

SUPPRESSION OF HETERODERA SACCHARI IN RICE WITH AGRICULTURAL WASTE-SILVER NANO PARTICLES

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ABSTRACT

Pests bring about significant decrease in rice production which translates to huge financial loss. Plant parasitic nematodes are economically important pests of rice. Three different agro-silver nano particles were synthesized using conventional methods with agricultural wastes: corn-cobs, milled maize residue also referred to as ogi residue and rice husk. The supernatant liquid was decanted and the residue was air dried at room temperature. This was incorporated into the soil of rice (NERICA 1 variety) plants inoculated with cyst nematodes *Heterodera sacchari*. The application of silver nano particles at 75g and 50g increased the vegetative growth and robustness of rice plants with comparatively higher yield than the yield obtained from untreated plants as demonstrated in pot experiments. Thus agro-wastes silver nano particle (AgNP) can be employed in the control of nematode pests of rice. The adoption of the agro-based nano particle by rural farmers is technically feasible.

Keywords: Cyst nematodes, pollution, bio-pesticide, nematicides, nano-particles

INTRODUCTION

Rice (*Oryza sativa*), a major commodity in world trade is the second most important cereal crop in the world after wheat in terms of production (Jones, 1995). Nigeria is the highest producer and consumer of rice in West Africa (WARDA, 1996; Imolehin and Wada, 2000). Diseases and pests take a heavy toll on rice production, thus they are one of the important constraints in achieving higher yield (Fademi, 1984; Coyne and Plowright, 1998). Several plant parasitic nematodes are associated with the rice plant. Export trade restrictions are often imposed due to the presence of quarantine nematode pests. The rice cyst nematode *Heterodera* spp are of particular importance and these include *H. oryzae*, *H. oryzaicola*, *H. elachista* and *H. sacchari* (Ibrahim *et al.*, 1993; Handoo, 1998; Audebert *et al.*, 2000; Ding *et al.*, 2012). Severe reduction in grain yield has been observed in rice fields infected with *H. sacchari* (Coyne and Plowright, 2000). Infected rice plants are severely chlorotic, stunted with fewer tillers due to reduced root growth and subsequently death of

the seedling (De Luca *et al.*, 2013). The damage induced ranges between 17-50% (Kumara and Kuriyan, 1981; Bridge *et al.*, 1990; Coyne and Plowright, 1998). Brown cysts and lemon shaped white females could be detected on infected roots, while there are obvious colour changes in the root from brown to black (Babatola, 1983; Handoo, 1998). The current most effective method for the control of nematodes is the application of nematicides. The use of synthetic nematicides, though an established internationally recognised effective approach has serious setback because of the toxicity and adverse effects on humans and the environment. Thus, intensive research for safer alternatives has become a focus of crop protection investigations. Agricultural wastes have been identified as excellent renewable source for the production of bio-pesticides; they control a number of pests and diseases Chindo *et al.*, (2012). The potential of agro-wastes in biological control is yet to be fully employed and new fascinating results are being obtained with the adoption of nano technology into the formulation of crop pesticides. Research is intensifying rapidly in this field (Morones, 2005). Nano particles are mostly prepared from lead, gold, silver and platinum.

However, silver is mostly used in the field of agriculture and biology (Parashar *et al.*, 2009). Important applications are attributed to silver nano particles; they are capable of purifying drinking water, degrading pesticides and killing human bacteria among others (Sinha *et al.*, 2009; Ojha *et al.*, 2012). The aim of this study is to synthesize silver nano particles using agricultural waste for application as an alternative to synthetic nematicides in the control of rice nematode *Heterodera sacchari*.

MATERIALS AND METHODS

Preparation of Agricultural waste

Rice husk, corncobs and milled corn residue were obtained from a local market in Ilorin metropolis. They were air dried for three weeks and later milled into powder using a Steel Man diesel engine with a 7Horse power capacity; model R175A.

Preparation of Silver nano Particles from Agricultural waste

1.7 g of silver nitrate was weighed into a beaker, 10mL of distilled water was added, and stirred gently until it totally dissolved to make 0.1M of AgNO_3 solution. 0.38 g of sodium borohydride was also weighed and 10mL of distilled water was added. The solution was stirred until it completely dissolved giving an equivalent of 0.1 M NaBH_4 solution. 100g of powdered rice husk was poured into a beaker. 500mL of distilled water was added and the mixture was stirred using magnetic stirrer for an hour. 0.1M of silver nitrate (AgNO_3) solution was added to the mixture and the stirring continued for about 45minutes under room temperature; 0.1M of sodium borohydride (NaBH_4) was then added and stirring continued for additional 45 minutes. On the addition of NaBH_4 , a greyish froth was produced. The mixture was filtered allowed to stand and was decanted and separated from the agricultural waste residue. The same process was repeated for corncob and milled maize residue (ogi residue).

Pot Experiment

Sandy loam soil, pasteurized at 85°C for two hours was filled into fifteen (15) litre capacity plastic buckets at 10kg each. Pots were arranged in a randomised complete block design (RCBD), there were four treatments at four rates of application and each treatment was replicated three times. *Heterodera sacchari* populations were collected from infested rice fields. The cysts were reproduced on Nerica 1 rice varieties in the nursery; they were later extracted from the soil using the technique of Southey, (1986). A week old Nerica 1 variety rice seedling each was transplanted into the experimental pots and watered adequately every other day. At two weeks the seedlings each were inoculated with 35 viable cysts in a hole around the rice root. Agro-waste silver nano

particles were applied at 75, 50 and 25grams (g/kg soil) while carbofuran 3G was applied at rate of 0.33g, 0.50g and 0.67g (kg/a.i/ha based on manufacturers specification). The applied silver nano particle dosages were based on preliminary results from in vitro (Petri dish) experiments.

Plant height and number of tillers were monitored over a period of 10 weeks from the 7th week after transplanting. Seed weight was taken at harvest, while number of cyst per pot and root were determined after harvesting using the wet-sieve decantation method (Southey, 1986). Data was subjected to analysis of variance and means were separated using Tukey's Honest test of Significant Difference (HSD) where necessary at 5% level of probability ($p=0.05$).

RESULTS

The colour change observed during the reaction indicates the reduction of Ag^+ ions to Ag^0 . The increase in intensity of colour change from colourless to grey confirms the formation of agro-waste silver nano particles. The effect of the agro-waste silver nano particles is depicted in Figures 1 to 8. All materials tested improved rice plant growth with reduction in nematode population. Among the various treatments used, ogi-residue nano particle (milled maize residue) was significantly ($p=0.05$) more effective than all the other substances. The mean height of rice plant, mean number of tillers and mean yield of rice plants treated with ogi-residue silver nano particles was significantly ($p=0.05$) more than corncob, rice husk and carbofuran (Figs. 1, 3 & 5). Mean number of cyst in root and soil of ogi-residue nano particles was also significantly ($p=0.05$) lower (Figure 7). In the untreated control, rice plants heights and number of tillers were significantly low at

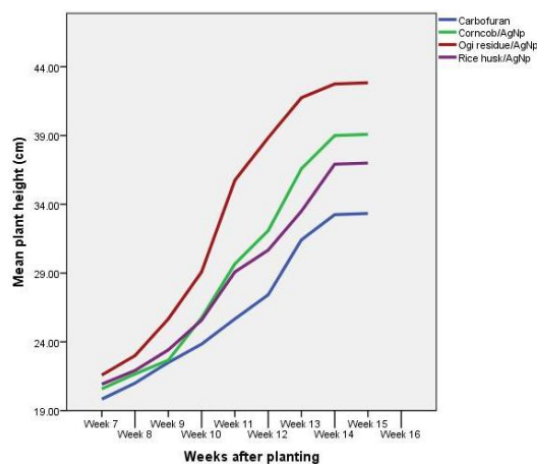


FIGURE 1
Effect of treatments on plant height of rice plants

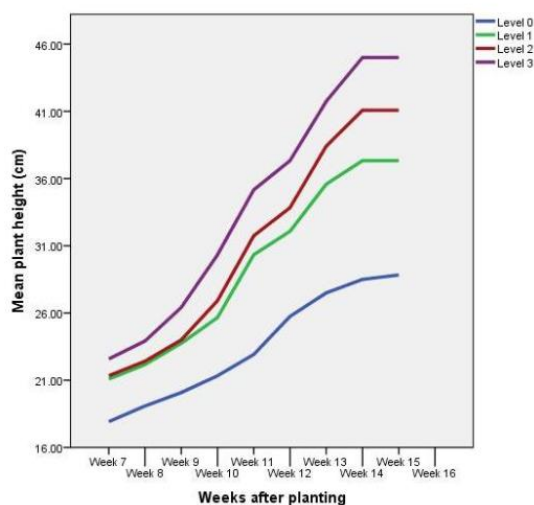


FIGURE 2

Effect of rates of application on plant height of rice plants

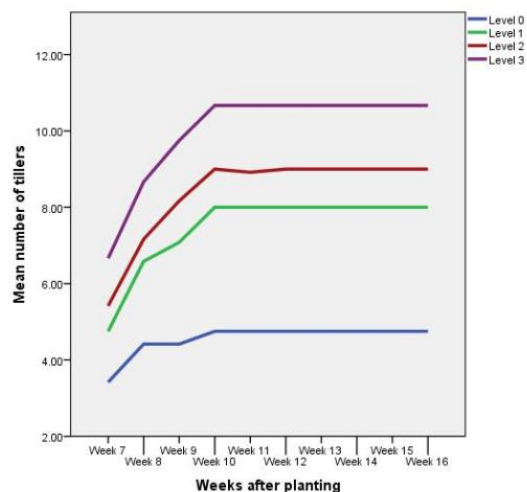


FIGURE 4

Effects of rates of application on number of tillers of rice

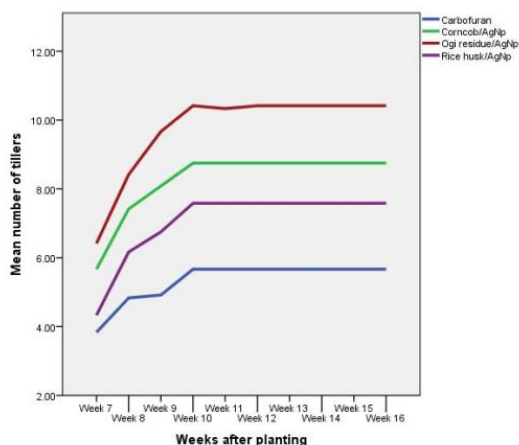


FIGURE 3

Effect of treatments on number of tillers of rice plants

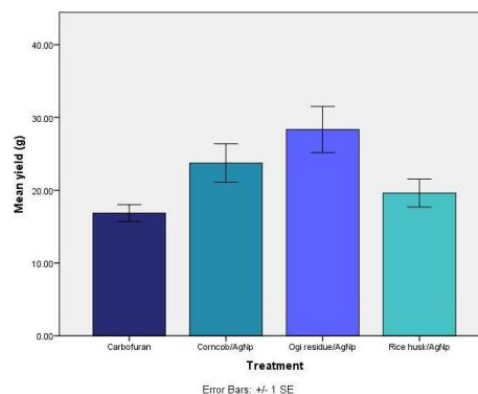


FIGURE 5

Effects of treatments on mean yield of rice

harvest (Figures 2 & 4), while cyst count was higher significantly ($p=0.05$) as opposed to what was obtained in rice plants treated with 75g and 50g of agro-waste silver nano particles (Figure 8).

DISCUSSION

From this study it is apparent that agro-waste silvernano particles could be employed in the management of plant parasitic nematode of rice *Heterodera sacchari*. The robustness of the rice plants treated with the highest rate (75g and 50g) of

ogi residue vis a vis the reduction in numbers of cyst demonstrated the nematicidal effect of agro-waste AgNP. This result corroborates the reports of Young-KiJo *et al.*, (2013) who evaluated silvernano particles in the control of *Belonolaimus* spp (sting nematodes) and the *Meloidogyne* spp (root-knot nematode) infecting Bermudagrass putting green. They established the nematicidal activity of silver nano particles with improvement in the quality of the turf grass. Similarly, Cromwell *et al.*, (2014) in a laboratory experiment reported that AgNP consistently decreased the activity of *Meloidogyne incognita* juveniles.

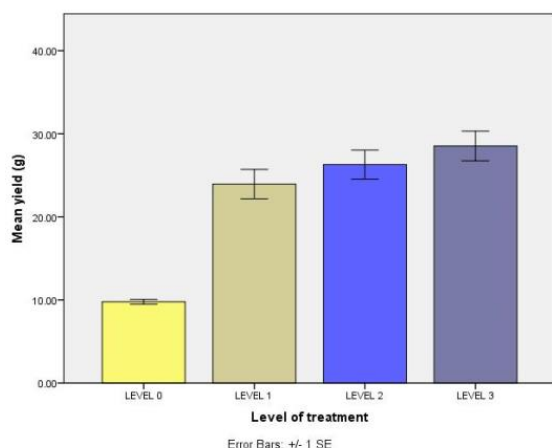


FIGURE 6

Effects of rates of application on mean yield of rice plant

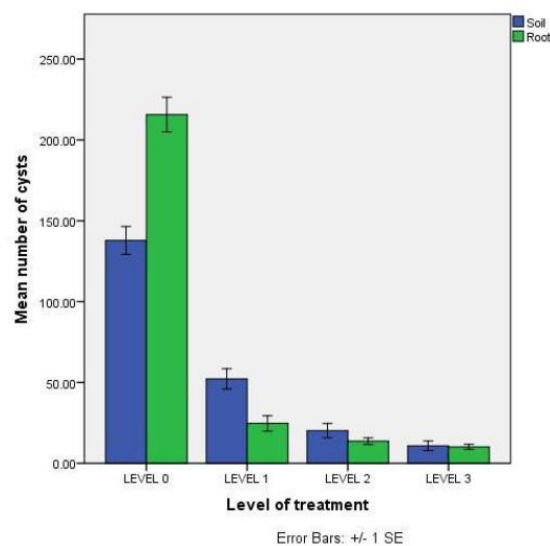


FIGURE 8

Effects of rates of application on mean number of cysts

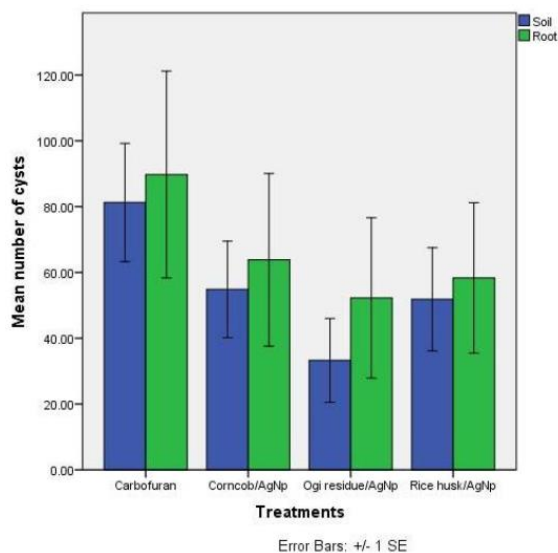


FIGURE 7

Effects of treatment on mean number of cysts

CONCLUSION

Silver nano particles have been produced using agricultural wastes through redox reaction in this study. Silver nano particles are used in several technologies and could also be adopted in the industrial production of nematicides. Agricultural wastes which litter the environment causing pollution and blockage of drainage systems sometimes resulting in flooding can be utilized in the production of nematicides.

These wastes are abundant and low-cost ligno- cellulosic material with good potential for use in the production of silver nano particles (AgNP) to control plant parasitic nematodes.

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