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Ajmer Ajwain 73: Revolutionizing Yield Potential with a Superior quality Ajwain Variety

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Abstract

Variety development programme at ICAR-NRCSS through AICRP on Spices has identified a new high-yielding variety named Ajmer Ajwain-73 (AA-73) during the Workshop of AICRP on Spices held at Tamil Nadu Agricultural University during 14th -16th November, 2019. AA-73 is a new variety of Ajwain developed through mass selection by material collected from Bari Sadri, District Chittorgarh, Rajasthan in May, 2001. AA-73 demonstrates a generally superior yield performance compared to AA-1 and AA-2 across different locations and years. In multi-locations testing during 2012-13 to 2018-19 at different locations across the country, the proposed variety gave an average seed yield of 1066.08 kg ha⁻¹, which was 25.91 and 21.93 per cent higher yield than Ajmer Ajwain-1 (National Check) and Ajmer Ajwain-2 (National Check), respectively. At ICAR-NRCSS Ajmer during 2012-13 to 2015-16, AA-73 produced (1428 kg ha⁻¹) 26.82% % higher than AA-1 (1045 kg ha⁻¹) and 11.43 % higher than AA-2 (1265 kg ha⁻¹). AA-73 contains 9.15% total oil, it is 7 and 39% higher total oil than AA-1 and AA-2, respectively. It also contains higher essential oil (6.38%) by 1 and 17% than AA- 1 and AA-2 respectively. This variety is more resistant against root rot and *Sclerotium* rot having a root rot PDI of 2.2, which is slightly lower than AA-1 (2.3) and significantly lower than AA-2 (2.9). AA-73 produced the highest seed yield (1321.0 kg/ha) compared to AA-2 (1202.8 kg/ha) and AA-93 (1047.2 kg ha⁻¹). It also gave the highest straw yield (2427.5 kg/ha), indicating its overall superior biomass production compared to the other genotypes. AA-73 is highly responsive to agronomic spacings of 40 cm x 20 cm and fertilizer doses of 125% RDF.

Keywords: Ajwain, Genotype, Spacing and Fertiliser

Introduction

Ajwain (*Trachyspermum ammi* L.), an annual herbaceous plant belongs to family Apiaceae is a popular seed spice. The major ajwain-producing countries in the world are primarily located in South Asia and the Middle East. India is the largest producer of ajwain. In

Pakistan it is mostly produced in Punjab and Sindh provinces. Persia, Iran, Egypt, Afghanistan and North Africa are other major ajwain producing countries in the world. It is a cold-loving crop primarily grown during the rabi season in India, particularly grown in the states of Rajasthan, Gujarat, Madhya Pradesh, and Uttar Pradesh, as a late *kharif* crop. Since 2002, India has seen an increase in the cultivation of ajwain. Its area in the nation increased from 10.4 to 43.1 thousand ha between 2002–03 and 2022–23 at a compound annual growth rate of 3.67% annually. As result ajwain production in India increased from 1.6 to 39 thousand tons in respective years (Graph 1).

In India it is mainly cultivated in Gujarat (23.23 '000 ha), Madhya Pradesh (7.27 '000 ha), Rajasthan (4.38 '000 ha), Andhra Pradesh (2.59 '000 ha), and Karnataka (5.91 '000ha) under 0.38 lakh hectares area with 0.28 lakh tonnes production at productivity of 737kg ha⁻¹ (2022-23, Spice Board).

Ajwain seed possesses high medicinal value, traditionally used as remedial measure against atonic dyspepsia, diarrhoea, abdominal tumours, abdominal pains, flatulence, piles, and bronchial problems, lack of appetite, galactagogue, asthma etc (Ashangi et al., 2023). Ajwain seed contain fiber (11.9%), carbohydrates (38.6%), tannins, glycosides, moisture (8.9%), protein (15.4%), fat (18.1%), saponins, flavone, and mineral matter (7.1%) (Bairwa et al., 2012). Moazeni et al. (2012) recognized 18 compounds in the essential oil, representing 99.54% of the total oil. The major constituents were thymol (50.07%), γ -terpinene (23.92%), and *p*-cymene (22.9%), along with α - and β -pinenes, α -thujen, myrcene, 1,8-cineole, and carvacrol, present in very low concentrations. In India, productivity of ajwain sowing increasing trend, enhanced from 200 kg ha⁻¹ in 2002-03 to 900 kg ha⁻¹ in 2022-23.

Materials and Methods

Evaluation of Ajmer Ajwain-73 (AA-73)

This variety has been developed through mass selection by seed material collected from Bari Sadri, District Chittorgarh, Rajasthan during May 2001 (IC-0632869SEEDS). Collected sample was multiplies at ICAR-National Research Centre on Seed Spices Ajmer (ICAR-NRCSS) for multiplication of the population and bulk selection of better plants. Subsequent generations

were raised and evaluated for seed yield and attributing traits at ICAR-NRCSS. Selected population was evaluated further on seed yield and other economic traits. The identified best population was taken up as station trial at ICAR-NRCSS for continues three years during 2012-13 to 2016-17.

Based on its superior performance over control varieties in yield trials at ICAR-NRCSS, AA-73 was introduced in AICRP in the year 2016 for multi-location testing across the country. This advanced line was evaluated during 2016-2019 at seven different locations at Ajmer, Hisar, Guntur, Jobner, Jagudan, Raigarh and Faizabad in multi-location replicated, initial and advanced varietal trails under All India Coordinated Research Project on Spices (AICRP (S)).

The data were analysed following standard statistical procedures using the software NAAS statistical computing facilities available at ICAR-IASRI webpage. Based on its performance over the years at different locations, the advanced AA-73 has been recommended for release in the 30th group meeting of AICRP(S) held at Tamil Nadu Agricultural University during 14-16 November, 2019. Subsequently, variety was released and notified as variety in the name of Ajmer Ajwain 73 (AA-73) by the Central Sub-Committee on Crop Standards Notification and Release of Varieties for Horticultural Crops, Ministry of Agriculture, Department of Agriculture and Co-operation, Government of India, New Delhi vide Gazette Notification S.O.No. 1480 (E); dated 01.04.2011.

Varietal description

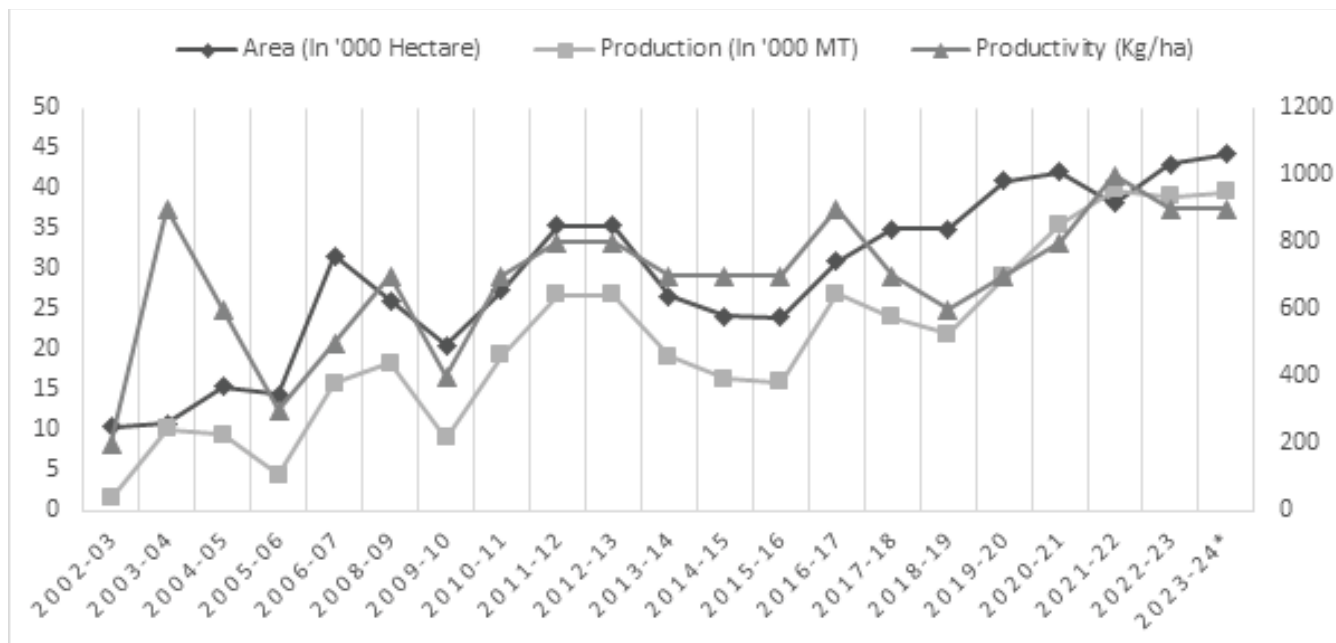
AA-73 demonstrates superior characteristics in terms of plant height, branching (both primary and secondary), number of umbels per plant, umbellates per umbel, and seeds per umbellate compared to AA-1 and AA-2. These traits proved AA-73 better among compared varieties. Primary branches were more than AA-1 & 2 ranging from 18 to 19. Seedling colour is light green. Early plant vigour is very good. Anthocyanin colouration is absent in cotyledon. Plant growth habit is spreading type. Stem is non-waxy without white lines. White ring on nodes is present on stem. Foliage at full grown stage is dense. Main umbel is more branched leafy structure with more than 15 umbel per branch. Angle of Primary Branch is narrow (<45 degree). Days

to 50% flowering varied from 90 to 94 days. Variety takes 165 to 170 days to attain 75% maturity. Plant height of AA-73 ranged from 118 to 121cm, taller than AA-2 and dwarf to AA-1. Number of umbels per plant, umbellate per umbel and seeds per umbellate was

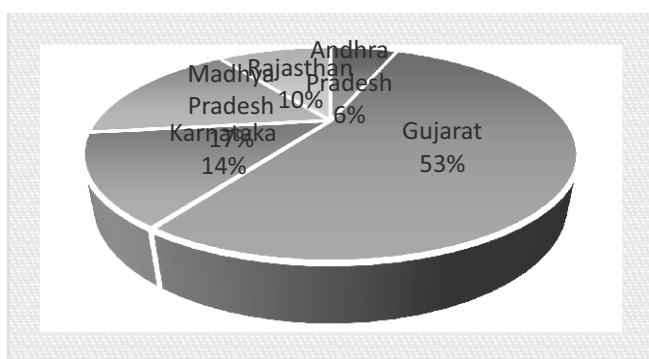
recorded higher in AA-73 than AA1 and AA2 resulted into higher yield in former compared to later (Table 1).

YIELD PERFORMANCE

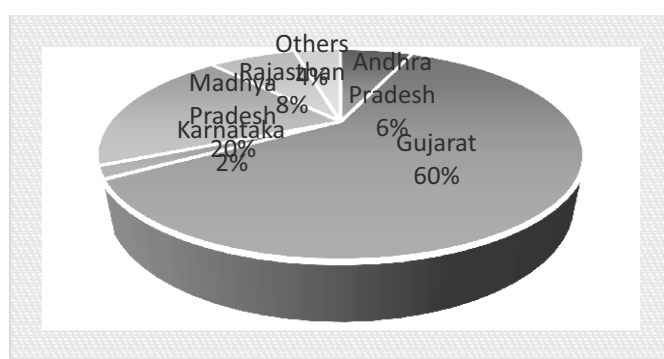
AA-73 demonstrates a generally superior yield performance compared to AA-1 and AA-2 across



Graph 1: Area, Production and Productivity of Ajwain in India; * (2nd Adv. Est.)



Area (In '000 Hectare)



Production (In '000 MT)

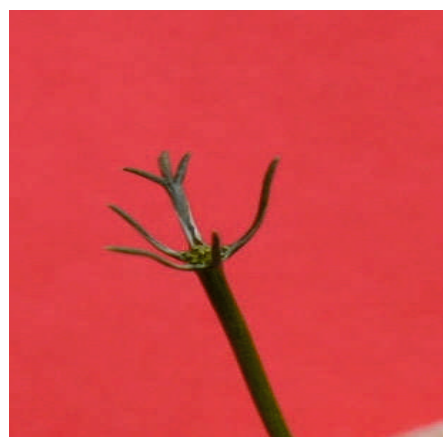
Graph 2: State-wise share in ajwain Area and production in India (2023-24; 2nd Adv. Est.)

Table 1: Mean characteristics of Ajmer Ajwain (AA-73) at Ajmer during 2016-17 to 2018-19

Characters	AA-73		AA-1 (NC)	AA-2 (NC)
	Range	Mean		
Plant height (cm)	118.8-121.1	119.6	120.3	107.1
No. of primary branches/plant	18.0-18.8	18.4	16.4	13.2
No. of secondary branches/plant	243.4-245.4	244.4	207.7	156.3
Days to 50% flowering	90-94	92.0	95.0	93.0
Days to 75% maturity	165-170	168.0	170.0	169.0
No. umbels per plant	265.6-298.8	282.3	233.4	235.6
No. of umbellate/ umbel	24.0-27.4	25.6	22.5	20.0
No. of seeds/ umbellate	19.0-19.5	19.4	17.0	17.0



Nature of main stem branching



Main Umbel: Single Leafy Structure



Cotyledon: Anthocynin distribution



Cotyledon: Anthocynin colouration

Fig. 1. Phenotypic visuals of AA-73

different locations and years, particularly in Ajmer and Guntur. The statistical data also supports the consistent superiority of AA-73, though variability exists across different environments, indicating its potential adaptability and robustness.

Station trials: At ICAR-NRCSS Ajmer during 2012-13 to 2015-16, AA-73 produced (1428 kg ha^{-1}) 26.82% % higher than AA-1 (1045 kg ha^{-1}) and 11.43 % higher than AA-2 (1265 kg ha^{-1}).

Multi-locations trials: During 2016-17 to 2018-19, AA-73 was grown on seven different locations namely, Ajmer, Hisar, Guntur, Jobner, Jagudan, Faizabad and Raigarh. Yield varied from station to station during this period. The average of all Coordinated and Station Trials, tested during 2012-13 to 2018-19 at different locations across the country was measured except Raigadh at seed yield of $1066.08 \text{ kg ha}^{-1}$, which was 21 and 18 per cent higher than Ajmer Ajwain-1 (National Check) and Ajmer Ajwain-2 (National Check), respectively. Highest yield was recorded at ICAR-NRCSS Ajmer followed by Jagudan and Guntur (Table 2). At Ajmer AA-73 consistently outperforms both AA-1 and AA-2, with significantly higher yields. The exception is 2015-16, where AA-73 still leads but with a smaller margin. At Hisar AA-73 shows a mixed performance, sometimes yielding lower or similar to AA-1 and AA-2. The yield differences are relatively small.

QUALITY TRAITS

Ajwain (*Trachyspermum ammi* L.) is used as an ayurvedic and medicinal purpose for different ailment (Bairwa, 2011 and Meena et al., 2018). The quantity of oil produced is secreted of the plant and its value for above properties, which varies with cultivars and climatic conditions during the crop growth (Zomorodian et al., 2011 and Asangi et al., 2020). There are 26 identified components present in ajwain essential oil accounting 96.3% of the total quantity. Thymol is the major constituent of the seeds, followed by γ -terpinene and *p*-cymene. It possesses antispasmodic, germicide and antifungal properties (Nagalakshmi et al., 2000 and Bhatt et al., 2018). The typical flavour of ajwain seed essential oil are mainly due to thymol (35-60%) and carvacrol content. The non thymol content is also present (Mohagheghzadeh et al., 2007). Thymol and carvacrol both are antiseptic, expectorant and antitussive agents (Trease and Evans., 2002). AA-73

contains 9.15% total oil, it is 7 and 39% higher total oil in than AA-1 and AA-2, respectively. It also contains higher essential oil (6.38%) by 1 and 17% than AA-1 and AA-2 respectively (Table 3). Essential oil is principal components in pharmaceuticals, functional foods, nutraceutical beverages and cosmetics values. Hence AA-73 variety is found more suitable for food, nutraceutical and other applications.

Tolerance to disease resistance

Diseases such as Root rot, Sclerotium rot and powdery mildew are commonly found affecting ajwain. Root rot is a most common and destructive disease of ajwain causing 10-100% yield losses in ajwain (Dhanbir 2000, Meena et al. 2009, Fagodia et al. 2019). Ajmer Ajwain (AA-73) shows better resistance to both Root rot and *Sclerotium* rot compared to AA-1 and AA-2. This makes AA-73 a more resilient variety against these diseases. AA-73 has a Root rot PDI of 2.2, which is slightly lower than AA-1 (2.3) and significantly lower than AA-2 (2.9). AA-73 has a *Sclerotium* rot PDI of 1.6, which is significantly lower than both AA-1 (4.3) and AA-2 (3.6). This suggests that AA-73 has a much better resistance to *Sclerotium* rot compared to AA-1 and AA-2. This indicates that AA-73 has a better resistance to Root rot compared to the other two varieties (Graph 1).

Crop management

The optimisation of crop management practices by adjusting spacing, fertilizer levels, and selecting the most effective genotype plays crucial role in yields determination in ajwain cultivation (Mehta et al., 2013). Table 4, examines the effects of crop geometry, fertilizer levels, and genotypes on various yield attributes of ajwain during 2016-17 and 2018-19. Results on crop geometry finds that wider spacing (40 cm x 20 cm) enhances both seed and straw yields compared to narrower spacing (30 cm x 15 cm). Higher fertilizer application (125% RDF) significantly improves yield attributes over the standard application (100% RDF). Application of 125% RDF leads to a higher seed yield (1275.9 kg/ha) compared to 100% RDF (1104.8 kg/ha) as additional nutrients likely enhance plant growth and seed production. Similarly, 125% RDF results in a higher straw yield (2396.0 kg/ha) compared to 100% RDF (2085.8 kg/ha), indicating that more fertilizer supports greater biomass production. Among different genotypes AA-73 performs best in terms of both seed and straw yields, showing it is the most

productive option. AA-73 also has the highest seed yield (1321.0 kg/ha) compared to AA-2 (1202.8 kg/ha) and AA-93 (1047.2 kg/ha). This indicates that AA-73 is the most productive genotype in terms of seed yield. AA-73 also leads to the highest straw yield (2427.5 kg/ha), indicating its overall superior biomass production compared to the other genotypes.

Results in table 5 examine the interaction effects of spacing, fertilizer levels, and genotypes on various yield attributes and seed yield. Adjusting spacing and fertilizer levels can significantly impact yield attributes, but genotype selection also plays a crucial role in achieving the highest performance. The genotype AA-73 combined with spacing 40 cm x 20 cm and fertilizer

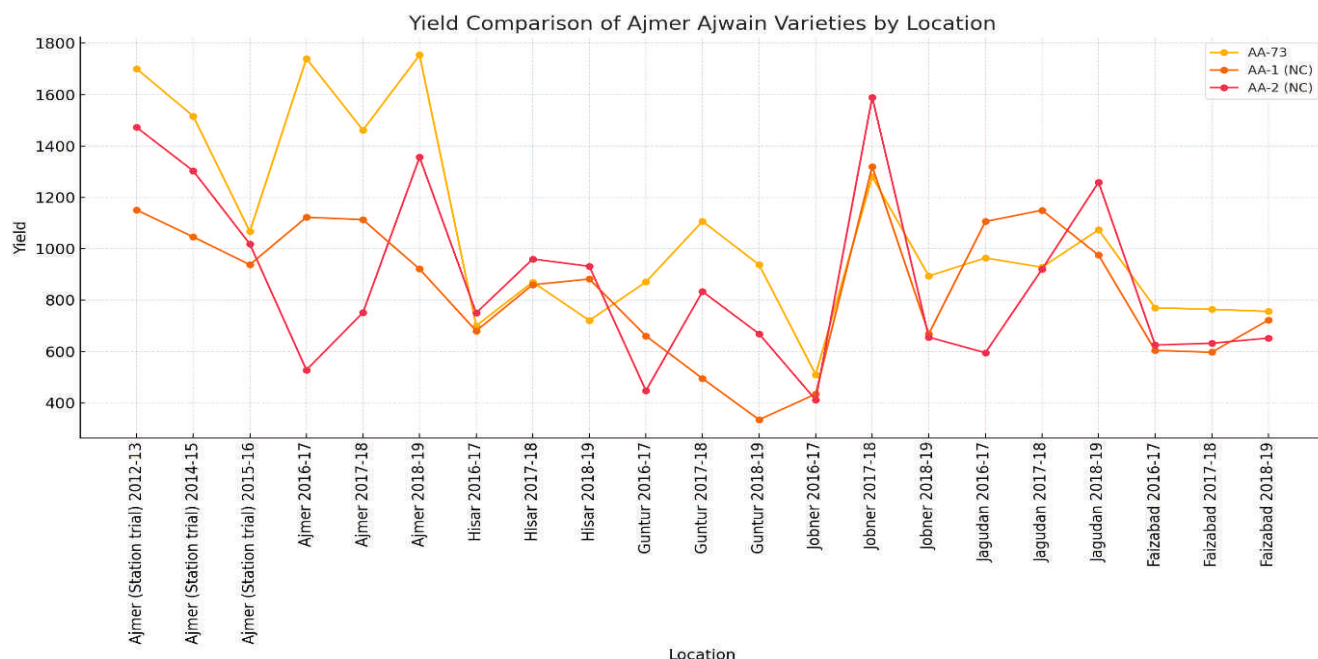
125% RDF results in the highest number of seeds per umbellate. This indicates that this genotype and treatment combination supports optimal seed development. The genotype AA-73 with 40 cm x 20 cm spacing and 125% RDF fertilizer produces the highest seed yield. This indicates that this combination of genotype, spacing, and fertilizer is most effective for maximizing seed yield. Genotype AA-73 with spacing 40 cm x 20 cm and 125% RDF fertilizer is the best combination for maximising yield and quality attributes.

Conclusion

Ajwain (*Trachyspermum ammi* L.), is a popular seed spice primarily grown in South Asia and the Middle East countries namely India, Pakistan, Persia, Iran, Egypt,

Table 2: Performance of Ajmer Ajwain-73 (AA-73) at Station Trials at ICAR-NRCSS, Ajmer and Coordinated trials in different locations during 2012-13 to 2018-19

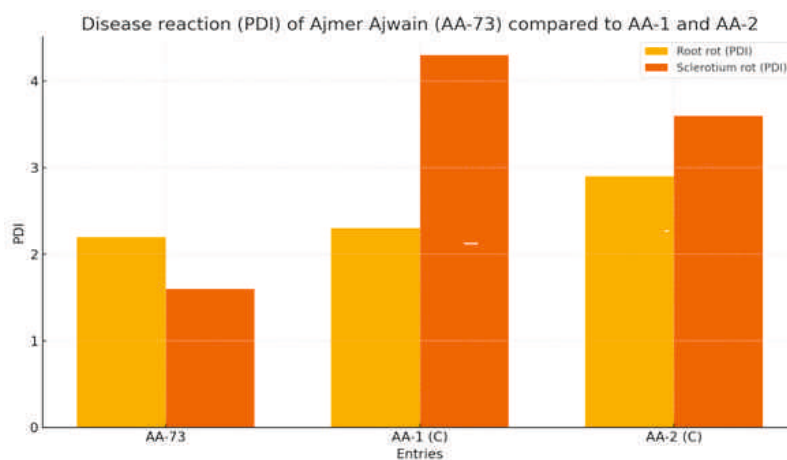
Sr. No.	Locations	Year	AA-73	AA-1 (NC)	AA-2 (N.C)	CD (P=0.05)	CV (%)
1	Ajmer (St)	2012-13	1701.0	1150.8	1472.6	141.7	6.9
2	Ajmer (St)	2014-15	1516.0	1046.0	1303.0	102.2	8.1
3	Ajmer (St)	2015-16	1067.2	938.0	1018.6	134.6	9.3
4	Ajmer	2016-17	1740.6	1122.6	528.0	46.9	6.9
5	Ajmer	2017-18	1462.0	1113.3	751.6	206.3	11.7
6	Ajmer	2018-19	1754.6	921.0	1356.4	93.1	4.2
7	Hisar	2016-17	700.0	680.0	750.0	65.4	5.7
8	Hisar	2017-18	870.0	860.0	960.0	10.7	6.7
9	Hisar	2018-19	720.7	881.7	931.7	122.1	7.8
10	Guntur	2016-17	870.5	660.6	447.3	204.7	13.9
11	Guntur	2017-18	1106.8	494.8	833.3	121.3	7.2
12	Guntur	2018-19	937.8	334.3	668.8	121.5	9.0
13	Jobner	2016-17	510.2	434.2	411.5	71.0	8.9
14	Jobner	2017-18	1280.0	1320.0	1590.0	225.1	10.9
15	Jobner	2018-19	893.9	668.9	655.5	159.3	11.5
16	Jagudan	2016-17	964.0	1106.0	595.0	N.S.	21.7
17	Jagudan	2017-18	928.0	1150.0	920.0	612.4	30.7
18	Jagudan	2018-19	1074.0	975.0	1259.0	161	19.2
19	Faizabad	2016-17	770.0	604.0	625.0	0.75	6.4
20	Faizabad	2017-18	764.0	597.0	632.0	0.45	0.9
21	Faizabad	2018-19	756.0	722.0	652.0	0.33	2.6
22	Average		1066.1	846.7	874.3		



Graph 1: Yield (Kg/ha⁻¹) performance of AA-73, AA-1 and AA-2 at different location over the year

Table 3: Quality attributes of the proposed variety Ajmer Ajwain (AA-73) tested at NRCSS, Ajmer during 2017-18

Name of Entry	Total Oil (%)	Essential Oil (%)
AA-73	9.15	6.38
Ajmer Ajwain-1	8.55	6.30
Ajmer Ajwain-2	6.57	5.44
% higher than AA-1	7.01	1.27
% higher than AA-2	39.26	17.27



Graph 2: Disease reaction (PDI) observed in AA-73, AA-1 and AA-2 at ICAR-NRCSS Ajmer

Table 4: Effect of spacing, fertilizer levels and genotypes on yield attributes and seed yield at Ajmer in ajwain during 2016-17 and 2018-19.

Treatments	No. of umbels/ plant	Seed yield (kg/ha)	Straw yield (kg/ha)
(A) Crop geometry			
30cm x 15cm	207.5	1040.5	1964.3
40cm x 20cm	220.6	1340.1	2517.5
S.Em±	3.4	17.7	47.5
CD (P = 0.05)	10.1	52.0	139.3
(B) Fertilizer levels			
100% RDF (NPK: 80:50:50)	207.1	1104.8	2085.8
125% RDF (NPK: 100:62.5:62.5)	221.0	1275.9	2396.0
S.Em±	3.4	17.7	47.5
CD (P = 0.05)	10.1	52.0	139.3
(C) Genotypes			
AA-2	216.9	1202.8	2263.3
AA-93	175.8	1047.2	2032.0
AA-73	249.5	1321.0	2427.5
S.Em±	4.2	21.7	58.2
CD (P = 0.05)	12.4	63.7	170.6
CV %	6.8	6.3	9.0

Table 5: Interaction effect of spacing (S), fertilizer levels (F) and genotypes (V) on yield attributes and seed yield in ajwain.

Treatments	No. of umbels/ plant	No. of umbellates/ umbel	No. of seeds/ umbellate	No. of seeds/ umbel	Seed yield (kg ha ⁻¹)	Test weight (g)
V ₁ S ₁ F ₁	209.53	16.86	18.33	305.52	1369.74	1.08
V ₁ S ₁ F ₂	218.53	18.15	20.73	364.67	1474.08	1.20
V ₁ S ₂ F ₁	218.73	19.00	19.93	329.75	660.00	0.98
V ₁ S ₂ F ₂	220.73	18.01	21.87	371.24	1307.50	1.40
V ₂ S ₁ F ₁	169.47	16.33	16.93	278.29	1415.25	0.87
V ₂ S ₁ F ₂	175.53	17.27	16.47	271.21	1082.25	0.85
V ₂ S ₂ F ₁	178.13	17.87	18.20	310.89	753.75	0.82
V ₂ S ₂ F ₂	180.13	17.67	17.33	304.05	937.50	0.96
V ₃ S ₁ F ₁	226.60	18.73	19.73	349.91	1191.03	0.96
V ₃ S ₁ F ₂	245.33	20.47	21.40	365.49	1345.63	1.00
V ₃ S ₂ F ₁	240.00	19.53	20.80	357.15	1238.75	0.97
V₃S₂F₂	285.87	23.87	22.47	377.04	1508.49	0.95
S.Em±	8.43	0.79	0.67	12.62	43.42	0.04
CD (P = 0.05)	24.73	2.30	1.97	37.00	127.33	0.11

Note: V₁, V₂ and V₃ represents AA-2, AA-93 and AA-73 respectively. S₁ and S₂ present 30cm x 15cm and 40cm x 20cm spacing. F₁ represents NPK: 80:50:50 and F₂ represents NPK: 100:62.5:62.5.

Afghanistan and North Africa. Ajwain cultivation is influenced by diverse factors ranging from climatic preferences and soil adaptability to varietal characteristics and agronomic practices. Ajwain variety AA-73 found suitable over AA-1 and AA-2 across multilocation trial in terms of yield, disease resistance and quality parameters. Optimal spacing and fertilizer management play important role in yield determination. The best combination for maximizing yield and quality attributes is genotype AA-73 with spacing 40 cm x 20 cm and 125% RDF fertilizer.

Conflicts of Interest: The authors declare no conflicts of interest.

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