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EVALUATION OF SAR CHEMICALS UNDER DIFFERENT CONCENTRATION AT *IN VITRO* CONDITION FOR THE MANAGEMENT OF LEAF SPOT (*PHLOEOSPORA MACULANS*) IN MULBERRY

[a]Bandna Manzal, [b]Ravinder Sharma, [b]Tasneem Kausar
[a]Department of Sericulture, Govt Degree College, Poonch
[b]Temperate Sericulture Research Institute, Mirgund, SKUAST-K,
*Corresponding author email: vandanamazal101085@gmail.com

ABSTRACT
The present experiment was conducted for the better management of leaf spot disease of mulberry (*Morus* spp) by using different systemic acquired resistance inducers namely Salicylic acid, Isonicotinic acid, Calcium chloride, Ascorbic acid *etc.*, at three different concentrations each, SAR chemicals were evaluated under greenhouse during 2011 and 2012 respectively.

KEY WORDS*:* Mulberry, leaf spot, SAR chemicals, *In vitro*.

INTRODUCTION

Mulberry *(Morus* sp.), the sole food plant of silkworm *(Bomyx mori* L) is cultivated in almost all parts of Kashmir for silkworm rearing. Leaf spot caused by *Phloeospora maculans* is one of the major foliar diseases of mulberry in Kashmir. The disease regularly appears during monsoon, affecting leaf yield and quality. The foliar diseases are more important than the diseases affecting the other plant parts, as these have direct relation to accessibility of mulberry leaves due to air- borne nature of pathogens. The quality and quantity of mulberry leaves is affected by various kinds of diseases like leaf spot, leaf rust, powdery mildew, leaf blight, twig blight, violet root rot, white root rot etc. Among these leaf spot is most prevalent disease. The leaf spot disease not only effect the quantity of mulberry leaves, but also their nutritive value. When leaf spot affected leaves are fed to the silkworm larvae, it results in poor larval growth, cocoon crop and affects the commercial characters of cocoons. The week larvae also become more susceptible to diseases, thereby often resulting in drastic reduction in cocoon yield (Sikdar *et al.*, 1979; Qadri *et al.*, 1999). The leaf spot disease is very common in Kashmir valley due to favourbale environmental conditions (temperature 20-30^{o}C and humidity 70-75%) for disease development. It appears from early May and reaches to its peak in the month of July, August and September. The disease incidence and intensity was recorded 41.44 and 24.44 per cent, respectively in the year 1999, with all the genotypes maintained in the germplasm bank of the institute affected by this disease (Kausar, 2005). Foliar sprays with carbendazim 50 WP @ 0.05% and Captan 50 WP @ 0.4% were found most effective fungicide for controlling leaf spot (Munshi *et al.*, 1987; Ahsan *et al.*, 1990; Ganga and Chetty, 1996). Triazoles 500 ppm (hexaconazol, penconazole and bitertanol) were also found more effective than carbendazim (Tanki *et al.*, 2005). Although chemical measures have been suggested for the control of disease in tropical conditions (Philip *et al.*, 1994; Gupta; 2001)**,** the chemical fungicides have not gained wide acceptance among the sericulturists owing to their high cost, the possible toxicity to silkworms, potential health hazards to mankind and environmental imbalance (Govindaiah *et al*., 1996). The fungicides besides causing the environmental hazards, adversely affects the non-target species including beneficial organisms and thereby disturbing the ecological balance. Moreover these chemicals are site specific in their action and provide protection only for a short period. Therefore, the frequent application of these fungicides are required for successful disease control which leads to the development of resistance in pathogen against these fungicides and thus either higher doses of recommended chemical or an effective alternative non- toxic chemicals are required. In addition to this, prolonged and extensive use of fungicides especially carbendazim results in the development of resistance, which is now an established fact (Singh, 1991).

Moreover, these chemicals are unable to reduce crop loss in a situation, where number of pathogens is involved and their incidence is frequent in nature. Due to all these constraints and problems associated with the chemical control, it is necessary to find out the alternatives of chemical control measures by developing ecologically safe methods for protecting the mulberry plants against the pathogens.

A variety of constitutive barriers (physical and chemical), which are present in plant prior to infection are collectively responsible for the natural resistance of plants. Plant defense system activates these barriers upon recognition of a pathogen or its products. The disease occurs either from failure of this recognition event or the ability of pathogen to avoid or overcome the resistance response. When a chemical or biological agent induces or activates the defense mechanism for the production or accumulation of defense components in the host plant, it may be regarded as Induced Systemic Resistance (ISR) or Systemic Acquired Resistance (SAR). In the recent past,

the research on SAR chemicals carried out on many plant-pathogen systems revealed that there are various non-toxic chemicals that elicit the Systemic Acquired Resistance in plants (Lyon *et al*., 1995; Ebel and Mithofer, 1998; Purkayastha, 1998; Vidhyasekaran, 1998; Oostendrop *et al*., 2001). Therefore a potential disease management strategy, which can be an alternative to chemical control, would be requested to activate the plant defense system by using non-toxic chemicals. Keeping in view, the present experiment was carried out to evaluate SAR chemicals under different concentration at Invitro condition for the management of Leaf Spot (*Phloeospora maculans*) in mulberry

MATERIALS & METHODS

Disease management

For the management of leaf spot disease of mulberry (*Morus* spp.) different systemic acquired resistance inducers were evaluated under greenhouse during 2011 and 2012 and further tested under field conditions.

Studies under greenhouse conditions

Experiment was conducted in greenhouse to test the efficacy of below mentioned systemic acquired resistance inducers at three different concentrations:

S. No.	Systemic acquired resistance inducer	Concentration (mg/ml)		
1.	Salicylic acid	0.5	1.0	1.5
2.	Isonicotinic acid	1.0	1.5	2.0
3.	Calcium chloride	5.0	10.0	15.0
4.	Ascorbic acid	1.0	2.0	3.0
5.	Ethylene diamine tetra acetic acid	0.25	0.50	1.0
6.	Sodium salicylate	0.10	0.15	0.20
7.	β-amino butyric acid	1.0	1.5	2.0
8.	Check (carbendazim) 50% WP	0.5	0.5	0.5
9.	Control (distilled water sprayed leaves)	-	-	-

The experimental trial was laid on one year old sapling of Kokuso-27 susceptible variety of mulberry planted in poly bags and kept in greenhouse as per the completely randomized design (CRD) during the year 2011 and 2012. All the seven systemic acquired resistance inducers (SAR) were tested at three concentrations, each concentration was replicated thrice and each replication comprised of three plants. Each chemical was dissolved in distilled water to make different concentrations (mg/ml) and was applied individually to mulberry plants by foliar spray on both the sides of leaf, one week after the first spray, leaves were inoculated with the fungal spores of the freshly isolated pathogen *Phloeospora maculans*. High humidity and optimum temperate 25±1^{o}C was maintained inside the greenhouse. The spore concentration was adjusted 30-40 spores per field (10x X 10x); one week after inoculum second spray of chemical is done.

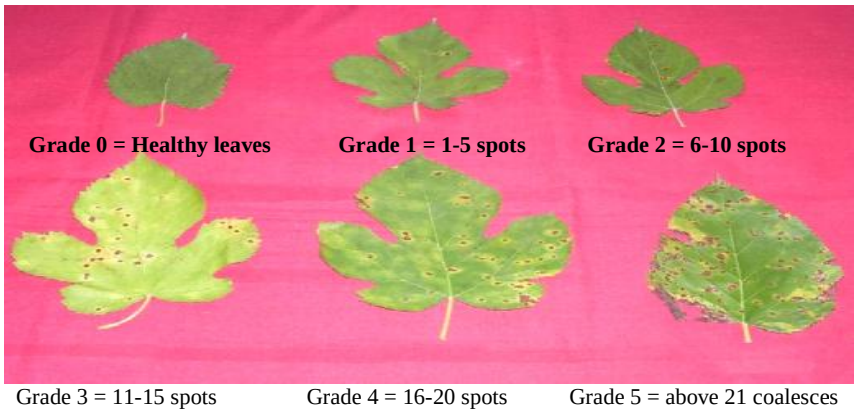
The elicitation of systemic acquired resistance of leaf spot disease was monitored 45 and 70 days after sprouting by visually estimating the leaf spot symptom. The total number of leaves on a plant was counted, then diseased leaves were categorized in six grades on the basis of number of spots by adopting the scale (Plate 1) given by Croxall *et al.* (1952) with slight modification as per the requirement as follows:

Grade	Leaf area affected
0	Leaves free from infection
1	1-5 spots
2	6-10 spots
3	11-15 spots
4	16-20 spots
5	Above 21- coalesces

The effectiveness of various systemic acquired resistance inducing chemicals at different concentrations was evaluated by recording the per cent disease incidence, per cent disease intensity and per cent disease control by using the following formula's :

$$\text{Per cent disease incidence} = \frac{\text{No. of diseased leaves}}{\text{Total No. of leaves examined}} \times 100$$

$$\text{Per cent disease intensity} = \frac{\Sigma \text{ numerical values x Grades}}{\text{Total No. of leaves examined}} \times \frac{100}{\text{Max. Grade}}$$



Grade 3 = 11-15 spots Grade 4 = 16-20 spots Grade 5 = above 21 coalesces

PLATE 1 : Scale used for measurement of disease intensity

$$\text{Per cent disease control} = \frac{C-T}{C} \times 100$$

C = Per cent disease intensity in control
T = Per cent disease intensity in treatment

RESULTS & DISCUSSION

Studies under greenhouse

In vitro studies were conducted in greenhouse to test the efficacy of seven (Plate 6) SAR chemicals at three different concentrations along with fungicide carbendazim as check on the basis of disease incidence, disease intensity and per cent disease control.

Efficacy of SAR chemicals on per cent disease incidence in greenhouse

The observations recorded on the efficacy of different SAR chemicals along with systemic fungicide carbendazim as check at three different concentrations revealed that all the treatments significantly lowered the disease incidence as compared to control (distilled water sprayed leaves).

PLATE 6: Evaluation of SAR chemicals in green house

Disease incidence 45 days after sprouting

An insight into the data (Table 1) revealed that disease incidence at 45 days after sprouting ranged from 12.59 to 34.46 per cent in chemical (SAR activators) treatments as compared to control (51.97%) indicating that all the SAR chemicals alongwith check (fungicide carbendazim) are significantly effective in lowering the disease incidence. The least disease incidence at 45 days after sprouting was found in BABA (2.0 mg/ml) with 12.59 per cent which is at par with carbendazim (0.5 mg/ml) having disease incidence 13.19 per cent. Carbendazim was followed by BABA (1.5 mg/ml) and INA (2.0 mg/ml) with disease incidence 15.86 and 18.21 per cent, respectively.

EDTA (0.25 mg/ml and 0.50 mg/ml) was found to be least effective with disease incidence 34.46 and 32.34 per cent respectively.

Per cent disease control at 45 days after sprouting

Per cent disease control at 45 days after sprouting (Table 1) ranged from 75.78 to 33.68 per cent. Highest per cent disease control was observed in BABA (2.0 mg/ml) 75.78 per cent followed by carbendazim (0.5 mg/ml) 74.63 per cent, BABA (1.5 mg/ml) and INA (2.0 mg/ml) with 69.49 and 64.96 per cent disease control.

Least per cent disease control was observed in EDTA (0.25 mg/ml) and (0.50 mg/ml) with diseases control 33.68 and 37.77 per cent respectively followed by ascorbic acid (1 mg/ml) with disease control 42.86 per cent.

Disease incidence at 70 days after sprouting

Perusal of data (Table 2) revealed that the per cent disease incidence was higher at 70 days after sprouting as compared to 45 days after sprouting; it ranged from 13.21 to 64.78 per cent. The least disease incidence was observed in BABA (2.0 mg/ml) 13.21 per cent which is at par with carbendazim (0.5 mg/ml) having disease incidence 15.62 per cent followed by BABA (1.5 mg/ml), INA (2.0 mg/ml).

TABLE 1: Effect of SAR chemicals at different concentration on percent disease incidence and per cent disease control (45 days after sprouting) under green house conditions

Treatment			45 days after sprouting			
Treatment code	Chemical	Conc. (mg/ml)	2011	2012	Pooled	Percent disease control
T_1		0.5	23.72 (4.97)	22.28 (4.82)	23.00 (4.90)	55.73
T_2	Salicylic acid	1.5	20.26 (4.61)	19.35 (4.51)	19.80 (4.56)	61.89
T_3		2.0	19.26 (4.50)	18.58 (4.42)	18.92 (4.46)	63.59
T_4		1.0	23.72 (4.97)	21.45 (4.74)	22.16 (4.81)	57.36
T_5	Isonicotinic acid	1.5	22.51 (4.85)	20.31 (4.61)	20.96 (4.68)	59.67
T_6		2.0	19.61 (4.54)	17.46 (4.29)	18.21 (4.38)	64.96
T_7		5.0	30.36 (5.60)	29.25 (5.50)	29.80 (5.55)	42.64
T_8	Calcium chloride	10.0	27.48 (5.33)	25.92 (5.19)	26.70 (5.26)	48.63
T_9		15.0	21.59 (4.75)	20.42 (4.63)	21.01 (4.69)	59.58
T_{10}		1.0	30.57 (5.62)	28.80 (5.46)	29.69 (5.54)	42.86
T_{11}	Ascorbic acid	2.0	28.89 (5.47)	27.24 (5.31)	28.06 (5.39)	45.99
T_{12}		3.0	25.47 (5.14)	23.90 (4.99)	24.69 (5.07)	52.49
T_{13}		0.25	35.50 (6.041)	33.42 (5.87)	34.46 (5.95)	33.68
T_{14}	Ethylene diamine tetra acetic acid	0.50	33.27 (5.85)	31.42 (5.70)	32.34 (5.77)	37.77
T_{15}		1.0	29.78 (5.55)	27.78 (5.36)	28.78 (5.455)	44.62
T_{16}		1.0	24.23 (5.02)	22.90 (4.89)	23.57 (4.95)	54.65
T_{17}	Sodium salicylate	1.5	21.64 (4.76)	20.55 (4.64)	21.10 (4.70)	59.40
T_{18}		2.0	21.26 (4.72)	19.70 (4.55)	20.48 (4.63)	60.60
T_{19}		1.0	18.78 (4.45)	17.86 (4.34)	18.32 (4.39)	64.75
T_{20}	β-amino butyric acid	1.5	16.25 (4.15)	15.46 (4.06)	15.86 (4.10)	69.49
T_{21}		2.0	12.66 (3.69)	12.52 (3.67)	12.59 (3.68)	75.78
T_{22}	Check (Carbendazim 50% WP)	0.5	13.88 (3.86)	12.59 (3.67)	13.19 (3.76)	74.63
T_{23}	Control (Distilled water sprayed leaves)	-	53.42 (7.38)	50.52 (7.18)	51.97 (7.28)	-
	CD ($p \leq 0.05$)		**0.169**	**0.184**	**0.123**	

*Figures in parenthesis are square root transformed values

TABLE 2 : Effect of SAR chemicals at different concentration on per cent disease incidence and per cent disease control (70 days after sprouting) under green house conditions

Treatment			70 days after sprouting			
Treatment code	Chemical	Conc. (mg/ml)	2011	2012	Pooled	Percent disease control
T_1		0.5	26.50 (5.24)	24.74 (5.07)	25.62 (5.16)	60.45
T_2	Salicylic acid	1.5	22.66 (4.86)	21.65 (4.76)	22.15 (4.85)	65.80
T_3		2.0	21.72 (4.76)	20.43 (4.63)	21.07 (4.70)	67.47
T_4		1.0	24.52 (5.05)	22.92 (4.89)	23.57 (4.93)	63.62
T_5	Isonicotinic acid	1.5	23.39 (4.94)	21.63 (4.76)	22.26 (4.59)	65.64
T_6		2.0	20.46 (4.63)	18.75 (4.44)	19.19 (4.49)	70.38
T_7		5.0	32.54 (5.79)	30.42 (5.60)	31.48 (5.70)	51.41
T_8	Calcium chloride	10.0	29.79 (5.55)	27.49 (5.34)	28.64 (5.44)	55.79
T_9		15.0	23.83 (4.98)	22.34 (4.83)	23.09 (4.91)	64.36
T_{10}		1.0	33.45 (5.87)	31.53 (5.70)	32.49 (5.78)	49.85
T_{11}	Ascorbic acid	2.0	30.29 (5.64)	28.86 (5.46)	29.83 (5.55)	53.96
T_{12}		3.0	27.45 (5.33)	25.91 (5.19)	26.68 (5.26)	58.81
T_{13}		0.25	37.90 (6.64)	35.42 (6.34)	36.66 (6.13)	43.40
T_{14}	Ethylene diamine tetra acetic acid	0.50	35.65 (6.05)	33.88 (5.90)	34.76 (5.98)	46.33
T_{15}		1.0	31.75 (5.72)	29.66 (5.54)	30.70 (5.63)	52.60
T_{16}		1.0	26.83 (5.27)	24.80 (5.08)	25.82 (5.18)	60.15
T_{17}	Sodium salicylate	1.5	23.85 (4.98)	21.75 (4.77)	22.80 (4.88)	64.82
T_{18}		2.0	23.51 (4.95)	21.42 (4.73)	22.46 (4.84)	65.33
T_{19}		1.0	20.92 (4.68)	19.55 (4.53)	20.24 (4.61)	68.76
T_{20}	β-amino butyric acid	1.5	18.89 (4.46)	17.56 (4.31)	18.22 (4.38)	71.87
T_{21}		2.0	13.83 (3.85)	12.59 (3.69)	13.21 (3.77)	79.60
T_{22}	Check (Carbendazim 50% WP)	0.5	16.72 (4.21)	14.53 (3.94)	15.62 (4.07)	75.88
T_{23}	Control (Distilled water sprayed leaves)	-	65.82 (8.17)	63.74 (8.05)	64.78 (8.11)	
	CD ($p \leq 0.05$)		**0.163**	**0.173**	**0.117**	

*Figures in parenthesis are square root transformed values BABA (1.0 mg/ml) with disease incidence of 18.22, 19.19 and 20.24 per cent, respectively. EDTA (0.25 mg/ml), (0.50 mg/ml) and ascorbic acid (1.0 mg/ml) were found to be least effective by exhibiting 36.66, 34.76 and 32.49 per cent disease incidence respectively.

Percent disease control at 70 days after sprouting

Per cent disease control at 70 days after sprouting (Table 2) ranged from 79.60 to 43.40 per cent. Highest per cent disease control was observed in BABA (2.0 mg/ml) 79.60 per cent followed by carbendazim (0.5 mg/ml) 75.88 per cent, BABA (1.5 mg/ml), INA (2.0 mg/ml) and BABA (1.0 mg/ml) with 71.87, 70.38 and 68.76 per cent disease control, respectively.

Least percent disease control was observed in EDTA (0.25 mg/ml), (0.50 mg/ml) and ascorbic acid (1.0 mg/ml) with 43.40, 46.33 and 49.85 per cent disease control, respectively. Maximum disease control was observed at higher concentration of all the SAR chemicals except calcium chloride (15 mg/ml) where phytotoxicity was

observed (Plate 7).

Efficacy of SAR chemicals on % disease intensity in greenhouse

The observations recorded on the efficacy of seven SAR chemicals along with fungicide carbendazim as check at three different concentrations at 45 and 70 days after sprouting indicated that all treatments significantly lowered the disease intensity as compared to control with distilled water sprayed leaves.

Disease intensity 45 days after sprouting

Analysis of data (Table 3) revealed that disease intensity at 45 days after sprouting ranged from 10.48 to 31.50 per cent in chemicals (SAR activators) treatments in comparison to control 42.29 per cent indicating that all the SAR chemicals along with check (fungicide carbendazim) are significantly effective in Lowering the disease intensity.

TABLE 3: Effect of SAR chemicals at different concentration on % disease intensity and per cent disease control (45 days after sprouting) under green house conditions

Treatment			45 days after sprouting			
Treatment code	Chemical	Conc. (mg/ml)	2011	2012	Pooled	Per cent disease control
T_1	Salicylic acid	0.5	20.09 (4.59)	18.61 (4.43)	19.35 (4.51)	54.25
T_2		1.5	17.92 (4.35)	16.49 (4.18)	17.20 (4.26)	59.34
T_3		2.0	16.77 (4.21)	15.52 (4.06)	16.14 (4.14)	61.83
T_4	Isonicotinic acid	1.0	19.38 (4.51)	18.48 (4.41)	18.93 (4.46)	55.25
T_5		1.5	18.42 (4.40)	17.58 (4.31)	18.00 (4.36)	57.45
T_6		2.0	15.58 (4.07)	14.61 (3.95)	15.09 (4.01)	64.32
T_7	Calcium chloride	5.0	27.63 (5.35)	26.42 (5.23)	27.02 (5.29)	36.12
T_8		10.0	24.55 (5.05)	22.75 (4.87)	23.65 (4.96)	44.09
T_9		15.0	18.72 (4.44)	16.59 (4.19)	17.65 (4.32)	58.26
T_{10}	Ascorbic acid	1.0	27.65 (5.35)	25.82 (5.18)	26.73 (5.26)	36.80
T_{11}		2.0	24.82 (5.08)	22.91 (4.89)	23.86 (4.98)	43.59
T_{12}		3.0	22.73 (4.87)	21.03 (4.69)	21.88 (4.78)	48.28
T_{13}	Ethylene diamine tetra acetic acid	0.25	32.28 (5.77)	30.71 (5.63)	31.50 (5.70)	25.53
T_{14}		0.50	30.61 (5.62)	28.87 (5.64)	29.74 (5.54)	29.69
T_{15}		1.0	26.56 (5.25)	24.72 (5.07)	25.64 (5.16)	39.38
T_{16}	Sodium salicylate	1.0	21.69 (4.76)	20.32 (4.62)	21.01 (4.69)	50.34
T_{17}		1.5	18.83 (4.45)	17.48 (4.30)	18.15 (4.37)	57.08
T_{18}		2.0	18.60 (4.42)	16.83 (4.22)	17.71 (4.32)	58.12
T_{19}	β-amino butyric acid	1.0	15.89 (4.11)	14.61 (3.95)	15.25 (4.03)	63.95
T_{20}		1.5	13.38 (3.79)	11.44 (3.52)	12.41 (3.66)	70.65
T_{21}		2.0	11.08 (3.47)	9.88 (3.30)	10.48 (3.39)	75.22
T_{22}	Check (Carbendazim 50% WP)	0.5	12.38 (3.66)	11.67 (3.56)	12.02 (3.61)	71.57
T_{23}	Control (Distilled water sprayed leaves)	-	43.25 (6.65)	41.35 (6.51)	42.30 (6.58)	-
	CD ($p \leq 0.05$)		**0.185**	**0.183**	**0.126**	

*Figures in parenthesis are square root transformed values

PLATE-7: Phytotoxicity at higher concentration (15 mg/ml) of calcium chloride

The least disease intensity at 45 days after sprouting was found in BABA (2.0 mg/ml) 10.48 per cent which is at par with carbendazim (0.5 mg/ml) with disease intensity 12.02 per cent. Carbendazim was followed by BABA (1.5 mg/ml) and INA (0.2 mg/ml) and BABA (1.0 mg/ml) with disease intensity 12.41, 15.09 and 15.24 per cent, respectively.

EDTA at 0.25 and 0.50 mg/ml was found to be least effective with disease intensity 31.50 and 29.74 per cent respectively.

Percent disease control at 45 days after sprouting

Per cent disease control at 45 days after sprouting (Table 4) ranged from 75.22 and 25.53 per cent. Highest per cent disease control was observed in BABA (2.0 mg/ml) 75.22 per cent and it was followed by carbendazim (0.5 mg/ml) 71.57 per cent and BABA (1.5 and 1.0 mg/ml) with 70.65 and 63.95 per cent disease control.

Least per cent disease control was observed in EDTA (0.25 and 0.50 mg/ml) with disease control 25.53 and 29.69 per cent, respectively.

Disease intensity 70 days after sprouting

Percent disease intensity was higher at 70 days after sprouting as compared to 45 days after sprouting, it ranged from 12.70 to 34.31 per cent (Table 5). The least disease intensity was observed in BABA (1.5 mg/ml) 12.70 per cent which is at par with carbendazim having disease intensity 13.90 per cent followed by BABA (1.5 and 1.0 mg/ml) with disease intensity 14.55 and 17.18 per cent.

EDTA (0.25 and 0.50 mg/ml) was found to be least effective with disease intensity 34.31 and 31.10 per cent respective

Percent disease control 70 days after sprouting

Percent disease control 70 days after sprouting ranged from 75.74 to 33.48 per cent (Table 4). Highest per cent disease control was observed in BABA (2.0 mg/ml) 75.34 per cent followed by carbendazim (0.5 mg/ml) 73.03 per cent and BABA (1.5 and 1.0 mg/ml) with 71.75 and 75.34 per cent disease control.

TABLE 4: Effect of SAR chemicals at different concentration on per cent disease intensity and per cent disease control (70 days after sprouting) under green house conditions

Treatment			70 days after sprouting			
Treatment code	Chemical	Conc. (mg/ml)	2011	2012	Pooled	Per cent disease control
T_1	Salicylic acid	0.5	22.48 (4.84)	20.79 (4.67)	21.63 (4.75)	58.01
T_2		1.5	19.78 (4.56)	19.41 (4.44)	19.60 (4.54)	61.60
T_3		2.0	19.31 (4.504)	17.92 (4.35)	18.61 (4.43)	63.87
T_4	Isonicotinic acid	1.0	21.75 (4.77)	20.85 (4.67)	21.30 (4.72)	58.65
T_5		1.5	20.62 (4.65)	19.85 (4.56)	20.23 (4.61)	60.73
T_6		2.0	17.75 (4.33)	16.93 (4.23)	17.34 (4.28)	66.34
T_7	Calcium chloride	5.0	30.63 (5.62)	28.63 (5.41)	29.63 (5.53)	42.49
T_8		10.0	26.82 (5.27)	24.82 (5.08)	25.82 (5.18)	49.89
T_9		15.0	20.83 (4.67)	18.79 (4.45)	19.77 (4.55)	61.62
T_{10}	Ascorbic acid	1.0	29.82 (5.50)	27.73 (5.36)	28.77 (5.45)	44.15
T_{11}		2.0	26.68 (5.260)	24.34 (5.03)	25.51 (5.15)	50.48

SAR chemicals under different concentration at *in vitro* condition for the management of leaf spot

T_{12}		3.0	24.69 (5.07)	22.86 (4.88)	23.78 (4.98)	53.85
T_{13}		0.25	35.54 (6.04)	33.08 (5.84)	34.31 (5.94)	33.40
T_{14}	Ethylene diamine tetra acetic acid	0.50	32.62 (5.80)	29.59 (5.53)	31.10 (5.66)	39.63
T_{15}		1.0	28.75 (5.45)	26.61 (5.25)	27.68 (5.35)	46.27
T_{16}		1.0	23.82 (4.98)	22.54 (4.85)	23.18 (4.91)	55.01
T_{17}	Sodium salicylate	1.5	21.75 (4.71)	19.78 (4.56)	20.77 (4.66)	59.69
T_{18}		2.0	20.78 (4.67)	18.79 (4.45)	19.79 (4.56)	61.59
T_{19}		1.0	17.79 (4.35)	16.48 (4.18)	17.18 (4.26)	66.65
T_{20}	β-amino butyric acid	1.5	15.39 (4.05)	13.72 (3.83)	14.55 (3.94)	71.75
T_{21}		2.0	12.92 (3.73)	12.49 (3.67)	12.70 (3.70)	75.34
T_{22}	Check (Carbendazim 50% WP)	0.5	14.75 (3.97)	13.05 (3.75)	13.90 (3.86)	73.02
T_{23}	Control (Distilled water sprayed leaves)	-	51.98 (7.28)	51.06 (7.21)	51.52 (7.25)	-
	CD ($p \leq 0.05$)		0.180	0.187	0.128	

*Figures in parenthesis are square root transformed values

Least per cent disease control was observed in EDTA (0.25 and 0.50 mg/ml) with disease control 33.40 and 39.63 per cent, respectively. Maximum disease control was observed at higher concentrations among all the SAR chemicals but phytotoxicity was also observed at highest concentration of calcium chloride (15 mg/ml).The most effective concentrations of different chemicals used under greenhouse conditions were further evaluated in field.

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