



Research Article

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Field Efficacy of Fungicides and Bio-Botanicals against Late Blight Disease of Potato

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Abstract

Potato (*Solanum tuberosum* L.) is one of the most important Solanaceous vegetable crops throughout the world, and a staple food in many parts of the world. Late blight caused by *Phytophthora infestans* (Mont.) de Bary is a serious disease, affects all parts of potato viz. leave, stem and tubers. The field experiments were conducted at Benuria, Birbhum during Rabi season of 2015-16 and 2016-17 under Red and Lateritic Agro-climatic Zone of West Bengal. The experiments were conducted to find out the effect of fungicides and bio-botanicals against late blight of potato (cv. Kufri Jyoti). It was revealed from the experiment that Ethaboxam 40% SC@1.33 ml/l appeared highly effective. Ethaboxam 40% SC@1.0 ml/l, Ethaboxam 40% SC@0.88ml/l, Ethaboxam 40%SC@0.75 ml/l were reduced the disease incidence successfully. FolioGold (Chlorothalonil 33% + Metalaxyl 3.3%SC), Ishaan (Chlorothalonil 75% WP) and Trichosol (*Trichoderma viride*) were also efficacious. Trichosol recorded less effective than other treatments. Botanical based treatments were non-effective. Glossiness of the tuber was measured on harvested tubers observing its colour and luster, and graded as more glossy, glossy, less glossy and non-glossy. Indofil M-45, FolioGold, Ishaan and Trichosol produced more glossy tubers while Ethaboxam and other botanical based treatments produced glossy tubers. Less glossy tubers were counted in untreated control.

Keywords: Potato; late blight; fungicide; Bio-botanical; management; *Phytophthora infestans*

Introduction

Potato (*Solanum tuberosum* L.), ‘The king of vegetables’, under the family solanaceae has about 200 wild species. It is the world’s fourth-largest food crop, following maize, wheat, and rice. Late blight (*Phytophthora infestans* (Mont.) de Bary) is the most destructive among all the potato diseases. It affects both foliage in the field, and tuber in the field and storage that can absolutely destroy a crop, producing a 100% crop loss [1]. The disease continues to represent the most serious threat to potato production due to the considerable adaptability of the pathogen [2]. The thick-walled and robust oospores are formed as a result of sexual reproduction. In contrast to sporangia, they can survive dry and cold conditions without a host. In the next growing season the germinating oospores can infect newly planted potatoes and cause early epidemics. However, the most important consequence of the occurrence of oospores is an increase in genetic variation within populations of *P. infestans*

and the appearance of new, recombined strains [3-5]. In addition to oospores and air-borne sporangia, the infected seed tubers are another important source of late blight inoculum [6,4]. Late blight affects all plant parts viz. leave, stem and tubers. It appears on the leaves as pale green, irregular spots which enlarge into large water soaked lesions. In moist weather the spots enlarge rapidly with central tissue turning necrotic and dark brown or black. Often, the spots have a purplish tinge. On the lower side, white mildew (cottony growth) ring forms around the dead areas. In dry weather the water soaked areas dry up and turn brown [7]. Tubers are readily infected while in soil by rain borne spores from blighted foliage. Initially the tubers show a shallow, reddish brown dry rot that spreads irregularly from the surface through the flesh. At low storage temperatures, the lesions usually remain firm and frequently show a metallic tinge especially at the border of healthy tissues [7]. Late blight is an increasing severity in many potato growing areas, a shift in pathogen population toward increased specific virulence and an increasing tolerance to the most effective late blight specific fungicides suggests a need to develop an appropriate disease management strategy [8]. A huge amount of yield loss occurs due to late blight depending on degree of susceptibility of the cultivar, time of appearance of the disease, age of plant and different epidemiological factors. New fungicides and bio-molecules are introducing in the country every year against the fungal disease whose efficacy needs to be ascertained. But indiscriminate use of chemical pesticides not only hampering ecological equilibrium but also inviting resurgence problems and developing resistance strains.

Methodology

Experimental details

The field experiments were conducted at Binuria under Birbhum district during Rabi season, 2015-16 and 2016-17 to study the field efficacy of different fungicides against early blight disease of potato. The experimental site is situated at an average altitude of 58.9 meter above msl and 23°39'N latitude and 87°42'E longitude under the Red and Lateritic Agroclimatic zones of West Bengal. The soil of the experimental site was slightly acidic (pH 5.5-6.0), sandy loam in texture having medium fertility status with good drainage facility.

Two sets of experiments were conducted in field condition following RBD with four replicates – (a) Some newer fungicides and bio-botanicals were applied thrice through spraying method. (b) Fungicides and bio-botanicals were applied through seed tuber treatment before planting along with spraying of the same twice. Solutions were prepared by dissolving specific amount of the chemicals and bio-botanicals in definite quantity of plain water. Spray was initiated just after detection of the disease symptoms in the experimental field, and repeated at an interval of 10 days. During spraying care was taken for both upper and lower surface of leaves as well as stems. Sprayer was thoroughly washed before spraying of each fungicidal solution. Data were recorded at 7 days after every spraying. General agronomic practices were followed to raise the crop (Table 1).

Recording of disease data

Randomly selected twenty-five plants in each replicated plot were selected and tagged for scoring the severity. The scoring of the

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Table 1: Materials use for the field experiment.

Treatments	Field dose	Source
Indofil M-45 (Mancozeb 75% WP)	3.0 g/l	Indofil Industries Ltd.
FolioGold (Chlorothalonil 33% + Metalaxyl 3.3% SC)	2.0 ml/l	Syngenta India Ltd.
Ethaboxam (Ethaboxam 40% SC)	1.0 ml/l	Sumitomo Chemical India Ltd.
Ethaboxam (Ethaboxam 40% SC)	0.63 ml/l	Sumitomo Chemical India Ltd.
Ethaboxam (Ethaboxam 40% SC)	0.75 ml/l	Sumitomo Chemical India Ltd.
Ethaboxam (Ethaboxam 40% SC)	0.88 ml/l	Sumitomo Chemical India Ltd.
Ethaboxam (Ethaboxam 40% SC)	1.0 ml/l	Sumitomo Chemical India Ltd.
Ishaan (Chlorothalonil 75% WP)	2.0g/l	Rallis Tata Enterprise
Trichosol (<i>Trichoderma viride</i> , cfu 10 ⁸)	6 g/l	Nitrofix Laboratories
Bombhastra (Raw cow dung, cow urine, neem, papaya or pomegranate leaf extract and water)	5 ml/l	Laka Kalyan Parishad
Agniastra (Cow urine, neem or <i>bon kolmi</i> leaf extract and ginger paste)	7 ml/l	Laka Kalyan Parishad
Sanjibak (Raw cow dung, cow urine, jaggery and water)	5 ml/l	Laka Kalyan Parishad
Nimbastra (Raw cow dung, cow urine, neem leaf extract and water)	7 ml/l	Laka Kalyan Parishad

Table 2: Rating scale for late blight of potato.

Grade	Description of the symptoms
0	No observable symptoms
1	Two to five leaflets per 10 plants affected. About five large lesions per quadrant (20 to 25 plants).
2	About five to 10 infected leaflets per plant, or about two affected leaves per plant.
3	General light infection. About 20 lesions per plant, or 10 leaves affected per plant, or 1 in 20 leaves affected severely.
4	About 100 lesions per plant. One in 10 leaflets affected, up to 50 leaves affected.
5	Nearly every leaflet infected but plants retain normal form. Plants may smell of blight. Field looks green although every plant is affected.
6	Every plant is affected and about 50% of the leaf area is destroyed. Field appears green flecked with brown.
7	About 75% of the leaf area destroyed. Field appears neither predominantly green nor brown.
8	Only a few leaves on plants, but stems are green.
9	All leaves dead, stems dead or dying.

blight disease was done based on 0-9 disease rating scale (Table 2). The periodic intensity of blight was recorded and was statistically analyzed.

A disease infection was then calculated according to the following:

$$\sum \text{Disease Scores} \times 100$$

Disease infection index%(PDI) =

$$\frac{\text{Number of Plants} \times \text{Maximum Disease Scores}}{\text{Assessed}} \times 100$$

Per cent tuber infection was recorded after harvesting. Tuber yield per hectare was computed based on total tuber yield per plot. Glossiness of the tubers, if any, was also recorded. Glossiness of the tuber was measured on harvested tubers. Observing the colour and luster of freshly harvested tubers a gradation was done *viz.* more glossy, glossy, less glossy and non-glossy. Only outer surface of the tubers was taken into account. PTI (Per cent Tuber Infection) was estimated by selecting 25 plants randomly from each plot followed by counting of total numbers of tubers and numbers of infected tubers.

$$\text{PTI} = \frac{\text{Infected tubers}}{\text{Total tubers}} \times 100$$

Whenever necessary, data were transformed. Treatment means (field data) was compared according to [9].

Results and Discussion

Efficacy of fungicides and bio-botanicals against late blight of potato in field condition through spraying (2015-16)

All the fungicides significantly reduced the per cent disease index (PDI), per cent tuber infection (PTI) and increased tuber yield over control (Table 3). The PDI due to application of different treatments ranged from 8.22 to 38.40 where the lowest and highest PDI were recorded in T₅ (Ethaboxam 40%SC@1.33ml/l) and T₈ (untreated control) treatment, respectively at 40 DAP. Whereas, at 60 DAP 12.50 to 55.50% disease incidence was recorded and the lowest and highest PDI were from the same treatment. At 80 DAP 20.10% disease incidence (DI) was recorded in T₅ treatment followed by T₄ treatment (Ethaboxam 40% SC@1.0ml/l) where 26% DI was recorded. Superiority of T₅ (Ethaboxam 40% SC@1.33ml/l) was recorded over all other treatments. Ethaboxam 40%SC@1.0ml/l (PDI 26.00) was statistically at par with T₃ (Ethaboxam 40% SC@0.88ml/l) where 28.90% DI was observed. Ethaboxam 40% SC@0.88ml/l ranked second position followed by Ethaboxam 40% SC@0.75ml/l (34.20), Ethaboxam 40% SC@0.63ml/l (39.24) and FolioGold (40.15) at 80 DAP. Similarity in respect of PDI at 80DAP was recorded between FolioGold (40.15) and Ishaan (42.60). Trichosol (44.00) was better than Sanjibak (59.22), Bromhastra (60.30), Nimbastra (62.10) and Agniastra (59.00). Regarding PDC (Per cent disease control), T₅ (Ethaboxam 40% SC@1.33ml/l) appeared highest (77.16) followed by T₄ (Ethaboxam 40% SC@1.0ml/l) (70.45), T₃ (Ethaboxam 40% SC@0.88ml/l) (67.16) and T₂ (Ethaboxam 40% SC@0.75ml/l) (61.14). While in between 50–60% PDC was recorded on T₁ (Ethaboxam 40% SC@0.63ml/l), T₇ (FolioGold), T₈ (Ishaan) and T₉ (Trichosol).

Efficacy of fungicides and bio-botanicals against late blight of potato in field condition through spraying (2016-17)

All the fungicides significantly reduced the per cent disease index (PDI), per cent tuber infection (PTI) and increased tuber yield over control (Table 4). The PDI due to application of different treatments ranged from 7.25 to 37.24 where the lowest and highest PDI were recorded respectively in T₅ (Ethaboxam 40% SC@1.33ml/l) and T₈ (untreated control) treatment at 40 DAP. Whereas, at 60 DAP 10.00 to 58.15% disease incidence was recorded and the lowest and highest PDI were from the same treatment. At 80 DAP 18.40% disease incidence (DI) was recorded in T₅ treatment followed by T₄ treatment (Ethaboxam 40% SC@1.0ml/l) where 22.40% DI was recorded. Superiority of T₅ (Ethaboxam 40% SC@1.33ml/l) was recorded over all other treatments. Ethaboxam 40% SC@0.88ml/l (T₃) also recorded effective (26.98% DI) followed by Ethaboxam 40% SC@0.75ml/l (T₂) (31.22% DI) than the other treatments. There were no statistical differences in respect to PDI in between Ethaboxam 40% SC@0.63ml/l (37.65) and FolioGold (38.88). Ishaan (41.25% DI), Indofil M-45 (45.55% DI) and Trichosol (46.20% DI) were better than Sanjibak (57.83), Bromhastra (58.56), Nimbastra (59.83) and Agniastra (60.20). Highest PDI was recorded in untreated control (82.66% DI). Regarding PDC (Per cent disease control), T₅ (Ethaboxam 40% SC@1.33ml/l) appeared highest (77.74) followed by T₄ (Ethaboxam 40% SC@1.0ml/l) (72.90), T₃ (Ethaboxam 40% SC@0.88ml/l) (67.36) and T₂ (Ethaboxam 40% SC@0.75ml/l) (62.23). While in between 50–60 % PDC was recorded on T₁ (Ethaboxam 40% SC@0.63ml/l), T₇ (FolioGold) and T₈ (Ishaan).

Efficacy of fungicides and bio-botanicals against late blight of potato in respect to per cent tuber infection (2015-16)

The per cent tuber infection (PTI) due to application of different fungicides ranged from 2.95 to 8.90 (Table 3). The highest PTI (8.90) was recorded in untreated control (T₁₄) 8 whereas lowest of that was observed in T₅ (Ethaboxam 40% SC@1.33ml/l) (2.50) treated plots followed by T₉ (Trichosol) (2.95) and Ethaboxam 40% SC @ 1ml/l (T₄) and 0.88ml/l (T₃). Superiority of all the treatments was observed than the untreated control (T₁₄) where maximum percentage of tuber infection (8.90) was recorded.

Glossiness of the tuber was measured on harvested tubers observing its colour and luster, and graded as more glossy, glossy, less glossy and non-glossy. It was depicted from the study that the Indofil M-45, FolioGold, Ishaan and Trichosol produced more glossy tubers while all other treatments produced glossy tubers except untreated control where less glossy tubers were counted (Table 3).

Tuber yield (t/ha) was varied from 14.21 to 25.05 in different treatments (Table 3). Lowest yield was obtained in untreated control (14.21 t/ha) and highest of that in T₅ (Ethaboxam 40% SC@1.33ml/l) i.e. 25.05 t/ha followed by T₄ (Ethaboxam 40% SC@1ml/l) (23.97 t/ha), T₇ (FolioGold) (22.68 t/ha) treated plot. Significantly higher yield was recorded in all the treatments from untreated control. There was no significant statistical difference between the treatments FolioGold (22.68 t/ha) and Ishaan (T₈) (22.09 t/ha). It was revealed from the study Table 3 that, Ethaboxam 40% SC@1.33ml/l, 1ml/l and 0.88ml/l was effective for controlling potato late blight than other treatments.

Table 3: Fungicides and bio-botanicals against late blight of potato through spraying (2015-16).

Treatment	PDI of late blight at DAP			PDC at DAP	PTI at harvest	Yield (t/ha)	Glossiness of tuber
	40	60	80				
T ₁ Ethaboxam	22.00 (27.97)	28.56 (32.30)	39.24 (38.79)	55.41	5.00 (12.92)	18.37	+++
T ₂ Ethaboxam	17.15 (24.46)	23.00 (28.66)	34.20 (35.79)	61.14	4.25 (11.90)	19.70	+++
T ₃ Ethaboxam	13.00 (21.13)	18.21 (25.26)	28.90 (32.52)	67.16	3.16 (10.24)	20.26	+++
T ₄ Ethaboxam	10.40 (18.81)	14.22 (22.15)	26.00 (30.66)	70.45	3.11 (10.16)	23.97	+++
T ₅ Ethaboxam	8.22 (16.66)	12.50 (20.70)	20.10 (26.64)	77.16	2.50 (9.10)	25.05	+++
T ₆ Indofil M-45	26.20 (30.76)	32.00 (34.45)	48.52 (44.15)	44.86	5.90 (14.06)	21.58	++++
T ₇ FolioGold	24.13 (29.42)	29.00 (32.58)	40.15 (39.32)	54.38	5.30 (13.31)	22.68	++++
T ₈ Ishaan	25.88 (30.58)	30.00 (33.21)	42.60 (40.74)	51.59	5.70 (13.81)	22.09	++++
T ₉ Trichosol	26.00 (30.66)	35.00 (36.27)	44.00 (41.55)	50.00	2.95 (9.89)	19.00	++++
T ₁₀ Sanjibak	30.10 (33.27)	44.25 (41.70)	59.22 (50.31)	32.70	6.29 (14.52)	16.23	+++
T ₁₁ Bombhastra	30.50 (33.52)	45.70 (42.53)	60.30 (50.94)	31.48	7.30 (15.68)	16.55	+++
T ₁₂ Nimbastra	31.00 (33.83)	45.32 (42.31)	62.10 (52.00)	29.43	8.44 (16.89)	15.42	+++
T ₁₃ Agniastra	30.45 (33.49)	44.00 (41.55)	59.00 (50.18)	32.95	8.51 (16.96)	15.85	+++
T ₁₄ Control	38.40 (34.29)	55.50 (48.16)	88.00 (69.73)	00.00	8.90 (17.36)	14.21	++
SEm (±)	1.02	0.89	1.30	-----	0.08	0.31	-----
CD (p=0.05)	2.88	2.53	3.68	-----	0.23	0.72	-----

PDI= Per cent Disease Index, PDC= Per cent Disease Control, PTI= Per cent Tuber Infection, DAP= Days after planting, +=Non-glossy, ++=Less glossy, +++=Glossy, ++++=More glossy, *Figure in parentheses indicate angular transform value

Efficacy of fungicides and bio-botanicals against late blight of potato in respect to per cent tuber infection (2016-17)

The per cent tuber infection (PTI) due to application of different fungicides ranged from 2.65 to 10.84 (Table 4). The highest PTI (10.84) was recorded in untreated control (T₁₄) whereas lowest of that was observed in T₅ (Ethaboxam 40% SC@1.33ml/l) (2.50) treated plots followed by T₉ (Trichosol) (3.00) and Ethaboxam 40% SC@1ml/l (T₄) and 0.88ml/l (T₃). All the treatments were superior to the untreated control (T₁₄) where maximum percentage of tuber infection was recorded. Glossiness of the tuber was measured on harvested tubers observing its colour and lustre, and graded as more glossy, glossy, less glossy and non-glossy.

It was depicted from the study that the Indofil M-45, FolioGold, Ishaan and Trichosol produced more glossy tubers while all other treatments produced glossy tubers except untreated control where less glossy tubers were counted Table 4.

Tuber yield (t/ha) was varied from 10.84 to 26.14 in different treatments Table 4. Lowest yield was obtained in untreated control (10.84 t/ha) and highest of that in T₅ (Ethaboxam 40% SC@1.33ml/l) i.e. 26.14 t/ha followed by T₄ (Ethaboxam 40% SC@1ml/l) (23.60 t/ha), T₇ (FolioGold) (22.76 t/ha) treated plot. Significantly higher yield was recorded in all the treatments from untreated control. There was no significant statistical difference between the treatments FolioGold (22.76 t/ha) and Ishaan (T₈) (22.15 t/ha).

It was revealed from the study Table 5 that, Ethaboxam 40%

SC@1.33ml/l, 1ml/l and 0.88ml/l was effective for controlling potato late blight than other treatments [10,11] recorded that the fungicides Ethaboxam was very much effective to inhibit/control the growth of oomycetes fungi including late blight of potato and tomato both in in vitro and field condition without producing any phytotoxic effect.

Efficacy of different fungicides and bio-agent against late blight of potato through seed tuber treatment-cum-spraying (2016-17)

An experiment was conducted at field condition for evaluating the efficacy of some fungicides as seed treatment followed by spraying of the same fungicides twice at an interval of 10 days starting from first appearance of the disease in the field. All the fungicides significantly reduced the per cent disease index (PDI), per cent tuber infection (PTI) and increased yield over control (Table 5). The PDI due to application of different treatments ranged from 5.75 to 38.40 where the lowest and highest PDI were recorded from T₅ (Ethaboxam 40 % SC@1.33ml/l) and T₇ (untreated control), respectively at 40 DAP. Whereas, at 60 DAP 9.84 to 60.25% disease incidence was recorded and the lowest and highest PDI were from the same treatment. Minimum PDI (15.22) at 80 DAP was recorded from Ethaboxam 40 % SC@1.33ml/l followed by Ethaboxam 40% SC @ 1ml/l (23.35). FolioGold (37.47% PDI) recorded third best treatment followed by Ishaan (40.40% PDI) and Indofil M-45 (43.93%) at 80 DAP (Table 5). There was no significant difference between the treatments Indofil M-45 and Ishaan. Trichosol (44.50% PDI) was also statistically at par with Indofil M-45. Regarding PDC (Per cent disease control), T₅

Table 4: Fungicides and bio-botanicals against late blight of potato through spraying (2016-17).

Treatment	PDI of late blight at DAP			PDC at DAP	PTI at harvest	Yield (t/ha)	Glossiness of tuber
	40	60	80				
T ₁ Ethaboxam	21.33 (27.51)	26.85 (31.21)	37.65 (37.85)	54.45	5.25 (13.25)	18.20	+++
T ₂ Ethaboxam	16.24 (23.77)	22.10 (28.04)	31.22 (33.97)	62.23	4.29 (11.95)	18.95	+++
T ₃ Ethaboxam	12.80 (20.96)	17.52 (24.74)	26.98 (31.29)	67.36	3.20 (10.30)	20.67	+++
T ₄ Ethaboxam	9.23 (17.69)	12.20 (20.44)	22.40 (28.25)	72.90	3.15 (10.22)	23.60	+++
T ₅ Ethaboxam	7.25 (15.62)	10.00 (18.43)	18.40 (25.40)	77.74	2.65 (9.37)	26.14	+++
T ₆ Indofil M-45	25.69 (30.45)	31.42 (34.09)	45.55 (42.45)	44.89	5.58 (13.66)	21.96	++++
T ₇ FolioGold	22.10 (28.04)	28.52 (32.28)	38.88 (38.57)	52.96	5.42 (13.46)	22.76	++++
T ₈ Ishaan	23.75 (29.17)	29.68 (33.01)	41.25 (39.96)	50.10	5.64 (13.74)	22.15	++++
T ₉ Trichosol	26.54 (31.01)	32.10 (34.51)	46.20 (42.82)	44.11	3.00 (9.97)	19.24	++++
T ₁₀ Sanjibak	29.15 (32.68)	43.51 (41.27)	57.83 (49.50)	30.04	6.92 (15.25)	16.05	+++
T ₁₁ Bombhastra	30.00 (33.21)	42.88 (40.91)	58.56 (49.93)	29.16	7.45 (15.84)	16.22	+++
T ₁₂ Nimbastra	30.60 (33.58)	43.30 (41.15)	59.83 (50.67)	27.62	8.66 (17.11)	15.30	+++
Zbn,m,m,jkhgfdsaasfg ghhjjkkT ₁₃ Agniastra	31.82 (34.34)	45.34 (42.33)	60.20 (50.89)	27.17	8.92 (17.38)	15.89	+++
T ₁₄ Control	37.24 (37.61)	58.15 (49.69)	82.66 (65.39)	-----	10.84 (19.22)	14.35	++
SEm (±)	0.98	0.91	1.05	-----	0.22	0.41	-----
CD (p=0.05)	2.82	2.62	3.05	-----	0.52	1.09	-----

PDI= Per cent Disease Index, PDC= Per cent Disease Control, PTI= Per cent Tuber Infection, DAP= Days after planting, +=Non-glossy, ++=Less glossy, +++=Glossy, ++++=More glossy, *Figure in parentheses indicate angular transform value

Table 5: Efficacy of fungicides and bio-agent against late blight of potato through seed tuber treatment-cum-spraying (2015-16).

Treatments	PDI of late blight at DAP			PDC at 90 DAP	PTI at harvest	Yield (t/ha)	Glossiness of tuber
	40	60	80				
T ₁ : Ishaan	18.15 (25.22)	27.20 (31.44)	40.40 (39.47)	53.35	5.25 (13.25)	23.60	++++
T ₂ : Indofil M-45	20.20 (26.71)	29.55 (32.93)	43.93 (41.51)	49.27	5.00 (12.92)	23.34	++++
T ₃ : FolioGold	16.29 (23.80)	25.62 (30.41)	37.74 (37.90)	56.42	4.70 (11.17)	24.45	++++
T ₄ : Ethaboxam	6.30 (14.54)	11.40 (19.73)	23.35 (28.90)	73.04	2.85 (9.72)	23.12	+++
T ₅ : Ethaboxam	5.75 (13.87)	9.84 (18.28)	15.22 (22.96)	82.42	2.70 (9.46)	25.48	+++
T ₆ : Trichosol	25.40 (30.26)	30.24 (33.36)	44.50 (41.84)	48.61	2.85 (9.72)	21.35	++++
T ₇ : Untreated control	38.40 (38.29)	60.25 (50.91)	86.60 (68.53)	00.00	16.00 (23.58)	13.91	++
SEm (±)	1.03	1.08	1.24	-	0.57	0.80	-
CD (p=0.05)	2.72	2.89	3.57	-	1.54	2.30	-

PDI= Per cent Disease Index, PDC= Per cent Disease Control, PTI= Per cent Tuber Infection, DAP= Days after planting, +=Non-glossy, +=Less glossy, +++=Glossy, ++++=More glossy, *Figure in parentheses indicate angular transform value

(Ethaboxam 40% SC@1.33ml/l) appeared highest (82.42) followed by T₄ (Ethaboxam 40% SC@1.0ml/l) (73.04), T₃ (FolioGold) (56.42) and T₁ (Ishaan) (53.35). No considerable difference was observed between Indofil M-45 (49.27% PDI) and Trichosol (48.61% PDI) [12]. recorded the effectiveness of Ethaboxam, FolioGold and Kavach in laboratory condition which is more or less similar with the present study.

Conclusion

Potato is one of the most important solanaceous vegetables that suffers every year from the devastating disease, late blight. Total failure of the crop is common in severe cases. Proper management strategies can overcome the situation. Care should be taken starting from seed treatment to harvesting. Fungicides like Ethaboxam, FolioGold (chlorothalonil 33% + metalaxyl 3.3% SC), Ishaan (chlorothalonil 75% WP) and Indofil M-45 (mancozeb) can be used for effective management of the disease. The results of the study can be incorporated into Integrated Disease Management (IDM) programme.

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