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Plant Based Extracts and Chemical Interventions for Management of *Pestalotiopsis psidii*- A Study on Guava Fruit Canker

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ABSTRACT

An investigation was conducted during March, 2019–February, 2020 in the Research Laboratory, Department of Plant Pathology, College of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh, India, to evaluate the in vitro efficacy of different plant-based extracts and chemical fungicides against *Pestalotiopsis psidii*, the causal organism of guava fruit canker. A total of four plant-based extracts and one natural product were evaluated for their antifungal properties. Among these, *Azadirachta indica* (neem) extract and 10 days old sour buttermilk inhibited the growth of *P. psidii* by 25.11 and 76.39%, respectively. In contrast, synthetic fungicides such as CabrioTop, Chlorothalonil, Tilt, Ridomil MZ, Bavistin, Blitox and Contaf demonstrated complete inhibition of the pathogen under invitro conditions, indicating their strong antifungal efficacy. Among the tested fungicides, CabrioTop was the most effective fungicide in both prophylactic (preventive) and curative (therapeutic) treatments. It not only completely suppressed the growth of *P. psidii* but also extended the incubation period (33.30 and 29.72 h) of the disease, thereby reducing disease severity (69.03 and 75.82%, respectively). In conclusion, CabrioTop could serve as a highly effective chemical control measure against guava fruit canker, providing rapid and dependable disease suppression in field conditions while, neem extract and sour buttermilk emerge as eco-friendly alternatives, offering antimicrobial properties that may reduce disease incidence without posing harm to the environment.

KEYWORDS: Antifungal, fruit canker, *Pestalotiopsis psidii*, plant extracts, synthetic

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1. INTRODUCTION

Guava (*Psidium guajava* L. 2n=2x=22), is also known as "Apple of the tropics" and popular fruit crop which belongs to the genus *P. sidium* (Myrtaceae) (Mishra et al., 2019; Mishra and Singh, 2022; Takeda et al., 2022) native to tropical and subtropical regions (Mathiazhagan et al., 2023). It can be grown on varied soils ranging from clay to sandy and with acidic (4.5) to alkaline (8.5) pH and hence it occupies a significant place in the horticultural wealth of our nation (Sharma and Kumawat, 2019). Moreover, guava grows naturally in regions with an average annual rainfall ranging from 1000 to 2000 mm (Heuzé et al., 2015).

It is a rich source of energy, fiber, carbohydrates, vitamin C (212 mg 100 g^{-1} fruit), niacin, riboflavin and vitamin B6 (Singh et al., 2022), ranking fourth among the most significant fruit crops, following mango, banana, and citrus (Anonymous, 2017). The global production of guava is estimated to be 55 mt (Anonymous, 2021). According to data from the Indian Council of Agricultural Research, guava cultivation in India spans an area of 345.45 t ha^{-1}, with an annual production of 5449.47 t mt^{-1} (Anonymous, 2024). It's popularity is attributed to its antioxidant, antidiabetic, anti-inflammatory, anticancer and anti-diarrheal properties (Shanthirasekaram et al., 2021; Blancas-Benitez et al., 2022) However, as guava cultivation has expanded, it has become highly susceptible to various diseases (Omayio et al., 2020).

Scabby fruit canker, caused by *Pestalotiopsis psidii*, is one of the most prevalent fruit diseases in guava-growing regions and affects fruits at all stages of development. Symptoms typically appear on green fruits and in rare instances, on leaves. The initial sign of infection on fruit is the appearance of minute, brown or rust-colored, unbroken, circular, necrotic areas that rupture the epidermis in a circulatory manner in advanced stages of infection (Sahana, 2023). Infected fruits remain underdeveloped, hard, malformed, and mummified, which leads to significant fruit drop. Occasionally, on leaves, small, rusty brown angular spots developed, whereas cankerous spots were common in winter, and minute red specks appeared during the rainy season (Dheir and Naser, 2019). This disease has been reported to significantly reduce fruit yield during the pre-harvest stage and fruit losses during post-harvest storage have been documented (Kwee, 1990). In India, *P. psidii* causes postharvest damage to ripe guava fruits (Kaushik et al., 1972). Approximately 90–100% fruits have been found to be infected (Chaube and Pundhir, 2005). In recent years, the prevalence of this disease has been reported in the subtropical zone of Himachal Pradesh, with an incidence ranging from 22 to 30% in guava fruits (Anonymous, 2016).

Considering the significant losses caused by the pathogen responsible for the scabby fruit canker in guava, the present study was initiated to assess the impact of various plant extracts and chemical treatments on the pathogen's growth and the severity of the disease. A comparative analysis was performed to pinpoint the most effective treatment by analyzing differences in disease occurrence, lesion formation and pathogen suppression across the treatments. The results of this research will aid in formulating on integrated disease management approach for guava farmers, reducing yield losses and enhancing fruit quality. The study aimed to evaluate the effectiveness of different plant-based and chemical control strategies in managing scabby fruit canker.

2. MATERIALS AND METHODS

An investigation was conducted during March, 2019-February, 2020 in the Research Laboratory, Department of Plant Pathology, College of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh, India.

2.1. In vitro evaluation of different chemicals

Eight fungicides viz., mancozeb (Dithane M-45®), metalaxyl 8%+ mancozeb 64% (Ridomil MZ®), chlorothalonil, copper oxychloride (Blitox-50®) tested at 500, 1000, 1500 and 2000 ppm. However, pyraclostrobin 5%+metiram 55% (CabrioTop®), carbendazim (Bavistin®), propiconazole (Tilt®) and hexaconazole (Contaf®) tested at 125, 250, 375 and 500 ppm were evaluated in vitro against the test pathogen by using poisoned food technique (Falck, 1907) and compared with untreated control. Data were recorded in terms of diametric growth of the fungus (mm) and growth inhibition (%) in relation to untreated control was further calculated on the basis of formula given by Vincent (1974).

2.2. In vitro evaluation of different botanicals and natural product

Four botanicals viz., *Lantana camara*, *Justicia adhatoda*, *Azadirachta indica* and *Murraya koenigii* were tested in vitro at 5, 10, 15 and 20% concentration whereas, one natural product i.e. 10 days old sour buttermilk was also tested at 10, 20, 30 and 40% concentrations to check their efficacy against the *P. psidii* by using poisoned food technique. Data were recorded in terms of diametric growth of the fungus (mm) and growth inhibition (%) in relation to untreated control was further calculated.

2.3. Effect of pre inoculation dip treatments on the development of disease

Young and healthy guava fruits were then dipped in the effective botanicals/natural products/chemicals showing best results for 1, 2, 3, 4, 5 and 6 h durations and then inoculated with *P. psidii*. These fruits were then incubated at room temperature to see the effect of chemical dip treatments on the development of scabby fruit canker. Fruits dipped in sterilized distilled water and inoculated

with pathogen culture served as check. Data were recorded in terms of incubation period (h) and disease severity (%). Disease severity (%) was calculated based on formula given by McKinney (1923).

2.4. Effect of post inoculation dip treatments on the development of disease

Young and healthy guava fruits procured from market were first washed under tap water thoroughly. They were then wiped with 1% sodium hypochlorite solution and again rinsed with sterilized distilled water and inoculated with *P. psidii*. These inoculated fruits were incubated for 2 h at room temperature and then dipped in the effective botanicals or natural products or chemicals and their combinations showing best results for 1, 2, 3, 4, 5 and 6 h duration and again incubated at room temperature to see the effect of post inoculation dip treatment on the development of particular scabby fruit canker. Data were recorded in terms of incubation period (h) and disease severity (%).

2.5. Statistical analysis

Data recorded in these experiments were further subjected to statistical analysis for completely randomized design by using OPSTAT.

3. RESULTS AND DISCUSSION

3.1. In vitro evaluation of botanicals and natural product against Pestalotiopsis psidii

It was clear from the Table 1 that significantly minimum (22.77 mm) diametric growth was recorded in 10 days old sour buttermilk treatment followed by *A. indica* (67.40 mm) in comparison to full growth of the fungus (90.00 mm) in control and rest three treatments, irrespective of the concentrations used. Whereas, irrespective of the botanicals and natural product tested, mean diametric growth of the fungus was recorded to be significantly maximum (76.63 mm) at lowest concentration tested which decreased significantly with increase in each level of concentration being minimum at highest concentration tested (73.42 mm). Body of the table reveals that the minimum growth was recorded in 10 days old sour buttermilk at 40% concentration (18.49 mm) which resulted in 79.46% growth inhibition. Maximum growth of the test pathogen was recorded in *L. camara*, *J. adhatoda* and *M. koenigii* tested at all the four concentrations which was equal to control (90.00 mm) leading to 0% growth inhibition. An intermediate growth was recorded in rest of the treatments at various concentrations tested leading to respective levels of growth inhibition.

3.2. In vitro evaluation of chemical fungicides against Pestalotiopsis psidii

Data present in the Table 2 clearly depicted that CabrioTop, Chlorothalonil, Tilt, Ridomil MZ and Bavistin completely inhibited the growth of the test pathogen at all the four concentrations tested, as the fungus failed to grow in these treatments. However, significantly minimum (3.54 mm) mean diametric growth was recorded in Dithane M-45 followed by Contaf (13.79 mm) and Blitox-50 (21.25 mm) in comparison to full growth of the fungus (90.00 mm) in control treatment, irrespective of the concentrations used. Whereas, irrespective of the fungicides tested, mean diametric growth of the fungus was significantly maximum (17.07 mm) at highest concentration evaluated which decreased significantly with increase in each level of concentration being minimum at highest concentration tested (13.21 mm).

Body of the table reveals that CabrioTop, Chlorothalonil, Tilt, Ridomil MZ, Bavistin at all concentrations tested and Dithane M-45 at 1000, 1500 and 2000 ppm significantly resulted in cent per cent inhibition of the growth followed by Dithane M-45 tested at 500 ppm (14.17 mm) which resulted in 96.06% growth inhibition. Significantly mean maximum (31.89 mm) growth of the test fungus was recorded in Blitox-50 when tested at 500 ppm leading to 64.57% growth inhibition followed by same chemical tested at 1000 (21.47 mm and 76.14%) and 1500 ppm (18.30 mm and 79.67%). An intermediate level of growth inhibition was recorded in rest of the treatments at different concentrations tested.

Table 1: Effect of different botanicals and natural products for the management of *Pestalotiopsis psidii* under *in vitro* conditions

Treatments	Diametric growth (mm) at concentration (%)				Overall mean
	5	10	15	20	
Lantana camara	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
Justicia adhatoda	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
Murraya koenigii	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
Azadiracta indica	71.20 (57.54)	68.54 (55.88)	67.85 (55.46)	62.02 (51.96)	67.40 (55.21)
Buttermilk*	28.60 (32.33)	24.43 (29.62)	19.55 (26.24)	18.49 (25.47)	22.77 (28.42)
Control	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
Overall mean	76.63 (62.69)	75.50 (61.96)	74.54 (61.33)	73.42 (60.61)	

Table 1: Continue...

Treatments	Inhibition (%) in diametric growth				Overall mean
	5	10	15	20	
Lantana camara	0	0	0	0	0
Justicia adhatoda	0	0	0	0	0
Murraya koenigii	0	0	0	0	0
Azadiracta indica	20.89	23.84	24.61	31.09	25.11
Buttermilk*	68.22	72.86	78.28	79.46	74.70
Control					
Overall mean	17.82	19.34	20.57	22.11	
Treatment×Concentration					
SEm±	0.06	0.04	0.12		
CD (p=0.05)	0.12	0.10	0.24		

*Concentrations tested were 125, 250, 375 and 500 ppm; Figures in parentheses indicates angular transformed value

Leaf extract of *A. indica* was found to inhibit the test pathogen up to certain extent. These findings were in conformity with the findings of Pandey et al. (1983), who reported that leaf extract of *A. indica* and *Ocimum sanctum* inhibited the germination of *P. psidii* spores in vitro. CabrioTop, Chlorothalonil, Tilt, Ridomil MZ and Bavistin inhibited the growth of the *P. psidii* in vitro. These results were in accordance with Ray et al. (2007) who reported that chlorothalonil, carbendazim, mancozeb and combination product of metalaxyl+mancozeb and carboxin+thiram gave good inhibition against *P. psidii in vitro*. These results were further supported by the findings of Sethi et al. (2022) who reported that Carbendazim (0.1%) and Propiconazole (25%) were effective in the management of guava canker disease. Cabrio Top, a combo product of strobilurin group of fungicides inhibited the growth of the fungus completely. These findings were in conformity with the findings of Parmar and Patel (2024) who reported that azoxystrobin (11%)+tebuconazole (18.3% SC) was the most effective fungicide for controlling the fruit canker of guava.

3.3. Effect of pre inoculation dip treatments on the development of scabby fruit canker in guava

It is clear from the Table 3 that all dip treatments were able to prolong the incubation period in comparison to the untreated control. Irrespective of duration of dip treatments, longest mean incubation period (33.30 h) was recorded in dip treatment with CabrioTop followed significantly by Tilt (29.00 h), Bavistin (27.39 h) and Dithane M-45 (26.94) which was statistically at par with Chlorothalonil (26.66) and Ridomil MZ (26.56 h). However, shortest mean incubation period was recorded in untreated control (24.00 h) followed significantly by *A. indica* (25.22 h) which was statistically at par with 10 days old sour buttermilk (25.25 h). Among the six durations tested, there was a significant increase in the average incubation period with the increase in dip treatment being minimum (24.57 h) in 1 h dip treatment and maximum in 6 h dip treatment (29.51 h) irrespective

Table 2: Effect of different fungicides for the management of *Pestalotiopsis psidii* under *in vitro* conditions

Treatments	Diametric growth (mm) at concentration (%)				Overall mean
	500	1000	1500	2000	
CabrioTop*	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
Chlorothalonil	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
Tilt*	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
Ridomil MZ	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
Bavistin*	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
Dithane M-45	14.17 (22.10)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	3.54 (8.57)
Contaf*	15.10 (22.87)	14.30 (22.22)	13.21 (21.31)	12.53 (20.73)	13.79 (21.78)
Blitox-50	31.89 (34.38)	21.47 (27.60)	18.30 (25.32)	13.33 (21.40)	21.25 (27.18)
Control	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
Overall mean	17.07 (19.02)	14.31 (16.19)	13.83 (15.84)	13.21 (15.34)	

Table 2: Continue...

Treatments	Inhibition (%) in diametric growth at concentration (ppm)				Overall mean
	500	1000	1500	2000	
CabrioTop*	100.00	100.00	100.00	100.00	100.00
Chlorothalonil	100.00	100.00	100.00	100.00	100.00
Tilt*	100.00	100.00	100.00	100.00	100.00
Ridomil MZ	100.00	100.00	100.00	100.00	100.00
Bavistin*	100.00	100.00	100.00	100.00	100.00
Dithane M-45	84.26	100.00	100.00	100.00	96.06
Contaf*	83.22	84.11	85.32	86.10	84.68
Blitox-50	64.57	76.14	79.67	85.19	76.39
Control					
Overall mean	91.50	95.03	95.62	96.41	
Treatment×Concentration					
SEm±	0.13	0.09	0.26		
CD (p=0.05)	0.26	0.17	0.52		

*Concentrations tested were 125, 250, 375 and 500 ppm; Figures in parentheses indicates angular transformed value

of chemicals, plant extract and natural product under study.

Interaction between duration and dip treatments revealed that dip treatment with CabrioTop for 6 h duration was able to prolong the incubation period to the maximum extent (39.33 h). However, dip treatments with *A. indica*, buttermilk, Contaf and Blitox-50 for 1 h duration resulted in significantly shortest incubation period (24.00 h) equivalent to untreated control (24.00 h). An intermediate incubation period was recorded in rest of the treatments under study.

As far as disease severity (%) was concerned, irrespective of the duration of dip treatments, significantly minimum (69.03%) mean disease severity was recorded in CabrioTop treated fruits followed by Chlorothalonil (71.88%) which was statistically at par with Bavistin (72.29%) which was further statistically at par with Tilt (72.52%). Significantly maximum disease severity (82.64%) was recorded in *A. indica* treated fruits next to untreated control (100%). However, irrespective of the treatments tested, there was significant

Table 3: Effect of pre inoculation dip treatments on the development of scabby fruit canker in guava

Treatments	Incubation period (h) in dip duration (h)						Overall mean
	1	2	3	4	5	6	
Cabriotop	28.00	29.17	31.67	34.33	37.33	39.33	33.30
Chlorothalonil	25.00	25.67	26.00	25.67	27.67	30.00	26.66
Dithane M-45	24.33	25.33	26.33	27.67	28.67	29.33	26.94
Ridomil MZ	24.33	24.67	26.00	27.33	27.67	29.33	26.56
Tilt	24.33	26.33	28.67	30.67	31.33	32.67	29.00
Contaf	24.00	24.33	25.33	26.00	27.33	28.33	25.89
Blitox-50	24.00	24.00	25.00	26.67	27.33	27.67	25.78
Bavistin	24.33	25.00	26.67	28.33	29.00	31.00	27.39
Buttermilk	24.00	24.33	24.83	25.67	26.00	26.67	25.25
A. indica	24.00	24.37	24.90	25.63	26.13	26.33	25.22
Control	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Overall mean	24.57	25.20	26.30	27.45	28.40	29.51	
Treatment×Concentration							
SEm±	0.20	0.15	0.50				
CD (p=0.05)	0.40	0.30	0.99				

Table 3: Continue...

Treatments	Disease severity (%) in dip duration (h)						Overall mean
	1	2	3	4	5	6	
Cabriotop	76.46 (8.80)	71.68 (8.52)	70.47 (8.45)	68.21 (8.31)	65.00 (8.12)	62.35 (7.95)	69.03 (8.36)
Chloro-thalonil	79.41 (8.97)	75.02 (8.71)	72.07 (8.54)	70.30 (8.44)	68.18 (8.31)	66.29 (8.20)	71.88 (8.53)
Dithane M-45	80.49 (9.02)	78.35 (8.90)	76.92 (8.82)	74.54 (8.69)	72.51 (8.57)	70.21 (8.43)	75.50 (8.74)
Ridomil-MZ	79.35 (8.96)	77.12 (8.83)	74.58 (8.69)	71.91 (8.53)	70.25 (8.44)	68.45 (8.33)	73.61 (8.63)
Tilt	78.35 (8.90)	75.35 (8.73)	73.41 (8.62)	71.22 (8.49)	69.48 (8.39)	67.32 (8.26)	72.52 (8.57)
Contaf	82.32 (9.12)	79.79 (8.98)	77.35 (8.85)	75.65 (8.75)	73.22 (8.61)	70.75 (8.47)	76.51 (8.80)
Blitox-50	80.32 (9.01)	78.39 (8.91)	76.28 (8.79)	74.45 (8.68)	72.22 (8.55)	70.89 (8.48)	75.42 (8.74)
Bavistin	77.97 (8.88)	76.07 (8.77)	72.72 (8.58)	70.51 (8.45)	68.75 (8.35)	67.75 (8.29)	72.29 (8.55)
Buttermilk	87.32 (9.39)	81.82 (9.10)	79.60 (8.97)	75.76 (8.76)	73.93 (8.65)	72.22 (8.55)	78.44 (8.90)
A. indica	86.06 (9.52)	84.91 (9.29)	83.59 (9.15)	82.58 (9.07)	80.33 (8.97)	78.39 (8.86)	82.64 (9.14)
Control	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)
Overall mean	83.45 (9.15)	80.77 (8.98)	78.82 (8.86)	76.83 (8.75)	74.90 (8.64)	73.14 (8.53)	
Treatment×Concentration							
SEm±	0.02	0.01	0.04				
CD (p=0.05)	0.04	0.03	0.09				

Figures in parentheses indicate square root transformed value

declined in the disease severity with the increase in each duration of dip treatment being significantly minimum (73.14%) in 6 h dip treatment and maximum (83.45%) in 1 h dip treatment.

Body of the table reveals that CabrioTop treatment for 6 h duration resulted in significantly minimum disease severity (62.35%) followed by 5 h dip treatment in the same chemical (65.00%) which was statistically at par with the disease severity recorded in the fruits treated with Cholorothalonil for 6 h duration (66.29%). However, maximum disease severity (86.06%) was recorded in *A. indica* treatment for 1 h duration next to untreated control (100%). An intermediate level of disease severity was recorded in rest of the dip treatments for different durations.

3.4. Effect of post inoculation dip treatments on the development of scabby fruit canker in guava

It is clear from the Table 4 that all dip treatments were able to prolong the incubation period in comparison to the untreated control. Significantly longest mean incubation period (29.72 h) was recorded in dip treatment with CabrioTop followed by Chlorothalonil (27.86 h) which was statistically at par with Dithane M-45 (27.66 h) followed significantly by Ridomil MZ (26.41 h) which was statistically at par with Bavistin (26.27 h), Tilt (26.12 h) irrespective of duration of dip treatments. However, shortest mean incubation period was recorded in untreated control (24.00 h) followed significantly by *A. indica* (24.97 h). Keeping aside the chemicals, plant extract and natural product used, there was a significant increase in the average incubation period with the increase in dip treatment being significantly maximum in 6 h dip treatment (28.16 h) out of six durations under study. Interaction body of the table revealed that dip treatment in CabrioTop for 6 h duration was able to prolong the incubation period to the maximum extent (32.25 h). However, dip treatment in Tilt, Contaf, Buttermilk and *A. indica* for 1 h (24.00 h) resulted in shortest incubation period equivalent to untreated control (24.00 h). An intermediate incubation period was recorded in rest of the treatments studied.

As far as disease severity (%) was concerned, irrespective of the duration of dip treatments, significantly minimum mean disease severity (75.82%) was recorded in CabrioTop treated fruits followed by Chlorothalonil (79.78%) which was statistically at par with Dithane M-45 (80.04%).

Table 4: Effect of post inoculation dip treatments on the development of scabby fruit canker in guava

Treatments	Incubation period (h) in dip duration (h)						Overall mean
	1	2	3	4	5	6	
Cabriotop	25.97	27.49	30.19	30.80	31.66	32.25	29.72
Chlorothalonil	24.67	25.83	27.13	29.03	29.87	30.66	27.86
Dithane M-45	24.67	27.00	27.33	28.33	29.33	29.33	27.66
Ridomil MZ	24.67	25.16	25.83	26.66	27.66	28.50	26.41
Tilt	24.00	25.00	25.63	26.38	27.33	28.40	26.12
Contaf	24.00	24.83	25.66	26.33	27.00	28.00	25.97
Blitox-50	24.33	25.00	25.33	25.66	26.66	27.33	25.72
Bavistin	24.67	25.33	25.66	26.66	27.33	28.00	26.27
Buttermilk	24.00	24.33	24.83	25.66	26.00	26.66	25.25
A. indica	24.00	24.16	24.66	25.00	25.33	26.66	24.97
Control	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Overall mean	24.45	25.28	26.02	26.77	27.47	28.16	
Treatment×Concentration							
SEm±	0.17	0.12	0.42				
CD (p=0.05)	0.34	0.25	0.83				

Table 4: Continue...

Treatments	Disease severity (%) in dip duration (h)						Overall mean
	1	2	3	4	5	6	
Cabriotop	80.17(9.01)	78.38(8.91)	76.58(8.80)	74.71(8.70)	73.31(8.62)	71.78(8.53)	75.82(8.76)
Chloro-thalonil	83.24(9.17)	82.28(9.12)	80.65(9.03)	78.91(8.94)	77.80(8.87)	75.81(8.76)	79.78(8.98)
Dithane M-45	87.73(9.42)	81.53(9.08)	80.21(9.01)	78.41(8.91)	77.05(8.83)	75.31(8.73)	80.04(9.00)
Ridomil MZ	88.49(9.42)	85.28(9.28)	81.21(9.06)	79.08(8.95)	77.61(8.86)	76.61(8.81)	81.38(9.07)
Tilt	87.75(9.48)	86.15(9.33)	85.30(9.29)	84.25(9.23)	82.38(9.13)	81.30(9.07)	84.52(9.24)
Contaf	87.75(9.47)	86.55(9.35)	85.20(9.28)	84.50(9.24)	83.63(9.20)	82.63(9.14)	85.04(9.28)
Blitox-50	88.86(9.73)	86.92(9.37)	85.58(9.30)	83.88(9.21)	83.10(9.17)	81.75(9.09)	85.01(9.27)
Bavistin	88.85(9.47)	86.15(9.33)	84.33(9.23)	81.61(9.08)	80.66(9.03)	79.36(8.96)	83.49(9.19)
Buttermilk	93.71(9.73)	92.75(9.68)	91.75(9.63)	90.25(9.55)	88.83(9.47)	87.66(9.41)	90.82(9.58)
A. indica	96.66(9.88)	95.48(9.82)	94.48(9.77)	92.58(9.67)	90.81(9.58)	90.25(9.55)	93.38(9.71)
Control	100.00(10.05)	100.00(10.05)	100.00(10.05)	100.00(10.05)	100.00(10.05)	100.00(10.05)	100.00(10.05)
Overall mean	89.38(9.50)	87.40(9.39)	85.93(9.31)	84.38(9.23)	83.20(9.16)	82.04(9.10)	
Treatment×Concentration							
SEm±	0.01	0.01	0.33				
CD (p=0.05)	0.03	0.02	0.06				

Figures in parentheses indicate square root transformed value

Significantly maximum disease severity (100%) was recorded in untreated control treatment significantly followed by *A. indica* (93.38%). However, irrespective of the treatments, there was a significant decline in the disease severity with the

increase in each duration of dip treatment being significantly minimum (82.04%) in 6 h dip treatment and maximum (89.38%) in 1 h dip treatment.

Body of the table reveals that CabrioTop treatment for 6 h duration resulted in significantly minimum disease severity (71.78%) followed by the same chemical dip treatment for 5 (73.31%) and 4 h (74.71%) dip treatments which was statistically at par with mean disease severity (75.31%) recorded in Dithane M-45 dip treatments for 6 h. However, maximum disease severity (100%) was recorded in untreated control followed by neem dip treatment for 1 h duration (96.66%).

It is pertinent to mention here that in case of dip treatments with Tilt for all the durations, although the symptom development was delayed to a significant extent and certain level of disease control was also achieved but, fruits suffered phytotoxicity due the chemical both in case of pre inoculation and post inoculation dip treatments.

The objective of testing different pre and post inoculation dip treatments during present studies was to check whether the particular treatment could manage the disease prophylactically or curatively. The effective treatments open avenues for further research in field trails by applying same chemicals/natural/plant products. It was observed that pre inoculation dip treatments could delay the infection as well as manage the disease to a considerable extent but, post inoculation dip treatments were not that effective indicating that to manage the disease at field level, prophylactic sprays will be more effective as compared to curative sprays. However, during present studies, Cabrio Top proved to be the best effective chemical against the disease in both the experiments. But, there were no reports in the literature regarding use of this chemical against any of the *Pestalotiopsis* species. So, these results could not be compared with any available literature. Other than this, rest seven chemicals as well as sour butter milk and leaf extract of *A. indica* tested were also found to delay the infection and reduce the disease levels in comparison to untreated control. These results were in accordance with Pandey et al. (1983) who reported that leaf extract of *A. indica* and *Ocimum sanctum* inhibit the germination of spores of *P. psidii*. Dipping of guava fruits in these extracts before or after inoculation was effective. Research findings of Ara et al. (2017) further confirm our results as they reported that Bavistin (1000 ppm) exhibited 100% inhibition of growth of the *Pestalotiopsis* sp under field conditions. Bavistin treated plants showed only 21.5% disease incidence, where disease control upto 85% was achieved. Efficacy of propiconazole as a pre harvest treatment for *Pestalotiopsis* sp. has also been earlier reported by Peterson et al. (1991).

4. CONCLUSION

Pestalotiopsis psidii was a significant guava pathogen prevalent in subtropical zone of Himachal Pradesh. The disease appeared as brown necrotic spots progressing into cankerous growth. In vitro studies revealed that extracts of *A. indica* and 10-days old sour buttermilk exhibited fungistatic properties. Fungicides like Cabriotop, Chlorothalonil, Ridomil MZ, Bavistin, Blitox-50, Tilt, and Contaf, effectively inhibited fungal growth. Under artificial inoculation, both pre and post-inoculation dip treatments with CabrioTop delayed disease progression, suggesting its potential as a foliar spray for effective management.

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