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Effect of Microalgae against Alternaria Blight of Flax (*Linum usitatissimum* L.)

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A B S T R A C T

Flax (*Linum usitatissimum* L.) is a food, fiber and oil seed crop cultivated in cooler regions. The oil content of the seed varies from 33–47%. In India it is grown mainly for seed used for extracting oil. The crop is affected by Alternaria blight caused by *Alternaria* spp. Different doses of microalgae were applied (@ 1.5, 2.5, 3.5, 4.5, 5.5 and 6.5 kg/acre) with irrigation at critical growth stages of crop (vegetative phase, flowering phase and maturity phase) and observations were recorded on plant growth parameters and per cent disease incidence of Alternaria Blight. Results revealed that, in field the application of microalgae i.e., 6.5kg/acre recorded minimum per cent disease incidence (23.08%) which was significant over other treatments and control (45.2%). Thus, the use of microalgae against Alternaria blight significantly reduced the per cent disease incidence and use of microalgae can be exploited for the management of blight diseases of flax.

Introduction

In India, the major linseed growing states are Madhya Pradesh, Maharashtra, Uttar Pradesh, Bihar, Rajasthan, Orissa, Karnataka, West Bengal, Assam, Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Punjab and Nagaland. Flax is a good source of energy for weight watchers, as it contains high fiber content, omega-3 fatty acids and antioxidants (Anonymous, 2005).

Flax crop is affected by several biotic stresses of which diseases like seedling blight, Brown stem blight (*Alternaria* spp.*)* and *(Alternaria linicola)* cause qualitative and quantitative reduction in yield. Alternaria blight or black bud in linseed is caused by three species of

Alternaria viz., *A. lini*(Dey, 1933), *A. linicola* (Groves and Skolko, 1944) and *A. infectoria*. However, *A. lini* is predominant under Indian conditions (Singh, 2004). The disease was reported for the first time from Kanpur, Gorakhpur, Uttar Pradesh (Dey, 1933). Later it was reported from IARI, Delhi (Arya and Prasad, 1952), Punjab (Kalia *et al.*, 1965) and Jabalpur.

The microalgae filterate exhibited an inhibitory activity against the fungal tested organisms. Significant stimulating effects were produced on the tomato seeds which previously soaked in *C. minutus* culture filtrate, in retarding the *Pythium* spp. symptoms (Ibrahim *et al.*, 2018).

Extracts from sea weeds (microalgae) sprayed on plants have been reported to reduce the incidence of *Botrytis cinera* (gray mold) on strawberries, *Erysiphe polygoni* (powdery mildew) on turnips, and damping-off of tomato seedlings (Kulik, 1995).

The Cynobacterial and algal extracts, the algal extracts used in the study showed higher efficiency towards antimicrobial activity.

Microalgae are able to produce biomass that might be used in different sectors such as: Fuel, food, animal feed, pharmaceutical and crop productions. Regarding crop productions, microalgae contain high levels of macronutrients and micronutrients essential for an optimal crop growth and development.

Arthrospira spp. and *Chlorella* spp. are the main microalgae species cultivated and used commercially. *Chlorella vulgaris* is an unicellular green algae which is one of the fast growing micro-algae. Green algae may produce phyto-harmones which can influence the growth of the plants (Czinkoczky and Nemeth, 2018) Micro-algae contain important quantities of plant growth harmones, auxins, abcisic acid, cytokinins have been proved to be one of the main active ingredient in micro-algae used as plant bio-stimulants (Oancea *et al.*, 2013).

Considering the above mentioned facts, a study entitled, “Effect of micro algae against Alternaria blight disease of flax (*Linum usitatissimum* L.) was undertaken.

Materials and Methods

Isolation and Identification of *Alternaria* spp. from leaf of flax

Isolation of *Alternaria* spp.

Infected leaves of flax were washed first in water and then in sodium hypochlorite to disinfect the surface of leaves. After that, leaves were cut into small pieces and transferred to the Petri plates containing PDA (four pieces per plate) and plates were incubated at 25±2^{0}C for 3-4 days in inverted position.

After 3-4 days, colonies of the fungus appeared and slides were prepared (Tuite, 1969). The fungus was purified through hyhal tip/single sclerotial method (Rangaswami and Mahadevan, 2004).

Identification of *Alternaria* spp.

The pathogen (*Alternaria* spp.) isolated in PDA was started growth as white-grayish airy mycelium at the margin with clear light to dark green inner zonation radiating from a common center. Dark brown conidia in chains were observed ranging in sizes from 5 to 35 µm.

The conidia surface was smooth to verruculose, slightly constricted with 4–6 transverse septa; the lower part of each portion had one or two longitudinal septa (David 1991, Malone and Muskett 1997, Barnett and Hunter 1998, Corlett and Corlett 1999).

Results and Discussion

Disease Incidence of Alternaria blight in flax at different DAS

Perusal of data (Table 1 and Figure 1) revealed minimum disease incidence in microalgae 6.5kg/acre treatment at 30 and 75 days after sowing (10.9% and 23.08%, respectively), followed by, microalgae 5.5kg/acre treatment (11.7% and 27.46%, respectively), microalgae 4.5kg/acre treatment (12.83% and 31.96%, respectively), microalgae 3.5kg/acre treatment (13.53% and 35.36%, respectively), microalgae 2.5kg/acre treatment (14.1% and 37.6%, respectively), microalgae 1.5kg/acre treatment (14.96% and 41.47%, respectively) and untreated check (15.16% and 45.2%, respectively). However, at 30 DAS the treatments ($T_2$and T_1) were found non-significant and statistically at par with each other. At 75 DAS all the treatments were found significant over control.

Plant growth parameters of flax

Plant height (cm)

Perusal of data (Table 2 and Figure 2) revealed maximum plant height (cm) in microalgae 6.5kg/acre treatment at 30, 60 and 90 days after sowing (20.1, 42.5, 89.5, respectively), followed by, microalgae 5.5kg/acre treatment (19.16, 40.3, 85.3, respectively), microalgae 4.5kg/acre treatment (17.96, 40, 78.2, respectively), microalgae 3.5kg/acre treatment (17.8, 35.3 and 73.8, respectively), microalgae 2.5kg/acre treatment (17.13, 35.9 and 71.63, respectively), microalgae 1.5kg/acre treatment (16.1, 35 and 50.2, respectively) and untreated check (15.46, 21.0 and 50.2, respectively). However, at 30 DAT the treatments (T_3 and T_4) were found non-significant and statistically at par with each other. At 60 and 90 DAT all the treatments were found significant over control.

Average number of branches/plant

Perusal of data (Table 3 and Figure 3) revealed maximum number of branches/plant recorded in microalgae 6.5kg/acre treatment at 30 and 90 days after sowing (4 and 5.6, respectively), followed by, microalgae 5.5kg/acre treatment (3.6 and 5.3, respectively), microalgae 4.5kg/acre treatment (3.3 and 5.3, respectively), microalgae 3.5kg/acre treatment (2.6 and 5.3, respectively), microalgae 2.5kg/acre treatment (2.6 and 5.0, respectively), microalgae 1.5kg/acre treatment (2.3 and 4.3, respectively) and untreated check (2.0 and 3.3, respectively). However, at 30 DAT the treatments (T_3 and T_4) were found non-significant and statistically at par with each other, At 60 and 90 DAT all the treatments were found significant over control.

Yield components of flax

Number of Pods per plant

Perusal of data (Table 4 and figure 4.1) revealed among all treatments maximum number of Pods per plant significantly increases in microalgae 6.5kg/acre treatment (67.3) followed by microalgae 5.5kg/acre treatment (64.6), microalgae 4.5kg/acre treatment (60.2), microalgae 3.5kg/acre treatment (55.2), microalgae 2.5kg/acre treatment (47.3) and microalgae 1.5kg/acre treatment (44.1) in comparison of control (40.8). However, all the treatments were significant over control.

Plant dry weight/plant (g)

Perusal of data (Table 4 and figure 4.2) revealed among all treatments maximum plant dry weight significantly increases in microalgae 6.5kg/acre treatment (9.53) followed by microalgae 5.5kg/acre treatment (9.34), microalgae 4.5kg/acre treatment (8.08), microalgae 3.5kg/acre treatment (7.10), microalgae 2.5kg/acre treatment (6.86) and microalgae 1.5kg/acre treatment (5.14) in comparison of control (4.43). However, all the treatments were significant over control.

1000 seed weight (g)

Perusal of data (Table 4 and figure 4.3) revealed among all treatments maximum 1000 seed weight significantly increased in microalgae 6.5kg/acre treatment (7.1) followed by microalgae 5.5kg/acre treatment (6.5), microalgae 4.5kg/acre treatment (6.2), microalgae 3.5kg/acre treatment (5.6), microalgae 2.5kg/acre treatment (5.2) and microalgae 1.5kg/acre treatment (4.8) in comparison of control (4.5). However, all the treatments were significant over control.

Grain yield (q/ha)

Perusal of data (Table 4 and figure 4.4) revealed among all treatments maximum grain yield significantly increased in microalgae 6.5kg/acre treatment (18.46) followed by microalgae 5.5kg/acre treatment (17.6), microalgae 4.5kg/acre treatment (16.7), microalgae 3.5kg/acre treatment (15.56), microalgae 2.5kg/acre treatment (14.4) and microalgae 1.5kg/acre treatment (14.26) in comparison of control (14.4). However, all the treatments were significant over control.

Stover yield (q/ha)

Perusal of data (Table 4 and figure 4.5) revealed among all treatments maximum stover yield significantly increased in microalgae 6.5kg/acre treatment (23.16) followed by microalgae 5.5kg/acre treatment (22.6), microalgae 4.5kg/acre treatment (21.53), microalgae 3.5kg/acre treatment (20.83), microalgae 2.5kg/acre treatment (20.36) and microalgae 1.5kg/acre treatment (19.96) in comparison of control (18.2). However, all the treatments were significant over control.

Table.1 Effect of microalgae on Disease incidence (%) at different DAS blight in flax

Treatment Details	30 DAS*	75 DAS*
T0-control	15.16	45.2
T1-Microalgae 1.5kg/acre	14.96	41.47
T2-Microalgae 2.5kg/acre	14.1	37.6
T3-Microalgae 3.5kg/acre	13.53	35.36
T4-Microalgae 4.5kg/acre	12.83	31.96
T5-Microalgae 5.5kg/acre	11.7	27.46
T6-Microalgae 6.5kg/acre	10.9	23.08
SEd(±)	0.251	1.412
CD (5%)	0.553	3.110

*Mean of Three Replications.

Table.2 Effect of microalgae on plant height (cm) of flax at different days interval

Treatment Details	Plant height (cm)*		
	30 DAS	60 DAS	90 DAS
T0-control	15.46	21	50.2
T1-Microalgae 1.5kg/acre	16.1	35	70
T2-Microalgae 2.5kg/acre	17.13	35.9	71.63
T3-Microalgae 3.5kg/acre	17.8	35.3	73.8
T4-Microalgae 4.5kg/acre	17.96	40	78.2
T5-Microalgae 5.5kg/acre	19.16	40.3	85.3
T6-Microalgae 6.5kg/acre	20.1	42.5	89.5
SEd(±)	0.300	2.671	1.759
CD (5%)	0.662	5.884	3.875

*Mean of three replications.

Table.3 Effect of treatments on average number of branches at 30 and 90 DAS interval

Treatment Details	30 DAS*	90DAS*
T0-control	2	3.3
T1-Microalgae 1.5kg/acre	2.3	4.3
T2-Microalgae 2.5kg/acre	2.6	5
T3-Microalgae 3.5kg/acre	2.6	5.3
T4-Microalgae 4.5kg/acre	3.3	5.3
T5-Microalgae 5.5kg/acre	3.6	5.3
T6-Microalgae 6.5kg/acre	4	5.6
SEd(±)	0.539	0.514
CD (5%)	1.188	1.133

*Average of 15 plants/treatment

Plate.1 Sub culture of *Alternaria* spp. (40x)

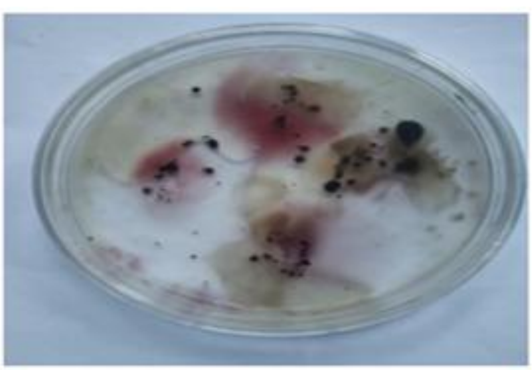


Plate.2 Conidia of *Alternaria* spp.

Fig.1 Effect of microalgae on Alternaria blight disease incidence (%) at different DAS

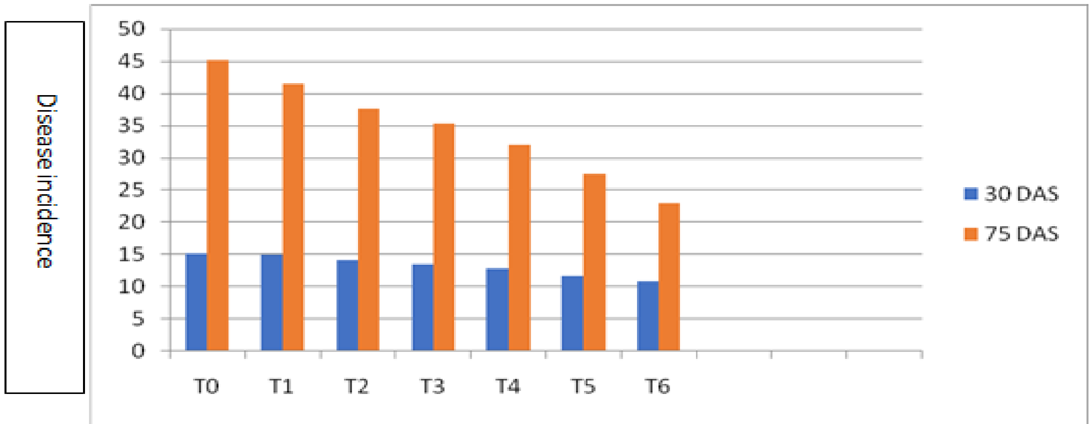


Plate.3 Infected and healthy plants of flax

Plate.4 Pathogencity test showing symptoms in inoculated plants (left pot)

Plate.5 Control plot

Plate.6 Microalgae 6.5kg/ha plot

Table.4 Effect of treatments on yield components of flax

Treatment Details	Yield components			Grain Yield (q/ha)	Stover Yield (q/ha)
	Number of pods per plant	Plant dry weight/plant(g)	1000 seed Weight (g)		
T0-control	40.8	4.43	4.5	13.4	18.2
T1-Microalgae 1.5kg/acre	44.1	5.14	4.8	14.26	19.16
T2-Microalgae 2.5kg/acre	47.3	6.86	5.2	14.4	20.36
T3-Microalgae 3.5kg/acre	55.2	7.1	5.6	15.56	20.83
T4-Microalgae 4.5kg/acre	60.2	8.08	6.2	16.7	21.53
T5-Microalgae 5.5kg/acre	64.6	9.34	6.5	17.6	22.6
T6-Microalgae 6.5kg/acre	67.3	9.53	7.1	18.46	23.16
SEd(±)	1.701	0.283	0.155	0.199	0.208
CD (5%)	3.747	0.623	0.342	0.439	0.459

Fig.2 Effect of microalgae on plant height(cm) of flax at different days interval

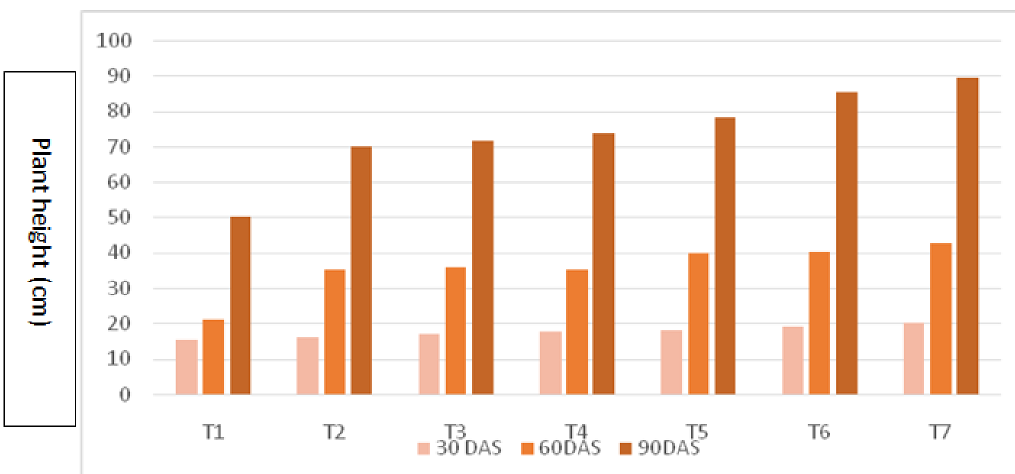


Fig.3 Effect of treatments on average number of branches at 30 and 90 DAS

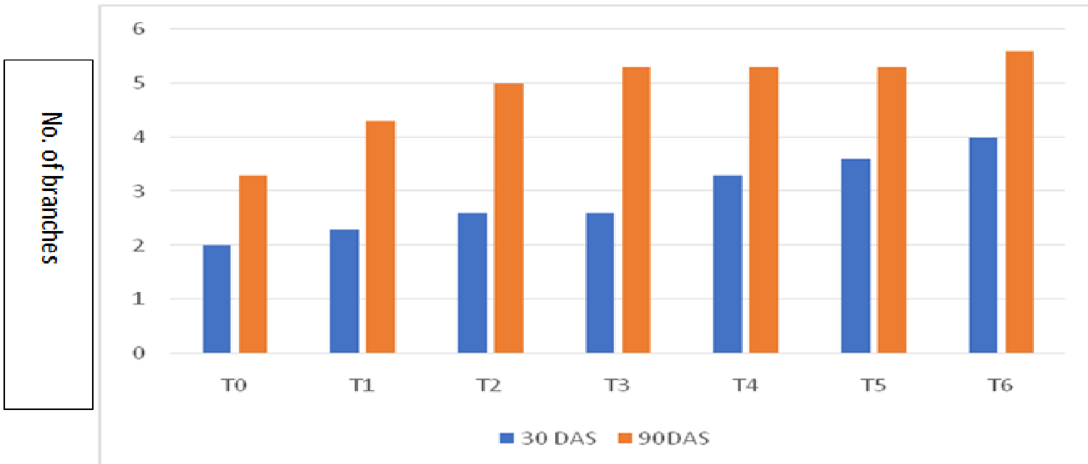


Fig.4 Effect of microalgae on yield parameters of flax

Fig.4.1 Number of pods/plant

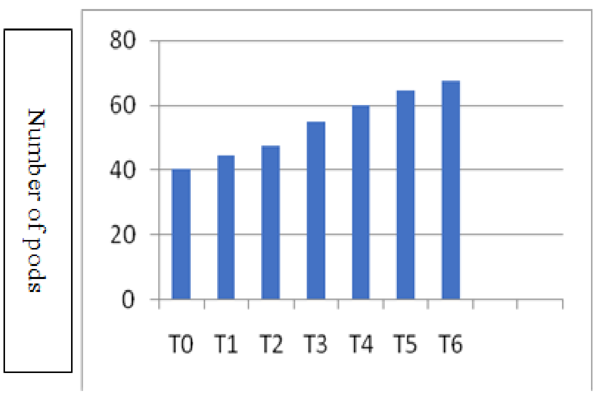


Fig.4.2 Plant dry weight(g)

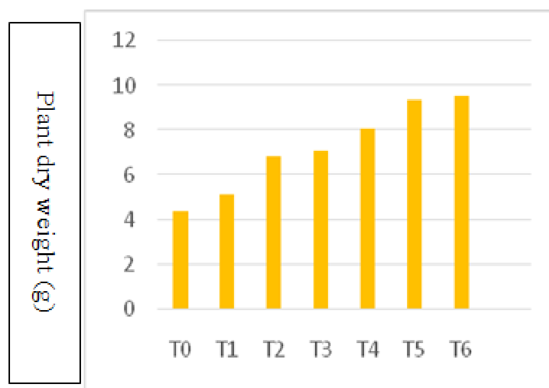


Fig.4.3 1000 seeds weight(g)

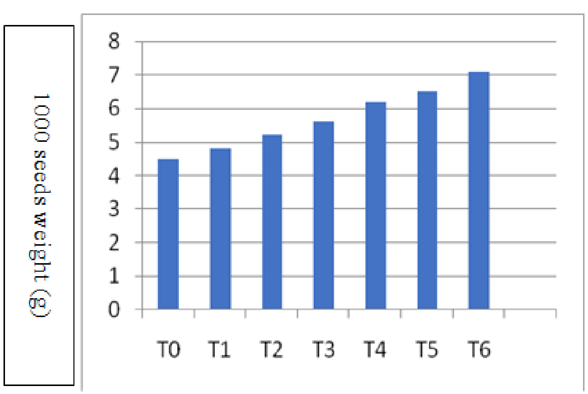


Fig.4.4 Grain yield(q/ha)

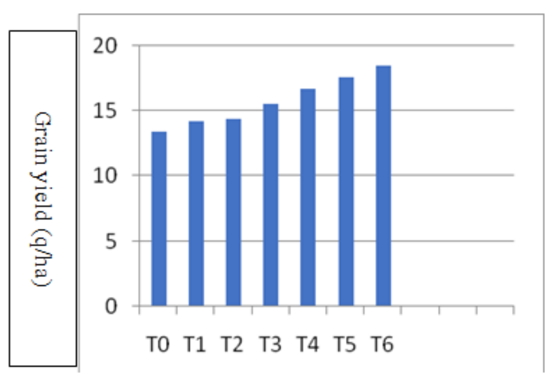
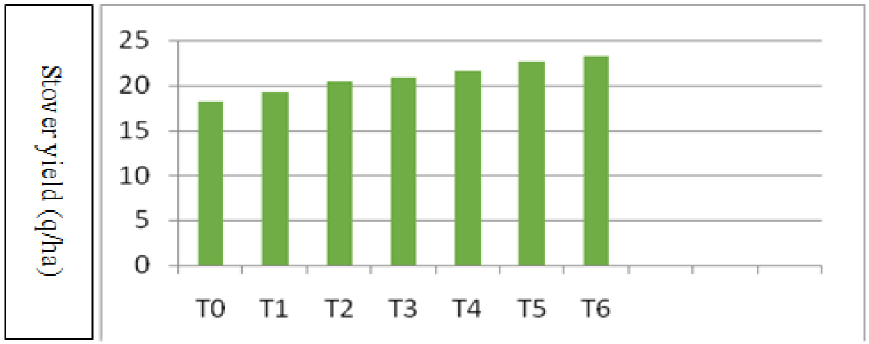


Fig.4.5 Stover yield (q/ha)



The present study reveals that the microalgae as soil application is effectively working on Alternaria blight disease management and has great impact on growth parameters. As the in-organic chemical use on crops is hazards to consumers and they leave the residues in soil which are harmful and loses the fertility of soil. Microalgae 6.5kg/ha recorded minimum disease incidence of Alternaria blight and maximum plant growth parameters and yield. So it concluded that the microalgae is best bio resource for management of Alternaria blight and has greater impact on growth parameters and yield. However, the present study was limited to one crop season under Prayagraj conditions, therefore to substantiate the present results more trials are needed for 2-3 seasons for further recommendation.

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