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Research Article

Impact of silicon on sugarcane leafhopper, *Pyrilla perpusilla* Walker by enhancing parasitism of *Epiricania melanoleuca* (Fletcher)

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ABSTRACT: To evaluate the effect of four silicon fertilizers, field experiment was conducted in farmer's holding at Poovanthi village of Sivagangai district, Tamil Nadu during 2017-2018 against sugarcane leaf hopper, *Pyrilla perpusilla* Walker and its parasitoid, *Epiricania melanoleuca* (Fletcher). Silicon fertilizers were applied @ 500 and 1000 kg ha^{-1} before planting and the leaf hopper population was recorded at 150, 180, 210, 240 and 270 days after application. The results of field experiment revealed that *Pyrilla* population was minimum in the plots treated with calcium silicate @ 1000 kg ha^{-1} (8.20 numbers/leaf) followed by calcium silicate @ 500 kg ha^{-1} (8.80 numbers/leaf) as compared over untreated check (98.20 numbers/leaf) and the percent reduction over untreated check was 82.45 and 73.71 per cent, respectively. Similarly, the per cent parasitism was maximum in the treatment with calcium silicate @ 1000 kg ha^{-1} (82.33%) during November, which was on par with untreated check. Hence, *Pyrilla* population declined to an extent of 82.45 per cent by enhancement of *E. melanoleuca* parasitism (82.33 %) due to the application of silicon fertilizers.

KEY WORDS: *Epiricania melanoleuca*, parasitism, *Pyrilla perpusilla*, silicon nutrition

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INTRODUCTION

Sugarcane is one of the most important cash crops and an important source of foreign exchange. In India, it is cultivated over 5.08 million hectares with an annual production and productivity of 3593.90 lakh tonnes and 70.86 tonnes per hectare, respectively (Anonymous, 2015). Sugarcane is a long duration crop of 10-12 months, therefore, is infested by a number of insect pests throughout its growth, which contributes in decline of production up to 20.0 per cent. Sugarcane leaf hopper, *Pyrilla perpusilla* is one of the major sucking pests of sugarcane and has been recorded from many parts of India. Both nymph and adults suck the cell sap from the ventral surface of the leaf. In severe condition, the leaves become pale and wilted and growth of the plant is arrested. Affected crop gives a sticky and blighted appearance, causing enormous losses (Jena and Nayak, 1994).

For the effective control of insect pests, farmers are using synthetic chemical pesticides indiscriminately leading to abatement of natural enemies, outbreak of secondary pests, development of resistance, resurgence in insect pests and cause pesticides residues in food and eco-system. In sugarcane ecosystem, natural enemies abundant but they are highly susceptible to pesticides.

To overcome the problems associated with the use of insecticides, development of eco-friendly approach is essential. It is reported that silicon application is a novel approach for the management of sugarcane leaf hopper and also for the enhancement of its biological agents. Reynolds *et al.* (2009) found that the silicon increased the resistance of plants to herbivorous insects and also have ability to generate an induced response by acting not only at the second trophic level, but also on third trophic level by attracting parasitoids and predators. So, the present study was conducted to evaluate the effect of silicon fertilizers on leaf hopper and also to quantify the influence of attraction of natural enemy, *Epiricania melanoleuca.*

MATERIALS AND METHODS

Field experiment was conducted to examine the effects of basal application of silicon fertilizers on *Pyrilla persusilla* and its ecto-parasitoids, *Epiricania melanoleuca* during 2017-2018 at farmer's field of Poovanthi village of Sivagangi district. There were nine treatments including T_1 = rice husk ash @ 500 kg ha^{-1} + SSB 2 kg ha^{-1}, T_2 = rice husk ash @ 1000 kg ha^{-1} + SSB 2 kg ha^{-1}, T_3 = baggase ash @ 500 kg ha^{-1}+ SSB 2 kg ha^{-1}, T_4 = baggase ash @ 1000 kg ha^{-1}+ SSB 2 kg ha^{-1}, T_5 = calcium silicate @ 500 kg ha^{-1}, T_6 =calcium silicate @ 1000 kg ha^{-1}, T_7 = sodium metasilicate @ 500 kg ha^{-1}, T_8 = sodium metasilicate @ 1000 kg ha^{-1} and T_9 = untreated check. The dose of silicon fertilizers was fixed based on the workdone by Phonde and Banerjee, and Nikpay *et al.* (2015). The field was well ploughed and planting was done during February, 2017. A plot size of 6 X 3 m^2 was maintained with intra row spacing of 90 cm and replicated thrice with five rows of planting (20 plants).

All the agronomical practices recommended by Crop production guide (CPG, 2012) for cultivation of sugarcane were followed. Silicon fertilizers were basally applied at their respective doses in all plots expect in untreated check. Observations were made on the population of nymphs and adults of leafhopper, *P. perpusilla* from randomly selected ten leaves on top, middle and bottom of the ten plants randomly selected at monthly intervals and the population was expressed as number of leaf hopper per leaf. The parasitized nymphs and adults of sugarcane leaf hopper were differentiated respectively by the presence of white cottony cushion like larva on back and on pleural abdominal region and the per cent parasitism were carried out by using the formula (Mishkat and Khalid, 2007).

$$\text{Percent parasitization (\%)} = \frac{\text{Number of parasitized nymph and adult}}{\text{Total number of nymph and adult}} \times 100$$

Statistical analysis

The data on leaf hopper population were subjected to square root transformation before statistical analysis. The data obtained from the field experiments were analyzed in Randomized Block Design (RBD). Mean values were compared by using Least Significant Difference (LSD) and at five per cent probability level critical difference values were calculated (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results indicated that significant differences existed among treatments in reducing the incidence of leafhopper due to the application of silicon fertilizers. The mean *Pyrilla* population in silicon treated plots ranged from 14.04 to 36.64 per leaf and it was 97.00 per leaf in untreated check. Among the treatments, leaf hopper population was significantly less in the basal application of calcium silicate 1000 kg ha^{-1} (14.04 number/leaf) and was found to be on par with calcium silicate 500 kg ha^{-1} (17.88 number/leaf). The percent reduction of leaf hopper over untreated check due to the application of calcium silicate @ 1000 kg ha^{-1} was 82.45 per cent and it was 73.71 per cent in calcium silicate @ 500 kg ha^{-1},whereas it was 60.66 per cent due to baggase ash at 1000 kg ha^{-1} + SSB @ 2 kg ha^{-1} (Table 1).

While comparing the individual treatments, the application of calcium silicate at 1000 kg $ha^{-1}$was found to be consistently superior for the period of experimentation i.e., from 150 to 270 Days After Planting (DAP) for leaf hopper. The leaf hopper population ranged from 8.20 to 20.60 numbers per leaf as against 84.20 to 126.20 numbers per leaf in untreated check. The population of *Pyrilla* was higher during September 2017 (20.60 number/leaf) and then declined gradually during October 2017 (12.20 number/leaf) and it got lowered in the month of November (8.20 number/ leaf).

The observations of the present study is in line with the findings of Gomes *et al.,* (2008) who reported that silicon applications reduced the aphid, *Myzus persicae* population in potato plants. Similarly, Korndorfer *et al.* (2010) found that sugarcane cultivars showed resistance to spittle bug, *Mahanarva filbriolata* induced by silicon application. Pereira *et al.* (2010) and Costa *et al.* (2011) also reported that greenbug, *Schizaphis graminum* reduced both the feeding time and phloem sap ingestion time on wheat when treated with silicon fertilizers. The finding is in confirmity with the study of Nikpay and Soleyman (2014) who showed significant differences among silicon based fertilizers and control plot against sugarcane yellow mite. In wheat and rice plants, silicon amendments decreased the nymphal survival rate and adult fecundity of *Sitobion avenae* (Dias *et al.,* 2014) and *Nilaparvata lugens* (He *et al.,* 2015). Similar effects were also reported by Lang *et al.* (2017) who found that high rate of silicon sources showed resistance to brown plant hopper in rice.

The similar trend was noticed with regard to parasitization of *Epiricania melanoleuca* among the treatments. Per cent parasitization was significantly high in the treatment with basal application of calcium silicate @ 1000 kg ha^{-1} (82.33%), which was on par with untreated check (82.33 %). Per cent parasitization was low in the months of July (28.67%) and August (56.67%) and again increased during September (62.99%), October (64.15%) and reached maximum during November (82.33%). Hence in the present study, among the silicon fertilizers applied, basal application of calcium silicate @ 1000 kg ha^{-1} was found to be highly effective in reducing the incidence of sugarcane leaf hopper, by enhancing the parasitization of *Epiricania.*

Silicon is not only involved in direct plant defenses, but also involve in indirect plant defense based on Herbivore Induced Plant Volatiles (HIPVs) production, which attracts the third trophic level, natural enemies like predators and parasitoids. When a plant is attacked by herbivores, immediately plant produces blend of HIPVs which attracts natural enemies of herbivore (Mumm and Dicke, 2010 and Schuman *et al*., 2012).

Silicon enhances the biological control (Qin and Tian, 2004). The plants treated with potassium silicate enhanced the attraction of predator, *Dicranolaius bellulus* through volatiles blend, infested by *Helicoverpa armigera* on cucumber (Kvedaras *et al*., 2010). Similarly, Connick (2011) found that soil application of potassium silicate on grapevine increased the attraction of predator, *D. bellulus* infested by grapevine moth, *Phalaenoides glycinae* by herbivore-induced plant volatiles. Similarly, Ahlawat and Kumar (2015) reported that strong natural parasitism (50.5 - 78.4%) of nymphs and adults of *P. perpusilla* were observed from mid August to last week of October by *Epiricania melanoleuca*.

CONCLUSION

Among different sources of silicon tested against *Pyrilla*, basal application of calcium silicate @ 1000 kg ha^{-1} was found to be highly and apparently effective in decreasing the leaf hopper

Table 1. Impact of organic and inorganic sources of silicon on leafhopper, *Pyrilla perpusilla* and its parasitoid, *Epiricania melano leuca* in sugarcane ecosystem.

Sl. No	Treatment details	*Pyrilla* - nymph and adult (Numbers/ leaf)*					Mean	Per cent reduction over check	% Parasitization of Epiricania melanoleuca on *Pyrilla**				
		150 DAP (July 15)	180 DAP (Aug 15)	210 DAP (Sep 15)	240 DAP (Oct 15)	270 DAP (Nov 15)			150 DAP (July 15)	180 DAP (Aug 15)	210 DAP (Sep 15)	240 DAP (Oct 15)	270 DAP (Nov 15)
T1	Rice husk ash @ 500 kg ha^{-1}+ SSB @ 2 kg ha^{-1}	44.40 $(6.70)^{f}$	48.40 $(6.99)^{f}$	52.40 $(7.27)^{f}$	21.00 $(4.64)^{d}$	17.00 $(4.18)^{e}$	36.64 $(6.09)^{f}$	62.23	22.00 $(27.97)^{d}$	51.15 $(45.66)^{d}$	54.67 $(47.68)^{d}$	52.00 $(46.15)^{d}$	67.00 $(54.94)^{c}$
T2	Rice husk ash @ 1000 kg ha^{-1}+ SSB @ 2 kg ha^{-1}	42.00 $(6.52)^{f}$	46.00 $(6.82)^{f}$	50.00 $(7.11)^{f}$	20.60 $(4.59)^{d}$	16.60 $(4.14)^{e}$	35.04 $(5.96)^{e}$	63.88	22.98 $(28.64)^{c}$	51.33 $(45.76)^{d}$	54.87 $(47.79)^{cd}$	52.15 $(46.23)^{d}$	67.97 $(55.53)^{bc}$
T3	Bagasse ash @ 500 kg ha^{-1} + SSB @ 2 kg ha^{-1}	38.40 $(6.24)^{e}$	42.40 $(6.55)^{e}$	46.40 $(6.85)^{e}$	17.60 $(4.25)^{c}$	13.60 $(3.75)^{d}$	31.68 $(5.67)^{de}$	67.34	26.00 $(30.66)^{b}$	54.00 $(47.29)^{b}$	60.00 $(50.77)^{b}$	62.00 $(51.94)^{bc}$	79.97 $(63.41)^{a}$
T4	Bagasse ash @ 1000 kg ha^{-1} + SSB @ 2 kg ha^{-1}	32.00 $(5.70)^{d}$	36.00 $(6.04)^{d}$	40.00 $(6.36)^{d}$	15.20 $(3.96)^{b}$	11.20 $(3.42)^{c}$	26.88 $(5.23)^{cd}$	60.66	26.67 $(31.09)^{b}$	54.67 $(47.68)^{ab}$	60.81 $(51.24)^{ab}$	62.81 $(52.42)^{bc}$	80.00 $(63.43)^{a}$
T5	Calcium silicate @ 500 kg ha^{-1}	18.60 $(4.37)^{b}$	22.60 $(4.81)^{b}$	26.60 $(5.21)^{b}$	12.80 $(3.65)^{a}$	8.80 $(3.05)^{ab}$	17.88 $(4.29)^{ab}$	73.71	28.00 $(31.95)^{a}$	56.00 $(48.45)^{a}$	62.00 $(52.94)^{ab}$	64.00 $(53.13)^{a}$	82.00 $(64.90)^{a}$
T6	Calcium silicate @ 1000 kg ha^{-1}	12.60 $(3.62)^{a}$	16.60 $(4.41)^{a}$	20.60 $(4.59)^{a}$	12.20 $(3.65)^{a}$	8.20 $(2.95)^{a}$	14.04 $(3.81)^{a}$	82.45	28.67 $(32.37)^{a}$	56.67 $(48.83)^{a}$	62.99 $(51.53)^{a}$	64.15 $(53.22)^{ab}$	82.33 $(65.14)^{a}$
T7	Sodium meta silicate @ 500 kg ha^{-1}	28.00 $(5.34)^{c}$	32.00 $(5.70)^{c}$	36.00 $(6.04)^{c}$	13.80 $(3.56)^{ab}$	9.80 $(3.21)^{b}$	23.92 $(4.94)^{bc}$	70.22	24.00 $(29.33)^{c}$	52.00 $(46.15)^{cd}$	56.00 $(48.45)^{cd}$	60.00 $(50.77)^{c}$	70.00 $(56.79)^{b}$
T8	Sodium meta silicate @ 1000 kg ha^{-1}	30.60 $(5.58)^{d}$	34.60 $(5.92)^{d}$	38.60 $(6.25)^{cd}$	13.00 $(3.78)^{a}$	9.00 $(3.08)^{ab}$	25.16 $(5.07)^{cd}$	69.32	24.98 $(29.99)^{bc}$	52.97 $(46.70)^{cd}$	56.67 $(48.83)^{cd}$	60.87 $(51.28)^{c}$	70.67 $(57.21)^{b}$
T9	Untreated check	86.20 $(9.31)^{g}$	90.20 $(9.52)^{g}$	126.20 $(11.26)^{g}$	98.20 $(9.93)^{f}$	84.20 $(3.67)^{e}$	97.00 $(9.87)^{f}$	00.00	28.67 $(32.37)^{a}$	56.67 $(48.83)^{a}$	62.99 $(52.53)^{a}$	64.15 $(53.22)^{ab}$	82.33 $(65.14)^{a}$
SEd		0.0859	0.0906	0.1003	0.0811	0.0673	0.3208		0.4920	0.9016	1.0039	1.0215	1.5683
CD (p= 0.05)		0.1820	0.1920	0.2126	0.1719	0.1427	0.6535		1.0430	1.9114	2.1282	2.1656	3.3246

*Mean of three replications
DAP = Day(s) after planting
Figures in parentheses are square root transformed values
In a column means followed by a common letter(s) are not significantly different by LSD (p=0.05)
SSB = Silica solubilizing bacteria

population by the attraction of lepidopteran ecto-parasitoids, *Epiricania melanoleuca*.

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