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Nanoinsecticidal effects of Zinc Oxide Nanoparticles on Rice weevil *Sitophilus oryzae* (L.), under laboratory conditions in stored wheat grains

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Abstract- *Sitophilus oryzae* (L.) causes high risk to wheat seeds in storage such as weight loss, reduced nutrition value, less germination of grains. The excessive use of pesticides and chemical compounds has an adverse effect on environment. The nanoparticles have received much attention for controlling stored grain pests. Screening test was conducted to evaluate the effect of Zinc Oxide nanoparticles (ZnO NPs) at different doses 1000 ppm, 2000 ppm, 3000 ppm, 4000 ppm and 5000 ppm per 20 g wheat grains along with control on *S. oryzae*. The results clearly showed that ZnO NPs had adverse effect on the adults of *S. oryzae.* The results obtained indicated that the insects mortality (%) increased by increasing the level of concentration of ZnO NPs and the period of exposure and the seed weight loss decreased after 40 days of storage. Thus, the ZnO NPs are use as an alternative method as pesticides to control the *S. oryzae* insect pest because ZnO NPs are safe for human and for environment.

Key words: Zinc Oxide Nanoparticles, *Sitophilus oryzae* (L.), Wheat grains, Mortality (%), Weight loss (%).

INTRODUCTION

Wheat is one of the major crops for world's population but the stored wheat grains are ravaged by a number of insect pests. A large number of insect pests gain access to the grain storage at various stages of processing of food grains viz., during the process of development and maturation of grains, processing in threshing yards, during transit or while in storage.[1] The *S.oryzae* causes extensive losses in the quality and quantity of stored Wheat grains. Both the adults and larvae feed on whole grains.[2] The efficient control of stored grain pest *S. oryzae* is the main aim of Entomologists. Synthetic chemical pesticides have been used for many years to control stored grain pests.[3] The application of insecticides and fumigants to control storage insect has led to many problems including the development of insecticide resistance, health hazards especially to mammals and the risk of environment contamination.[4] The chemical insecticides show negative impact to the environment and are so much expensive. Reacting to the disadvantages of using traditional chemical pesticides was the need to use a new methods of combat, such as nanotechnology.[5]

Nanoparticles have shown great role in agriculture including management of pest. Nanoparticles having one or more dimensions in the order of 100 nm or less.[6] In the present research ZnO NPs were chosen to reduce the stored grain pests. They kill the arthropods by removing or adsorbing the epicuticular lipid layers causing excessive

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water loss through cuticle.[7] The potential of some nanoparticles as insecticides in insect pest management such as nanosilica,[8] silver nanoparticles[9] and aluminum nanoparticles[7] have been reported in several studies.

The objectives of the present study were:

- to evaluate the pesticidal effect of ZnO NPs against *S.oryzae* adults.
- to study the reduction in the weight loss of wheat grains treated with ZnO NPs.

MATERIALS & METHODS

Location of experiment

Research was conducted at the Entomology Laboratory of University Department of Zoology, Ranchi University Ranchi, Ranchi, Jharkhand, India.

Insect used

The adults of *S. oryzae* were collected from the wheat grains reared in the Entomology laboratory of University Department of Zoology, Ranchi University, Ranchi. Insects were reared under laboratory conditions of 30±2°C, 50±5% relative humidity in continuous darkness. For the experiment new adults were selected.

Zinc Oxide nanoparticles

The colloidal form of ZnO NPs were obtained from authorized Nano Research Lab.

Supplier	:	Nano Research Lab
Appearance	:	Powder
Colour	:	White
Solubility	:	Dispersed in water
pH	:	Neutral

Preparation of wheat grains and treatment with ZnO NPs

500 g of wheat grains were taken, washed with water and dried in sunlight. Then wheat grains were sieved to remove stone, dust, insects. Five batches of wheat grains were selected for the experiment. Three replicates of each five batches of wheat grains containing 13% moisture were sterilized at 60°C in hot air oven for one hour and left to cool and reabsorb moisture. In three replicates 20 grams of wheat grains were weighed in 150 ml jar for treatments and control. Different concentrations of ZnO NPs, that is concentrations 1000 ppm, 2000 ppm, 3000 ppm, 4000 ppm and 5000 ppm were prepared and mixed with all five batches of the wheat grains in required doses.

Jars were shaken manually for 2 minutes for equal distribution of ZnO NPs on wheat grains. The treated jars were left for 24 hours before introduce the adults of *S. oryzae*. After 24 hours of treatment 20 newly emerged adults of *S. oryzae* were introduced in each batch for infestation.

All treated batches and control were kept at 30±2°C and 50±5% R.H. in incubator. Insect Mortality Percentage was recorded after 1, 3, 5, 7, 9, 11, 13 and 15 days post treatment. Adult mortality of *S. oryzae* was calculated by using the formula described by Devi *et al.*, (2014)[10].

$$\text{Adult Mortality (\%)} = \frac{\text{Number of dead insects}}{\text{Total number of insects}} \times 100$$

The reduction in the weight loss of wheat grains was calculated on 40th day after treatment. Initial weight and final weight of all the five batches of wheat grains was recorded and weight loss (%) was calculated by using the formula described by Harris and Limblad (1978)[11].

$$\text{Weight loss (\%)} = \frac{Wo - W1}{Wo} \text{ x } 100$$

Where, W_0 = Initial weight of sample (g)
W_1 = Final weight of sample (g)

RESULT

Effect of ZnO NPs on adult mortality (%) of *S.oryzae*

Table 1 represents the toxic effect of ZnO NPs against *S. oryzae*. The result obtained in table 1 indicated that the percentage mortality increases with the increase in concentration and period of exposure. In the higher

Table 1- Toxicity of ZnO NPs mixed with the media against *Sitophilus oryzae*

Treatments (ZnO NPs, ppm)	Adult mortality (%)							
	Days after treatment (DAT)							
	1	3	5	7	9	11	13	15
1000	0.00	1.89	2.05	2.29	3.65	5.86	8.30	8.46
2000	1.65	3.30	5.64	6.24	7.67	7.88	11.56	11.65
3000	1.79	4.39	6.87	7.38	11.99	20.79	29.17	31.85
4000	1.86	8.81	17.21	18.37	19.32	29.17	36.30	39.14
5000	5.00	10.16	17.52	27.63	32.20	57.06	65.34	66.44
Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00

concentration 5000 ppm adult mortality (%) varied in the range of 5% to 66.44% from 1 to 15 days post treatment. The highest mortality (%) found in treatment 1000 ppm, 2000 ppm, 3000 ppm, 4000 ppm were 8.46%, 11.65%, 31.85%, 39.14% at 15 days post treatment. In control there was 5% mortality at 15 days post treatment.

Weight loss (%) of treated wheat grains due to *S. oryzae*

Table 2 represents the weight loss (%) of treated wheat grains due to infestation by *S. oryzae*. Data was recorded on 40th day after treatment. Data indicated that at 5000 ppm ZnO NPs the weight loss (%) was minimum that is 0.9%. The control recorded 5.66% loss in grain weight on 40th day of imposing treatment.

Table 2- Efficacy of ZnO NPs in weight loss reduction against *S. oryzae*

Treatments (ZnO NPs, ppm)	Weight Loss (%)
1000	3.70
2000	1.65
3000	1.60
4000	1.35
5000	0.90
Control	5.66

DISCUSSION

From the data it was evident that the ZnO NPs were effective because of increased insect cuticle contact. Insecticidal efficacy of the dust becomes enhanced if the particles are finely divided.[12] Damage occurs to the insect protective wax coat on the cuticle, by sorption and abrasion.[8] The insects begin to lose water as the water barrier is damaged[13] and due to desiccation they die.

Since there is no reviews available on ZnO NPs toxic effect against adult mortality of *S. oryzae* at temperature (30±2°C, 50±5% R.H), so reviews of ZnO NPs at 28±2°C,70±5% R.H and other nanoparticles are presented here. Wille (1923)[14] reported variable duration of life cycle with 45 days in summer but taking as long as five months in cool weather of autumn and winter for completion of one generation. Attia Y. Keratum *et al.,* (2015)[2] noticed that the adult mortality percent ranged between 2 and 46.8% from 3 to 15 days of exposure with concentration % ranged from 0.1 w/w to 0.8 w/w. Rouhani *et al.*, (2012)[15] showed the most mortality effect pertained to 28% ZnO against *Frankliniella occidentalis*. Sabbour (2013)[16] found that aluminium oxide had the highest cumulative mortality 73.3% followed by titanium dioxide reached 59.7% after 7 days against *S. oryzae*. Debnath *et al.,* (2011)[8] reported, the *in vitro* cellular toxicity in human fibroblast cell line and acute oral toxicity study in mice revealed that similar to the silica NPs (25, 50, 125, 800, 2000, 5000 ppm) non toxic. ZnO NPs are less toxic than SNPs. So, ZnO NPs can be used to control *S. oryzae* in stored grains. Nanoparticles can be useful in pest management as insecticides, however more research is required to find out the detailed mechanisms of action of ZnO NPs as nanocides.

CONCLUSIONS

At temperature 30±2°C, 50±5 % R.H the dose 1000 ppm of ZnO NPs causes mortality after 3 days of post treatment. The ZnO NPs of concentration 5000 ppm causes 5% mortality after 1 day of post treatment and after that mortality (%) increases upto 66.44% on increasing the day of exposure. The weight loss (%) of wheat grains decreases from 3.7% to 0.9% after treated with ZnO NPs of concentration 1000 ppm to 5000 ppm. From the result it is clear that ZnO NPs can used as an alternative to kill the *S. oryzae*.

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REFERENCES

1. **Wazid Khan M. A., Shirazi M. U., Summiya F., Saba M. 2018.** Seed priming induced high temperature tolerance in wheat by regulating germination metabolism and physio-biochemical properties. *International Journal of Agriculture and Biology.* **20(9):**2140-2148.

2. **Attia Y. Keratum, Raffat B. Abo Arab, Ahmed A. Ismail and George M. Nasr. 2015.** Impact of nanoparticle Zinc oxide and Aluminum Oxide against rice weevil *Sitophilus oryzae* (Coleoptera: Curculionidae) under laboratory conditions. *Egy. J. Plant Pro. Res.* **3(3):**30-38.

3. **Salem S. A., Abou-Ela R. G., Matter M. M., El-Kholy M. Y. 2007.** Entomocidal effect of *Brassica napusex* - tracts on two store pests, *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (Fab.) (Coleoptera). *J. Appl. Sci. Res.* **3(4):**317-322.

4. **Cox P. D. 2004.** Potential for using semiochemicals to protect stored products from insect infestation. *Journal of Stored Products Reseach*. **40:**1-25.

5. **Zayed Gamal M. M. 2018.** Nanoparticles: A recent approach for controlling stored grain insect pest. *Academia Journal of Agricultural Research.* **6(5):** 088-094.

6. **Auffan M., Rose J., Bottero J. Y., Lowry G. V., Jolivet J. P., Wiesner M. R. 2009.** Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective. *Nature Nanotechno.* **4:**634-64.

7. **Stadler T., Buteler N., Weaver D. K. and Sofie S. 2010b.** Novel use of nanostructural alumina as an insecticide. *Pest. Mang. Sci*. **66:**577-5

8. **Debnath N., Dipanker D., Chandra R., Bhattacharya S. and Goswami A. 2011.** Entomotoxic effect of silica nanoparticles against *S.oryzae* (L.). *J. Pestic. Scik.* **84:** 99-105.

9. **Arjunan N. K., Murugon K., Rejeet C. H. and Barnard D. R. 2012.** Green synthesis of silver nanoparticles for the control of mosquito vectors of malaria and dengue. *Vector Borne Zoonotic Diseases.* **12:**262-268.

10. **Devi M. B., Devi N. V., Singh S. N. 2014.** Effects of six botanical plant powder extracts on the control of rice weevil, *Sitophilus oryzae* L. in stored rice grains. *Internaional Journal of Agriculture Innovation and Research.* **2:**683-686.

11. **Harris K. L., Lindblad C. I. 1978.** Post Harvest grains loss assessment method. American Association of cereal chemist, St. Paul., Minnesota, U.S.A. 193.

12. **Ebeling W., Wagner R. E. 1959.** Rapid desiccation of dry wood termited with inert sorptive dusts and other substances. *Journal Econ. Entomology.* **52:**190-207.

13. **Ebeling W. 1971.** Sorptive dusts for pest control. *Ann. Rev. Entomol.* **16:**123-158.

14. **Wille J. 1923.** Contribution to the biology of rice weevil *S. oryzae. Zeitschift Fuer Angewandte*. **9:**333-342.

15. **Rouhani M., Samih M. A., Kalantari S. 2012.** Insecticidal effect of silica and silver nano particles on the cowpea seed beetle *Callosobruchus maculates* F. (Col.:Bruchidae). *Journal of the Entomological Research Society.* **4:**297-305.

16. **Sabbour M., Sabbour M. M. 2013.** Entomotoxicity assay of nanoparticle 4-(silica gel Cab-O-Sil-750, silica gel Cab-O-Sil-500) against *Sitophilus oryzae* under laboratory and store conditions in Egypt. *Speciality Journal of Biological Sciences*.**1(2):**67-74.

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