BIOLOGICAL MANAGEMENT OF COMMON SCAB (*STREPTOMYCES SCABIEI*) OF POTATO

Abstract

At the Potato Research Station, S. D. Agricultural University, Deesa, Gujarat (India) a field experiment was carried out from 2019–20 to 2021–22 to assess the effectiveness of the three most widely used bioagents against the potato common scab. Five distinct treatments were assessed: T_1 seed treatment with *Trichoderma viride* and soil application of *Trichoderma viride* enriched FYM; T_2 seed treatment with *Pseudomonas fluorescens* and soil application of *Pseudomonas fluorescens* enriched FYM; T_3 seed treatment with *Bacillus subtilis* and soil application of *Bacillus subtilis* enriched FYM; T_4 seed treatment and soil application with boric acid and T_5 served as the control. The pooled data result showed that T_4 *i.e.* seed treatment and soil application with boric acid, had the lowest disease incidence and severity (33.95% & 38.67%) of common scab. This was found at par to T_3 (39.06% & 44.40%) which involved seed treatment with *Bacillus subtilis* and soil application with *Bacillus subtilis* enriched FYM. Next best treatment was T_2 (47.04% & 46.93%), which was seed treatment with *Pseudomonas fluorescens* and soil application with *Pseudomonas fluorescens* enriched FYM. There was no significant difference between treatments in terms of tuber yield (t/ha).

Key word: Common scab, potato, biological, tuber yield, boric acid.

Introduction:

Potato (*Solanum tuberosum* Linn.) is an important vegetable crop cultivated throughout the world. It is a perennial herb native to South America's Andean Plateau and a member of the *Solanaceae* family. In the times of war and famine, the potato's nutritional value has been known to save millions of lives. It is also a staple meal in many nations around the world. With almost twice as many calories per hectare as maize, wheat, and rice, it is considered as the fourth most important food crop in the world. Approximately double amount of calories per hectare makes it the fourth most important food crop after maize, wheat, and rice. It is most commonly used to make potato flour, potato chips, French fries, frozen potatoes, potato starch, and potato tapiocas. Each 100 g portion of fresh potato has 1.6 g of protein, 22.6 g of carbohydrates, 0.6 g of minerals, 0.4 g of crude fiber, 0.10 g of fat, and 25 mg of vitamin C (Saini and Umrav, 2008). Potatoes contain high levels of phenolic compounds and vitamin C, which act as powerful antioxidants by inactivating reactive oxygen species, reducing oxidative damage, improving immune function, and lowering the risk of cardiovascular disease, cancer, cataract, diabetes, and ageing (Brown, 2005; Kour *et al*., 2004). Recognizing the importance of potatoes as a basic crop and a source of food security, the United Nations named 2008 the International Year of the Potato. Potatoes are hence referred to as the "King of Vegetables" (Shailbala and Pathak, 2008).

Potatoes are vegetatively propagated, allowing diseases to spread from generation to generation through tubers. Among the potato diseases, common scab

is one of the major tuber borne as well as soil borne disease. It disseminates through the tuber and become soil borne. The disease is caused by *Streptomyces scabies* (ex. Thaxter) Lambert & Loria. It is an actinomycete belonging to the order *Actinomycetales* and family *Streptomycetaceae*. The disease causes superficial, erumpent or pitted lesion types, but erumpent lesions were most common and most. lesions have a raised, rough and corky appearance (Loria *et al*., 1997). Although disease do not directly impact on yield, they do affect tuber quality and acceptability, which in turn impacts potato market prices (Arora, 2012). The incidence and severity of common scab of potato are increasing year after year in major potato growing areas of Gujarat. Nowadays disease become dominant in Gujrat because continuous cultivation of potato on same field year after year, use of disease infected tubers and the common scab susceptible variety Kufri Pukhraj grown in more than 50 per cent area of Gujrat. Pesticides, or chemicals used indiscriminately to manage disease, have caused significant harm to people, animals, plants, and the ecosystem as a whole. Farmers are focusing more on using eco-friendly, non-hazardous pesticides, botanicals, and biocontrol agents as consumer awareness increased toward organic/naturally produced products. Considering the seriousness of the disease, this experiment was conducted for evaluation of various biological formulations against common scab of disease potato.

Materials and methods:

The field experiment was carried out at Potato Research Station, S. D. Agricultural University, Deesa (Gujarat) to study the biological management of common scab (*streptomyces scabiei*) disease of potato for three consecutive years *Rabi* 2019-20 to 2021-22. The site of the experiment and various treatment was fixed priorly and on same site the experiment was conducted for three consecutive years for better multiplication biological control agent on same site. The experiment was laid out in a non-replicated large plot design with five treatments and five quadrates (1.0 m. x 1.0 m.) with 10.0 m × 10.0 m plot size. The planting was done at row spacing of 50 cm and plant to plant spacing of 20 cm. The recommended dosage of fertilizers 275 kg N, 138 kg P and 275 kg K per hectare was applied. Five different treatments *viz.,* T_1 : Seed treatment with *Trichoderma viride*@ 1 litre/ ha seed and Soil application with *Trichoderma viride* (1 kg mixed in 100 kg FYM, incubated for a week and applied at the time of planting), T_2: Seed treatment with *Pseudomonas fluorescens*@ 1 kg/ ha seed and Soil application with *Pseudomonas fluorescens* (1 kg mixed in 100 kg FYM, incubated for a week and applied at the time of planting), T_3: Seed treatment with *Bacillus subtilis*@ 1 kg/ ha seed and Soil application with *Bacillus subtilis* (1 kg mixed in 100 kg FYM, incubated for a week and applied at the time of planting), T_4: Seed treatment with 3% boric acid solution + Soil application of boric acid @ 4kg/ha and T_5: Control. For Seed treatment, the respective bio-agents were mixed in 50 litre of water and the solution was sprayed on 1-hectare whole seed tubers (*i.e.* 3000 kg) before planting. The seed treatment of respective biocontrol agent was given before planting while the seed treatment of boric acid was given before tuber sprouting.

Observations recorded:

- Per cent disease incidence (By using standard formula).
- Per cent disease severity (By using standard formula) and severity scale as below. (Table 1)

Table 1 : Disease Severity Scale for Common scab (Driscoll *et al*., 2009)

Rating	Scab lesion percent are	Pitted lesion percent surface area
0	0	0
1	1-10	0
2	11-25	0
3	26-50	1-5
4	>50	6-25
5	>50	>25

- Total tuber yield
- Economics of various treatments

Results and Discussion

2019-20 & 2020-21:

In both years the minimum disease incidence (41.69% & 38.90%) was recorded in T_4 Seed treatment with 3% boric acid solution + soil application of boric acid @ 4kg/ha which was found at par with T_3 (46.23% & 44.13%) seed treatment with *Bacillus subtilis* @ 1 kg/ ha seed and soil application with *Bacillus subtilis* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting). The next best treatment in sequence were T_2 (63.42% & 55.93%) seed treatment with *Pseudomonas fluorescens*@ 1 kg/ ha seed and soil application with *Pseudomonas fluorescens* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting) and T_1 (67.19% & 56.13%) seed treatment with *Trichoderma viride*@ 1 kg / ha seed and Soil application with *Trichoderma viride (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting*). The same pattern was observed in disease severity of common scab. The effect of treatments were found non-significant on total tuber yield (t/ha). (Table:2)

2021-22:

The minimum disease incidence and severity (21.25% & 28%) were recorded in T_4 seed treatment with 3% boric acid solution + soil application of boric acid @ 4kg/ha which was at par with T_2 (21.78% & 30.80%) seed treatment with *Pseudomonas fluorescens*@ 1 kg/ ha seed and soil application with *Pseudomonas fluorescens* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time) and T_3 (26.81% & 33.60%) seed treatment with *Bacillus subtilis* @ 1 kg/ ha seed and soil application with *Bacillus subtilis* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting). The next best treatment in sequence were T_1 (34.10% & 41.20%) seed treatment with *Trichoderma viride*@ 1 kg/ ha seed and soil application with *Trichoderma viride (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting)*. The effect of treatments were found non-significant on total tuber yield (t/ha). (Table:2)

Pooled:

The pooled data shows that the minimum disease incidence and severity (33.95% & 38.67%) were recorded in T_4 seed treatment with 3% boric acid solution + soil application of boric acid @ 4kg/ha which was at par with T_3 (39.06% & 44.40%) seed treatment with *Bacillus subtilis* @ 1 kg/ ha seed and soil application with *Bacillus subtilis* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting). The next best treatment in sequence were T_2 (47.04% & 46.93%) seed treatment with *Pseudomonas fluorescens*@ 1 kg/ ha seed and soil application with *Pseudomonas fluorescens* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting) and T_1 (52.47% & 51.20%) seed treatment with *Trichoderma viride*@ 1 kg/ ha seed and soil application with *Trichoderma viride (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting)*. The effect of treatments were found non-significant on total tuber yield (t/ha). (Table:2)

Economics:

The economics of treatments shows that higher BC ratio (18.30) was recorded with T_3 seed treatment with *Bacillus subtilis* @ 1 kg/ ha seed and soil application with *Bacillus subtilis* (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting) which was followed by T_4 seed treatment with 3% boric acid solution + soil application of boric acid @ 4kg/ha which recorded 14.79 BC ratio. (Table:3)

Discussion:

The results are in agreement with finding of Gharate *et al.,* (2016) they reported the tuber treatment with 3 per cent boric acid spray before planting recorded the lowest disease incidence (48.0%) and disease index (1.46) with highest healthy (163.07 q/ha) and total tuber yield (339.30 q/ha). Khalil *et al*., 2015 also reported that the severity of potato common scab disease significantly reduced by seed treatments with *B. subtilis* (56.1%), fludioxonil (57.8%) and soil addition of mustard meal (63.1%). The same treatments significantly increased marketable yield by 32.5%, 24.6%, and 24.6%, respectively. Singh and Chaudhary (2012) also reported that tuber treatment with 3 per cent boric acid followed by *B. subtilis* tuber treatment@ 2.5g/kg recorded the lowest disease incidence (31.62%) and index (1.76). Khan *et al.* (2003) also reported that the 3% boric acid solution and 3% elemental sulphur solution gave significant control of Potato common scab disease as compared to the control.

Conclusion:

The seed treatment with 3% boric acid solution + soil application of boric acid (IP) @ 4kg/ha and seed treatment with *Bacillus subtilis* 1×10^8 @ 1 kg/ ha seed and soil application with *Bacillus subtilis* 1×10^8 (1 kg mixed in 100 kg FYM, incubate for a week and applied at the time of planting) recorded minimum disease incidence and severity of common scab of potato.

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Authors Contribution:
All authors contributed equally

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Table 2: Percent disease incidence and severity of common scab of Potato

Treatments	Disease Incidence (%)				Disease severity (%)				Total tuber yield (t/ha)			
	2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled	2019-20	2020-21	2021-22	Pooled
T_1	67.19	56.13	34.10	52.47	68.80	43.60	41.20	51.20	50.58	39.00	53.53	47.70
T_2	63.42	55.93	21.78	47.04	68.00	42.00	30.80	46.93	50.41	37.36	45.79	44.52
T_3	46.23	44.13	26.81	39.06	63.20	36.40	33.60	44.40	55.23	40.18	53.39	49.60
T_4	41.69	38.90	21.25	33.95	56.80	31.20	28.00	38.67	53.15	38.30	47.89	46.45
T_5	69.43	62.24	45.71	59.13	74.40	54.80	56.00	61.73	54.69	36.44	50.03	47.05
S.Em.(T)	3.18	2.77	2.79	2.96	3.74	2.87	2.88	2.06	4.17	3.07	3.04	2.12
CD(0.05)(T)	9.39	8.17	8.23	9.66	11.04	8.47	8.49	5.82	NS	NS	NS	NS
S.Em. (Y)	-	-	-	1.31	-	-	-	1.43	-	-	-	1.55
S.Em.(YxT)	-	-	-	2.92	-	-	-	3.19	-	-	-	3.47
CD(0.05) (YxT)	-	-	-	8.26	-	-	-	NS	-	-	-	NS
CV%	12.36	12.04	20.85	14.10	12.64	15.43	16.98	14.68	17.65	17.98	13.55	16.47

Table 3: Economics of various treatments evaluated against potato common scab.											
Treatment	**Qty. of material (kg/ha)**	**Cost of material (₹/ha)**	**Labour cost (₹)**	**Total Cost of treatment**	**Healthy tuber yield (t/ha)**	**Infected tuber yield (t/ha)**	**Yield (t/ha)**	**Gross realization (₹/ha)**	**Net Realization over control (₹/ha)**	**Net Gain (₹/ha)**	**PCBR**
T_1	2.00	500	1420	1920	22.67	25.03	47.70	199780	10556	8636	1:5.50
T_2	2.00	500	1420	1920	23.58	20.94	44.52	192504	3281	1361	1:1.71
T_3	2.00	500	1420	1920	30.23	19.37	49.60	224366	35142	33222	1:18.30
T_4	5.50	550	1420	1970	31.60	14.85	46.45	218350	29126	27156	1:14.79
T_5	0.00	0	0	0	19.23	27.82	47.05	189223	-	-	-

T. Viride : ₹150/kg

P. Fluorescens : ₹150/kg

B. Subtillus : ₹150/kg

Boric acid (IP) : ₹ 100/kg

Labour : ₹355/day

Healthy Potato : ₹5.5/kg

Scab Infected Potato : ₹3/kg

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