BIOASSAY VALIDATION OF AN APPLICATOR DEVELOPED TO PRECISELY CONTROL THE WIPING OF CONCENTRATED INSECTICIDE ONTO A MOVING GRAIN STREAM

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ABSTRACT

An accurate metering device has been developed to apply concentrated insecticide to grain to prevent misting or aerosolling by wiping the concentrate directly onto the wheat stream. The need for water dilution of concentrate is eliminated, thus reducing operator contact with insecticides and improving the workplace environment.

Using standard grain bioassay techniques and target application rate of 1:8:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion, no difference was found between wiped concentrated insecticide and sprayed diluted insecticide, either in 4 tonne farm-scale treatments or in 750 tonne bulk handler's silo treatments.

Test insects were young adult Sitophilus oryzae, Rhyzopertha dominica, Tribolium castaneum and Oryzaephilus surinamensis, and bioassay times were 0, 1.5, 3, 4.5, 6 and 9 months post-treatment.

INTRODUCTION

With appropriate insecticides carefully applied, insects can be prevented from infesting grain during storage and transport to the consumer.

For more than 30 years, concentrated insecticides have been diluted with water and applied at the rate of 1 litre diluted insecticide on each tonne of grain.

One of the questions often raised when discussing the application of concentrated insecticide instead of spraying water-diluted concentrate onto wheat was how thoroughly would 32 ml concentrate, wiped onto the moving grain, be distributed on 1 tonne.

MATERIALS AND METHODS

The Wellcome Grain Pesticide Applicator was programmed to wipe 32 ml concentrated insecticide comprising 20 ml BRM 5/50 Grain protectant (active constituents 50g/litre bioresmethrin and 400g/litre piperonyl butoxide) and 12 ml Fenitrogard Liquid Insecticide (active constituent 1000g/litre fenitrothion) on each tonne of grain, both in farm and bulk handler's silo treatments.

The Cooper Grain Sprayer, in the farm treatment, and their own manufactured grain sprayer in NSW Grain Handling Authority, (now Grain Corp's) storage were adjusted to spray 1000 ml water-diluted insecticide, comprising 20 ml BRM 5/50 Grain Protectant and 12 ml Fenitrogard Liquid Insecticide (each with the active constituents listed above), mixed in 968 ml water, on each tonne of wheat.

The approximate tonnages treated were 4 tonnes in flat steelwelded farm silos at "Bangalla", for each method of application, and 750 tonnes in steel-reinforced concrete silos for each application at Holmwood, N.S.W.

Treatment points were in the chute leading into an auger for the farm application and on a conveyor belt in the bulk handler's storage complex.

Target application rates of insecticides were 1:8:12 mg/kg bioresmethrin: piperonyl butoxide:fenitrothion for both farm and bulk handler's treatment.

Standard and single grain bioassays were carried out on grain treated by wiper and spray and compared with untreated wheat at approximately 0, 1.5, 3, 4.5, 6 and 9 months after treatment.

Standard "Bangalla" grain assaying technique used two to three week old adult insects, in lots of 110, placed on composite silo bin samples. 150g wheat was used for each of Sitophilus oryzae and Rhyzopertha dominica but 300g of wheat was used for each of Tribolium castaneum and Oryzaephilus surinamensis bioassays. The glass jars, with internal "fluon" (Fluon GPI polytetra-fluoroethylene) skid zone for 2 cm down from the mouth, were stored in a temperature and humidity controlled bioassay room set at 25°C and 55% relative humidity. Percentage mortality of the 110 added adults was assessed after 21 days on wheat being tested and then these adults were destroyed. Progeny numbers were noted at each count made 10, 12 and 14 weeks after the bioassay was commenced. After each count these insects were also destroyed.

Single grain/single insect bioassays were devised using Durham or fermentation tubes 25mm long, 3.5mm internal diameter, 6mm external diameter, held upright in Cooke microtiter or Kayline U-plate trays. From composite bin samples, 96 single whole wheat grains were selected at random and placed one to each tube. The internal top 1cm of each tube had a dried "fluon" skid zone to prevent young Sitophilus oryzae adults (of approximately 2 weeks) escaping. Mortality was read after 21 days.

RESULTS

Excellent mortality and progeny reduction occurred with Bangalla strains of Sitophilus oryzae (Table I) and Rhyzopertha dominica (Table II) on treated wheat stored in both steel farm and concrete bulk handler's bins.

Good mortality and progeny reduction occurred with the Bangalla strain of Tribolium castaneum (Table III) whether the treated wheat was stored in the small sized farm bins or large bulk handler's bins.

Although mortality was poor with the formulation used, the progeny reduction of the Bangalla fenitrothion-resistant strain of Oryzaephilus surinamensis was good (Table IV) and comparable by both treatment methods.

From Table V the distribution of concentrated insecticide appeared to be excellent with the farm treatment which used two augers to transport the treated grain from the wiping site into the silo bin. In the bulk handling situation a bucket elevator lifted the wheat from the conveyor belt into the silo bin and perhaps the mixing action may not be quite as thorough as with a screw conveyor.

DISCUSSION

Where the insecticide chosen was appropriate to the control of the specific insect and strain tested, both wiper and sprayer applications were successful.

Wiper or sprayer applied fenitrothion was inappropriate for use with the fenitrothion-resistant strain of Oryzaephilus surinamensis as far as mortality was concerned but successful for the purpose of progeny reduction whether applied by wiper or sprayer.

CONCLUSION

The concept of applying concentrated insecticides appropriate to the insect species encountered in grain had many advantages to the operator and produced excellent results equivalent to the use of water-diluted sprays.

Table I: Percentage mortalities at 21 days and F1 progeny reduction for Sitophilus oryzae in wheat treated with 1:10:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion and silo stored prior to assay in 1987

Silo Fabric	Insecticide Application Method	21 day mortalities Approx. time after application (months) 0	1.5	3	4.5	6	9
Steel	Wiper	100	100	100	100	100	100
	Sprayer	100	100	100	100	100	100
	Untreated	1	0	0	0	0	2
Concrete	Wiper	100	100	100	100	100	100
	Sprayer	100	100	100	100	100	100
Silo Fabric	Insecticide Application method	F^1 progeny reduction Approx. time after application (months) 0	1.5	3	4.5	6	9
Steel	Wiper	100	99.90	99.97	99.98	99.96	99.90
	Sprayer	100	100	99.94	99.98	100	99.94
Concrete	Wiper	100	100	100	100	100	100
	Sprayer	100	99.8	100	100	100	99.97

Table II: Percentage mortalities at 21 days and F1 progeny reduction for Rhyzopertha dominica in wheat treated with 1:10:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion and silo stored prior to assay in 1987

Silo Fabric	Insecticide Application Method	21 day mortalities Approx. time after application (months)					
		0	1.5	3	4.5	6	9
Steel	Wiper	100	100	100	100	100	100
	Sprayer	100	100	100	100	100	100
	Untreated	4	7	3	1	0	0
Concrete	Wiper	100	100	100	100	100	100
	Sprayer	100	100	100	100	100	100
Silo Fabric	Insecticide Application Method	F1 progeny reduction Approx. time after application (months)					
		0	1.5	3	4.5	6	9
Steel	Wiper	100	100	100	99.93	100	100
	Sprayer	100	100	100	99.93	100	100
Concrete	Wiper	100	*	*	100	100	100
	Sprayer	100	**	**	100	100	100

KEY:

* 1 dead adult found in treatment bioassay but control numbers were too low (20) for valid progeny suppression calculation.

** No progeny found in treatment bioassay but control numbers were too low (32)

Table III: Percentage mortality at 21 days and F1 progeny reduction for Tribolium castaneum in wheat treated with 1:10:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion and silo stored prior to assay in 1987

Silo Fabric	Insecticide Application Method	21 day mortalities Approx. time after application (months)					
		0	1.5	3	4.5	6	9
Steel	Wiper	100	100	100	100	99	100
	Sprayer	100	100	100	100	100	100
	Untreated	0	0	2	1	3	2
Concrete	Wiper	100	100	100	100	97	96
	Sprayer	100	100	100	95	100	97
Silo Fabric	Insecticide Application Method	F1 progeny reduction Approx. time after application (months)					
		0	1.5	3	4.5	6	9
Steel	Wiper	*	***	100	100	99.90	99.7
	Sprayer	***	***	100	100	99.8	99.7
Concrete	Wiper	***	***	**	100	99.0	99.8
	Sprayer	***	*	***	100	100	100

Key:

* 1 dead adult found in treatment bioassay but control numbers were too low.

** 2 dead adults found in treatment bioassay but control numbers were too low.

*** No progeny found in treatment bioassay but control numbers were too low.

Table IV: Percentage mortalities at 21 days and F1 progeny reduction for Oryzaephilus surinamensis in wheat treated with 1:10:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion and silos stored prior to assay in 1987

Silo Fabric	Insecticide Application Method	21 day mortalities Approx. time after application (months) 0	1.5	3	4.5	6	9
Steel	Wiper	91	70	79	25	38	12
	Sprayer	100	39	60	17	2	2
	Untreated	0	0	5	1	0	5
Concrete	Wiper	100	85	50	45	72	9
	Sprayer	99	39	46	30	78	16
Silo Fabric	Insecticide Application Method	F1 progeny reduction Approx. time after application (months) 0	1.5	3	4.5	6	9
Steel	Wiper	***	***	99.8	100	99.9	100
	Sprayer	***	***	100	100	100	100
Concrete	Wiper	100	**	***	100	100	100
	Sprayer	100	*	***	100	99.8	100

Key:

* 2 dead adults found in treatment bioassay but control numbers were too low.

** 3 dead adults found in treatment bioassay but control numbers were too low.

*** No progeny found in treatment bioassay but control numbers were too low.

Table V: Percentage mortalities at 21 days using single grain/single insect biosssays for Sitophilus oryzae in wheat treated with 1:10:12 mg/kg bioresmethrin:piperonyl butoxide:fenitrothion and silo stored prior to assay in 1987

Silo Fabric	Insecticide Application Method	21 day mortalities Approx. time after application (months) 0	1.5	3	4.5	6	9
Steel	Wiper	100	100	100	100	100	100
	Sprayer	100	100	100	100	100	93
	Untreated	1	0	0	0	0	0
Concrete	Wiper	-	100	99	100	100	99
	Sprayer	-	100	100	99	100	100

Key:

- No assays made as method had not been devised at this stage.

VALIDATION PAR BIO-MESURE DU BON FONCTIONNEMENT D'UN EPANDEUR CONCU POUR CONTROLER AVEC PRECISION L'EPANDAGE D'INSECTICIDE CONCENTRE SUR DU GRAIN EN MOUVEMENT

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RESUME

Un dispositif de mesure précis a été conçu pour appliquer un insecticide concentré sur du grain en vue d'empêcher l'apparition de brouillard en badigeonnant le concentré directement sur le grain en mouvement, éliminant ainsi le besoin de le diluer et réduisant donc le contact entre l'insecticide et l'opérateur, ce qui améliore également l'environnement du poste de travail.

En utilisant des techniques de mesures biologiques standards et un taux d'application sur la cible 1:8:12 $mgkg^{-1}$ de bioresméthrine : pipéronyl butoxyde : fénitrothion, aucune différence n'a été constatée entre l'insecticide appliqué en concentré et celui pulvirisé classiquement, soit au cours de traitements à petite échelle sur 4 tonnes en milieu fermier, soit au cours de traitements à grande échelle dans des silos de vrac sur 750 tonnes.

Les insectes témoins étaient des adultes jeunes de *Sitophilus oryzae, Rhyzopertha dominica, Tribolium castaneum* et *Oryzaephilus surinamensis*, pour des périodes de mesures de 0 ; 1,5 ; 3 ; 4,5 ; 6 et 9 mois après le traitement.