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To,

Director,

IPM, Biocontrol Labs Pvt. Ltd.,

Plot # 58, 2-28-206, 1st Floor, A.P. Text Book Colony,

Karkhana, Secunderabad-9

Dear Sir,

Enclosed please find two copies of the duly signed report of the project entitled **"Bioefficiency of Different Liquid Bioformulations Against Late Blight of Potato Caused By *Phytophthora infestans*"** for your kind consideration and necessary action.

Kindly acknowledge its receipt.

Regards,

Sincerely yours,

(H.B. Singh)

Professor & P.I.

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Project Report

**BIOEFFICIACY OF DIFFERENT LIQUID BIOFORMULATIONS
AGAINST LATE BLIGHT OF POTATO CAUSED BY *Phytophthora infestans***



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Sponsored by

M/S. IPM BIOCONTROL LABS (P) LTD., HYDERABAD

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Bio-efficacy of different liquid bioformulations against late blight of potato caused by *Phytophthora infestans*

OBJECTIVES

- Assessment of bio-efficacy of liquid formulations of six bioinoculants (*Pseudomonas fluorescens*, *Trichoderma viride*, Phosphate solubilizing bacteria, Potash mobilizing bacteria, *Azotobacter*, and *Azospirillum*) against the late blight disease of potato caused by *Phytophthora infestans*.
- Assessment of the effect of bioinoculants on beneficial microbes in potato rhizosphere.
- Assessment of the phytotoxic affect of bioinoculants on potato, if any.

ABSTRACT

Liquid formulation of six bioinoculants (*P. fluorescens*, *T. viride*, Phosphate solubilizing bacteria (PSB), Potash mobilizing bacteria (KMB), *Azotobacter*, and *Azospirillum*) applied as seed treatment in potato significantly reduced the late blight disease caused by *Phytophthora infestans*. The yield of potato was also significantly enhanced. The formulations did not have any phytotoxic effect on potato plants at 2.0 ml/kg seed dosage tested for bio-efficacy. The formulations applications have no adverse effect on the beneficial rhizospheric microbes, like Arbuscular Mycorrhizae (*Glomus* spp.) in potato rhizosphere which were confirmed by microscopic observations. Based on the above findings, it is concluded that all the liquid bioinoculants increased yield and reduced the incidence of *Phytophthora* blight. The bioinoculants are also found safe and effective for their uses as an efficient & eco-safe alternative to synthetic fungicides.

INTRODUCTION


The late blight is a serious disease of potato incited by *P. infestans* that limits the cultivation of potato leading to reduction in yield as well as the quality of the tubers. The severely affected plants may even die at the young stage and thereby causing severe loss to the growers. *P. infestans* is tropical as well as temperate pathogen with wide occurrence and not easy to control even by using chemical fungicides. The use of fungicides leads to residual effect on crop as well as soil leading to biomagnification through food chain to human being as potato is an important vegetable crop in India. To overcome the problem, liquid formulations of different bioinoculants were tested against the potato pathogen *P. infestans* developed by M/s. IPM Biocontrol Labs (P) Ltd., Hyderabad.

MATERIALS AND METHODS

A field trial was conducted during second week of November 2008 at the experimental field of Banaras Hindu University, Varanasi and the crop was harvested in the last week of February 2009.

The experiments were conducted in a randomized block design with seven treatments with three replications. A susceptible variety of potato "Kufri Badshah" was


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selected for the field trial and all agronomical practices for the crop were followed according to packages and practices.

TREATMENT DETAILS


T ₁	-	<i>Pseudomonas fluorescens</i> (@ 1.0 ml/kg seed)
T ₂		<i>Pseudomonas fluorescens</i> (@ 2.0 ml/kg seed)
T ₃		<i>Pseudomonas fluorescens</i> (@ 4.0 ml/kg seed)
T ₄		<i>Trichoderma viride</i> (@ 1.0 ml/kg seed)
T ₅		<i>Trichoderma viride</i> (@ 2.0 ml/kg seed)
T ₆		<i>Trichoderma viride</i> (@ 4.0 ml/kg seed)
T ₇		Phosphate Solubilizing Bacteria (PSB) (@ 1.0 ml/kg seed)
T ₈		Phosphate Solubilizing Bacteria (PSB) (@ 2.0 ml/kg seed)
T ₉		Phosphate Solubilizing Bacteria (PSB) (@ 4.0 ml/kg seed)
T ₁₀		Potassium Mobilizing Bacteria (KMB) (@ 1.0 ml/kg seed)
T ₁₁		Potassium Mobilizing Bacteria (KMB) (@ 2.0 ml/kg seed)
T ₁₂		Potassium Mobilizing Bacteria (KMB) (@ 4.0 ml/kg seed)
T ₁₃		<i>Azotobacter</i> (@ 1.0 ml/kg seed)
T ₁₄		<i>Azotobacter</i> (@ 2.0 ml/kg seed)
T ₁₅		<i>Azotobacter</i> (@ 4.0 ml/kg seed)
T ₁₆	-	<i>Azospirillum</i> (@ 1.0 ml/kg seed)
T ₁₇		<i>Azospirillum</i> (@ 2.0 ml/kg seed)
T ₁₈		<i>Azospirillum</i> (@ 4.0 ml/kg seed)
T ₁₉		Control
Replications	-	Three
Variety	-	Kufri Badshah

EXPERIMENTAL DETAILS

Design	-	Randomized Block Design
Replications	-	3
Total Plots	-	57
Variety	-	Kufri Badshah
Row to row distance	-	60 cm
Plant to plant distance	-	15 cm
Plot size	-	3 x 3 m ²

The disease severity was rated after two months of sowing on a scale of 1-5 where 1 = no symptoms; 2 = light symptom development with slight browning (1-20% foliage affected); 3 = moderate symptom development with necrosis (21-50% foliage affected); 4=heavy symptom development with necrosis and rotting of stem and leaves (51-80% foliage affected) and 5 = severe symptom development with complete rotting of stem/leaves/or dead plants (81-100% foliage and capsules affected).


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OBSERVATIONS

Disease incidence (Average disease severity) & growth promotion parameters (plant height and dry weight) were recorded from different treatment and control plants. The results are presented in Table-1.

Qualitative phytotoxicity symptoms i.e. injury on leaf tips & leaf surface, wilting, vein clearing, necrosis, epinasty & hyponasty from ten randomly selected potato plants from each treatment were recorded as per standard phytotoxicity assessment methods of pesticides.

The effect on the beneficial rhizospheric microbes like Arbuscular Mycorrhiza (*Glomus* spp.) in potato rhizosphere at all dosage levels in treated & controls plots were also recorded.

RESULTS

Table 1. Efficacy of different bioinoculants against late blight disease of potato caused by *Phytophthora infestans*

S. No	Treatments	Per cent disease incidence	Plant height (cm)	Dry weight (g) Plant ⁻¹	Yield (tons ha ⁻¹)
1	T ₁	62.26±3.51	47.11±2.93	4.93±0.31	25.09±2.18
2.	T ₂	60.17±2.98	56.71±3.02	6.82±0.39	31.27±2.13
3.	T ₃	63.09±2.61	55.38±2.84	6.69±0.43	31.05±2.49
4.	T ₄	67.82±3.19	43.41±2.58	4.30±0.35	21.44±2.52
5.	T ₅	65.28±3.37	51.62 ± 2.83	6.07±0.33	28.62± 2.05
6.	T ₆	68.86±2.82	51.42±2.99	6.00±0.29	28.54±2.11
7.	T ₇	71.83±3.92	43.84±2.93	4.41±0.31	22.06±2.39
8.	T ₈	72.39±3.86	53.22±3.18	6.26±0.46	25.82±2.43
9.	T ₉	72.73±3.81	53.00±3.41	6.01±0.55	25.31±2.22
10.	T ₁₀	69.11±3.84	41.29±2.83	4.22±0.41	18.73±2.11
11.	T ₁₁	69.92±4.04	44.16± 2.23	4.59±0.34	20.18±1.72
12.	T ₁₂	70.19±3.62	43.91±2.12	4.53±0.38	20.09±2.16
13.	T ₁₃	73.99±4.03	41.04±2.61	4.27±0.42	18.19±2.47
14.	T ₁₄	71.15±3.27	48.13 ± 2.99	5.21±0.39	22.02±1.78
15.	T ₁₅	72.92±2.94	47.18±2.64	5.00±0.40	21.11±2.05
16.	T ₁₆	70.82±4.29	41.52±3.17	4.39±0.39	19.42±2.41
17.	T ₁₇	70.41±4.09	45.38±2.73	5.04±0.42	21.61±1.52
18.	T ₁₈	70.96±3.74	44.81±2.83	5.00±0.38	21.12±1.39
19	T ₁₉ (Control)	77.19±4.18	39.70±2.08	4.06±0.26	17.03±1.23
	CD at 5 %	3.84	2.79	1.02	1.19

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The data from the present investigation as represented in Table 1 indicates that the per cent plant height was increased by 40.46, 23.09, 25.40, 10.09, 17.51 & 12.51% by the six liquid bioinoculants (*P. fluorescens*, *T. viride*, Phosphate solubilizing bacteria (PSB), Potash mobilizing bacteria (KMB), *Azotobacter*, and *Azospirillum*) at 2 ml/kg dose. Similarly, the dry weight of potato plants was also increased by 40.46%, 33.11%, 35.14%, 11.54%, 22.07% & 19.44% at the same dose. The yield of potato tubers also showed an increase of 45.53, 40.60, 34.04, 15.60, 22.26 & 21.11% by the liquid formulations of bioinoculants at 2 ml/kg.

The formulation had no phytotoxic effect on the potato plants following its application at all the dosage levels tested for bio-efficacy.


The liquid formulation of six bioinoculants (*P. fluorescens*, *T. viride*, PSB, KMB, *Azotobacter*, and *Azospirillum*) have also no adverse effect on the beneficial rhizospheric microbes like Arbuscular Mycorrhiza (*Glomus* spp.) in potato rhizosphere.

Thus the results indicate that among the seven treatments *Pseudomonas fluorescens* was the best and dosage level of 2 ml/kg was the best dose for all the treatments.


CONCLUSION

From the present study it may be concluded that treatment of potato tuber with six liquid bioinoculants (*P. fluorescens*, *T. viride*, PSB, KMB, *Azotobacter*, and *Azospirillum*) @ 2.0 ml/kg seeds resulted in significant enhancement in tuber yield in comparison to the control. There was also no phytotoxic effect on potato plants and no adverse effect on beneficial microbes in potato rhizosphere.

In view of the above findings, the six liquid bioinoculants developed by M/s. IPM Biocontrol Labs (P) Ltd., Hyderabad may be used as an efficient & ecologically safe alternative of synthetic chemicals for the management of late blight disease of potato and for obtaining higher yields. The best treatment was obtained from *Pseudomonas fluorescens* and the best dose was recorded to be 2 ml/kg seed of all the treatments.


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