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Effect of soybean-based silver nanoparticles AgNps against sucking pest, mite *Tetranychus urticaete*

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Abstract
The application of nanotechnology in crop protection holds a significant role in management of insects and pests. Nanoparticles are highly stable and can be successfully employed in production of Nano capsules for delivery of pesticides, fertilizers and other agrochemicals. Nanoparticles display slow release of encapsulated functional molecules and reduce its frequent applications. Red spider mite, *Tetranychus urticae* Koch (Tetranychidae), is a major sucking pest on vegetables in Karnataka, India. One of the major obstacles in the control of *T. urticae* is its ability to rapidly develop resistance to many important acaricides, even after only a few applications. Green nanotechnology is emerging as a rapidly growing field with its application in science and technology for manufacturing new materials at the nanoscale. We have synthesized soybean based silver NPs and characterized them by UV–Visible spectroscopy, PSA and SEM. Spiromesifen 240 SC @ 2ml/l was used as standard check. For comparison purposes, plant extract (soybean seed extract) and precursor ($AgNO_3$) were used was prepared and tested on deutonymph (*T. urticae*). Soybean AgNPs of different concentrations, namely, 1000, 750, 500, 250 and 100ppm, were tested on mite.

Keywords: Red spider mite, *Tetranychus urticae* and Green nanotechnology

Introduction
The word "Nano" is developed from the Greek word meaning "dwarf". In more technical terms, the word "nano" means 10^{-9} m. Metal nanoparticles are nanoparticles of metals like gold, silver, iron, copper etc. They are a focus of interest because of their huge potential in nanotechnology. These nanoparticles possess insecticidal property due to novel characteristics like extra ordinary strength, chemical reactivity and electrical conductivity. These nanoparticles are effective against plant pathogens, insects and pests. Hence, nanoparticles can be used in the preparation of new formulation like pesticides, insecticides and insect repellants (Barik *et al*., 2008) [1].

Sucking pests are among the most destructive insect pests on cultivated plants. In addition to weakening the plant by sucking sap, they act as vectors for plant viruses and disfigure ornamental plants with deposits of honeydew and the subsequent growth of sooty moulds. Because of their ability to rapidly increase in numbers by asexual reproduction. However, plant extracts are eco-friendly and easily available can be an economic and efficient alternative for the large-scale synthesis of synthetic and other chemical insecticides (Manoj and Patil, 2018) [5].

Green nanoparticles are very important in developing sustainable technologies for the future. Synthesis of nanoparticles by plants is a green chemistry approach that interconnects nanotechnology and biotechnology. Plant extracts are used for bio reduction of metal ions to form nanoparticles. Hence, the study was carried out to evaluate the effect of soybean based silver nanoparticles AgNps on non-insect such as mite.

Material and Methods
Protocol for green synthesis of silver nanoparticles using soybean seed extract was followed (Indrakumar, 2016) [4]. Green nanoparticles were characterized using UV-Visible spectrophotometer (spectrum, sp uv 500DB/VBD) at wavelength range of 200 to 700 nm. Particle size was characterized using particle size analyser (nicomp) and scanning electron microscope SEM (Carl zeiss-evo-18-uk). The (deutonymph) mites required for the experiment were used from the insect culture maintained in the PG laboratory, department of agricultural entomology. Mulberry leaves were place in petri plates. The treatments were made by spray method using potter tower sprayer.

Ten nymphs of mites were introduced into petri plates. Microscopic observation was made at 24, 48 and 72 hours after the treatment.

Statistical analysis

The results obtained were subjected to statistical analysis using a factorial completely randomized design. The mean values of treatments were then subjected to Duncan's Multiple Range Test (DMRT) as suggested by Gomez and Gomez (1984) [3].

Results and Discussion

Spiromesifen 240 SC @ 2 ml/l was significantly superior over all the treatments with 93.33 per cent mortality. This was followed by soybean AgNPs 1000 (63.33 per cent) and 750 (53.33 per cent) ppm and were on par with each other. The soybean AgNPs 500 ppm recorded 36.67 per cent mortality. Soybean AgNPs at 1000 ppm concentration, recorded cent per cent mortality at 48 HAT. However, soybean AgNPs 750 and 500 ppm concentrations, mortality reached a maximum of cent per cent only at 72 HAT and this was followed by soybean AgNPs at 250 and 100 ppm (Table 1).

Bioassay with deutonymph recorded that spiromesifen 240 SC @ 2 ml/l was significantly superior to other treatments with 93.33 per cent mortality followed by soybean AgNPs 1000 and 750 ppm concentration at 24 HAT. At 1000 ppm concentration soybean AgNPs showed 100 per cent mortality at 48 HAT. Similar results were reported by Ghidan *et al.* (2017) [2] who bio-assayed the nanoparticles synthesized using *Punica granatum* peel extract at different concentrations against green peach aphid, *Myzus persicae*. He obtained highest mortality (75.5 per cent) of 1st and 2nd nymphal instar at 8000 µg/ml concentration after 24 hr, which reached cent per cent after 48 and 72 h. Mortality increased with increased concentrations.

Table 1: Effect of soybean based silver green nanoparticles on deutonymph, *Tetranychus urticae*

Sl. No.	Treatments	Concentrations	Cumulative mortality per cent at hours after treatment (HAT)		
			24 h	48 h	72 h
1	Soybean AgNPs	1000 ppm	63.33(8.02)^{b}	100.00(10.05)^{a}	100.00(10.05)^{a}
2	Soybean AgNPs	750 ppm	53.33(7.36)^{b}	90.00(9.54)^{a}	100.00(10.05)^{a}
3	Soybean AgNPs	500 ppm	36.67(6.12)^{c}	70.00(8.41)^{b}	100.00(10.05)^{a}
4	Soybean AgNPs	250 ppm	26.67(5.24)^{d}	56.67(7.59)^{c}	86.67(9.36)^{b}
5	Soybean AgNPs	100 ppm	23.33(4.91)^{d}	53.33(7.36)^{c}	83.33(9.18)^{b}
6	$AgNO_3$ alone	1 mM	0.00(1.00)^{e}	0.00(1.00)^{d}	23.33(4.91)^{c}
7	Soybean seed extract alone	30 (%)	0.00(1.00)^{e}	0.00(1.00)^{d}	0.00(1.00)^{e}
8	Spiromesifen 240 SC	2 ml/l	93.33(9.71)^{a}	100.00(10.05)^{a}	100.00(10.05)^{a}
9	Control	-	0.00(1.00)^{e}	0.00(1.00)^{d}	10.00(3.32)^{d}
S.Em. ±			0.21	0.16	0.14
C. D. @ 1%			0.87	0.63	0.56

Figures in the parentheses are $\sqrt{X + 1}$ transformed values.

In vertical columns, means followed by same letter do not differ significantly by DMRT (P= 0.01)

Conclusion

Soybean based silver green nanoparticles can be effectively used for the management of sucking pests, such as mite in laboratory and which cause mortality for the insects and this can be used an alternate strategy to chemical control. Since mites have an exceptional intrinsic potential for developments in Nano science caused many gains with agriculture, including pest management in near future. Research on NPs and insect control should be geared towards the introduction of faster and eco-friendly pesticides in the future. This green nanotechnology will give quick and easily adaptable technology and this technology will be sustainable throughout the year.

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