vigor Index-I	Seedling Vigor Index-II
		1	2	3	4	5	6	7	8	9
1	V ₁ T ₁	10.33	70.00	1.99	1.61	3.59	99.33	6.42	251	449.4
2	V ₁ T ₂	19.66	78.33	2.64	2.42	5.06	204.33	8.11	396	635.5
3	V ₁ T ₃	38.33	82.00	3.10	2.67	5.78	108.67	7.84	473	642.7
4	V ₁ T ₄	24.66	67.33	2.22	1.82	4.03	103.67	7.25	271	488.1
5	V ₂ T ₁	20.33	76.00	2.62	2.20	4.82	98.33	7.94	366	603.5
6	V ₂ T ₂	26.66	86.00	3.93	3.17	7.10	215.67	9.89	610	850.3
7	V ₂ T ₃	49.66	93.33	4.81	3.83	8.64	120.67	8.92	806	832.5
8	V ₂ T ₄	32.66	74.00	2.38	2.33	4.71	115.33	7.89	349	583.2
	S. E±	3.57	3.58	0.33	0.33	0.65	27.77	0.54	60.41	65.24
	CD @ 5%	11.66	11.71	1.08	1.09	2.11	90.73	1.78	205.25	210.67
	CV (%)	2.1	2.3	1.2	2.5	2.1	3.5	1.9	2.5	1.6

Local variety T₂ treatment had the maximum seedling dry weight (8.11mg) followed by T₃ (7.84mg) and T₄ (7.25mg) and T₁ had the minimum (6.42mg). Among the treatment combinations, maximum seedling dry weight was recorded with V₂T₂ (9.89 mg) and the minimum seedling dry weight values were recorded with V₁T₁ (6.42 mg). In present study the data revealed that maximum seedling dry weight was observed in V₂T₂ due to maximum seedling length, speed of germination and seedling vigour. The data revealed that maximum seedling dry weight was observed in V₂T₂ due to initial higher germination, seedling length, seedling fresh weight and germination of seed and minimum seedling fresh weight was observed V₁T₁ due to lower initial germination, seedling length, seedling fresh weight and germination of seed. This result was in agreement with [9] in wheat, [11, 12] in cotton and [14].

Seedling vigour index-I

The seed vigour index I was calculated by multiplying germination percentage and seedling length. Significantly maximum seedling vigour index-I observed in AA-1-19 (806) and in Local (473). However, the maximum seedling vigour index-I was observed in variety AA-1-19 with treatment T₃ (806) followed by T₂ (610) and T₁ (366) whereas the minimum was in T₄ (349). In Local T₃ treatment had the maximum seedling vigour index-I (473) followed by T₂ (396) and T₄ (271) and T₁ had the minimum (251). Among the treatment combinations, maximum seedling vigour index-I was recorded with V₂T₃ (806) and the minimum seedling vigour index-I values were

recorded with V₁T₁ (251). In present study the data revealed that maximum vigour index-I was observed in V₂T₃ due to maximum germination per cent, root, shoot and seedling length and minimum seed vigour index-I was observed in V₁T₁ due to lower germination per cent and minimum seedling length. This result was in agreement with [9] in wheat, [11, 12] in cotton and [14] in rice.

Seedling vigour index-II

The seedling vigour index II was calculated by multiplying germination percentage and seedling dry weight. The result showed that significantly maximum seedling vigour index-II was recorded in AA-1-19 (850) as compared to Local (642.7). However, the maximum seedling vigour index-II was observed in variety AA-1-19 with treatment T₂ (850.3) followed by T₃ (832.5) and T₁ (603.5) whereas the minimum was in T₄ (583.2). In Local variety T₃ treatment had the maximum seedling vigour index-II (642.7) followed by T₂ (635.5) and T₄ (488.1) and T₁ had the minimum (449.4). Among the treatment combinations, maximum seedling vigour index-II was recorded with V₂T₃ (806) and the minimum seedling vigour index-II values were recorded with V₁T₁ (251). In present study the data revealed that maximum vigour index-II was observed in V₂T₂ (20°C) due to maximum germination per cent and seedling dry weight. This result conformed with [9] in wheat, [11, 12] in cotton, [14] in rice [15] in oat, [16] in fenugreek, [17] in ground nut and [18] in *Aspilia*. Recent studies in soybean [19] has also revealed the importance of temperature effect on seed quality.

CONCLUSION

The various temperature treatments had a major influence on variety as well. Significantly high seed germination and seed quality parameters was observed in variety AA-1-19 with temperature 30°C i.e. first count (49.66%), germination percentage (93.33%), root length (4.81cm), shoot length (3.83 cm), seedling length (8.64 cm), seedling fresh weight (215.67mg), seedling vigour index I (806) and seedling vigour index II (850.5). The maximum seedling dry weight was observed in variety AA-1-19 at temperature 30°C (9.89 mg). From different temperature treatment it is concluded that the seeds should be germinated at the temperature of 30°C. All the parameters were maximum at this temperature range. It is also important to study the emergence at 25°C.

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