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Effect of Biogenic Silica Nano-Composites as Vegetative Growth Promoter and Pesticidal Agent on Cotton Crop

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ABSTRACT:

Silica is a dominant and abundant natural molecule found in earth crust. It is also available as phytoliths in the plants/crops. It is a super growth supplement for the crops maintaining the internal strength and rigidity in the crops. Silica creates strong cell wall which leads to stronger and bigger branches and stem responsible for uptake and absorption of more water, nutrients and plant secretions throughout the plant body, facilitating faster growth rate and stronger plant. Silica enables the proper development of over all growth of crops and maintaining the fruits health and rigidity within it. Silica enables enhanced metabolic function, showing higher concentration of chlorophyll in leafy tissues. It also enables better use of CO2 and higher rate of photosynthesis. Silica accelerates synthesis of protein and starch, increasing brix level in plants. Silica activates at least 60 different enzymes involved in plant growth. In the present investigation, silica solubilizing bacteria (SSB) were utilized in suitable media formulation using Silica as one of the major compositions. SSB degrades the silica in the media composition releasing the blend of silica nanocomposites, some growth factors, proteins and plant hormones responsible for enhancing the sustainable agriculture and productivity. The suitable blend of above composition was tested on cotton crop in assessing growth promotion activities and pesticidal activities on cotton crop. The results were found to be effective and significant as there were promising growth promotion activities on cotton crop and reduction in percent population of boll worm.

Keywords: Silica, Biogenic silica, silica nano-composites, silica solubilizing bacteria, growth promotion activities, pesticidal activities, cotton crop.

INTRODUCTION:

Silicon is a significant polymer having characteristic properties responsible for enhancing the agricultural productivity. Silica is having importance in providing the resistance to crops against biotic and abiotic stress like conditions. There are majority of plant growth promoting rhizobacteria (PGPRs) which are able to solubilize the complex salts, responsible for producing enzymes and metabolites, similar is the case of silica solubilizing bacteria which dissolve silica to form biogenic silica/silica nano-composites. These nano- composites can overcome the challenges in agriculture. Different rapid challenges have thrown focus in agriculture productivity[1-10]. Silica is abundantly available in plant bodies as a defensive barrier and is termed as phytoliths. Phytoliths are formed after absorbing silica in soluble form. These provide mechanical strength and rigidity to plant parts and act as defense system against insects, pests and fungal infestations as well as improve water balance, plant growth and yield, rates of photosynthesis and reproduction. The silica deposits create an active defense against fungal infections and pests attacks[11-13].

MATERIALS AND METHODS:

Preparation Silica from rice husk

Silica was procured from rice husk via thermo dynamical activation at a temperature range of 150^0C to 250^0C. The silica was further processed and activated quickly and make it bio-available.

Preparation of potassium silicate from crude silica

The silica was processed via industrial process to prepare potassium silicate using potassium hydroxide. Silica was used in terms of Silicon dioxide (SiO2) having 20.8% concentration and potassium hydroxide was used in the form of Potassium oxide (K2O). The silica was mixed with potassium hydroxide at 120^0C with continuous blending and mixing. The blending was performed for 45 minutes in alternate duration of 15 minutes producing potassium silicate solution[14-16].

Preparation of Silica nano composites using silica solubilizing bacteria

The loopful inoculum of silica solubilizing bacteria was inoculated in potassium silicate via submerged fermentation for 7 days at 30^0 C. After the completion of 7 days cycle, the liquid material was centrifuged to obtain the liquid preparation of silica nano-composites/biogenic silica.

Field trials of silica nanocomposites

The silica nano composites was diluted in dosages viz 5.0 ml/liter, further tested on cotton crop via foliar spray for control of pests.

RESULTS:

The results of the study revealed the significant effect of biogenic silica (silica nanocomposites) on cotton crop. The results showed promising activity of the same on vegetative and reproductive growth of cotton crop and pesticidal activity against boll worm **(Table 1; Figure 1; Figure 2).**

Table 1: Effect of Biogenic silica/silica nano-composites on vegetative growth; reproductive growth and reduction in population of boll worm on cotton crops (Average readings of best 5 plots)- after 2 months' time period (Fertilizer – cow dung manure)

Treatment Sets/Control		**Average readings of best 5 plots (25 crops per plot) after 2 months**			
	Crops number per plot	**Height (cm)**	**Leaves number (cm)**	**Boll formation appearance**	**Percent reduction of population of Boll worm**
Control plot (Without treatment)	25	15.0	22.0	70.0	0.0

Treatment of Biogenic silica only (5 ml per liter)	25	55.0	38.0	15.0	45.0

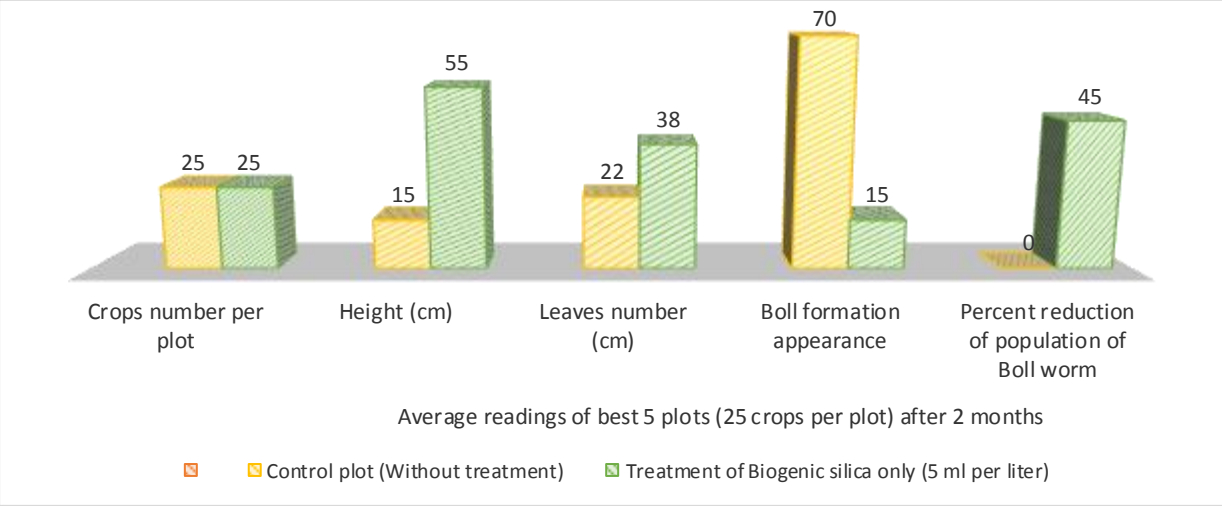

Figure 2: Graphical representation of effect of Biogenic silica/silica nanocomposites on vegetative growth; reproductive growth and reduction in population of boll worm on cotton crops (Average readings of best 5 plots)- after 2 months' time period (Fertilizer – cow dung manure).

Figure 2: Effect of Biogenic silica/silica nanocomposites on –
a) Vegetative growth of cotton crops; b) percent population of cotton boll worm
b)

DISCUSSION AND CONCLUSION

The results of the study illustrate the growth promotion activity and pesticidal activity of Biogenic silica/silica nanocomposites on cotton crop. The results corelate with the previous findings[17-18]. The studies thus concluded that, biogenic silica/silica nano-composites can be

utilized as growth promotion and pesticidal agent against the pest attacking on cotton crop. However further trials are required to determine the bio-efficacy trials of biogenic silica/silica nanocomposites on multiple crops and different agro-climatic regions.

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