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Plant activator and silicon nutrient mediated resistance against powdery mildew of Black gram (Vigna mungo L. Hepper)

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ABSTRACT *Black gram is an important pulse crop grown under rainfed conditions and it is mostly affected by powdery mildew disease caused by Erysiphe polygoni. Field evaluation of plant activators, silicon nutrients and tridemorph at various levels showed that, the results of all the plant activators reduced the powdery mildew disease incidence over control. Among them, resistance inducing plant activators viz., salicylic acid at 50ppm was the most effective (6.10%) in reducing the powdery mildew incidence followed by plots sprayed with acetyl salicylic acid at 50ppm level (7.55%). Silicon nutrient treatments like sodium silicate at 1.0 per cent level was the most effective (5.21%) as compared to 32.40 per cent observed in control. In general, Salicylic acid 50ppm sprayed plots recorded maximum black gram pod yield and minimum disease incidence compared to test fungicide and untreated control.*

KEYWORDS : Black gram, Powdery mildew, Induced systemic resistance

Introduction

Pulses have been cultivated as protein sources, under low input agriculture for thousands of years. Though constitute the main sources of essential protein and for predominantly vegetarian population of India. Among these black gram (*Vigna mungo* L. Hepper) is pulse crop of many Asian countries and it belongs to family leguminosae. Black gram occupies about 14 per cent of the total area under pulse in the country and ranks fourth in area and production. It is widely affected by quite a number of diseases caused by fungi, bacteria, viruses and mycoplasma which results in higher yield losses. Powdery mildew incited by *Erysiphe polygoni* DC is a major disease occurring in almost all the black gram growing areas of the world and is the most destructive fungal disease of black gram causing yield loss up to 20-40 per cent (Reddy *et al.,* 1999) despite decades of research towards its management. Though fungicides are effective and widely used for the control of powdery mildew, the environmental problems they pose and being uneconomical paves way to search for alternative control strategies. Recently, plant activators and systemic resistant inducers were play wide tackle to the fungal disease menace in crop plants.

Induced resistance by organic chemicals may provide an efficient approach to plant protection especially for problems not satisfactorily controlled by various fungicides (Schoenbeck *et al.,* 1980). Resistant inducing chemicals are known as inducers of phytoalexins and/or elicitors of resistance in different plant species (Shabana *et al.,* 2008; Hadi and Balali, 2010). Several chemicals *viz.,* Salicylic acid (Sarwar *et al*., 2011), Acibenzolar-S-Methyl (Bengtsson *et al.,* 2008), Acetyl Salicylic acid (White, 1979), Nicotinic acid (Jaiganesh, 2005), Jasmonic acid (Cohen *et al.,* 1993) and Oxalic acid (Toal and Jones, 1999) have shown induced resistance in various crops. Besides, a promising alternative for the control of powdery mildew is the application of silicon (Si) (Datnoff *et al*., 2007). In recent years, silicon is being used for the control of fungal diseases (Yanar *et al.,* 2011) and silicon accumulation has been reported to be one of the main factors responsible for enhanced resistance against various pathogens of different crops (Junior *et al*., 2009). Hence with this aim, an attempt was made to evaluate plant activators and silicon nutrients against powdery mildew fungi, *E. polygoni* in black gram.

Materials and Methods:

Sources of Chemicals and Seeds: The chemicals *viz.,* calcium silicate, sodium silicate, potassium silicate, nicotinic acid, acetyl salicylic acid and salicylic acid were obtained from National Scientifics, Pondicherry. The black gram *var.* ADT 4 collected from TNAU, Coimbatore was raised in field at Chidambaram.

Experimental design: The field experiments were conducted during December-January in Chidambaram, with a randomized block design with eleven treatments with three replications. The treatments corresponded to foliar application of plant activators, Si nutrients, fungicide and control. The experiment was repeated twice.

Treatment details: Foliar spraying at pre-flowering and pod formation stage

Experiment 1 (Plant activators)	Experiment 2 (Silicon nutrients)
T1: Acetyl salicylic acid 10ppm	T1: Calcium silicate 0.50%
T2: Acetyl salicylic acid 20ppm	T2: Calcium silicate 0.75%
T3: Acetyl salicylic acid 50ppm	T3: Calcium silicate 1.00%
T4: Nicotinic acid 10ppm	T4: Sodium silicate 0.50%
T5: Nicotinic acid 20ppm	T5: Sodium silicate 0.75%
T6: Nicotinic acid 50ppm	T6: Sodium silicate 1.00%
T7: Salicylic acid 10ppm	T7: Potassium silicate 0.50%
T8: Salicylic acid 20ppm	T8: Potassium silicate 0.75%
T9: Salicylic acid 50ppm	T9: Potassium silicate 1.00%
T10: Tridemorph 0.05%	T10: Tridemorph 0.05%
T11: Unsprayed control	T11: Unsprayed control

Plant growth and application of the treatments: Black gram seeds were sterilized in 10% NaCl for 1.5 min, rinsed in sterilized water for 3 min and sowed. Five days after emergence, each hill was thinned. During, pre-flowering stage 1st spraying of Plant activators and Silicon nutrients were adopted in respective trials and 2nd spraying was adopted at pod formation stage followed by biometrical observation, disease incidence and yield will be attributed.

Disease assessment: In all the studies observations on disease incidence and yield were recorded at the time of harvest. The disease incidence was observed from a randomly selected set of three hills per trial plot.

Score description:

0	:	No symptoms of powdery mildew.
1	:	Small scattered powdery mildew specks covering 1 per cent or less leaf area.
3	:	Small powdery lesions covering 1-10 per cent of leaf area.
5	:	Small powdery lesions covering 1-10 per cent of leaf area.
7	:	Powdery lesions coalesce to form big patches covering 26- 50 per cent of leaf area.
9	:	Big powdery patches covering 51 per cent or more of leaf area and defoliation occur.

The per cent disease index (PDI) was calculated with following formula

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total number of samples observed}} \times \frac{100}{\text{Maximum disease grade}}$$

Statistical analysis: The data were statistically analyzed using the IRRISTAT version 92. Prior to statistical analysis of variance (ANOVA) the percentage values of the disease index were arcsine transformed. Data were subjected to analysis of variance (ANOVA) at two significant levels ($P< 0.05$ and $P< 0.01$) and means were compared by Duncan's Multiple Range Test.

Result and Discussion:

Several evidences in the literature indicate that induced resistance in plants were actively mediated by plant defence activators and silicon materials, Salicylic acid (SA) has been recognized as an important plant hormone and an essential signal molecule in plant defense against pathogens. SA, when elevated in plant tissues, can trigger the expression of several defense-related proteins and ultimately can induce systemic acquired resistance (SAR) throughout the plant (Metraux *et al*., 2002). It was also reported that SA induced plant resistance against pathogens and stimulated plant growth (Nickell, 1983). Salicylic acid was reported to reduce the mycelial growth and zoospore germination of *Pythium aphanidermatum* (Chen *et al.,* 1999) and was shown to induce resistance to *Cucumber Mosaic Virus* and increase the yield characters in squash and tobacco (Kone *et al.,* 2009). Abo-Elyousr *et al.* (2009) proved that combined application of salicylic acid, bion, *Trichoderma hamatum* and *Paecilomyces lilacinus* completely reduced the incidence of root rot disease in cotton caused by *Fusarium* spp. and *Pythium debaryanum*. Similar results have been also reported in chilli (Anand *et al.,* 2009). Foliar application of salicylic acid significantly reduced the leaf blight disease (*Alternaria alternata*) intensity and increased the pod yield (Chitra *et al.,* 2008).

Silicon has been reported to prevent the incidence of powdery mildew disease, which is caused by *Sphaerotheca fuliginea,* in a number of plant species. It was also reported that by increasing the Si concentration, resulting in a reduced incidence of powdery mildew disease (Cherif *et al*. 1994). In strawberry, when the Si content of leaves increased proportionally to the increase of phytoalexin activity, the incidence of powdery mildew decreased (Kanto *et al*., 2006). Silicon deficiency in barley and wheat leads to a poor growth habit and increased powdery mildew susceptibility (Datnoff *et al*., 2007).

In the presence study, we investigated the induced defence response and protective effects against *E. polygoni* by application of silicon nutrients and plant activators to black gram. Black gram plants sprayed twice with minimal concentrations of silicon nutrients (calcium silicate, sodium silicate and potassium silicate) and plant activators (acetyl salicylic acid, nicotinic acid and salicylic acid) respectively. Disease severity and yield attributes was examined in the treated and control plants. Drastic reduction of disease severity was observed in all the treated plants similar to test fungicide (tridemorph) salicylic acid at 50ppm was the most effective (6.10%) in reducing the powdery mildew incidence followed by plots sprayed with acetyl salicylic acid at 50ppm level (7.55%) (Table 1). Silicon nutrient treatments like sodium silicate at 1.0 per cent level was the most effective (5.21%) over the other nutrients followed by potassium silicate at one per cent in reducing disease incidence (9.52%) as compared to 32.40 per cent observed in control (Table 2). Basically, salicylic acid sprayed plots recorded maximum pod yield and minimum disease incidence compared to test fungicide and mock. Also, yield was significantly higher in all plant activator and silicon nutrients treated plots.

Table 1. Evaluation of Silicon based nutrients against powdery mildew of black gram

Sl. No.	Silicon nutrients		Disease incidence (%)	Yield (as Kg/ha level)	Hundred black gram weight (gms)
1.	Potassium silicate	0.50%	13.65	1075	4.2
		0.75%	12.29	1123	4.3
		1.0%	09.52	1216	4.5
2.	Calcium silicate	0.50%	15.47	1081	4.1
		0.75%	13.84	1137	4.2
		1.0%	11.02	1205	4.3
3.	Sodium silicate	0.50%	10.80	1198	4.6
		0.75%	08.92	1306	4.6
		1.0%	05.21	1482	4.8
4.	Tridemorph	0.05%	10.98	1100	4.3
5.	Control		32.40	920	4.0
C.D. (p=0.05)			0.243	--	--

Table 2. Evaluation of Plant activators based nutrients against powdery mildew of black gram

Sl. No.	Plant activators		Disease incidence (%)	Yield (as Kg/ha level)	Hundred black gram weight (gms)
1.	Acetyl Salicylic acid	10ppm	11.79	1222	4.2
		20ppm	09.23	1337	4.3
		50ppm	07.55	1429	4.5
2.	Nicotinic acid	10ppm	14.73	1100	4.3
		20ppm	12.96	1258	4.5
		50ppm	10.08	1330	4.6
3.	Salicylic acid	10ppm	09.83	1285	4.6
		20ppm	08.98	1438	4.8
		50ppm	06.10	1476	5.0
4.	Tridemorph	0.05%	12.15	1088	4.3
5.	Control		34.20	958	4.0
C.D. (p=0.05)			0.371	---	--

In conclusion, the results of this study provide evidence that application of simple non-toxic chemicals as silicon nutrients and plant activators can control powdery mildew of Black gram. Their low toxicity to animals, comparative environmental safety and nutrient value make them ideal foliar fertilizers, which can be used for application in the field for disease control.

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