

Integrated management of *Alternaria* Leaf spot of cauliflower under pot conditions

Abstract:

Cauliflower is widely grown throughout the world. *Alternaria* leaf spot of Cauliflower caused by *Alternaria brassicae* is the most destructive disease at the curd stage and seed setting stage, attributed to causing 30-50% losses and in severe cases reaching up to 98% in seed crop. In the present investigation, the pathogen *Alternaria brassicae* was found to produce typical symptoms of the disease as small, irregular brown spots with concentric rings, also surrounded by a yellow chlorotic halo. Later on, lesions were found to coalesce forming irregular, brown to dark brown patches with concentric rings. The disease is difficult to manage alone with fungicides or bio agents or botanicals. Hence the present study was undertaken to manage the disease effectively by application of fungicides, bio agents, botanicals and their combinations. During the investigation on integrated management under sick pot conditions, the combination of *T. viride* + Neem + Azoxystrobin (10.81% Percent Disease Index) was found most effective with inhibition of disease by 79.02%. This was followed by *T. viride* + Azoxystrobin (11.63% Percent Disease Index) with inhibition of the disease by 77.40% compared to the control 51.52% Percent Disease Index.

Keywords: *Alternaria brassicae*, Botanicals, Bio agents, Cauliflower, Fungicides, Percent Disease index.

Introduction:

Cauliflower (*Brassica oleracea*) belongs to the family Brassicaceae. It is a widely grown winter vegetable across the world. In India, it is mostly grown in Bihar, U.P., Orissa, M.P., Assam, Gujarat and Haryana. It occupies an area (469ha) having production (9103 MT) with productivity (19.2 MT/ha) (Anonymous, 2019). The extensive and continuous cultivation of cauliflower crop has been attributed to resulting in an outbreak of serious diseases like damping off, downy mildew, stalk rot, black rot, *Alternaria* leaf spot, *Fusarium* wilt etc., (Ramsey and Smith, 1961). Of these diseases, *Alternaria* leaf spot or blight disease, is the most destructive disease of cauliflower with worldwide distribution; but more prevalent in subtropical and temperate areas. *Alternaria* leaf spot is incited by *Alternaria* - *Alternaria brassicae* and *Alternaria brassicicola*. *A. brassicicola* incites dark-colored, zonated leaf spots whereas *A. brassicae* develops light brown or grey-colored leaf spots on cruciferous vegetables. At least 20% of wastage in agriculture is attributed to *Alternaria* spp. In severe

cases, the yield losses may go as high as 80%. In India, the loss due to disease in cauliflower vegetable crop is about 30 - 50%, whereas 5 - 30% loss is caused by *A. brassicae* alone (Mishra *et al.* 2012). The management of *Alternaria* leaf spot requires frequent fungicidal spray of synthetic fungicides resulting in adverse consequences such as residues in feed and food, pathogen resistance, toxicity to non-target organisms and environmental pollution. Therefore, in order to avoid such harmful implications, it becomes obligatory to come out with eco-friendly approaches to fit into eco-friendly disease management strategy. Therefore considering these facts and the economic importance of the crop present study was undertaken during 2020-21 at the Department of Plant Pathology, RPCAU, Pusa.

MATERIALS AND METHODS

Integrated disease management (Pot culture)

The pot culture experiment was conducted in green house at the Department of Plant Pathology, during Rabi season of 2020-21, to evaluate the efficacy of bio agents, botanicals and fungicides, which were found most effective under *in vitro* condition, for the management of *Alternaria* leaf spot disease under pots.

Local Cauliflower variety was selected for the pot experiment. The effective amount of inoculum of the pathogen was inoculated in topsoil. After one week, cauliflower seedlings were planted in pots filled with potting mixture. The potting mixture in the pot comprised of soil, sand and FYM in 2:1:1 ratio. The design followed for conducting this experiment was a completely randomized design. Three replications were maintained for each treatment and each pot consists of only one plant. Aqueous extracts of two effective botanicals (Neem & Datura) at 10% concentration were prepared using the requisite quantity of the test botanicals in sterile distilled water (w/v), filtered through double-layer muslin cloth and the resultant extract was used for spraying on cauliflower plants. Two effective native bio agents were used as soil treatment @ 10 g. The two effective fungicides (Azoxystrobin & Propiconazole) were sprayed at 0.1% concentrations, respectively. After the appearance of the initial symptom of *Alternaria* leaf spot on cauliflower plants, spraying of all treatments was undertaken.

List 1 : Standard disease rating scale (0-9) for accessing Percent Disease Index (PDI) of *Alternaria* leaf spot of cauliflower

Rating scale	Percentage area of leaf infected
0	No symptoms on leaves

1	Small, irregular brown spots covering 1 percent or less of the leaf area
3	Small, irregular, brown spots with concentric rings covering 1-10 percent of the leaf area.
5	Lesions enlarging, irregular, brown with concentric rings covering 11-25 percent of the leaf area.
7	Lesions coalescing to form irregular brown patches with concentric rings. Covering 26-50 percent of the leaf area. Lesions also on stem and petioles.
9	Lesions coalescing to form irregular, dark brown patches with concentric rings covering 51 percent or more of the leaf area. Lesions on stem and petioles.

Three replications per treatment were maintained and three leaves/plant (bottom, middle and top) were selected for observation. For recording Disease development, (PDI), 0-9 rating scale was used (Mayee and Datar, 1986). Based on the numerical ratings scale observed, Per cent Disease Index (PDI) was worked out by applying the formula given by (McKinney, 1923) as described below.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of individual ratings}}{\text{Total number of plants/ Leaves observed}} \times \frac{100}{\text{Maximum disease grade}}$$

$$\text{Percent Disease Control (PDC)} = \frac{\text{PDI in control pot} - \text{PDI in treatment pot}}{\text{PDI in control pot}} \times 100$$

Statistical analysis

The data generated during present investigation were presented in tabular form and analyzed using statistical method applicable under Completely Randomized Design as per procedure given by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

The most effective biocontrol agent, botanicals and fungicides were evaluated for their effect on disease development by *A. brassicae* under sick pots, which were inoculated with effective amount of inoculum of the pathogen and observation of disease development (PDI),

are presented in below Table 1. It is clear from the results that all the treatments were effective in controlling the disease. Initially, disease development (Percent Disease Index) increased steadily up to 20 days of the treatment, subsequently further development of the disease was checked, and PDI was found to reduce when observed after 30 days.

After ten days of the treatment, the disease development (Percent Disease Index) was recorded in the range of 12.50% PDI (Neem + *T. viride* + Azoxystrobin) to 27.23% PDI (*Datura*) as compared to 34.52 percent PDI in control. The combination of Neem + *T. viride* + Azoxystrobin was found most effective with the least disease development (12.50% PDI) showing highest inhibition (63.77%) of the disease development. This was followed by *T. viride* + Azoxystrobin which resulted 13.71% PDI and inhibition of disease development by 60.28%, Azoxystrobin + Neem (14.13% PDI) with inhibition by 59.04%, Neem + *T. viride* (18.57% PDI) causing 46.18% inhibition, Azoxystrobin (14.32% PDI) showing 58.51% inhibition, Propiconazole (15.70% PDI) with 54.51% inhibition, *T. viride* (19.72% PDI) with inhibition of 42.87%, *T. asperellum* (21.15% PDI) and inhibition of 38.73%, *A. indica* (25.32%) with inhibition of disease by 26.65% and maximum PDI was recorded with treatment of *Datura* (27.23%) with only 21.1 % inhibition in disease development.

When observations were recorded after twenty days of the treatment, the disease development was recorded in the range from 15.10 % PDI (Neem + *T. viride* + Azoxystrobin) to 37.26 % PDI (*Datura*) as compared to control with 43.42 percent (PDI). The most effective treatment was the combination of Neem + *T. viride* + Azoxystrobin which allowed the least disease development (15.10% PDI) showing 65.22 % inhibition of disease development. This was followed by *T. viride* + Azoxystrobin (16.96% PDI) showing inhibition of disease by 60.95%, Azoxystrobin + Neem (17.36% PDI) with inhibition of disease by 60.01%, Neem + *T. viride* (23.27% PDI) with inhibition of disease by 46.41%, Azoxystrobin (17.67% PDI) with inhibition of disease by 59.32%, Propiconazole (19.27% PDI) and inhibition of the disease by 55.61%), *T. viride* (25.88% PDI) and inhibition of the disease by 40.39%, *T. asperellum* (28.47% PDI) and inhibition of disease by 34.43%, *A. indica* (34.79% PDI) with inhibition of 19.87% and maximum disease development (PDI) was recorded with treatment of *Datura* (37.26% PDI) with only 14.18 % inhibition in disease development.

Treatments	Percent Disease Index (%)
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	Conc .	10 days after treatment	Inhibition (%)	20 days after treatment	Inhibition (%)	30 days after treatment	Reduction (%)
T1-Azoxystrobin	0.1	14.32	58.51	17.67	59.32	12.65	75.44
T2-Propiconazole	0.1	15.70	54.51	19.27	55.61	14.41	72.03
T3-<i>T. viride</i>	0.5	19.72	42.87	25.88	40.39	17.44	66.16
T4-<i>T. asperellum</i>	0.5	21.15	38.73	28.47	34.43	18.62	63.85
T5-Neem	10	25.32	26.65	34.79	19.87	25.14	51.20
T6-Datura	10	27.23	21.11	37.27	14.18	26.36	48.85
T7-Neem+<i>T. viride</i>	-	18.57	46.18	23.27	46.41	16.52	67.93
T8-<i>T. viride</i>+Azoxystrobin	-	13.71	60.28	16.96	60.95	11.63	77.42
T9-Azoxystrobin+Neem	-	14.13	59.04	17.36	60.01	12.34	76.05
T10-Neem+<i>T. viride</i>+Azoxystrobin	-	12.50	63.77	15.10	65.22	10.81	79.02
T11-Control	-	34.52	00.00	43.42	00.00	51.52	00.00
C.D.	-	0.73		0.69		0.79	
SE(m)	-	0.25		0.23		0.26	
C.V.	-	2.16		1.59		2.36	

Table 1: Efficacy of effective fungicides, bio agents and botanicals against Alternaria leaf spot disease in cauliflower under *in vivo* condition

C.D. = Coefficient of deviation, SE (m) = Standard error mean, C.V. = Coefficient of variation, PDI calculated based on the formula mentioned in above. By considering Disease Rating Scale

After thirty days of the treatment, the disease development (PDI) in different treatments were observed in the ranged from 10.81 % (Neem + *T. viride* + Azoxystrobin) to 26.35 % (Datura) percent as compared to 51.52 percent in untreated control. However, the least PDI was recorded in case of combination of Neem + *T. viride* + Azoxystrobin which was found most effective in checking the development of disease at the level of 10.81% PDI with inhibition of disease by 79.02 %, followed by *T. viride* + Azoxystrobin (11.63 % PDI) with inhibition of the disease by 77.40%, Azoxystrobin + Neem (12.34 % PDI) with inhibition of the disease by 76.05%, Neem + *T. viride* (16.52%) PDI with inhibition of disease by 67.93%, Azoxystrobin (12.65% PDI) with inhibition of the disease by 75.44 %, Propiconazole (14.41% PDI) and inhibition of the disease by 72.03%, *T. viride* (17.43 % PDI) and inhibition of disease by 66.16 %, *T. asperellum* (18.62% PDI) and inhibition of the disease by 63.85%, *A. indica* (25.14 % PDI) with 51.20% inhibition in disease development as compared to Control. The

treatment of *Datura* was found to be the least effective with 26.3% PDI and only 48.85 % inhibition in disease development.

In the present study, 10g bio-agents - *T. viride* and *T. asperellum* (as soil application), botanicals – Neem (*Azadirachta indica*) and Datura @ 10%, chemicals - Propiconazole and Azoxystrobin were evaluated (as spray) for their effect on *Alternaria* leaf spot of cauliflower. The most effective treatment was the combination of *T. viride* + Neem + Azoxystrobin, which allowed the least disease development (15.10% PDI) showing 65.22 % inhibition when observed after 20 days of treatment. The PDI was found to reduce further (10.81 PDI) when observed after 30 of treatment due to healthy growth of plants restricting the further development of symptoms. The findings of the present study, showing the superiority of an integrated disease management approach, conforms with the observations in earlier studies (Singh and Kerkhi, 2010; Waghe *et al.*, 2015; Chavan *et al.*, 2015; Valvi *et al.*, 2019; kakraliya *et al.*, 2017).

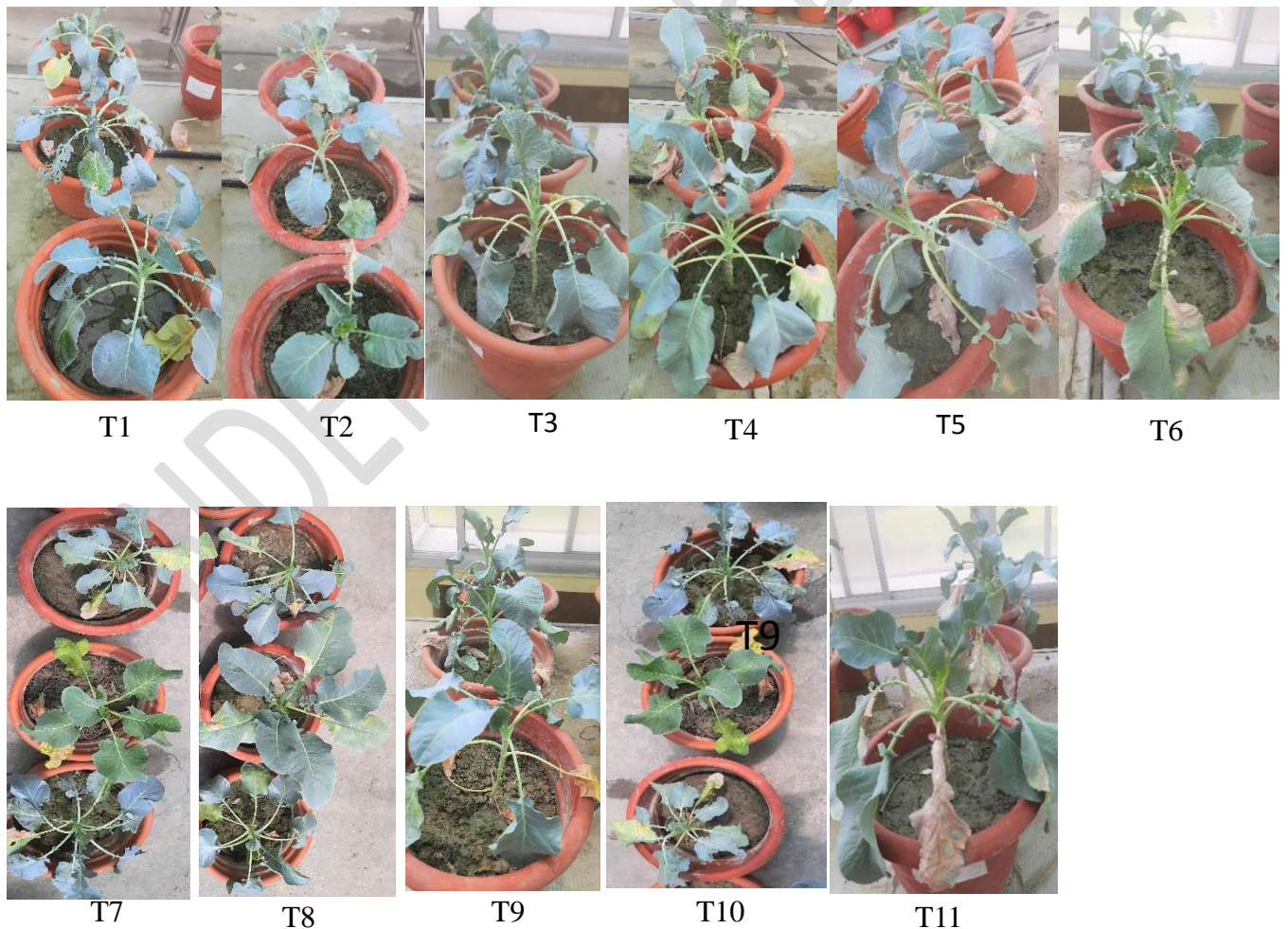


PLATE I. View of Pot culture experiment on evaluation of effective fungicides, bio agents and botanicals against *A. brassicae*

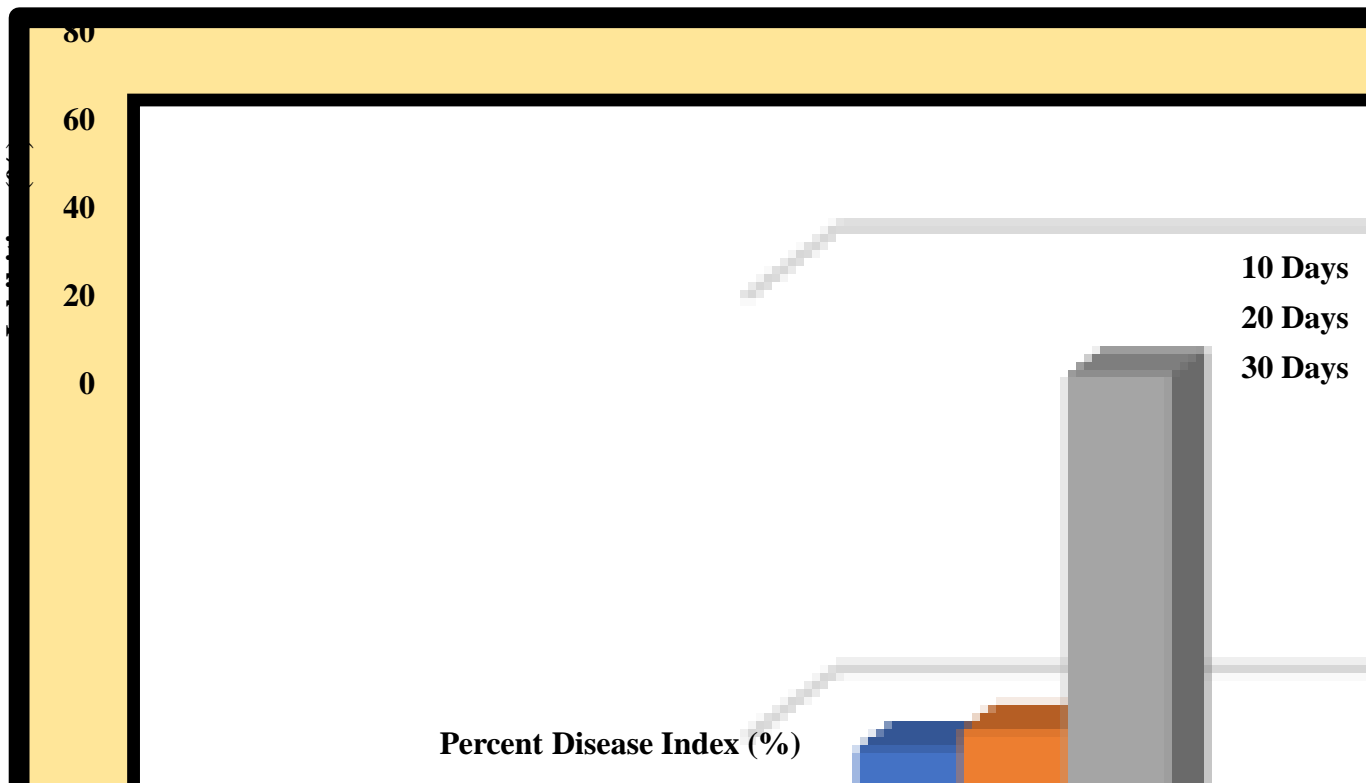


Figure 1. Efficacy of effective fungicides, bio agents and botanicals against *Alternaria* leaf spot disease in cauliflower under in vivo condition

CONCLUSIONS:

Although, satisfactory control of the disease with various chemicals has been documented in the literature; however, rapid and extensive use of agrochemicals to control plant diseases may pose several problems like disturbance in the ecological balance, toxicity to non-target organisms, development of resistance among the population of the pathogens, environmental pollution and increased health risks. Therefore, several alternative methods viz., use of living organisms, phyto extracts and integrated management etc. are gaining importance and it is imperative to exploit these alternatives for sustainable agriculture, food safety and better tomorrow to the mankind. The studies on integrated management of *Alternaria* leaf spot (*A. brassicae*) disease under pot culture (Rabi 2020-21) indicated that the fungicides viz., Azoxystrobin, Propiconazole, bioagents *T. viride*, *T. asperellum* and botanicals *A. indica*, *Datura* were effective with significant reduction of disease over untreated control. The combined soil application of *T. viride* @ 10g along with foliar spray of Neem @ 10% and 0.1% Azoxystrobin treatment was most effective and showed highest disease reduction percent.

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