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Management of Clusterbean Diseases using Multiple Tactics: A Review

Singh J[1], Goyal SK[1]*, Bagri RK[2], Godika S[3], Meena AK[1] and Sharma P[1]

[1]Assistant Professor, Department of Plant Pathology, Sri Karan Narendra Agriculture University, India
[2]Associate Professor, Department of Plant Pathology, Sri Karan Narendra Agriculture University, India
[3]Professor & Head, Department of Plant Pathology, Sri Karan Narendra Agriculture University, India

***Corresponding author:** Shashi Kant Goyal, Department of Plant Pathology SKN College of Agriculture Sri Karan Narendra Agriculture University, Jobner, India, Tel: +91 9414517537; Email: skgoyal.skncoa@sknau.ac.in

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Abstract

Clusterbean [*Cyamopsis tetragonaloba* (L.) Taub], belongs to the *Leguminaceae* family and is useful for vegetables and a variety of other purposes. It is a seasonal *Kharif* crop planted in arid and semiarid zones of India, primarily in Rajasthan, Haryana, Punjab, Gujrat, and portions of Uttar Pradesh and Madhya Pradesh. Guar may also be cultivated well in irrigated locations during the *Zaid* season. Although several cultivars have been developed from various Indian research organizations that may readily be cultivated in arid and semi-arid environments, some of these types are prone to a variety of phytopathogenic fungal and bacterial infections. These pathogenic diseases have a significant impact on both efficiency and quality. Alternaria blight, anthracnose, Curvularia leaf spot, dry root rot, vascular wilt, charcoal decay, Myrothecium leaf spot and damping off, Ascochyta leaf blight, and bacterial blight are some of the infectious diseases that contaminate and impair the crop. In this review work, a major clusterbean disease affected by a combination of fungal and bacterial diseases is discussed. Disease suppression by biocontrol agents such as *Trichoderma harzianum, Trichoderma viride,* and *Bacillus subtilis* is the result of interactions between the plant, the pathogen, the biocontrol agent, the microbial community on and around the plant, and the physical environment, with pathogen growth being inhibited. Essential oils and plant extracts include a slew of bioactive compounds that are toxic to fungus, bacteria, and nematodes. It has been successful. Chemical control, such as carbendazim, topsin M-70, captan, thiram, mancozeb, copper oxychloride, and foliar sprays of carbendazim, topsin M-70, captan, thiram, mancozeb, and copper oxychloride, is an effective method for treating several clusterbean diseases. Non-chemical treatment procedures are time-consuming and ineffective against soil-borne plant infections. Chemical management is an effective method of disease control in agricultural crops. Carbendazim and biocontrol agents *Trichoderma viride* and *T. harizianum* were shown to be successful by a group of researchers that studied the compatibility of microbial inoculants with fungicides.

Keywords: *Curvularia*; Clusterbean; *Leguminaceae; Ascochyta; Myrothecium*; Bio-control

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Introduction

Clusterbean [*Cyamopsis tetragonaloba* (L.) Taub], often recognized as guar, is a plant in the *Leguminaceae* family that is used for food, animal feed, green manure, and industrial "Guar gum" [1]. It is grown as a fodder as well as for the production of guar gum (galactomannan), which is used in the food business as a fat substitute in human food, as well as in the paper, pharmaceutical, petroleum, and cosmetic industries. Furthermore, the guar crop improves the soil by fixing nitrogen in the soil [2]. It has been grown in India since antiquity and is said to be of African origin. Guar is a robust crop that can withstand drought. It is the country's annual *Kharif* crop, which is largely farmed in the country's dry and semi - desert zones. Guar can also be cultivated well in irrigated locations during the *Zaid* season. Countries account for 80% of worldwide guar output and 75% of global guar commerce [3]. Rajasthan has the highest output rate of any state. The crop has been praised for its ability to provide high-quality gum for industry. Although several cultivars have been developed from various Indian research institutes that may readily be cultivated in arid and semi-arid environments, some of these types are prone to a variety of phytopathogenic fungal and bacterial infections. These biotic diseases have a significant impact on grain and fodder production productivity and quality [4]. The decline in yield of clusterbean is due to several fungal, bacterial and viral diseases [5]. Kishnawat, et al. [6] reported various fungal diseases which infect and cause devastated damage to the crop are *viz.,* Alternaria blight (*Alternaria cucumarina* var. *cyamopsidis*), Anthracnose (*Colletotrichum capsici* f. sp. *cyamopsidis), Curvularia lunata*, dry root rot/leaf blight (*Fusarium solani* and *Rhizoctonia solani*), vascular wilt (*Fusarium moniliformae*)

Alternaria Blight

Alternaria is an extremely damaging pathogen that wreaks havoc on vegetables and other economically valuable crops [7]. Alternaria blight, caused by *Alternaria cucumarina* var. *cyamopsidis*, is a significant disease of cluster beans that is found across Northern India's guar-growing regions. In all of the clusterbean emerging places, primarily in rainfed conditions, the climatic components favour disease sprouting and propagation without delays and indirectly, hampered production [8]. Alternaria blight has become a major concern in guar-growing areas, with the disease posing a significant threat to crop productivity, particularly in rainfed areas [9]. The disease affected the potential threat to the yield of clusterbean seed [10] (Figure 1).

Figure 1: Alternaria Blight.

The disease manifests itself in practically every aerial component of the plant, including the cotyledons, leaves, petioles, stems, and pods. Water-soaked sores on the leaf blades are the first signs of infection. The lesions grow from greyish brown to dark brown, with concentric zonation delineated by light brown lines. In certain lesions, prominent darker border ridges with or without chlorotic halo can be detected. If the plants are infected prematurely in their development cycle, blooming and pod production may not occur [8].

Conidia were also described as being 105-200 x 13-20 m in size, having both vertical and horizontal septa, a septate beak, and being broad at the base and narrowing towards the

apex, according to Saharan, et al. [11]. The pathogen persists on seeds and infected plant debris in the form of conidia and mycelium in the soil. Various agents, such as wind and rain, disperse conidia and mycelia.

Disease Management: Because the fungus *Alternaria cucumarina* var. *cyamopsidis,* which causes clusterbean blight, may live in soil with or without infected plant debris or on the surface of seeds in the latent stage, it must be removed as a key inoculum source. To prevent soil-borne main inoculum, prior crop plant detritus should be burned, and seed treatment is required to eliminate seed-borne disease. Management of the disease by spraying of bio- agent *Trichoderma harzianum* is effective and eco-friendly to environment too [12]. Before planting the crop, implement cultural field methods or seed treatment. The seed must be collected from a disease-free crop, the land must be kept clean, and heavy summer plowing must be followed. Mancozeb was applied to the seeds at a rate of 2.5 grams per kilogram of seed.

On the soybean crop, bulb extracts of *Allium sativum* and *Allium cepa* considerably decreased the disease intensity caused by Alternaria leaf spot [13].

Garlic bulb extract and the fungicidal combo azoxystrobin-difenaconazole lowered the severity of the disease [14].

Anupriya [9] recommended spraying with a fungicidal mixture of carbendazim (12 percent) + mancozeb (63 percent) and garlic bulb extract twice at a 10-day interval to control alternaria blight. Carbendazim (0.1%) + Mancozeb (0.2%) concentrations of Allium cepa leaf extract and Carbendazim (0.1%) + Mancozeb (0.2%) concentrations were shown to be beneficial in lowering the severity of Alternaria blight disease [15,16].

Dry Root Rot

Dry root rot, also known as charcoal rot, is a devastating disease of cluster beans caused by *Rhizoctonia bataticola* (*Macrophomina phaseolina*), a soil and seed-borne polyphagous pathogen that infects over 500 crop species. In South and Southeast Asia, Macrophomina species infect a variety of field crops, particularly common bean (*Phaseolus vulgaris* L.), cowpea (*Vigna unguiculata* (L.), Walp), urdbean (*Vigna mungo* (L.) Hepper), soybean (*Glycine max* (L.) Merr.), and potato (*Phaseolus tuberosus* L.) (*Solanum tuberosum* L.). Between 25 and 48 per cent of productivity is lost as a result of the condition [17] (Figure 2).

Figure 2: Root Rot.

The very first sign of disease is browning of the leaves, which lasts for two or three days before shrinking. After the onset of the first adverse effect, the plant may wither within seven days. When the stem is examined closely, dull lesions on the bark at the ground level may be visible. In the cutting-edge situation, the tissues are debilitated and sever effectively, and sclerotial bodies may be seen disseminated on the damaged tissues. When a pathogen infects a plant's roots, it causes root rot, plant wilt, and eventually death when the illness progresses [18].

M. phaseolina is a soil-borne pathogen that may infect chickpeas at any stage of growth, although it prefers to infect them after they have finished reproducing [19].

During infection on the host, the fungus produces cell wall disintegrating enzymes and phytotoxins such as phaseolinone and botryodiplodin by rotting the roots of plants [20].

R. bataticola grows anamorphically (sclerotially) in soil and on plant waste. On medium culture, the fungus produces brown to grey mycelium that develops into darker, thin, hyaline, septate, dichotomously branched hyphae that eventually generate black sclerotia. A distinguishing feature of the fungus is right-angle branching of the mycelium with constriction of the hyphal branch at the place of origin. The sclerotia are dark in colour.

Management: *M. phaseolina* is a species of microorganism. Pathogens are soil and seed-borne pathogens that may knock out microorganisms from inoculum wellsprings. The methods for reducing sclerotia from the soil and limiting interaction with the host and inoculum. The severity of the disease is limited by changes in social behaviours, soil and seed treatment with drug or natural experts. To avoid the disease, it's also important to use cultivars with low yields and a low risk of infection [21].

Soil solarization is a cost-effective method for reducing pathogen populations in the soil, although it takes a long time and is dependent on weather conditions.

According to Puri [2], soil solarization has been demonstrated to suppress illnesses caused by a variety of infectious microorganisms, including *Rhizoctonia solani* and *Macrophomina phaseolina.*

Biocontrol agents can decrease soil-borne illness by interacting with microbes and pathogens in the rhizosphere plant canopy. Wet root rot of mung bean caused by *R. solani* was treated by combining soil application and seed treatment with *Trichoderma* spp., according to Gardiner [22]. Seed treatment and soil treatment with combination with *T. harzianum* + *Pseudomonas fluorescens* was effective in reduction of disease incidence and enhanced the seed yield [23]. Botanical extracts include a diverse range of bioactive chemicals, including fungus, bacteria, and fungi. When utilized in the field, plant bioactive compounds can deteriorate or become volatile, yet they are still effective against pathogens.

In pot experiments, Kishnawat, et al. [6] discovered that carbendazim (69.92 and 75.74 percent) had the best disease control, followed by tebuconazole + tryfloxystrobin (56.04 and 70.43 percent), *T. harzianum* (49.41 and 53.67 percent), *T. viride* (44.85 and 48.89 percent), and neem leaves extract (30.63 and 39.34 per cent). Seed treatment by fungicides effective to minimise the losses of crops due to dry root rot caused by *R. bataticola* that seedling is the vulnerable stage for the pathogen to establish infection. Massoud, et al. [24] reported with their studies that reduction in pre and post emergence seedling rot disease incidence and increase seed yield in cluster bean was observed was while seed treated with carbendazim.

Powdery Mildew

Powdery mildew is most commonly occurring disease of cluster bean crop caused by *Leveillula taurica* (Lev.). The disease occurs almost all guar growing regions of the world. Under severe conditions entire plant can cover by white cottony mycelial growth the fungus (Figure 3).

Figure 3: Powdery Mildew.

At final stage small black or brown cleistothecia (fruiting bodies) appears on the mycelial mats [25].

Because the pathogen is an obligate parasite, it could only persist in cleistothecial form without even a living host. The primary inoculum is disseminated via the air, possibly across considerable distances from the primary source of inoculum. Powdery mildew is a fungus that spreads by air regionally and over large distances, and it can be caused by both conidia and ascospores. When circumstances are good, the virus infects fast, causing symptoms to manifest within three to seven days and producing a significant number of conidia in a short amount of time. Powdery mildew in beans requires

a temperature range of 22-27°C, as well as high humidity at night and low humidity during the day [26].

In heavy dews, disease incidence rises, allowing the germ tube to penetrate the host epidermal surface, where the fungus produces haustoria to absorb nutrients from the host cells [27].

Management: Powdery disease may be effectively stopped from spreading by accurately identifying and detecting it and taking early action to control it. This reduces both production and quality of the products. In most circumstances, resistance cultivars may be grown wherever they are accessible, and sound cultural practices can be followed. Grow the crop in a sunny location to provide enough aeration inside the crop canopy. Powdery mildew spores may be flushed away from the plants if they are overwatered.

To limit the use of chemical pesticides that contaminate the environment, non-chemical pesticides must be used to manage plant diseases. Plants are unaffected by biocontrol agents and botanical extracts at the phyllosphare and rhizosphare, and beneficial microbes are unaffected. Milk has been demonstrated in certain studies to be as effective as some other treatments for powdery mildew diseases.

Root rot and powdery mildew of fenugreek are reduced by soil application of neem cake + seed treatment with *T. viride* + four sprays of BD-501 or *Ampelomyces quisqualis* [28].

The usage of neem oil (1.0 percent) and Arstemisia extract (1.0 percent) reduced conidial germination and disease incidence of lucerne powdery mildew, with neem oil having the lowest (23.8 per cent) disease incidence and Arstemisia extract being considerably at par [29].

Chemical fungicides may successfully and precisely control powdery mildew disease, but an integrated programme is the best way to accomplish effective control since the pathogen is excellent at generating new strains resistant to particular fungicides or resistant types. Fungicides must be used.

Jha, et al. [30] found that foliar spraying pea crops with the fungicide hexaconazole 0.1 percent was most effective in reducing the severity of powdery mildew to 8.83 percent, followed by dinocarp (0.1 per cent) with disease severity of 11.74 per cent, while using both fungicides twice at a 15-day interval, starting 40 days after sowing the crop and 37.66 per cent disease severity observed in check, indicating that both fungus.

Guar variety RGC-1017, produced in 2002 from the Rajasthan Agriculture Research Institute in Durgapura, Rajasthan, is relatively resistant to bacterial blight, powdery mildew, and root rot diseases.

Anthracnose

Colletotrichum is one of the most common plant pathogenic fungus that causes anthracnose in a variety of plant types [31]. Anthracnose of cluster beans is caused by *Colletotrichum capsici* f. sp. *cyamopsicola,* a major agricultural disease that affects pod quality, grain quality, and production. Desai and Prasad initially reported it in 1955 at the Agriculture Institute in Anand, Gujarat. Diseases may be found all throughout the country, wreaking havoc on crops. In nature, pathogens are both soil and seed carried. Corda characterised the *Colletotrichum* fungus for the first time in 1831 [32] (Figure 4).

Figure 4: Anthracnose.

Colletotrichum conidia are single celled, hyaline, oval to elongate, falcate conidia that form on conidiophores in acervuli with setae.

Septate, branching at the base, hyaline to pale brown, and smooth conidiophores. Butler [33] investigated the saltation of C. capsici and proposed that it is a polymorphic species that produces morphologically similar *Colletotrichum* under the same species.

Vermicularia capsici was renamed *C. capsici* by Butler, et al. [34]. The infection infects seedlings initially, leaving necrotic, black patches on the cotyledon and main leaves. Necrotic signs appear on the leaves and stems, which later become brown with a black border. Later, these spots expand to cover a vast area of plant parts and consolidate, causing blighting, withering, and drying of diseased tissues. On stem lesions, fungus produces black acervuli. The pods turn dark, with brown to black patches on the surface, and when the

pods are split open, the seeds seem to be diseased, tiny, malformed, and purple in colour. Pathogens need warm, humid weather to infect a variety of host plants, including fruits, ornamentals, vegetables, field crops, and even grasses. *Colletotrichum* is a fungus that affects the majority of crops farmed across the world [35].

Management: Plant diseases can be managed in a variety of ways. Anthracnose of cluster beans may not be manageable with a single technique. Because the virus is seed-borne, wind-borne, and water-borne rather than soil-borne, methods to restrict its spread should focus on three key areas in the field for creating an illness-free harvest: genuine waste, crop rotation, and evacuation of any tainted plant sections. To manage the illness in an environmentally responsible manner, plant extracts and bio-agents can be used instead of chemicals. The application of extracts from neem (*Azadirachta indica*), mahogany (*Swietenia mahagoni),* and garlic (*Allium sativum*) reduced the occurrence of chilli anthracnose [36]. Traditionally uses of combination fungicide are more effective against anthracnose diseases than single one.

In vitro and field studies were conducted by Yadav, et al. [37] to determine the viability of propiconazole (0.1 per cent), captan (0.2 per cent), carbendazim (0.2 per cent), carboxin+thiram (0.1 per cent), and thiram (0.2 per cent) against bean stew anthracnose. Propiconazole had the greatest amount of mycelium restriction, followed by captan and vitavax power. In a field evaluation of fungicides, propiconazole was shown to be the most effective at 0.1 per cent concentration, with a disease list of 20.32 per cent compared to 62.15 per cent in control, followed by vitavax power and captan. Propiconazole produced the highest yield (18.76 kg/plot), followed by vitavax powder.

The uses of resistant cultivars eliminate the losses from diseases as well as eliminate the chemical and mechanical expenses of disease control. Verma, et al. [38] by varietal screening in breeding program found five resistance guar varieties i.e. HG 563, RGC 1066, RGC 1033, HG 2-20 and GAUG- 1502 against anthracnose disease out of fifteen varieties tested.

Bacterial Blight

Bacterial blight of cluster beans is the most serious disease caused by *Xanthomonas axonopodis* pv. *cyamopsidis,* which causes yield reductions of 50-70 percent in extreme cases. In 1953, Patel, et al. [39] from Patna (Bihar) and Khopoli (Bombay) in India initially reported the disease, which manifested as olive-colored spots on the leaf lamina and was dubbed bacterial leaf spot. Seedling mortality is the principal cause of harm caused by the disease. Infection of above-ground plant components is caused by secondary disease transmission. The crop plants are more susceptible to the disease at maturity [40].

The disease symptoms include wilt of seedling plants at later stages of plant growth, the infected plants exhibit rotting near the soil which results in wilting of the plant. The infection from blighted leaves spreads to stem through petiole and in advance stages, stem gets cracked, wilting which causes defoliation and in severe cases vascular necrosis, dieback and black streaking of the stem along with continuous oozing of exudates. The pods also show heavy spotting [41] (Figure 5).

Figure 5: Bacterial Blight.

According to Singh [29], disease propagation is aided by sporadic rainfall, high temperatures (20-30°C), and greater humidity. Higher nitrogen dosages and a plant's early development stage (20-30 days) made it more susceptible to stem rot, causing it to dry out.

Management: Infected seeds are major source of primary inoculum; therefore generally seed treatment is advocated to prevent the disease. Diseased free seeds from the summer grown irrigated crop should be used and the seed from the monsoon should be hot water treatment.

Singh [29] asserted that bacterial blight of cluster bean can be managed by seed dip in agrimycine (250ppm) or streptocycline (200ppm) solution for 3 hrs. and spray

on standing crop of 35-40 days with streptocycline 5gm or plantomycine 50gm in 100 litre of per hectare can also effective to control the disease.

Kumhar, et al. [42] experiments conducted for three year to investigate the efficacy of thirteen different treatments alone and with combination tested against the bacterial blight of cluster bean and observed three years trial of all thirteen treatments, among them lowest per cent disease intensity (PDI) (7.5, 8.5 and 5.83) with treatment of streptocycline (200ppm) + blitox (0.2%) by two sprays at 15 days interval followed by 11.0, 11.83 and 8.16 PDI with treatment of streptocycline (150ppm) + carbendazim 12% + mancozeb 63% @ 0.2% sprayed twice at an interval of 15 days. The per cent disease reduction also highest 83.27 % in the treatment first and 76.37 % in the treatment second respectively.

Jagtap, et al. [43] revealed the reduction in disease intensity of bacterial blight of cotton bean with 8.35 per cent disease severity was noticed in treatment of carbendazim 0.1% + streptocycline 100 ppm combination.

Seed therapy with streptocycline 500 ppm + 2 sprays of copper hydroxide (0.2 percent) over a 15-day period produced the highest yield and disease intensity, followed by seed therapy with streptocycline 500 ppm + 2 sprays of copper hydroxide (0.2 percent) + streptocycline 250 ppm over a 15-day period [40].

Amin, et al. [44] discovered that Seed absorbing streptocycline @ 250 ppm for 30 minutes in addition to a splash of streptocycline @ 250 ppm at the onset of the illness and a second at the fifteenth day following the first shower (therapy 1) had the highest output.

Wilt

Fusarium solani is polyphagous fungi which causes important soil borne as well as seed borne diseases like wilt, root rot, damping off in legumes, oilseeds, medicinal and ornamental crops and and cause severe economic losses. The pathogen *F. solani* which incited the wilt and root rot in cluster bean crop and cause devastatic damage to the crop. The pathogen is seed borne and transmitted to all parts of cluster bean plant (Figure 6).

Figure 6: Wilt.

Cluster bean wilt was first reported by Singh [45] from Kanpur. Haware, et al. [46] advocated that chick pea wilt incited by *Fusarium oxysporum* f. sp. *ciceris* is soil borne pathogen, however, Inoculum of *F. solani* transmitted from seed to seedling caused devastatic damaged to pre and post emergence seedlings. Heavily infected plant showed the symptoms as necrotic patches on leaves and yellow black streaks on roots and shoots. Fungal mycelium and

spores were also observed in the spit of the stem and root cortical region. Among the diverse pathogens infecting the crop, *F. solani* (Mart.) Sacc.is the major pathogen, which is responsible to cause the wilt of cluster bean. The seed borne inoculum of *F. solani* transmitted from seed to seedling give rise to pre and post emergence damage to the crop. Studied that mycelium is cottony white having brown pigmentation in majority of the various isolates of *Fusrium* from collected from different locations. Microconidia, macroconidia and chlamydospores produced from the mycelium. Microconidia are hyaline ova to cylindrical, slight allantoidal with blunt end and macroconidia are hyaline, fusoid and septate [47].

Satyaprasad, et al. [48] isolated the fungus from wilt infected cluster bean plant roots also formed both microconidia and macroconidia. The macroconidia were cylindrical and 5.0-10.0 x 3.0-4.0 in size, whereas macroconidia were septate with 13.0-27.5 x 3.0- 4.5 in size.

Rani [49] Reported that minimum cluster bean wilt disease incidence in crop sown in second fortnight of July and heavy disease incidence observe in early June sown crop.

Management: Controlling soil-borne diseases like *Fusarium* wilt has always been a difficult task. To remove the pathogen, soil treatment is challenging. As a result, wilt control options include seeding resistant cultivars and other cultural measures. Crop rotation is the most effective approach to eliminate soil-borne pathogens.

By increasing soil temperature and covering the soil with mulching materials, F. oxysporum inoculum can be reduced.

In the field, Kiran, et al. [50] evaluated biocontrol agents, natural concentrates, and fungicides for group bean shrivel (*F. solani*).

They noticed Maximum seed germination (82.78%), least per cent wilt incidence (12.92%) with most elevated wither control 75.66%, 85.04% recorded at 40 and 60 days, individually in the treatment mix of Tebuconazole (ST) + *T. viride* (SA) + neem cake (SA) that was seen as best followed by Tebuconazole (ST) +*T. viride* (SA) had 77.22% germination, 17.39 % wilt incidence with 79.88% wilt control at 60days in the wake of planting.

Anita, et al. [51] found that seed treatment with carbendazim + neem oil and soil application of *Trichoderma harzenium* + neem cake were both efficient in controlling *F. solani*-induced root rot in pea. Kumar, et al. [52] found that seed and soil treatment of *T. viride* + soil application of neem cake (150 kg/ha.) + mancozeb (0.3 percent) soil soaking effectively reduced cow pea Fusarium wilt, with a minimal disease index of 16.66 percent.

Fusarium wilt of safflower crop can be managed by seed treatment with carbendazim or thiram @ 2g/kg or carbendazim 1gm + thiram 1gm/kg and can also be managed with bio agent cultures of *T. viride* 4g/kg or *Pseudomonas fluorescens* @ 10g/kg of seed as well as application of heavy doses of organic manure and green manures also reduce the disease inoculum in soil [8]. Chemicals in techniques to manage soil-borne illness, on the other hand, have several limits in terms of economics, the environment, and human and animal health. Anush, et al. [41] discovered that a Bacillus isolate (BC-10) with a combination application of soil and seed treatment against Fusarium wilt of chickpea exhibited significant potential in terms as a biocontrol agent.

Kushawah [53] found that a 0.2 percent fungicidal combination of pyraclostrobin 5% + mitiram 55% was effective in controlling cluster bean wilt in pots.

Patel, et al. [54] revealed with their pot experiments against Fusarium cotton wilt through soil drenching that disease incidence was observed lowest in treatment with 0.2% fungicidal combination of pyraclostrobin 5% + mitiram 55% a.i. 84.07 per cent effectiveness followed by 0.2% combination of captan 70% + hexaconazole 5% with 82.52% effectiveness over control.

Conclusion

Various fungal and bacterial diseases damage the clusterbean crop which is a huge manufacturing restriction. Non-chemical opportunity procedures are time-consuming and ineffective against soil-borne plant infections. Chemical management is an effective method of disease control in agricultural crops. Disease suppression by biocontrol agents such as *Trichoderma harzianum, Trichoderma viride*, and *Bacillus subtilis* is the result of long-term interactions between the plant, the pathogen, the biocontrol agent, the microbial community on and around the plant, and the physical environment, with pathogen growth being inhibited. Essential oils and plant extracts include a slew of bioactive compounds that are toxic to fungus, bacteria, and nematodes. Various researchers discovered that neem oil, turmeric, and garlic were effective against clusterbean infections. Chemical control, such as carbendazim, topsin M-70, captan, thiram, mancozeb, copper oxychloride, and foliar sprays of carbendazim, topsin M-70, captan, thiram, mancozeb, and copper oxychloride, is an effective method for treating several clusterbean diseases. Carbendazim and biocontrol agents *Trichoderma viride, T. harizianum* have been found to be effective against numerous clusterbean diseases, and compatibility of biocontrol agents with fungicides has now been discovered.

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