



Reviewed By

Dr. Kedar Nath

Regional Rice Research Station,
Navsari Agricultural University,
Vyara-394 650, Dist.- Tapi, Gujarat.
Email: drkdkushwaha@nau.in

Aerial diseases and their management in *Cuminum cyminum*: A review

R. D. Meena^{*1}, N.L. Meena², Y.K. Sharma¹, N. Chaudhary¹, N. K. Meena¹, M.K. Mahatma¹, S.S. Meena¹, S.N. Saxena¹, M.D. Meena¹, M.K. Gurjar³, R.S. Meena¹ and Vinay Bhardwaj¹

*Correspondence

R.D. Meena

meenard2005@gmail.com

Received: 25 March 2022

Revision: 12 January 2024

Accepted: 14 February 2024

Citation

Meena, R.D., Meena, N.L., Sharma¹, Y.K., Chaudhary¹, N., Meena¹, N.K., Mahatma¹, M.K., Meena¹, S.S., Saxena¹, S.N., Meena¹, M.D., Gurjar³, M.K., Meena¹, R.S. and Vinay Bhardwaj. 2022. Aerial diseases and their management in *Cuminum cyminum*: A review. *Int J Seed Spices*. 12 (1), 34-38

DOI

<https://doi.org/10.56093/IJSS.v12i1.3>

Affiliation

¹ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan, India

²Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan, India

³ICAR-Indian Agricultural Research Institute, New Delhi, Rajasthan, India

Abstract

Cumin usually known as Jeera and scientifically known as *Cuminum cyminum* L. is annual and one of the most important spice crop that is more prone to several diseases among which the aerial diseases cause severe losses in both yield and quality. Aerial diseases are those diseases which cause de-formalities in aboveground system of the plant and may include stem, leaves, flower, seed, fruit etc. The threats of Aerial diseases are epidemics in crop production, high cost of chemical fungicides and development of fungicide resistance, climate change, new disease outbreaks and increasing concerns regarding environmental as well as soil health are becoming increasingly obvious. These demand the use of integrated aerial disease management strategies for the crop. This article summarized the methods for management of aerial diseases in cumin seed production which included legal methods, resistant cultivars, sanitation, and cropping system, biological control, soil amendments and soil fertility and weather parameters, plant nutrients, and chemical control. Decision support systems developed to predict disease allow choosing good management methods such as the use of healthy seeds, cultural practices and biological control agents for each aerial cumin disease. The complexity in interactions between a pathogen and its host, influenced by biotic and abiotic factors of the environment, build the control of the diseases frequently very hard. However, profound awareness of host-pathogen systems allows constructing integrated pest management systems enhances the production of good quantity as well as quality seed.

Keywords: Aerial diseases, cumin, blight, powdery mildew, management.

Introduction

Cumin (*Cuminum cyminum* L.) is an annual herb belongs to Apiaceae family which is grows to a height of 15- 30 cm according to environmental conditions. According to Panday *et al.*, 2019 cumin is native of Iran and Syria (Medeterian region). Cumin is known as one of the most important medicinal plants in Iran. Cumin seeds have an aromatic fragrance due to cuminol. Cumin is produced in India, Iran, Lebanon, Cypress, Egypt, Syria, China, Indonesia, Mexico and Iran (Meena *et al.*, 2018a). India is the largest producer (70% of world production), exporter and consumer of cumin seed across the globe (Shastry and Anandaraj, 2014). In India, a cumin seed was produced 9.12 lakh tonnes from 12.76 lakh hectare areas

during 2019-20 (Anonymous, 2020). Cumin is very much vulnerable to a range of pathogenic organisms that reduce yield by killing the plant or reduces quality of produce, thus making it unmarketable. Aerial diseases are considered a major limitation to crop production. Aerial plant pathogens which appears at farmer fields are *Alternaria burnsii* causes blight, *Erysiphe polygoni* causes powdery mildew, *Alternaria alternata* causes leaf spot disease, *Pseudomonas cumini* causes bacterial blight disease and phytoplasma causes witches broom disease (Khare *et al.*, 2014) while VDMV (*Vanilla distortion mosaic virus*) causes yellowing disease is a new disease in cumin (Meena *et al.*, 2022). Aerial diseases in cumin may causes up to 100% crop losses on susceptible cultivars under ideal conditions and hence these diseases are among the major factors contributing to low yields of organic produce. It causes high yield losses, up to 100% in severely damaged areas with disease-promoting environments (Abo-Elyousr *et al.*, 2022). The respective pathogen often survives for long periods in host plant debris and so they remained in field, soil organic matter or nearby on alternative hosts. Accurate diagnosis of a specific disease is difficult due to the similarity in symptoms such as seedling stunting, bark cracking, yellowing and branch dieback which in turn makes the disease harder to manage. With the rising awareness of the adverse effects of chemical pesticides, people are looking for organically grown vegetables and managing aerial pathogens by natural means. Consumers are increasingly choosing organic foods due to the perception that they are healthier than those conventionally grown.

Important aerial diseases of cumin

1. Fungal blight:

Alternaria blight disease in cumin caused by *Alternaria burnsii* was first reported from Gujarat by Uppal *et al.* (1938). It is a very common and one of the most important diseases of cumin that causes heavy loss. Now, it is a common disease in all the cumin growing areas favoured by humid and cloudy weather (Khare *et al.*, 2014). Small necrotic spots develop on almost all the aerial parts which enlarge, coalesce and turn brown to black. Under humid conditions stem and flowers are also infected which may be killed. Either seeds are not formed on diseased plants, if produced they remain small, shriveled, very light and blackish. 23-28°C temperature range is optimum for disease development (Ghemawat and Prasad, 1972). Early planting results in greater severity of the disease and the pathogen is seed borne (Khare *et al.*, 2014). It is also soil borne surviving in crop

debris. Sekhawat *et al.* (2013) have reported five pathogenic groups out of which the isolate from Jalore district was most virulent. Volatile oil content of seeds is reduced due to the disease. According to Lakra (2005) the incidence of *Alternaria* blight increased with the increase in the duration of dewfall, leaf wetness, relative humidity, congenial temperature and number of rainy days. Arora *et al.* (2008). December sown crop had least disease incidence while highest blight incidence was in October sown crop (Champawat and Singh, 2008).

Management

Seed treatment with difolatan, captan is beneficial. Cuman, mancozeb, copper oxychloride, zineb are recommended as spray (Gemawat and Prasad, 1969). Sharma *et al.* (2013) recently evaluated ten fungicides of which propiconazole (0.1%), carbendazim + iprodione (0.2%) chlorothalonil (0.2%) were better in giving least disease incidence and higher yield (Khare *et al.*, 2014). Akbhari and Dhruj (1995) tested nine fungicides and found three sprays of Mancozeb (0.2%) best in checking the disease resulting in higher yields. It was followed by propiconazole. Cumin plants are generally attacked by *A. burnsii* after flowering. This is a low sugar disease. It has been observed that maltose and sucrose are not present in plants before flowering. They are present at flowering and disappear in mature plants and seeds. D-mannose and benzenedene have been found in plants before flowering but not at flowering and in diseased plants. Presence of maltose and sucrose after flowering and in the diseased plants exhibit their support to the pathogen and to make the plant susceptible (Khare *et al.*, 2014). The presence of Dt serine and phenylamine creat favourable conditions for the disease development (Gemawat and Prasad, 1969). *Trichoderma harzianum* grown on sorghum seeds when applied in the soil (24 g/6 m²) resulted least blight disease. Similarly, when 10% spore suspension of *T. harzianum* was used as seed treatment and as spray at flowering resulted in best control of the disease (Deepak *et al.*, 2008). Meena *et al.* (2010) in advanced production technology of cumin have recommended seed treatment with thiram or carbendazim to control seed borne pathogens and mixing of 100 g *Trichoderma* formulations with one kg seed to control all the diseases of cumin. Prophylactic spray of 0.2% Mancozeb or Difolatan or Zineb is suggested during cloudy weather or at first symptoms (Khare *et al.*, 2014). The plant protection schedule comprising seed treatment with carbendazim + thiram (1:1) or tebuconazole, soil drenching with metalaxyl or carbendazim and foliar application of mancozeb

followed by propiconazole and dinocap at later stage proves effective to combat wilt, blight and powdery mildew of cumin (Sharma *et al.*, 2011). Further, prophylactic spray of chlorothalonil followed by two sprays of azoxystrobin or propiconazole efficiently manages the cumin blight disease under field conditions.

2. Powdery mildew:

Powdery mildew of cumin is caused by a fungal pathogen (*Erysiphe polygoni* DC). The powdery mildew disease caused by *Erysiphe polygoni* DC reduced seed yield up to 50 per cent under favourable weather conditions. Under severe disease condition, the total failure of the crop has been observed (Champawat and Singh, 2008; Patel *et al.*, 2017). The fungus is ectoparasite on aerial plant parts resulting in yield losses upto 50% under favourable weather conditions (Khare *et al.*, 2014). The disease appears in February and March at the flowering time. The disease spreads fast under warm (27-35°C) and moist conditions. The seeds formed on the diseased plants remain small shriveled and lighter in weight. All the plant parts get covered with white powdery mass of conidia. The late sown crop under irrigated condition gets severely affected (Khare *et al.*, 2014). The fungus perpetuates as dormant mycelium on the seed. The perfect stage is not formed in India. Under severe disease situation total failure of the crop has been observed (Champawat and Singh, 2008). The disease is common in Bulgaria where perithecial stage has been reported (Dodoff and Naceff, 1936).

Management

Single dusting of 300 meshes sulphur 20-25 kg ha⁻¹ at the time of flowering in January is essential (Khare *et al.*, 2014). Dinocap (0.1%), carbendazim (0.1%), tridemorph (0.05%) and wettable sulphur (0.2%) are also effective (Sharma *et al.* 2013; Mathur *et al.*, 1971; Gohil *et al.*, 1985, Meena *et al.*, 2010). Sowing of cumin at spacing of 30 cm x 10 cm and fertilized by 10 kg k₂ O ha⁻¹ along with RDF (40 + 15 kg NP ha⁻¹) save the crop from diseases i.e. blight and powdery mildew and increased the seed yield (Patel *et al.*, 2017).

3. Cumin yellowing:

Cumin yellowing is comparatively a new viral disease in cumin and may be characterized by a group of symptoms like mosaic, leaf distortion, enation, yellowing of leaves, stunting and bushy type growth in Zinnia (Balaji *et al.*, 2014) and on cumin (Meena *et al.*, 2022), was observed on young plant leaves initially and then extended to whole aerial plant parts. Average losses from the disease were reported up to 30% yield. In a survey cumin plant samples, exhibited chlorosis and

mosaics. Electron microscopy showed presence of flexuous, rod shaped and filamentous nucleocapsid, approximately 680 nm long and 12 nm in diameter, with similarity to particles from the genus *Potyvirus* (Meena *et al.*, 2022).

4. Other microorganisms:

Ten fungal species associated with cumin seeds- *Alternaria alternata*, *Aspergillus flavus*, *A. niger*, *A. ochraceus*, *Bipolaris hawaiiensis*, *B. spicifer*, *Curvularia prasadii*, *Chaetomium sp.* *Fusarium miniliforme* and *Rhizopus oryzae* were reported by (Jain and Jain, 1995). These are not usual pathogens causing diseases of importance in cumin but they influence the germinability of seed and may infect aerial plant parts.

Legal Methods of plant disease management

Most of the developing countries, either due to lack of technology or skilled manpower or both, suffer more from the diseases that are being imported with the seeds and plant materials. The regulatory measures are constantly being updated and enforced. However, even with quarantines, there is always a risk of additional aerial plant pathogen introductions. (Panth *et al.*, 2020). Legal methods are any regulation, rule, law or quarantine that prevents the movement of a disease-causing agent or a pest from a country, region, and state. The long-distance movement of aerial plant pathogens may occur through packing materials, containers, seeds, plant material, plant products, animals, soil or even humans. Introduced new pathogens can stay below the detection threshold level for several years and can emerge later with destructive intensity (Crooks, 2005). Several studies shown that the plant trade is one of the main pathways for the dispersal of pathogens such as *Phytophthora* species (*P. ramorum*, *P. drechsleri*, *P. hedraiaandra*, *P. hibernalis*, *P. nicotianae*, *P. palmivora* and *P. syringae*) in plants (Goss *et al.*, 2009; Moralejo *et al.*, 2009).

Sanitation of field and surroundings

By means of the resting structures like chlamydospores, oospores, microsclerotia or sclerotia and basic reproductive systems, aerial plant pathogens can stay alive in the soil for a very elongated time, yet in the absence of a living host or plant debris and soil organic matter. Therefore, it becomes very important to remove the plant debris away from crop growing areas whenever possible residue breakdown. Sanitation includes any kind of activities aimed to prevent the spread of pathogens by removing diseased and infected plant

parts, sanitization of tools and equipment and washing hands and feet (Panth *et al.*, 2020). Weeds surrounding or even in field and volunteer plants should be ruined as they can function as a host for several aerial pathogens as well as increase the relative humidity (change in microclimate) around the crop canopy, creating an environment in which many pathogens flourish for longer period. Ploughing infected crop debris is also a good sanitation measure to control certain aerial plant pathogens because the tillage can expose the infected plant materials to the direct sunlight, that can kill some plant pathogens. The diseased plants and the nearby soil around its canopy should be discarded to decrease the further extend of some diseases (Baysal-Gurel *et al.*, 2018). Meena *et al.*, 2018b found that cumin seed takes 10-12 days in germination which is more than enough to cover the cumin field by the weeds as weed seed usually takes few days only. Cumin, being a short size crop with slow initial growth, heavily infested with several weed species which cause severe competition, resulting in yield reduction of cumin up to 99%. Solarization significantly reduced weed pressure in cumin crop and increases yield (Meena *et al.*, 2018b).

Disinfection of tools and equipments

Tools that are used should be disinfected or cleaned at a minimum, when moving equipment between different plants or fields using different methods such as heat treatment, ultraviolet (UV) treatment and chlorine treatment. Thus, preventative measures should be adopted to avoid pathogen contamination. Field sanitation in combination with many other methods can yield a desirable outcome. This is the first step for the management of aerial diseases in an integrated system (Panth *et al.*, 2020).

Summary

Control of the aerial diseases worldwide is becoming a great challenge along with sustaining the quality of degraded soils as an increasing crop production in them. Using antagonistic microorganisms and phytochemicals in controlling aerial infecting fungi offers an alternate approach to the prevalent use of synthetic pesticides. Mixtures of several bio-control agents that have the benefit of exercising a broad spectrum activity against several pathogens. This review established that a single management approach or practice such as a biological amendment or crop rotation, alone will probably not be effective in establishing aerial disease suppression, but multiple approaches such as combinations of crop rotations, cover crops, organic and biological amendments, soil

solarization, and chemical measures as well as legal management need to be optimized and coordinated together as part of an integrated pest management program. Active management of soil microbial communities for disease suppression through the use of effective crop rotations and biological amendments has a huge potential

Conflicts of Interest : The authors declare no conflicts of interest.

References

- Abo-Elyousr, K.A.M., Saad, M.M., Al-Qurashi, A.D., Ibrahim, O.H.M., Mousa, M.A.A. 2022. Management of cumin wilt caused by *fusarium oxysporum* using native endophytic bacteria. *Agronomy* 12, 2510. doi: 10.3390/agronomy12102510
- Akbhari, L.F. and Dhruj I.U. 1995. Chemical control of Alternaria blight of cumin (*Cuminum cymium* L.). *J. Spi Arom Crops*, 4:82-83
- Anonymous. 2020. Spices Board, Govt. of India. WWW.Indianspices.com
- Arora, D., Saran, P.L. and Lal, G. 2008. Evaluation of cumin varieties against blight and wilt diseases with time of sowing. *Annals PI Protec Sci.*, 16:441-443.
- Balaji, C.G., Aravintharaj, R., Nagendran, K., Priyanka, Rand Karthikeyan, G. 2014. First report of vanilla distortion mosaic virus (VDMV) in ornamental zinnia bicolor in India. *J PI Pathol.*, [https:// doi.org/10.4454/JPP.V96I4.009](https://doi.org/10.4454/JPP.V96I4.009)
- Baysal-Gurel, F. and Kabir, N. 2018. Comparative performance of fungicides and biocontrol products in suppression of *Rhizoctonia* root rot in viburnum. *J. PI Pathol Microbiol.*, 9:451.
- Champawat, R.S and Singh, V. 2008. Seed Spices. In Disease Management in Arid Land Crops. Eds. Lodha,S., Mawar, R and Rathore, B. S. Scientific Publishers (India) Jodhpur, p.197- 232.
- Crooks, J.A. 2005. Lag times and exotic species. The ecology and management of biological invasions in slow-motion. *Ecoscience*, 12:316–329.
- Deepak, P., Aran, L. and Lal, G. 2008. Control of wilt and blight diseases of cumin through antagonistic fungi under *in vitro* and field conditions. *Notulae Botanicae, Hort Agrobotanici, Chuj-Napoca*, 36:91-96.
- Dodoff, D.N. and Naceff, N.P. 1936. Cumin growing in Bulgaria plain. *Agric Nut Domeains Safia.*, p.29

- Gemawat, P.D. and Prasad, N. 1972. Epidemiological studies on *Alternaria* blight of *Cuminum cymanium* L. *Indian J Mycol PI Pathol.*, 2:65-74
- Gemawat, P.D. and Prasad, N. 1969. Efficacy of different fungicides for the control of *Alternaria* blight of *Cuminum cyminum* L., *Indian Phytopath.*, 22:49-52.
- Gohil, V.P., Patel, A.T. and Jain S.M. 1985. Field evaluation of fungicides for the control of powdery mildew of cumin. *Indian Phytopath.*, 38:783-784.
- Goss, E.M., Carbone, I. and Grunwald, N.J. 2009. Ancient isolation and independent evolution of the three clonal lineages of the exotic sudden oak death pathogen *Phytophthora ramorum* *Mol Ecol.*, 18:1161–1174.
- Jain, M.P. and Jain S. L. 1995. Seed borne fungi of seed spices. *J Spi Arom crops*, 4:78-79.
- Khare, M.N., Tiwari, S.P. and Sharma, Y.K. 2014. Disease problems in the cultivation of Cumin (*Cuminum cyminum* L.) and Caraway (*Carum carvi* L.) and their management leading to the production of high quality pathogen free seed. *Int J Seed Spi.*, 4(1):1-8
- Lakra, B.S. 2005. The role of certain environmental variables in the epidemiology of *Alternaria* blight of cumin. *PI Dis Res.*, 20:198-200.
- Mathur, R.L., Masih, B. and Sankhta, H.C. 1971. Evaluation of fungicides against powdery mildew disease of cumin (*Cuminum cyminum* L.) caused by *Erysiphe polygoni*. *Ind Phytopath.*, 24:796-798.
- Meena, R.D., Lal. G., Mehta, P., Sharma, Y.K., Meena, S.S. and Meena, N.L. 2018b. Impact of soil solarization on weed infestation and productivity of cumin (*Cuminum cyminum* L.) *Int J Seed Spi.*, 8(2):54-57.
- Meena, R.D., Lal, G., Mehta, P., Sharma, Y.K., Meena, S.S., R.S., Meena, N.K., Mishra, B.K., Meena, R.L., Meena, N.L. and Tripathi, G.K., 2018a. Efficacy of soil solarization on growth and yield of cumin (*Cuminum syminum* L.) under arid conditions. *Int J Seed Spi.*, 8(1):74-79.
- Meena, R.D., Baranwal, V.K., Lal, G., Sharma, Y.K., Meena, S.S. and Meena, N.K. 2022. First report of vanilla distortion mosaic virus on cumin (*Cuminum syminum* L.) in India. *J PI Pathol.*, <http://doi:10.1007/542216>
- Meena, R.S., Anwar, M.M., Lal, G., Krishna Kant and Mehta, R.S. 2010. *Advanced Production Technology of Cumin*. National research Centre on Seed Spices (ICAR), Ajmer.p.28.
- Moralejo, E., Perez-Sierra, A.M., Alvarez, L.A., Belbahri, L., Lefort, F. and Descals, E. 2009. Multiple alien *Phytophthora taxa* discovered on diseased ornamental plants in Spain. *PI Pathol.*, 58:100–110.
- Panday, R., Mishra, A.K., Singh, H.B., Kalra, A. and Singh, D. 2019. Diseases of medicinal and aromatic plants and their management. Today and Tomorrow Printers and Publisher, New Delhi (India), Pp-335-339.
- Panth, M., Hassler, S.C. and Baysal-Gurel, F. 2020. Methods for Management of Soilborne Diseases in Crop Production. *Agriculture*, 10(16): doi:10.3390.pp2-21.
- Patel, N.R. Amin, A.M. and Amin, A.U. 2017. Management of blight and powdery mildew diseases of cumin by spacing and potash application. *Int J Seed Spi.*, 7(1):44-47.
- Sharma, Y.K., Kant, K., Solanki, R.K. and Saxena, R.P. 2013. Prevalence of cumin diseases on farmer's field: A survey of Rajasthan and Gujarat states. *Int J Seed Spi.*, 3:46-49.
- Sharma, Y.K., Kant, K. Mehta, R.S. and Anwer, M.M. 2011. Evaluation of plant protection schedule for diseases, pests and yield attributing factors of cumin. *Souvenir and Abstracts, "National Symposium on Crop Health Management for Sustainable Agri-horticultural Cropping System"*, 17-19 February, 2011 at CARI, Port Blair.
- Shastri, E.V.D. and Anandaraj, M. 2014. Soils, plant growth and crop production-Cumin, Fennel and Fenugreek, www.eolss.net/sample-chapters/c10/e1-05a-50.pdf pp 1-10.
- Shekhawat, N. Trivedi, A. Sharma, S.K. and Ashok Kumar. 2013. Cultural Morphological and pathogenic variability in *Alternaria burnsii* causing blight of cumin. *J Mycol Plant Pathol.*, 43:80-83.
- Uppal, B.N., Patel, M.K. and Kamat, M.N. 1938. *Alternaria* blight of cumin. *Ind J Agric Sci.*, 8:49-62.