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Novel Insecticides as Seed Treatment in Paddy Storage

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A B S T R A C T

A Laboratory experiment was carried out to know the efficacy of new insecticidal molecules as seed treatment on storage insect pests and seed viability during storage under ambient conditions on paddy from July2024 to April 2025. Among the insecticides, seed treated with broflanilide @3 ppm recorded 73%germination, 9.57%moisture, 0.29% seed damage upto nine months after storage.

Introduction

In India the total post-harvest losses at different stages have added upto about 36% in rice. Storage loss due to insect pests alone is ranging from 4 to 6% for cereals. Apart from quantitative loss, they also deteriorate quality by contaminating the grains due to which stored products get bad odour, colour and taste (Patil *et al.,* 2019)

After harvest, storage of seeds until the next cropping season without reducing their quality is crucial for successful seed production. Effective seed storage ensures that seeds remain viable, maintaining their germination potential and vigour. The challenge lies in preserving quality of seeds over time, which can be affected by various factors such as moisture, temperature and insect pests. Post-harvest damages by insect pests have been an increasingly important constraint to food legume supplies worldwide. Insects pose a significant threat to stored seeds, often leading to substantial losses.

The lesser grain borer (*Rhyzopertha dominica*) is a major primary pest of stored paddy causing significant quantitative and qualitative damage Both adult and larval are internal feeders bore into and feed on the whole grains, often leaving them hollowed out. The larvae develop inside the grain kernel, and adults bore irregularly shaped holes. Infestation leads to weight loss, a "shot hole" appearance in the grains, characteristic sweet, musty odor in heavily infested stores. The pest's activity significantly reduces the germination ability of the seeds and the milling quality of the rice. Angoumois grain moth, *Sitotroga cerealella* is regarded as one of the most destructive internal feeder in stored grains of rice.

Early infestation is difficult to detect because the hole made by young larva is so small that it cannot be seen. The appearance of moths in the stores and round holes on the grain or sometimes heating of the grain in the bin provides the first indication of infestation. *S cerealella* caused reduction in weight, germination of seed and the loss of nutritional value and market value of rice.

Insecticides with various mode of action must be rotated often to maintain effective management of pest population. Emamectin benzoate, deltamethrin, spinosad and other regularly used insecticides are crucial in the management of pests. Insect pests are developing resistance to these insecticides after two or three years of their application. Therefore, it is necessary to assess newer and safer chemical molecules (Patil *et al.,* 2025)

Seed treatment is one of the important management practices to protect the seed from insect pests during storage. In view of the safety to human beings as well as protection against these insect pests, there is a need to evaluate insecticides of new origin.

Synthetic insecticides of organic as well as inorganic nature are in use for the management of stored grain pests which are proved to be safe from the view of application as well as consumers. Broflanilide is a new meta-diamide insecticide with a novel mode of action without known cross-resistance that delivers excellent efficacy in controlling problematic chewing insect pests, including Lepidopterans, coleopteran and thysanopteran pests. Broflanilide acts as an allosteric modulator of the GABA receptor disrupting insect neurotransmission and leading to paralysis and death.

Dinotefuran is furanicotinyl insecticide which belongs to the third generation of neonicotinoids with a broad spectrum and systemic insecticidal activity. Dinotefuran provides a tetrahydrofuran (THF) moiety distinct from other neonicotinoids with a chloropyridine or chlorothiazole ring, which is considered to be an essential structural element for the neonicotinoid action. The unique chemical and excellent biological properties and favourable toxicological profile make dinotefuran available for pest management in wide range of crops with a variety of application methods

Therefore, to manage the insect pests of paddy during storage, new molecules with a novel mode of action are needed. Due to the significant vulnerability of seeds to deterioration caused by insect pest infestation, new molecules like broflanilide and dinotefuran are used along with check. Taking into consideration the need for the management of storage insect pest infestation and increase the storage life of seeds, present investigations were made to study the effect of new molecules as seed treatment against storage insect pests, seed quality and storability in paddy.

Materials and Methods

One kg of freshly harvested certified seed with very high percentage of germination and low moisture content (<10%) was taken for each treatment per replication. Required quantity of insecticides were diluted in water to make total volume of 5 ml for treating one kg of seed for proper coating (if required). After drying in shade, seeds were packed and kept in room under ambient temperature.

Residual toxicity was studied by taking out 100 g of treated seed and releasing 10 adult insects of *Rhizopertha dominica* and mortality recorded after 3, 7 and 15 days and thereafter, every three months for a total period of nine months. Observations recorded were Seed germination, seed moisture, Insect infestation (% kernel damage)

Germination percentage: It was determined by adopting the rolled paper towel method by the following formula.

$$\text{Moisture content (\%)} = \frac{\text{No. of seeds germinated}}{\text{Total no. of seeds kept for germination}} \times 100$$

The seeds were coarse ground and dried in an oven at 130ºC for 2 hours, cooled in desiccators over silica gel.

The samples were weighed and the seed moisture content was calculated and expressed in percentage on wet weight basis by using following formula

$$\frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M_1: Weight of the empty container
M_2: Weight of the container +seed sample (before drying)
M_3: Weight of container + seed sample (after drying)

Table.1 Effect of treatments on seed germination (%), Seed damage% and moisture content (%) in Paddy, 2024-25

	Germination%			Seed Damage %			Moisture content (%)		
Treatments	**3M**	**6M**	**9M**	**3M**	**6M**	**9M**	**3M**	**6M**	**9M**
T1: Broflanilide @ 1 ppm (300 SC @3.33 mg /kg seed)	93.33 (75.01)	86.33 (68.29)	76.33 (60.87)	0	0.32 (3.22)	0.50 (4.03)	11.13 (19.47)	10.73 (19.1)	9.93 (18.36)
T2: Broflanilide @ 2 ppm (300 SC @6.66 mg/kg seed)	94.67 (76.62)	84.67 (66.92)	70.67 (57.18)	0	0.26 (2.93)	0.39 (3.59)	10.93 (19.27)	11.23 (19.56)	10.10 (18.47)
T3: Broflanilide @ 3 ppm (300 SC @9.99 mg /kg seed)	94.00 (75.82)	85.33 (67.45)	73.00 (58.68)	0	0.19 (2.47)	0.29 (3.1)	10.90 (19.26)	10.77 (19.14)	9.57 (18.01)
T4: Dinotefuran @ 1 ppm (20SG @5 mg/kg seed)	94.33 (76.21)	80.00 (63.4)	74.33 (59.54)	0	0.92 (5.5)	1.01 (5.75)	10.63 (18.96)	9.23 (17.66)	9.73 (18.17)
T5: Dinotefuran @ 2 ppm (20SG @10 mg/kg seed)	92.67 (74.26)	80.00 (63.4)	72.00 (58.04)	0	0.83 (5.23)	0.85 (5.29)	10.50 (18.88)	9.83 (18.25)	9.70 (18.13)
T6: Dinotefuran @ 3 ppm (20SG @20 mg/kg seed)	95.67 (77.97)	82.33 (65.12)	71.67 (57.83)	0	0.78 (5.05)	0.57 (4.33)	10.67 (19.05)	10.73 (19.1)	9.80 (18.23)
T7: Emamectin benzoate @2ppm (Proclaim 5SG @40.0 mg/kg seed)	94.67 (76.62)	80.00 (63.4)	78.67 (62.47)	0	0.22 (2.68)	0.37 (3.48)	9.90 (18.3)	9.97 (18.39)	9.73 (18.17)
T8:Deltamethrin @ 1ppm (2.8EC @0.04 ml/kg of seed)	93.33 (75.01)	80.00 (63.4)	76.00 (60.65)	0	0.49 (4.01)	0.52 (4.12)	10.57 (18.94)	9.80 (18.23)	9.77 (18.2)
T9: Untreated control	94.67 (76.67)	87.67 (69.41)	78.33 (62.25)	0	0.97 (5.62)	1.76 (7.61)	9.90 (18.32)	10.40 (18.78)	9.57 (18.01)
CD (P=0.05)	1.55	0.91	2.17	NS	0.44	0.43	NS	NS	NS

Figures in ( ) are arcsin transformed values

Table.2 Percent Mortality of *Rhizopertha dominica* released to 100 g treated seeds at different storage interval in paddy

	Immediately after seed treatment			3 months after storage			6 months after storage			9MAS		
Treatments	**3 DAT**	**7DAT**	**15DAT**	**3 DAT**	**7DAT**	**15DAT**	**3 DAT**	**7DAT**	**15DAT**	**3 DAT**	**7DAT**	**15DAT**
Ti	61.7 (51.73)	93.3 (77.69)	100 (90)	46.67 (43.07)	76.67 (66.13)	100 (90)	23.33 (28.76)	66.67 (54.76)	100	33.3	76.7 (61.19)	100
T2	78.3 (62.45)	100.0 (90)	100 (90)	58.67 (49.97)	96.67 (83.84)	100 (90)	23.33 (28.76)	66.67 (54.76)	100	33.3	86.7 (68.82)	100
T3	88.0 (69.74)	100.0 (90)	100 (90)	70.67 (57.18)	100 (90)	100 (90)	23.33 (28.76)	70.00 (56.76)	100	46.7	96.7 (83.84)	100
T4	33.3 (35.2)	46.7 (43.07)	86.0 (68.02)	30.67 (33.61)	63.00 (52.51)	70.67 (57.18)	20.00 (26.55)	63.33 (52.75)	100	30.0	83.3 (66.61)	100
T5	46.7 (42.97)	50.0 (44.98)	92.3 (74.04)	39.33 (38.82)	68.33 (55.73)	81.33 (64.4)	16.67 (23.84)	70.00 (56.76)	100	33.3	86.7 (72.76)	100
T6	50.0 (44.98)	61.7 (51.73)	99.0 (86.66)	47.00 (43.26)	70.67 (57.18)	81.67 (64.66)	16.67 (23.84)	70.00 (56.97)	100	43.3	96.7 (83.84)	100
T7	68.3 (55.74)	100.0 (90)	100.0 (90)	66.00 (54.31)	89.33 (70.92)	100 (90)	16.67 (23.84)	73.33 (59.18)	100	33.3	93.3 (77.69)	100
T8	52.7 (46.51)	96.7 (83.84)	100 (90)	55.00 (47.86)	83.33 (66.11)	100 (90)	23.33 (28.76)	66.67 (54.76)	100	33.3	80.0 (63.9)	100
T9	11.7 (19.87)	37.7 (37.83)	50.7 (45.36)	11.67 (19.87)	33.33 (35.2)	53.33 (46.89)	10.00 (18.42)	56.67 (48.82)	100	26.7	73.3 (58.98)	100
CD (P=0.05)	7.63	8.83	3.81	2.66	14.83	1.91	6.44	NS	NS	NS	16.26	NS

Figures in ( ) are arcsin transformed values

Seed damage (per cent)

From each treatment, 400 seeds were selected randomly and number of weevil infected seeds were counted and expressed as percentage seed damage.

Experiment was conducted in completely randomized design with nine treatments and three replications in Seed Research Technology Centre, Rajendranagar, Hyderabad.

Broflanilide @ 1 ppm (300 SC @ 3.33 mg /kg seed)
Broflanilide @ 2 ppm (300 SC @6.66 mg/kg seed)
Broflanilide @ 3 ppm (300 SC @9.99 mg /kg seed)
Dinotefuran @ 1 ppm (20SG @5 mg/kg seed)
Dinotefuran @ 2 ppm (20SG @10 mg/kg seed)
Dinotefuran @ 3 ppm (20SG @20 mg/kg seed)
Emamectin benzoate @2ppm (5SG @40.0 mg/kg seed)
Deltamethrin @ 1.0 ppm (Deltamethrin 2.8EC@ 0.04 ml/kg seed)
Untreated control

Results and Discussion

No seed damage was observed in paddy seeds in all treatments after three months of storage. After six months 0.19% damage was recorded in seeds treated with Broflanilide @ 3 ppm (T3) and highest 0.97% in control. Highest damage of 1.76% was recorded in control at nine months and lowest 0.29% in T3. Emamectin benzoate @2ppm (T7) was on par with T3 at six and nine months of storage. Basavanjali 2019 reported that spinosad 45 SC @ 4.4 mg kg-1 and emamectin benzoate 5 SG @ 40 mg kg-1 recorded least seed damage, least seed weight loss and suppression of adult population at one hundred and eighty days of treatment imposition and both differed significantly from remaining treatments.

Moisture content decreased with storage duration. No significant difference occurred among treatments. Germination per cent decreased with increase in duration of storage. At three months of storage, germination in control was 94.67% on par were T6 (95.67%), T7, T4 and T2. At six months of storage 87.67% germination was recorded in control which was significantly higher compared to other treatments. But at nine months Broflanilide @ 1 ppm (T1),T7 and Deltamethrin @ 1.0 ppm (T8) were significantly similar to control(78.33) with respect to germination%. Frandoloso 2018 observed that maize seeds germination was not influenced by seed treatment chemicals (thiametoxan, metalaxyl + fludioxonil + thiabendazole and pyraclostrobin + methyl thiophanate + fipronil) or storage period. Padmasri *et al.,* 2019 found that Spinosad 45 SC @ 2 ppm kg-1 seed had recorded highest germination percentage (93.67), seedling vigour index (3113), less moisture per cent (11.33), lowest infestation (0.33 per cent) and adult emergence (1.00) of *S.oryzae* at the end of nine months.

Mortality recorded at three days after release of *Rhizopertha dominica* immediately after seed treatment was 88% in seeds treated with Broflanilide @ 3 ppm (T3) while lowest (11.7%) mortality was recorded in control. At seven days after release of insects Broflanilide @ 2 ppm (T2), T3, T7 (Emamectin benzoate @2ppm) and T8 (Deltamethrin @ 1.0 ppm) were significantly similar with 100% mortality of released insects. At 15 days after release of insects, all treatments were found to be significantly different with each other.

At three months of storage, three days after release 70.67% mortality was observed in seeds treated with Broflanilide @ 3 ppm (T3) and significantly lowest mortality of 11.67% in control. At seven days after release of insects, 100% mortality was recorded in T3 and on par was Broflanilide @ 2 ppm (T2). At 15 days after release, 100% mortality in T1 to T3, T7 and T8.

After six months of storage, at three days after release of lesser grain borer adults all treatments were on par with each other except control. At seven days after release, no significant difference was noticed among treatments. Mortality was 100% in all the treatments at 15days after release of insects. Nine months after storage, mortality of released insects was 46.7% in T3 at three days and it was on par with T6. Seven days after release 96.7% mortality was recorded in T3, Dinotefuran @ 3 ppm (T6) and on par was. Emamectin benzoate @2ppm (T7). At 15 days after release, 100% mortality was observed in all the treatments.

The present results are in concurrence with that of Patil *et al.,* 2025 in cowpea. Deshpande *et al.,* 2024 reported that seed treatment in Greengram with emamectin benzoate 5 SG (4 ppm/kg of seed) was most effective in controlling pulse beetle infestation recording the highest adult mortality (87.75%) and lowest seed damage (3.67%). A successful seed storage management strategy that kept seed quality of paddy for up to nine months of storage was the broflanilide @3 ppm (300 SC @ 9.99 mg/kg seed) treatment.

Author Contributions

Anuradha: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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