More efficient and effective use of grain storage pesticide by subsistence farmers:

An invitation to participate in farmer trials

Summary – On-station research trials have shown that confining pesticide treatments to either the bottom or top and bottom, of grain bulks can give adequate protection at much reduced cost. Adoption of this method by subsistence farmers could make grain protection more accessible and reduce failure rates due to under-dosing. The next stage in this study is to work with farmers to see if they can achieve these benefits themselves with this method. We invite all stakeholders to participate with us in the farmer trials.

Introduction

For subsistence farmers, insecticides to protect their grain stocks are expensive. Also treatment failures are sometimes reported. In Zimbabwe, for at least one well known storage protectant this has been attributed to under-dosing. Under-dosing probably occurs because farmers are either unable or unwilling to pay for enough insecticide to give a complete treatment. This has a negative effect as farmers come to distrust insecticide use and subsequently suffer unnecessary grain losses. For the grain market this is also undesirable as it reduces the supply of better quality grain and so limits the potential for exports.

One means of improving the efficacy of storage pesticides may be to bring the costs of treatment within the price range of most subsistence farmers. To do this, we have been developing methods of treatment that substantially reduce the amount of insecticide required but still give adequate protection. In Ghana, we tested the efficacy of pesticide treatments restricted to only the bottom 20% of maize cob stores (Fig. 1). Such treatment was successful although losses were a little higher than expected after a complete treatment. We believe that the success in this case is possibly due to behaviour of the initial colonisers of grain. Beetles like the weevils *Sitophilus* spp and the Larger Grain Borer (*Prostephanus truncatus*) have a strong tendency to migrate downwards when first arriving in a grain mass, and will consequently come into contact with the treated bottom layer.

Figure 1 – Typical Ghanian maize cobs store

In Zimbabwe, we decided to test the same technique, but for the protection of small bulks of shelled grain instead. The bottom 20% of the grain bulk was treated with or without the top 10% layer, i.e. reductions of 70% or 80% of the normal full treatment (Fig. 2).

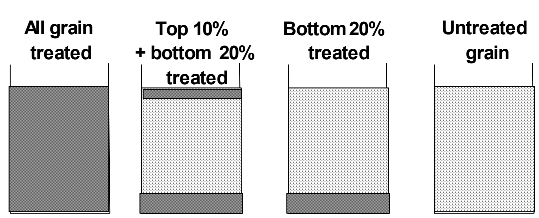

Figure 2 - Treatments tested in farm stores using Zimbabwe maize grain

Two pesticides were included in the trial, Actellic Super and a diatomaceous earth preparation (Protect-it). The latter had already been shown to be a possible alternative to synthetic pesticides for the protection of grain in Zimbabwe.

How we did the trial

An eight-month trial was undertaken at the IAE campus in Harare. Four brick-built farm stores (Fig. 3) were used, each with six compartments able to hold at least 300 kg of maize grain (depth 106 cm). The compartments were in two rows of three separated by a 1.5 m-wide gangway.

Figure 3 – Barns, each with six grain compartments used for the trial

Compartments of the stores were filled with 300 kg of white, dent, hybrid maize. This grain had been fumigated with phosphine. Samples were taken from the grain for estimation of initial weight loss and grain damage using the count and weigh method.

There were six treatments (Table 1), each applied once in each of the four barns giving a total of four replicates for each treatment. When half the grain had been loaded into a compartment, ten 2-week old adult weevils (*Sitophilus zeamais)* were added to simulate pre-harvest infestation.

Treatments were allocated to the compartments in each barn so that no treatment was next to or opposite another on more than one occasion. The Actellic Super dilute dust formulation (active ingredient confirmed at NRI by GC/analysis 1.62% pirimiphos methyl, 0.31% permethrin) was admixed at the manufacturer's recommended rate of 0.5 g dust/kg grain. The diatomaceous earth ('Protect-it') was admixed at 1g dust/kg grain.

Table 1: Treatments used in the trial

Pesticide	Extent of treatment
Control	no treatment
Actellic Super	all grain treated
Protect-it	all grain treated
Actellic Super	top 10% + bottom 20%
Protect-it	top 10% + bottom 20%
Actellic Super	Bottom 20% only

At the end of the trial, the grain in each compartment was sampled using a 1.25 m brass compartmentalised sampling spear (Fig. 4). The spear had three compartments which when inserted into the grain extracted a sample of the bottom, middle and top 20 cm-layers of each compartment. The spear was inserted at nine equally spaced points across the surface of each compartment, giving a bulked sample of about 900 g for each of the three layers. The samples were returned to the laboratory where they were weighed and then sifted for insects that were then identified and counted. Weight loss due to insect damage was determined on two 250 g sub-samples.

Figure 4: Emptying the grain spear used to sample the barn compartments

What we found

At the time maize was loaded into the barns, no live insects were observed except for the *S. zeamais* that were seeded in the middle of each grain bulk. The grain weight loss (± se) was 0.05%± 0.01. After eight months storage infestation by *S. zeamais* was prevalent, especially in the untreated control (Fig. 4) where numbers as high as 1000/kg were recorded. Other insect species observed were *Tribolium castaneum* (Herbst) and *Gnatocerus cornutus* (Fabricius) (Fig. 5). These were distributed throughout the bulk but at much lower numbers than *S. zeamais.* The moth *Plodia interpunctella* (Hübner) was also observed but confined to only the top layers.

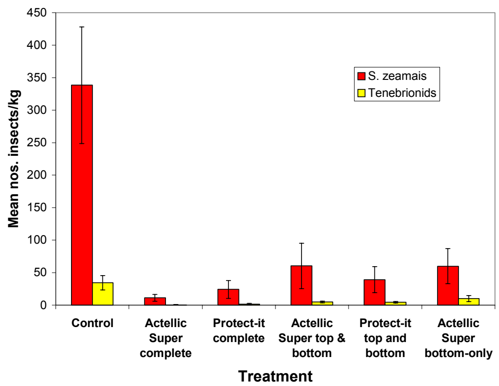

Figure 5: Mean numbers of *Sitophilus zeamais*/kg ±se of tenebrionids (*Tribolium castaneum* and *Gnatocerus cornutus)*/kg ± se infesting maize grain in farm granaries given various treatments (n = 4)

After eight months storage, weight losses were much higher in the control than in grain receiving any of the treatments (Fig. 6). There was a trend for losses to rise as the treatments became more reduced but reducing the treatment by 80% increased average weight losses by only 0.7%.

What we think these findings mean

All the partial treatments used in this trial resulted in good protection of stored grain and all were significantly better than the storage of untreated grain. Under Harare conditions, there was little or no difference in the degree of protection provided by a complete treatment of Actellic Super or the inert dust Protect-it. When pesticide applications were reduced by 70%, top and bottom treatments of Actellic Super or Protect-it, both gave good protection.

However, the overall trend was for Actellic Super to give slightly better results.

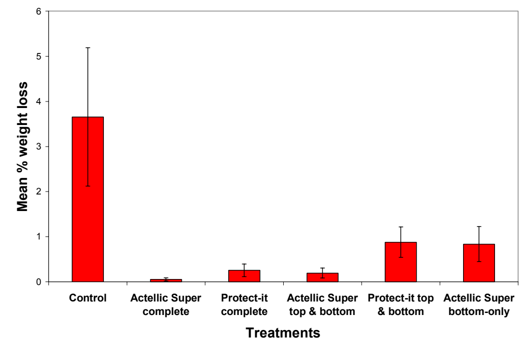

Figure 6: Mean % weight loss ±se due to insect attack in farm stored maize grain given various pesticide treatments and stored for eight months (n = 4)

If farmers are to adopt a partial pesticide treatment then the options are a top and bottom or bottom-only treatment. If they sell or consume the top layers of grain soon after storage then the bottom only option would seem most appropriate although a top treatment could be added in due course. For long periods of undisturbed storage the top and bottom option may offer the best results.

Maximum benefit from the reduced pesticide method will be obtained by those farmers who previously had no protection for their grain because they could not afford a treatment. For those farmers who can afford the full treatment the benefits, aside from the health and environmental considerations, will be in proportion to the ratio between the cost of treatment and the price of maize. This relationship has to take into account the small additional losses that will result if a reduced treatment is adopted. Typical weight losses from untreated grain due to insect attack during storage would be 5% and if this is taken as the norm then losses associated with reduced treatment, observed in the current trial, become 0.3% for top and bottom and 1.12% for bottom-only. If these are the expected losses and it is assumed a full treatment costs 1.95 Zim$/kg, then there is a clear financial benefit from adopting the top and bottom treatment (Fig. 7) when storing long-term. This relationship is probably reasonably reliable when farmers are consuming their own grain and the reduction in losses helps them avoid having to make maize purchases. For farmers who sell grain it is much less certain since the relationship between grain damage, rather than weight loss, and market value is not known.

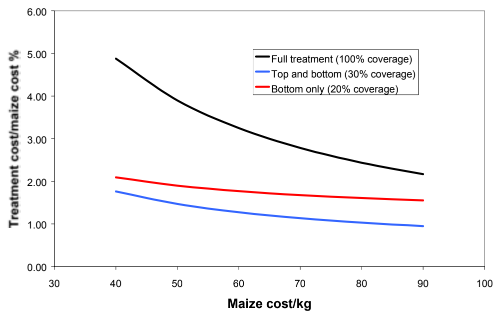

Figure 7: Changing benefit from different approaches to insecticide application as price of maize varies (assuming treatment cost of 1.95 Zim$/kg, and the following weight losses no treatment 5%, top and bottom 0.3%, bottom-only 1.2%)

Next steps

The next phase in our studies will be to work together with farmers to examine whether or not they can benefit from targeted insecticide application and whether other stakeholders such as the insecticide companies will support the proposed method.

The techniques will be assessed by farming communities near Hurungwe in the next maize storage season (July 2001 onwards). You are invited to visit this work as it progresses, however we plan to get everyone together towards the end of the season in March 2002. Stakeholders will be invited for discussion and development of the technique, and samples of grain from the season will be available for assessment.

How you could help

To make our studies a success we are very keen for the participation of all parties interested in helping poorer farmers make the best use of pesticides to preserve their grain stocks. We will be making contact with stakeholders we already know to ask for their participation but if we have forgotten to ask you but you would like to participate then please get in touch with any of the trial team listed below. We would be very grateful for your help.

Trial team

Joshua Karuma -Plant Protection Research Institute, Harare, Zimbabwe (pestmngt@africaonline.co.zw)

Jonas Chigariro - Institute of Agricultural Engineering, Hatcliffe, Harare, Zimbabwe (Jonas@africaonline.co.zw)

Lucy Birkinshaw & Rick Hodges – Food Systems Dept., Natural Resources Institute, Chatham, Kent ME4 4TB, UK (L.A.Birkinshaw@gre.ac.uk)

Main stakeholder groups

- ✓ Maize-farming communities
- ✓ Agricultural extension workers
- ✓ NGO's working in this sector
- ✓ Insecticide producers/distributors
- ✓ Farming unions/networks…