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REVIEW ARTICLE

Cumin (*Cuminum cyminum* L.) cultivation in Rajasthan as an opportunity- A soil and climatic suitability evaluation

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ABSTRACT
Cumin (Cuminum cyminum L.; Family: Umbelliferae) is a seed spice of commercial importance as well as it is a potential medicinal herb with immense therapeutic uses not withstanding its significance in health food formulations. It has a distinctive strong flavor and its warm aroma is due to its essential oil content. Its main constituent of aroma compounds is cuminaldehyde and cuminic alcohol. Rajasthan and Gujarat are also known as "Seed Spices Bowl" and contributes more than 80% of total seed spices production in India. The suitable climatic setup as well as characteristics of soil are a boon for Rajasthan. These conditions not only suited for the production of cumin production but also reduces the disease and insect infestation to the crop. The all above production factor contributes significantly for cumin cultivation growth horizontally as well as vertically in state. This will be not only help in doubling the income of farmers but also enhances the economy of the state.
Keywords: seed spices, export, soil suitability, area, production

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INTRODUCTION

India is the "Land of Spices "and has an old history of cultivation of spices and takes benefit of being a largest producer, exporter and consumer in the world. There are total 63 spices which are grown in India and out of which 20 are being classified as seed spices. The major seed spices grown in India are Cumin, Fenugreek, Coriander and Fennel. India is the single largest producer as well as consumer of cumin in the world accounting for about 70% of world production. Other important producers of cumin are Syria, Iran, Turkey. Although no reliable data are available on world cumin output, it is expected be around 5-6 lakh tonnes. Syria is the second largest producer followed by Iran and Turkey. India is biggest exporter of cumin seed, powder and oils. Indian spices exports have registered substantial growth during the last five years, registering a compound annual average growth rate of 14% in rupee terms and 5%dollar in terms of value and India commands a formidable position in the World Spice Trade. India is the major exporter of cumin in the world. During the year 2011-12, the cumin export was to the tune of 45.5 thousand tones valued Rupees 64.4 million. It was increased to 88, 167, 242, and 116 percent during the year 2012-13, 2013-14, 2014-15 and 2015-16, respectively [1].

BOTANICAL DESCRIPTION

Cumin seeds are obtained from the herb *Cuminum cyminum*, native from East Mediterranean to South Asia belonging to the family Apiaceae—a member of the parsley family. Cumin seeds are oblong and yellowish grey. Cumin seeds are liberally used in several cuisines of many different food cultures since ancient times, in both whole and ground forms. In India, cumin seeds have been used for thousands of years as a traditional ingredient of innumerable dishes including kormas and soups and also form an ingredient of several other spice blends. Besides food use, it has also many applications in traditional

medicine. In the Ayurvedic system of medicine in India, cumin seeds have immense medicinal value, particularly for digestive disorders. They are used in chronic diarrhea and dyspepsia (Table 1).

Table 1: Differences between seed spices closely related to cumin seeds

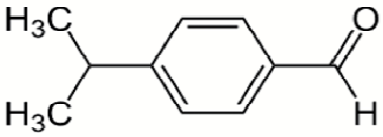
Common name of the spice	Cumin	Black cumin (Nigella/kalonji)	Bitter cumin (Kashmiri jeera/ Shahi jeera)
Scientific name	*Cuminum cyminum*	*Nigella sativa*	*Cuminum nigrum* or *Bunium persicum*
Genus/family	*Cuminum/Apiaceae* (member of Parsley family)	*Nigella/Ranunculaceae*	*Cuminum/Apiaceae*
Native of countries growing	East Meditaranian to South Asia. Now mostly grown in Pakistan, India, Uzbekistan Iran, Turkey, Morocco, Egypt, Syria, Chile, Mexico, and China	South to Southwest Asia. Middle Eastern Mediterranean region, South Europe, Northern India, Pakistan, Syria, Turkey, Iran, and Saudi Arabia	Central Asia to Northern India. Mountainous regions of North India
Traditional uses	Both whole and ground seeds are used in the cuisines of many cultures for ages. It has also many uses in traditional medicine. They are used in chronic diarrhoea and dyspepsia	A spice in Indian and Middle Eastern cuisines. In the ancient Egypt, it was used as a preservative in mummification. Traditionally, it is used for asthma, diabetes, hypertension, fever, inflammation, bronchitis, dizziness, eczema, and gastrointestinal disturbances	A spice in Northern Indian cookery, often the Moghul cooking
Main constituents	Cuminaldehyde	Thymoquinone	Cuminaldehyde, p-mentha-1,3-dien-7-al and p-mentha-1,4-dien-7-al

Black seed (also known as black cumin; *Nigella sativa*) is an annual flowering plant belonging to the family Ranunculaceae and is a native of Southern Europe, North Africa, and Southwest Asia. Black cumin is cultivated in the Middle Eastern Mediterranean region, Southern Europe, Northern India, Pakistan, Syria, Turkey, Iran, and Saudi Arabia. *Nigella sativa* seeds and their oil have a long history of folklore usage in Indian and Arabian civilization as food and medicine [2]. The seeds of *N. sativa* have a pungent bitter taste and aroma and are used as a spice in Indian and extensively in Middle Eastern cuisines. The dry-roasted nigella seeds flavour curries, vegetables, and pulses. Black seeds are used in food as a flavouring additive in breads and pickles. It is also used as an ingredient of the spice mixture (panch phoron) and also independently of many recipes in Bengali cuisine. Cumin was traditionally used as a preservative in mummification in the ancient Egyptian civilization. Black cumin has a long history of use as medicine in the Indian traditional system of medicine like Unani and Ayurveda [3]. The black cumin seeds have traditionally been used in the Southeast Asian and Middle East countries for the treatment of diseases such as asthma, bronchitis, rheumatism, and other inflammatory diseases. *Nigella sativa* has extensively been used because of its therapeutic potential and possesses a wide spectrum of activities, namely, diuretic, antihypertensive, antidiabetic, anticancer, immune-modulatory, antimicrobial, anthelmintic, analgesic and anti-inflammatory, spasmolytic, bronchodilator, gastroprotective, hepatoprotective, and renal protective properties. Traditionally, seeds of *N. sativa* are widely used for asthma, diabetes, hypertension, fever, inflammation, bronchitis, dizziness, rheumatism, skin disorders, and gastrointestinal disturbances (Table 1). It is also used as a liver tonic, digestive, antidiarrhoeal, emmenagogue, and to control parasitic infections and boost immune system [4].
Bunium persicum (occasionally referred to as *Cuminum nigrum*; also known as Shahi jeera), belonging to *Apiaceae* (parsley family), is a smaller variety of cumin with a different flavour, popularly used in North Indian, Pakistani, and Iranian foods (Figure 1). Until now, there is only very little scientific information on this spice.

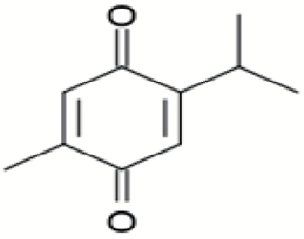
CHEMICAL CONSTITUENTS

Cumin seeds are nutritionally rich; they provide high amounts of fat (especially monounsaturated fat), protein, and dietary fibre. Vitamins B and E and several dietary minerals, especially iron, are also considerable in cumin seeds. Cuminaldehyde (Figure 1), cymene, and terpenoids are the major volatile components of cumin [5]. Cumin has a distinctive strong flavour. It's warm aroma is due to its essential oil

content. Its main constituent of aroma compounds is cuminaldehyde and cuminic alcohol. Other important aroma compounds of roasted cumin are the substituted pyrazines, 2-ethoxy-3-isopropylpyrazine, 2-methoxy-3-sec-butylpyrazine, and 2-methoxy-3-methylpyrazine. Other components include γ-terpinene, safranal, p-cymene, and β-pinene [6].



Cuminaldehyde
(Major bioactive compound in *C. cyminum*)



Thymoquinone
(Major bioactive compound in *N. sativa*)

Fig. 1 : Major bioactive compounds of cumin and black seeds.

Nigella sativa seeds contain protein (26.7%), fat (28.5%), carbohydrates (24.9%), crude fibre (8.4%), and total ash (4.8%). *Nigella sativa* seeds also contain a good amount of various vitamins and minerals like Cu, P, Zn, and Fe. Many active compounds have been identified in *N. sativa*. The most important active compounds of *N. sativa* are thymoquinone (TQ) (30–48%) (Figure 2), thymohydroquinone, dithymoquinone (nigellone), p-cymene (7–15%), carvacrol (6–12%), 4-terpineol (2–7%), t-anethole (1–4%), sesquiterpene longifolene (1–8%), α-pinene, and thymol. [7] [8]. *Nigella sativa* also contains other compounds such as carvone, limonene, citronellol in trace amounts, and two varieties of alkaloids, i.e. isoquinoline alkaloids (e.g. nigellicimine and nigellicimine-N-oxide) and pyrazole alkaloids (e.g. nigellidine and nigellicine). *Nigella sativa* seeds also contain α-hederin, a water soluble pentacyclic triterpene [9] [10]. The pharmacological properties of *N. sativa* are mainly attributable to its quinine constituents, TQ being the most abundant. The *N. sativa* seeds contain fatty oil rich in unsaturated fatty acids, constituting linoleic acid (50–60%), oleic acid (20%), eicosadienoic acid (3%), and dihomolinoleic acid (10%), and saturated fatty acids (palmitic and stearic acids) constitute up to 30 per cent. α-Sitosterol is the major sterol, accounting for 44–54% of the total sterols in N. sativa oils, followed by stigmasterol (6.57–20.9% of total sterols) [11] [12].

Bitter cumin (Shahi jeera) seeds contain calcium, vitamin A, potassium, sodium, iron, magnesium, and phosphorus. Bitter cumin (*B. persicum*) has 0.5 to 1.6 per cent essential oil, mainly carvone (45–60%), limonene, and p-cymene. Oleoresin of bitter cumin is brownish to yellowish green. As there is not enough scientific information on the health effects of bitter cumin, this review is limited to *C. cyminum*(cumin seeds) and N. sativa (black seeds or black cumin)

As per USDA, the nutritional profile of cumin is given below in Table 2 [13].

Table 2 : Nutrient data for Spices: cumin seed

Nutrient	Unit	1Value per 100 g	1 tsp, whole = 2.1g	1 tbsp, whole = 6.0g	
Proximates					
Water	g	8.06	0.17	0.48	
Energy	kcal	375	8	22	
Protein	g	17.81	0.37	1.07	
Total lipid (fat)	g	22.27	0.47	1.34	
Carbohydrate, by difference	g	44.24	0.93	2.65	
Fiber, total dietary	g	10.5	0.2	0.6	
Sugars, total	g	2.25	0.05	0.14	
Minerals					
Calcium, Ca	mg	931	20	56	
Iron, Fe	mg	66.36	1.39	3.98	
Magnesium, Mg	mg	366	8	22	
Phosphorus, P	mg	499	10	30	
Potassium, K	mg	1788	38	107	
Sodium, Na	mg	168	4	10	
Zinc, Zn	mg	4.8	0.1	0.29	

Vitamins					
Vitamin C, total ascorbic acid	mg	7.7	0.2	0.5	
Thiamin	mg	0.628	0.013	0.038	
Riboflavin	mg	0.327	0.007	0.02	
Niacin	mg	4.579	0.096	0.275	
Vitamin B-6	mg	0.435	0.009	0.026	
Folate, DFE	µg	10	0	1	
Vitamin B-12	µg	0	0	0	
Vitamin A, RAE	µg	64	1	4	
Vitamin A, IU	IU	1270	27	76	
Vitamin E (alpha-tocopherol)	mg	3.33	0.07	0.2	
Vitamin D (D2 + D3)	µg	0	0	0	
Vitamin D	IU	0	0	0	
Vitamin K (phylloquinone)	µg	5.4	0.1	0.3	
Lipids					
Fatty acids, total saturated	g	1.535	0.032	0.092	
Fatty acids, total monounsaturated	g	14.04	0.295	0.842	
Fatty acids, total polyunsaturated	g	3.279	0.069	0.197	
Cholesterol	mg	0	0	0	
Other					
Caffeine	mg	0	0	0	

HEALTH EFFECTS OF C. *CYMINUM*

Although the seeds of cumin (*C. cyminum* L.) are widely used as the spice for their distinctive aroma, they are also commonly used in traditional medicine to treat a variety of diseases, including chronic diarrhoea and dyspepsia, acute gastritis, diabetes, and cancer. The literature presents ample evidence for the biological and biomedical activities of cumin, which have generally been ascribed to its bioactive constituents such as terpenes, phenols, and flavonoids [14].

SOIL SUITABILITY CRITERIA FOR CUMIN PRODUCTION

The scientist of National Bureau of Soil Survey and Land Use Planning, Regional Centre, Udaipur reported that soil quality and climatic suitability for cumin in Jodhpur, Barmer, Jaisalmer, Pali, Nagore and Sirohi districts of Rajasthan might be one of the reasons for involvement of the cumin crop in cropping systems. A soil suitability criteria (Table 3) for cumin production that include soil depth, slope, texture, erosion, available water content (AWC) and length of growing period (LGP) [15]. The limitations considered for assessment of soils are climatic, topographic, wetness, salinity and alkalinity, soil fertility and physical limitation. Cumin can be cultivated in all most all types of soils but well drained coarse loamy or loamy textured soil suits well. Fertile soils with cloud free sunny environment are conducive for its growth. It thrives well between 9^{o} to 26^{o} C and annual rainfall of 30 to 270 mm. Cumin is the winter season crop, grows abundantly in the mild, equable climate. These conditions are very much suits to the environment of western Rajasthan.

The crop can be grown well in soils having pH in the range of 6.5 to 8.5. However, for higher productivity of the crop and quality seed production, it is suggested that pH should be in the range of 6.5-7.5 with more than /or equal to 0.6 percent organic carbon and less than 10 percent calcium carbonate content. The essential plant nutrients should be applied through fertilizers and organic manures as per the prescription for agro-ecological/agro-climatic zones of India. Plants can tolerate even moderate salinity. Cumin can be grown up to 4.0 (dSm^{-1}) EC and 10.0 ESP (exchangeable sodium percentage). However, for ideal conditions soils should have EC and ESP less than 2 dSm^{-1} and 5, respectively.

PACKAGE OF PRACTICES FOR CUMIN PRODUCTION

Cumin varieties recommended for cultivation in Western Rajasthan are GC-1, GC-2, GC-3, GC-4, RZ-19, RZ-209, RZ-345 and RZ-223. Crop duration is 110-120 days depending on the variety. Unlike other tropical plants, it requires relatively less irrigation water (218 mm) [16], and rainfall during the harvesting period is unfavorable for the seed quality, hence under optimum conditions it requires 90-120 days LGP (Length of Growing Period). The production of cumin seeds is regulated by most limiting factor. Generally, 2-5 irrigations are mandatory for cumin crop, depending on the type of soils and average annual rainfall. Under normal agro-climatic conditions a light irrigation is done soon after sowing and there after second irrigation should be applied 8–10 days after first irrigation. Depending upon the soil type and climatic conditions the subsequent irrigations may be given at 15–25 intervals. Last heavy irrigation must be

given at the time of seed formation. Avoid irrigation at the time of active seed filling because it increases the incidence of powdery mildew, blight and aphid infestation [16] [17].

Table 3: Soil suitability criteria for cumin cultivation [15]

Characteristics	S1- Highly suitable	S2-Moderately suitable	S3-Marginally suitable	N- Not suitable
Climate				
LGP(days)	105-120	90-105	<90	<90
Precipitation(mm)	250	150-250	100-150	<100
Mean temp. of growing cycle(^{o}C)	13-22	10-13	5-10	<5
Topography				
Slope (%)	<1	1-3	3-8	>8
erosion	slight	Moderate	Severe	Very severe
Coarse fragment	<15	15-35	35-55	>55
Wetness				
Drainage	Well	Well	Moderately well drained	Permeable
Flooding	No	No	<5 cm water for 2-3 days	<5 cm water for 3-7 days
Physical condition of soil				
Depth(cm)	>50	20-50	25-50	<25
Texture	loam, silty clay loam, clay loam	Fine sand, fine loamy	Sand, Clay	Massive clay, coarse sand
AWC(mm)	>75	50-75	50-75	<50
Fertility of soils				
pH	6.5-7.5	7.5-8.0	8.0-8.5	>8.5
OC(%)	0.6	0.4-0.6	0.4	<0.4
$CaCO_3$(%)	<10	<10	10-20	>20
Salinity-EC(dSm^{-1})	<2	2-4	2-4	>4
Alkalinity-ESP	<5	<5	5-10	>10

RAJASTHAN STATE AS AN OPPORTUNITY

The soils of four districts comprising Ajmer, Bhilwara, Pali and Rajsmand using a GIS approach for potential soil suitability for cumin, coriander, fennel and fenugreek and found that most of the soils were marginally suitable whereas only two per cent area was moderately suitable for coriander production [18].

Potential cumin growing area in hot arid region ofJaisalmer district concluded that 51 per cent area of TGA has the potential for cumin cultivation. Considering the slope, erosion and soil fertility limitation 13.4 lakh hectares (34.97%) area is suitable for cumin cultivation [19]. Approximately 6.36 lakh hectare land is suitable for cumin keeping the fertility as one of the limitations. Presently farmers of Jaisalmer district cultivate cumin only in 44061ha land [17].

In India the production of cumin is highest in Gujarat followed by Rajasthan. The present status of area and production of cumin seed in Rajasthan and Gujarat given in Table 4. The above study and data suggested that still there is a scope to increase about 40-50 % cumin crop growth, since the productivity of cumin crop in Gujarat is 1045 kg/ ha, while in Rajasthan it is only 413 kg/ha in the year 2017-18[1].

Table 4: Area and Production of cumin in Rajasthan and Gujarat (000 ha/mt)

State	**Rajasthan**			**Gujarat**		
Year	**2015-16**	**2016-17**	**2017-18 (est.)**	**2015-16**	**2016-17**	**2017-18 (est.)**
Area	511.1	500.1	500.1	295.4	278.7	278.7
Production	200.8	206.9	206.9	300.9	291.4	291.4

CLIMATE AND SOILS OF RAJASTHAN:

The climate of Rajasthan ranges from the semi arid to arid on the west of Aravallis and semi-arid to subhurnid on the east of Aravallis.The mean annual rainfall in the west varies from 100 to 400 mm while it ranges between 557 mm to 1000 mm in the east. The mean annual temperature ranges between 24°

and 27°C. In the western part, the higher average temperature, as recorded in the months of May and June, is around 40° to 43°C, while the mean winter temperature drops to 12.9^{0}C during the months of December and January. The variation in temperature is not distinctly different in the western and eastern sectors of the state. In general the month of May is the hottest and January is the coldest, while July and August represent the rainy months.

Soils of the state belong to five orders namely Alfisols 250675 ha(0.73%), Aridisols6694468.4 ha (19.55 %), Entisols 12619679 ha (36.85%), lnceptisols 7487986.7 ha (21.86%) and Vertisols 970103.46 ha (2.83%). The characteristics of 60 % soils are gently to moderately

Sloping, very deep to deep, somewhat excessively drained, neutral, coarse loamy/fine loamy, low to medium AWC.The rest soils characteristics are loamy skeletal / coarse loamy to fine loamy, low to medium and high AWC [19].

CONCLUSION

With the changing climate, resources of the farmers and prevailing marketing conditions, over a period of time there is slight change in the land use system. Among the major crops, area under pearl millet is declining over the past four decade while area under Guar, Gram and Rape is increasing. The state has modest area under wheat, groundnut and mung in recent past while area under moth, sesame and jower is small but constant over the years. Presently the area under cumin crop is increasing rapidly since last few years. Since cumin crop is sown at about one cm depth and requires less water for its life cycle, and also the evapotranspiration during cumin growth period is very less. Further, due to the low air humidity of the environment, prominent diseases of cumin like powdery mildew and downy mildew is prevented automatically. The sprinkler system of irrigation is best fitted in the undulating topography of the area for cumin cultivation. The all above production factor contributes significantly for cumin cultivation growth horizontally as well as vertically in state. Further, the suitable climatic setup is a boon for Rajasthan with low use of insecticide and fertilizers, offering good scope for organic cumin seed cultivation (Sharma et al. 2018).

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