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Silicon and Gibberellic Acid as Resistance Inducers in Green Gram against Leaf Hopper *Empoasca kerri* (Pruthi)

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***Abstract*:** Experiment was carried out at Nattapatti village, Madurai district to evaluate the effects of silicon (Si) fertilization on green gram plants for reducing damage of *Empoasca kerri*. Treatments comprised two types of Si sources such as silicic acid @ 0.1 and 0.2% and potassium silicate @ 0.5 and 1.0% with gibberellic acid @ 50 and 100 ppm (foliar spraying). The population density of *E. kerri* was observed weekly during the growth season. The treatment with potassium silicate 1.0% @ 10 DAS & 20 DAS with gibberellic acid 100 ppm @ 30 DAS and 40 DAS significantly decreased the population of *E. kerri*.

***Keywords*:** Silicon, Gibberellic acid, Green gram, *Empoasca kerri,* Leaf hopper, *Rabi*, Foliar spray

Mungbean [*Vigna radiata* (L.) Wilczek] is a short-duration grain legume crop native to India that ranks third in popularity after chickpea and pigeonpea. In India, green gram is grown in an area of 34.37 lakh ha with the production of 17.83 lakh tonnes per year during 2019-20. Mungbean has a yield potential of 2.5–3.0 t/ha, however its average productivity is remarkably low at 0.5 t/ha. Abiotic and biotic stresses, inadequate crop management practices, and a lack of quality seeds of superior varieties are all contributing to low productivity (Chauhan et al 2010, Pratap et al 2019). The major biotic factors include insect-pests such as leaf hopper, whitefly, thrips, aphids, bruchids, and pod borers and diseases especially yellow mosaic, powdery mildew, anthracnose, dry root rot, cercospora leaf spot, halo blight, and tan spot (Singh et al 2000, War et al 2017, Pandey et al 2018). Among the 64 insect pest species recorded on green gram whitefly, *Bemisia tabaci* (Genn.); cowpea aphid, *Aphis craccivora* Koch; Thrips, *Caliothrips indicus* Bagnall; jassid, *Empoasca kerri* Pruthi; pod borer, *Maruca testulalis* Geyer; stem fly, *Ophiomyia phaseoli* (Tryon.); semilooper, *Plusia orichalcea* (Hubner); cutworm, *Agrotis ipsilon* (Hufnagel); galerucid beetle *Madurasia obscurella* Jacoby; green bug, *Nezara viridula* L.; pod borer, *Helicoverpa armigera* (Hubner) and blue beetle, *Raphidopalpa intermedia* are important (Dar et al 2002). Leafhoppers, *Empoasca kerri* Pruthi, and bean aphids, *Aphis craccivora* Koch, are two of the most prominent sap-feeding insects, causing detriment to the leaves and pods, respectively (Swaminathan et al 2007). Farmers use synthetic chemical pesticides inappropriately to manage insect pests, resulting in the recurrence of insect pests, the elimination of natural enemies, development of resistance and pesticide residues in food and the ecosystems. The development of an eco-friendly strategy is critical to overcoming the challenges related with the usage of insecticides. Silicon use has been reported as a novel approach for the control of green gram insect pests. Meena et al (2014) reported that deposition of silica on epidermal layers offers a physical barrier to insects of rice. Sucking pests and leaf eating caterpillars have a low preference for the silicified plant tissues. The objective of the present study was to evaluate the response of green gram crop to the Si formulation that could enhance anti-herbivore resistance against leaf hopper *E. kerri*.

MATERIAL AND METHODS

Field experiment was conducted at Nattapatti, Madurai district situated between latitude 9.97º N and longitude 77.85º E to evaluate the effects of foliar application of silicon fertilizers on *E. kerri*. The area is semiarid with a mean annual rainfall of 880 mm and 218 meters from above mean sea level. Field trial was carried out during *Rabi*, 2022. The experiment was laid out in a Randomised block design with three replications and twelve treatment combinations with plot size of 20m^2. The treatments comprised of T_1=Foliar spray of silicic acid @ 0.1%, T_2=Foliar spray of silicic acid @ 0.2%, T_3=Foliar spray of potassium silicate @ 0.5%, T_4=Foliar spray of potassium silicate @ 1.0%, T_5=T_1 + Gibberellic acid @ 50 ppm, T_6= T_2 + Gibberellic acid @ 100 ppm, T_7=T_3 + Gibberellic acid @ 50 ppm, T_8=T_4 + Gibberellic acid @ 100 ppm, T_9=Silicate Solubilizing Bacteria @ 2 kg ha^{-}

^{1}, T_{10}=Neem oil @ 2%, T_{11}=Chlorpyriphos 20 EC @ 1.5 ml/l, and T_{12}=Untreated check. Foliar spray was done at 10, 20, 30 and 40 Days After Sowing. All foliar sprays were applied by a 10 l volume knapsack sprayer. Foliar application of silicic acid and potassium silicate was done at 10 DAS & 20 DAS and gibberellic acid at 30 DAS & 40 DAS.

For the cultivation of green gram, all of the agronomical practices recommended by the crop production guide were followed (CPG 2021). In all plots except the untreated control, silicon nutrients were foliar sprayed at their respective doses. The population density of nymphs and adults of the leafhopper, *Empoasca kerri*, was assessed in three randomly selected leaves from the top, middle, and bottom of 10 randomly selected plants. The pretreatment population counts for the first spray were taken one day before the first spraying, and the post-treatment population counts were taken after third and ninth day of each spray from ten randomly selected plants each replicate (Fleming and Retnakaran 1985). The data collected were subjected to statistical analysis of variance by SPSS software and means were compared with Tukey's test at $P \leq 0.05$ (Tukey 1977).

RESULTS AND DISCUSSION

All the treatments were effective over the untreated check in reducing leaf hopper population (Table 1). After first spray, the treatment with foliar spray of potassium silicate @ 0.5% and gibberellic acid @ 50 ppm recorded minimum leaf hopper population of 1.01 per plant followed by foliar spray of potassium silicate @ 1.0% and gibberellic acid @ 100 ppm and the untreated check (2.41 insects/plant). Similarly after second spray, the treatment with foliar spray of potassium silicate @ 1.0% and gibberellic acid @ 100 ppm minimum mean leaf hopper population of 0.90 numbers per plant which was on par with foliar spray of potassium silicate @ 0.5% and gibberellic acid @ 50 ppm (0.93 numbers per plant). After third spray, untreated check recorded maximum mean leaf hopper of population (2.57 insects/plant) and the treatment with foliar spray of potassium silicate @ 1.0% and gibberellic acid @ 100 ppm recorded minimum mean leaf hopper population of 0.47 numbers per plant followed by foliar spray of potassium silicate @ 0.5% and gibberellic acid @ 50 ppm (0.69 numbers per plant). On fourth spray, the same trend was observed among different treatments. Hence, in the present study, minimum population of leaf hopper was recorded with foliar spray of potassium silicate @ 1.0% and gibberellic acid @ 100 ppm which was significantly effective at third and fourth spray than other treatments but on par with foliar spray of potassium silicate @ 0.5% and gibberellic acid @ 50 ppm at second spray. Nikpay and Laane (2020) who reported that four spray application of silicic acid was more effective than other treatments on sugarcane mite damage. Ramirez-Godoy et al (2018) showed that application of

Table 1. Efficacy of different sources of silica against leaf hopper, *Empoasca kerri* on green gram

Treatments	No of leaf hopper/ plant*												
	Pre-count	I Spray			II Spray			III Spray			IV spray		
		3 DAS	9 DAS	Mean	3 DAS	9 DAS	Mean	3 DAS	9 DAS	Mean	3 DAS	9 DAS	Mean
T_1 Silicic acid @ 0.1%	1.88	1.78^{ab}	1.69^{ab}	1.73^{bc}	1.62^{b}	1.56^{bc}	1.59^{bc}	1.45^{c}	1.41^{c}	1.43^{d}	1.30^{c}	1.19^{c}	1.24^{d}
T_2 - Silicic acid @ 0.2%	1.71	1.69^{ab}	1.61^{a}	1.65^{bc}	1.55^{b}	1.47^{abc}	1.51^{b}	1.55^{c}	1.35^{c}	1.45^{d}	1.24^{c}	1.12^{c}	1.18^{cd}
T_3 - Potassium silicate @ 0.5%	1.63	1.63^{ab}	1.55^{ab}	1.59^{ab}	1.48^{b}	1.40^{abc}	1.44^{b}	1.31^{bc}	1.23^{bc}	1.27^{cd}	1.11^{bc}	1.02^{bc}	1.07^{cd}
T_4 - Potassium silicate @ 1.0%	1.69	1.57^{ab}	1.50^{ab}	1.53^{ab}	1.40^{ab}	1.33^{abc}	1.37^{ab}	1.21^{bc}	1.10^{bc}	1.16^{cd}	0.99^{bc}	0.85^{bc}	0.92^{bcd}
T_5 - T_1 + Gibberellic acid @ 50 ppm	1.81	1.51^{ab}	1.45^{ab}	1.48^{ab}	1.42^{ab}	1.21^{ab}	1.31^{ab}	1.08^{abc}	0.98^{abc}	1.03^{bcd}	0.87^{bc}	0.93^{bc}	0.90^{bcd}
T_6 - T_2 + Gibberellic acid @ 100 ppm	1.88	1.47^{ab}	1.33^{ab}	1.40^{ab}	1.21^{ab}	1.09^{ab}	1.15^{ab}	0.96^{abc}	0.81^{abc}	0.89^{bc}	0.70^{abc}	0.58^{ab}	0.64^{abc}
T_7 - T_3 + Gibberellic acid @ 50 ppm	1.45	1.26^{ab}	1.07^{a}	1.01^{a}	0.97^{ab}	0.89^{ab}	0.70^{a}	0.73^{ab}	0.65^{ab}	0.69^{ab}	0.52^{ab}	0.44^{ab}	0.48^{ab}
T_8 - T_4 + Gibberellic acid @ 100 ppm	1.56	1.08^{a}	0.94^{a}	1.17^{ab}	0.81^{a}	0.64^{a}	0.73^{a}	0.51^{a}	0.43^{a}	0.47^{a}	0.35^{a}	0.27^{a}	0.31^{a}
T_9 - Silicate Solubilizing Bacteria @ 2 Kg/ha	1.89	1.89^{ab}	1.89^{ab}	1.61^{ab}	1.66^{bc}	1.60^{abc}	1.63^{cd}	1.53^{c}	1.47^{c}	1.50^{d}	1.36^{c}	1.24^{c}	1.30^{d}
T_{10} – Neem oil @ 2%	1.64	1.63^{ab}	1.34^{ab}	1.59^{ab}	1.48^{b}	1.40^{abc}	1.44^{b}	1.31^{ab}	1.23^{bc}	1.27^{cd}	1.11^{bc}	1.02^{bc}	1.07^{cd}
T_{11} – Chlorpyriphos 20EC @ 1.5 ml/l	1.34	1.57^{ab}	1.55^{ab}	1.53^{ab}	1.40^{ab}	1.33^{abc}	1.37^{ab}	1.21^{bc}	1.10^{bc}	1.16^{cd}	0.99^{bc}	0.85^{bc}	0.92^{bcd}
T_{12} - Untreated check	1.67	2.30^{b}	2.51^{b}	2.41^{c}	2.55^{c}	2.41^{c}	2.48^{c}	2.48^{d}	2.66^{d}	2.57^{e}	2.45^{d}	2.30^{d}	2.38^{d}

* Mean values of three replications; Means followed by the same letter (s) are not significantly different at $p \leq 0.05$ by Tukey's test; DAS – Days After Sowing

silicon in the form of potassium silicate (2 ml/L) significantly reduced the oviposition rate of *Diaphorina citri* up to 60% in Tahiti lime.

Callis-Duehl et al (2017) reported that application of potassium silicate solution (30 ml of 2 mM), reduced number of *Bemisia tabaci* on cucumber leaves whereas the number of whiteflies on untreated cucumber leaves was higher (44.5%). This finding revealed that a *B. tabaci* population has less preference to treated silicon plants. Almeida et al (2009) also observed that the mortality of *Frankliniella schultzei* nymphs was significantly higher in the calcium silicate alone @ 15g/L and calcium silicate plus organic mineral fertilizer treatments than in the control, with an increase of 50% insect mortality in calcium silicate alone compared with control. Alyousuf et al (2021) demonstrated that application of silicic acid @ 0.8% significantly decreased the population of whitefly and tomato leaf miner on tomato crop in the greenhouse.

CONCLUSION

The use of potassium silicate combined with gibberellic acid reduced the number of leaf hoppers on green gram significantly. In organic farming, the use of silicon products is widely accepted, and it may be considered as a suitable, effective, and eco-friendly strategy for reducing pest in the field condition.

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