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A REVIEW ON AGROTECHNOLOGY OF FENNEL (*Foeniculum vulgare* Mill)

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ABSTRACT

The time of sowing of fennel varies from 1 October to 30 October, the range of fertilizer application vary from 25 to 100 kg N and 20 to 60 kg. P_2O_5/ha under Indian conditions. The closer row spacings of 30 or 45 cm are better as compared to under row spacking of 60 cm. Mass Selection-1, S-79, PF-35 and UF-32 are the high yielding varieties of fennel. The crop did not respond to irrigation more than one irrigation. The soil content and oil quality was not affected by the various agronomic inputs. However, for essential oil the herb crop should be harvested at the grain formation at tertiary umbels but the seed crop could be harvested at half length seed stage. The powdery mildew is the major disease of this crop.

Fennel is used in cooking for candy and liquers. On an average, it contains 3-5 per cent volatile oil which is used in perfume, soaps and medicines. The main constituents of oil in *Foeniculum vulgare* is anethole (50-60%). The fruits are aromatic, stimulent and carminative. They are recognised efficiently in the pharamacopoeias of all countries and are used in the treatment of diseases of the chest, spleen and kidney. It is also largely used as a spice in cooking.

In order to get higher seed yield of the crop, all the agronomic factors should be in optimum combination. The present review aims at to meet this objective and also to help the research workers to plan theirwork on the lacking aspects of this crop.

Cultivar

Joshi (1962) reported that the varieties NP (P) 32 and 186, NP (J) 13 and 269, NP (P) 163 and NP (K) 1 produced the 8-140 per cent higher yield than the local variety in preliminary trials. In Gujarat, the Department of Agriculture released two high yielding selections S- 79 and PF - 35 with an yield potential of more than 1600 kg/ha. Bhati and Agarwal (1987) identified two high yielding varieties i.e., Mass Selection -1 and UE- 32.

Effect of sowing time on seed yield

Sowing time vary from region to region depending upon the climate. Siever (1948) investigated the production of drug and condimental plants on a well drained soil and recommended that fennel might be sown late or in early spring in the USA. In Nebraska, Moreau (1966) reported that the yield of fennel was higher under April 20 and May 10 sowing as compared to later sowing of May 20. However, in Germany, fennel could be sown after 10 July (Seitz, 1975). The same conclusion was drawn by Anderson and Frenz (1981) who observed that earliest sowing in May resulted in bolted plants. In Egypt, El-Gengaihi and Abdallah (1979) observed that 20 September sowing produced the highest seed yield than the late sowing.

The results of the experiments conducted at the Punjab Agricultural University, Ludhiana by Singh (1975), Randhawa *et al.*, (1978, 1981) revealed that 21 October sowing gave the highest seed yield as compared with the late sowings. However, Uppal (1983) reported that 30 September and 10 October sowing produced significantly higher seed yield. In trials at cultivator's field in Amritsar district of Punjab (India), fennel sown in last week of October or first week of November gave the normal yields (Anonymous, 1980). Randhawa and Mahey (1985) revealed that with each delay in sowing from September 30 to January 5, there was progressive decrease in seed yield.

The experiment conducted during the *rabi* seasons of 1977-78 and 1978-79 at S.K.N. College of Agriculture, Jobner, on loamy sand soil by Bhati and Agarwal (1987) revealed that the early sowing (1 October) gave significantly higher seed yield and yield attributes as compared to late sowings (15 October and 30 October) in both the years. However, Patel and Patel (1987) reported in Gujarat, that growth attributes and grain yield were favourably influenced by planting the fennel variety PF. 35 in mid-October with a spacing of 45 x 10 cm after *bajra* crop. This planting gave the highest seed yield as well as net profit per hectare.

Mehta *et al.*, (1987) reported that fennel being a long duration crop, as it takes about 225 days for maturity and thus only single crop is possible if one desire to grow this crop northern area of Gujarat under normal recommended practices i.e. planting the crop in the month of August.

Oil content

Fernands and Cordosado (1959) reported that the fennel plant harvested in September contained 0.45 per cent oil and the oil content in fennel was considerably decreased as sowing was delayed from May 10 to May 23 (Moreau, 1966). However, Singh (1975), Randhawa *et al.*, (1978), El-Gangaihi and Abdallah (1979) and Uppal (1983) observed that the oil content in seed and herb did not vary when fennel sown on different dates, however the earliest sown crop produced the highest oil yield. Chubey *et al.*, (1976) reported that oil content in fennel seed was the highest when it was harvested at full bloom stage.

Oil quality

The fennel fruits when harvested in October contained both camphor and valeric acid (Fernands and Cordosado, 1959). Bhatnagar and Handa (1968) found that oil of fennel seeds in the 4-6 weeks old flowering umbel contained fewer components than the mature seeds. The chemical composition of oil upto the second week of fruiting was found to be variable but afterwards there was no change in its chemical composition. Embong *et al.*, (1977) reported that 19 and 14 constituents were recorded in herb and seed oil of fennel respectively. Of these, the major constituents, *viz.*, transanethole, fenchone, estragol and lemonens represented 99.2 per cent of herb oil and 93.1 per cent of the fruit oil.

Effect of fertilizer application on seed yield

The studies conducted at the Punjab Agricultural University, Ludhiana, by Randhawa *et al.*, (1978) found that the application of 75 kg. N/ha gave the maximum seed yield on a loamy sand soil during winter seasons of 1974-75 and 1975-76. However, Randhawa *et al.* (1981) observed that 50-75 kg N/ha is optimum for obtaining higher seed yield. Response of phosphorus to seed yield has been observed upto 40 kg P_2O_5 /ha during 1976-77, 1977-78 and 1978-79.

The mean seed yield was highest with the application of 50 kg N/ha when crop sown in row 45 cm apart (Randhawa and Gill, 1985). Similarly Randhawa and Mahey (1985) also reported that seed yield increased significantly upto 50 kg/ha of nitrogen and there was no response with further increase in nitrogen dose. The crop responded to 20 kg P_2O_5 /ha only. Gill and Samra (1986) revealed that for obtaining good seed yield, the crop may be supplied with 25 kg N/ha in two equal splits, half at sowing and half at 60 days after sowing.

In Maharashtra, Paliwal and Singh (1981) recorded a significant increase in seed yield with 90 kg N and 60 kg P_2O_5 /ha. However, the application of NPK at the rate of 90: 60: 90 kg/ha produced the highest seed yield of 19.9 q/ha (Afridi *et al.*, 1983). Bhati *et al.*, (1987) revealed that application of nitrogen increased seed yield umbellets/plant and seeds/umbellet. Maximum seed yield of 15.14 q/ha was obtained with 45 kg N/ha. The response of fennel to phosphorus application was low. Another experiment conducted during winter season of 1985-96 by Bhati *et al.*, (1988) also revealed significant increase in seed, straw, biological yield, harvest index and yield attributes *viz.*, umbels/plant, seed/umbellet, test weight, seed yield/plant due to nitrogen application. The maximum seed yield was obtained with 90 kg N/ha followed by 60 kg N/ha but these were statistically at par with one another. Bhati (1990) indicated that application of 90 kg N/ha produced maximum average seed yield (13.77 g/ha) and net profit (Rs.17817/ha) followed by 60 kg N/ha (11.66 q/ha of seed yield and Rs.13158/ha net profit) as against 9.30 q/ha of seed yield and Rs.10024/ha net profit in control.

Ahmed *et al.*, (1988) revealed that seed yield increased with application of 100 kg N/ha. The effect of phosphorus was significant upto 35 kg P_2O_5 /ha. Fennel responded upto the highest dose of 60 kg P_2O_5 /ha (Sharma and Prasad, 1987_a). On an average, the fennel crop did not respond significantly to N more than 40 kg N/ha.

Oil content

The application of nitrogen and phosphorus did not have any significant effect on oil content of fennel (Joshi, 1963; Singh. 1975: Randhawa *et al.*, 1978, 1981; Randhawa and Gill, 1985; Ahmed *et al.*, 1988). However, Joshi (1963) reported that the crop harvested at fully mature stage and dried in shade gave the higher essential percentage of oil content in seed than the fully mature harvested crop dried in sun or harvested at dried ripe stage.

Effect of seed rate and spacing on seed yield

The experiments conducted for four years by Kazakova (1971_a) revealed that when fennel seed sown with 15-20 kg seed/ha in rows 25 cm apart without thinning gave the best results on friable soils. On soils with a tendency to compaction and needing light cultivation in summer, sowing of crop with 25 or even 50 per cent less seed in rows 60 cm apart without thinning were the most satisfactory.

El-Gengaihi and Abdallah (1979) reported that the widest spacing produced the taller plants and the maximum number of umbels per plant. Seed yield per plant was highest at the widest spacing but the 30 cm spacing produced the highest seed yield than row spacings of 20 and 40 cm.

An experiment conducted at the farmer's field in Amritsar district revealed that three seed rates of 10, 15. 20 kg/ha did not differ significantly with respect to seed yield. On the basis of data for two years, it was concluded that fennel should be sown by *kera* method in row 45 cm apart (Anonymous, 1980). Similar results have been obtained by Randhawa and Gill (1985). They tried row spacings 30, 45, 60, 75 and 90 cm. However, Randhawa and Mahey (1985) found that closer row spacing of 30 cm gave significantly higher seed yield than wider row spacings.

Patel and Patel (1987) observed that the growth attributes and seed yield were influenced by planting the fennel (variety PF.35) in 15 Oct. with a spacing 45 x 10 cm after *bajra* crop. Sharma and Prasad (1987_b) reported that best yield was obtained when the crop was sown with 30 kg/ha of seed rate as compared to 20 and 40 kg seed/ha at New Delhi. There was significant increase in seed yield of fennel at 23 cm and 30 cm row spacing over narrow spacing of 15 cm. The results with bold seeded fennel were more pronounced than with the small seeded. Ahmed *et al.*, (1988) reported that plant spacing of 45 x 30 cm gave the higher seed yield as compared to 60 x 15, 60 x 20 and 45 x 20 cm spacings.

Oil content

Oil content was similar under narrow as well as under wider row spacing (Moreau, 1966; El-Gengaihi and Abdallah, 1979; Randhawa and Gill, 1985; Ahmed *et al.*, 1988). However, El-Gengaihi and Abdallah (1979) also observed that 30 cm spacing produced the highest oil yield as compared with 20 and 40 cm row spacings.

Effect of irrigation

Sharma and Prasad (1987) reported that on an average the crop did not respond to irrigation more than one irrigation for the increase in seed yield. Under Delhi conditions, fennel respods well to only one irrigation at IW/CPE of 0.4 and nitrogen application (80 kg/ha).

Weed Control

Weed Flora : *Portulaca oleracae Triticum durum, Amaranthus spp., Stillaria media*

Eliner (1963) recorded that C-1983 (N-4 (p-chlorophenoxy) - phenyl-NN-dimethyl-urea) controlled annual weeds in fennel when applied at a rate of 3.5 - 5 kg a.i. per ha 2-4 days after sowing.

Kazakova (1971_b) observed that the pre-emergence application of prometryne 2 kg or afalon 1.5 kg/ha gave 85-90 per cent control of annual weeds and did not adversely affect the plant development, seed yield and germination of fennel.

Desmarest and Derchue (1986) indicated that linuron, prometryne, propazine and linuron + monalide might be suitable for use in fennel.

The most effective herbicide was 0.5 kg propazine per ha. The pre- emergence 4 kg prometryne per ha when Cruciferae were not numerous or 0.75 kg linuron post-emergence gave satisfactory results.

Damato *et al.*, (1986) observed that trifluralin applied before sowing followed by linuron post-emergence, pendimethalin pre-emergence alone or followed by fluazifopbutyl post-emergence, chlorthaldimethyl pre-emergence followed by fluazifopbutyl post- emergence, metolochlor pre-emergence followed by linuron post emergence, EPTC before sowing followed by prometryne post-emergence gave best control of weeds.

Effect of stage of harvesting

Chubey *et al.*, (1976) observed that the oil content of fennel seed was the highest when the plant was in full bloom stage. Randhawa and Mahey (1985) reported the oil content from the fresh herb (fennel) was extracted at 10 days interval from petal shedding (150 days) to dead maturity stage (220 days after sowing). The date revealed that the oil content in the herb tended to increase with the formation of grain on the primary, secondary and tertiary umbels and it decreased when the grains on the tertiary umbels were fully mature. Whereas with each delay in harvesting, the seed yield tended to increase upto 210 days after sowing.

Bhati (1990) indicated that maximum seed yield was obtained with umbel picking at full length grain seed (12.26 q/ha) followed by full grown turning yellow seed (12.13 q/ha) and half length seed (9.30 q/ha) whereas umbel picking of half length seed gave maximum net profit (Rs.1535/ha).

Diseases and Pests

The major disease of the crop is powdery mildew. The crop is attacked mainly by the aphid.

Mildew appears occasionally on fennel. In Rajasthan, the disease has been observed in February and March. The pathogen is known to attack several other plants.

The extent of damage and the method of perennative of mildew are not known. It has been reported to cause extensive loss occasionally in Rajasthan, and dusting of sulphur is recommended for its control.

Blight

Fennel blight has been reported from Pusa, Kashmir and other parts of India (Sydow and Mcrae, 1928). Recently, it has been noticed in the Ajmer division, Rajasthan also. There is considarable reduction in yield owing to destruction of foliage and poor development of fruits. Brwon to black lesions are formed on the leaves, stems, peduncles and even on seeds. Severely infected plants present blighted appearence .

Periods of high humidity and high temperature have been found to favour infection in Rajasthan. Diseased plant residues constitute an important source of infection.

Spraying a suspension of colloidal sulphur @ 2.5 g/h of water during February-March is recommended for the control of the disease in Rajasthan.

Aphids

Both nymphs and adults congregate in clolonies on ventral surface of leaves and suck the cell sap. Due to copious production honeydew, the leaves give a glistening appearence in the begining but later covered with a surperficial black coating as the mould fungi grow rapidly on honey dew. The honey dew also attracts black ants.

If the infestation is in the early stage and isolated pockets, removal of infested plant parts bearing colonies of aphids is recommended. When the infesaton is severe, application of any one of systemic insectcides like dimethoate (0.03%) phosphamidon (0.05) is suggested.

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