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THE POTENTIAL APPLICATION OF SEAWEEDS EXTRACTS TO CONTROL *FUSARIUM* WILT OF TOMATO UNDER FIELD CONDITION

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Abstract

Seaweed extracts are used as nutrient supplements, biostimulants or biofertilizers in agriculture and horticulture to increase plant growth and yield. In this study, we examined the effect of liquid seaweed extracts (LSEs) made from among the ten treatments tested, T_8-(T_5+T_6+T_7) significantly recorded (79.51) per cent disease reduction followed by T_5, T_6 and T_7 were statistically, which accounted 77.73, 77.13 and 73.31 per cent reduction of the disease. Among the treatment disease incidence was maximum in T_4- *Trichoderma viride* (20.00), which indicated (60.41) per cent disease reduction. The comparative check carbendazim reported (20.64) per cent wilt incidence, which accounted (59.41) per cent disease reduction.

Key words : Seaweed extracts, biofertilizers, liquid seaweed, *T. viride*.

Introduction

Vegetables are the most sought after diets in Indian cuisine. Tomato (*Lycopersicon esculentum* Mill. 2n = 24), a self pollinated crop is one of the important solanaceous vegetable crops grown widely all over the world because of its special nutritive value and also it's wider spread production (Ameer Junaithal Begum, 2016). *Fusarium* wilt of tomato caused by *Fusarium oxysporum* f. sp. *lycopersici* that is one of the economically most important disease in major tomato growing regions worldwide (Abdallah *et al*., 2016). It is a highly destructive pathogen, causing 10 to 50% yield loss in many tomato production areas (Ghazalibiglar *et al*., 2016). *Fusarium* wilt caused by *Fusarium udum* is the most important soil borne disease of pigeon pea capable of causing 30-100% loss in grain yield (Reddy *et al*., 1990). However, the widespread use of chemical fungicides has been a subject of public concern and security due to their potentially harmful effects on the environment and human health and their undesirable effect on non-target organisms. The most common method to check the disease is by using fungicides, but the frequent and indiscriminate use of fungicide leads to atmospheric pollution and development of fungicide resistance in pathogens. In recent years, biological control has become a promising alternative to chemical control in the management of soil borne disease. Seaweed species are rich in amino acids and bio-plant enhancers and often regarded as underutilized bio-resources. More than 33 species of seaweeds are identified in coastal regions of Tamil Nadu. Many are being used as food, industrial raw materials, cosmetics and therapeutics for centuries. Seaweed induced systemic resistance in cotton against charcoal rot and also improved plant growth as reported by Rahman *et al*. (2017). Application of seaweed as soil amendment for the control of soil borne plant diseases has increased in recent years due to their environmentally friendly role. Marine algae exhibit antiviral, hypocholesterolemic, hypertensive, antibacterial, anticoagulant, antihelmintic, anticancer, antialgal, cytotoxic and antifungal activities (Saleh *et al*., 1993). Seaweed extracts are known to enhance seed germination, improve plant growth, and induce resistance to frost, fungal and insect attack and increase nutrient uptake from the soil (Mohan *et al*., 1994; Venkataraman *et al*., 1993). In recent years, there have been many reports of macro Marine bioactive substances extracted from seaweeds have been used for several decades to enhance plant growth and productivity (Rathore *et al*., 2009). The

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Brown seaweed extract is a well known plant growth stimulator, which improves general plant health and enhances plant resistance to nematodes, pests and fungal diseases (Jayaraj *et al*., 2008).

Materials and Methods

Survey of the incidence of *Fusarium* wilt disease in tomato

A survey was undertaken during 2015-2016 in major tomato growing of Tamil Nadu *viz*., Tirunelveli, Madurai, Salem, Dharmapuri, Ariyalur, Cuddalore, Coimbatore, Pudukottai, Krishnagiri, Viruthunagar districts in Tamil Nadu. In each district two to three villages were selected to assess the *Fusarium* wilt incidence. The names of the villages surveyed along with districts are listed. In each village, four fields were selected and four plots in each field having an average area of ten square meters were marked at random. Total and infected plants were counted in all the selected fields and the wilt incidence was calculated by using the following formula:

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Isolation and identification of the pathogen

The pathogen was isolated from the root and stem samples of tomato collected from the fields. The segments were surface sterilized with 10% sodium hypochloride solution for 5 min and rinsed twice with sterilized distilled water. The excised segment were then placed on sterilized filter paper to dry. After drying,0.5 cm sections were cut from both ends of the segments and the center segments placed on potato dextrose agar (PDA). The plates were incubated at 28^0C for 24-48 h. Fungal colonies growing out of the stem or root segments were transferred to fresh PDA. The transfers were allowed to grow until sporulation had occurred and single spore culture was then prepared (Roslianah and Sariah, 2010).

Field experiments

Two field trials were conducted in farmers' holdings comprising one at Vallampadukai in Caddulore district of Tamil Nadu during January to April 2017 to test the efficacy of seaweeds against *Fusarium* wilt disease under drip irrigation. The experiments were laid out in Randomized Block Design with nine treatments. Three replications for each treatment were maintained. Tomato PKM 1 variety was used for field experiments. In the field, the tomato seeds were seed treatment with a seaweed aqueous solution @ 10 ml/kg. Seedling dip @ 1000ml per ha. were performed transplanted in the field. The foliar spray of 30% seaweed aqueous carried of 45 days after transplanting. The soil application of *Trichoderma viride* at 2.5kg per ha. was done after sowing.

Treatment details

T_1 - ST with *Sargassum wightii* aqueous formulation @ 10 ml/kg

T_2 - ST with *Enteromorpha compressa* aqueous formulation @ 10 ml/kg

T_3- ST with *Gracillaria corticata* aqueous formulation @ 10 ml/kg

T_4- ST with *Trichoderma viride* talc 5g/pot

T_5 - ST (10 ml/kg) + SD @ 1000 ml/ha+FS 20 lit/ha with *Sargassum wightii*+SA (2.5 kg/ha) Tv1

T_6 - ST (10 ml/kg) + SD @ 1000 ml/ha+FS20 lit/ha With *Enteromorpha compressa*+ SA (2.5 kg/ha) Tv1

T_7 -ST (10 ml/kg) + SD (1000 ml/ha) + FS 20 lit/ha with *Gracillaria corticata* + SA (2.5 kg/ha) Tv1

T_8- ST (10 ml/kg) + SD (1000 ml/ha) + FS20 lit/ha with T_5+T_6+T_7

T_9- ST (2 g/kg) + SD (0.1%) + SA with chemical control @ 0.1% Carbendazim

T_{10}- Pathogen inoculated Control

T_{11}- Healthy control

ST : Seed Treatment SD: Seedling dip

SA : Soil application as drench

Assessment of disease incidence of wilt

$$\text{Per cent disease Incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Yield assessment

The seaweeds aqueous formulation of brown algae *Sargassum wightii* was tested for their efficacy on growth promotion. The yield of ripened fruits per plant was recorded.

Assay of lycopene content in tomato fruits

Ten g of sample was extracted with acetone. The acetone extract was transferred to a separating funnel containing 15 ml of petroleum ether and mixed gently. The lower acetone phase was diluted with water containing five per cent sodium sulphate and then transferred to another funnel. The extraction was repeated with petroleum ether. An 68 aliquot of 5 ml was diluted to 50 ml and the colour was read at 503 nm in a spectrophotometer against petroleum ether as blank. The lycopene content of the sample was calculated by the following formula expressed as mg 100 g spectrophotometer against petroleum ether as blank. The lycopene content of the sample was calculated by the following formula expressed as mg

$$\frac{100\ g^{-1}.3.1206 \times \text{O.D value of sample} \times \text{volume made up} \times \text{dilution} \times 100}{1.0 \times \text{weight of sample} \times 100}$$

Results

Efficacy of seaweeds and biocontrol agent, chemicals and their combination against incidence of wilt disease and growth parameters of tomato in field condition

Among the ten treatments tested, T_8 (T_5+T_6+T_7) significantly recorded 79.51 per cent disease reduction followed by T_5, T_6 and T_7 were statistically, which accounted 77.73, 77.13 and 73.31 per cent reduction of the disease. Among the treatment disease incidence was maximum in *Trichoderma viride* (20.00 per cent), which indicated 60.41 per cent disease reduction. The comparative check carbendazim reported 20.64 per cent wilt incidence which accounted 59.14 per cent disease reduction (table 1). The treatment T_8 (T_5+T_6+T_7) was found to increase the shoot length of 38.93 cm and root length (8.95 cm) with more number of fruits (16.00) than other treatments. The treatment T_4- *Trichoderma viride* was found to be least effective in respect of growth parameters (table 2). Tomato yield was highest in the treatment T_8 (T_5+T_6+T_7), which recorded kg/ha with C:B ratio 1:4.39 (table 3).

Discussion

In the present study, application of seaweeds as consortial fertilizers was more effective in suppressing the wilt of tomato caused by *F.o.*f.sp. *lycopersici* rather than individual application of seaweeds under field condition. The maximum T_8-(SA+FS+SD with T_5 + T_6 + T_7) significantly recorded (79.51) per cent disease reduction followed by T_5, T_6 and T_7 were statistically which accounted (.73, 77.13 and 73.31 per cent reduction) of the disease Consortial formulation of T_3, T_4 and T_9 recorded the least disease incidence of wilt under field condition. The tomato plants were inoculated with *F. oxysporum* to test the capability of the fungus producing disease symptoms in tomato *in vivo*. In the present study the inoculated plant showed wilting symptoms and percentage of disease incidence was (62.64%) (Nesrain Abdul Karem Al-Mekhlafi *et al*., 2019). In the present day world, the seaweed fertilizers are often found to be more successful that the chemical fertilizers. The brown pigments of Phaeophytes is due to the dominance of xanthophylls and fucoxanthin pigments and the reason

Table 1 : Effect of seaweeds antagonistic chemical and their combination on *Fusarium* wilt incidence of tomato plant in field condition.

S. no.	Treatments	Disease incidence (%)						Mean disease incidence (%)	Percent reduction over control (%)
		10 DAS	25 DAS	40 DAS	55 DAS	70 DAS	85 DAS		
1.	**ST with *Sargassum wightii***	3.05(10.05)	6.67(14.96)	10.12(18.54)	15.50(23.18)	20.18(26.69)	29.62(32.97)	14.19	71.91e
2.	**ST with *Enteromorpha compressa***	2.48(9.06)	7.75(16.16)	10.46 (18.87)	15.77(23.39)	25.50(30.33)	32.48(34.74)	15.74	68.84f
3.	**ST with *Gracillaria corticata***	3.82(11.27)	9.45(17.90)	12.68(20.86)	16.78(24.18)	26.35(30.88)	30.42(33.47)	16.58	67.18
4.	**ST with *Trichoderma viride*$_1$**	3.95(11.46)	11.44(19.76)	18.72(25.63)	21.65(27.73)	29.72(33.03)	34.56(36.00)	20.00	60.41
5.	**SA+FS+SD withT1+T4**	3.25(10.38)	5.22(13.20)	9.55(18.00)	11.46(17.57)	17.92(20.63)	20.12(25.17)	11.25	77.73
6.	**SA+FS+SD withT2+T4**	2.15(8.43)	5.79(13.92)	9.12(17.57)	12.42(20.63)	18.10(25.17)	21.76(27.80)	11.55	77.13
7.	**SA+FS+SD withT3+T4**	3.34(10.53)	6.25(14.47)	9.75(18.19)	11.92(20.19)	20.18(26.69)	29.44(32.86)	13.48	73.31
8.	**SA+FS+SD withT5+T6+T7**	0.75(4.96)	4.86(12.73)	9.72(18.16)	11.00(19.37)	16.00(23.57)	19.77(26.40)	10.35	79.51
9.	**Carbendazim (0.1%)**	2.60(9.27)	9.18(17.63)	17.65(24.84)	22.50(28.31)	32.56(34.79)	39.40(38.88)	20.64	59.14
10.	**Control**	17.68	29.45	38.92	54.69	72.87	85.96	50.52	-

*Mean of three replications, Figure in the parentheses are arc sine transformed values, DAS = Days After Sowing.

CD (P = 0.05)

Treatments = 0.45, Days = 0.25, Treatments × Days = 1.87

Table 2 : Effects of seaweeds, antagonists and their combination on growth parameter of tomato plant in field condition.

S. no.	Treatments	Shoot length(cm)*	Root length(cm)*	Number of fruits /plant*
1	**ST with *Sargassum wightii***	33.45	7.79	10.00
2	**ST with *Enteromorpha compressa***	33.37	7.22	8.33
3	**ST with *Gracillaria corticata***	32.24	6.42	7.00
4	**ST with *Trichoderma viride*$_1$**	28.56	5.34	6.33
5	**SA+FS+SD withT1+T4**	37.43	8.86	15.00
6	**SA+FS+SD withT2+T4**	36.23	8.76	14.33
7	**SA+FS+SD withT3+T4**	35.52	7.98	12.00
8	**SA+FS+SD withT5+T6+T7**	38.93	8.95	16.00
9	**Carbendazim (0.1%)**	25.64	5.27	6.00
10	**Control**	22.85	5.15	5.00
	CD (P=0.05)	**0.58**	**0.15**	**0.08**

* Mean of three replications.

Table 3 : Yield of tomato in field condition and cost benefit ratio.

Treatments	Yield Kg/Plot	Fruit yieldt/ha	Percent increasein yield	C:B ratio
ST with *Sargassum wightii*	47.75	48.00	10.70	1:2.92
ST with *Enteromorpha compressa*	45.15	46.25	7.67	1:2.85
ST with *Gracillaria corticata*	44.00	45.90	15.76	1:2.57
ST with *Trichoderma viride*$_1$	42.00	44.90	18.68	1:2.54
SA+FS+SD withT1+T4	62.55	55.54	8.00	1:3.23
SA+FS+SD withT2+T4	50.55	52.60	9.48	1:3.20
SA+FS+SD withT3+T4	48.00	50.55	8.16	1:3.05
SA+FS+SD withT5+T6+T7	60.10	58.65	5.30	1:3.40
Carbendazim (0.1%)	40.00	40.00	10.00	1:1.45
Control	33.67	36.86	-	-

* Mean of three replications

for red color in Rodophytes is due to phycoerythrin pigment. The present study intends to investigate the effect of Seaweed Liquid Fertilizer (SLF) prepared from *G. textorii* and *H. musciformis* on the seed germination, growth and fruit development of various vegetable crops such as Brinjal, Tomato. In the developing world, the use of seaweed liquid fertilizer should be urged to avoid environmental pollution by heavy doses of chemical fertilizer in the soil. The growth enhancing potential of seaweeds might be attributed to the presence of carbohydrates, phenylacetic acid (Taylor and Wilkinson, 1997). There are several workers have been reported on the efficacy of seaweed extracts against fungal pathogens (Norrie *et al*., 2002; Jayaraet *et al*., 2008). *F. oxysporum* f. sp. *lycopersici* were found to be less sensitive to *N. glauca* organic extracts as compared to aqueous extracts (Asma Rinez *et al*., 2012). Biostimulants are organic matters, when applied in small amount can enhance plant growth, while efficacy of traditional plant nutrients are unable to produce similar benefits (Hamed *et al*., 2017). Some seaweed besides suppressing root rotting fungi and root knot nematode also improved plant growth. Seaweed has been used as biostimulant in agriculture that enhanced plant growth and yield. Interest in the application of seaweed extract has been increasing recently due to their plant growth promoting properties, triggering disease resistance pathway and increasing stress tolerance (Arioli *et al*., 2015). In field experiments, application of seaweed as a soil amendment caused a marked reduction of pathogenic fungi and root knot nematode on cotton roots. The suppressive effect of seaweed on root pathogens is comparable with commercial fungicide and nematicide in reducing the fungal root infection, nematode galls on roots and nematode population in soil around roots (Vicar Sultana *et al*., 2018).

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