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Research Article

In Vivo Evaluation of Bioresources Against Late Blight of Potato Caused by *Phytophthora infestans*, Plant Growth and Yield of Potato (*Solanum tuberosum* L.)

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ABSTRACT

Potato (*Solanum tuberosum* L.) is a solanaceous crop which have an importance as both food and cash crop for many poor people and is considered as food security in developing countries. Important fungal diseases, which affect potato crop are late blight, early blight, black scurf, dry rots, wart, powdery scab, charcoal rots *etc*., A detailed experiment was conducted to study the efficacy of bioresources against late blight of potato (*P. infestans*). Among all the treatments T3 (VC+SMC+NK) reduced disease incidence (%), disease intensity (%), CODEX (%) followed by T5 (SMC+VC), T2 (VC), T6 (MA), T4 (SMC), T1 (NK), T0 (Control). Similarly, among treatments T3 (VC+SMC+NK) maximised yield (gm) & plant height (cm) followed by T5 (SMC+VC), T2 (VC), T6 (MA), T4 (SMC), T1 (NK) and T0 (Control).

Keywords: Late blight; Solanaceous; Potato; Cash Crop; *Phytophthora infestans*; Disease incidence; Intensity; CODEX

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important non-cereal food crops and regarded as a staple food in many countries of the world. It ranks third in importance as a food crop, following wheat and rice belonging to the family Solanaceae. It is originated in the regions of Peru and Bolivia of Andreas high land of South America [1]. It is an important food and cash crop for many poor people and is often considered an important mechanism for poverty alleviation and food security in developing countries [2].

In India, the major potato growing states are Uttar Pradesh (14430.28 MT), West Bengal (11591 MT), Bihar (6640.60 MT), Gujarat (2499 MT), and Madhya Pradesh (2299 MT). Potato is grown over 20.45 lakh hectares with an annual production of 480.86 lakh tons and having productivity of 23.07 tons per hectare (National Horticultural Research and Development Foundation Nasik, 2016). Its tubers are rich in starch, vitamin B, C and mineral salts, glycoalcaloides, alphasolanine and alphachaconine (FAO, 2010).

Major fungal diseases, which affect potato crop are late blight, early blight, black scurf, dry rots, wart, powdery scab and charcoal rots. Potato crop can be affected by approximately 160 diseases and disorders of which 50 are caused by fungi, 10 by bacteria, 40 by viruses and others by non-parasitic, or due to unknown causes. Diseases may affect potato at any stage of crop growth or even during storage. They may affect foliage, tubers or both [3].

Late blight is the most devastating disease worldwide of both tomato and potato [4]. Annual crop losses from late blight are estimated at over five billion USD [5]. This pathogen infects multiple plant species in the Solanaceae, including potato and tomato. In the mid-19th century, *P. infestans* devastated the potato crop and caused the Irish famine [6]. It is the best-known, highly studied and most destructive disease of all potato-producing countries. The estimated annual loss due to late blight is more than $5 billion; hence it is considered as threat for global food security [7]. The decrease in yields is principally due to fungal and bacterial diseases, especially late blight caused by *Phytophthora infestans* (Mont.) de Bary and bacterial wilt caused by Ralstonia solanacearum [8].

The pathogen perpetuates through soil and seed tubers through production of resting spore i.e., oospore. Therefore, management of the disease can be done through host resistance, cultural adjustments, biological management and use of fungicides. Cultural practice like field sanitation; summer ploughing, soil solarization, soil amendments and crop rotation etc., can minimize the possibility of disease but cannot completely control the disease in standing crops.

In horticulture, the application of compost to soil improves soil structure and plant root growth and results in an overall increase

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in yield of several crops, such as tomato [9]. Furthermore, compost provides essential plant nutrients such as nitrogen, phosphorus, and calcium and thereby reduces the need for synthetic fertilizers [10]. Composts can be made of raw feedstocks such as yard trimmings, food waste, manure, tree leaves/bark and worm castings. The antagonistic and biological effect of compost for disease suppression is quite well-known.

Late blight appears first as water- soaked irregular pale green lesions mostly near tip and margins of leaves. These lesions rapidly grow into large brown to purplish black necrotic spots. During morning hours, a white mildew, which consists of sporangia and spores of the pathogen, can be seen on lower surface of infected leaves especially around the edges of the necrotic lesions. It is caused by *Phytophthora infestans* (Mont.) de Bary. It belongs to order Peronosporales of class Oomycetes. The fungus is characterized by lemon shaped detachable, papillate sporangia produced on sympodially branched sporangiophores of indeterminate growth. The sporangiophores exhibit a characterized swelling at junction where sporangia are attached with the sporangiophores.

MATERIALS AND METHODS

The present study was carried out at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Naini, Prayagraj during 2019-20, to study the efficacy of bioresources against plant growth and late blight of potato caused by *Phytophthora infestans*. Potato seed tubers were planted in plot of 2 m x 2 m size. Experimental plots were treated with bioresources at different days of interval. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 7 treatments as presented Table 1.

Observations on efficacy of bioresources against plant growth and late blight of potato disease incidence, intensity and codex was recorded at 40,80 & 120 DAS (Figures 1 and 2). Yield data was recorded after final harvest of potato crop. All the observed infected leaves were individually scored on 0-9 scale [11] presented in Table 2. The data collected were subjected to statistical analysis and the differences exhibited by the treatments were tested for their significance [12].

The percent disease index was calculated by using formula [13].

Percent disease incidence:

The incidence was calculated according to the formula

$$\text{Percent disease incidence} = \frac{(\text{Number of diseased plants})}{(\text{Total number of plants observed})} X100$$

Percent disease index:

Percent disease index was calculated by the formula

$$\text{Index} = \frac{\text{Sum of all numerical ratings in plants infected}}{2\alpha\text{Total rating X maximum disease score}} X100$$

Coefficient of disease index (CODEX):

CODEX was calculated by the formula

$$\text{CODEX} = \frac{\text{Percent disease incidence X percent disease index}}{100}$$

RESULTS AND DISCUSSION

Results based on field experiment, the effect of bioresources on Plant growth significantly increases as compared to control. As shown in Table 3, plant height (cm) significantly increased from untreated control T0 (24.06 cm). Maximum plant height (cm) was observed in treatment T3 (VC+SMC+NK -28.10 cm) followed by

Table 1: Treatment details.

Treatment Code	Treatment Details
T0	Control (untreated)
T1	Neem cake @ 250 kg/ha soil application at 0, 40 & 80 DAS
T2	Vermicomposting @10 t/ha soil application at 0, 40 & 80 DAS
T3	SMC+VC+NK @ (1:1:1) soil application at 0, 40 & 80 DAS
T4	Spent Mushroom Compost @ 10 t/ha soil application at 0, 40 & 80 DAS
T5	SMC+Vermicomposting @ 10 t/ha soil application at 0, 40 & 80 DAS
T6	Microalgae 7 kg/ha (liquid formulation) soil application at 0, 40 & 80 DAS

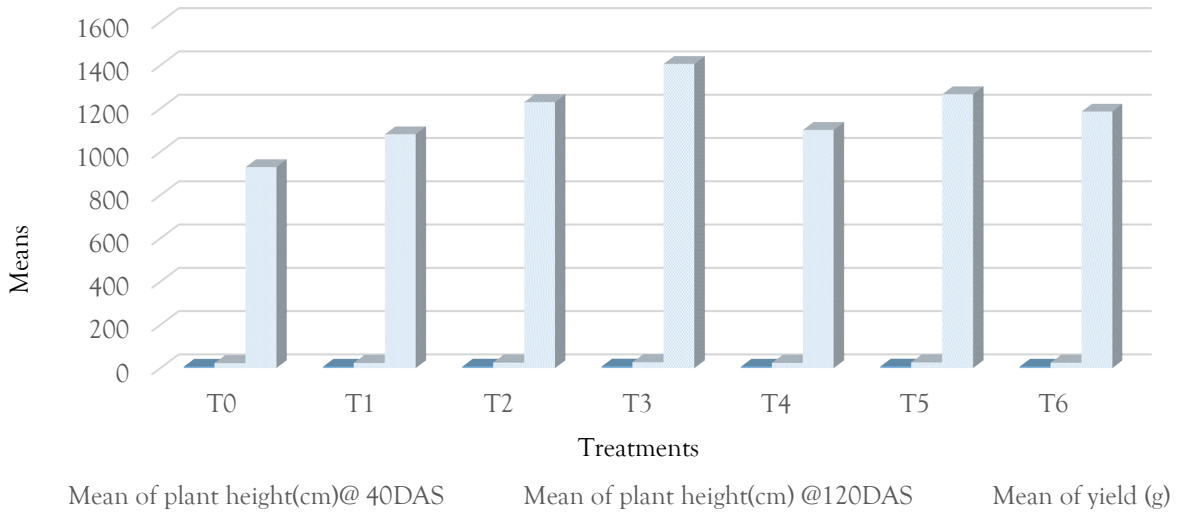

Figure 1: Efficacy of bio resources on plant growth (cm) and yield (g) of potato.

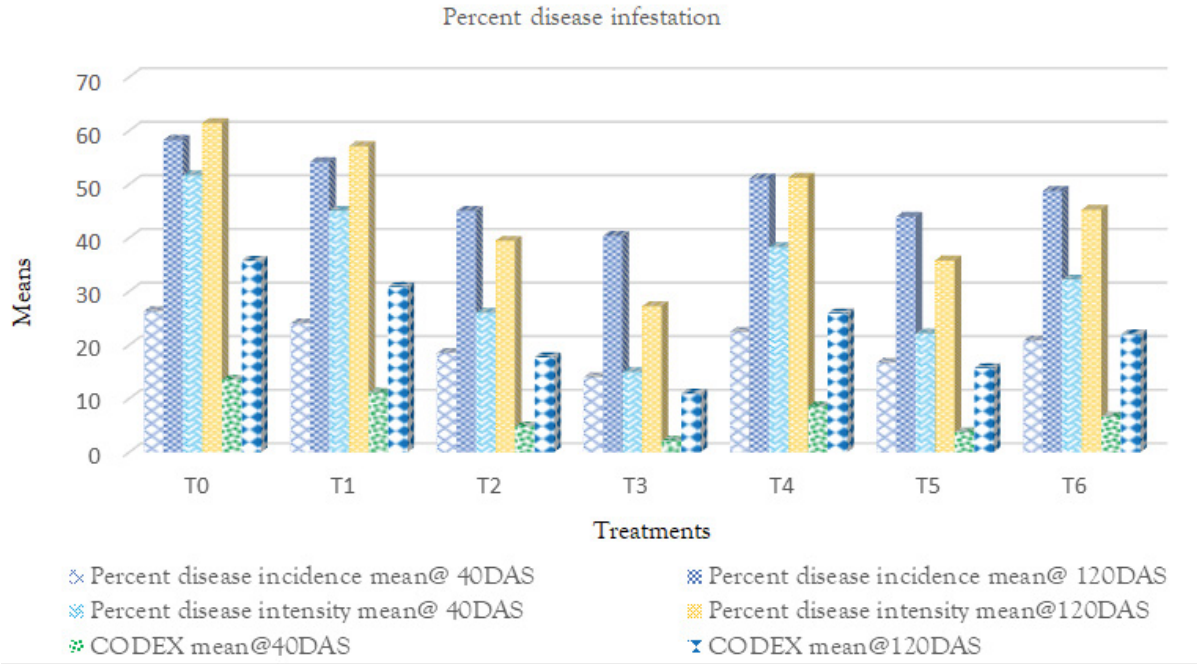

Figure 2: Efficacy of bio resources against disease incidence, intensity & CODEX of *Phytophthora infestans* @ 40 & 120 DAS.

Table 2: Scale given by Mayee and Datar.

Ratings	Description
0	No symptoms
1	Spots covering less than 1% leaf area
3	Spots covering 1-10% leaf area
5	Spots covering 11-25% leaf area
7	Spots covering 26-50% leaf area
9	Spots covering more than 51% leaf area

Table 3: Effect of bio resources against plant height (cm) & yield (g) of potato @ 40 & 120 DAS (Days after sowing).

Treatment	Mean of Plant Height (cm) @		Mean of Yield (g/4m^2) @
	40 DAS	120 DAS	
T0	7.32	24.06	930.00
T1	7.50	25.00	1,081.66
T2	8.02	26.80	1,230.00
T3	8.42	28.10	1,406.66
T4	7.71	25.36	1,101.66
T5	8.34	27.50	1,266.66
T6	7.91	25.84	1,186.66
C.D.	0.17	0.42	201.48
SE (m)	0.05	0.13	64.67
SE (d)	0.07	0.19	91.45

T5 (SMC+VC -27.50 cm), T2 (VC -26.80 cm), T6 (MA -25.84 cm), T4 (SMC – 25.36 cm) and T1 (NK – 25.00 cm), while yield of potato significantly increased from untreated control T0 (930 g). Maximum yield was observed in T3 ((VC+SMC+NK–1406.6 g) followed by T5 (SMC+VC -1266.6 g), T2 (VC–1230 g), T6 (MA -1186.6 g), T4 (SMC-1101.6 g) and T1 (NK-1081.6 g).

As shown in Table 4, Percent of disease incidence, Intensity and CODEX of potato increased significantly from T3 (VC+SMC+NK) followed by T5 (SMC+VC), T2(VC), T6 (MA), T4 (SMC), T1 (NK) and T0 (untreated control). The results of the treatments significantly differed among themselves as compared to control (Figure 3).

Table 4: Effect of bio resources against late blight of potato disease incidence, intensity & codex of potato @ 40 & 120 DAS (Days after sowing).

Treatment	Percent Disease Incidence Mean@		Percent Disease Intensity Mean@		CODEX Mean@	
	40 DAS	120 DAS	40 DAS	120 DAS	40 DAS	120 DAS
T0	26.30	58.23	51.60	61.40	13.50	35.70
T1	24.00	54.14	45.00	57.09	11.03	30.88
T2	18.50	45.00	26.00	39.43	4.78	17.69
T3	13.98	40.36	14.90	27.23	2.07	10.94
T4	22.43	51.03	38.23	51.20	8.51	25.92
T5	16.65	43.94	22.10	35.73	3.68	15.68
T6	20.80	48.71	32.16	45.23	6.63	21.96
C.D.	0.98	2.02	3.92	4.15	1.00	2.54
SE (m)	0.31	0.65	1.25	1.33	0.32	0.81
SE (d)	0.44	0.92	1.78	1.88	0.45	1.15

Figure 3: Symptoms of late blight.

CONCLUSION

The present experimental study on effect of bioresources on late blight of potato clearly indicates that T3 (VC+SMC+NK) shows minimum disease incidence (40.36%), disease intensity (27.23%) & CODEX (10.94%), with highest yield (1406.6 g/4m^2), plant height (28.1 cm). So, recommendation of bioresources can be economical, long lasting and also free from harmful residual side effects which don't change the properties of soil but instead improves soil properties.

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