*The Andhra Agric. J* 64 (4): 837-840, 2017

# "Influence of Diatomaceous Earth in Combination with Spinosad to Control *Sitophilus Oryzae* (Linn.) (Curculionidae: Coleoptera)".

**K Anil Kumar Yadav, T Madhumathi, P V Krishnayya and V Manoj Kumar**
Department of Entomology, Agricultural College, Bapatla 522 101, Andhra Pradesh

**ABSTRACT**

The efficacy and persistence of Diatomaceous earth (DE) alone and in combination with spinosad as grain mixture treatment was studied under the laboratory conditions. Maize kernels were tested against *Sitophilus oryzae*. The mortality of *S. oryzae* in DE alone and spinosad alone treatments decreased over 150 DAT and the combined application treatments enhanced the mortality rate of the test insects *S. oryzae* compared with DE alone or spinosad alone treatments. At 150 DAT by 14 DAR the highest cumulative mortality (100.00 %) of *S. oryzae* was observed in the DE in combination with spinosad treatments *viz.*, DE + spinosad @ 750 mg/kg + 1.0 mg/kg and @ 1000 mg/kg + 1.0 mg/kg. All the DE alone @ 750 mg/kg and 1000 mg/kg and spinosad alone treatments @ 0.5 mg/kg and 1.0 mg/kg found to be decreased in their efficacy by 14 DAR at 150 DAT against *S. oryzae* on maize kernels.

Key words*:* Diatomaceous earth (DE), DAR (days after release), DAT (days after treatment), Spinosad, *Sitophilus oryzae*. .

Diatomaceous earth (DE) is used in a number of countries for stored-product protection. The commercial DE formulations currently available are predominantly made up of amorphous silica and contain little or no crystalline silica (Subramanyam and Roesli, 2000). DE is used as an industrial absorbent and as non-toxic insecticide to control stored-product and household pests. The modes of action of inert dusts include the following, inert dusts block insect spiracles and insects die from asphyxiation, inert dusts lodging between cuticular segments increase water loss through abrasion of the cuticle, inert dusts absorb water from the insect's cuticle, insects may die from ingesting the dust particles and inert dusts absorb the epicuticular lipids of insects leading to excessive loss from the cuticle (Subramanyam and Roesli, 2000).

Spinosad is a reduced-risk commercial insecticide which is a naturally-derived insecticide produced by fermentation of *Saccharopolyspora spinosa* Mertz & Yao (Bacteria: Actinobacteridae) an actinomycete bacterium. It is a neurotoxin comprising a mixture of spinosyns A and D (hence spinosAD), which are tetracyclic-macrolide compounds that act upon the post-synaptic nicotinic acetylcholine receptor and the GABA receptors and this mode of action is unique among other known insecticides (Thompson *et al*., 2000). It has been labeled for use on over 250 crops in more than 50 countries (Mertz & Yao, 1990; Thompson *et al*., 2000). It exhibits both stomach and contact activities against insects. Spinosad has low mammalian toxicity anddegrades quickly when exposed to sunlight (Thompson *et al*., 2000), but it was relatively stable in stored-grain protection (Fang *et al*., 2002b, Flinn *et al*., 2004). These benign properties make it an ideal product for use in stored grain insect pest management.

Hence in the present study, an attempt has been made to assess the efficacy of diatomaceous earth (inert material) and spinosad (insecticide) for safe storage of maize kernels against *S. oryzae*.

## MATERIAL AND METHODS

The effectiveness of spinosad (Tracer 45 SC) and diatomaceous earth as grain protectants against *S. oryzae*was evaluated by treating the grains. Maize kernels were used for testing against *S. oryzae*. The sound and healthy kernels of maize were separated and disinfested by subjecting them to fumigation with aluminium phosphide tablets @ 3g/t for seven days to ensure that they were free from insects and mites. Then the grains were well aerated to remove phosphine residues. Diatomaceous earth and spinosad were tested at

eight different treatments and combinations *viz.*,DE + spinosad @ 750 mg/kg + 0.5 mg/kg, @ 750 mg/kg + 1.0 mg/kg, @ 1000 mg/kg + 0.5 mg/kg and @ 1000 mg/kg + 1.0 mg/kg and DE alone @ 750 mg/kg, @ 1000 mg/kg and spinosad alone @ 0.5 mg/kg and 1.0 mg/kg of maize kernels.

Five hundred grams of maize and wheat were taken in three replications for each treatment in plastic jars of size 15 x 9 cm. Different concentrations of spinosad mentioned in the above table were prepared by using distilled water. One ml of different spinosad solutions *i.e.* 0.5 and 1.0 mg a.i./ kg of grain were added to 500 g of kernels of maize/ grains of wheat in such a way which results in above treatments. Then the seeds were manually mixed for five minutes and allowed to dry for 12 hours. Now the required quantity of diatomaceous earth mentioned in the above table for each treatment was weighed and thoroughly mixed with grain that is treated/ untreated with spinosad solutions to result different treatments mentioned above. The moisture content of the all samples was recorded before the treatment. All the treatments were replicated thrice. Control was treated with distilled water and also replicated thrice. Ten pairs of freshly emerged one day old *S. oryzae* adults were released into each plastic jar containing treated kernels of maize kernels. The treated containers were closed with muslin cloth using rubber bands. The dead insects were removed after 14$^{th}$ day and the treated commodities were observed for recording the per cent cumulative mortality of *S. oryzae* adults in treated containers at 14 daysafter the release of test insects, which was calculated based on number of number of dead insects.

This practice of releasing and removing the test insects and observing for per cent cumulative mortality of *S. oryzae* was continued at one DAT, 30 DAT, 60 DAT, 90 DAT, 120 DAT and 150 DAT.

## RESULTS AND DISCUSSION

As a grain mixture treatment Diatomaceous earth (DE) in combination with spinosad at all the concentrations *viz.*, DE + spinosad @ 750 mg/kg + 0.5 mg/kg, @ 750 mg/kg + 1.0 mg/kg, @ 1000 mg/kg + 0.5 mg/kg and @ 1000 mg/kg + 1.0 mg/kg and spinosad alone @ 1.0 mg/kg had recorded cent per cent cumulative mortality of parental *S. oryzae* on treated maize kernels by 14 DAR, atone DAT. These were as followed by spinosad alone @ 0.5 mg/kg with 90.74 Per cent, DE alone treatment DE @ 1000 mg/kg with 88.89 Per cent and DE alone @ 750 mg/kg with 64.81 Per cent mortality of by *S. oryzae* 14 DAR at one DAT.

The spinosad alone treatment has also recorded cent per cent mortality by 14 DAR at 30 DAT along with all the combination treatments of diatomaceous earth and spinosad. They were followed by spinosad alone @ 0.5 mg/kg with 94.74 %, DE alone @ 1000 mg/kg with 91.23 Per cent and DE alone @ 750 mg/kg with 68.42 % mortalities. All the treatments were found significantly superior over the control.

Along with all the combination treatments of diatomaceous earth and spinosad, the spinosad alone treatment has also recorded cent per cent mortality by 14 DAR at 60 DAT. They were followed by spinosad alone @ 0.5 mg/kg with 94.74 per cent, DE alone @ 1000 mg/kg with 89.47 per cent and DE alone @ 750 mg/kg with 66.67 per cent mortalities. All the treatments were found significantly superior over the control.

The spinosad alone @ 1.0 mg/kg recorded 98.15 per cent mortality by 14 DAR at 90 DAT, which was on par with the 100 percent mortalities of all the combination treatments of diatomaceous earth and spinosad. They were followed by spinosad alone @ 0.5 mg/kg (88.89 per cent) and DE alone @ 1000 mg/kg (85.19 per cent) treatments which were on par with each another. Least mortality was recorded in the treatment DE alone @ 750 mg/kg with 62.96 Per cent. All the treatments were found significantly superior over the untreated control.

All treatments with combination of diatomaceous earth and spinosad have recorded cent per cent mortality by 14 DAR at 120 DAT. They were followed by spinosad alone @ 1.0 mg/kg with 94.44 per cent mortality, spinosad alone @ 0.5 mg/kg with 85.19 per cent mortality, DE alone @ 1000 mg/kg with 81.48 per cent mortality and DE alone @ 750 mg/kg with 59.26 per cent mortality of *S. oryzae*, which differ significantly with one another. All the treatments were found significantly superior over the untreated control in causing mortality of *S. oryzae*.

**Table1. Per cent cumulative mortality of *S. oryzae* on maize kernels treated with DE and spinosad from one DAT to 150 DAT.**

| S. No. | Treatments | Dosage (mg/kg) | 1 DAT | 30 DAT | 60 DAT | 90 DAT | 120 DAT | 150 DAT |
|---|---|---|---|---|---|---|---|---|
| 1 | $T_1$- Diatomaceous earth + Spinosad | 750 + 0.5 | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 96.08 (80.64)$^{bc}$ |
| 2 | $T_2$- Diatomaceous earth + Spinosad | 750 + 1.0 | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ |
| 3 | $T_3$- Diatomaceous earth + Spinosad | 1000 + 0.5 | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 98.04 (85.32)$^{ab}$ |
| 4 | $T_4$- Diatomaceous earth + Spinosad | 1000 + 1.0 | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ |
| 5 | $T_5$- Diatomaceous earth | 750 | 64.81 (53.63)$^c$ | 68.42 (55.81)$^d$ | 66.67 (54.75)$^d$ | 62.96 (52.53)$^c$ | 59.26 (50.34)$^e$ | 54.90 (47.82)$^e$ |
| 6 | $T_6$- Diatomaceous earth | 1000 | 88.89 (70.53)$^b$ | 91.23 (72.96)$^c$ | 89.47 (71.07)$^c$ | 85.19 (67.45)$^b$ | 81.48 (64.56)$^d$ | 78.43 (62.38)$^d$ |
| 7 | $T_7$- Spinosad | 0.5 | 90.74 (72.47)$^b$ | 94.74 (76.74)$^b$ | 94.74 (76.74)$^b$ | 88.89 (70.53)$^b$ | 85.19 (67.45)$^c$ | 82.35 (65.16)$^d$ |
| 8 | $T_8$- Spinosad | 1.0 | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 100.00 (90.00)$^a$ | 98.15 (85.46)$^a$ | 94.44 (76.37)$^b$ | 92.16 (73.96)$^c$ |
| 9 | $T_9$- Control | | 0.00 (0.00)$^d$ | 0.00 (0.00)$^e$ | 0.00 (0.00)$^e$ | 0.00 (0.00)$^d$ | 0.00 (0.00)$^f$ | 0.00 (0.00)$^f$ |
| | SEm ± | | 0.74 | 0.62 | 0.35 | 1.64 | 0.77 | 2.38 |
| | CD (0.05) | | 2.21 | 1.87 | 1.04 | 4.87 | 2.28 | 7.07 |
| | CV | | 1.79 | 1.49 | 0.84 | 4.02 | 1.94 | 6.23 |

DAT- Days after treatment
Figures in parentheses are arcsine transformed values
Means in the columns followed by the same alphabet do not differ significantly.

The treatments with combination of diatomaceous earth and spinosad *i.e.*, DE + spinosad @ 1000 mg/kg + 1.0 mg/kg and 750 mg/ kg + 1.0 mg/kg shown cent per cent mortality of *S. oryzae* by 14 DAR at 150 DAT and were on par with each other and differ significantly with DE + spinosad @ 750 mg/kg + 0.5 mg/kg (96.06 per cent) but were on par with DE + spinosad @ 1000 mg/ kg + 0.5 mg/kg (98.04 per cent). The next best treatments were spinosad alone @ 0.5 mg/kg and DE alone @ 1000 mg/kg with 82.35 % and 78.43 Per cent mortalities respectively which were on par with each other. DE alone @ 750 mg/kg recorded 54.90 per cent mortality which was the least among all the treatments. All the treatments were found significantly superior over the untreated control.

Diatomaceous earth (DE) in combination with spinosad at in the concentrations *viz.*, DE + spinosad @ 750 mg/kg + 0.5 mg/kg had shown decrease in its efficacy from cent per cent mortality at one DAT to 96.08 per cent at 150 DAT and DE + spinosad @ 1000 mg/kg + 0.5 mg/kg from cent per cent to 98.04 per cent. The efficacy of DE alone @ 750 mg/ kg and 1000 mg/kg had also shown decreased efficacy from 64.81 per cent and 88.89 per cnt at one DAT to 54.90 per cent and 78.43 per cent at 150 DAT, respectively. The spinosad alone treatments @ 0.5 mg/kg and @ 1.0 mg/kg had also shown decreased efficacy from 90.74 per cent and 100.00 per cent at one DAT to 82.35 per cent and 92.16 per cent at 150 DAT, respectively.

In case of DE these results also stand in accordance with the previous studies assessing other DE formulations against *S. oryzae* (Subramanyam and Roseli, 2000). The exposure of 10, 20, and 30 mixed sex adults of rice weevil

for one week on wheat treated with 300 ppm Protect-It, produced cent per cent mortality. The mortality of *S. oryzae* adults reported by Athanassiou *et al.* (2005) over 270 days exceeded 90 per cent, and fecundity was below one adult per sample, regardless of the application dose (0.75, 1.0 or 1.5 g/kg) of DE. Korunic (1998) also reported that there was a little degradation or loss in efficacy of DE with time. Fang and Subramanyam (2003) also found that 0.1 ppm of spinosad on wheat caused 100 per cent mortality of *R. dominica* adults and notably suppressed the progeny production. Nayak *et al.* (2005) tested several *R. dominica* strains with various succeptebility levels to some of the most commonly used grain protectants and found that 0.1 ppm of spinosad provide 93-99 per cent adult mortality after seven days of exposure.

## LITERATURE CITED

**Athanassiou C G, Kavallieratos N G, Economou L P, Dimizas C B, Vayias B J, Tomanovic S and Milutinovic M 2005** Persistence and efficacy of three diatomaceous earth formulations against *Sitophilus oryzae* (Coleoptera: Curculionidae) on wheat and barley. *Journal of Economic Entomol*ogy, 98 (4): 1404-1412.

**Fang L A, Subramanyam B and Arthur F H 2002b** Effectiveness of spinosad on four classes of wheat against five stored product insects. *Journal of Economic Entomol*ogy, 95 (3): 640–650

**Fang L and Subramanyam Bh 2003** Activity of spinosad against adults of *Rhizopertha domanica* (F.) (Coleoptera: Bostrychidae) is not affected by wheat temperature and moisture. *Journal of Kansas Entomological Society*, 75: 529-532.

**Flinn P W, Subramanyam B and Arthur F H 2004.** Comparison of aeration and spinosad for suppressing insects in stored wheat. *Journal of Economic Entomology,* 97: 1465-1473.

**Korunic Z 1998** Diatomaceous earth, a group of natural insecticides. *Journal of Stored Product Research*, 34: 87-97.

**Mertz E P and Yao R C 1990** *Saccharopoly spora spinosa* sp. nov isolated from soil collected in a sugar drum still. *International Journal of Systematic Bacteriology,* 40: 34-39.

**Nayak M K, Daglish G J and Byrne V S 2005** Effectiveness of spinosad as a grain protectant against resistant beetle and psocid pests of stored grain in Australia. *Journal of Stored Products Research,* 41 (4): 455-467.

**Subramanyam Bh and Roesli R 2000** *Alternatives to Pesticides in Stored-Product IPM*. Dordreecht: Kluwer Academic Publishers. 321-380.

**Thompson G D, Dutton Rand Sparks T C 2000** Spinosad-a case study: an example from a natural products discovery programme. *Pest Management Science,* 56: 696-702.

(Received on 13.07.2016 and revised on 22.12.2016)