International Journal Of
Recent Scientific
Research
ISSN: 0976-3031
Volume: 7(4) April -2016

INSECTICIDAL ACTIVITY OF GREEN SYNTHESIZED SILVER NANOPARTICLES

Bodaiah B., Usha Kiranmayi M., Sudhakar P.,
Ravi Varma A and Bhushanam K

THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 4, pp. 10652-10656, April, 2016

International Journal of Recent Scientific Research

Review Article

INSECTICIDAL ACTIVITY OF GREEN SYNTHESIZED SILVER NANOPARTICLES

Bodaiah B[1]., Usha Kiranmayi M[2]., Sudhakar P[1]*., Ravi Varma A[1] and Bhushanam K[1]

[1]Department of Biotechnology, Acharya Nagarjuna University, Guntur-522510, India
[2]Department of Botany and Microbiology, Acharya Nagarjuna University, Guntur-522510, India

ARTICLE INFO

Article History:

Received 11[th] January, 2016
Received in revised form 14[th] February, 2016
Accepted 18[th] March, 2016
Published online 28[th] April, 2016

Keywords:

AgNPs, Bio synthesis, Insecticidal, Mosquitoes, Notorious pests

ABSTRACT

Nanotechnology is an interdisciplinary science deals with the synthesis and application of nanoparticles. The synthesis of metal nanoparticles came in to light due to wide range of applications in different fields. Biosynthesis of silver nanoparticles by plant extracts is a cost effective, ecofriendly and less time consuming process where the seconadary metabolites present in the plant extracts acts as reducing and stabilizing agents of silver nanoparticles. In the present days people are suffering from dengue and malaria due to increased rate of mosquitoes and another side agriculture is under threat due to increased rate of pests. The green synthesized silver nanoparticles (AgNPs) are showing remarkable results in controlling the population of both vector and pests. In the present review the nature of different insect vector and pests were discussed. The article also contains the nature of different plants which were used in the synthesis of silver nanoparticles. This review mainly focussed on the insecticidal activity of plant mediated silver nanoparticles against selected insect vectors and pests.

INTRODUCTION

In the present decade human beings are suffering from dangerous diseases like malaria, dengue, cancer, tuberculosis, hepatitis, yellow fever and AIDS due to increased rate of pollution and change in life style. Some of the lethal diseases stated above are transferred from one person to another through insect vectors. Simultaneously agriculture is under threat due to increased rate of pests and diseases on major food producing and commercial crops. So it is the time to learn about different secrets that are resent in the nature which can save the life of humans from these dangerous diseases. It is also necessary for us to save the agriculture from the damage caused by the pests and diseases to feed the growing population. Nanotechnology is an emerging, interdisciplinary branch of science with wide range of applications in the field of medicine and agriculture. Nanotechnology has become one of the most promising new approach for both vector and pest control in recent years (Timothy T. Epidi *et al.*, 2010). In 1959, Richard Feynman was the first person discussed the concept of nanotechnology (Gribbin J and Gribbin M., 1997). The term nanotechnology was coined by Professor Norio Taniguchi of Tokyo Science University in the year 1974 and derived from the Greek vocabulary where the word "Nano" means extremely small. Nanotechnology deals with the bunch of atoms in the size of 1-100nm (Taniguchi, Norio., 1974*)*. In the ancient times the metal silver was used as an antimicrobial agent in healing diseases (Wesley Alexander J., 2009). The special enthusiasm of present researchers on silver nanoparticles (AgNPs) is due to their peculiar and ample of applications. The bacterial infections in open wounds and ulcers were easily weeded out by silver nanoparticles. AgNPs were also used in the manufacture of medical devices, cosmetics, textiles and electronics. From the recent research information it can be known that AgNPs were used in biosensing, drug delivery, nanodevice fabrication and catalysis. Earlier records also shows that the AgNPs were also used in the remedy of brucellosis and as well as mosquito larvicidal and anti-inflammatory agents (Hemali P *et al.*, 2015).

The synthesis of silver nanoparticles can be done by various methods i.e. electrochemical, radiation, chemical methods, Langmuir-Blodgett and biological synthesis using extracts of bacteria, fungi, algae and plants (Keat *et al.*, 2015). But the physical and chemical methods used for the synthesis of silver nanoparticles are time consuming and create biological risks. To solve the above problems the contemporary research focused on the commercially viable and ecofriendly synthesis of silver nanoparticles. Since ancient times plants with therapeutic amalgamations were used in traditional medicine in the healing of the diseases. Plants and their metabolites have been analyzed regularly to use in the field of pharmaceutical, agricultural and textile industry. In the field of biotechnology

**Corresponding author:* Sudhakar P
Department of Biotechnology, Acharya Nagarjuna University, Guntur-522510, India

green synthesis or biosynthesis of silver nanoparticles with plant extracts gained much popularity recently than microbial cultures because more prudent and complicated procedures are required to maintain the microbial cultures (Sastry M *et al*, 2003). Biosynthesis of nanoparticles are triggered by several compounds such as carbonyl groups, terpenoids, phenolics, flavonones, amines, amides, proteins, pigments, alkaloids and other reducing agents present in the biological extracts. Especially these compounds are more abundant in plants. In general the aqueous silver nitrate ($AgNO_3$) solution is used for the green synthesis of silver nanoparticles. The silver ions present in the $AgNO_3$ solution first reduces to atoms by the action of reducing agent. The atoms then divide in to small clusters and then to particles. The size and shape of the silver nanoparticles is totally depends on the type and concentration of the reducing agents (Iravani *et al*., 2014). Whatever may be the biological material and metal used in the synthesis, metal nanoparticles are generally characterised by UV-Visible spectroscopy, X-ray diffraction(XRD), Fourier transform infrared spectrophotometer(FTIR), Scanning electron microscope (SEM) and Transmission electron microscope (TEM) etc. The surface Plasmon resonance spectrum of silver nanoparticles form the highest peak at the range of 400-500nm in UV-Visible spectral analysis. XRD spectrum gives the crystalline nature and size of the nanoparticles. FTIR gives the data of secondary metabolites of plants which are responsible for reduction and stabilisation of metal nanoparticles. SEM analysis gives the average particle size and aggregation of nanoparticles. TEM images gives more accurate information than SEM about the size, shape and distribution of the nanoparticles (Geoprincy *et al*., 2013). There are also other techniques like Particle size analyzer and Atomic force microscope etc for the characterisation of biologically synthesized metal nanoparticles, each one have its own significance.

Insects are the biggest animal population belongs to the invertebrate phylum Arthropoda and class Insecta. Insects have successful evaluative history where some of them are useful to humans (Honey bee and Silk moth etc), some knowingly or unknowingly acts as vectors to dangerous diseases(Mosquitoes) and others cause huge damage to agricultural crops(Cabbage cluster caterpillar and the cotton bollworm etc). Insects were seen all over the world in all possible environments. The success of the insects is mainly due to evolutionary aspects like wings, malleable exoskeleton, high reproductive potential, habits diversification, desiccation resistant eggs and metamorphosis etc (Sabry A.H *et al*., 2014). The review discussed the nature of different vector and pest insects. The review also contains the nature of the plants which were used in the synthesis of silver nanoparticles. The article is mainly focused on the potential use of green synthesized silver nanoparticles to control insect vectors and pests.

Vector control by plant mediated nanoparticles

Some living organisms carry disease causing pathogens in their body and transmits them between humans. Some carry diseases from animals to humans. These are all called vectors. Most of the vectors are blood sucking insects (Eg: Mosquitoes, ticks and sand flies). Among all the vectors, mosquitoes transmit serious human diseases, causing millions of death every year. The use of synthetic insecticides to control mosquitoes has caused physiological resistance and adverse environmental effects in addition to high operational cost. Biosynthesis of insecticides from plant extracts is currently under exploitation. Plant extracts are cost effective and ecofriendly and thus can be an economic and efficient alternative for the large scale synthesis of synthetic and other chemical insecticides. *Aedes albopictus* is a mosquito belongs to the family culicidae and acts as vector in the transfer of diseases like dengue and chicken guinea. It is commonly called tiger mosquito or forest mosquito. It is now seen all over the world but native to tropical and subtropical areas of south east asia. Sarah J.S *et al* (2012) studied larvicidal potential of biologically synthesised silver nanoparticles from aqueous leaf extract of *Hibiscus rosasinensis* against *Aedes Albopictus*. The plant belongs to the family malvaceae and commonly called as chinese hibiscus or china rose. It is an evergreen shrub and native to East Asia. The experimental insect larvae were reared in rubber plantation. The parasite larvae were exposed to varying concentrations of green synthesized silver nanoparticles of *H. rosasinensis* for 24h as per WHO protocols and the percentage mortality was recorded. The synthesized nanoparticles exhibited significant larvicidal activity. The *Pergularia daemia* is a perennial wine and belongs to the family apocyanaceae. Here the latex of *P. daemia* was used in the synthesis of silver nanoparticles and screened insecticidal activity against the larval instars of *Aedes aegypti* and *Anopheles stephensi*. The mosquito *Aedes aegypti* is a native of africa and now seen in tropical and subtropical regions of the world (*Mousson L et al*., 2005). It acts as vector to both yellow fever and dengue diseases. *Anopheles stephensi* is a primary vector to the malarial parasite *Plasmodium falciparum* in urban india (Valenzuela J.G *et al*., 2003). The green synthesized AgNPs of *Pergularia daemia* were highly lethal to the larval instars of both the mosquitoes (Patil Ch.D *et al*., 2012). Research records also reveals that silver nanoparticles synthesized from aqueous leaves extracts of *Jatropha gossypifolia, Euphorbia tirucalli, Pedilanthus tithymaloides* and *Alstonia macrophylla* has shown insecticidal activity on on IInd and IVth instars larvae of *Aedes aegypti* and *Anopheles stephensi*. *J. gossypifolia* is a flowering plant of the family Euphorbiaceae and grows upto 4 meters height. The plant *E. tirucalli* is also belongs to the family euphorbiaceae. The shrubby plant grows generally in semi arid tropical climates. *P. tithymaloides* grows up to 2 meters height and belongs to the family euphorbiaceae. *A. macrophylla* is a tree grows up to 30 meters height and belongs to the family apocyanaceae. The plant is a native of indonesia, philippines, malaysia. IInd and IVth instars larvae of *A. aegypti* and *A. stephensi* were exposed to varying concentrations of AgNPs synthesized from the above plants. AgNPs from all the plants has shown promising larvicidal activity under investigation for 24 hours (Borase *et al*., 2013).

The potentiality of green synthesized nanoparticles against insect vectors is highly remarkable. In 2014 more research findings on insecticidal activity of green synthesized nanoparticles came in to light. Kartikeyan J *et al* (2014) studied the larvicidal efficacy of green synthesized nanoaprticles using leaves of *Melia dubia.* It is a tree and belongs to the family Meliaceae. The 4^{th} instar larva of *Culex quinquefasciatus* were exposed to different concentrations of silver nanoparticles for 24hrs. *Culex quinquefasciatus* is generally seen in tropical and subtropical regions of the world.

The southern house mosquito is a vector to *Wuchereria bancrofti*, avian malaria and West nile virus (Foster WA and Walker ED., 2002). The observations reveal that the silver nanoparticles synthesized using *Melia dubia* leaves were more effective over *Culex quinquefasciatus* by altering the carbohydrates and protein levels. The larvicidal activity of AgNPs is because of the phytoconstituents coated with the nanoparticles. It is interesting to know that silver nanoparticles synthesized using *Delphinium denudatum* root extract exhibits mosquito larvicidal activities. The plant belongs to Ranunculaceae family seen on outer ranges of western himalayas especially from Kashmir to Kumaon. The plant roots are used in the treatment of brain diseases, fungal infections and toothache (Khory RN and Katrak NN., 1985). The AgNPs showed potent larvicidal activity against second instar larvae of dengue vector *Aedes aegypti* with a LC50 value of 9.6ppm (Suresh G *et al.*,2014). The plant *Calotropis gigantea* belongs to the family apocyanaceae and native to tropical Africa (*Bingtao Li et al., 2015)*. It is a large shrub and grows up to 4 meters height. The latex of the plant contains cardiac glycocides, fatty acids and calcium oxalate. Contemporary research results has also shown that the AgNPs synthesized using leaf extract of *Calotropis gigantea* were highly lethal to dengue vector *Aedes aegypti*, malarial vector *Anopheles stephensi.* These results suggest that the synthesized AgNPs have the potential to be used as an ideal eco-friendly approach for the control of the *A. aegypti* and *A. Stephensi* (Murugan K *et al*., 2014).

Plants are the natural factories of potential secondary metaboites having antimicrobial, pesticidal activity. Some mangrove plants having active compounds were also used in medicine. Here silver nanoparticles synthesized from a mangrove plant were tested against *Armigeressubalbatus* and *Aedes aegypti* mosquito larvae. *Acanthus ilicifolius* is a small shrub and belongs to the family acanthaceae. It grows along sea shores and used as medicine to asthma and rheumatism (Singh A *et al*., 2009). The mosquito *Armigeres subalbatus* is commonly seen in the rice feilds of Taiwan and transmits Japanese encephalitis virus (Chen WJ *et al*., 2000). The invitro larvicidal activity studies revealed that the AgNPs of mangrove plant were active against the selected insects and the LC50 values are 0.532 and 0.754mg/L for *A. subalbatus* and *Ae. aegypti* respectively. Further, the LC90 values are also determined as 2.13 and 5.98mg/L for *A. subalbatus* and *Ae. aegypti* respectively (Ali M.S *et al.,* 2015). Research on insecticidal activty of green synthesized silver nanoparticles increasing day by day. *Cassia roxburghii* is a flowering plant of the family fabaceae and grows upto 15-20 meters height. Recently AgNPs synthesized using *C. roxburghii* plant leaf extract were screened for insecticidal activity against *Anopheles stephensi*, *Aedes aegypti,* and *Culex quinquefasciatus*. Larvae were exposed to varying concentrations of synthesized AgNPs and aqueous leaf extracts for 24 h. The synthesized AgNPs showed extensive mortality rate against *An. stephensi*, *Ae. aegypti*, and *C. Quinquefasciatus* when compared to plant extract(Muthukumaran U *et al*., 2016).

Pest control by green synthesized silver nanoparticles

According to International plant protection convention (1951), plant pest is a species of a living organism, may be an animal or a pathogenic species which is injurious to plants and their products. Some insects depends on plants for their food are called plant pests. Insect pests are mainly two types i.e. crop pest and storage pest where crop pest damages the crops by eating young leaves and fruits and storage pest eats and damages the stored grains. Eradication of plant pests by green synthesized silver nanoparticles is a novel and ecofriendly approach. Rahuman A *et al* (2012) evaluated the insecticidal activity of aqueous leaf extract mediated silver nanoparticles against *Sitophilus oryzae*. The plant *Euphorbia prostrate* belongs to the family Euphorbiaceae and is native to certain parts of South America and Caribbean. Now it is seen all over the world as a road side weed. The plant extracts contain flavanoids, phenolics and phenolic acids and used in the treatment of bleeding hemorroids (Girish D B *et al., 2008*). The insect *Sitophilus oryzae* is commonly called rice weevil. It is a storage pest mainly attacks rice, wheat and maize grains. Adult rice weevils are able to fly and can survive for up to two years. The larva develops within the grain, hollowing it out while feeding. It then pupates within the grain kernel and emerges 2–4 days after eclosion (Birch LC., 1944). Invitro pesticidal activity tests were conducted at varying concentrations for 14 days and the LD50 and LD90 of AgNPs againt the selected pest were 44.69 mg/kg -1 and 168.28 mg/kg -1, respectively. It is possible to control the damage caused by the cotton bollworm, *Helicoverpa armigera* (Lepidoptera: Noctuidae) in crop fields. The pest is cosmopolitan in distribution and polyphagous in nature i.e. it depends on different crops for food (Robinson G. S. *et al*., 2010). *Euphorbia hirta* is a hairy herb and native to India. The plant belongs to euphorbiaceae and grows generally in open grasslands and road sides. The silver nanoparticles (AgNPs) synthesized by using the leaves of *E. hirta* against the first to fourth instar larvae and pupae of the cotton boll worm showed considerable larval mortality (Devi G.D *et al.,* 2014). Another plant *Aristolochia indica* commonly grows in forests and rocky hillslopes. The creeping plant belongs to the family aristolocaceae, flowers once in a year to produce seeds and seen in southern india and srilanka. The AgNPs synthesized by using aqueous leaf extract of *A. Indica* were tested against third instar larvae of *Helicoverpa armigera* by leaf disc no choice and leaf dipping methods. The maximum antifeedant and larvicidal efficacy of AgNPs against *H. armigera* larvae were LC50= 766.54, and 309.98 mg/mL respectively (Siva C *et al*., 2015).

CONCLUSION

In the present era the production of novel bio insecticides and pesticides which can replace the chemical insecticides and save the world from ecological problems is a great challenge to young scientists in the field of life sciences. Nanotechnology came in to light as a novel approach with promising results in the control of vectors and pests. Recent research investigations revealed that green synthesized silver nanoparticles were shown potential insecticidal activity in the control of wide variety of insect vectors and pests. The AgNPs synthesized by using some plants and their extracts were discussed above are highly lethal to dangerous vectors like *Aedes aegypti* and *Culex quinquefasciatus etc*. The silver nanoparticles of another account plants were active against notorious agricultural pests like *Sitophilus oryzae* and *Helicoverpa armigera* etc. However the insecticidal activity of AgNPs varies with the type of plant extract and also dose dependant.

References

1. Bhattachayya, A., Bhaumik, A., Usha Rani, P., Mandal, S and Timothy, T. Epidi. Nano-particles - A recent approach to insect pest control. *African Journal of Biotechnology*. Vol. 9(24), pp. 3489-3493, (2010).
2. Gribbin, John and Gribbin, Mary. Richard Feynman: A Life in Science. Dutton. p. 170, (1997).
3. Taniguchi, Norio. "On the Basic Concept of 'Nano-Technology'". Proceedings of the International Conference on Production Engineering, Tokyo. Part II, Japan Society of Precision Engineering, (1974).
4. Wesley, Alexander. History of the Medical Use of Silver., Surgical infections. Volume 10, Number 3, (2009).
5. Hemali, Padalia., Pooja, Moteriya., Sumitra, Chanda., Green synthesis of silver nanoparticles from marigold flower and its synergistic antimicrobial potential. *Arabian Journal of Chemistry*. Volume 8, Issue 5, Pages 732–741, (2015).
6. Liang, Keat., Azila, Aziz., Ahmad M Eid and Nagib A. Elmarzugi. Biosynthesis of nanoparticles and silver nanoparticles. Bioresources and Bioprocessing, 2:47, (2015).
7. Sastry, M., Ahmad, A., Islam, NI., Kumar, R. Biosynthesis of metal nanoparticles using fungi and actinomycetes. Current Sci. 85: 162-170, (2003).
8. Iravani, Siavash., Korbekandi, Hassan., Mirmohammadi, Seyed Vahid., Mekanik, Hasti. Plants in Nanoparticle Synthesis., Reviews in Advanced Sciences and Engineering, Volume 3, pp. 261-274, (2014).
9. G. Geoprincy, B.N.Vidhya SRRI, U.Poonguzali, N.Nagendra Gandhi, S.Renganadhan. A review on green synthesis of silver nanoparticles. *Asian Journal of Pharmaceutical and Clinical Research*. Vol 6, Suppl 1, (2013)
10. Mohamed, Ragaei and Sabry, A.H. Nanotechnology for insect pest control, *International Journal of Science, Environment and Technology*. Vol. 3, No 2, 528 – 545, (2014).
11. Sarah, J.S., Raji, K.P., Mohana Kumar, N.Ch. and Balagopalan, M. Larvicidal Potential of Biologically Synthesised Silver Nanoparticles against *Aedes albopictus*. *Research Journal of Recent Sciences*., Vol. 1, 52-56, (2012).
12. Laurence Mousson., Catherine Dauga., Thomas Garrigues., Francis Schaffner., Marie Vazeille and Anna-Bella Failloux. "Phylogeography of Aedes (Stegomyia) aegypti (L.) And Aedes (Stegomyia) albopictus (Skuse) (Diptera: Culicidae) based on mitochondrial DNA variations". Genetical research, Volume 86, pp 1-11, (2005).
13. Valenzuela, J.G., Francischetti, I.M.B., Pham, V.M., Garfield, M.K., and Ribeiro, J.M.C. Exploring the salivary gland transcriptome and proteome of the *Anopheles stephensi* mosquito. Insect Biochemistry and Molecular Biology, 33, 717-732, (2003).
14. Chandrashekhar D. Patil., Hemant P. Borase., Satish V. Patil., Rahul B. Salunkhe and Bipinchandra K. Salunke. Larvicidal activity of silver nanoparticles synthesized using *Pergularia daemia* plant latex against *Aedes aegypti* and *Anopheles stephensi* and nontarget fish *Poecillia reticulate*. Parasitol Res, 111:555–562, (2012).
15. Hemant P Borase., Chandrashekhar D Patil., Rahul B Salunkhe., Chandrakant P. Narkhede., Bipinchandra K Salunke and Satish V Patil. Phyto-Synthesized Silver Nanoparticles: A Potent Mosquito Biolarvicidal Agent, Nanomedicine & Biotherapeutic Discovery, J Nanomedine Biotherapeutic Discov, 3:1, (2013).
16. Jagadeesan Karthikeyan, Kamalnathan Mullainila, George Thooyavan, Elangovan Vimal Kumar, Larvicidal and antibacterial efficiency of green synthesized silver nanoparticles using *Melia dubia*. *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol 6, Issue7, (2014).
17. Foster WA and Walker ED. Mosquitoes (Culicidae), pp. 245-249. Medical and Veterinary Entomology. Academic Press. New York, (2002).
18. Khory RN and Katrak NN. Materia Medica of India and their therapeutics. Delhi: Neeraj Publishing House., 10–11, (1985).
19. Suresh G., Gunasekar PH., Kokila D., Prabhu D., Dinesh D., Ravichandran N., Ramesh B., Koodalingam A and Vijaiyan Siva G. Green synthesis of silver nanoparticles using *Delphinium denudatum* root extract exhibits antibacterial and mosquito larvicidal activities. Spectrochim Acta A Mol Biomol Spectrosc.; 127:61-6, (2014).
20. *Bingtao Li., Gilbert MG and Stevens WD. "Calotropis gigantea (Linnaeus)* W. T. Aiton, Hortus Kew. ed. 2. 2: 78. 1811*", Flora of China online,* (2015).
21. Priya S., Murugan K., Priya A., Dinesh D., Panneerselvam., Durga Devi G., Chandramohan B., Mahesh Kumar P, Donald R. Barnard., Rui-De Xue., Jiang-Shiou Hwang., M. Nicoletti,R., Chandrasekar., A. Amsath., R. Bhagooli., Hui Wei. Green synthesis of silver nanoparticles using *Calotropis gigantea*, *International Journal of Pure and Applied Zoology*., Volume 2, Issue 2, pp: 128-137, (2014).
22. Amritpal Singh., Sanjiv Duggal and Ashish Suttee. *Acanthus ilicifolius* –Lesser known medicinal Plants with Significant Pharmacological Activities. Ethno botanical Leaf lets. 13: 431-36, (2009).
23. Chen WJ., Dong CF., Chiou LY and Chuang WL. Potential role of *Armigeres subalbatus* (Diptera: Culicidae) in the transmission of Japanese encephalitis virus in the absence of rice culture on Liu-chiu islet, Taiwan. J Med Entomol.37(1):108-13, (2000).
24. Mohamed Yacoob Syed Ali., Anuradha V., Yogananth N., Rajathilagam., Chanthuru A; Mohamed Marzook S. Green synthesis of Silver nanoparticle by *Acanthus ilicifolius* mangrove plant against *Armigeres subalbatus* and *Aedes aegypti* mosquito larvae., *International Journal of Nano dimension*., Article 12, Volume 6, Issue 2, Page 197-204, (2015).
25. Muthukumaran U., Govindarajan M and Rajeswary M. Green synthesis of silver nanoparticles from *Cassia roxburghii*-a most potent power for mosquito control. Parasitol Res. 114(12):4385-95, (2015).

26. Abduz Zahir A, Bagavan A, Kamaraj C, Elango G, Abdul Rahuman. Efficacy of plant-mediated synthesized silver nanoparticles against *Sitophilus oryzae*., JBiopest, 5 (Supplementary): 95 – 102, (2012).
27. Bakhshi, Girish D., Langade, Deepak G and Desai, Vidyadhar S. "Prospective, Open Label Study of Euphorbia *Prostrata* Extract 100 mg in the Treatment of Bleeding Haemorrhoids"*(PDF). Bombay Hospital Journal 50 (4): 577–583, (2015).*
28. Birch LC. Two strains of *Calandra oryzae* L (Coleoptera). *Australian Journal of experimental Biology and Medical Science*, 22:271-275, (1944).
29. Robinson, G S., Ackery PR., Kitching IJ., Beccaloni GW., Hernández LM . "Hosts - A Database of the World's Lepidopteran Hostplants". London: Natural History Museum, (2010).
30. Durga Devi G., Murugan K and Panneer Selvam C., Green synthesis of silver nanoparticles using *Euphorbia hirta* (Euphorbiaceae) leaf extract against crop pest of cotton bollworm, *Helicoverpa armigera* (Lepidoptera: Noctuidae)., JBiopest 7(Supp.): 54-66, (2014).
31. Siva C., M and Santhosh Kumar. Pesticidal activity of eco-friendly synthesized silver nanoparticles using *Aristolochia indica* extract against *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae). *International Journal of Advanced Scientific and Technical Research* Issue 5 volume 2, (2015).

****

How to cite this article:

Bodaiah B *et al*.2016, Insecticidal Activity of Green Synthesized Silver Nanoparticles. *Int J Recent Sci Res.* 7(4), pp. 10652-10656.

ISSN 0976-3031