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## Gujarat Ajwain 3: High yielding and bold seeded cultivar

**Surabhi S. Chauhan\*, P. J. Patel, S. M. Patel and N. R. Patel**

#### Abstract

A new variety of Ajwain (*Trachyspermum ammi* L.), Gujarat Ajwain 3 (GA 3) was tested in six trials at Jagudan and three trials of CVT at seven different locations (Jagudan, Jobner, Ajmer, Guntur, Hisar, Kumarganj, Raigardh) across India. Gujarat Ajwain 3 (GA 3) is high yielding variety with 12.9 and 4.5 per cent higher seed yield over national checks viz., AA 1 and AA 2, respectively. This new variety had uniform seed size with attractive seed colour, bold seed size, more pungent and good aroma. Gujarat Ajwain 3 has Medium leafy, green foliage colour and medium maturity duration. Due to all above salient feature variety was recommended for release in Gujarat, Rajasthan, Haryana, Andhra Pradesh, Uttar Pradesh and Chhattisgarh.

**Keywords:** Gujarat Ajwain 3, Essential oil, thymol

#### Introduction

Ajwain (*Trachyspermum ammi* L., 2n=18) otherwise known as Carom seed or Carom Ajowan or Bishop's weed, is one of the important commercial seed spices, belonging to the family Apiaceae. This Egyptian native crop is distributed in India, Iran, Afghanistan, and many other parts of the world. Ajwain is an erect glabrous or minutely pubescent annual herb that grows to a height of 70-90 cm. They produce profusely branched striated leafy stems. The leaves appear feathery and are 2-3 pinnately divided. The flowers are borne terminal or seemingly lateral in compound umbels and are white in colour. They are cross-pollinated but self-fertile, pollination is by wind and insects. The pollinated flowers appear pinkish. The seeds are greyish brown cremocarps with distinct ridges and tubular surfaces and are one-seeded (Farooqi *et al.*, 2005). It is grown throughout country, mainly in plains, but flourishes equally well at higher altitudes, in plateaus and on hills. It is grown on a commercial scale in Rajasthan, Gujarat, Madhya Pradesh, Andhra Pradesh, Maharashtra, Uttar Pradesh and to considerable extent in Bihar and West Bengal. Large quantity of ajwain is consumed in India and entire demand is met by indigenous production. The major ajwain importing countries are Yemen, Dubai, Malaysia, Pakistan, Saudi Arabia,

Indonesia, Singapore, UAE and USA (Ravindrababu *et al.*, 2012).

Ajwain contains volatile oil, which is yellow brownish in colour and is employed in various Ayurvedic treatments and industries. Ajwain seeds contain about 8.9% moisture, 15.4% protein, 18.1% fat (ether extract), 11.9% fibre, 38.6% carbohydrates and 7.1% minerals (Meena *et al.*, 2014). Both seeds and oil of ajwain are used in formation of many ayurvedic medicines and industries. Thymol separated from the oil as crystals, sold as 'ajowan ka phul' or 'sat ajwain' and is much valued as medicine in pharmaceutical industries. Its distinctive aromatic flavour and pungent taste make it popular as a spice in curry. The steam distillation of ajwain seeds yields essential oil of about 2.5 to 4.5 per cent and the most important active constituents in ajwain are thymol (30-60%) and carvacrol (Bhatt *et al.*, 2018; Patel *et al.*, 2022). Ajwain seeds are used as condiments in soups, processed meats, sauces, pickles etc. Green leaves are also used for vegetable purpose.

Recent past, area under Ajwain cultivation is increased due to non-risky nature, higher market price and less requirement of scarce and costly inputs as compared to other *rabi* crops *viz.*, wheat, mustard, cumin, fennel etc. Productivity of this crop is low due to its cultivation on marginal lands with low fertility level, lack of improved varieties, short duration varieties, production and plant protection technology. Seed Spices Research Station, S. D. Agricultural University, Jagudan has initiated crop improvement work on ajwain and developed a high yielding and bold seeded variety, namely GA 3 (Gujarat Ajwain 3) for getting higher returns.

## Materials and Methods

### DNA fingerprinting

DNA fingerprinting of proposed variety JA 17-06 along with 2 check varieties GA-2 and AA-1 was performed using 10 ISSR primers (Table 1). Standard cycling conditions and composition of PCR mixture were used as per Table 2 and Table 3, respectively. All primers amplified properly.

### Evaluation and testing of variety

Gujarat ajwain 3 was tested under code name JA 2017-06 in station trials. It was developed through Mass selection and evaluated in germplasm during 2015-16

to 2016-17. The genotype was tested under station trials from 2017-18 to 2018-19 at Jagudan. In CVT trials it was tested under code name of AJN 2 at eight different locations across India.

For field evaluation, standard Randomized Block Design (RBD) was followed. Weighted mean for seed yield over different checks/ varieties were calculated to find out superiority of Gujarat ajwain 3 over check varieties. Quality parameters estimation was carried out *viz.*, volatile oil content at SSRS, SDAU, Jagudan and essential oil profiling was carried out at NRCSS, Ajmer (Rajasthan). DNA fingerprinting was carried out at Central laboratory, SDAU.

Based on its performance over the years/ locations, the variety has been recommended for release in the XXXIV annual group meeting of AICRP Spices during 30th October -01 November, 2023 at COH, Bengaluru. Subsequently, it was released and notified as variety in the name of Gujarat ajwain 3 by the 31<sup>st</sup> meeting of 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 held on 19 July, 2024.

**Table 1.** List of primers used in fingerprinting

Sr.No.	Name of primer	Sequence of primer
1	ISSR10	CACACACACACACACACC
2	ISSR21	GCCTCTCTCTCTCTCT
3	ISSR22	GACTCTCTCTCTCTCT
4	ISSR23	GTCTCTCTCTCTCTCT
5	ISSR25	GCCCTCTCTCTCTCTCT
6	ISSR26	GCACTCTCTCTCTCTCT
7	ISSR28	GCGCTCTCTCTCTCTCT
8	ISSR29	GAAGAAGAAGAAGAACT
9	ISSR31	GAAGAAGAAGAAGAACG
10	ISSR32	GAAGAAGAAGAAGAACC

### Varietal description

1. High yielding variety with Compact seeds in umbellate

2. More number of umbels per plant
3. More number of seeds per umbel
4. Bold seed size (Test weight 1.15 g)

#### **DNA fingerprinting**

DNA fingerprinting of proposed variety JA 17-06 along with 2 check varieties GA-2 and AA-1 was performed using 10 ISSR primers (Table 1). Standard cycling conditions and composition of PCR mixture were used as per Table 2 and Table 3, respectively. All primers amplified properly.

#### **Results and discussion**

##### **DNA fingerprinting using ISSR**

Among the 10 ISSR primer used, two primers namely, ISSR31 and ISSR32 showed polymorphic bands between JA 17-06 and other check genotypes. Polymorphic bands were demonstrated using arrow symbol (Fig 1).

Gujarat ajwain 3 formally named as JA 2017-06 was Ajwain being less effort and inputs intensive crop, it's area is growing day by day along with awareness of its health benefits. So far only two varieties viz., GA 1 and GA 2 has been released for general cultivation of ajwain growing area in Gujarat. Seed yield is not a single character but it is conglomerate of many characters, ancillary observation like braches per plant, plant height (cm), number of umbels plant<sup>-1</sup>, number of seeds umbels<sup>-1</sup> and Test wt. (g) are directly influences on seed yield. Gujarat ajwain 3 variety is found superior for all these characters than check varieties.

The variety was tested in two trials at Jagudan and it was found superior with 11.92 per cent increase over check variety GA 2. In Co-ordinated varietal trial the released variety was tested at eight different locations in India from 2020-21 to 2022-23 as AJN 2. It was found superior at Hisar, Jagudan, Guntur, Jobner, Kumarganj

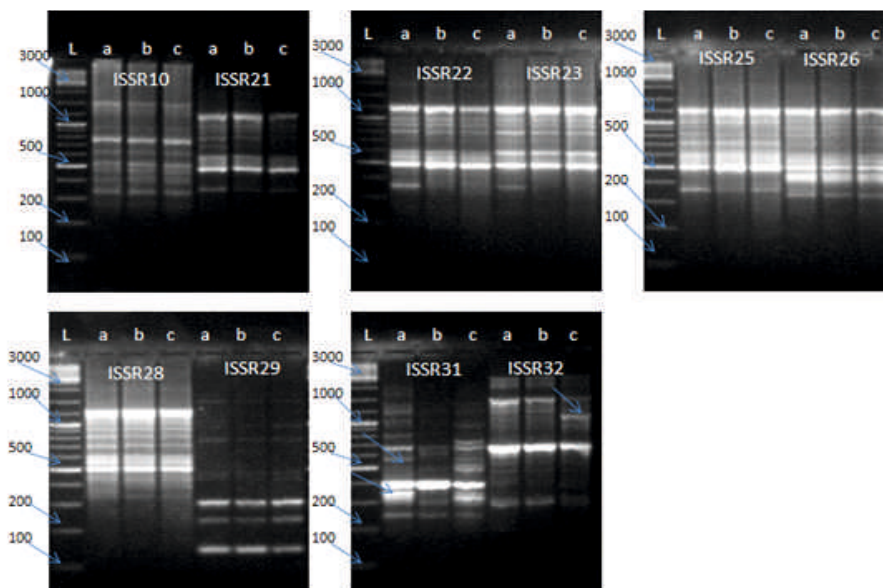
and Raigardh locations. At Jagudan it was superior in two trials with 1261 kg ha<sup>-1</sup> seed production which was 11.9 and 9.4 per cent higher than the checks AA-2 and AA-1, respectively. At Guntur, it was found superior with 779 kg ha<sup>-1</sup> which was 22.7 and 19.3 per cent higher than national checks AA-1 and AA-2, respectively. At Hisar, it was found superior in yield with 1159 kg ha<sup>-1</sup> which was 25.8 percent higher than national check AA-1. At Jobner, it was found superior with 1009 kg ha<sup>-1</sup> which was 26.6 and 23.8 per cent higher than national checks AA-1 and AA-2, respectively. At Kumarganj, it was found superior with 1039 kg ha<sup>-1</sup> which was 30.9 and 26.4 per cent higher than national checks AA-1 and AA-2, respectively. At Raigardh, it was found superior with 720 kg ha<sup>-1</sup> which was 16.1 and 21.2 per cent higher than national checks AA-1 and AA-2, respectively. Gujarat Ajwain 3 (GA 3) was found superior among all the entries and across seven locations, it produced an average seed yield of 1035 kg ha<sup>-1</sup>, which is 12.9 and 4.5 per cent higher seed yield over national checks viz., AA 1 and AA 2, respectively. Higher yield in this variety resulted due to presence more number of umbels per plant and more number of seed per umbel (Table 4, 5 and 6). This new variety had uniform seed size with attractive seed colour, bold seed size, more pungent and good aroma. The essential oil and *thymol* content (48.17) of seed were higher than check varieties AA1 and AA 2 (Table 7 and 8). Gujarat Ajwain 3 has Medium leafy, green foliage colour and medium maturity duration. Morphological features of variety are shown in Fig 2. This variety was recommended for release in Gujarat, Rajasthan, Haryana, Andhra Pradesh, Uttar Pradesh and Chhattisgarh. Agronomic Package of Practices are given in Table 9 for optimum yield gain.

**Table 2.** Concentration of PCR components.

S. N.	PCR component	Stock concentration	Volume used (20 µl)
1	DNA	20ng/µl (approximate )	2.0 µl
2	Buffer (with MgCl <sub>2</sub> )	10X	2.0 µl
3	dNTP	10.0mM each	0.4 µl
4	Primer	5.0 pMol/ µl	2.0 µl
5	Taq DNA polymerase	5 Unit/ µl	0.15 µl
6	Nuclease free water	-	13.45 µl
			20.0 µl

**Table 3.** PCR conditions

S.N.	Condition	Temperature	Time in minutes	Number of cycles
1	Initial denaturation	94 °C	4.00	1
2	Denaturation	94 °C	1.00	40
3	Annealing	50 °C	1.00	
4	Extension	72 °C	2.00	
5	Final Extension	72 °C	7.00	1
6	Store	4 °C	Infinite	



**Figure 1:** DNA profiling of Ajwain genotypes  
 L: Ladder: a: JA 17-06, b: GA-2, c: AA-1 ISSR number represent for ISSR markers.



**Umbel of JA 2017-06**



**Seed of JA 2017-06**



**Single Plant of JA 2017-06**



**Field view of JA 2017-06**

**Fig 2:** Morphological features of Gujarat Ajwain 3

Table 4. Seed yield (kg ha<sup>-1</sup>) data in Coordinated trials

Name of proposed variety			Gujarat Ajwain 3 (JA 2017-06)			Production condition: Irrigated				CD@ 5%	C.V. %
Name of Trial/s	Year/s	Locations	JA 2017-06	Check varieties			% Increase over checks				
				AA 1 (NC) (a)	AA 2 (NC) (b)	GA 2 (LC)	AA 1 (NC)	AA 2 (NC)	GA 2 (LC)		
National trial (PET/IET)	2017-18		2052	-	-	1944	-	-	5.5	346	8.59
	2018-19	Jagudan	1253	-	-	1008	-	-	24.3	272	15.30
	Mean		1652			1476	-	-	11.92	-	-
National trial (CVT)	2020-21		397	741	1754	-	-	-	-	72.7	4.90
	2021-22	Ajmer	1634	1649	2164	-	-	-	-	347	11.4
	2022-23		1801	2097	1582	-	-	13.8	-	250	8.60
Mean		1277	1496	1833	-	-	-	-	-	-	
National trial (CVT)	2020-21		887	320	464	-	177.2	91.2	-	77.4	7.69
	2021-22	Guntur	264	443	574	-	-	-	-	104	9.77
	2022-23		1186	1142	922	-	3.9	28.6	-	207	8.27
Mean		779	635	653	-	22.7	19.3	-	-	-	
National trial (CVT)	2020-21		1129 <sup>a</sup>	946	1203	-	19.3	-	-	167	9.06
	2021-22	Hisar	1174 <sup>a</sup>	948	1190	-	23.8	-	-	107	5.84
	2022-23		1173 <sup>a</sup>	870	1147	-	34.8	2.3	-	114	5.81
Mean		1159	921	1180	-	25.8	-	-	-	-	
National trial (CVT)	2020-21		1126	1139	1342	-	-	-	-	266	13.41
	2021-22	Jagudan	1688 <sup>a</sup>	1332	1414	-	26.7	19.4	-	306	12.69
	2022-23		969 <sup>b</sup>	989	625	-	-	55.0	-	239	15.00
Mean		1261	1153	1127	-	9.4	11.9	-	-	-	
National trial (CVT)	2020-21		1609	1462	1450	-	10.1	11.0	-	228	9.80
	2021-22	Jobner	692 <sup>ab</sup>	570	457	-	21.4	51.4	-	116	11.28
	2022-23		726 <sup>ab</sup>	358	538	-	102.8	34.9	-	115	11.33
Mean		1009	797	815	-	26.6	23.8	-	-	-	
National trial (CVT)	2020-21		986 <sup>ab</sup>	757	826	-	30.3	19.4	-	94.5	7.14
	2021-22	Kumarganj	1181 <sup>ab</sup>	958	931	-	23.3	26.9	-	219	13.08
	2022-23		952 <sup>ab</sup>	667	708	-	42.7	34.5	-	129	9.01
Mean		1039	794	822	-	30.9	26.4	-	-	-	
National trial (CVT)	2020-21		427	560	563	-	-	-	-	199	19.73
	2021-22	Raigarh	588 <sup>a</sup>	351	465	-	67.5	26.5	-	181	18.54
	2022-23		1145 <sup>b</sup>	949	754	-	20.7	51.9	-	294	19.32
Mean		720	620	594	-	16.1	21.2	-	-	-	
Mean Seed Yield (kg/ha)	2020-21		937	847	1086	-	10.7	-	-	-	-
	2021-22		1032	893	1028	-	15.6	0.4	-	-	-
	2022-23	7 locations	1136	1010	897	-	12.4	26.7	-	-	-
	Weighted Mean		1035	917	1004	-	12.9	4.5	-	-	-
Frequency in the top three groups (pooled for three years)			9/21	2/21	4/21	-	-	-	-	-	-

Source: Annual reports of AICRPS

Note: a and b are indicating significant over AA 1 and AA 2, respectively

**Table 5.** Seed yield (kg ha<sup>-1</sup>) data in Coordinated trials

Particulars	Year of testing	No. of trials/ locations	Name of proposed variety: Gujarat Ajwain 3 (JA 2017-06)										
			Check (AA-1)	Check (AA-2)	JA-18-05	JA-17-06	AA-3	AA-27	AA-96	HAJ-24	HAJ-29	NDAJ-21	NDA3-30
Mean Seed Yield (Kg/ha)	2020	7	847	1086	918	937	900.2	832.3	819.1	823.4	1003.6	996.9	962.1
	2021	7	893	1028	1044	1032	913.9	927.1	919.0	1043.8	1071.2	1021.4	957.0
	2022	7	1010	897	1068	1136	1127.6	1087.6	980.5	912.5	1000.6	1072.3	1092.2
<b>Weighted Mean</b>		21	917	1004	1010	<b>1035</b>	981	949	906	927	1025	1030	1004
Percentage increase or decrease over the Best check (i.e. AA-2)	2020	7	--	--	-15.4	-13.7	-17.1	-23.4	-24.6	-24.2	-7.6	-8.2	-11.4
	2021	7	--	--	1.5	0.4	-11.1	-9.8	-10.6	1.6	4.2	-0.6	-6.9
	2022	7	--	--	19.1	26.7	25.8	21.3	9.4	1.8	11.6	19.6	21.8
Weighted mean		21	--	--	1.7	<b>4.5</b>	-0.8	-4.0	-8.6	-6.9	2.7	3.6	1.2
Percentage increase or decrease over the Second best check (i.e. AA-1)	2020	7	--	--	8.5	10.7	6.3	-1.7	-3.2	-2.7	18.6	17.8	13.7
	2021	7	--	--	16.9	15.6	2.4	3.8	2.9	16.9	20	14.4	7.2
	2022	7	--	--	5.7	12.4	11.6	7.6	-3	-9.7	-1	6.1	8.1
Weighted mean		21	--	--	10.4	<b>12.9</b>	6.8	3.2	-1.1	1.5	12.5	12.8	9.7
Frequency in the top three group (pooled for three years)		21			3/21	<b>9/21</b>	9/21	4/21	1/21	6/21	10/21	10/21	5/21

**Source:** Annual reports of AICRPS

**Table 6.** Yield ancillary characters data of Coordinated Varietal Trials on Ajwain (2020-2022)

<b>Name of proposed variety: Gujarat Ajwain 3 (JA 2017 -06)</b>					
<b>Sr. No.</b>	<b>Character</b>	<b>Year</b>	<b>Proposed entry JA 2017-06</b>	<b>AA 1 (NC)</b>	<b>AA 2 (NC)</b>
1.	Days to 50% Flowering	2020	106.9	110.7	106.5
		2021	103.6	106.8	104.8
		2022	97.2	97.7	98.1
		<b>Mean</b>	<b>103</b>	<b>106</b>	<b>103</b>
2.	Plant Height (cm)	2020	117.2	111.9	110.2
		2021	111.8	113.2	113.8
		2022	116.8	111.5	114.8
		<b>Mean</b>	<b>115</b>	<b>112</b>	<b>113</b>
3.	Primary Branches per plant	2020	9.6	9.2	9.8
		2021	10.6	11.3	10.9
		2022	10.4	11.0	10.1
		<b>Mean</b>	<b>10.2</b>	<b>10.6</b>	<b>10.3</b>
4.	Umbels per plant	2020	156.5	149.7	157.9
		2021	169.7	156.1	168.5
		2022	162.0	155.7	158.0
		<b>Mean</b>	<b>163.0</b>	<b>154.0</b>	<b>161.6</b>
5.	Umbellets per Umbel	2020	16.9	16.9	16.7
		2021	19.9	22.2	20.4
		2022	15.9	16.2	16.0
		<b>Mean</b>	<b>17.6</b>	<b>18.5</b>	<b>17.8</b>
6.	Seeds per Umbels	2020	286	265	277
		2021	188	181	160
		2022	234	232	211
		<b>Mean</b>	<b>236</b>	<b>226</b>	<b>216</b>
7.	Test Weight (g)	2020	1.049	1.082	1.109
		2021	1.284	1.140	1.206
		2022	1.141	0.995	1.128
		<b>Mean</b>	<b>1.158</b>	<b>1.072</b>	<b>1.148</b>

**Source:** Annual reports of AICRPS

**Table 7.** Volatile oil content (%) data of Coordinated Varietal Trials on Ajwain (2020-2022)

<b>Entries</b>	<b>Ajmer</b>	<b>Guntur</b>	<b>Jagudan</b>	<b>Jobner</b>	<b>Grand Mean</b>
JA -18 -05	4.05	3.75	5.40	6.25	4.86
<b>JA -17 -06</b>	<b>4.20</b>	<b>4.40</b>	<b>4.56</b>	<b>5.83</b>	<b>4.74</b>
AA -3	4.86	4.65	5.14	6.10	5.19
AA -27	4.44	3.60	4.89	6.11	4.76
AA -96	4.47	3.20	5.41	5.57	4.66
HAI -24	3.67	3.20	4.82	5.56	4.31
HAI -29	4.23	3.35	4.25	5.54	4.34
NDAJ -21	5.77	3.35	4.42	5.57	4.78
NDA3 -30	6.89	4.15	4.93	5.18	5.29
<b>AA -1 (Check)</b>	<b>4.21</b>	<b>4.95</b>	<b>4.80</b>	<b>5.77</b>	<b>4.93</b>
<b>AA -2 (Check)</b>	<b>4.10</b>	<b>4.60</b>	<b>5.63</b>	<b>5.76</b>	<b>5.02</b>

**Source:** Annual reports of AICRPS

**Table 8.** Essential oil profiling of Ajwain genotypes in Coordinated Varietal Trials on Ajwain (2020-2022)

Entries	Thymoquenon	Geraniol	Thymol	Carvacrol	Geranyl acetate	Alpha pinene	Beta Pinene	M-cymene	P-cymene	Gama Terpinen
JA-17-06	0.72	0.59	<b>48.17</b>	0.89	0.00	0.21	1.80	0.28	13.78	17.76
AA-1 (Check)	0.05	0.12	47.09	0.60	0.00	<b>0.32</b>	<b>3.33</b>	<b>0.45</b>	14.02	<b>28.93</b>
AA-2 (Check)	<b>1.02</b>	<b>0.68</b>	46.03	<b>0.91</b>	<b>0.11</b>	0.22	1.62	0.20	<b>16.77</b>	17.31
CD (5%)	0.073	0.068	3.486	0.1	0.034	0.08	0.317	0.095	1.787	1.844
CV (%)	7.053	11.17	4.418	7.041	4.62	16.55	8.16	20.58	6.54	5.195

**Source:** AICRPS reports of NRCSS, Ajmer centre

**Table 9.** Agronomic Package of Practices

Sr. No.	Particulars	Details
1	<b>Selection of field/ land preparation</b>	Level land with medium depth soil is desirable, 2 -3 cultivations with addition of sufficient organic matter are desirable to make soil well pulverized.
2	<b>Sowing time</b>	<i>Rabi</i> season (first week of November for normal sowing)
3	<b>Seed rate</b>	➤ Seed rate: 2.5 kg /ha ➤ Spacing : Drilling 45 cm apart
4	<b>Fertilizer dose and time of fertilizer application</b>	20:20:00 kg N:P <sub>2</sub> O <sub>5</sub> : K <sub>2</sub> O/ha ➤ 40% Nitrogen and full dose of phosphorus as a basal ➤ 40% Nitrogen at tillering stage ➤ 20% Nitrogen at panicle initiation stage
5	<b>Weed control</b>	➤ Pendimethalin @ 1.0 kg a.i./ha as pre-emergence ➤ 2 hand weeding at 15 days interval after one month oftransplanting.
6	<b>Irrigation schedule</b>	Total eight irrigation during the crop period 1. At the time of sowing 2. Sixth days after sowing 3. Rest six irrigation at the interval of 15 days

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