Advance Production Technology of

Cumin

(*Cuminium cyminium* L.)

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PREFACE

The cumin is mainly cultivated in India, Turkey, Syria, United Arab Emirates (UAE), Iran, Egypt, Pakistan, and Italy. India is estimated toproduce more than 70% of the world's cumin, from approximately 841940hectares under cultivation, yielding 546750tonnescumin seed (2019-20).In India Cumin is mostly cultivated in Rajasthan (503230hectares) and Gujarat (337007hectares) and in some part ofM.P. and U.P. as a *rabi* crop. The two states Rajasthan and Gujarat have leading position in terms of area and production which contribute more than 99%of the total production of cumin in India.

Cumin is believed to be the native of upper Egypt, Turkey and East Mediterranean region. The productivity level of cumin in our country is low. The main reasons of low productivity are lack of adoption of improved variety, package of practices including weed management and control of insect pests as well as inadequate extension services and laggard attitude of fanners for adoption of new innovation due to fear of poor performance on their fields.

The technology that have emanated out of research efforts at NRCSS and at different centres located in the different agro climatic regions, under the AICRP on spices at various SAU's and NRC on Seed Spices has been compiled in this volume of advance production technology for cumin. We are sure that this publication shall prove highly useful to various stake holders such as field functionaries, growers, exporters, students and others having interest in cultivation of cumin scientifically.

We hope this technical bulletin will provide relevant information. Suggestion if any for its improvement are welcome for future publication.

Ajmer Authors

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Introduction

The cumin commonly known as Jeera, (*Cuminium cyminium* L.) belongs to family Apiaceae. It is an important spice occupying more than 22% of spice acreage (3824260 hectares) and largest grown seed spice with having more than 48% seed spice acreage (1737610 hectares) in the country. In India Cumin is mostly cultivated in Rajasthan and Gujarat and in some part of M.P. and U.P. as a *rabi* crop. Rajasthan and Gujarat have important position in terms of area and production and contribute 99% of the total production of cumin in India. In India, cumin occupies an area of 8.42 lakh hectares and the total production is 5.47 lakh tonnes (2019-20). Major cumin producing states with districts are given in table 1, 2 and 3.

Table 1: Area, production and yield of cumin in India, Rajasthan and Gujarat (2019-20)

Name	Area (Hectare)	Production (Tonnes)	Yield (Kg/ha)
India	841940	546750	649.39
Rajasthan	503230	213070	423.40
Gujarat	337007	331940	984.96

Source: DASD,Kozhikkode

Table 2. Major cumin producing districts in Rajasthan (2018-19)

District name	Area (Hectare)	Production (Tonnes)	Yield (Kg/ha)
Barmer	171482	49024	286
Jodhpur	168050	136662	813
Jalore	127564	67459	529
Jaisalmer	87046	44519	511
Nagaur	72815	51836	712
Rajasthan	676240	378654	560

Source: Agricultural Statistics at a Glance, Government of Rajasthan

Table 3. Major cumin producing districts in Gujarat (2018-19)

District name	Area (Hectare)	Production (Tonnes)	Yield (Kg/ha)
Surendranagar	95740	95740	1000
Banaskantha	75687	76444	1010
Patan	64213	32749	510
Kutch	45901	48655	1060
Junagadh	18805	16925	900
Gujarat	349552	319862	915

Source: Director of Horticulture, Government of Gujarat

Cultural requirements

The cultural requirements for higher production of cumin are given as under:

Climate

The crop is successfully cultivated in moderately cool and dry climate. It does not prefer humidity in the atmosphere during flowering and seed setting stage because it is prone to attack by several diseases. It is also susceptible to frost injury during flowering and early fruit setting stage. Therefore, cumin cultivation is restricted in the area, where atmospheric humidity is low and winters are not severe. The frequent rain during flowering or early fruit setting and at the time of maturity period is highly undesirable.

Soil

Cumin can be cultivated in wide range of soils, however either sandy with low organic matter or clay and clay loam soils having good amount of organic matter are more suitable. Sandy loam soil is not much suitable as that of Clay of sandy.The soil should have better drainage facility because stagnated water and excessive moisture is very harmful to cumin crop. Soil having high pH or high pH calcareous soil are not much suitable for better crop growth and yield. It has been reported that cumin can be adopted well under soil suspension EC, 14.0 dSm^{-1} and highest salinity tolerant among the seed spices. Seed filling is better at slightly saline soil or irrigation water, hence cumin is a boon for the farmers under such conditions. It can be grown on both deep, shallow soils, however gravely or stony soils having good soil porosity and drainage facility is most suitable.

RECOMMENDED IMPROVED VARIETIES

(A)Rajasthan

RZ-19:

It was developed at Sri Karan Narendra Agriculture University (SKNAU), Jobner through selection from a local collection. The plants are erect in growth habit, bear pink coloured flowers and bold seeds. It takes 120-140 days to mature and gives an average yield of 5-6 q/ha.

RZ-209:

It was developed at Sri Karan Narendra Agriculture University (SKNAU), Jobner through selection. The variety has shown tolerance to wilt. It takes 140-150 days to mature and gives an average seed yield of 6.5 q/ha.

RZ-223:

This variety was developed at Sri Karan Narendra Agriculture University (SKNAU), Jobner through selection. The variety has found resistant to wilt. Its gives seed yield of 6.0 q/ha and seeds contains essential oil 3.2%.

RZ-341:

This variety was developed at Sri Karan Narendra Agriculture University (SKNAU), Jobner through selection.The plant bushy and semi erect growth habitand long and bold seeds.. It takes 120-130 days to mature.It is tolerance to wilt, blight and powdery mildew. Its gives seed yield 4.5 q/ha.

RZ-345:

This variety was developed at Sri Karan Narendra Agriculture University (SKNAU), Jobner through selection.The plant bushy and semi erect growth habitand long and bold seeds.. It takes 120-130 days to mature.It is tolerance to wilt, blight and powdery mildew. Its gives seed yield 6.07 q/ha.

(B) Gujarat

GC-1:

It was developed by Sardar Krushinagar Dantiwada Agricultural University (SDAU), Spice Research Centre, Jagudan from local germplasm. The plants are erect with pink flowers and bold, linear, oblong ash brown colourseeds. The variety is tolerant to wilt disease. It matures in 105-110 days and gives an average yield of 7.0 q/ha.

GC-2:

It was developed by Sardar Krushinagar Dantiwada Agricultural University (SDAU), Spice Research Centre, Jagudan through pure line selection. The plants are bushy with good branching and attractive seeds. It matures in 100 days and gives an average yield of 7.0 q/ha.

GC-3:

It was developed by Sardar Krushinagar Dantiwada Agricultural University (SDAU), Spice Research Centre, Jagudan through selection from exotic line. The variety is resistant to wilt. It matures in 100 days and gives an average yield of 7.0 q/ha. Its seeds contain essential oil 3.5%.

GC-4:

This variety was developed by Sardar Krushinagar Dantiwada Agricultural University (SDAU), Spice Research Centre, Jagudan through selection from GC-3. It gives an average yield of 8.75 q/ha andis also resistant to *Fusarium* wilt.

GC-5:

This variety was developed by Sardar Krushinagar Dantiwada Agricultural University (SDAU), Spice Research Centre, Jagudan. It is early maturing variety (92 days).Its gives an average seed yield of 6.86 q/ha.

Cultural practices

Manure and fertilizers

The requirement of fertilizer depends upon the fertility status of the soil. Therefore, fertilizer should be applied based on soil testing report. In order to maintain good soil structure and biological property apply as 10 t/ha FYM or 5 t/ha compost three weeks before sowing of the crop. The crop responds well to fertilizer application. Therefore in addition to FYM, apply 15 Kg N, 20 Kg P_2O_5, and 20 kg K_2O /ha as basal dose and remaining 30 kg should be applied after 60 days of sowing as a top dressing. Recommendation of fertilizer and manure are given in table 2.

Table 2. Fertilizer and manure recommendation for cumin

State	Recommendation
Gujarat	30 Kg N and 15 Kg P/ha. Half N and full P + 10 t compost/FYM as basal dose and the balance N given are monthly after sowing as top dressing. 25:20:20 Kg/ha is also recommended.
Rajasthan	30 Kg N and 20 Kg P/ha. The rest of N should be applied 60 DAS and full P as basal + 10 t compost/FYM at sowing.
Tamil Nadu	70:60:40 Kg NPK/ha 30Kg N and P and K are applied as basal and the remaining N in two equal splits at 30 and 60 DAS.

Preparation of land

Soil is brought to fine tilth by 2-3 ploughings with harrow or *desi* plough. In the termite prone areas. Endosulfan4.0%, Quinalphos 1.5% should be added in soil before planking. The field at then leveled with the help of plank. The beds of conveniant are prepared with provision of irrigation channels. The FYM or compost is to be incorporated in to the soil during the third ploughing.

Sowing time

Time of sowing is an important agro-technique involving no cost but level of production and disease and pest incidence to a greater extent. Therefore, in order to protect cumin from incidence of disease and pest, it should be grown at appropriate time so to that critical period of flowering of cumin may escape higher humidity content in atmosphere. The optimum sowing time recommended for different states is given in the table 3.

Table 3. Sowing time recommended for cumin

State	Sowing time
Gujarat	First week of November
Rajasthan	15-3O November
Tamil Nadu	First fortnight of November
Andhra Pradesh	First fortnight of November
Madhya Pradesh	First week of November
Uttar Pradesh	15-30 November

Seed rate

Keeping optimum seed rate is an important technique for ensuring optimum plant population for realising higher yield of cumin. The seed rates depend upon type of variety and method of sowing. Generally higher seed rate in used for bold seeded variety. The seed rate used in different states is given in table 4.

Table 4. Seed rate recommended for cumin

State	Seed rate
Gujarat	16-20 Kg/ha
Rajasthan	12-15 Kg/ha
Tamil Nadu	8-10 Kg/ha

Seed treatment

The seed should be treated with *Trichoderma* culture (10g/kg seed) or Thiram or carbendazim @ 2.5 g/kg seed to control the seed borne diseases.

Sowing Method

Sowing of cumin is done by two methods i.e. line sowing and broad-casting. Traditionally farmers sow cumin by broadcasting method but sowing done in lines facilitates intercultural operations. The line to line distance should be kept at 25 cm. The seed should not be sown deeper than 1.5 cm

and the same should be covered with a thin layer of soil. Deeper sowing delay seed germination. Seed drill can also be used for sowing of cumin.

Crop geometry

Crop geometry is an important non monitory agro technique which plays an important role for proper interception of sun light which in turn results optimum physiological activities of plants. Maintenance of optimum plant population for cumin is a pre-requisite for better translocation of photosynthates from source to sink. If plant population is more than recommended then there is competition for light, space, water and nutrient resulting in lower dry matter accumulation per plant. Therefore in order to realisehigher production of cumin, it is necessary to maintain plant, population by adjusting crop geometry. State wise recommended crop geometry of cumin is given in Table 5.

Table 5. State wise recommended crop geometry for cumin

Name of state	Crop geometry
Gujarat	22.5- 30 cm or 15 cm x 30 cm
Rajasthan	30- 30 cm or 20 x 30 cm
Tamil Nadu	30 x 15cm

Cropping system

Cumin is not recommended to grow mixed or as an intercrop. In order to manage certain soil borne disease, it is necessary to follow crop rotation involving different crop in some season in succeeding year.

Some of the suggested cropping systems for cumin growing areas could be:

(i) Dhaincha -Cumin

(ii) Dhaincha- Cumin-Green gram

(iii)Maize - Cumin - Summer Moong

(iv) Pearl Millet-Cumin

Irrigation

After sowing a light irrigation should be applied for getting good germination. The germination of the seed will be visible after 10-12 days of sowing. The crop is irrigated at an interval of about 30 days depending upon the weather condition and soil type. It is however important to keep in mind that irrigation should be avoided when the crop is at maturity stage, as this may affect seed

quality adversely. Sprinkler is also good for thecumin cultivation and as when plant show wilting point. Drip may also be used in cumin cultivation but it is very costly system.

Intercultural operation

The crop should be kept free from weeds for proper growth and development of plants. Generally 2-3 hand weeding are required to keep the crop weed free. Pre-emergence of Fluchloralin @ 0.77 to 1.00 kg/ha or Basalin @-2.5 kg/ha or Stamp F-34 @3.33 kg/ha should be applied as pre-emergence weedicide. Pre-emergence application of Oxidiagal @75 g/ha has been formed very effective for control of weed in cumin at NRCSS, Ajmer. These weedicide should be applied after sowing but before germination of weed.

Crop protection

Frost injury

Sometime cumin is affected with frost injury in the area where there is sudden fall in temperature during cropping season. Cumin is susceptible to frost during initial flowering and seed formation stage. It is better to irrigate the crop in anticipation of frost if atmosphere is clear, wind stops flowing and there is an expectation of frost sudden fall in temperature. An arrangement of smoke should also be made in the field so that crop can be protected from frost. Along with this application of 0.1 % commercial H_2SO_4 has been found effective to protect the crop against incidence of frost.

Diseases

Blight:

The infected plants show dark brown blight appearance on the leaves and stem resulting in withering off in affected plants.

Control

- The disease can be controlled by spray application of Mancozeb (0.2%) or Difenoconazole (0.05%) or Azoxystrobin (0.1%) at the time of appearance of disease symptoms. The above-mentioned fungicides should be sprayed after dissolving in 500 lt. water per hectare area. The spray should be repeated at 15 days interval.
- Spray scheduling of mancozeb at 45-60 days of sowing followed by 2-3 spray of difenoconazole or azoxystrobin at 15 days interval is effectively manage the disease.

Wilt:

The infected plants exhibit drooping of leaves and epinasty later lead to death of the plant. The wilt infection may occur in patches at any stage of crop growth. After occurrence of the wilt in cumin, it becomes very difficult to reduce the damage.

Control:

The disease can be managed effectively by adopting integrated approach as given below:-

- Summer ploughing should be done.
- Crop rotation of at least three year should he followed with non-host crops.
- Healthy and disease free seed should be procured for sowing.
- Before sowing seed it should be treated with appropriate/recommended fungicides or *Trichoderma*.
- Soil solarization for 2-3 weeks during summer followed by seed treatment with *Trichoderma viride* is effective to manage the disease.
- Seed treatment (10g/kg) and soil application (2.5 kg/ha mixed with 50 kg FYM) with consortia of *Trichoderma* species is also effective for the management of wilt disease of cumin.

Powdery mildew:

White powdery mass appears on the leaves and twigs of the plant in the initial stages. Later on whole plant is covered with this whitish powder.

Control

- The powdery mildew in cumin may be controlled by dusting of Sulphur @ 20-25 kg/ha or spraying Wettable Sulphur 0.2 % at 15 days interval starting from initiation of disease.

Insect pest

Aphid (*Aphids gossypii* and *Myzuspersicae*)

Aphids are the most damaging insect pest of cumin. Populations build up of aphids on cumin starts at vegetative stage and peaks at flowering to seed formation stages. In unprotected crops, loss due to aphid infestation could increase more than 50 percent of total yield. It not only affects the intrinsic quality (low total and essential oil) but also on extrinsic quality by deposition of sootymould on seed surface, late sown crop suffer more damage than timely sown crop. Aphids appear in the field during January and maximum population develops during February (flowering initiation stage) and remain static until the crop maturity. Rise in maximum temperature and decrease in relative humidity along with rainfall has adverse effect on aphid population. There is a considerable interaction in between the temperature and biotype of aphid in

influencing its development. The thermal requirements determine over a range of constant temperature from 12.4 to 29.4°C revealed that off-springs produced and survived decreases as temperature increase. Timely and effective management of aphids are required to prevent from losses.

Management:

1. Trapping: Yellow colours attract the winged aphids and can be utilized in trapping the pest. Sticky traps have been used in minimizing the aphid population.
2. Timely sowing of crop in between second week of October to first week of November. Cumin should be sown up to the first week of November has low infestation than the crop some after this date. Higher yield can also be obtained in early sown crop.
3. Crop should sown in desired geometry.
4. Recommended doses of nitrogenous fertilizers should be applied. Because higher application of nitrogenous fertilizers causes more succulent to the crop.
5. Spraying of Neem Seed Kernel Extract (NSKE) @ 5 % or Neem oil 2% effectively cheek the early population build up of aphids on the crop.
6. Application of entomopathogen *Verticillium lecanii* (10^8 spores/g) powder formulation @5.0 g/lire of water gives good result.
7. At high aphid population any one of the synthetic insecticides should he sprayed i.eDimethoate 0.03%, Metasytox - 0.03%, Emamectin benzoate @ 10 g ai/ha, or Imidachlorprid - 0.005%.
8. Cumin crops known to attract large number of predators and pollinators. Application of botanicals/ bioagents help in natural predation of aphids on the crop.
9. Insect's natural enemies or predators & parasitoids, viz., *Coccinella septumpunctata* L., *Bromides suturalis* F., *Menochilhussesxmacalatus* and *Aphidius* spp. should be conserve as they can suppress the population of aphid by feeding on them.

Thrip (*Thrips tabaci*)

Infestation of thrips started at early vegetative growth of crop and found up to flowering stages. They suck the leave of plant and causes yellowing and drying of leaves. Higher population resulted drying of whole plants.

Control:

- Spraying of Neem Seed Kernel Extract (NSKE) at 5% or neem oil at 2% or Dimethoate - 0.03% or Metasystox - 0.03% or Thiomethoxam - 0.025% control pest effectively.

Store insect pests

Cigarette beetle (*Lasioderma serricorne* F.)

The cigarette beetle infests under storage conditions to vast variety of commodities including specialized commodities such as spices, saffron, nuts etc. It is distributed practically all over the world. The cigarette beetle is native of Egypt.

The adult cigarette beetle is a small, red-brown to yellowish-brown beetle. It is 3 to 4 mm long. The antennae are serrate. The wing covering (elytra) are smooth without longitudinal groove. They are strong fliers and attracted to light at night. The eggs are white oval and too small to be easily seen itli the naked eyes. The larvae are white and covered with long hairs given them a fuzzy appearance. When full grown they are about 4 mm long and pupate inside a cocoon.

Nature of damage:

Cigarette beetle is most damaging pest of most of seed spices including cumin, fennel, ajwain, coriander andanise. More than 50 per cent annual loss has been recorded on seed spices stored without taking care of preventive and curative measures. Both the grubs and beetles attack making holes through the food materials. In serious infestation, numerous small light coloured brown headed grubs or brown beetles can be seen doing damage.

Drugstore beetle (*Stegobiumpanaceum* L.)

The drugstore beetle is a cosmopolitan pest that can infest almost any dry food substances or stored commodities. The beetles are cylindrical 2.25 to 3.6 mm long and are uniform brown to reddish brown. They have longitudinal rows of fine hairs on the elytra. Drugstore beetles are similar in appearance to the cigarette beetle. The antennae of the cigarette beetle are serrated while the antennae of the drugstore beetle have rows of pits giving them a striated appearance while those of cigarette beetle are smooth. The larvae of drugstore beetles are white in colour, the later instars are scarab-like. They are similar to cigarette beetle larvae.

Nature of damage:

The drugstore beetle attacks such a wide variety of foods and material that one anonymous quote states that it “eats anything but cast iron”. It gets its name from its habit of feeding on prescription drugs. It also feeds on flours, dry mixes, breads, cookies, chocolates and other sweets and spices. Non food material includes wool, hair, leather, horn and museum specimens. It is found in pigeon nests and is known to bore into books, wooden objects and in some cases, tin or aluminum foil and lead sheets. Larval feeding accounts for the greatest amount of damage. Museum and herbarium specimens are vulnerable to attack. Slight damage and contamination can ruin these valuable priceless items. Drugstore beetle harbor symbiotic yeasts that produce B vitamins. The

yeasts are deposited on the eggs as they pass through the oviduct and are consumed by the larvae during egg hatch. These yeasts enable the drugstore beetle to feed and survive on many foods and other items of poor nutritional quality. It is second most common species found on various seed spices.

Flour beetle :

Triboliumcastaneum Herb. is the pest of stored cereals as well as seed spices. This pest belongs to the family *Tenebrionidae* of the order Coleoptera and is known as Rust red flour beetle. The beetle is of tapering form, very small, flat, reddish brown with clubs form antennae. It does not harm healthy grains. It attacks damaged seed and powdered material. When the grains are severely infested, they emit a pungent smell. The infected seed could not germinate in the field, resulting in severe loss in initial stage of crop stand.

Nature of damage:

In storage condition nigella seed infested by this pest only. More than 50 per cent damage of nigella seed has been recorded over a year by this species. Both larvae and adults feed on seeds, and turn it in powder if not controlled over long time.

Management of storage insect pests

A-Preventive measures

1. Sanitation: All debris present in storage room or godown should remove before stacking the seed. The debris serves as host to storage pests and micro organism to survive and multiply on them. These pests start feeding and colonization on arrival of fresh stock. To prevent re infestation, clean up of store places thoroughly the areas where the contaminated items were stored. Insure that bags placed in store should be thoroughly packed and no spoilage occurs during period of storage.

2. Disinfestation of Store/receptacles: Cracks and crevices present in the store room serve as hiding place for the insect. The store insect remains in these place and start fresh attack on seed spice once it stored fresh. To prevent these hidden storage pest, all cracks and crevices should be plastered with cement. Wall, ceiling and floors should be treated with insecticide, malathion 50% EC 10 ml per liter of water.

3. Trapping and Monitoring through Pheromone Trap: Pheromone trap and lure for most of storage pest are available in market. It is very effective even at very low level of infestation. This can be utilize for monitoring of pest information in storage for curative treatments.

B. Scientific storage:

1. Storage Precautions: Cleaned, dried seeds are filled in bags and stored in damp-free aerated storehouses. On commercial scale seeds are cleaned with the help of vacuum gravity separator and spiral gravity separator. The material should be stored ensuring protection from dampness. Care should be taken to stack the bags 50 to 60 cm, away from the wall. Under any circumstances, no insecticide should, be used directly on the dried material for the seed used for consumption. Stored material should be subjected to periodic fumigation for which only authorized persons should be engaged. Insects, rodents and other animals should be effectively prevented from getting access to the premises where the material is stored. Stored product should be periodically exposed to the sun.

2. Storage: The dried seeds are usually packed into sacks and stored in cool dry room. It should be stored at room temperature (25°-28°C) where the critical moisture level and relative humidity should not be more than 13-19 percent and 81 percent, respectively. During prolonged storage of spices, free fatty acids are increased by lipolytic action on fixed oil. This value is a good indicator of the period of storage. The loss of volatile oil content is fairly rapid in powdered spices. The deterioration in quality of powdered seed spices can be reduced by storing in aluminium foil bags.

3. Storage Bag: Seed spices especially cumin, ajwain, fennel and anise seeds are hygroscopic in nature. Seed of such spices absorb environmental moisture lead to detritions of seed and help in fast development of pests and microbes. Poly pack are useful to store seed spice for prolong storage. Insecticide impregnated bags are now available which can utilize to control insect infestation during storage. Insect pest try to enter the bag get killed by the action of insecticides present on surface of bag.

C-Curative Methods

1. Chemical Control

a) **Knockdown Chemicals**: Pyrethrum spray, Fumigation strips or Aerosols are aimed against flying insect but may kill the insects on surfaces as well as in cracks and crevices.

b) **Seed protectants**: Mixing of chemical dust with the seed spices meant for human consumption is not recommended. However, the grain meant for seed can be protected by mixing insecticides life pyrethrum dust or malathoin 5% @ 250 gram per quintal of seed.

c) **Fumigation**

i) Aluminium phosphide

- For cover fumigation: 3 tablet of Aluminium Phosphide (3 gm. Each) per tonne. Insert the tablets in between the bags in different layer and cover them with fumigation cover.
- For shed fumigation: 21 tablet of 3 gm each for 28 cu. Meters.
- Period of fumigation: 5-7 days.

- Plaster the edges of cover all around with wet earth or clay plaster to make them leak proof.
- Remove the mud plaster after fumigation period, lift the cover from a corner and allow gas to escape.

ii) Ethylene di bromide (EDB): It is available in ample and prescribed dose is 3-5ml/qt.

iii) Ethylene di chloride corbon tetra chloride (EDCT) is used in mixture of 3:1 v/v ratio. Use 55ml/qts. of grain irrespective of bulk or bag storage.

Harvesting and yield

Generally, cumin crop takes about 90-120 days to reach maturity. There after the crop is beaten and trampled on a clean threshing floor. Now a days threshing of cumin by thresher is also very popular among the farmers. Under the scientific management condition 8-10 q/ha cumin seeds of improved varieties can yield.

Cleaning, packaging and storage

Vacuum gravity separator is used for cleaning cumin seeds. The properly cleaned cumin seeds stored with an initial moisture level of 7-8% and at an equilibrium relative humidity of 40%. Seeds are used to store in gunny bags lined with polythene film. Cumin seeds well packed and stored in ventilated dry and cool place under ordinary conditions till sowing of next season crop.

Processing & Post Harvest Technology

The cumin seeds are dried in partial shade in the sun and the moisture content of seed should be kept to 9 per cent. High seed moisture content may lead to chances of storage contamination by fungus. The dried, cleaned, graded produce is packed in the standard sized packs/containers and appropriately labelled. The dried seed is filled in gunny bags lined with degradable environment friendly plastic film. Waste generating packaging material should be avoided. Each bag is sealed and stored under clean, dry and ventilated place.

Processing methods of cumin are based on mechanised, physical and biological processes. Care should be taken to maintain the vital quality of an organic ingredient throughout each step of its processing. Processing method is to be selected in such a way that it will limit the number and quantity of additives and processing aids. The mature dried seeds are distilled to obtain the essential oil. Hydro or steam distillation method is generally used for extraction of essential oil. The dried seeds are crushed or as such steam distilled to yield 2.5 to 4.5% of valuable volatile oil depending upon variety and location. The oleoresin from cumin has good demand in the international market. The processed products include cumin essential oil, cumin powder, cumin oleoresin and fixed oil. Volatile oil should be kept in well sealed bottles or aluminium containers.

Other names of Cumin

Hindi	Jeera
Telugu	Jikaka
Tamil	Jiragarn
Marathi	Jareegir
Punjabi	Safed jeera
Bengali	Safed jeera
Gujarati	Joru, jiru
Southern India	Jeerakam
Malayalam	*Jeerige*
India and Nepal	jeera or jira
Iran, Pakistan and Afghanistan	Zeera
Sri Lanka	*Duru*
Iran, South Asia and Central Asia	*Zireh*
Turkey	*Kimyon*
China	Ziran
Arabic	*al-kamuwn*
Ethiopian	*kemun*

Uses:

Cumin as condiment is an essential ingredient in all mixed spices, curry powders and for flavouring soups, sausages, pickles etc. Seed are also used for seasoning bakery products such as bread and cakes. It is widely used in Indian, Iranian, Egyptian and Turkish dishes. Cumin is commonly used in confectionary, meat, sausages and bread manufacturing and as a preservative in food processing. The essential oil is used in perfume, cosmetics and flavouring beverages. The characteristic odour of Cumin oil is due to the presence of cuminaldehyde in cumin oil. The oil is extensively used in perfumery and for flavouring liquors and cordials.

Cumin possesses carminative, stimulant, stomachic, antimicrobial and astringent properties. It is widely used as traditional medicine to treat flatulence, digestive disorders, diarrhea, insomnia, colds, and fevers and in the treatment of wounds. In India, it is popularly used as a carminative in veterinary practice. Consumption of cumin seeds increase secretion of mother milk after birth of child. Cumin powdered seed mixed with honey, salt and butter is applied externally for scorpion bite. The byproduct*Ark Jeera* after extraction of essential oil possess good medicinal properties forcuring indigestion problems at home level.

The essential oil of cumin has a number of documented medicinal uses like it has effects on the gastrointestinal system, reproductive system, nervous system and immune system and hypoglycaemic, hypolipidaemic, antimicrobial, antioxidant and chemoprotective activity but defined uses and validation of its active secondary metabolites are still awaited.Alcohol and

water extract of cumin are reported to possess many nutraceutical properties like anti-allergic, antioxidant, anti-platelet aggregation, and hypoglycemic. Cumin and value added products from cumin can be a good source of nutraceuticals with many biological activities.

Quality specification for export

Whole seed

The quality specifications for cumin whole seed can be classified into three categories *viz*., commercial requirements, cleanliness and health specifications.

Commercial specification

These requirements vary from country to country on cumin. It depends on many factors like customer needs, acceptability and country specifications. The commercial specifications of cumin are color, appearance, taste, pungency, texture, shape,volatile oil and packaging. The general commercial and general requirements for cumin seed are light brown, large seeded, non-splting, free flowing, aromatic, high volatile oil (min.2.2%).

Cleanliness specifications:

The cleanliness specifications as per ASTA, ESA and ISO are given in below:

Specification	Permissible Limit
Whole insect dead (by count)	4
Excretes mammalian (mg/lb)	3
Excreta other (mg/I b)	5
Mould (% wt)	1
Insect defiled/ in fected(% wt)	1
Extraneous foreign matter (% wt)	0.5

Other quality standards for cumin as per ESAand ISO

Specification	Permissible Limit
Ash level % w/w (min.)	14
Acid insoluble ash % w/w (max.)	3.0
Moisture content % (max)	13
Volatile oil % (Min.)	1.5

Health specification:

The micro contaminants such as pesticide residue, microbial counts, aflatoxins, heavy metals etc. comprise the health specifications. These contaminants make the food unsafe. The importing countries have limited the maximum level of these contaminants and limits are given here.

Maximum residue Level = 0.05 to 0.2%

Microbial counts = 1x 10^2/g to 1 x 10^6/g (*salmonella, E. coli,*yeast, moulds)

Aflatoxin = 5 pph to 10 ppb (Max.) AfIatoxin. Mycotoxins

Heave metals =Arsenic (5 mg/kg), Copper (20 mg/kg) lead (10 mg/kg),Zinc (50 mg/kg)

Essential oil

The specifications for cumin oil are

- Colourless or pale yellow
- Specific gravity (25°/25°C, 0.905 to 0.925)
- Optical rotation (20°C), +3 to +8
- Refractive index, 1.501 to 1.506
- Solubility (80% ethanol), 8 vol
- Aldehydes (cuminic aldehyde) 40 to 52%

Oleoresin

The cumin oleoresin should be prepared with recommended organic solvents followed by the subsequent removal of the solvent as per specifications of importing countries.

Cumin powder

The cumin powdered hygienically through permittable devices should at least 95%of the ground product pass through a U.S. Standard No 30 sieve.

Cost of Cultivation

Based on an assessment survey of 150 farmers conducted during 2018-19 the estimated cost of cultivation of cumin in major cumin growing districts of Rajasthan, namely Barmer, Nagore, Jodhpur and Jaisalmer districts is as below:

Table 6: Costs and returns from cumin cultivation (Rs./ha; N=150)

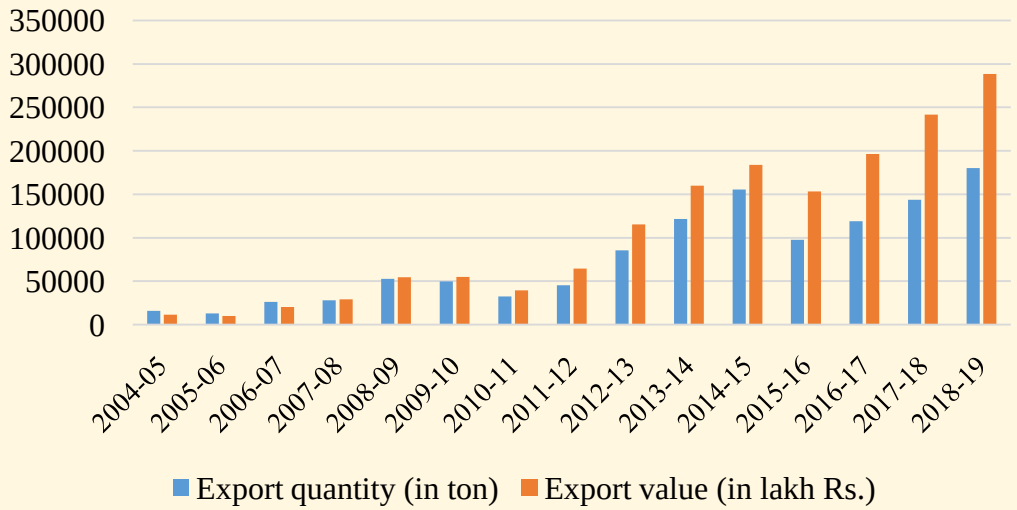
Particulars	Physical Unit	Cost	Share in total cost
Land preparation	3 to 4 operations	3643.64	5.89
Seed	14.31 $Kgha^{-1}$	4968.73	8.04
Sowing	--	1143.32	1.85
FYM	3617.44 $Kgha^{-1}$	3464.10	5.60
Urea	98.94 $Kgha^{-1}$	647.92	1.05
DAP	105.81 $Kgha^{-1}$	2773.85	4.49
Gypsum/Micronutrients	16.50 $Kgha^{-1}$	2034.59	3.29
Intercultural operations	1 to 3 operations	6449.11	10.43

Plant protection	2 to 3 spray	7420.13	12.00
Irrigation	4 to 5 irrigations	5895.78	9.54
Harvesting	18 to 20 labourer ha^{-1}	5675.87	9.18
Threshing	3 Hrs ha^{-1}	2472.70	4.00
Interest on WC	@ 7% per annum	1630.64	2.64
Variable cost		48220.38	78.00
Fixed cost		13596.94	22.00
Total cost		61817.32	100.00
Yield (Kg $ha^{-1)}$		797.25	
Avg. farm gate price		13018.50	
Gross Value of Produce (GVP)		103789.99	
GVP-Variable cost		55569.61	
GVP-Total cost		41972.67	
Return per rupee of Variable cost		2.15	
Return per rupee of Total Cost		1.68	
Cost of production ($Rsql^{-1}$)		7753.81	

Cumin export

Cumin export from India registered 19.61 and 26.86 percent compound annual growth in quantity and value, respectively from 2004-05 to 2018-19. Its export increased by more than eleven times from 15767 to 180300 tonnes in respective years. In value term it increased by more than 25 times, from 115 to 2884 crore rupees (figure 1). As result of increased export of cumin its export share to total spice export from the country increased from four percent in 2004-05 to 17.75 percent in 2018-19 in volume.

During 2004-05 to 2018-19, Vietnam, U.A.E., U.S.A., Nepal and U.K. were major importer of Indian cumin.



Cumin prices in India

In India, during 2008 to 2019cumin price varies between 7221 to 19155 rupees per quintal. There was increasing trend in cumin prices from 2008 to 2019 except 2014. Lowest price was found in month of March when highest arrival was there in these markets. Whereas highest prices were observed in January month.

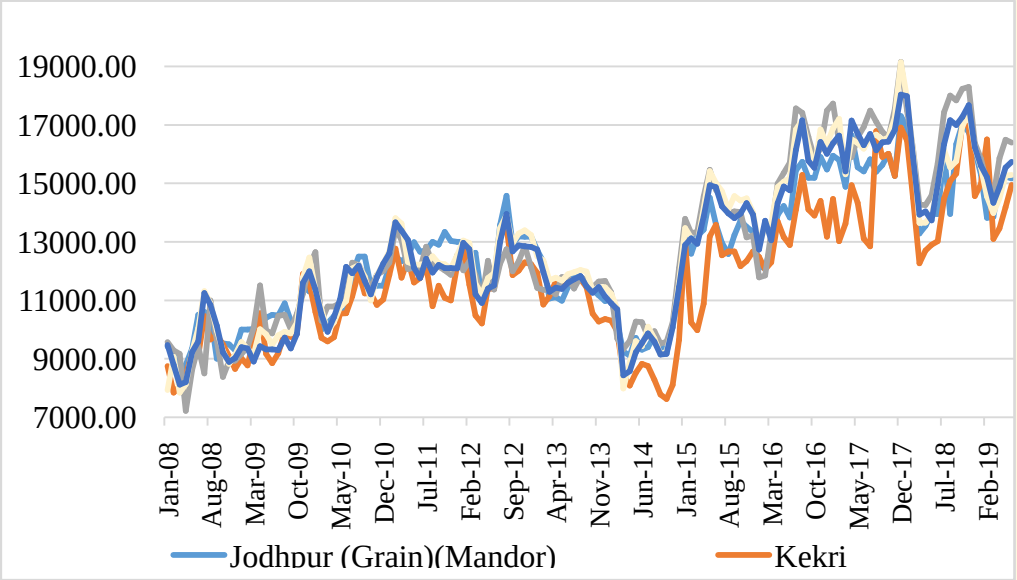


Figure 1: Monthly prices of cumin in major markets in India (Rs/Quintal)

Acknowledgement:

This matter has been collated from original research work carried out at NRCSS and from research reports of other centres and also from AICRP on spices. It includes the following references.

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