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Efficacy of Silica nanoparticles against *Sitophilus oryzae* on stored Lens culinaris (masoor dal : lentil) under laboratory conditions.

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ABSTRACT

Lens culinaris which is popularly known as masoor dal or red lentil is an important part of diet of the entire world population. Lentils are cultivated on a large scale and hence used as a stored grain. This makes the lentils prone to pests. One of the major stored grain pests is *Sitophilus oryzae*. *S. oryzae* is a true weevil which belongs to family Curculionidae and it affects a variety of stored grain. The present study was aimed to determine how these pests can be controlled without the use of conventional chemical pesticides. Nanotechnology has become a very advancing field and its use can be seen in various sectors. Use of nanopesticides in the field of agriculture is an emerging field that can help in crop protection. In this study Silica nanoparticles or Silicon Oxide nanoparticles (SiO_2 NPs) were used on *L. culinaris* to study its efficacy on *S.oryzae*. The various concentrations of SiO_2 NPs used were 100 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm and 500ppm. It was found that SiO_2 NPs at highest concentration i.e., 500 ppm were most effective on *S. oryzae.*

Key Words - Silicon oxide, *Sitophilus oryzae, Lens culinaris,* nanotechnology

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INTRODUCTION

Lentil is a legume crop that belongs to family Fabaceae. These are rich sources of proteins, fibres, amino acid lysine and the nutrient folate, thymine, phosphorus and Iron. It contains moderate amount of minerals, vitamins and complex carbohydrates. Health magazine has listed lentils as one of the five healthiest foods. Lentils are grown throughout the world. Since, lentils are grown as stored grain they are subjected to both biotic and abiotic stresses. Pests attack the crops in the agriculture field as well as the places where the are stored as bulk. The problem of stored grain is a major area of concern faced by the farmers as well as the retailers. This cause extensive post harvest losses, spoilage and less demand in markets (Ahmad *et al.,* 2021). On of the major pests that feed on *L. culinaris* is *Sitophilus oryzae. S. oryzae* are the true weevils which belongs to family Curculionidae.

To control pests many chemical insecticides were used but owing to their negative environmental impacts a new branch of science which is Nanotechnology has been emerging as an important field in controlling pest population. Thus, this study focusses on use of silica nanoparticles to control *S. oryzae.* The term “Nano” is consequent from Greek word that means “dwarf” and in simple it is science of small. Nano is defined as the one billionth of something or 10^9 (Shahid *et al*., 2021). Nanopesticides defines as any formulation that intentionally includes elements in the nm size range and claims novel properties associated with these small size range, it would appear that some nanopesticides have already been on the market for several years (Ragaci and Sabry, 2014). Nanopesticides are expected deal with the limitations of existing strategies to control insect pests and provide newer and advanced formulations that can penetrate the insect body, remain active and stable in the target ecosystem and be benign to the non-target organism, be cost-effective, and minimize defence of the target pests (Deka *et al.,* 2021).

SiO_2 when used as nanopesticides has lethal properties. Nanoparticles are more effective on adults than on larvae. Si NPs cause abrasion of the insect cuticle. They also block digestive tract and cause malformation of eternal morphology. This is due to their dehydrating property. Silica may impair the digestive tract in insect herbivores that feed on silica treated plants (Smith, 1969). SiO_2 NPs can also block spiracles and tracheas and also damage protective wax coating on the cuticle. SiO_2NPs are stable and environment friendly safe approach to the pest management not only because of their versatility as an insecticide but also for improving the other chemical insecticides (Thabet *et al.,* 2020).

MATERIALS & METHODS

The experiments were performed in the Entomology laboratory of University Department of Zoology, Ranchi University, Ranchi.

S. oryzae were collected from a store of wheat grains and was allowed to rear in laboratory at around 30±2°C and 20±2% relative humidity in continuous darkness. After rearing new store adults were chosen for the experiment.

SiO_2 colloidal form was obtained from Nano Research Lab, East Singhbhum, Jamshedpur, Jharkhand.

Three replicas of seven batches of *L. culinaris* were taken, measured 20g each were sterilized at 60°C in hot air oven for about an hour and was then allowed to cool and reabsorb moisture.

Different concentrations of SiO_2 were prepared using stock solution of 1000 ppm of SiO_2 colloidal solution. The different concentrations prepared were 100 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm and 500 ppm.

After their preparation all the six batches of the three replicates were mixed with *L. culinaris.*

After their addition jars were shaken for few minutes to allow equal distribution of SiO_2 NPs on *L. culinaris*. The treatment jars were then allowed to dry and was left for 24 hours.

After 24 hours 20 newly emerged adults of *Sitophilus oryzae* were introduced in each batch for infestation.

Control jar was also prepared in which SiO_2 NPs were not treated. All the batches were kept at 30±2°C and 20±2% relative humidity in the incubator.

Mortality percentage was calculated 1, 3, 5, 7, 9, 11 and 13 days post treatment.

Adult mortality of *S. oryzae* was calculated using the formula derived by (Devi *et al.,* 2014).

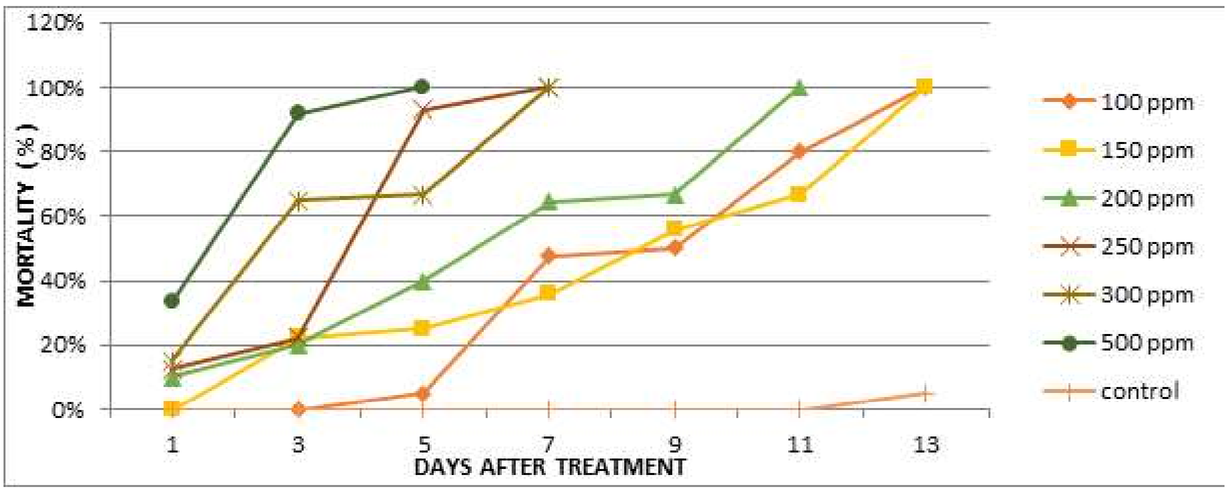
$$\text{Adult mortality (\%)} = \frac{\text{Number of dead insects}}{\text{Total number of insects}} \times 100$$

RESULTS & DISCUSSION

Table 1 represents the effect of treatment of SiO_2 NPs on stored *L. culinaris*. The table represents the mortality percentage of *S. oryzae* on various concentrations of SiO_2 NPs on the respective days post treatment. Graph I show the percentage mortality of *S. oryzae* vs. Different concentrations of SiO_2:100 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm and 500 ppm. It was found that with the increase in concentration and period of exposure the mortality percentage increases. SiO_2NPs at 500 ppm was found to be highly effective as it caused 100% mortality within 5 days after treatment (DAT). SiO_2 NPs at 300 and 250 ppm caused 100% mortality within 7 DAT. SiO_2 NPs at lower concentrations caused 100% mortality in 13 DAT. However, only 5% mortality was observed in control on 13 days after treatment.

Table 1- EFFICACY OF SiO_2 NPs ON *S. oryzae*

CONCENTRATION OF SiO_2 NANOPARTICLES (in ppm)	ADULT MORTALITY (%) (DAYS AFTER TREATMENT)						
	1DAT	3DAT	5DAT	7DAT	9DAT	11DAT	13DAT
100	0	0	5	47.5	50	80	100
150	0	22.2	25	35.7	55.6	66.7	100
200	10	20	40	64.3	66.7	100	
250	12.5	22.2	92.8	100			
300	15	64.7	66.7	100			
500	33.3	91.7	100				
Control	0	0	0	0	0	0	5



Graph 1- Mortality (%) of *S. oryzae* vs days after treatment of SiO_2 NPs various concentrations

From the above data and observations, it is clear that SiO_2 NPs can be used as an effective method to control the population of stored grain pests without the use of conventional pesticides. Contact insecticides contaminate food with toxic pesticide residues. As result of prolonged exposure to such chemicals play neuronal and hormonal disorders are caused. From the results obtained from the above experiment it was found that as the concentration and period of exposure to SiO_2 NPs increases the mortality percentage increases. This was found in accordance with Zayad Gamal M. M. (2017) was also found in accordance with Sabbour M. M. (2015) according to which accumulative mortality percentage of *S. oryzae* gradually increased with increasing period of exposure in case of treated with different tested SiO_2NPs.In the experiment 500 ppm of SiO_2 NPs was highly effective against *S. oryzae* which caused 100% mortality earlier than any other concentrations of SiO_2 used. This is in accordance with Padmasri *et al.* (2018) according to which 500 ppm was highly effective and caused cent percent mortality in one day. The results were also found in accordance with Rouhani M. *et al.* (2012) according to which 2.5mg/kg nanosilica caused 100% mortality in *Callossobruchus maculatus* and also in accordance with Debnath *et al*. (2011) [11] who reported cent percent mortality of *S. oryzae* when nanosilica was applied in 2mg/kg. Padmasri *et al*. (2018) took SEM images of treated insects which revealed that nano silica particles distribute uniformly on the surface of the insect cuticle thereby resulting in the loss of water from the body and also defacing of mandibles as a result of which insect death occurs. Thus, it can be put forward that in the above experiment the death of *S. oryzae* could be because of dehydration and loss of water from the cuticle. Damage could have occurred to the protective wax coat on the cuticle of insects, both by sorption and abrasion (Debnath *et al.,* 2011).

CONCLUSION

Thus, it can be concluded that silica nanoparticles can be used to control stored grain pests. Further research is however required on the safety issues of these materials on human health and bio safety to non target organisms before they can be considered for commercialization. Due to their uncontrollable use and discharge to natural environment there can be health hazard concerns. Thus, this issue should be considered to make the nanoparticles environment friendly and convenient to use.

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REFERENCES

Ahmad R., Hassan S., Ahmad S., Nighat S., Devi Y. K., Javeed K., Usmani S., Ansari M. J., Erturk S., Alkan M. and Hussain B. 2021. Stored Grain Pests and Current Advances for Their Management. In (Ed.). Postharvest Technology- Recent Advances, New Perspectives and Applications. *Intech Open*. https://doi.org/10.5772intechopen. 10503.

Debnath N., Das S. and Seth D. 2011. Entomotoxic effect of silica nanoparticles against *Sitophilus oryzae* (L.). *Journal of Pest Science.* 84:9-105.

Deka B., Babu A., Baruah C., and Barthakur M. 2021. Nanopesticides: A Systematic Review of Their Prospects with Special Reference to Tea Pest Management. *Frontiers in nutrition*, 8, 686131.https://doi.org/10.3389/fnut. 2021.686131.

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

Padmasri A., Kumara J. A., Anil B., Ramesh K., Srinivas C., Lakshmi K. V. and Pradeep T. 2018. Efficacy of nanoparticles against rice weevil *Sitophilus oryzae* (Linnaeus) on maize seeds. *J. Entomol. Zool Stud*. 6(5):326 330.

Ragaci M. and Sabry A. H. 2014. Nanotechnology for insect pest control. *International Journal of Science, Environment and Technology.* 3(2):528-545.

Rouhani M., Samih M. A. and Kalantari S. 2013. Insecticidal effect of silica and silver nanoparticles on the cowpea seed beetle, *Callosobruchus maculatus* F. (Col.: Bruchidae). *Journal of Entomological Research.* 4(4):297-305.

Sabbour M. M. 2015.Entomotoxicity assay of Nanoparticle 4-(silica gelCab-O-Sil-750, silica gel Cab-O-Sil-500) Against *Sitophilus oryzae* Under Laboratory and Store Conditions in Egypt. *Specialty Journal of Biological Sciences*. 1(2): 7-13.

Shahid M., Ullah U. N., Khan W. S., Saeed S. and Razzaq K. 2021. Application of Nano technology for Insect Pests Management: A Review. *Journal of Innovative Sciences*. 7(1):28-39.

Smith B. C. 1969. Effects of silica on the survival of *Coleomeigella maculata lungi* (Coleoptera: Crysomelidae) *Can. Entomol.* 101:460-462.

Thabet A. F., Galal O., Tuda M., Samahy E., Fujita R. and Hino M. 2020. Silica nanoparticle effect on an internal feeder, American serpentine leafminer. doi: 10.2094/preprints202010. 3369.vl.

Zayed Gamal M. M.2017.Nano-particles: A recent approach for controlling stored grain insect pests. *Academia Journal of Agricultural Research.* 6(5): 088-094.