Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP2: 626-628

R Dhanasekarapandian
Dept. of Soil Science and Agrl. Chemistry, SRS Institute of Agriculture and Technology, Vedasandur, Tamil Nadu, India

N Kumarasamy
Dept. of Agribusiness Management, SRS Institute of Agriculture and Technology, Vedasandur, Tamil Nadu, India

Correspondence
R Dhanasekarapandian
Dept. of Soil Science and Agrl. Chemistry, SRS Institute of Agriculture and Technology, Vedasandur, Tamil Nadu, India

Enhancing productivity of low land rice through silicon nutrition

R Dhanasekarapandian and N Kumarasamy

Abstract
A field experiment was conducted in clay loam soil belonging to *Kondal* series (Vertisols- *Typic Haplusterts*) during 2017 with an objective of studying the effect of foliar and soil application of silicon on growth, yield, nutrient uptake and their availability in rice var. *ADT 43*. The treatments consisted of T_1- Control- (RDF 120:32:32 N, P_2O_5, K_2O kg ha^{-1}), T_2 - 2 ml L^{-1} Si , T_3 - 4 ml L^{-1} Si and T_4 - 8 ml L^{-1} Si, T_5 -1.63 kg available Si ha^{-1} (5 t LFA ha^{-1}), T_6 - 3.26 kg available Si ha^{-1} (10 t LFA ha^{-1}), T_7 - 4.89 kg available Si ha^{-1} (15 t LFA ha^{-1}), T_8 - 1.63 kg available Si ha^{-1} (5 t LFA ha^{-1}) + T_4, T_9 - 3.26 kg available Si ha^{-1} (10 t LFA ha^{-1}) + T_3 and T_{10} - 4.89 kg available Si ha^{-1} (15 t LFA ha^{-1}) + T_2. All the treatments received uniform dose of NPK (120:32:32 N: P_2O_5: K_2O kg ha^{-1}). The treatments T_2, T_3, T_4 received foliar spray of silicon, T_5, T_6, T_7 received soil application of silicon and T_8, T_9, T_{10} received foliar plus soil application of silicon. The results revealed the positive and significant performance of rice to foliar, soil application of silicon and their combinations in terms of growth, yield, nutrient uptake and availability over control. The impact of treatments on the performance of rice was high and well pronounced when foliar spray of silicon supplied through a formulation named OSABBB was resorted compared to soil application of silicon through lignite fly ash (LFA) and their combinations. The highest uptake and availability of nutrients was again noticed in T_4 (Foliar spray of silicon @ 8 ml L^{-1} + RDF) which was comparable with T_3 (Foliar spray of silicon @ 4 ml L^{-1} + RDF) and T_2 (Foliar spray of silicon @ 2 ml L^{-1} + RDF). Soil application and foliar spray of silicon was comparable with foliar spray of silicon @ 2 ml L^{-1} for certain parameters. When the effect of treatments on the performance of rice was compartmentalized, it was clearly expressed that on an average the foliar spray of silicon caused 18.4 per cent increase followed by foliar + soil application (15.4%) and soil application (10.3 %) over control.

Keywords: LFA (Lignite Fly Ash), RDF (Recommended dose of fertilizers), OSABBB (Original Silicic Acid Boron Bioavailable & Biocompatible)

Introduction
Rice plays a major role in India's diet, economy, employment, culture and history. Ninety per cent of rice produced is consumed within the country. With 44 million hectares, India has the biggest area under rice worldwide; with a production of 96.43 million tones, it comes second only behind China in total rice production. The area under rice accounts for 34% of India's food crop and 42% of its cereal crop areas. In fact, rice cultivation is in crisis the world over and India is no exception, with a shrinking area, fluctuating annual production, stagnating yields and escalating input costs. The cost of cultivation of paddy has consistently been increasing owing to the escalating costs of seeds, fertilizers and labour. With increasing labour scarcity due to urbanization, sustaining the interest of farmers in rice cultivation has become a challenge. There is clearly an urgent need to find ways to grow more rice, but with less water and fewer inputs. In intensive cropping, indiscriminate use of chemical fertilizers has led to deterioration of soil fertility and depletion of essential nutrients. This has resulted in low and inconsistent production of crops in rice based cropping system. This calls for development of an integrated nutrient management system. Silica (Si) is the second most abundant element of the earth crust. Silica is considered to be essential for siliceous plants such as rice, maize, sugarcane etc. Silica fertilization has a double effect on soil-plant system. Firstly, improve plant Si nutrition, reinforces plant protective properties against disease, insect attack and unfavorable climatic conditions. Secondly, soil treatment with bio-geochemically active Si substance optimizes soil fertility through improved water, physical and chemical properties, plant resistance to both biotic and abiotic stresses, including salt stress (Mengel *et al.*, 2001) [1]. There are several hypothesis for this effect, they are (i) Improved photosynthetic activity (ii) Enhanced K:Na selectivity ratio (iii) Increased enzyme activity and (iv) Increased concentration of soluble substance in xylem, which results in reduced sodium adsorption by plants. Silica is now becoming recognized as "agronomically" essential elements for plants especially siliceous plants. These elements tend to maintain erectness of leaves, increases

photosynthesis and imparts greater resistance to diseases and insect pests (Tisdale *et al*., 1985). It influences in high N and P use efficiency. It increases the oxidation power of roots and reduces Fe and Mn toxicity by reducing uptake of these elements.

Materials and methods

A field experiment was carried out to study the effect of foliar spray and soil application of silicon on growth and yield of rice cultivar ADT - 43 at Annamalai University experimental farm, Annamalai Nagar during Kuruvai season (June – September 2017). The treatment consist of the following details,

T_1 - Control + (RDF - 120:38:38 N: P_2O_5: K_2O kg ha^{-1})
T_2 - 2 ml L^{-1} of foliar silicon
T_3 - 4 ml L^{-1} of foliar silicon
T_4 - 8 ml L^{-1} of foliar silicon
T_5 - 1.63 kg available Si ha^{-1} (5 t LFA ha^{-1}) soil application
T_6 - 3.26 kg available Si ha^{-1} (10 t LFA ha^{-1}) soil application
T_7 - 4.89 kg available Si ha^{-1} (15 t LFA ha^{-1}) soil application
T_8 - 1.63 kg available Si ha^{-1} (5 t LFA ha^{-1}) soil application + T_4
T_9 - 3.26 kg available Si ha^{-1} (10 t LFA ha^{-1}) soil application + T_3
T_{10} - 4.89 kg available Si ha^{-1} (15 t LFA ha^{-1}) soil application + T_2

All the treatments received uniform dose of NPK (120: 32: 32 N: P_2O_5: K_2O kg ha^{-1}). The treatments T_2, T_3, T_4 received foliar spray of silicon, T_5, T_6, T_7 received soil application of silicon and T_8, T_9, T_{10} received foliar plus soil application of silicon. The first foliar spray of silicon was given on 21 DAT and totally four sprays were given through a formulation called OSABBB with 15 days interval and the spray fluid for 2 ml L^{-1} Si was 500, 500, 1000 and 1000 L and for 4 and 8 ml L^{-1} Si was 1000, 1000, 2000, 2000 L ha^{-1} respectively. Soil application of Si through Lignite Fly Ash (LFA) was done basally.

Results and discussion

Plant height

Application of silicon through foliar or soil or their combinations significantly improved plant height at all stages of crop growth except tillering stage. The overall effect of treatments on plant height indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The tallest plant of 36.6, 58.6 and 74.6 cm at tillering, panicle initiation and harvest stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 (foliar spray of silicon @ 4 ml L^{-1}) but superior to rest of the treatments.

LAI and Productive tillers

Application of silicon through foliar or soil or their combinations improved LAI and number of productive tillers The LAI values ranged from 1.99 to 2.19 and 2.93 to 3.25 at tillering and panicle initiation stages respectively. The overall effect of treatments on LAI indicated that foliar spray of silicon was superior to soil and foliar spray and soil application of silicon alone. The maximum LAI of 2.19 and 3.25 at tillering and panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was followed by T_3 (foliar spray of silicon @ 4 ml L^{-1}) and T_2 treatments. The number of productive tillers ranged from 12.0 to 14.7. Among the treatments the productive tillers progressively increased with increased concentration of foliar application of silica through OSABBB.

Dry matter production

The overall effect of treatments on dry matter production indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The highest dry matter production of 2740 kg ha^{-1} at tillering, and 5750 kg ha^{-1} panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 (foliar spray of silicon @ 4 ml L^{-1}) but superior to T_2 treatment.

Number of panicles m^{-2}

The number of panicles m^{-2} ranged from 321 to 380. The overall effect of treatments on number of panicles m^{-2} indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum (380) number of panicles m^{-2} was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was significant over T_3 (foliar spray of silicon @ 4 ml L^{-1}) and T_2 treatments.

Number of grains $panicle^{-1}$

The number of grains $panicle^{-1}$ ranged from 124 to165. The overall effect of treatments on number of grains $panicle^{-1}$ indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum (165) number of grains $panicle^{-1}$ was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was significant over T_3 (foliar spray of silicon @ 4 ml L^{-1}) and T_2 treatments.

Panicle length

The overall effect of treatments on length of panicle indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum (19.4 cm) length of panicle was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 and significant over T_2 treatments.

Thousand-grain weight

The thousand grain weight ranged from 17.1 to 18.3 g. The overall effect of treatments on thousand grain weight indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum (18.34 g) thousand grain weights was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 and T_2 treatments.

Nitrogen uptake

The nitrogen uptake ranged from 35.2 to 46.5 and 69.2 to 82.5 kg ha^{-1} at tillering and panicle initiation stages respectively. The overall effect of treatments on nitrogen uptake indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum nitrogen uptake of 46.5, and 82.5 kg ha^{-1} at tillering and panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 (foliar spray of silicon @ 4 ml L^{-1}) at tillering but significantly superior to T_3 and T_2 treatment at panicle initiation stage.

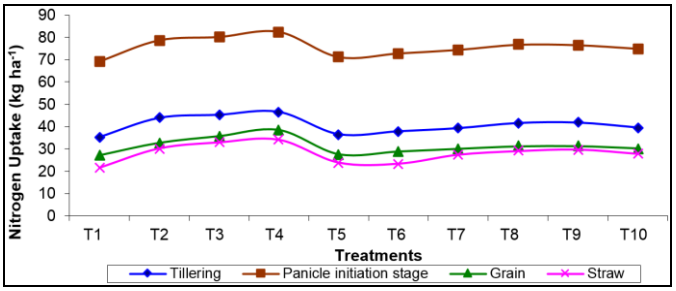

Fig 1: Effect of foliar and soil application of silicon on nitrogen uptake

Phosphorus uptake

The phosphorus uptake ranged from 9.5 to 15.7 and 15.0 to 23.5 kg ha^{-1} at tillering and panicle initiation stages respectively. The overall effect of treatments on phosphorus uptake indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum phosphorus uptake of 15.7 and 23.5 kg ha^{-1} at tillering and panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was significantly superior to T_3 and T_2 treatment at tillering but at panicle initiation stage comparable with T_3 (foliar spray of LFA @ 4 ml L^{-1}) only.

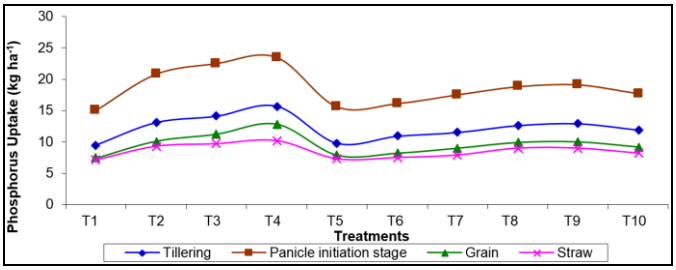

Fig 2: Effect of foliar and soil application of silicon on phosphorus uptake

Potassium uptake

The potassium uptake ranged from 18.1 to 26.8 and 30.8 to 43.5 kg ha^{-1} at tillering and panicle initiation stages respectively. The overall effect of treatments on potassium uptake indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum potassium uptake of 26.8, and 43.5 kg ha^{-1} at tillering and panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 and T_2 at tillering but significantly superior to T_2 and on par with T_3 treatment at panicle initiation stage.

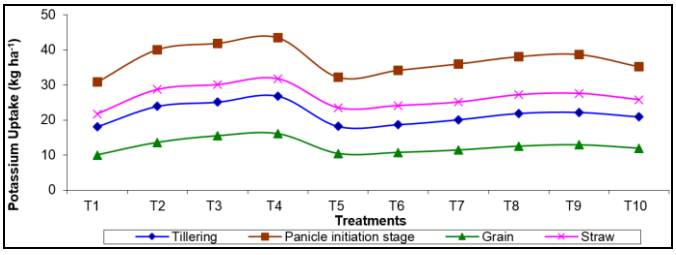

Fig 3: Effect of foliar and soil application of silicon on potassium uptake

Silica uptake

Application of silicon through foliar or soil or their combinations significantly improved silicon uptake at all stages of crop growth and in grain and straw. The silicon uptake ranged from 24.2 to 37.4 and 50.7 to 67.4 kg ha^{-1} at tillering and panicle initiation stages respectively. The overall effect of treatments on silicon uptake indicated that foliar spray of silicon was superior to soil and foliar spray plus soil application of silicon. The maximum silicon uptake of 37.4, and 67.4 kg ha^{-1} at tillering and panicle initiation stages respectively was noticed with foliar spray of silicon applied @ 8 ml L^{-1} through OSABBB formulation (T_4) which was comparable with T_3 and T_2 (foliar spray of silicon @ 4 ml L^{-1}) at tillering but significantly superior to T_3 and T_2 treatment at panicle initiation stage.

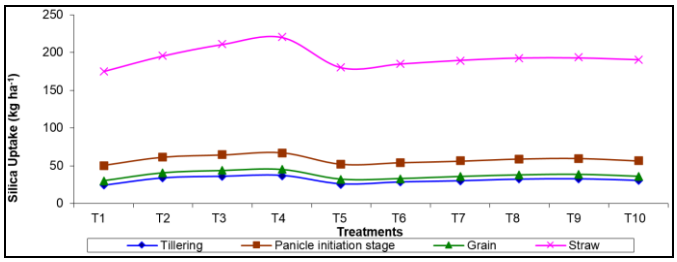

Fig 4: Effect of foliar and soil application of silicon on silica uptake

In the present experiment growth attributes viz., plant height, LAI, number of productive tillers and DMP and yield attributes viz., number of panicles m^{-2}, panicle length, number of grains panicle^{-1} and thousand grain weight were significantly influenced by silicon application. The attributes values increased with increased levels of foliar concentration of silica and LFA. Application of Si @ 8 ml L^{-1} recorded highest values at both active growth stages and at harvest. In the present study foliar application of Si significantly influenced the uptake of N,P,K and Si at all stages of crop growth followed by combined application of Si and LFA and LFA alone treatments (Fig. 4,5,6, and 7). At harvest, grain showed higher N and P uptake while straw showed higher K and Si uptake in all treatments because of the appreciable respective nutrients in the specific part of the plant and higher biomass production. The uptake values were being the summation effect of nutrient concentration in plant and DMP, supply of nutrients through foliar spray had favorable effect on either one or both of these as seen in the present study might have influenced the uptake of all nutrients. In the present investigation the uptake of N, P, K and Si increased with increase in concentration of Si up to 8 ml L^{-1} at all stages in grain and straw.

Conclusion

From the above results it can be inferred that application of foliar spray of silicon supplied through a formulation named OSABBB increased significantly the growth, yield and uptake of nutrients in rice crop and maximum yield can be obtained by spraying 8 ml L^{-1} with 1000, 1000, 2000, 2000 L ha^{-1}. Further, to realize economical yield, foliar spray of silicon through a formulation named OSABBB (commercial name is OSABBB - Original Silica Acid and Boron Bio Compartable & Bio Available) @ 4 ml L^{-1} at four sprays from 21 DAT with 1000, 1000, 2000, 2000 L ha^{-1} can be recommended.

References

1. Mengel K, Kirkby EA. Further elements of importance. In: Principles of plant Nutrition, fifth ed. Kluwer Academic Publication, Dordrecht. The Netherlands, Chapter 19, 2001, 643-649.