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Eco-friendly Management of Purple Blotch of Garlic (*Allium sativum* L.) caused by *Alternaria porri* (Ellis) Cif

Shubham Singh*, Shashi Tiwari, Jasmine Jyoti Murmu and G.M.J. Jennifer

Department of Plant Pathology, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, India

**Corresponding author*

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A B S T R A C T

Garlic commonly known as 'Lasan' is the second major important bulb crop grown and used as a spice or condiment, next to onion in India. Among different fungal diseases of garlic, Purple blotch caused by *Alternaria porri* has currently become one of the most important disease of all garlic varieties. Loss due to the disease has been huge and varying on different factors. Therefore, present investigation was undertaken for the management of Purple blotch. Botanicals and *Trichoderma viride* were evaluated for their efficacy under *in vivo* against Purple blotch incited by *Alternaria porri. Trichoderma viride* followed by neem oil showed minimum disease spread than rest of treatments. Effects of different botanicals and *Trichoderma viride* was evaluated on different growth parameters of garlic crop under field condition at Prayagraj during *Rabi* 2019-2020. Maximum plant height @ 30 DAS (38.30 cm), 60 DAS (54.50 cm) and 90 DAS (57.56 cm) and maximum number of leaves @ 30 DAS (5.60), 60 DAS (5.87) and 90 DAS (5.93) was obtained by the treatment with *Trichoderma viride.* Among the treatments, *Trichoderma viride* was found most effective in inhibiting the percent disease intensity by upto 73.60% inhibition of purple blotch of garlic, followed by Neem oil as compared to rest all treatments and control.

Introduction

Garlic is the second most important Allium crop after onion grown throughout the plains of India, of family Alliaceae amongst the spices and condiments. It is commonly termed as "Lasan" and botanically known as *Allium sativum* (Linnaeus). It comprises of more than 600 species. It is believed to be a native of Central Asia Mediterranean regions. It is mostly used for culinary purposes and as a condiment for different food items. Garlic is widely used around the world for its pungent flavour as a seasoning or condiment ingredient. It is chiefly used for flavouring and seasoning vegetable dishes. Garlic cloves are used for consumption (raw or cooked) or for medicinal purposes (Agarwal, 1996).

Purple blotch, caused by *Alternaria porri* (Ellis) Cif., is the most destructive disease of *Allium* spp. (onions, garlic, shallots, leeks, scallions and chives). The pathogenicity of *Alternaria* spp. is due to production of host

specific or nonspecific toxins that may induce disease. These toxins are mainly secondary metabolites that destroy susceptible cultivars by leaf necrosis. The disease usually affects the leaves and bulbs of a plant, and reducing their yield up to 97%. Purple blotch disease is severe in high humidity and moderate temperature of 80–90% and 25–30°C, respectively (Dar *et al.*, 2020).

Alternaria porri causing purple blotch of garlic is a common saprophyte on plant debris and plant tissue. The initial symptoms on host leaves and floral stalks are white flecks which enlarge and produce sunken purple lesions sometimes surrounded by a yellow to pale brown border.

The disease manifests itself on leaves and seed stalks first with small, sunken, whitish flecks with purple-coloured centres. Later, the spots enlarge rapidly into purplish areas and distinct yellowish discoloration usually extends from the spots to the tips and bases of the leaves. The leaves shrivel, usually from the tip (Nolla, 1927).

The fungus does not persist in the soil. Air-borne spores often invade plants through wounds, bruises or uncured neck tissue. In storage, infection or contact is through surface wounds or through the basal plate; the fungus grows through the fleshy tissue and sporulation occurs on the surface of the lesions. Entire cloves may eventually be filled with spores (Uddin *et al.*, 2006).

The disease occurs on all commercial cultivars with varying severity every year. In the absence of resistant cultivars farmers must rely on repeated application of fungicides, which has significant environmental and economic consequences. In order to reduce fungicide use, an assessment needed to be made of how much disease can be tolerated without significant yield loss, and the amount of loss attributable to the disease also needed to be defined accurately (Bisht and Agrawal, 1994). Moreover, the application of chemicals to the soil is not only cost-expensive but also affects the environment severely. The control and management of purple blotch disease with eco-friendly management must be applied and should be practiced more.

Essential oils have been reported to show antifungal activity against *Alternaria porri*. Pawar and Thaker (2007) evaluated the anti-*Alternaria porri* effects for 75 different essential oils. The most active essential oils found were those of lemongrass, clove, cinnamon bark, cinnamon leaf, cassia, fennel, basil and evening primrose. *Trichoderma* spp. is one of the potent biocontrol agents for the management of *Alternaria porri*. This bioagent, present in the soils, can control phytopathogens through various mechanisms including mycoparasitism, antibiosis and competition. *Trichoderma* produces chemicals called trichodermin which is responsible for its antagonistic properties. *Trichoderma viride* exhibited disease incidence of 36.33% as compared to 83.33% in control (Fayzalla *et al.*, 2011). In view of this, the use of biocontrol agents and essential oils as substitutive solutions to synthetic pesticides is being aimed at.

Materials and Methods

Experimental site

The present study was carried out in the Central Research Field under the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, during *Rabi* 2019-2020. The field experiment was laid-out in Randomized Block Design (RBD) with three replications of eight treatments, each in 2×1 m sized plots.

Seed treatment

Seed treatment of garlic cloves with botanicals and bioagent was performed before sowing. Taking seed rate as 60 cloves per plot (2 m^2), seven treatments were applied along with a control. Treatments included neem oil, castor oil, clove oil and *Trichoderma viride* (all at 5% concentration). Also, *T. viride* at 2.5% was used in combination with 2.5% of neem oil, castor oil or clove oil. The seeds were dipped in the allotted suspensions for 25-30 minutes and then allowed to air dry for 15 minutes, followed by sowing in the designated treatment plots.

Assessment for growth parameters and disease intensity of *Alternaria porri*

Basic assessment of the plant growth parameters was done and any disease symptoms were observed and recorded. Observations were recorded at 30, 60 and 90 days after sowing (DAS) for plant height (cm), number of leaves and per cent Disease Intensity (PDI) of purple blotch. To calculate PDI, ten plants were examined randomly in each plot, and scored for disease severity by following 0-5 scale as given by Sharma (1986).

0 - No disease symptoms.
1 - A few spots towards tip covering 10% leaf area.
2 - Several dark purplish brown patch covering upto 20% leaf area.
3 - Several patches with paler outer zone covering upto 40% leaf area.
4 - Leaf streaks covering upto 75% leaf area or breaking of the leaves from centre.
5 - Complete drying of the leaves or breaking of the leaves from center.

Percent disease index was calculated by using the following formula (Wheeler, 1969).

$$PDI = \frac{\text{Sum of disease ratings}}{\text{Total no.of observations} \times \text{Highest disease grade}} \times 100$$

Isolation and identification of pathogen *Alternaria porri*

Preparation of Potato Dextrose Agar (PDA) Media

200 grams of peeled and cut potatoes was boiled in 1000 ml of distilled water. The potato extract passed through muslin cloth and 20 grams each of agar-agar and dextrose was dissolved in it. pH was maintained at 5.6-6.5. The final volume was made up to 1000 ml by adding distilled water. For sterilization, The PDA solution was then poured into conical flasks and tubes, plugged with non-absorbent cotton and autoclaved at 121.6°C and 15 psi pressure, for 20 minutes. Slants were prepared by allowing the tubes to stand in inclined position.

Isolation and identification

Tissue culture method was used (Ali, 2008) to isolate the pathogen from the disease infected plants and identified using spore suspension technique. Infected leaves of garlic were collected. The infected leaves were cut into small pieces (0.5 cm^2), surface sterilized with mercuric chloride (0.1%) for 15-30 seconds, rinsed with three changes of sterile distilled water to remove the disinfectant and blotted dry.

The sterilized pieces were plated (4 pieces/dish) on potato dextrose agar (PDA) medium in. Petri plates under aseptic conditions and incubated at 25°C for 2 weeks. Pure cultures were obtained by sub culturing, for which small bits of the fungus were taken at the tip of a sterilized needle and transferred aseptically to the centre of fresh PDA medium

in Petri plates. The plates were incubated for 2 weeks at 25°C in the dark.

Results and Discussion

The first symptoms of purple blotch of garlic were observed in the field at 25-30 DAS. The characteristic symptoms of the disease were found in the form of white spots which produced sunken purple lesions with yellow to pale brown border. The affected leaves appeared to shrivel up and become dry with the brown to black coloured tips (Figure 1). In the subsequent days, the disease intensity of purple blotch continued to increase.

Based on the study of the morphological characters of the fungal culture obtained by the isolation of disease infected leaves, the pathogen was identified as *Alternaria porri*. Conidia were straight or curved with tapering beak, about the same size as the body or slightly longer, muriform and dark coloured (Figure 2). On PDA, the fungus produced septate, branched and light brown hyphae which turned darker with age.

Effect of treatments on plant growth parameters

Table 1 indicates that at all stages of the garlic crop, at 30, 60 and 90 DAS, treatment T_4 (*Trichoderma viride*) produced significantly superior results for all growth parameters *viz.*, plant height and number of leaves. This was followed by T_1 (Neem oil) and T_5 (*Trichoderma viride* + neem oil).

As illustrated in Fig. 3, comparatively, at 90 DAS, maximum plant height (cm) was recorded in treatment T_4 (57.56), followed by T_1 (55.04), T_5 (53.51), T_2 (52.67), T_3 (52.05), T_6 (51.63), T_7 (49.90) and T_0 (44.65) and the maximum number of leaves was recorded in treatment T_4 (5.93), followed by T_1 (5.60), T_2 (5.47), T_3 (5.37), T_5 (5.33), T_6 (5.30), T_7 (5.20) and T_0 (4.40).

Table.1 Effect of botanicals and *Trichoderma viride* on the plant height (cm) and number of leaves in Garlic at 30, 60 and 90 DAS

Treatments		30 DAS		60 DAS		90 DAS	
		Plant Height (cm)	No. of Leaves	Plant Height (cm)	No. of Leaves	Plant Height (cm)	No. of Leaves
T_0	Control	25.15	3.20	40.91	4.10	44.65	4.40
T_1	Neem oil 5%	35.30	5.20	53.00	5.40	55.04	5.60
T_2	Castor oil 5%	31.28	4.60	50.23	4.80	52.67	5.47
T_3	Clove oil 5%	30.33	4.50	50.89	4.60	52.05	5.37
T_4	***Trichoderma viride* 5%**	**38.30**	**5.60**	**54.50**	**5.87**	**57.56**	**5.93**
T_5	*T. viride* + Neem oil 2.5% + 2.5%	32.27	4.80	51.57	4.87	53.51	5.33
T_6	*T. viride* + Castor oil 2.5% + 2.5%	29.86	4.10	49.11	4.67	51.63	5.30
T_7	*T. viride* + Clove oil 2.5% + 2.5%	28.38	4.10	48.55	4.47	49.90	5.20
C.D. (5%)		1.198	0.262	0.857	0.363	0.968	0.270
SE(d) (±)		0.553	0.121	0.396	0.168	0.447	0.125

Table.2 Effect of botanicals and *Trichoderma viride* on the Disease Intensity of Purple Blotch disease in Garlic at 30, 60 and 90 DAS

Treatments		Disease Intensity (%)		
		30 DAS	**60 DAS**	**90 DAS**
T_0	Control (untreated)	9.86	37.53	48.63
T_1	Neem oil @5%	5.20	25.80	33.07
T_2	Castor oil @5%	7.20	30.07	37.02
T_3	Clove oil @5%	7.80	31.27	36.33
T_4	***Trichoderma viride* @5%**	**4.00**	**19.33**	**26.40**
T_5	*Trichoderma viride* (2.5%) + Neem oil (2.5%)	6.80	27.73	36.13
T_6	*Trichoderma viride* (2.5%) + Castor oil (2.5%)	8.80	31.30	39.93
T_7	*Trichoderna viride* (2.5%) + Clove oil (2.5%)	9.60	35.07	42.53
C. D		1.144	1.288	2.009
S. Ed. (±)		0.528	0.595	0.928

Fig.1 Purple blotch symptoms on leaves of garlic

Fig.2 Microscopic view of conidium of *Alternaria porri* from field sample of purple blotch of garlic

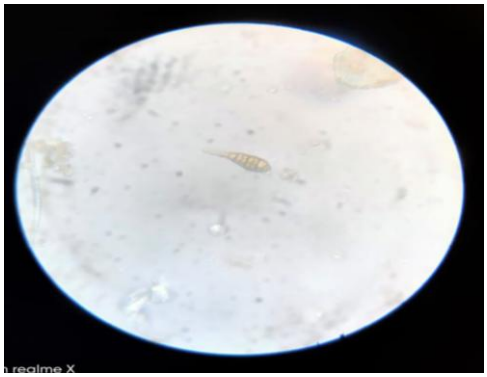


Fig.3 Effect of botanicals and *Trichoderma viride* on the plant height (cm) and number of leaves in Garlic at 30, 60 and 90 DAS

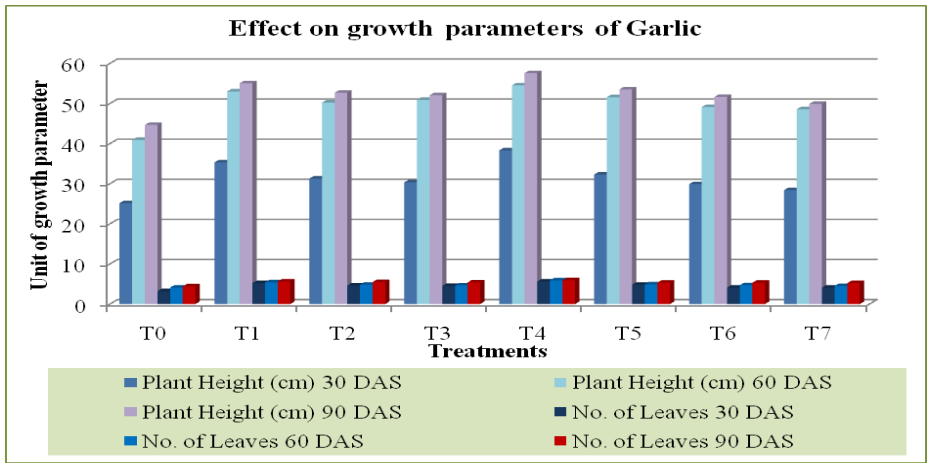
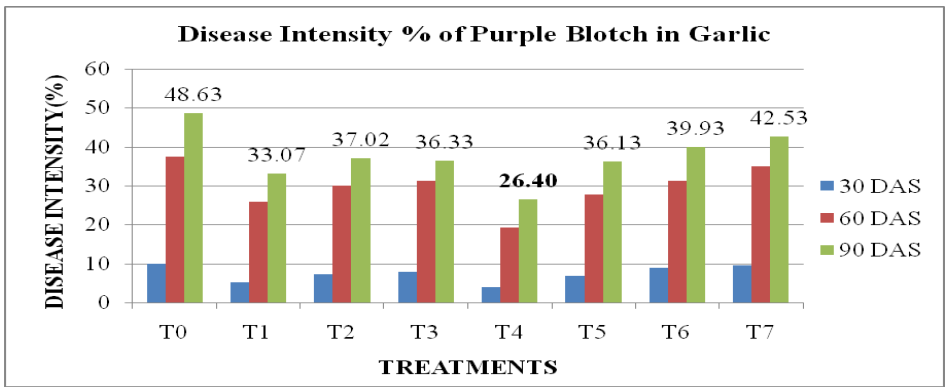


Fig.4 Efficacy of *Trichoderma* sp. and botanicals on Disease Intensity of *Alternaria porri* on garlic leaves at 30, 60 & 90 DAS



Effect of Treatments on Disease Intensity

As depicted in Table 2, T_4 treatment also exhibited the minimum disease intensity of purple blotch, thus providing the highest control for *Alternaria sp.* among the treatments. Treatment with *Trichoderma viride* resulted in minimum disease intensity of 4% at 30 DAS (Figure 3), 19.33% at 60 DAS and 26.40% at 90 DAS.

At 90 DAS, minimum DI percentage was recorded in T_4 (26.40%), followed by T_1 (33.07%), T_5 (36.13%), T_3 (36.33%), T_2 (37.02%), T_6 (39.93%), T_7 (42.53%) and T_0 (48.63%) (Figure 4).

Similar study has been done by Mishra and Gupta (2012) and Agale *et al.,* (2014**)** who reported that *Trichoderma viride* was effective against purple blotch with inhibition upto 56.15%. The control of *A. porri by* antagonistic effects of *Trichoderma viride, and* maximum reduction in growth of *A. porri* was observed *by* Rahman *et al.,* (2015**)**. Kapgate *et al.,* (2019) investigated the efficacy of biocontrol agents against *Alternaria porri and Trichoderma viride* (76.55% inhibition) showed best results. Bhandekar *et al.,* (2019) reported that the maximum inhibition of *A. porri* was recorded with *Trichoderma viride* (85.45%).

Based on the results obtained from present investigations it was concluded that bio-agent T_4 (*Trichoderma viride*) was the most effective treatment against purple blotch disease of garlic and also provided the best plant height and the maximum number of leaves. This was followed by T_1 (neem oil). T_4 (*Trichoderma viride*) caused 73.60% inhibition of purple blotch disease of garlic. The treatment resulted in inhibition of 96% at 30 DAS and 80.77% at 60 DAS and 73.60% at 90 DAS. Therefore, being beneficial and eco-friendly, easy to get for farmers, it may be recommended for the better management of purple blotch disease of garlic.

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