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Influence of Organic Amendments and Inorganic Fertilizers on Late Blight Incidence and Yield of Tomato (*Lycopersicon esculentum* Mill.)

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Abstract: ***The influence of organic amendments and inorganic fertilizers on natural infestation of late blight and fruit yield of tomato was investigated with an aim to develop best possible nutrient schedule for tomato. The treatments were selected for sole and combined application of varied levels of vermicompost and farmyard manure along with 100% and 75% of recommended dose of fertilizers (RDF-100:60:60 kg N P K ha^{-1}) in presence and absence of biofertilizer. Fourteen treatment combinations were laid out in RBD with three replications. The result revealed that none of the treatments were found completely free from late blight incidence, however the incidence varied in different treatments. Higher levels of vermicompost emerged as better organic nutrient source over that of farmyard manure and use of biofertilizer exerted more benefits over the uninoculated treatments. Application of 75% RDF along with vermicompost (4 tonnes ha^{-1}) inoculated with biofertilizer recorded significantly lowest percent disease index (PDI-13.84%) and produced highest marketable fruit yield (26.14 tonnes ha^{-1}) compared to highest PDI of 31.62% and lowest fruit yield (15.42 tonnes ha^{-1}) by the treatment containing 100% sole inorganic fertilizers.***

Keywords: Late blight of tomato, organic amendments, inorganic fertilizers

1. Introduction

Tomato is an important and popular vegetable extensively grown throughout the world. Late blight disease is one of the major constraints in tomato production during winter months that drastically reduces the crop growth and fruit yield. The disease is caused by the pathogen *Phytophthora infestans*. The same pathogen that caused the Irish Potato Famine in the 1840s. The disease can be destructive under cool, cloudy and high humid condition. Under such weather, the pathogen can produce a lot of wind-dispersed spores and multiply very fast causing infection to new plants. Farmers are indiscriminately using hazardous fungicides to control the late blight incidence that leads to several ill effects such as resistance development, resurgence of newer strains of pathogens and ultimately affecting soil, ground water, environment and consumers health. Again excess use of chemical fertilizers especially nitrogen can often promote succulence and excessive vegetative growth that may increase the susceptibility of disease pathogen. The potential of organic amendments over synthetic inorganic fertilizers in suppression of disease incidence has long been recognized. Evidence of suppression of disease attack by different forms of organic amendments has been reported by various researchers [1-3]. Organic amendments provides more balanced and better timed source of nutrition for plant growth through the gradual decomposition of the organic matter by microorganisms and slower mineralization and release of nutrients that it contains[4-5]. Litterick and Wood [6] pointed out that disease suppression usually results from the competition for nutrients and ecological niches by numerous bacterial and fungal species that adversely affect the activity of, or induce microbiostasis of plant pathogens. Vermicompost, a organic manure obtained in the form of casting of ingested biomass by earthworm after undergoing physical, chemical and microbial transformations. Besides macro and micronutrients it also contains humic acids, plant growth promoting substances like auxins, gibberellins, and cytokinins [7], N-fixing and P-solubilizing bacteria, enzymes and vitamins [8]. The water soluble components of vermicompost such as humic acid, growth regulators, vitamins, micronutrients and beneficial microorganism increases the availability of plant nutrients, results in increased growth, higher yield and better quality produce [9]. In addition to vermicompost, farmyard manure and biofertilizers also play vital role as organic nutrient sources for sustainable soil health and crop growth [10]. The present work was formulated to evaluate the comparative performance of organic and inorganic sources of nutrients on incidence of late blight and fruit yield of tomato.

2. Materials and methods

The field experiment was conducted at the experimental field of UBKV, Pundibari, CoochBehar, West Bengal (89°23′53″ E longitude and 26°19′86″ N latitude) during winter season (November to March) of 2005-2006 and

2006-2007. The soil was well drained sandy loam having pH of 5.74, organic carbon content 0.85% and available N, P_2O_5, K_2O, were 155.85 kg ha^{-1}, 20.23 kg ha^{-1} and 125.90 kg ha^{-1} respectively. The treatment consisted of 14 combinations of different nutrient sources and was laid out in randomized block design with three replications. The treatments were selected for sole and combined application of varied levels of vermicompost and farmyard manure (FYM) along with 100% and 75% of recommended dose of inorganic fertilizers in presence and absence of biofertilizer. The combinations were T_1-100% Recommended dose of fertilizer (RDF) (100:60:60 kg N P K ha^{-1}) ; T_2-100% RDF + 6 tonnes FYM ha^{-1} + biofertilizer; T_3-100% RDF + 2 tonnes vermicompost ha^{-1} + biofertilizer ; T_4-100% RDF + 3 tonnes FYM ha^{-1} + 1 ton vermicompost ha^{-1} + biofertilizer ; T_5 -75% RDF + 6 tonnes FYM ha^{-1} ; T_6 -75% RDF + 6 tonnes FYM ha^{-1} + biofertilizer ; T_7 -75% RDF + 2 tonnes vermicompost ha^{-1} ; T_8-75% RDF + 2 tonnes vermicompost ha^{-1} + biofertilizer ; T_9 -75% RDF + 3 tonnes FYM ha^{-1} + 1ton vermicompost ha^{-1} + biofertilizer ; T_{10} - 75% RDF + 12 tonnes FYM ha^{-1} ; T_{11}-75% RDF +12 tonnes FYM ha^{-1} + biofertilizer ; T_{12}-75% RDF + 4 tonnes vermicompost ha^{-1} ; T_{13}-75% RDF + 4 tonnes vermicompost ha^{-1} + biofertilizer and T_{14} -75% RDF + 6 tonnes FYM ha^{-1} + 2 tonnes vermicompost ha^{-1} + biofertilizer. Tomato seedlings (cv. Pusa Ruby) were transplanted in 3.75 m × 3.75 m plots with a spacing of 75 cm within and between rows. Vermicompost and farmyard manure were applied to the respective plots at the time of transplanting. *Azophos, Azotobacter* and phosphate solubilizing bacteria (PSB) containing biofertilizer were applied as seedling dipping (250 g $litre^{-1}$ water) just before transplanting. Full dose of P_2O_5 and K_2O along with half N were applied as basal and rest N was top dressed at 30 days after transplanting. The crop was raised adopting standard cultural practices. To record the late blight incidence, ten plants per plot were randomly selected and disease scoring was done with the help of disease scoring scale (0-9 scale), thereafter percent disease index (PDI) was worked out as suggested by McKinney [11].

$$PDI\ (\%) = \frac{\text{3. Sum of all ratings}}{\text{No. of plant examined} \times \text{maximum score}} \times 100$$

Two years data collected on PDI and fruit yield of tomato were pooled and statistically analyzed as per method suggested by Panse and Sukhatme [12].

3 Results and discussion

The findings revealed that none of the treatments were found completely free from late blight incidence, however the occurrence of late blight was significantly influenced with the differences in source of nutrition(Table 1). The weather condition of the second year of experimentation was more favourable for late blight development in tomato plants (Fig. 1). The maximum incidence of late blight was recorded among the treatments containing 100% inorganic fertilizers treatment combination (T_1 to T_4) as compared to the treatments having 75% inorganic fertilizers treatment combination(T_5 to T_{14}). Among the inorganic fertilizers treatment combination, the highest PDI (31.62%) was recorded for the treatment containing 100% sole inorganic fertilizers (T_1). Tomato plants grown in the nutrient combination having 75% inorganic fertilizer along with higher amount of organic manures (T_{10} to T_{14}) significantly reduced the late blight incidence. The result also showed that presence of biofertilizer had pronounced the efficiency of vermicompost and farmyard manure. However higher levels of vermicompost performed better over farmyard manure as organic amendment for late blight suppression and yield enhancement of tomato. The treatment combining 75% RDF of inorganic fertilizers and highest level of vermicompost (4 tonnes ha^{-1}) inoculated with biofertilizer (T_{13}) emerged as best nutrient source and recorded lowest PDI (13.84%) and produced highest marketable fruit yield (26.14 tonnes ha^{-1}) resulted in 41% improvement in fruit yield over the control. The finding indicated that reduced levels of inorganic fertilizers and increased levels of organic manures were highly effective in reducing the incidence of late blight in tomato. Vermicompost contains a well balanced composition of nutrients. The combined application of optimum levels of inorganic fertilizers and higher amount vermicompost might have improved the physicochemical and biological characteristics of the growth medium and favoured the growth of soil micro flora which subsequently resulted in greater uptake of plant nutrients and healthy plant growth [13]. The humic acid and humic substances of vermicompost might have provided growth promoting substances, vitamins and enzymes which were not available in sole inorganic fertilizers and these probably have increased the plant resistance to pathogen. Joshi *et al.*,[14] opined that the suppressive effect of compost is predominantly biological rather than chemical or physical in nature. Hoitink and Fahy [15] described four different mechanisms through which biological control agents (BCAs) suppresses plant pathogens namely antibiosis, competition for nutrients, parasitism or predation, and induced systemic resistance. However the major role in determining the ability of compost to suppress plant pathogens is played by the microbes involved in organic matter decomposition [16].

Fig. 1: Meteorological parameters at different months during field experiment

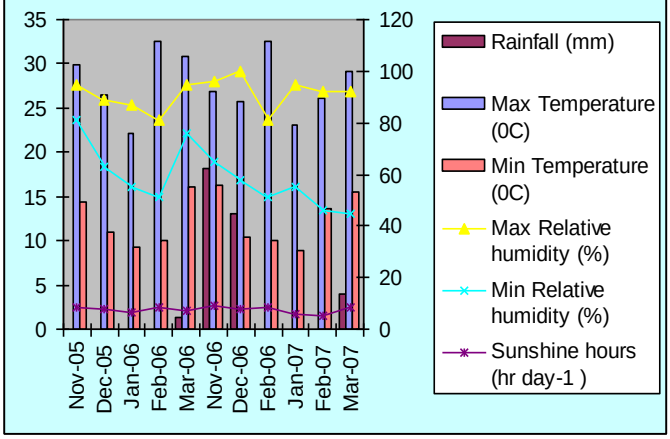

Table 1. Effect of different nutrient sources on late blight incidence of tomato

*Treatments	Percent disease index (%)			Fruit yield (tonnes ha^{-1}) (Pooled mean)
	1st year	2nd year	Pooled mean	
T_1	29.70	33.54	31.62	15.42
T_2	27.43	29.35	28.39	21.67
T_3	25.56	29.08	27.32	22.20
T_4	26.10	29.64	27.87	21.89
T_5	23.45	27.33	25.39	19.68
T_6	23.90	25.68	24.79	20.23
T_7	22.48	25.20	23.84	20.89
T_8	20.39	23.87	22.13	21.48
T_9	22.27	25.09	23.68	21.13
T_{10}	16.04	18.20	17.12	22.76
T_{11}	14.59	18.09	16.34	23.82
T_{12}	12.87	15.89	14.38	24.26
T_{13}	12.48	15.2	13.84	26.14
T_{14}	13.37	16.87	15.12	24.83
S.Em (±)	0.47	0.51	0.43	0.98
CD (P=0.05)	1.38	1.49	1.26	2.77

R.D.F.-Recommended dose of fertilizer; FYM: Farmyard manure; VC-Vermicompost; S.Em-Standard error of the mean; CD-Critical difference.

*Treatment details are mentioned in Materials and Methods.

4. Conclusion

The present study revealed that organic amendments have positive influence on late blight suppression and fruit yield enhancement in tomato. Partial substitution of inorganic fertilizers through vermicompost is highly effective and higher levels of vermicompost emerged as better organic nutrient source over that of farmyard manure. Application of biofertilizer exerted more benefits over the uninoculated treatments by improving nutrient uptake and increasing plant defense. Organic amendments can be used as part of late blight disease management of tomato and the treatment comprising of 75% RDF of inorganic fertilizers and vermicompost (4 tonnes ha^{-1}) inoculated with *Azophos* biofertilizer may be practiced for sustainable tomato cultivation.

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