International Journal of Current Research and Academic Review

ISSN: 2347-3215 Volume 3 Number 5 (May-2015) pp. 74-80
www.ijcrar.com

Effect of silixol granules on silicon uptake, stem borer and leaf folder incidence in rice

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KEYWORDS

Silixol Granules,
Rice,
Silicon uptake,
Stem borer
and leaf folder

A B S T R A C T

Field experiment was conducted at Annamalai University Experimental Farm, Annamalai Nagar, Tamil Nadu, India during Kharif 2014 to study the effect of Silixol Granules on silicon uptake, stem borer and leaf folder incidence in rice. The treatments comprised of 100 % recommended dose of fertilizers (T_1), T_1 + Calcium silicate @ 2 t ha^{-1} (T_2), T_1 + 120 kg Si ha^{-1} through Fly Ash (T_3), T_1 + Silixol Granules @12.5 kg ha^{-1}(T_4), T_1 + Silixol Granules @ 25.0 kg ha^{-1} (T_5) and T_1 + Silixol Granules @ 37.5 kg ha^{-1} (T_6). The experiment was laid out in randomized block design with three replications. Among the different treatment imposed, 100 % recommended dose of fertilizers + Silixol Granules @ 37.5 kg ha^{-1} recorded higher values for silicon uptake by rice crop at tillering and flowering stages. The same treatment significantly decreased the per cent incidence of rice stem borer and leaf folder at tillering and flowering stages. Thus, it can be concluded that soil application of Silixol Granules @ 37.5 kg ha^{-1} along with 100 % recommended dose of fertilizers reduced the infestation of stem borer and leaf folder in rice by enhancing silicon content in plants.

Introduction

Rice (*Oryza sativa (L.*)) is one of the most important stable food crops in the world. In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. In India, rice is cultivated round the year in one or the other part of the country, in diverse ecologies spread over 44.6 m.ha with a production of 132 m.t of rice with average productivity of 2.96 t ha^{-1} (Yogendra *et al.*, 2014). Among the rice growing countries of the world, India has the largest rice acreage and ranked second in production (Anonymous, 2006). The burgeoning population of our country may stabilize around 1.4 and 1.6 billion by 2025 and 2050, requiring annually 380 and 450 m.t of food grains respectively (Siddiq, 2000; Yadav *et al.,* 2009). Rice yields are either decelerating/stagnating/declining in post green revolution era mainly due to imbalance in fertilizer use, soil degradation, type of cropping system practiced, lack of suitable rice genotypes for low moisture adaptability, pest and disease resistance (Prakash, 2010). Among them insect pests greatly affects the growth and yield of rice.

In India losses incurred by different insect pests of rice are reported to the tune of 15,120 million rupees which in turn works out to 18.60 per cent of total losses. The current scenario of rice pests in the country causes severe yield reduction which includes brown plant hopper (BPH), *Nilaparvata lugens* (Stal.); white backed plant hopper (WBPH), *Sogatella furcifera* (Horvath); green leafhopper (GLH), *Nephotettix virescens* (Distant); stem borer, *Scirpophaga incertulas* (Walker); leaf folder *Cnaphalocrocis medinalis* (Guenee) and gall midge, *Orseolia oryzae* (Wood-Mason) (Chandramani *et al.,* 2010).Over reliance on highly toxic, hazardous pesticides has created higher magnitude of environmental pollution leading to imbalance in natural ecosystem. Development of resistance in insects becomes a major problem due to indiscriminate use of pesticides. Hence the use of less toxic compounds of natural plant origin, host resistance, bioagent, and adoption of cultural practices and inclusion of non rice crops in cropping system are given priority as important components for implementation of IPM programme. In the absence of natural heritable resistance in rice varieties, resistance could be induced by alternate strategies to suppress certain insect pests. One such strategy is enrichment of silicon in plants.

Silicon (Si) is the second most abundant element of the earth's surface and plays a significant role in imparting biotic, abiotic stress resistance and enhancing crop productivity (Savant *et al.*, 1997; Korndorfer and Lepsch, 2001; Jawahar and Vaiyapuri, 2010). Silicon plays a crucial in preventing or minimizing lodging in cereal crops, a matter of great importance in agricultural productivity. Silicon is the only element known that does not damage plants with excess accumulation. It has been has been demonstrated to be necessary for healthy growth and stable production. Rice is a high Si accumulator plant and absorbs high amount of silicon, an average of 150-300 Kg of Si per hectare (Yoshida, 1975). For this reason, Si has been recognized as an "agronomically essential element" in Japan and silicate fertilizers have since then been applied to paddy soils (Ma *et al.,* 2001). Si is required for the development of strong leaves, stems and roots. The formation of a thick silicated epidermal cell layer reduces the susceptibility of rice plants to 'insects' *viz*., stem borers, plant hoppers and mite pests etc., According to Ishizuka (1964), the Si content of rice varies with plant age. Mature plants and older leaves have more Si than that in younger plants and leaves. In rice plants supply of Si also changed the total contents of carbohydrate, protein, phenol and these changes varied slightly with the stage of the crop and plant part (Ashoka Rani *et al.,* 1997). Maxwell *et al.* (1972) and Panda *et al.* (1977) found that the infestations of rice stem borer were markedly reduced by adding silicon to soil. Tayabi and Azizi (1984) concluded that the application of silica at 1t/ha reduced the density of stem borer (*Scirpophaga incertulas*). Subramanian and Gopalswamy (1991) reported that addition of silicate materials significantly reduced the incidence of *Cnaphalocrocis medinalis* and *Orseolia oryzae* in rice at tillering stage.

Although silicon is the second largest element present in the soil but due to its presence in the amorphous form, it is not available for plants. Plants absorb silicon from the soil solution in the form of monosilicic acid, also called orthosilicic acid [H_4SiO_4] (Lewin and Reimann, 1969). This molecule is highly unstable and readily becomes into non available form i.e. polymeric silicic acid or forms complex with other compounds to form metasilicates. Upper 20 cm of soil contains an average of 0.1 to 1.6 kg Si ha^{-1} as monomeric silicic acid. Unstable nature of this molecule is not in many products which are available in market. Generally, the silicon is supplied as calcium or potassium silicates as fertilizers. However, their formulation contains the silicon in the form, which is not readily absorbed by plants. Privi Life Sciences, India has stabilized the Ortho Silicic Acid (OSA) through a patented technology. Now they are commercializing the formulation with a brand name *"Silixol granules"*. Application of theses silixol granules along with 100 % recommended dose of fertilizers recorded higher values for growth (plant height, number of tillers $plant^{-1}$, root length, root volume, leaf area index and dry matter production), yield attributing (number of panicles m^{-2}, number of grains $panicle^{-1}$ and test weight) characters and yield (grain and straw) of rice (Jawahar *et al.,* 2015). As far as silixol granules concerned no work has been reported on insect pests. Hence the present experiment was conducted to study effect of silixol granules on silicon uptake, stem borer and leaf folder incidence in rice.

Materials and Methods

Experimental site and soil

The experiment was performed on a wetland field of Annamalai University Experimental Farm, (11^o 24' N and 79^o 44' E with an altitude of + 5.7 m. m.s.l.), Annamalai Nagar, Tamil Nadu, India during Kharif 2014.The soil of the experimental field is low in available N, medium in available P, high in available K and medium in available Si and the soil is clay loam in texture with the pH of 7.6.

Season, crop and variety

Season	Crop	Variety
Kharif,2014	Rice	ADT - 43

Treatment details

The treatments comprised of 100 % Recommended dose of fertilizers (RDF) (T_1), T_1 + Calcium silicate @ 2 t ha^{-1} (T2), T_1 + 120 kg Si ha^{-1} through Fly Ash (T_3), T_1 + Silixol Granules @12.5 kg ha^{-1}(T_4), T_1 + Silixol Granules @ 25.0 kg ha^{-1} (T_5) and T_1 + Silixol Granules @ 37.5 kg ha^{-1} (T_6). The experiment was laid out in randomized block design with three replications. The Silixol Granules were obtained from Privi Life Sciences Pvt. Ltd. Navi Mumbai, India. – 400709.

Fertilizer application

The rice crop was fertilized with 120:38:38 kg of N, P2O5 and K2O ha-1 in the form of urea (46% N), DAP (18% N and 46% P2O5) and muriate of potash (60% K2O). The entire dose of P2O5, K2O and half of the dose of N was applied as basal. The remaining half of N was top dressed in two equal splits at active tillering and panicle primordial initiation stage. The amount of applied K was adjusted according to the nutrients content of fly ash.

Silixol granules application

Half of the dose of Silixol granule was applied as basal. The remaining half was top dressed in two equal splits at active tillering and panicle primordial initiation stage.

Plant protection

A recommended dose of pesticides were sprayed for all the treatments at 20 and 40 days after planting.

Measurements

Silicon uptake

The plant samples used for dry matter estimation were ground into fine powder and used for uptake of silicon at various stages of crop growth with procedure outlined by Jackson (1973)

Biometric observation on insect pest

Assessment of rice stem borer per cent incidence

Counts were taken on number of dead heart/white ears and total number of tillers/panicle from 10 randomly selected hills. The percent incidence (dead heart/white ears) was calculated as follows

$$\text{Per cent incidence} = \frac{\text{Number of dead heart/white ears}}{\text{Total number of tillers/panicle}} \times 100$$

Assessment of rice leaf folder per cent incidence

The damaged leaves and total leaves from 10 randomly selected hills were observed in each plot. The percentage of leaf damage was calculated as follows

$$\text{Per cent incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Statistical analysis

The data on various characters studied during the investigation were statistically analyzed as suggested by Gomez and Gomez (1994) and wherever the treatment differences were found significant (F test), critical differences were worked out at five per cent probability level and the values were furnished. Treatment differences which were not significant are denoted as “NS”.

Result and Discussion

Silicon uptake

Application of silixol granules significantly influenced the uptake of silicon by rice crop (Table 1). Among the different treatments tried, combined application of 100 % recommended dose of fertilizers + Silixol Granules @ 37.5 kg ha^{-1} (T_6) significantly increased the silicon uptake of 39.25 and 67.50 kg ha^{-1} at tillering and flowering stages, respectively. This was followed by T_5 (100 % recommended dose of fertilizers +Silixol Granules @ 25.0 kg ha^{-1}) which was on par with T_4 (100 % recommended dose of fertilizers + Silixol Granules @ 12.50 kg ha^{-1}). Increase in silicon uptake could be due to increase in root growth and enhanced bio availability orthosilicic acid in Silixol granules. This finding is in agreement with the reports of Kalyan Singh *et al.* (2006) and Jawahar and Vaiyapuri (2013).

Stem borer and leaf folder

Silixol granule application greatly affected the stem borer and leaf folder per cent incidence in rice crop. Application of silicon nutrition significantly decreased the per cent incidence of dead heart and white ears at tillering and flowering stages (Fig.1).

Table.1 Effect of silixol granules on silicon uptake (kg ha^{-1}) of rice

Treatments	Silicon Uptake (kg ha^{-1})	
	Tillering	Flowering
T_1 – Control (Recommended dose of fertilizers)	24.93	50.92
T_2 – T_1 + Calcium silicate @ 2 t ha^{-1}	30.36	54.79
T_3 – T_1 + 120 kg Si ha^{-1} through Fly ash	31.34	55.81
T_4 – T_1 + Silixol Granules @ 12.5 kg ha^{-1}	34.70	62.06
T_5 – T_1 + Silixol Granules @ 25 kg ha^{-1}	36.28	65.19
T_6 – T_1 + Silixol Granules @ 37.5 kg ha^{-1}	39.25	67.50
CD(P=0.05)	**2.45**	**1.74**

Fig.1 Effect of silixol granules on stem borer per cent incidence in rice

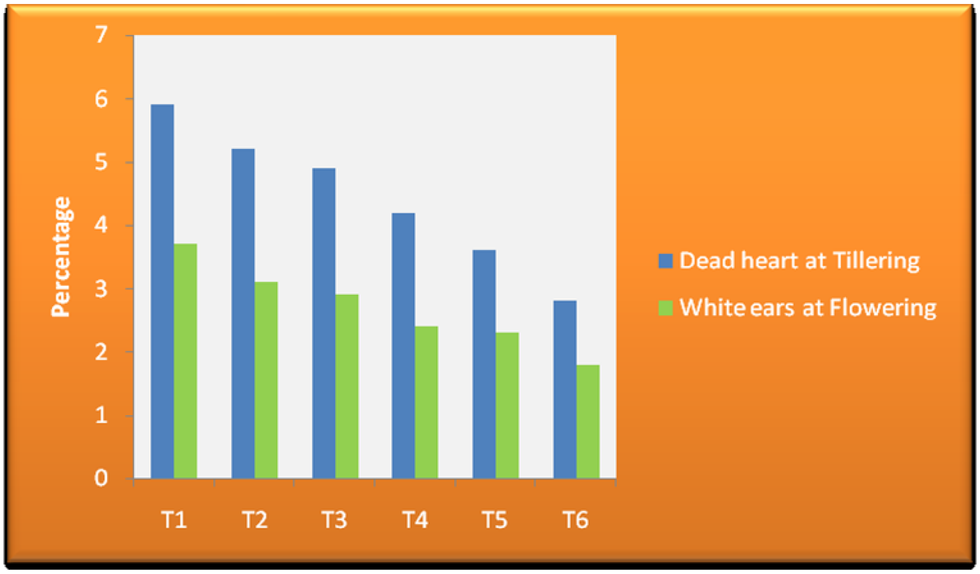

Fig.2 Effect of silixol granules on leaf folder per cent incidence in rice

The least incidence was observed under the plots receiving 100 % recommended dose of fertilizers + silixol granules @ 37.5 kg ha^{-1} (T_6). This was 52.54 and 51.35 per cent decreased over 100 % recommended dose of fertilizers at tillering and flowering stages which was closely followed by T_5 (100 % recommended dose of fertilizers + silixol granules @ 25.0 kg ha^{-1}). It was on par with T_4 (100 % recommended dose of fertilizers +Silixol Granules @ 12.50 kg ha^{-1}).

The data in respect of different treatments against the incidence of rice leaf folder is given in Fig.2. The minimum leaf damage at tillering and flowering was observed in treatment T6 (100 % recommended dose of fertilizers + Silixol Granules @ 37.5 kg ha-1), which was 57.89 and 61.29 per cent decreased over 100 % recommended dose of fertilizers at tillering and flowering stages, respectively. This was followed by T5 (100 % recommended dose of fertilizers +Silixol Granules @ 25.0 kg ha-1). The higher stem borer and leaf folder per cent incidence was noticed at 100 % recommended dose of fertilizers (T1). The beneficial effect of silica granules against rice stem borer and leaf folder could be attributed due to rice plant absorbs Si by the roots in the form of ortho silicic acid (H4SiO4) along with water and translocated to the shoots, due to loss of water through transpiration, silicic acid is concentrated and polymerized to silica (SiO2) and finally deposited on the epidermal layer (Yoshida 1975). Hence it serves as a physical barrier against stem borer and leaf folder (Panda et al.1977). As the plant grew older, silica content proportionately increased in plants as observed by Ishizuka (1964). The treatment 100 % recommended dose of fertilizers + Silixol Granules @ 37.5 kg ha-1 recorded significantly higher silica content at tillering and flowering stages as compared to other treatments which caused death of stem borer and leaf folder due to breakdown of mandibles and main feeding organs which resulted in functionless mandibles so that the insects like leaf folder, and stem borer of paddy die without food. This is in consonance with the findings of Chandramani et al. (2010).

Hence it can be concluded that the conjoint application of silixol granules @ 37.5 kg ha^{-1} along with 100 % recommended dose of fertilizers reduced the infestation of stem borer and leaf folder in rice. Further, silixol granules can be a suitable alternate to synthetic pesticide for controlling rice pest without disrupting agro-ecosystem.

Acknowledgement

This project was funded by Privi Life Sciences Pvt. Ltd. Navi Mumbai, India. – 400709. The experiment was conducted under the guidance of Dr.V.Vaiyapuri, Professor of Agronomy, Annamalai University. Authors gratefully acknowledge the authorities of Annamalai University for the facilities offered and encouragement to carry out this work.

References

Anonymous, 2006. Hand book of Agriculture. ICAR, Publication, New Delhi.

Ashoka Rani, Y., Narayanan, A., Saraswathi Devi, V., Subbaramamma, P. 1997. The effect of silicon application on growth and yield of rice plants. *Ann. Plant Physiol.*, 11(2): 123–128.

Chandramani,P., Rajendran, R., Muthiah, C., Chinniah, C. 2010. Organic source induced silica on leaf folder, stem borer and gall midge population and rice yield. *J. Biopest.*, 3(2): 423–427.

Gomez, K.A., Gomez, A.A. 1994. Statistical procedure for agricultural research, II^{nd} edn. John Wiley and Sons, New York. 680 Pp.

Ishizuka, Y. 1964. Nutrient uptake at different stages of growth. In: The mineral nutrition of rice plant, Symp. IRRI, John Hopkins press, Baltimore, Maryland, 199 Pp.

Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India, New Delhi. 498 Pp.

Jawahar, S., Vaiyapuri, V. 2010. Effect of sulphur and silicon fertilization on growth and yield of rice. *Int. J. Curr. Res.,* 9(1): 36–38.

Jawahar, S., Vaiyapuri, V. 2013. Effect of sulphur and silicon fertilization on yield, nutrient uptake and economics of rice. *Int. Res. J. Chem.,* 1(1): 34–43.

Jawahar, S., Vijayakumar, D., Raj Bommera, Neeru Jain, Jeevanandham, T. 2015. Effect of silixol granules on growth and yield of rice. *Int. J. Curr. Res. Aca. Rev.,* 3(1): 168–174.

Kalyan Singh, Ragavendra Singh, J.P. Singh, Yogeshwar Singh, Singh, K.K. 2006. Effect of level and time of Silicon application on growth, yield and its uptake by rice (*Oryza sativa*). *Indian J. Agric. Sci.,* 76(7): 410–413.

Korndorfer, G.H., Lepsch, 2001. Effect of silicon on plant growth and crop yield. In: Silicon in Agriculture. Datonoff, L., Korndorfer, G., Synder, G. (Eds). Elsevier Science, New York. Pp. 133–147.

Lewin, C.J., Reimann, B.E. 1969. Silicon and plant growth. *Annu. Rev. Plant Physiol.,* 20: 289–304.

Ma, J.F., Miyake, Y., Takahashi, E. 2001. Silicon as a beneficial element for crop plants. Silicon in Agriculture. Elsevier Science Publishing, New York. Pp. 17–39.

Maxwell, F.G., Jenkins, J.N., Parroot, W.L. 1972. Resistance of plants to insects. *Adv. Agron.,* 24: 187–265.

Panda, N., Pradhan, B., Samalo, A.P., Rao, P.S.P. 1977. Note on the relationship of some biochemical factors with resistance in rice varieties to yellow borer. *Indian J. Agric. Sci.,* 45: 499–501.

Prakash, N.B. 2010. Different sources of silicon for rice farming in Karnataka. Paper presented in Indo-Us workshop on Silicon in Agriculture held at University of Agricultural Sciences, Bangalore, India. 25-27th February 2010. Pp. 14.

Savant, N.K., Snyder, G.H., Datnoff, L.E. 1997. Silicon management and sustainable rice production. *Adv. Agron.,* 58: 151–199.

Siddiq, E.A. 2000. Yawning productivity gaps. The Hindu Survey of Indian Agriculture, The Hindu Publication, Chennai. Pp. 39–44.

Subramanian, S., Gopalswamy, A. 1991. Effect of silica materials on incidence of rice pests. *Madras Agricult. J.,* 78(5 & 8): 213–215.

Tayabi, K., Azizi, P. 1984. Influence of silica on rice yield and stem borer (Chilo supremani) in result) Iron in 1979-1980. *Pesticides,* 18: 20–22.

Yadav, G.S., Kumar, D., Shivay, Y.S., Singh, H. 2009. Zinc-enriched urea improves grain yield and quality of aromatic rice. *Better Crops,* 3(1): 4–5.

Yogendra, N.D., Kumara, B.H., Chandrashekar, N., Prakasn, N.B., Anatha, M.S., Jeyedeva, H.M. 2014. Effect of silicon on real time nitrogen management in a rice ecosystem. *Afr. J. Agricult. Res.,* 9(9): 831–840.

Yoshida, 1975. The physiology of silicon in rice. Technical bulletin, no. 25. Food and Fertilizer Technology Center, Taipei, Taiwan.