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Integrated Storage Pest Management System by Application of Warehouse Neem(Brand :Wellsto)(Azadirachtin 1 500 ppm min.)

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Introduction

Food grains constitute the bulk of the diet of human beings. The stored foodgrains require to be protected from the ravages of insect pests through application of various insecticides. The insecticide resistance combined with need for residue free food has prompted development of alternative methods of insect control. The development of resistance in eight insect pests of stored grain to Malathion 50% E. C. and other commonly used insecticide has been noticed (Madhumathi,1997). This calls for the need to consider the use of biorational or low risk insecticides such as neem formulations as a component in stored grain pest management. The effectiveness of plant derivatives against stored product insect has already been demonstrated, among which the extracts of Neem(*Azadirachta indica* A. Juss) have received more attention. The pesticidal and medicinal properties from the neem tree have been exploited for atleast the last 2 500 years. Neem oil is also known to be active against 400 insect pests.

Ali et al. (1983) reported that neem oil at 0.5 ml. Per 100 grams caused more than 50% mortality and at higher dosages of 1 mL. per 100 gram,cent percent mortality in *Callasobruchus chinensis* . In a study by Devi etal(2004) on *Callasobruchus chinesis* . ,it was noticed that 0.03% Azadirachtin affected the fecundity,fertility of eggs and development of Larvae. Mukherjee and Rama Chandran(1989) reported that Azadirachtin incorporated in the wheat flour at upto 10 ppm reduced growth and survival of the larvae in case of *Tribolium castaneum* at 1 ppm and above. Study carried out by Lakwah and Kashlan 1999 observed 100% mortality of *Sitophilous oryzae* at all tested concentration between 20 – 1 000 ppm 14 days post treatment. Mortality of *C. . maculatus* adults reached 38.4%,92.2% and 97.8% at concentrations of 50ppm,500ppm and 1 000 ppm one day after the treatment and from 97.8 to 100% at 50 – 1 000 ppm after 7days. Cent percent mortality of *Tribolium castaneum* at concentration of 1 000 ppm after 14 days treatment was noticed.

The Azadirachtin($C_{35}H_{44}O_{16}$) is a chemical extracted from the neem seeds. This has got a broad spectrum activity. . Neem pesticide being safe and harmless to non target and beneficial organisms like pollinators. Honey bee etc. was evaluated against Malathion,in a collaborative project between Central warehousing corporation, ITC Limited and Indian Grain Storage Management & Research institute ,to determine its suitability under Integrated Pest Management System.

The Project was Divided Intofollowing Stages

(Ⅰ)**Bio efficacy studies** carried out at Acharya N. G. Ranga Agricultural University (ANGRAU), Baptala(A. P) in a joint project with ITC Limited,GUNTUR

(Ⅱ)**Bio efficacy studies** at Indian Grain Storage Management & Research Institute(IGMRI) Hapur in association with Central Warehousing Corporation and ITC Limited,GUNTUR

(Ⅲ)**Field trials** at Central Warehouse Anakapally(A. P.). jointly by central warehousing corporation,I. T. C. GUNTUR and Indian Grain Storage Management & Research Institute (IGMRI) Hapur/hyderabad

(Ⅳ)**Residue analysis** of wheat stocks treated with Malathion and Warehouse Neem (Wellsto) and

(Ⅴ)**Baking test** of Chapathi (Indian Bread) made from wheat samples treated with Malathion and Warehouse Neem (Wellsto) through reputed laboratories.

(Ⅰ)**STAGE – 1:Study on Bioassay of Neem at Acharya N. G. Ranga Agricultural University(Angrau):**

A collaborative project of(1)*Central Warehousing Corporation*,(*A Government of India undertaking*),*New Delhi*(2)*Indian Grain Storage Management and Research Institute*(*IGMRI*),*Ministry of Consumer affairs*,*Food & Public distribution*,*Government of India*,*New Delhi &*(3)*ITC Limited ILTD Division*,*Guntur.*

Methods

The test insects included *Tribolium castaneum* (*Herbst*), *Callasobruchus chinensis* Linn., *Rhizopertha dominica* (Fabricius), *Corcyra cephalonica* (Stainton), *Cryptolestes ferrugineus* (Stephens), *Oryzaephilus surinamensis* and *Lassioderma serricorne*. The population of these insects were collected from various locations of CWC in the State of A. P. and reared under laboratory conditions. Series of concentration was prepared by using sereal dilution techniques from the commercial preparationof warehouse neem (Wellsto) provided by ITC Limited. The wide range of concentrations were tested followed by a narrow range of concentrations to get mortality in the range of 10 to 90%.

In the present study the LC_{50} values of Warehouse Neem (Wellsto) ranged from 0.00017 to 0.0004% for the above mentioned stored grain insect pests. The LC_{80} values of Warehouse Neem (Wellsto) ranged from 0.00158 to 0.0082% for the above mentioned stored grain insect pests. The LC_{90} values of Warehouse Neem (Wellsto) ranged from 0.0012 to 0.00757% for the above mentioned stored grain insect pests. Warehouse Neem (Wellsto) found to be 39.88, 31.89 and 27.26 times more toxic than malathion against *T. castaneum*. Since Warehouse Neem (Wellsto) has showed better toxicity than Malathion to which many of the stored grain pests have developed resistance, it can be better used as a tool in the management of stored grain insect pests.

(Ⅱ) STAGE – 2: Bio Efficacy Studies at Indian Grain Storage Management & Research Institute (Igmri) Hapur.

Methods

Malathion 50% EC at a normal dosage of 1:100dilution with water @ 3Lit./100 Sq. m was compared with Warehouse Neem (Wellsto) Azadirachtin 1 500ppm using 3 dosages (40, 50 and 60mL./litre of water @ 3Lit./100Sq. m. The statement of corrected mortality percentages on an average of 3 replications of ITC's Warehouse Neem azadirachtin 1 500 ppm (min.)) (Brand Wellsto) and Malathion 50% E. C. formulations are presented in Tables 1 and 2 below respectively.

Table 1. Warehouse Neem (Wellsto) (Azadirachtin 1 500 ppm (min.))

S. No.	Concentration	Period afterSpray	*Sitophilus oryzae*	*Rhizopertha dominica*
1	40 mL/Litre (1.8 mg a. i./Sq. m)	60 minutes	1.6%	51.7%
2	50 ml/Litre (2.25 mg a. i./Sq. m)	60 minutes	70%	100%
3	60 ml (2.7 mg a. i/Sq. m)	60 minutes	80%	100%

Table 2. Malathion 50% E. C.

S. No.	Concentration	Period afterSpray	*Sitophilus oryzae*	*Rhizopertha dominica*
1.	Malathion 150 mg a. i./Sq. m (10 ml/litre).	60 minutes	68.3%	60.9%

From the above tables, it is observed that at a concentration of 1.8 mg a. i./Sq. m (40 ml/litre) of Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto), the corrected mortality of *Rhizopertha dominica* was at 51.7% comparable with 60.9% mortality of the same insect with Malathion 50% E. C. at 150 mg a. i./Sq. m (10 mL/Litre). At higher concentration of Warehouse Neem i. e., 2.25 mg and 2.75 mg of a. i/Sq. m., the corrected mortality rates of *Rhizopertha dominica* and *Sitophilus spp.* were higher than 150 mg a. i./Sq. m of Malathion 50%. Especially in case of *Rhizopertha dominica*, the corrected mortality was 100% in both the higher concentrations. Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) had considerable impact over *Rhizopertha dominica* at lower concentrations i. e. 1.8 mg a. i./Sq. m (40 ml/Litre). However, higher concentrations of the same formulation showed better mortality rates in case of *Sitophilus oryzae*.

(Ⅲ) STAGE – 3: Field Trials at Central Warehouse Anakapally (East Coast of Andhra Pradesh State) Jointly by Central Warehousing Corporation, ITC Limited, Guntur and Indian Grain Storage Management & Research Institute (IGMRI) HA-

PUR/HYDERABAD

The field studies(Surface & space spray) were carried out at Central warehouse – Anakapally(AP). Two compartments of the godown belonging to CWC comprising of minimum of 6 stacks(150 – 200 metric tones) were selected for the studies. Freshly procured wheat, packed in jute bags, untreated with any of insecticide were selected for trials. 6 stacks from one of the compartment were treated with Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) and 6 stacks in the second compartment were treated with Malathion 50% EC(500 000 ppm).

The stacks were left without any prophylactic/fumigation operations so that crawling infestation appear prior to initiation of the study. The stocks were fumigated as per normal schedule(i. e. up to 3 fumigations in a year) as per requirement.

Dosages

The dosage of Warehouse Neem (Azadirachtin 1 500 ppm(min.))(Brand Wellsto) formulation was recommended by ITC Limited @ 40 ml./litre of water, the solution of 3 litre sprayed per 100 m^2 of surface area. The prescribed dosage for Malathion 50% E. C. @. 10 ml/litre of water, the solution of 3 litre sprayed per 100 m^2 surface area used in the compartment under control.

Record of Observations

6 stacks were selected for the purpose of making observations to count insect population before and after the treatment. Each stack was marked with 5 spots of an area of 0. 25 sq. mtr., (50 cm × 50 cm) @ one each on all four sides and one at the top of the stack. Thus, 6 stacks selected for study had 30 spots for recording observations, which were labeled as S – 1 to S – 30. Similarly, 10 spots were selected on the floor, which were marked as F – 1 to F – 10. 10 spots were also marked on the walls, which were marked as W – 1 to W – 10. The data sheets for all these 50 spots each for the control compartment (Malathion 50% EC) and the experimental compartment (Warehouse Neem (Wellsto) Azadirachtin 1 500 ppm. (min.) were prepared with details of insect population before and after the treatment. In order to ensure representative sampling, these spots were marked at different lengths.

Frequency of Treatment

The neem preparation Warehouse Neem Azadirachtin 1 500 ppm (Brand : Wellsto) was sprayed in the experimental compartment at fortnightly cycle as in the case of malathion 50% E. C. The experiment was carried out for approximate 10 – 12 months period.

Data Recording

Mortality of insects on the marked spots were recorded at an interval of 1, 3, 7 and 15 days from the date of spraying. The scientist from IGMRI – Hapur/Hyderabad recorded data in association with CWC & ITC on 1st, 3rd, 7th and 15th days of initial spray. The data for the study period was recorded by all officials involved in the trials.

Statistical Analysis and Interpretation

Relavent statistical tools are used for compiling and analysis of data as given below.

Table 3. Field trials Anakapalli: Test on average population(statistical t – test' at 95% level of confidence) compared to Malathion:

PARAMTERS CONSIDERED	HIGHER/EQUAL/LOWER
Live population at 0th day	Equal
Overall live population on Stacks (18 cycles)	Equal
Overall dead population Stacks (18 cycles)	Lower
Overall live population on Walls (18 Cycles)	Equal
Overall dead population on Walls (18 Cycles)	Equal
Overall live population on Floor (18 Cycles)	Equal
Overall dead population on Floor (18 Cycles)	Lower
Tribolium – Stacks + Walls + Floor – 18 Cycles – Live	Equal
Tribolium – Stacks + Walls + Floor – 18 Cycles – Dead	Equal
Rhizopertha – Stacks + Walls + Floor – 18 Cycles – Live	Equal
Rhizopertha – Stacks + Walls + Floor – 18 Cycles – Dead	Lower
Ephestia – Stacks + Walls + Floor – 18 Cycles – Live	Equal
Ephestia – Stacks + Walls + Floor – 18 Cycles – Dead	Equal

Table 4. Field trials Anakapalli: Test on variation ('ANOVAF test' at 95% level of confidence) compared to Malathion:

PARAMTERS CONSIDERED	HIGHER/EQUAL/LOWER
On Stacks (Live population) Between Treatments	Equal
On Floor (Live population) Between Treatments	Equal
On Walls (Live population) Between Treatments	Equal
On Stacks (Dead population) Between Treatments	Equal
On Floor (Dead population) Between Treatments	Equal
On Walls (Dead population) Between Treatments	Equal

Table 5. Field trials Anakapalli: Analysis of Pest infestation in Wheat Samples (Chi – Square test at 95% level of confidence) compared to Malathion:

PARAMTERS CONSIDERED	HIGHER/EQUAL/LOWER
Clear Infestation	Equal
Few Infestation (up to 2live insects/kg)	Equal
Heavy Infestation (> 2live insects/kg)	Equal

The above statistical analysis with several parameters showing equality both in mean and variance analyses in case of Warehouse Neem (Wellsto) (Azadirachtin 1 500 ppm) and Malathion, converge to the point that Warehouse Neem (Azadirachtin 1 500 ppm) efficiency is not less than that of Malathion amongst several key parameters and also in some cases, superior in terms of lower variances. This leads to the statistical conclusion that Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) can be included in Integrated Storage Pest Management. This statistical statement is validated by the above tests at 95% level of confidence.

(Ⅳ) STAGE – 4: Residue Analysis of Wheat Stocks Treated With Malathion and Warehouse Neem (Wellsto).

The Wheat samples from both the compartment of CWC Anakapalli Warehouse where field trials with Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) and Malathion 50% E. C. were subjected for evaluation of residues at Indian Institute of Chemical Technology, Hyderabad and CFTRI Mysore The results are presented in the table below.

Table 6. Chemical Residue analysis in Wheat samples.

CHEMICAL	ANAKAPALLI	TEST CARRIEDOUT BY IICT, CFTRI
Malathion	1.98 ppm	CFTRI, Mysore
Azadirachtin	NIL	IICT, Hyd

Perusal of the above residue analysis table clearly shows that there are absolutely no traces of Azadirachtin, active ingredient of Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) vis – a – vis Malathion 50% E. C. where the residues were observed in the Wheat samples collected from the control compartment.

(Ⅴ) STAGE – 5: Baking Test of Chapathi (Indian Bread) Made from Wheat Samples Treated with Malathion and Warehouse Neem (Wellsto)

The flour of Wheat samples taken from both the compartments of CWC, Anakapalli where field trials were conducted with Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) and Malathion 50% E. C., were analysed for any impact of bitter compounds on the baking quality and other quality parameters as per the Prevention of Food Adulteration Act (PFA, 1954).

Table 7. Baking test of chapathi (Indian bread)

S. No	Parameters	Scale/Unit	Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) (B2 Compartment in CWC Anakapalli)	Malathion 50% E. C (B3 Compartment in CWC, Anakapalli)
1	Appearance	10	8.5	8.0
2	Tearing strength	10	9.0	8.5
3	Pliability	10	8.5	8.5
4	Aroma	10	9.0	8.5

S. No	Parameters	Scale/Unit	Warehouse Neem (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) (B2 Compartment in CWC Anakapalli)	Malathion 50% E. C (B3 Compartment in CWC, Anakapalli)
5	Eating quality	10	9.0	8.5
6	Overall quality	10	44.0	42.0
7	Shear force	g	770	650

Table 8. Evaluation of Wheat Flour Based on Prevention of Food Adulteration Act(PFA,1954)

S. No	Parameters	Warehouse Neem) (Azadirachtin 1 500 ppm (min.)) (Brand Wellsto) (B2 Compartment in CWC Anakapalli)	Malathion 50% E. C(B3 Compartment in CWC, Anakapalli)	PFA Specification-sA. 18.01	Test Method
1	Moisture,%	9.6	10.0	Max:14.0	AOAC 17th Edn. 2000,925.10
2	Total ash,% (on dry weight basis)	1.7	1.8	Max:2.0	AOAC 17th Edn. 2000,923.03
3	Acid insoluble ash in dil HCl,% (on dry weight basis)	Not detected	Not detected	Max:0.15	AOAC 17th Edn. 2000,941.12
4	Gluten,% (on dry weight basis)	9.1	9.2	Min:6.0	IS:1155 – 1968
5	Alcoholic Acidity expressed as sulphuric acid,% (on dry weight basis)	0.13	0.13	Max:0.18	IS:1155 – 1968
6	Rodent hair and excreta	Not detected	Not detected	Should be free from Rodent hair and excreta	AOAC 17th Edn. 2000, 993. 26 & 943.06

On perusal of results of both the tests (baking quality of Wheat flour and other quality parameters as per PFA,1954), it is observed that samples from Warehouse Neem(Azadirachtin 1 500 ppm(min.))(Brand Wellsto) is on par with Malathion 50% E. C. treated samples.

Conclusion

In light of concerns over pesticide residues in agricultural produce coupled with increasing pest resistance to chemical pesticides, there is an immediate need for developing or adopting effective alternative methods or natural pesticides which do not pose such serious negative impact. The concept of Integrated Pest Management(IPM), addressing the problems of insect resistance and pesticide residues, needs to be applied in Storage pest management also.

The results of the bio-efficacy trials conducted at ANGRAU, Bapatla show the target species *T. castaneum* has developed resistance to Malathion 50% E. C. and Warehouse Neem (Wellsto) is 40 times more effective than Malathion 50% E. C. in terms of efficacy. The trials conducted at IGMRI, Hapur show that Warehouse Neem(Azadirachtin 1 500 ppm(min.))(Brand Wellsto) is more effective against *Rhizopertha dominica* at 40 ml/litre and at higher concentrations 50ml/litre and 60 mL/litre it is effective against *Sitophilus oryzae*.

The field trials conducted at. CWC, Anakapalli, Andhra Pradesh, for a year clearly show that Warehouse Neem (Wellsto) (Azadirachtin 1 500 ppm) is on par with Malathion 50% E. C. in terms of pest management. The pest infestation(as per the standard guidelines) recorded in the stored product(Wheat grains) clearly show that the grain is well protected by Warehouse Neem (Wellsto) (Azadirachtin 1 500 ppm) during the entire one year study which was the objective of the study.

The overall quality of the grain, in terms of pest infestation, chemical residues, baking quality and other quality attributes as per the PFA, 1954, was maintained in good order even after one complete year of trial. This shows that the

product has no deleterious impact on the quality of the food grain and is a best fit in Integrated Pest Management System.

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