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Role of Biopesticides in Reducing Incidence of Potato Leafroll Virus (PLRV) in Field Conditions

Aditya Trivedi[1], A. N. Chaubey[2*], Virendra Singh[3]

[1,2,3]School of Agricultural Sciences and Engineering, IFTM University, Moradabad - 244 102 India

Email ID: adityapp108@gmail.com

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ABSTRACT

Viruses are microorganisms that infect all kinds of living organisms including plants, and cause remarkable lose in crop production. Although pesticides showed that they can protect plants from pest infections, there are no effective substances that can be used as potent virucides. Therefore, there is a continuous demand to produce chemicals in order to stop and cure viral infections in plants. However, toxicity and carcinogenicity issues were always attributed to chemical pesticides. Screening of natural products shined in the dark to find new safe virucides. An experiment was designed to test the efficacy of a few botanical extracts on the potato viral diseases. Minimum disease incidence recorded was 24.97 % and 23.22% percent in potato plots which received tuber treatment *Terminila arjuna* bark extract and two foliar sprays of Enviro (botanical virucides). Whereas, tuber treatment and six sprays with *Tinospora cordifolia* (aerial stem extract) reduced disease incidence by 29.21% and 30.82% followed by tuber treatment and six foliar spray with *Allium sativum* (garlic clove extract) 33.51% and 34.57%., maximum disease control (70.49 % and 71.99%), Maximum plant height (44.53 cm and 45.60 cm) and total number of tubers (10.20 and 10.30 per plant), were recorded in plots having tuber treatment *Terminila arjuna* bark extract and two foliar sprays of Enviro (botanical virucides)followed by tuber treatment and six sprays with *Tinospora cordifolia* (aerial stem extract) and uber treatment and six foliar spray with *Allium sativum* (garlic clove extract) during 2022-23 and 2023-24, respectively.

Keywords: *Biopesticides, Management, Potato, Viruses,*

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is the world's fourth most important food crop, with a global production of about 374.78 million tons per year according to the Food and Agriculture Organization Corporate Statistical Database, 2022 (Anonymous, 2022). China is the largest potato producer, accounting for 25.5% of global production followed by India at 15.0%. Along with the transportation of seed potatoes, potato diseases, especially viral diseases are rapidly spreading across potato planting areas worldwide.

The attack of various bacterial, fungal and viral diseases is main obstacle in obtaining high yield of potato. At present, potato production is being seriously threatened by virus infection, which not only causes yield and quality decline but also induces seed degradation (Solomon- Blackburn and Barker 2001a). Hitherto, more than 50 viruses have been identified in potato plants (Kreuze et al. 2020a). Viral diseases are challenging to control for which more attention is needed (Gebhardt and Valkonen, 2001). It largely affects the tuber and foliage. A numbers of viral diseases have been reported on this crop by several workers in the world, which produced various types of typical symptoms. Mosaic and leaf roll are the major diseases of this crop which cause huge losses in yield as well as quality of tubers. They usually limit the production of this crop hence the use of various practices is needed for successful management of the diseases.

Viral diseases cannot be controlled directly but can be avoided by some preventive measure like application of various chemicals. Recently we have been able to isolate a few antiviral agents from certain plants which have shown very high antiviral activity against many viruses infecting different crops [Verma *et al*., 1979 (a, b); Chaubey, 2014].

Table-1: Effect of antiviral agents on Per cent disease incidence in potato during 2022-2023 and 2023-24

Treatments		**PDI**	
		2022-23	**2023-24**
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	72.85 (58.57)	71.26 (57.56)
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf	62.37 (52.14)	61.86 (51.84)

	extract) @ (10%)		
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	60.82 (51.23)	59.08 (50.21)
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	68.55 (55.87)	67.53 (55.24)
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	63.74 (52.96)	61.86 (51.84)
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	51.12 (45.62)	49.34 (44.60)
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	39.15 (38.72)	38.63 (38.41)
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	37.38 (37.68)	36.41 (37.10)
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	45.20 (42.23)	43.93 (41.50)
T_{10}	$T_1 + T_5$	40.96 (39.77)	38.52 (38.35)
T_{11}	$T_2 + T_6$	33.51 (35.36)	34.57 (36.00)
T_{12}	$T_3 + T_7$	29.21 (32.69)	30.82 (33.71)
T_{13}	$T_4 + T_8$	24.97 (29.96)	23.22 (28.80)
T_{14}	Control	84.61 (66.88)	82.89 (65.55)
	CD at 5%	1.39 (0.85)	1.37 (0.84)
	SEm±	0.47 (0.29)	0.47 (0.29)
	CV	1.61 (1.11)	1.63 (1.10)

2. METHODS AND MATERIALS

Healthy tubers of potato cultivar Kufri Ashoka were sown in 3 × 3 m plot accommodating Spacing 60 cm x 20 cm during winter (*rabi)* season of 2022-23 and 2023-24 with 14 treatments and three replications under Randomized Block Design. An experiment was conducted to study the efficacy of extract of five plants and one botanical virucide *viz*., *Allium sativum* (clove extract), *Clerodendrum aculeatum* (leaf extract), *Tinospora cordifolia* (aerial stem extract), *Terminlia arjuna* (bark extract) and *Zingiber officinale* (rhizome extract) and Enviro (botanical virucide). The plant extracts were prepared by crushing the different parts of plants separately with distilled water (w/v) in a juicer grinder. Crude extracts were prepared by making suspension in tap water (1:10). The pulp was strained through two folds of cheese cloth and the homogenate was clarified by centrifugation at 3000g for 15 minutes. The supernatants were used for experimental works. Tubers of "Kufri Ashoka" variety were soaked in the plant extracts viz., *Allium sativum* (clove extract), *Clerodendrum aculeatum* (leaf extract), *Tinospora cordifolia* (aerial stem extract), *Terminlia arjuna* (bark extract) and *Zingiber officinale* (rhizome extract) separately for 24 hrs. The first spray of antiviral agents @ 10% was done after first appearance of disease. The second, third, fourth fifth and sixth sprays were done at eight days interval with same concentration. Water alone was sprayed instead of antiviral substance in control plots. Per cent disease incidence was calculated by the following formula:

$$\text{Per cent disease intensity (PDI)} = \frac{\text{Sum of total numerical ratings}}{\text{Total no. of leaves examined x maximum disease grade}} \text{x} 100$$

3. RESULTS AND DISCUSSION

Effect of biopesticides on Disease Incidence:

The application of biopesticides and plant-derived products significantly reduced the incidence of viral diseases in potato crops, accompanied by improvements in plant height, tuber size, and the total number of tubers per plant.

Among the treatments, **T13** recorded the **lowest disease incidence** with **24.97% in 2022–23 and 23.22% in 2023–24**, indicating the highest efficacy. Other treatments also showed a progressive reduction in disease incidence compared to the control (**T14**), which recorded the **highest disease incidence** of **84.61% and 82.89%** during the respective years.

The order of effectiveness, based on decreasing disease incidence, was as T13 (24.97%, 23.22%), T12 (29.21%, 30.82%), T11 (33.51%, 34.57%), T8 (37.38%, 36.41%), T7 (39.15%, 38.63%), T10 (40.96%, 38.52%), T9 (45.20%, 43.93%), T6 (51.52%, 49.34%), T3 (60.82%, 59.07%), T2 (62.37%, 61.86%), T5 (63.74%, 61.86%), T4 (68.55%, 67.53%), T1 (72.85%, 71.26%), T14 - Control (84.61%, 82.89%). The corresponding percentage disease control compared to the control ranged from 13.89% to 71.99%, with T13 achieving the highest disease suppression (70.49% in 2022–23 and 71.99% in 2023–24), followed by T12 and T11. The least effective treatments were T1 and T4, which showed minimal reduction in disease incidence.

These findings suggest that biopesticides, particularly those in T13, T12, and T11, are effective alternatives for managing viral diseases in potato crops under field conditions.

Table-2: Per cent disease control through antiviral agents of plant origin during 2022-2023 and 2023-24

Treatments		Per cent disease control	
		2022-23	2023-24
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	13.89 (21.85)	14.03 (21.98)
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	26.28 (30.82)	25.37 (30.23)
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	28.11 (32.00)	28.73 (32.40)
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	18.98 (25.81)	18.54 (25.49)
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	24.66 (29.75)	25.38 (30.24)
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	39.56 (38.95)	40.47 (39.49)
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	53.72 (47.16)	53.39 (46.93)
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	55.81 (48.32)	56.07 (48.47)
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	46.57 (43.02)	47.01 (43.26)
T_{10}	$T_1 + T_5$	51.5 (45.89)	53.53 (47.01)
T_{11}	$T_2 + T_6$	60.39 (50.98)	58.29 (49.76)
T_{12}	$T_3 + T_7$	65.48 (53.99)	62.82 (52.41)

T_{13}	$T_4 + T_8$	70.49 (57.07)	71.99 (58.02)
T_{14}	Control	0.00 (0.00)	0 (0.00)
	CD at 5%	1.69 (1.07)	1.59 (0.99)
	SEm±	0.57 (0.36)	0.55 (0.34
	CV	2.49 (1.68)	2.38 (1.56)

Effect of biopesticides on Plant Height

A progressive increase in plant height was observed with an increasing number of biopesticide applications. The treatment T13 recorded the maximum plant height, measuring 44.53 cm in 2022–23 and 45.60 cm in 2023–24, indicating the most effective response among all treatments.

This was followed by T12 (41.67 cm and 43.19 cm) and T11 (39.19 cm and 40.64 cm), which also exhibited significantly greater plant height compared to other treatments. The subsequent treatments showed moderate increases in plant height asT_8 (35.35 cm and 37.34cm), T_7 (34.12 cm and 35.53cm), T_{10} (32.95 cm and 33.70cm), T_9 (33.73 cm and 34.67cm)T_6 (32.53 cm and 34.19cm), T3 (31.90 cm and 33.45cm), T_2 (31.83 cm and 33.78cm), T_5 (31.60 cm and 32.67cm), T_4 (31.50 cm and 32.45cm) and T_1 (31.18 cm and 32.46cm The **control treatment (T14)** recorded the **lowest plant height**, at **27.52 cm in 2022–23 and 29.04 cm in 2023–24**.

Table-3: Effect of antiviral agent on height of plants during 2022-2023 and 2023-24.

Treatments		**Plant Height (cm)**	
		2022-23	**2023-24**
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	31.18	32.46
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	31.83	33.78
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	31.90	33.45
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	31.50	32.45
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	31.60	32.67
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	32.53	34.19
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	34.12	35.53
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	35.35	37.34
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	33.73	34.67
T_{10}	$T_1 + T_5$	32.95	33.70
T_{11}	$T_2 + T_6$	39.19	40.64
T_{12}	$T_3 + T_7$	41.67	43.19
T_{13}	$T_4 + T_8$	44.53	45.60
T_{14}	Control	27.52	29.04
	CD at 5%	1.28	1.07
	SEm±	0.44	0.37
	CV	2.23	1.78

Statistical analysis revealed that treatments **T13, T12, and T11** were significantly superior in promoting plant height. In contrast, treatments from T8 to T1 did not significantly differ from one another and were statistically at par. These results indicate that certain biopesticides, especially those in T13, T12, and T11, have the potential to enhance vegetative growth in potatoes by positively influencing plant height.

Effect of biopesticides on Yield Related Parameters

Application of biopesticides significantly improved yield-related parameters in potato compared to the untreated control (T14). All treatments involving botanical extracts enhanced the number of tubers per plant, tuber size, and tuber yield, with notable differences among treatments.

The highest number of tubers per plant was recorded in T13 with 10.20 and 10.30 tubers per plant during 2022–23 and 2023–24, respectively. This was statistically at par with T12 (9.47 and 9.64) and T11 (9.20 and 9.42). The following treatments also showed a positive response but differed significantly from each other and from the top-performing treatments T8: 7.73 and 7.57, T7: 7.37 and 7.57, T10: 6.93 and 7.06, T9: 6.57 and 6.75, T6: 6.57 and 6.67, T2: 6.20 and 6.40, T3: 6.13 and 6.20, T5: 6.10 and 6.13, T1: 6.10 and 6.30,T4: 6.03 and 6.06.

A gradual increase in tuber size was observed with an increasing number of biopesticide applications. The maximum tuber size was recorded in T13 (26.29 cm² and 26.97 cm²), which was statistically at par with T11, and significantly superior to all other treatments.

Similarly, tuber yield per plant (kg) was significantly enhanced by biopesticide treatments. The highest yield was recorded in T13 (0.73 kg and 0.76 kg per plant), which was statistically superior to all other treatments. All treatments resulted in higher yields than the control.

In terms of avoidable yield loss, T13 recorded the lowest loss (41.48%), indicating the highest protection against yield reduction due to viral diseases. The order of avoidable yield loss across treatments (2022–23 and 2023–24) was as T13: 41.48%, T12: 52.95% and 53.01%, T11: 51.65% and 52.51%, T8: 50.82% and 52.95%, T7: 44.78% and 45.45%, T10: 43.54% and 44.06%, T9: 42.10% and 45.83%, T6: 39.68% and 42.79%, T3: 34.13% and 37.64%, T2: 29.55% and 39.07%, T4: 27.70% and 28.83%, T5: 22.70% and 29.19%, T1: 16.16% and 23.86%.

These results clearly demonstrate the efficacy of biopesticides, particularly in T13, T12, and T11, in improving tuber production and mitigating yield losses due to viral infections in potato crops.

Table-4: Effect of antiviral agents on number of tubers/plant during 2022-2023 and 2023-24.

Treatments		**Number of tubers/plant**	
		2022-23	**2023-24**
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	6.10	6.30
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	6.20	6.40
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	6.13	6.20
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	6.03	6.06
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	6.10	6.13
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	6.57	6.67
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	7.37	7.57
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	7.73	7.81
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	6.57	6.75
T_{10}	$T_1 + T_5$	6.93	7.06
T_{11}	$T_2 + T_6$	9.20	9.42
T_{12}	$T_3 + T_7$	9.47	9.64
T_{13}	$T_4 + T_8$	10.20	10.30
T_{14}	Control	4.90	5.02

	CD at 5%	0.66	0.17
	SEm±	0.22	0.06
	CV	5.47	1.35

Table-5: Effect of antiviral agents on tuber size (cm^2) during 2022-2023 and 2023-24.

Treatments		**Tuber size (cm^2)**	
		2022-23	**2023-24**
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	12.97	13.56
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	16.13	16.64
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	17.77	17.60
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	13.57	14.15
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	14.97	15.25
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	17.87	18.75
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	20.03	21.86
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	21.73	22.71
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	18.83	19.85
T_{10}	$T_1 + T_5$	18.83	19.26
T_{11}	$T_2 + T_6$	23.23	24.15
T_{12}	$T_3 + T_7$	24.40	24.89
T_{13}	$T_4 + T_8$	26.29	26.97
T_{14}	Control	11.03	11.97
	CD at 5%	12.97	0.58
	SEm±	12.97	0.19
	CV	4.00	1.79

Table-6: Effect of antiviral agents on tuber yield per plant (kg) during 2022-2023 and 2023-24.

Treatments		**Tuber yield per plant (kg)**	
		2022-23	**2023-24**
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract*)* @ (10%)	0.33	0.42
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	0.42	0.52
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	0.45	0.50
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	0.41	0.44
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	0.38	0.44
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	0.49	0.54
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	0.53	0.57
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	0.59	0.66
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	0.51	0.57
T_{10}	$T_1 + T_5$	0.52	0.59
T_{11}	$T_2 + T_6$	0.61	0.65
T_{12}	$T_3 + T_7$	0.62	0.66
T_{13}	$T_4 + T_8$	0.73	0.76

T_{14}	Control	0.29	0.32
	CD at 5%	0.05	0.07
	SEm±	0.02	0.02
	CV	5.49	7.77

Table-7: Avoidable yield loss (%) during 2022-2023 and 2023-24.

Treatments		Avoidable yield loss (%)	
		2022-23	2023-24
T_1	Tuber treatment with *Allium sativum* (*Garlic* clove extract) @ (10%)	16.16	23.86
T_2	Tuber treatment with *Clerodendrum aculeatum* (leaf extract) @ (10%)	29.55	39.07
T_3	Tuber treatment with *Tinospora cordifolia* (aerial stem extract) @ (10%)	34.13	37.64
T_4	Tuber treatment with *Terminlia arjuna* (bark extract) @ (10%)	27.70	28.83
T_5	Six foliar sprays with *Allium sativum* (*Garlic* clove extract) @ (10%)	22.70	29.19
T_6	Six foliar sprays with *Clerodendrum aculeatum* (leaf extract) @ (10%)	39.68	42.79
T_7	Six foliar sprays with *Tinospora cordifolia* (aerial stem extract)@ (10%)	44.78	45.45
T_8	Two foliar spray of Enviro (botanical virucide) @ 0.25%	50.82	52.95
T_9	Two foliar sprays of *Zingiber officinale* (Ginger- rhizome extract) @ 10%)	42.10	45.83
T_{10}	$T_1 + T_5$	43.54	47.06
T_{11}	$T_2 + T_6$	51.65	52.51
T_{12}	$T_3 + T_7$	52.95	53.01
T_{13}	$T_4 + T_8$	59.27	59.21
T_{14}	Control	0.00	0.00
	CD at 5%	5.03	9.56
	SEm±	1.72	3.27
	CV	8.19	14.22

4. DISCUSSIONS

The present study demonstrated that biopesticide treatments, particularly those based on *Tinospora cordifolia*, *Ipomoea fistulosa*, and *Aloe vera*, significantly reduced the incidence of viral diseases in potato and enhanced yield-related parameters. The observed inhibitory effects may be attributed to the presence of naturally occurring resistance-inducing compounds in these botanicals.

Similar findings have been reported in earlier studies. Awasthi et al. (1984) showed that pre-inoculation foliar sprays with *Boerhaavia diffusa* root extract were effective in suppressing a range of plant viral diseases, including tobacco mosaic virus (TMV) in tobacco, cucumber mosaic virus (CMV) and TMV in tomato, cucumber green mottle mosaic virus in melon, sunnhemp rosette virus in *Crotolaria juncea*, and Gomphrena globosa virus.

Further supporting evidence comes from Verma et al. (1985), who reported the successful suppression of mungbean yellow mosaic virus (MYMV) in mungbean and urdbean using aqueous and partially clarified leaf extracts of *Clerodendrum fragrans* and *Aerva sanguinolenta*, as well as root extracts of *B. diffusa*. These extracts were shown to be effective in reducing natural infection levels and enhancing disease resistance in the host plants.

Hoda and Waziri (2015) also documented the antiviral properties of several plant extracts, including *Boerhaavia diffusa* and *Clerodendrum aculeatum*, which were found to act as systemic resistance inducers. These botanicals are thought to trigger defense mechanisms in uninfected parts of the plant, possibly through the activation of ribosome-inactivating proteins (RIPs), which inhibit viral replication.

Singh (2002), and later Singh and Awasthi (2002), demonstrated that aqueous root extracts of *B. diffusa* effectively reduced the incidence of mungbean yellow mosaic virus and bean common mosaic virus under field conditions, accompanied by an increase in grain yield. Their findings were further substantiated by Awasthi and Kumar (2003a,b) and Kumar and Awasthi (2003a,b), who observed that weekly sprays of *B. diffusa* root extract significantly inhibited the infection, replication, and systemic spread of viruses such as cucumber mosaic virus, bottle gourd mosaic virus, cucumber green mottle mosaic virus, and pumpkin mosaic virus in cucurbitaceous crops.

Collectively, these studies support the current findings and affirm the potential of botanical biopesticides as eco-friendly and sustainable tools for the management of plant viral diseases. The mode of action of these botanicals likely involves the induction of systemic acquired resistance (SAR) and direct antiviral effects, making them promising alternatives to synthetic chemicals in integrated disease management programs.

5. CONCLUSION

Biopesticides derived from *Tinospora cordifolia*, *Ipomoea fistulosa*, and *Aloe vera* effectively reduced viral disease incidence in potato while improving plant growth and yield parameters. Among the treatments, T13 showed the best performance across both seasons. The efficacy of these botanicals is attributed to their resistance-inducing and antiviral properties. This study highlights the potential of biopesticides as eco-friendly, sustainable alternatives to chemical control in managing potato viral diseases under field conditions.

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