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Effect of Green Manure and Neem Oil on Anthracnose Disease of Chilli (*Capsicum annuum* L.)

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A B S T R A C T

Chilli (*Capsicum annuum* L.) is an important vegetable crop, cultivated around the world. Among different fungal diseases of Chilli, anthracnose caused by *Colletotrichum capsici* has currently become important disease for yield loss. An attempt was therefore made to, isolation Rhizobium from the collected rhizosphere soil samples from research plot. Where, the populations of rhizobia were counted and were found maximum at post - sowing stage. Therefore, effect of green manures (Cowpea, Sunhemp, Dhaincha, Green gram, Black gram, Cluster bean) with two foliar spray of neem oil@0.5% used against *Colletotrichum capsici* of anthracnose in chilli and growth parameters of chilli. Seven treatments were under taken with three replications and data was analyzed using RBD. Minimum disease intensity was recorded in T_4 - Sun hemp+ neem oil (25.79%) and maximum Yield T_4 - Sun hemp + neem oil (90.23q/ha) followed by T_6 -Dhaincha+neem oil (26.63%) with Yield (90.03q/ha), T_5 - Cluster bean +Neem oil (28.63%) with yield (84q/ha),T_1- Cowpea +Neem oil (33.36%) with yield (79.47q/ha), T_2-Black gram +Neem oil (29.57%) with yield (72.20q/ha), T_3-Green gram +Neem oil (31.56%) with yield (65.70q/ha) maximum disease intensity was recorded in control (43.40%) and lowest yield (49.47q/ha).

Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable and spice crop, cultivated around the world. It is not only used in cooking but also found to have many medicinal properties. The genus Capsicum contain about 20-25 species, out of which *C. annuum, C. baccatum, C. chinense, C. frutescens* and *C. pubescens* are cultivated. *Capsicum annuum* was widely cultivated variety, second being *C. frutescens* (Sahitya *et al.,* 2014). India contributes 25% of the world's total production of chilli. In India, chilli was mainly grown in states like Andhra Pradesh, Maharashtra, Karnataka, Gujarat, Tamil Nadu and Orissa (Lydia and Zacharia, 2012). Chilli has been affected by several diseases like fungal, bacterial and viral of which, chilli anthracnose causes significant damage, impose severe quantitative and qualitative losses. The estimated loss due to this disease is ranged from 8 to 60% in different parts of India. The disease symptoms can occur on

leaves, stems, and both pre- and post-harvest fruits. Typical anthracnose symptoms on chilli fruit include sunken necrotic tissues, with concentric rings of acervuli (Agrios, 2005). The fungus pathogen is both seed borne and air borne and affects seed germination and vigour to a greater extent (Gopinath *et al.*, 2006; Shovan *et al.*, 2008). Currently the disease is mostly managed by using chemical fungicides. The continuous and indiscriminate use of fungicides leads to toxic residues on chilli products, development of fungicide resistance and also serves as a cause for environmental pollution (Suji and Raj 2015). To overcome the undesirable effects of chemical usage, use of green manure amendments and neem oil to control the infection came at rescue. Investigations proved that application of green manure amendments significantly reduced the fruit rot incidence and enhanced the fruit yield and dry matter production.

Green manure is a type of cover crop grown primarily for two months that is meant to incorporated into the soil to improve the nitrogen supply and use of application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure and nutrient status of soil (Willumsen and Thorup, 2001) Investigations proved that application of green manuring significantly reduced the fruit rot incidence and enhanced the fruit yield and dry matter production.Green manures are rich in mineral, organic matters and bioactive compounds which help for better growth of plants and control of plant diseases (Nabin and Geetha, 2014) Legumes fix atmospheric nitrogen and mobilize less available nutrients from the soil; they also improve soil structure and decrease leaching losses of nutrients.

Neem oil is usually used as an insecticide but also has fungicide action. Although neem oil (or) water extracts of neem cake controls insects and pests, plant parasitic nematodes and Soil borne pathogens. (Pervaiz *et al.*, 2003) Neem oil evaluated for their effects on vector activities, disease incidence and yield attributing characters during Rabi 2019-20 cropping season. It reduces the disease incidence using the doses at different intervals (Gur jar *et al.*, 2012). Neem oil foliar spray after initiation of disease symptoms in order to have a higher profitable yield and higher economic return without health risk as well as environmental pollution.

Materials and Methods

The present work was carried out in the laboratory of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P.) during Rabi season 2019-20. The experiment was conducted in Randomized block design (RBD) in field consisting of seven treatments union with three replicates. Two foliar sprays of neem oil @ 0.5% at 15 days interval, starting first spray at appearance of anthracnose symptoms. One plot per replication was maintained as the control. Five plants per treatment per replication were selected randomly and tagged; three leaves (bottom, middle and top) from main branch on each observation plant were selected for recording observations. Observations on foliage anthracnose disease intensity were recorded applying standard 0-9 grade disease rating scale (Mayee and Datar, 1986) one day before each spraying and last observation was recorded.

Green manure preparation and application

Green manure seeds of each plant species were sown directly into their respective field where appropriate and seeds of cowpea (25kg/ha), cluster bean (10kg/ha), sunhemp (25kg/ha), green gram (15kg/ha), black gram

(15kg/ha), Dhaincha (25kg/ha) were sown and allowed to grow for about 60 days, before they reached to 50% flowering then they were incorporated into the soil. Therefore, the plots of green manures were allowed to decompose for 15days after incorporation. Then the chilli seedlings were transplanted in the respective field (Willumsen and Thorup, 2001)

Raising and transplanting of Chilli seedlings

The Chilli seeds were sown in pro trays which were filled with cocopeat and the local variety of chilli seeds were sown @ 3 seeds per cell at ¼ inch deep and the seeds were covered with potting mixture, water was sprinkled when required. After 5 weeks chilli seedlings were taken to the field while removing the seedlings, proper care was taken and transferred to the field with the spacing of 60 x 45 cm (row X row and Plant X Plant) (Gopakkali and Sharanappa, 2014).

Foliar spray of neem oil

Foliar spray of Neem oil @ 0.5% was done after the first appearance of *Colletotrichum* disease symptoms followed by two sprays at 15 days of interval by hand sprayer.

Isolation of *Colletotrichum capsici*

Isolation of pathogen was done following the procedure mentioned by Ahmed *et al.*, (2013).Infected leaf specimens were gathered from central research field SHUATS Allahabad. The leaf specimens were washed with tap water, the infected parts were cut into small pieces (5 mm), sterilized with 0.1% NaOCl for 2 min and washed in sterilized water for 3 times and dried between folds of purified filter paper. The washed leaf pieces were transferred to sterilized PDA plates and incubated at room temperature for 5 days. Mycelial bits were transferred to sterile Petri dishes containing PDA medium and pure cultures of the pathogens was maintained for further studies. The inoculated Petri plates were incubated at a temperature of 25 ± 1^0 c and observed periodically for the growth of emerging fungus developed from diseased tissues. The hyphal growth of the fungus was then transferred to PDA slants and Petri plates and incubated at $25^0C \pm 1^0$ c and pure culture thus obtained through hyphal tip was maintained.

Disease intensity

Standard disease rating scale (0-9 scale) was used for accessing PDI of anthracnose of chilli given by Mayee and Datar (1986).

Rating scale disease intensity

No symptoms on the leaf or branch or fruit.

1 Small, irregular brown spots covering 1 percent or less area of the leaf or branch or fruit.

Brown, dirty, pin headed spots covering 1-10 per cent area on the leaf or branch or fruit. Dark brown, dirty black spots with blackish margin covering 1 per cent of the area of leaf or branch or fruit.

Dark brown, circular or irregular spots with blackish covering 26-50 per cent area of leaf or branch or fruit.

Dark brown, circular or irregular spots with blackish covering 51 per Cent and above area of leaf or branch or fruit. The per cent disease index (Chester, 1959 and Wheeler, 1969) was calculated as,

$$\text{Percent disease index(PDI)}\ (\%) = \frac{\text{Sum of all individual disease ratings}}{\text{Total number of plants} \times \text{Maximum disease grade}} \times 100$$

Benefit cost ratio

Gross return was calculated by multiplying total yield with the market price of the produce. Cost of cultivation and cost of treatment imposition was deducted from the gross returns, to find out net returns and cost benefit ratio by following formula

$$B:C = \frac{\text{Gross return}}{\text{Cost of treatment}}$$

Were, B: C –Benefit and Cost ratio (Hossain *et al.*, 2010)

Results and Discussion

Result based on field experiment, the effectiveness of the soil, green manuring and foliar spray of neem oil on the plant growth parameters increases significantly as compared to control. The maximum plant height was observed in the treatment T_4 - Sun hemp + neem oil (49.92 cm) followed T_6 - Dhaincha + neem oil (49.13 cm), T_5 - Cluster bean + neem oil (48.46 cm), T_1 - Cowpea + neem oil (47.60 cm), T_2 - Black gram+ neem oil (46.50 cm), T_3 - Green gram + neem oil (46.30 cm). While minimum of plant height was recorded in untreated control (44.14 cm). Hiremath *et al.*, (2005) who observed and proved that green manuring gives more nutrients uptake to the soil for growth of the crop, significantly effective for growth of the plants and gives nutrients to the soil like N, P, K**.** In case, of fruit length the maximum was recorded in T_4 - Sun hemp + neem oil (9.05 cm) followed T_6 - Dhaincha + neem oil (9.0 cm), T_5 - Cluster bean + neem oil (8.96 cm), T_1 - Cowpea + neem oil (8.72 cm), T_2 - Black gram+ neem oil (8.63 cm), T_3 - Green gram + neem oil (8.6 cm). While minimum of plant height was recorded in untreated control (7.09 cm). Dileep and Shashikala (2009), Singh *et al.*, (2014) also reported similar findings inchilli crop, thereby increasing the availability of nutrients, especially protein synthesis and significantly increases in number of fruits (Fig. 1 and 2; Table 1 and 2).

Table.1 Effect of green manuring and neem oil on anthracnose isease intensity (%) of chilli at 30, 60 and 90 DAT

Sr.no	Treatments	Average of 3 replicates					
		Before spray	% reduction over control	1st spray of neem oil at 60DAT	% reduction over control	2nd spray of neem oil at 90DAT	% reduction over control
T_0	Control	18.66	_	34.93	_	43.40	_
T_1	Cowpea +Neem oil	18.16	26.35	25.37	27.36	33.36	23.13
T_2	Black gram +Neem oil	17.40	29.44	21.50	38.44	29.57	31.86
T_3	Green gram +Neem oil	18.13	26.48	22.16	36.55	31.56	27.28
T_4	Sun hemp +Neem oil	15.0	39.17	20.60	41.02	25.79	40.57
T_5	Clusterbean +Neem oil	16.66	32.44	20.80	40.45	28.63	34.03
T_6	Dhaincha + Neem oil	15.26	38.11	20.76	40.56	26.63	38.64
	SEd±	0.33		0.60		0.50	
	C.D (5%)	0.73		1.31		1.08	

Table.2 Effect of green manuring and neem oil on plant growth and yield of chilli

Sr.no	Treatments	Average of 3 replicates Plant height (cm)			Fruit length (cm)	Yield t/ha	C: B ratio
		30DAT	60DAT	90DAT			
T_0	Control	11.26	24.65	44.14	7.09	4.94	1:1.63
T_1	Cowpea + Neem oil	14.0	27.02	47.60	8.72	7.99	1:3.14
T_2	Black gram + Neem oil	13.5	26.69	46.50	8.63	7.22	1:2.75
T_3	Green gram + Neem oil	13.16	26.28	46.30	8.6	6.57	1:2.42
T_4	Sun hemp + Neem oil	15.42	29.50	49.92	9.04	9.02	1:3.67
T_5	Cluster bean + Neem oil	15.0	28.06	48.46	8.96	8.40	1:3.63
T_6	Dhaincha + Neem oil	15.33	29.26	49.13	9.0	9.0	1:3.65
	SEd±	0.70	1.24	0.48	0.23	0.13	_
	C.D (5%)	1.53	2.70	1.05	0.51	0.27	_

Fig.1 Effect of green manuring and neem oil on anthracnose disease intensity (%) of chilli at 30, 60 and 90 DAT

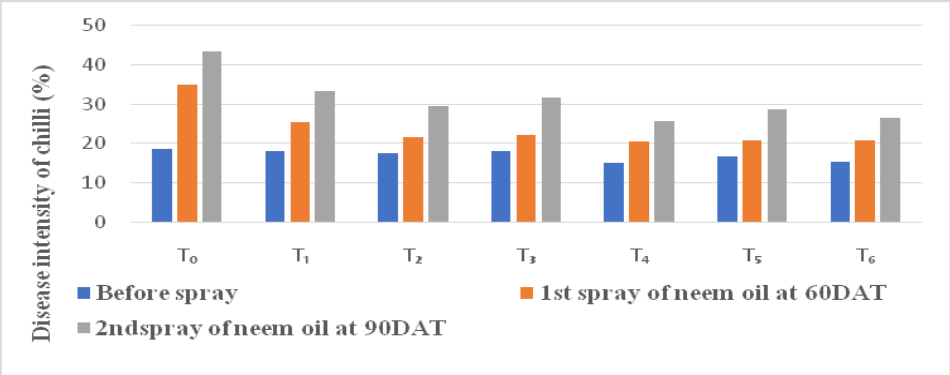

Fig.2 Effect of green manuring and neem oil on plant growth and yield of chilli

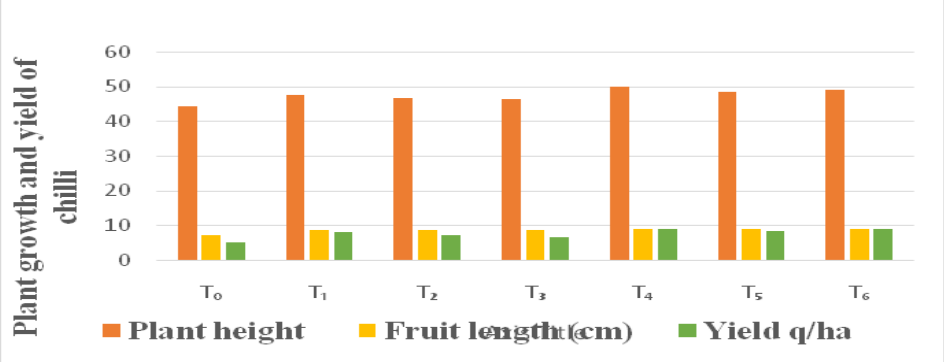

Plate.1

(a) pure culture of *Colletotrichum capsici*in plates(b) pure culture of *Colletotrichum capsici* in test tubes

(c) Leaf spotof Chilli(d) Fruit rot of chilli

Maximum disease intensity was observed in T_1 Cowpea + Neem oil (33.36%), followed by T_3 Green gram+ Neem oil (31.56%), T_2 Black gram + Neem oil (29.57%), T_5 Cluster bean + Neem oil (28.63%), T_6Dhaincha + Neem oil (26.63%), T_4 Sun hemp + Neem oil (25.79%). while minimum of disease intensity was recorded in untreated control (43.40 %). Ahmed *et al.*, (2001) observes that the effective treatment of two sprays of neem oil, which recorded disease incidence over control followed by neem oil. Bunker *et al.*, (2019)who observed, the foliar spray of neem oil was significantly effective to suppress the disease but, it was not effective for longer period due to less persistence period.

The maximum yield of chilli was recorded in the treatment was T_4 Sun hemp+ Neem oil (90.23q/ha) as compared to untreated control (49.47q/ha) and other was shown as T_6 - Dhaincha + neem oil (90.03q/ha), T_5 - Cluster bean + neem oil (84.07q/ha), T_1 Cowpea+ Neem oil (79.97q/ha), T_2 Black gram+ Neem oil (72.20q/ha), T_3 - Green gram + neem oil (65.70q/ha). Hongal, (2001) reported significantly higher yield of chilli due to green manuring of sunnhemp than green manuring of green gram and cowpea.

From the present study it was concluded that, the severity of anthracnose of chilli disease can significantly be reduced by the use of Neem oil at least two times foliar spray after initiation of disease symptoms in order to have a higher profitable yield and higher economic return without health risk as well as environmental pollution. Sun hemp + Neem oil @0.5% proved that best effect in maximizing the plant growth and also yield as well. It can be concluded that Sun hemp + Neem oil @0.5% is the most economical, eco-friendly way to control anthracnose of chilli. Therefore, the farmers may be advised

to take an integrated approach, which should be raised a profitable production without polluting the environment.

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