AN OVERVIEW ON GRAIN INSECT PROBLEMS AND WAYS TO CONTROL THEM ON FARM STORAGE, IN BRAZIL

SANTOS, Jamilton P. & FONTES, Renato A.

Centro Nacional de Pesquisa de Milho e Sorgo/EMBRAPA

Caixa Postal - 151
35700 - Sete Lagoas, MG. Brasil

ABSTRACT - Maize can be stored as shelled grain, in bags and on the cobs with the husk. At the Brazilian farms prevails the storage of whole maize ears in wood cribs. This storage method accounts for about 50% of the country's total corn production. Stored grain pests as **Sitophilus zeamais,** and **Sitotroga cerealella** are major problems in Brazil as they become more difficult to control in unhusked stored maize. Loss assessments have shown average insect damage up to 17.3%, 36.4% and 44.5% of the grains after 3,6 and 9 months of storage. To this amount of damage corresponded, respectively, 3.1%, 10.4% and 14.3% weight loss. The infestation observed in maize stored in wood cribs treated with malathion-4% powder applied at 20 ppm rate (500g c.p./t) did not differentiate from the control treatment. Fumigation with phosphine at 1 g a.i./m3 before ears storage reduced losses to about half. Whereas, dusting with the deltamethrin - 0,2% at 1 ppm (500c.p./t) cut down 75% of the weight loss. The good results obtained with Deltamethrin at the experimental station was confirmed by the extension service agronomists under farm condition.

INTRODUCTION

Maize is one of the most important crops grown in Brazil. It takes the largest acreage and is planted all over the country by almost every farmer. The total corn production is about 25 million tons; however, the average yield is as low as 2 t/ha. In the Southern region the productivity is higher than in the Northern.

In Brazil maize is stored as shelled grain either in large bins, in bags in the warehouses and as ear corn in cribs.At the Brazilian farms prevails the storage of the whole maize ears in wood cribs. This storage method accounts for about 50% of the country's total corn production (Santos and Fontes, 1982). Stored grain pests as **Sitophilus zeamais**, and **Sitotroga cerealella** are

major problems in Brazil as they become more difficult to control in unhusked stored maize. Loss assessments have shown average insect damage up to 17.3%, 36.4% and 44.5% of the grains after 3, 6 and 9 months of storage. To this amount of damage corresponded, respectively, 3.1%, 10.4% and 14.3% weight loss (Santos et al, 1983).

Grain loss due to insect attack in bins or warehouses is minimum because the insect are controlled efficiently.

Greater difficulties are observed when attempting to preserve the grain stored on the farms. This happens specially because of the rusticity and deficiency of the storage structures, the incapacity of the small farmers to make money investiments to build more appropriate storage facilities and also because of the farmers traditional hesitation to adopt new technologies. We believe that only the diffusion of method for controlling stored grain insect and rodent, which are,at the same time efficient, of low cost, simple and easy to apply could reduce substantially storage loss at the farm level. Thus, more attention should be dedicated to research to decrease the great amount of loss which occurs yearly to the maize stored on the farms.

The first recommendations in Brazil to control the insect pests of maize stored on the farms came from the application of DDT powder (Oliveira, 1947). Later the farmers were advised to apply Malathion 2% dust (Chaves and Coonrob, 1964). However Triplehorn et al (1966) reported that Malathion 2% dust was not efficient to control the weevils and the Angoumois grain moth attacking maize stored with the ears. Regardless of the inefficiency, also reported in other publications (Bitran et al, 1976; 1979 and 1980) the Malathion dust has been intensively used in Brazil in the last 30 years.

Today, even though, the Ministry of Agriculture has canceled the permission to use Malathion dust to control insect in ear corn (Anon. 1983), the insecticide is still used. Nevertheless, it has been observed great reduction in the use of Malathion dust as the extension service and the farmers become aware of the more recent research conducted aiming to reduce loss caused by the insect damage to farm stored maize (Santos et al, 1987; Santos and Merege, 1989; Santos e Ferreira, 1989). With Malathion dust legally out of the market after August 1983, phosphine became the only alternative insecticide to control stored grain pest of ear corn in wood cribs. Thus, it was shown to the extension service staff and farmers that fumigation of the maize ears with phosphine, treated just one time, before storage, would reduce 50% of the losses(Santos et al, 1987), whereas repeating fumigation at 3 months interval could cut down the losses.

When maize ears are stored in wood cribs, in order to repeat the fumigation the farmer should unload the crib, cover the ears with the polyethilene sheet, put sand, or soil around the edges of the plastic cover and introduce the phosphine tablets for fumigation. The procedure to remove the ears and put

them back into the crib after fumigation takes a lot of labor and it has been a limitation for repeating fumigation. To solve this problem some low cost brick structures have been developed that permit fumigation of the maize ears inside the storage structure (Pradella and Monegat, 1985; Santos and Fontes, 1989). So, repeated fumigation at 3 months interval has been possible to be used as an eficient method to control ear corn storage pasts.

In spite of the new structures for fumigation, there is still a great demand from the small farmers, who already have a wood crib, for a dust insecticide to use in substitution of the Malathion. Therefore a research was conducted to test some experimental pyrethroid and organophosphate insecticides as dust formulation to control ear corn storage pests.

MATERIALS AND METHODS

The research was conducted at the experimental station of the National Maize and Sorghum Research Center - EMBRAPA located at the of city Sete Lagoas, Minas Gerais State, Brazil. The climate in this area is semi-arid with a dry season from April to August. This climate create good condition for the maize grain to dry out in the field to 13% moisture content, before harvest, which occurs more frequently between May and June. The experiments were started immediately after harvest in June and all conducted with the maize ears stored with the husk in 2 x 2 x 2 m wood cribs. This size of a crib is enough to store 2t of maize ears. The treatments were assigned to each crib at random. The maize ears used in all tests came from the same field in every year of test. The various treatments were applied at the rate as indicated in Table - I. The insecticides were distributed at the time of loading the cribs by dusting a calculated amount of the insecticide at every 25 cm high layer of maize ears. No other application was made during the storage period.

Immediately before the distribution of the insecticides, in each crib, one evaluation was made following a sampling procedure to know the initial infestation which in fact, was the field infestation. The evaluation was repeated at 2 months interval to observe any progress of the infestation during the storage period. From each crib one sample of 150 maize ears was taken, at random, collecting 30 ears from the central area and from each of the four corners, at about 50 cm distance from the walls, trying to represent the situation of the crib. The superficial layer of 20 cm was removed in each point to avoid sampling an area more heavily infested. The 150 ears where then separated in the categories of closed husk ears (CHE) and open husk ears (OHE).

CLOSED HUSK EARS (CHE) - are the ears which the husks are long enough to protect the grains by closing tight for at least 2 cm beyond the tip of the cobs.

OPEN HUSK EARS (OHE) - are the ears which the husks are short and do not protect the grains because they do not cover the

entire ear, exposing the grains and the tip of the cobs.

After the ears were separated, the proportion of each category was calculated. Next, a split-sample of 15 ears was taken at random from each category, shelled and the volume (ml) of the grains was taken to have a measure of the ear size.

The damage rate was obtained by checking for insect attack in one liter of a mixture of grains from the CHE and OHE.

The mixed sample was prepared considering the percentage of each ear category and the average size of the ears. This procedure was necessary because the tendency of the OHE to be bigger than the CHE and to suffer greater insect damage. The proportional volume of grain of one ear category was obtained by the expression.

$$VPOHE = \frac{VOHE \cdot \% OHE}{(VONE \cdot \% OHE) + (VCHE \cdot \% CHE)} \quad or \quad X = \frac{A \cdot B}{(A.B)+(C.D)}$$

X : Proporcional volume of grain from the OHE to form the mixed sample.

A and C: Represent the volume of grains obtained from the subsample of the 15 OHE and CHE, respectively.

B and D: Represent the % of the OHE and CHE, respectively, observed in the crib, obtained from the 150 ear sample.

The 1000 ml mixed sample was finally obtained by 1000-X = Y , where Y was the volume proportional of grain from the CHE. After completely homogenizing the mixture of grains, 3 small samples of 100 ml were taken to check for the insect damage and to get the percentage of infestation. Only the grains with the insect exit hole were considered as damaged. The hidden infestation was not considered in this study.

Table - I. Insecticides and dosage rate tested to control pests of maize ears stored in wood cribs.

Formulations 1/	ppm	Dose c.p./t of maize ears.
1.Deltamethrin - 2 g/kg	1.0	500 g/t
2.Cypermethrin - 5 g/kg	5.0	1000 g/t
3.Malathion - 40 g/kg	20.0	500 g/t
4.Pirimiphus-metil - 20 g/kg	10.0	500 g/t
5.Fenitrothion - 20 g/kg	10.0	500 g/t
6.Phosphine - 1 g p.a./3 g tablet		3 g/t

1/ Only Deltamethrin and Phosphine are registered for use.

RESULTS AND DISCUSSION

The results obtained at the experimental station about the efficiency of some treatments to control the stored grain pests in ear corn stored in wood cribs may be observed in Table - II. The Malathion 4% dust inseticide was included in these tests as a reference product as its registration of use has been suspended since 1983. Because the farmers were so much accustumed to use Malathion some of them still apply it today although , from the results, one can observe no positive effect of this insecticide. In fact the insects caused a litle bit more damage to the grain treated with Malathion (mean average of 4 years data) than the control treatment (mean average of 5 years). One reason might be the effect of Malathion on the natural enemies.

To the small farmers it has been shown that the selection and the storage of the CHE separated from the OHE and using these last ones first and more quickly, can be used as a method to avoid great insect damage. The CHE husk ears usually suffer low insect attack as can be seen in Table - II.

Fumigation with phosphine, under plastic cover, is also a good insect control method even for the small scalle storage of unhusked maize ears. On this aspect it is very important to teach the farmers the basic principles to be followed for satisfactory results. Fumigating the maize ears one time before storage might reduce losses to about a half;however, repeating fumigation at 3 months interval would keep the pest under control (Table - II) without the incorporation of toxic residue to the grain. To

Table II- Efficiency of some treatments to control the stored grain pests in unhusked maize ears stored in wood cribs. Sete Lagoas, MG, Brazil, 1990.

Treatments 1/	Number years tested	% Damaged Grains 2/			
		July	Oct.	Dec.	Feb.
1. Malathion-4% dust	4	1.55	13.16	30.11	36.13
2. Control	5	1.19	4.77	19.84	33.54
3. Closed husk ears (selected)	1	0.50	1.60	8.30	14.00
4. Phosphine Fumigation (before storage)	3	0.83	1.56	4.20	21.89
5. Phosphine Fumigation (every 3 months)	1	1.50	1.50	4.00	5.00
6. Deltamethrin-0,2% dust	5	0.99	1.51	2.08	3.07
7. Pirimiphos-metil(s)-2% dust	2	0.95	1.54	3.41	9.57
8. Cypemetrin-0,5% dust	3	1.13	2.60	3.07	8.47
9. Fenitrothion-2% dust	3	1.73	3.39	2.91	7.18

1/ Refers to Table - I for doses of the insecticidos.

2/ The values represent the mean average of the respective number of years studied.

repeat the fumigation without removing the maize ears from the crib it is necessary to have a properly built storage structure (Pradella and Monegat, 1985; Santos and Fontes, 1989). Thus for those farmers who do not have the appropriate structure for fumigation it will be necessary a ready to use, low concentrated, low toxicity dust insecticide to control the insects in in unhusked ear corn. The pyrethroid Deltamethrin - 0,2% dust tests iniciated in 1985, come to the registration of a formulation to be used to control the insects attacking maize ears stored with the husk in wood cribs. So far the Deltamethrin has been tested for 5 consecutive years with excellent insect control (Table - II). Other dust insecticides like the Cypermethrim - 0,5%, the Pirimiphos metil - 2% and Fenitrothion - 2% have also been tested with good results but they have not yet been registered for use.

The good results obtained with Deltamethrin at the experimental station were confirmed by the extension service agronomists under farm condition. So far, 150 tests have been conducted in some of the most importants maize producing states in Brazil. The results of these on the farm level tests can be observed in Table-III. In the treated cribs the average inicial infestation of 6.0 % of the grains in June increased to 12.6 % in December; whereas in the no treated cribs the inicial infestation of 5.7 % increased to 29.7 % in the same period. It means about 3.64 fold more damage in the no treated cribs.

C O N C L U S I O N

1. Because of its inefficiency the Malathion - 4% dust insecticide should not be used to control the stored grain pests in unhusked maize ears stored in wood cribs.

2. A cultivar with good husk protection or the selection and storage of the closed husk ears (CHE) separated from the open husk ears (OHE), and the use of the OHE first, and more quickly, could be a good method to avoid great insect damage.

3. The use of low cost but properly built storage structure that permit fumigation of the maize ears at 3 months interval would keep the pests under control

4. The use of the Deltamethrin (2 g a.i./kg) dust formulation, at the rate of 500 g/t of maize ears,has a potential to reduce significantly the loss caused by the stored grain pests in maize stored in wood cribs.

Table III - Efficiency of Deltamethrin dust to control insect in maize ears stored in wood cribs under farm condition. Brazil, 1990.

States	Number years tested	% Damaged grains			
		Deltamethrin 1/		Control	
		June	Dec.	June	Dec.
Minas Gerais (53 - 46)	3 2/	4.8	9.6	4.5	21.3
São Paulo (57 - 53)	2	5.9	13.8	5.2	36.5
Paraná (18-18)	2	10.0	18.3	8.9	30.7
S.Catarina (22 - 14)	3	5.9	12.4	4.7	29.8
Mean average (150-131)		6.0	12.6	5.7	29.7

1/
Deltamethrin - 0,2% dust applied at the rate of 500g/t of maize ears.

2/
In parenthesis (A-B) the number of cribs treated (A) and not treated(B)

R E F E R E N C E S

ANONIMO.(1983)Portaria n 50/83. Diário oficial n 148, de 03 de agosto de 1983.

BITRAN, E.A.; CAMPOS, T.B.; OLIVEIRA; D.A. AND ARAÚJO, J.B .M. (1976) Ensaio de proteção de milho em espiga com palha em paiol em função do ataque de **Sitophilus zeamais** Motschulsky, 1855 e **Sitotroga cerealella**(Oliver, 1919). **Arq.Inst.Biol.**, São Paulo, **43**, 57-63.

ITRAN, E.A.; CAMPOS, T.B.; OLIVEIRA, D.A. AND ARAÚJO, J.B.M. (1979) Ensaio de proteção de milho armazenado em paiol através

do emprego de malathion e de pirimiphos metil, em aplicação isolada ou complementarmente à fumigação **An.Soc.Entomol.Brasil.8**, 29-38.

BITRAN, E.A.; CAMPOS, T.B.; OLIVEIRA, D.A. AND ARAÚJO, J.B.M. (1980) Avaliação da ação do produto experimental CGA-20168 (metacrifos) na proteção de milho armazenado em paiol. **O Biológico**, São Paulo, 4:85-96.

CHAVES, A.M. AND COONROB, L.G. (1964) **Milho bem guardado lucro dobrado**. Divisão de Informação ABCAR. Rio de Janeiro. Brasil.

FONTES, R.A.; SANTOS, J.P.; CRUZ, I.; AND OLIVEIRA, A.C.(1982). Situação atual do armazenamento de milho nas propriedades do Estado de Minas Gerais. In: XIV Congresso Brasileiro de Milho e Sorgo. FLORIANÓPOLIS, SC. **esumo** n. 182.

OLIVEIRA, J.S.Proteção de grãos expurgados contra a Re-infestação de caruncho s e outros insetos, com "Gerasol-p". **Boletim do Campo**, **14**, 21-22.

PRADELLA, F. J. AND MONEGAT, C. (1985) Um modelo de paiol eficaz e funcional. Chapecó. ACARESC. Escritório Regional. 41p.

SANTOS,J.P. CRUZ, I. AND FONTES, R.A. (1987) **Armazenamento e controle de pragas de milho**. 30p. (EMBRAPA/CNPMS - Documentos 1).

SANTOS, J.P. AND FERREIRA, J.G. (1989) Recomendações para o combate ao caruncho e ratos no milho armazenado em paiol. **O Ruralista**. no. 370.

SANTOS, J.P. AND FONTES, R.A. (1989) Avaliação técnica de uma estrutura para armazenamento do milho em espiga. In: II Congresso Brasileiro de Pós-Colheita. São Paulo. SP.

SANTOS, J.P.; FONTES, R.A.; CRUZ, I. AND FERRARI; R.A.R. (1983) Avaliação de danos e controle de pragas de grãos armazenados a nível de fazenda no Estado de Minas Gerais, Brasil. In: I Seminário Latino de Perdas Pós-Colheita de Grãos. 1. Viçosa, MG. **Anais**. p.105-110.

SANTOS, J.P. AND MEREGE, W.H. (1989) Armazenamento de milho na propriedade rural. Campinas, Coordenadoria de Assistência Técnica Integral. Instrução Prática 247. 19p.

TRIPLEHORN, G.A.;HERUM, F.L.; PIGATI, P.; GIANNOTI, O. AND PIGATTI, O. (1966) O paiol de tela para armazenamento de milho. **O Biológico**, São Paulo, **32**, 257-66.

UN SURVOL DES PROBLEMES OCCASIONNES PAR LES RAVAGEURS DU GRAIN ET DE LA LUTTE DANS LE STOCKAGE A LA FERME AU BRESIL

J. P. SANTOS et R. A. FONTES

Centro Nacional de Pesquina de Milho e Sorgo / EMBRAPA
Caixa Postal 151 35700, Sete Lagoas, MG. Brasil

Résumé

Le maïs peut se stocker en grains en vrac, dans des sacs et en épi dans ses spathes. Dans les fermes brésiliennes, c'est le stockage des épis de maïs entiers en cribs de bois qui prévaut. Cette méthode compte pour environ 50 % du total de la production de maïs du pays. Les ravageurs comme *Sitophilus zeamais* et *Sitrotoga cerealella* sont les principales nuisances au Brésil car ils sont de plus en plus difficiles à éliminer dans les stocks de maïs "déspathé" (en crib). L'évaluation des pertes montre que les nuisances occasionnées par les insectes constituent jusqu'à 17,3, 36,4 et 44,5 % de pertes en poids après 3, 6 et 9 mois de conservation respectivement. L'infestation traitée au malathion 4 % en poudre répandue au taux de 20 ppm (500 g produit commercial/t), observée avec du maïs stocké en crib n'a pas été différente de celle des témoins. La fumigation à la phosphine avant stockage des épis, à raison de 1 g matière active/m3, a rabaissé le taux de dégradation de moitié environ. Tandis que le saupoudrage à la deltaméthrine 0,2 % à 1 ppm (500 g p.c./t) a diminué de 75 % la perte de poids. Aussi, les agronomes ayant étudié ce traitement en milieu fermier ont-ils constaté une élimination sensible des insectes. Les essais comparatifs pratiqués avec des formules expérimentales en poudre à base de pirimiphos méthyl, de fénitrothion et de cyperméthrine ont donné de bons résultats.