

CUMIN, FENNEL AND FENUGREEK

E. V. Divakara Sastry

SKN College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Jobner, India

Muthuswamy Anandaraj

Indian Institute of Spices Research, Calicut, India.

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Summary

Spices are grouped according to the type and part of plant used, and growing time (annual or perennial). The three spice crops dealt in this article are annuals, two of which belonging to the Apiaceae family. The third one, fenugreek, is part of the family Fabaceae (earlier known as Papilionoideae, under Leguminosae).

The characteristic feature of the Apiaceae is their inflorescence (umbel) with small pentamerous flowers with a bicarpellary ovary maturing into a schizocarpic fruit which separates into two merocarps, each containing a single seed. The members of this family are some of the oldest spices known since biblical times, valued mostly for their digestive properties and for flavoring bread and other dishes during periods of ceremonial fasting.

Along with coriander, seed spices like cumin, fennel and fenugreek are extensively used for culinary and medicinal purposes and as condiments; they add color, flavor and zing to food, besides helping digestion. All three are also used as medicinal plants, and find their place in traditional and modern medicine.

Cumin and fenugreek originate from the Near East and India; fennel is found in these two regions and in Europe, both in wild and cultivated forms. Weed management forms a major component of crop care; water management is crucial for flowering and fruit set. Excess moisture leads to diseases and pest problems.

The commercial value of seed spices is determined by: color, appearance, taste, pungency, texture, shape, volatile oil content, and packaging. Moisture content after harvest should be reduced to about 9% in order to prevent occurrence of mycotoxic molds.

1. Introduction

A spice is substance of plant origin, primarily from various parts of the plant such as dried seed, fruit, root, or bark which is used in very small quantities as a food additive for flavor, color, or as a preservative. Many spices are also used for purposes of medicine and religious rituals in Asia and in cosmetics, perfumery and liquorices in other parts of the world.

Spices add color, flavor and zing to food, besides helping digestion. About 60 spices are cultivated, most of which are concentrated in the Mediterranean region and Asia, from where they most probably originated. Spices are grouped according to the type of plant, the part of the plant used, and growing time. Based on the last criterion, they can be subdivided into perennials and annuals. The three spice crops dealt in this paper are

annuals. These are also called seed spices along with coriander because it is the seed which is used as spice.

Spices are consumed in small quantities, hence the value of spices cannot be judged on their nutritive values, as they do not provide essential nutrients. Besides being used as spice, cumin, fennel and fenugreek are also valued as medicinal plants. They have obvious medicinal properties, and find their place in traditional and modern medicine. Fennel and cumin are also aromatic crops, as they provide essential oils which are used in the perfumery and confectionary industries.

Cumin and fenugreek originate in the Near East and India, while fennel is also found in Europe, both in wild and cultivated forms. The area and production figures for these individual crops are not available, and data provided by FAO (<http://faostat.fao.org>) refer only to combined figures for anise, badian, fennel and coriander as a whole, which make comparisons difficult.

2. Cumin

Cumin (*Cuminum cyminum* Linn.) is an important seed spice and one of the earliest known minor spices used by mankind. It is believed to be native of Egypt and Syria, Turkestan and the Eastern Mediterranean region. The typical pleasant aroma of the seeds is due to their volatile oil content, the principal constituent of which is cuminal (cuminaldehyde).

Cumin is known under various names in different countries: Kreuzkümmel, Mutterkümmel, Weiser Kümmel, Römischer Kümmel, Welscher Kümmel, Kumin or Cumin in German; Comino in Spanish; Cumin (blanc), Cumin de Maroc, Faux Anis in French; Jeera in Hindi; Cumino or Cumino Romano in Italian; Romai köminy in Hungarian; komijn in Belgium and The Netherlands; Spisskummen and Spisskarve in Norwegian; Komin Rzymiski in Polish; Spisskumin in Swedish; Kimyon in Turkish, etc.

2.1. Origin and Distribution

Cumin has a long history, referring almost 5000 years back to the ancient Egyptian civilization, where it was used both as a spice and a preservative in mummification. The western world got to know it as a spice from Iran, and the name cumin has its roots in the word *Kerman*, a city in Iran around which it was extensively cultivated. The phrase “carrying cumin to *Kerman*” aptly expresses its relation to that city. *Kerman*, locally called *Kermun*, would have become *Kumun*, and then cumin in the European languages.

Cumin is mentioned in the Bible, both the Old and New Testament, where it is said that cumin was used as currency to pay “tithe” to the priests. It was also known in Ancient Greece and Rome, where it was used as a kind of pepper. Superstition during the Middle Ages kept it temporarily out of favor in Europe. Spanish and Portuguese explorers introduced it in the Americas. While in middle ages it almost lost its importance in Europe except in Spain and Malta. To date, cumin is widely cultivated also in Uzbekistan, Tajikistan, Turkey, Morocco, Egypt, India, Syria, Mexico and Chile (Azeez, 2008).

The estimated world production is around 300,000 tons. Today, cumin production is

mainly concentrated in Central and South Asia. Nowadays India is the largest producer (70% of world production), exporter and consumer of cumin seed in the world. In 2006-2007 it was cultivated over 409,033 ha and produced 176,511 tons (Table 1), mainly concentrated in Gujarat and Rajasthan. The production is relatively stable over the years. The other main producing countries are Syria (7%), Turkey (6%) and Iran (6%); all other producers together account for about 10%. China is a major producer but has no statistics available (http://agricommodityprices.com/cumin_seed.php).

| | 2005 – 2006 | | 2006 – 2007 | |
|------------------|-------------|-------------------|-------------|-------------------|
| | Area (ha) | Production (tons) | Area (ha) | Production (tons) |
| Cumin | 403,033 | 199,854 | 409,033 | 176,511 |
| Fennel | 40,909 | 61,307 | 61,128 | 92,260 |
| Fenugreek | 33,393 | 38,990 | 44,984 | 55,780 |

Table 1. Production area (in ha) and national production (in tons) in India (Source: Spices Board, India, www.indianspices.com)

The production in Syria, the second larger producer, is between 10,000 and 20,000 tons, but shows important variations due to changes in cultivation area and rainfall; 95% of the Syrian production is concentrated in the region of Aleppo, Idleb, Hama, Al-Rakka and Homs with Aleppo contributing around half of it. In 2004, 1,287 ha of cumin area was irrigated, while 53,864 ha were under rain fed cultivation.

Turkey produces between 7,000 and 15,000 tons; Iran between 5,000 and 10,000 tons; and China around 8,000 tons per year. Khorasan province of Iran is an important producer of cumin, with a contribution of about 88% of the national production. It is also cultivated on a limited area in Jordan.

On the consumption side, the Middle East exports around 85-90% of its cumin production. Main consumers are India, China, Indonesia, UAE, UK, USA, Singapore, Malaysia, Bangladesh and Nepal. India consumes almost 90% of its total production.

2.2. Plant Description

Cumin (*Cuminum cyminum* L.) is a thin herbaceous annual plant growing to a height of 30-45 cm. The plant is slender, with a main stem that branches up to five secondary branches from the base; each branch may have 2-3 sub-branches. All the branches attain the same height, giving the plant a uniform canopy. The plant has a branched glabrous stem, 3-5cm in diameter, with a grey or dark green color, having alternate, dissected leaves with filiform segments, angular, sparsely hairy, bluish green and petioles sheathing the stem at the base.

The inflorescence is a compound umbel with white or pinkish flowers. The leaves are pinnate or bi-pinnate with thread-like leaflets (Figure 1). The flowers are small and either pink or white colored. Typical to the Apiaceae family the flowers are born in umbels, and each umbel has 5 to 7 umbellets. The fruit is a schizocarp, 4-5 mm long, containing two mericarps with a single seed. Cross pollination, mediated through bees, is the rule although the occurrence and intensity of cross pollination varies. The fruit is a

lateral fusiform or ovoid achene, containing a single seed. Cumin seeds are similar to fennel and anise seeds in appearance, but are smaller and darker in color. The fruits have eight ridges with oil canals. Seeds are hairy, in some varieties these hairs are prominent, and otherwise it is difficult to see them.

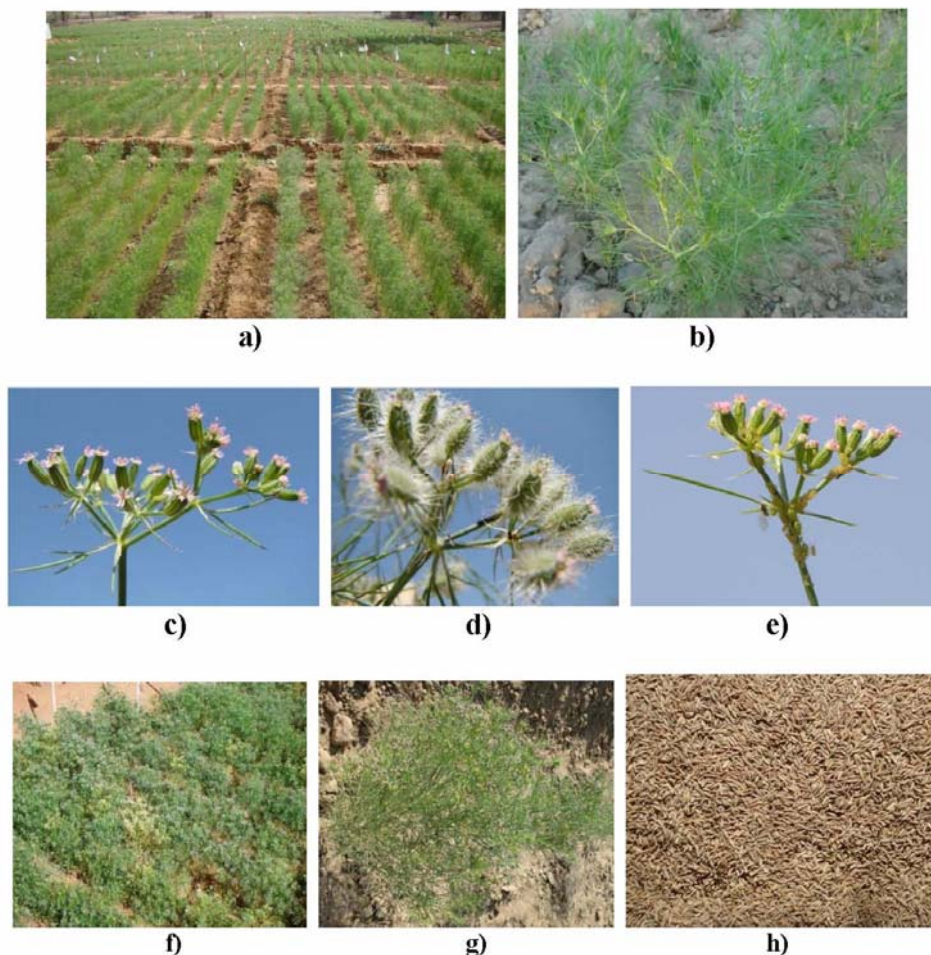


Figure 1. Cumin growth stages: a) young plants in rows; b) branching; c) young inflorescence; d) hairy cumin; e) aphid infestation on inflorescence; f) cumin affected by root rot and yellowing in the field; g) mature plant with flowers and fruits; h) commercial product cumin.

2.3. Botany

Cumin (*Cuminum cyminum* L.) belongs to the family Apiaceae, and the genus *Cumin* has a single species *cyminum*. The synonyms are: *Cuminum odorum* Salisb. or *Selinumcyminum* L.Krause.

2.4. Breeding

The germplasm of cumin is maintained in research stations across producing countries. In India, about 600 accessions consisting primarily of local collections are maintained in the coordinating centers of All India Coordinated Research Project on Spices (AICRPS). The Nordic gene bank report one collection of cumin contributed by IPK,

Leibniz (www.Norgen.org). Published information from other countries is hardly available.

Cumin is a cross pollinated crop, and bees often help in pollination. The flowers being small and slender, artificial pollination is rather difficult and varieties are developed by sib mating in enclosed chambers. Most of the varieties that are available today are selections. In Morocco, an individual selection of plants from the local collections was used to produce improved varieties (Al Faiz, 2005-06).

The chromosome number of cumin is $2n=14$. Based on selections focused on local conditions a number of varieties are released for the farmers in each country.

2.5. Ecology and Growing Conditions

Cumin requires a moderately cool and dry climate for its growth, with a temperatures between 25° and 30° C. The crop is highly sensitive to rain, and any rain during harvesting time reduces yield and crop quality. Crop quality is badly affected by diseases, and is reflected in a lower price once the seeds have turned black.

The crop is most vulnerable to frost damage, especially at flowering and early seed formation stages. Control measures include: spraying with sulfuric acid (0.1%), irrigating the crop prior to frost incidence, setting up wind breaks against cool waves, or creating an early morning smoke cover.

Cumin grows best on well drained sandy loam to loamy soils with a pH range of 6.8 to 8.3. Acidic soils and alkaline soil reduce yield unless soil acidity is lowered to pH = 7.5 (Weiss, 2002).

2.6. Land and Crop Husbandry

Sowing time – The sowing time varies as a function of the local environmental conditions. In India, the sowing period is from October and continues till the first week of December. The crop is then harvested from February onwards, and arrives in the market during March-April. In Gujarat and Rajasthan States, the crop is grown as a winter (rabi) crop, and sowing takes place between mid-November and December 5.

In Syria, cumin is also sown as a winter crop, e.g. from mid-November to mid-December, with a possible extension up to mid-January; the crop is ready for harvesting in June-July. In Iran, cumin is sown in the same period, and harvest is in June-July. In Turkey it is sown a little earlier and harvested between July and September. Cumin is not an important crop in Jordan, but research has shown that early sowing in December could increase seed yield by 26% in this area.

Seed rate - A seed rate of 12-15 kg/ha is required for optimum plant population, depending upon the method of sowing and the type of soil. It is helpful to soak the seeds for 8 hours before sowing to get a good germination. Soaked seeds should afterwards be dried in the shade to facilitate broadcasting. Sowing at higher depth affects the germination of seeds adversely. Crop rotation is required to avoid incidence of pest and diseases. Bio-priming cumin seeds with plant growth promoting rhizobacteria (*Pseudomonas putida* and *Microbacterium paraoxidans*) enhances growth and promotes yields in India (AICRPS, 2010).

Two sowing methods of cumin are applied. The first is by broadcasting, in which the field is divided into beds of convenient size, and the seeds are then uniformly broadcast and covered with soil by running an iron rake in the beds. The second method uses a line sowing; this is more preferred than the broadcasting method because the intercultural operations like weeding, hoeing, spraying, etc. are much easier in this case. In line sowing, shallow furrows are traced at a distance of 20 to 25 cm with iron or wooden hooks. Care must be taken that all seeds are uniformly covered with soil in such a manner that the sowing depth does not exceed 1 cm. Germination and subsequent crop stand are adversely affected when the seeds are deeper because cumin is slow in germination, hence, young plants suffer from severe competition with weeds.

Nutrient management – Nutrient application varies as a function of soil properties and yield expected. At the time of field preparation, about 10-15 tons/ha of farmyard manure or compost may be incorporated in the soil. In India 20 kg phosphate/ha is commonly applied at the time of sowing; and 30 kg N/ha may be added as top dressing, either in a single dose at 30 days after sowing or in two equal splits at respectively 30 and 60 days after sowing. In Syria the common practice is to apply 50 kg/ha triple super phosphate and 50 kg/ha of urea at planting. In addition, when spring rains are abundant, 50 kg/ha of top dressed ammonium nitrate is recommended.

Weed Control - Cumin faces a severe weed competition at all stages of its growth cycle because of its slow growth and short stature. For proper aeration and control of weeds, at least two hoeing and weeding sessions are necessary, respectively 30 and 60 days after sowing. Thinning should also be done during the first hoeing, as well as weeding to remove excess plants. Similar recommendations are also made in Syria. In India, *Cynodon dactylon*, *Chenopodium* spp. and *Plantago pumila* are common weeds, whereas in Ethiopia *Plantago psyllium* is more common.

Use of herbicides has been found to be very effective in cumin fields in India. Application of the pre-emergent herbicides Terbutryn or Oxadiazon at a rate of 0.5-1.0 kg/ha or pre-plant Fluchloralin or pre-emergent Pendamethalin at the rate of 1.0 kg/ha have been found very effective in controlling weeds. At the time of herbicide application due care must be taken that sufficient moisture is present in the soil. In Syria the recommendation is to apply Treflan 15 days before planting, and Afalon and Gesagard soon after emergence.

Water management – Cumin requires less water than most other spices. In all growing countries like India, Egypt and Sudan light irrigation is given immediately after sowing to moisten the surface soil. At this time, the water flow in beds must be slow so as not to disturb the seeds. At the time of germination, a second irrigation is applied some 8-10 days after the first irrigation. Depending upon the soil type and climatic conditions, subsequent irrigations may be given at an interval of 15-25 days. The last heavy irrigation must be given at the time of seed formation. Additional water supply at the time of active seed filling is to be avoided, because this increases the incidence of pests and diseases.

Pests and diseases - The most important diseases in cumin cultivation are: wilt, blight and powdery mildew. Wilt is caused by *Fusarium oxysporum* f. sp. *cumini*, resulting in yield losses as high as 80 %. The fungus is both soil- and seed-borne. Frequent epidemics are caused when the soil temperature is between 12.5° C and 14° C, and in

fields which are not adequately fertilized. A proper management strategy involves the use of healthy seeds, the application of a summer plowing session, a crop rotation with beans, wheat, cluster beans and mustard, and seed treatment with fungicides or antagonistic fungi like *Trichoderma*. Die back is an important disease in cumin grown in Morocco. The disease effect is apparently stronger in early sown crops than in late sown cumin.

Cumin blight is the second important disease. It is caused by *Alternaria burnsii* and, together with wilt, could be most damaging. Blight appears in the form of dark brown spots on leaves and stems, whereby the stem tips bend downwards. *A. alternata* has been reported to be seed-borne and to cause seedling blight in India. Cloudy weather after flowering increases the incidence of the disease. As the spread of the disease is very fast, only prophylactic measures are recommended for effective prevention.

Powdery mildew is of less importance and is caused by *Erysiphe polygoni*. The fungus grows on the surface as a white powdery mass on leaves and twigs in the initial stages of development; later on, the whole plant is covered with this whitish powder. If incidence occurs at an early stage, seeds do not form; if the incidence occurs late, small and discolored seeds are formed. Control measures include the use of sulfuric fungicides at 20-25 kg/ha. Fungicides such as carbendazim/ tridemorph (0.15%) are applied as a spray solution at a dose of 400-500l /ha.

Pest monitoring is an important aspect of cumin cultivation. It should be repeated once every seven days in order to work out the economic threshold level (ETL). The general control strategy includes setting up of yellow pan/sticky traps for monitoring the aphids at 10 yellow pans/sticky traps per hectare; and the collection and destruction of the larvae of cutworm and leaf defoliators. As pollination in cumin is by honeybees, it is recommended to use chemicals that are harmless to the bees and that leave no residues in the crop.

Aphids, *Myzus persicae*, *Acyrtosiphon pisum* and *Aphis craccivora* attack cumin at the flowering stage by sucking the sap of the plant from the tender parts and flowers. The affected plants turn yellow resulting in poor seed formation and thus reduce the yield as well as the quality of the produce. The control measures include: removing the heavily infested plant parts, spraying the crop with pressurized water, application of fish oil rosin soap or *neem* seed kernel-extract (3%), *neem* oil (2%) or tobacco decoction (0.05%). Mites (*Petrobia latens*) frequently attack the crop; the whole plant becomes whitish yellow and appears sickly. The insect mostly feeds on young leaves and, hence, the infestation is more severe on young inflorescences. Small mites are seen on the lower sides of the leaves and, when serious, cause webbing and feed within the web.

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Biographical sketches

E.V. Divakara Sastry obtained his education from Banaras Hindu University (1982) and since then has been working at S.K.N. College of Agriculture, Rajasthan Agricultural University, Campus Jobner. At present he is Senior Breeder (All India Coordinated Research Project on Spices) and Head, Department of Plant Breeding and Genetics. He has been involved in teaching Biometrical Genetics for the last 2 decades. He has also worked as biometrics expert at Alemaya University (now Haramaya University), Ethiopia under a World Bank-ARTP Project.

Currently, Dr. Sastry is in charge of the spices project which maintains a large collection of seed spices germplasm and their characterization. He has developed one variety in taramira (*Eruca sativa*) and is involved in the development of 8 varieties in seed spices. His research interests include salinity tolerance in crop plants, dwarfism in wheat and fodder quality in pearl millet. He has published more than a 80 research papers in peer reviewed journals, several book chapters on seed spices, and has authored several practical manuals. He has also co-edited the much acclaimed book "Seed Spices: Production, Quality and Export" published by Pointer Publishers.

Muthuswamy Anandaraj holds a M.Sc. in Botany (1975) from Mysore University and a Ph.D. in Botany (1997) from Calicut University. He has 32 years of research experience in the field of plantation crops and spices, and has headed the Division of Crop Protection, Indian Institute of Spices Research, Calicut, India. His research has mainly focused on epidemiology and disease management, and he has developed and released a *Phytophthora* tolerant variety of black pepper in India and studied the mechanism of resistance in that variety. He is the author and co-author of several research papers published in national and international journals and has contributed chapters for several books on spices and edited a few of them. He has also contributed chapters for EOLSS.

Dr. Anandaraj is presently working as Project Coordinator of All India Combined Research Projects on Spices (AICRPS) which is responsible for the formulation of research projects, monitoring and release of location specific varieties and technologies for 12 spice crops in India. He is also coordinating the research conducted on three soil-borne pathogens, *Phytophthora*, *Fusarium* and *Ralstonia* in 17 institutes under Indian Council of Agricultural Research (ICAR).