

REVIEW ARTICLE

Diseases Of Major Bulbous Vegetable Crops and Their Management.

ABSTRACT

Onion and garlic are the major bulbous vegetable crops grown throughout the world. They are commercially used in the form of spice, vegetable or medicine. India ranks second in world production of both onion and garlic. These are mostly grown in states of Maharashtra, Uttar Pradesh, Orissa, Gujarat, Haryana, Jammu and Kashmir and Karnataka. These bulbous crops are attacked by various pests and diseases at different growth stages causing considerable losses in yield, besides reducing the export potential. The continuous use of chemicals and pesticides pose severe threats to both environment and mankind, besides enhancing insect resistance to chemicals. It also disturbs microbial diversity which is an essential part of an ecosystem. This has created a new dimension in research for biological control and integrated approach for insect pest and disease control. Essential diseases and pests affecting major bulbous vegetable crops and their management are summarised in this manuscript.

INTRODUCTION

Onion and garlic are the most essential bulb crops cultivated throughout the world and used both as a vegetable and spice in many ways. India occupies second position in an area as well as a production of onion, producing 1.6 million MT annually after China [1]; however, the productivity and per capita availability are quite low as compared to other countries. The productivity of onion in India is 14.35 t/ha which is at least 5 times lesser as compared to republic of Korea (66.16 t/ha), about 4 times less than USA (56.13 t/ha), Spain (55.21 t/ha), Netherland (51.64 t/ha) and Myanmar (46.21 t/ha) [2]. Several factors are responsible for the low productivity of these crops, of which diseases and insect pests are most essential and cause considerable damage and should be taken care of. A number of post-harvest management practices for different onion and garlic varieties have been standardized. V. Anbukkarasi *et al.* [3] reported that during the off-season the efficient storage facility plays an important role for the consumers as well as for the producers which ultimately prevents serious losses due to rotting and sprouting. Plant protection measures for managing diseases and insect pests have also been developed. There is, however, a great scope for boosting the production by minimizing the losses due to various biotic stresses.

32 The major diseases of onion and garlic have been elaborated with an emphasis on those
33 for which effective disease management systems have been put into practice.

34

35 **Basal Rot:** *Fusarium oxysporum* f.sp. *cepae*

36 **Symptoms**

37 The leaves turn yellow and then dry up slowly. The affected plant shows drying of leaf
38 tip downwards. There is complete drying of the foliage. The affected bulb shows rotting
39 symptoms with whitish mouldy growth on the scale. This disease can begin in the field and
40 continue in storage [4,5,6,7,8]

41 **Pathogen characteristics**

42 The fungus produces many chlamydospores, which are thick walled resting spores and
43 microconidia which are one celled and thin walled.

44 **Mode of spread and survival**

45 The pathogen is soil-borne and the optimum temperatures for disease development are 28
46 - 32°C. Infection occurs through the root either directly or through wounds.

47 **Management**

48 Growers must follow crop rotation, and harvested bulbs must be thoroughly cured, by
49 shade drying in a field for 10-15 days, to reduce potential storage losses. Onions are very
50 sensitive to low soil copper levels. To optimise crop production and disease susceptibility,
51 additional soil copper fertility may be needed especially on mucky and sandy soils. Soil
52 drenching with Copper oxychloride @ 0.25 % is recommended.

53

54 **Downy mildew:** *Peronospora destructor*

55 **Symptoms**

56 White downy growth appears on the surface of the leaves. Finally the infected leaves are
57 dried up.

58 **Pathogen characteristics**

59 The sporangiospores are non-septate, long and swollen at the base. Sporangia are pyriform to
60 fusiform, attached to the sterigmata by their pointed end. These sporangia germinate by one or
61 two germ tubes. The coenocytic mycelium is intercellular with filamentous haustoria. Oogonia
62 are formed in the intercellular spaces.

63 **Mode of spread and survival.**

64 The fungus attacks the seed stalks in a seed crop and has been found on and in seed as
65 mycelium. The main sources of perennation are the diseased bulbs, **containing oospores**, used for
66 propagation. If infected bulbs are planted, the fungus grows up with the foliage, produces
67 sporangia and then **spread to healthy ones**.

68 **Disease Cycle**

69 **Dormant Period**

70 It is believed that the DM fungus overwinters primarily as mycelium in infected onions
71 that remain in onion fields or in nearby cull piles. The pathogen also can overwinter in perennial
72 varieties of onion in home gardens. **The fungal spores** that persist in the soil may directly infect
73 the roots of young onion plants. These plants become systemically infected and serve **as a source**
74 for infection in commercial onion fields.

75 **Primary Spread**

76 **Under** favourable environmental conditions, the overwintering fungal mycelium in
77 systemically infected plants produces spores **and after** dissemination through the air, these spores
78 infect the leaves of onion plants in commercial fields. Spores are formed at night when high
79 humidity and temperatures of 4–25°C persists, with an optimal temperature of 13°C. The spores
80 mature early in the morning and are disseminated during the day. Spores remain viable for about
81 4 days. Germination occurs in free water from 1–28°C with an optimal range of 7–16°C. Rain is
82 not needed for infection if heavy dews occur continuously during the night and morning hours.

83 **Secondary spread**

84 The mycelium of DM in leaves of infected plants produces a new crop of spores called
85 conidia in cycles of approximately 11–15 days. As the upper portions of a leaf are killed, the
86 fungus infects the next lower part of the leaf in each successive cycle of spore formation. Such
87 sequences can be repeated several times until the leaf may be completely killed. These repeated
88 cycles of spore formation can result in severe and continued epidemics if disease favourable
89 environmental conditions persists.

90 **Management**

91 Three spraying with Mancozeb 0.2 % is effective. Spraying should be started 20 days
92 after transplanting and repeated at 10-12 days interval.

93 **Leaf Blight (Blast):** *Botrytis* spp.

94 **Symptoms**

95 Botrytis is the major disease occurring in cool climatic conditions. Light infections do not
96 affect yields but heavy infections causing major yield reductions can occur. Hundreds of white
97 specks are seen on the foliage **which** spreads very rapidly.

98 **Pathogen characteristics**

99 Botrytis is characterized by its conidiophores **giving** an appearance of grape bunch. The
100 conidiophores are long, erect and branches irregularly or dichotomously. They are dark and
101 septate. The terminal cells swell to produce sporogenous ampullae. On each ampulla numerous
102 conidia arise simultaneously on short lenticles. The conidia are hyaline or tinted, aseptate and
103 globose to ovoid.

104 **Dormant Period**

105 The Botrytis leaf blight pathogen over winters as sclerotic (compact mass of fungi
106 capable of surviving unfavorable environmental conditions). These are produced on infected
107 onion bulbs left in cull piles, on mother bulbs, stored for seed production and on bulbs left in the
108 field. Sclerotic also over winter directly in the soil and on leaves that persist as debris in
109 commercial onion fields. The sclerotia are formed on infected leaves and the necks and upper
110 portions of bulbs before or after harvest. Infected leaves may be raked or washed together and
111 persist as leaf tissue debris in which many sclerotic can be found. Sclerotic in the soil result from
112 the disintegration and decay of infected leaves on which sclerotic were formed.

113 **Primary Spread**

114 Sclerotia on leaf debris produce conidia and ascospores (sexual spores) that infect leaves
115 of onion plants. Because ascospores are the result of sexual reproduction, they may serve as the
116 source of new strains of the pathogen that are tolerant to fungicides. The ability of sclerotic to
117 germinate and produce conidia repeatedly (up to four times) results in the production of conidia
118 over an extended period of time. Sclerotic on the bulbs of volunteer onions produce conidia that
119 infect either leaves of the same plant or those of onion plants in commercial fields. In the
120 absence of seed fields and cull piles, it provide the primary source of inoculum for outbreaks of
121 Botrytis leaf blight in commercial onion fields.

122 **Secondary Spread**

123 The dense, tangled growth of leaves that develop from bulbs in cull piles provides
124 conditions (little air movement and high relative humidity) that are favorable for subsequent
125 production of spores on dead leaf tissue. This results in secondary cycles of infection in the cull
126 piles. Conidia are blown from the seed fields and cull piles to commercial bulb production fields
127 and the disease cycles continue. Leaves of onion plants in commercial fields can be infected by
128 conidia that develop from sclerotic in the soil. These infected leaves serve as secondary sources
129 of inoculums, once conidia are produced on the dead leaf tissue. Leaves of onion plants grown
130 for commercial production are repeatedly infected, and these serve as the source of inoculum for
131 infecting new leaves throughout the growing season.

132 **Management**

133 Bulb treatment with Captan /Thiram @ 0.25% is desired. Spraying of Maneb or
134 Mancozeb or Chlorothalonil is recommended. Fungicides may be applied every 5 - 7 days for
135 disease control.

136 **Pythium root rot:** *Pythium aphanidermatum*, *P. debaryanum* and *P. ultimum*

137 **Symptoms**

138 This disease causes seed rotting and pre-emergence damping off. The disease appears in
139 circular patches in the field. If disease occurs prior to seed germination, it causes gappiness. The
140 seeds or seed materials are killed before their establishment. The disease also occurs after
141 establishment of the crop *i.e* after 15 to 30 days of sowing or planting. This stage is called post-
142 emergence damping off. At later stage of infection, it causes stunting of the plant and rotting of
143 the roots.

144 **Pathogen characteristics**

145 *Pythium aphanidermatum*

146 **Epidemiology**

147 The fungus is mainly soil borne. The disease is favoured by ill drained conditions in the
148 field due to stagnation of water. High soil moisture or continuous rain may favour rapid
149 development of the disease.

150 **Management**

151 Seed treatment with Thiram or Captan @ 4g/kg or dipping of bulbs in Thiram solution
152 0.25% is recommended.

153 **Smut:** *Urocystis cepulae*

154 **Symptoms**

155 Black smut sori are seen at the base of the leaves and leaf surface. Black powdery mass is
156 seen after rupturing of sorus wall.

157 **Pathogen characteristics**

158 The sori of *Urocystis cepulae* contain dark coloured and powdery spore masses. These spores are
159 found in permanent balls. Each ball consists of an enveloping cortex of tined, sterile, bladder
160 like cells with one or two central dark coloured thick walled chlamydospores. The spores
161 germinate by means of short promycelium while still in the ball.

162 **Mode of spread and survival**

163 The fungus remains viable for 15 years in infected soil by means of spore balls. It persists
164 in soil as a saprophyte. Onion bulbs and onion transplants are important means of widespread
165 distribution of the fungus. Implements also help in the spread. Wind borne soil and surface
166 drainage water are important means of local dissemination.

167 **Management**

168 Seed treatment with Thiram or Captan @ 4g/kg. The bulbs may be dipped in Thiram
169 solution 0.25%.

170 **White Rot: *Sclerotium cepivorum***

171 **Symptoms**

172 The leaves become yellow and show die-back symptoms. The base of the bulb is covered
173 with a white or grey fungal growth. Later, numerous small black spherical sclerotia are
174 produced. Finally, the bulb completely rots.

175 **Mode of spread and survival**

176 The disease is more severe in warm summers or during warm spell in autumn or spring.
177 Sclerotia persist in soil for eight years. The primary inoculum consists of spherical small black
178 sclerotia produced in infested fissure during previous years. Sclerotia are transported from field
179 to field by flood water.

180 **Disease Cycle**

181 The sclerotia on the decaying host will remain dormant until a host plant's root exudates
182 stimulate germination. Cool weather is important for germination of sclerotia and hyphal growth.
183 Mycelium grow through the soil, encounters host roots and form appresoria which penetrates the

184 **host.** Mycelium can grow outwards from the roots of one plant to the roots of a neighboring
185 plant. Sclerotia are formed on the decaying host tissue, and once the host tissue completely
186 decays the sclerotia are free in soil. If the bulbs survive long enough to be placed into storage,
187 the pathogen may continue to decay the bulbs if there is high humidity and low temperatures

188 **Management**

189 Crop rotation and clean seed are the only effective control. Heavy manuring with organic
190 manures reduces the disease in the crop. Seed dressing with Benomyl, Carbendazim or
191 Thiophanate-methyl (100 to 150 g/kg seed) gives effective control.

192 **Purple blotch:** *Alternaria porri*

193 **Symptoms**

194 This disease occurs mainly at the top of the leaves as whitish minute dots with irregular
195 chlorotic areas on tip portion. Circular to oblong concentric black velvety rings appear in the
196 chlorotic area. The lesions later develop towards the base of the leaf. The spots join together and
197 spread quickly to the entire leaf area. The leaves gradually die from the tip downwards.

198 **Pathogen characteristics**

199 *Alternaria porri* mycelium is branched, coloured and septate. Conidiophores arise singly
200 or in groups. They are straight or flexuous, sometimes geniculate.

201 **Management**

202 Disease free bulb should be selected for planting. Seeds should be treated with Thiram @
203 4 g/kg seed. The field should be well drained. Three foliar sprayings with Copper oxychloride
204 0.25 % or Chlorothalonil 0.2 % or Zineb 0.2 % or Mancozeb 0.2 % **should be practiced.**

205 **Neck Rot** : *Botrytis allii*, *B. squamosa* and *B. cinerea*

206 Symptoms usually appear after harvest, although infections originate in the field. Greatest
207 epidemic development occurs when cool (50° to 75°F), moist weather prevails for some days
208 before or during harvest. Symptoms are first seen as a softening of the tissues around the neck of
209 the bulb, or more rarely, at a wound. A definite margin separates diseased and healthy tissues.
210 Infected tissues become sunken, soft, and appear brownish to grayish in color, as if they had
211 been cooked. These symptoms progress gradually to the base of the bulb. Then the entire bulb
212 may become mummified. Hard, irregularly shaped kernel-like bodies, sclerotia, may form
213 between scales, especially at the neck region.

214 **Mode of spread and survival**

215 The fungi that cause neck rot survive in winter on previously infected onion debris in the
216 soil, in cull piles and refuse dumps. Water may be source of pathogen; and could be transferred
217 from water to the vegetables [9,10]. Initial symptoms include water soaked areas on the outer
218 surface of scales. Later, a green to blue green, powdery mold may develop on the surface of the
219 lesions. Infected areas of fleshy scales are tan or gray when cut. In advanced stages, infected
220 bulbs may disintegrate into a watery rot. Many species of *Penicillium* can cause blue mold.
221 These fungi are common saprophytes on plant debris and senescent plant tissue.

222 **Pathogen characteristics**

223 *Penicillium* produces an enormous number of spores on a broom like conidiophore. Some
224 of these spores are in the air at all times and are carried to long distances by wind. In moist air
225 they germinate readily. Symptoms develop slowly on the bulbs.

226 **Mode of spread and survival**

227 Invasion of onion bulbs and garlic is usually through wounds, bruises, or uncured neck
228 tissue. Once inside the bulb, the mycelium grows through the fleshy scales, eventually
229 sporulating profusely on the surface of lesions and wounds. Optimum conditions include
230 moderate temperatures 70° to 77°F (21° to 25°C) and high relative humidity.

231 **Black mould-** *Aspergillus niger* Infected bulbs are discolored black around the neck, and affected
232 scales shrivel. Masses of powdery black spores are arranged as streaks along veins on and
233 between outer dry scales. Infection may advance from the neck into the central fleshy scales. In
234 advanced disease stages, the entire bulb surface turns black, and secondary bacterial soft rot may
235 make the bulb soft and mushy. No external symptoms may be found with some bulbs.
236 *Aspergillus niger* is able to produce mycotoxin which reduces the quality and quantity of food
237 products and feed-stuff which is a potent hepatic- carcinogen in humans and
238 animals.[11,12,13,14,]

239 **Management**

240 Seeds should be treated with Thiram @ 4 g/kg seed. The field should be well drained.
241 Three foliar sprayings with Copper oxychloride 0.25 % or Chlorothalonil 0.2 % or Zineb 0.2 %
242 or Mancozeb 0.2 % **should be carried out**. Growers must follow crop rotation and harvested
243 bulbs must be thoroughly cured to reduce potential storage losses. Soil drenching with Copper
244 oxychloride 0.25 %

245 **Conclusion**

246 A major problem in the production, storage and processing of vegetables is caused by
247 diseases . The farmers are nowadays facing heavy yield losses both in quality and quantity of
248 vegetable crops due to damage as a result of various diseases . These diseases develop through
249 soil-borne, infections and by insect as a vectors. The present review gives inclusive information
250 regarding various pathological aspects of the fungal ,bacterial and other diseases, their causes
251 and management strategies accomplished on them. Many studies have been carried out with
252 respect to occurrence, causal organisms, severity, losses, Pathogenicity and disease management.
253 This review may help the future researchers to devise a concrete strategy for evaluating different
254 pathological aspects and management of pre and post harvest diseases of vegetables. However,
255 further study is needed to reveal all the other recent reports about various pathological aspects on
256 the diseases of vegetables and management strategies opted for diseases

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