INTEGRATED PEST MANAGEMENT, INCLUDING FUMIGATION PROVISION, OF TRADERS' STOCKS IN NORTHERN GHANA

P. Golob[1], P.S.Tyler [1], B.M.D. Tran[1] and H.F. Andan[2]

[1]Natural Resources Institute, University of Greenwich, Chatham Maritime, Kent, UK
[2]Ministry of Food and Agriculture, Tamale, Ghana

Abstract

Small-scale traders operating in Tamale market store grain for up to five months. Individual traders may store as much as 30-40 t in sacks. Storage facilities and their conditions are very poor. Sheds are constructed with walls of ill-fitting timber planks, roofs of rusty, holed corrugated metal sheets and concrete floors are invariably broken up. Stores are frequently shared by several traders, making good commodity management extremely difficult to implement. These conditions, together with a lack of appropriate knowledge or training, have resulted in traders suffering large losses in both weight and quality of stored grain, principally as a result of insect infestation, including that by the Khapra beetle, *Trogoderma granarium*.

Trials were conducted to assess both conventional insecticide application and novel methods of protection, including: applying inert dusts; covering stacks with treated cotton or polythene sheeting; and phosphine fumigation. A system was developed allowing an integrated approach to grain protection to be introduced, which included improvements to store hygiene, albeit at a minimal level. Furthermore, a small, fumigation centre was constructed adjacent to the market, which enabled centralised disinfest commodities before storage. This centre, constructed for $15,000, together with the IPM system, could provide a practical template for traders in other African countries.

Introduction

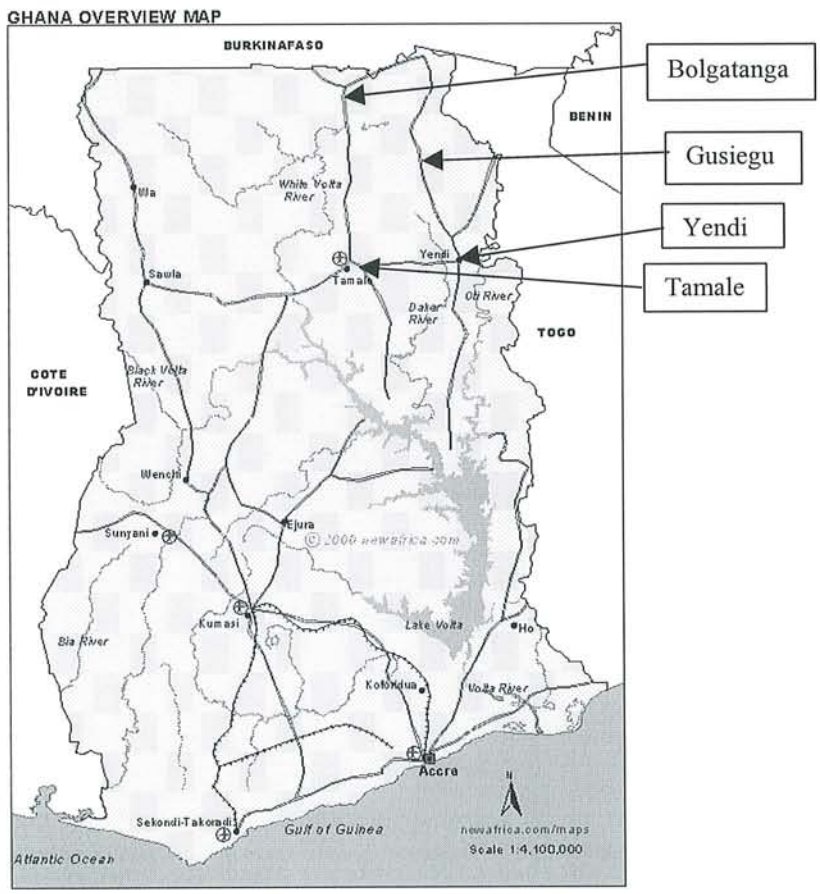
Until some ten years ago, the procurement and distribution of the major food staples in Africa was the responsibility of large parastatal marketing corporations. These bodies often took care of the entire needs of the farmer, providing seeds, hoes, fertiliser, insecticide, sacks, transportation for the crop and, often, credit. These marketing boards were responsible for the crop from the moment it was sold by the farmer until it was resold to the consumer or exported. Boards had buying and collection points in the rural areas and large warehouses and silos in the cities. They carried out essential crop management procedures including all pest control operations. Each board had its own dedicated pest control teams whose members were trained in all relevant procedures, including the use of phosphine and methyl bromide fumigation. Even though these teams were often relatively inefficient they did generally successfully protect the crop against pest damage whilst it remained in the board's stores. In many countries, apart from the occasional large-scale milling enterprise, which produced meal for urban populations, the private sector was either outlawed or, at best, tolerated but severely discriminated against. All resources were allocated to the parastatal boards, nothing to the private sector.

Since 1990 the responsibilities of the marketing boards has greatly diminished. The imposition by IMF, World Bank and other donors of structural readjustment programmes, together with the liberalisation of agricultural marketing, has resulted in an upsurge of the private sector. Most of the functions of the grain trade, including procurement, storage and marketing, has passed into the hands of private enterprise. Traders now buy directly from markets and they resell to retailers, wholesalers or exporters. Where grain is stored it is done so by traders, with the exception of that

retained for national strategic grain reserves, which remain the responsibility of government.

The switch from government to private sector intervention in grain procurement and storage happened very rapidly. Insufficient time has passed to allow traders to develop an expertise in the various aspects of managing the system. Traders spend all of their time attempting to maximise profits and this is most easily achieved by turning stocks over quickly. It is only in recent years, in some countries where it has become apparent to traders, that there are advantages to be gained by storing. However, traders are ill equipped to take on this role as they possess neither training nor suitable infrastructure to enable them to make the best use of the system.

This paper describes an example of trader storage in one country in Africa, Ghana and shows how some of the problems have been overcome.



Trader storage in Tamale market, Northern Region, Ghana

Tamale is the capital of Northern Region. Its main market acts as a collection centre for many town and rural markets throughout the Region and for main markets of adjacent Upper East and Upper West Regions. It is also a distribution point for produce supplied from southern Ghana and Burkina Faso, supplying communities in the north during the lean season between July and September. Wholesalers also purchase commodities for transportation to the major markets in the southern cities of Accra, Kumasi and Cape Coast.

For much of the year, Tamale is purely a transit centre, crops remaining in store for just a few days at most. However, between October to December traders buy locally to store, particularly cowpeas, maize, sorghum and groundnuts. These commodities are then resold in May just before commodities from the south flood the market. During storage, produce becomes heavily damaged by a variety of insects, including the Khapra beetle, *Trogoderma granarium.*

Grain quality and prices

Poor quality grain affects prices obtained at market, especially at periods of peak demand. Traders in the main markets frequently store cowpeas for 4-5 months before selling on to wholesalers from the urban communities in the south, in order to add value to the commodity. Grain of high quality fetches a premium both for the local trader and for the farmer, particularly as insect-damaged grain is difficult to find. However, whilst the grain remains in the traders' store, insect damage may increase significantly. Spot checks in Ghanaian markets have shown that damage in cowpea, for example, may exceed more than 50% holed grain (Gudrups *et al.*, 1997).

A small survey was undertaken in Tamale market to determine the extent of insect damage that occurs during storage. Samples of cowpea were collected monthly from a randomly selected small group of traders, some of whom carried out some method of pest management though the majority did not. Table 1 illustrates the results obtained.

Table 1. Insect damage in Traders' stocks of cowpea stored at Tamale market

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Percentage damage in traders' stocks with no treatment									
Imoro Mahama	4	21	44	54	58	61	sold		
Abdul Azzis	4	6	10	49	58	59	62	65	sold
Abdulai Alhassan	-	10	20	20	35	37	72	75	sold
Alhadji Moro Shaibu	-	-	18	21	-	28	30	sold	
Issaka Nichema	12	-	20	35	46	sold			
Average	6.67	12.25	22.35	35.70	49.19	46.35	54.67	70.00	
SEM	2.667	4.404	5.659	6.985	5.498	8.215	12.667	5.000	
Percentage damage in traders' stocks with treatment									
Tahiri & Amadu	9	19	42	59	63	sold			
Fuseini Nabila	3	3	3	4	3	4	5	6	sold
Mahamadu Iddrissu	2	2	3	4	-	32	33	37	sold
Average	4.58	8.13	15.90	22.17	32.75	17.75	19.00	21.50	
SEM	2.103	5.641	13.151	18.167	29.750	14.250	14.000	15.500	

At the beginning of the storage season, most of the cowpea on sale on the market had little to no insect damage. Conversely, after several months of storage, all the cowpea was damaged, and it was almost impossible to find good quality grain, without holes. The effect of grain treatment was very variable, only one of the three traders was able to maintain the grain in good condition beyond four months storage. This was a reflection of the poor condition of stores and pest control practices.

Until recent years, quality has not affected market price (Golob *et al.,* 1996) because it has been difficult to find good quality grain other than just after harvest. Price was solely reflected by supply and demand so that, towards the end of the storage season, when food is relatively scarce, even very heavily damaged cowpea was expensive. However, with the entry into the market of southern traders supplying to relatively sophisticated urban markets, price differentials based on quality have begun to appear. Loss of quality has resulted in a loss of income, which is passed back to the farmer. For example, in Tamale market in 1997, in April, large clean cowpea sold for 120,000 cedis per sack whereas cowpea that had 25% damage was 106,000 cedis, a 12% loss in value, and when prices dropped to their lowest level in August this loss of quality resulted in an 18% loss in value (Bediako, 1998).

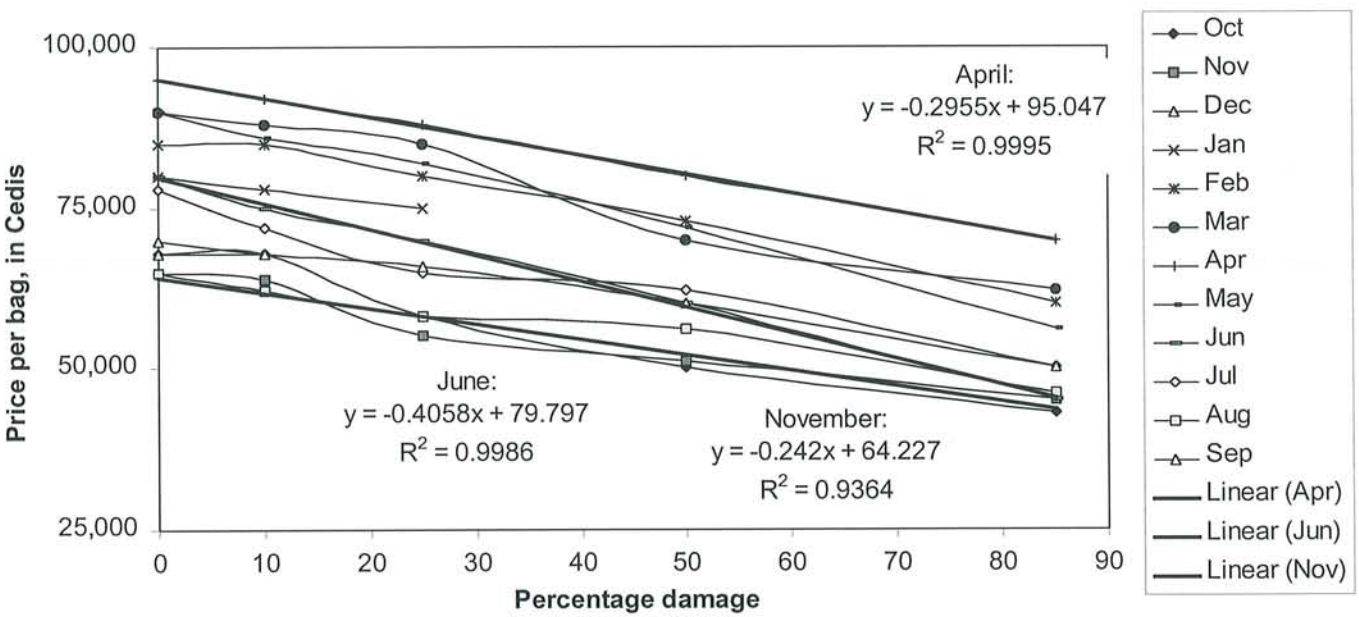


Figure 2 The relationship between grain damage and market price offered for cowpea in northern Ghana

A recently conducted study has demonstrated, for the first time, a connection between price of grain legumes and the presence of insect damage in northern Ghana. Batches of grain (5 kg) with levels of damage of 0%, 10%, 25%, 50% and 80%were artificially created. These were frozen and then presented every month to traders, who were asked to value them, in five markets in northern Ghana. Although the data collected during this study does not necessarily reflect actual market prices (as specific grades may have not been traded every month), the estimated prices provide a useful insight into the relationship between price and quality.

In the Tamale catchment towns of Bolgatanga, Bowku, Yendi and Gushiegu, prices increased steadily during the storage season. The prices given by traders did not differentiate between low levels of damage (0% and 10%), but higher levels of damage imposed lower prices. In Tamale itself, where the situation was somewhat different, prices reach a peak in May then fell, the effect of damage on the prices was

more marked. The relationship is clear, as demonstrated by significant regressions between the price and the percentage damage for every month except January when 25, 50 and 80% damage were not tested (figure 2).

The grain traders in Tamale market

The market comprises permanent stalls and stores of the wholesalers together with innumerable small retailers and sellers. The infrastructure is basic. The roads and paths are compacted earth and lack drainage. Apart from the butchery and a few rows of small shops there are few substantial buildings. A typical grain trader's premises is usually rented from the Municipal Council rather than personally owned and may be sub-let or jointly shared with others. It adjoins others along a row and is constructed from rough timber and corrugated metal sheet. The floors are uneven either bare earth or with a thin cement rendering which is cracked. Partition walls are mostly timber planks with spaces between, occasionally of cement plastered block construction. Dunnage poles and timber offcuts are commonly used under the bag-stacks.

There is no bulk storage of grain. Traders use the 100kg 'maxi-bag', which is frequently stuffed to 110-120 kg. (Other than for shea nuts, bag scales are rarely used in the market.) There is an abundant supply of second-hand cocoa sacks made of strong jute (B twill). Woven polypropylene (wpp) bags are available but they are not favoured for the storage of grains, particularly cowpeas, due the risk of heating and mould damage.

Figure 3 Typical trader store at Tamale market

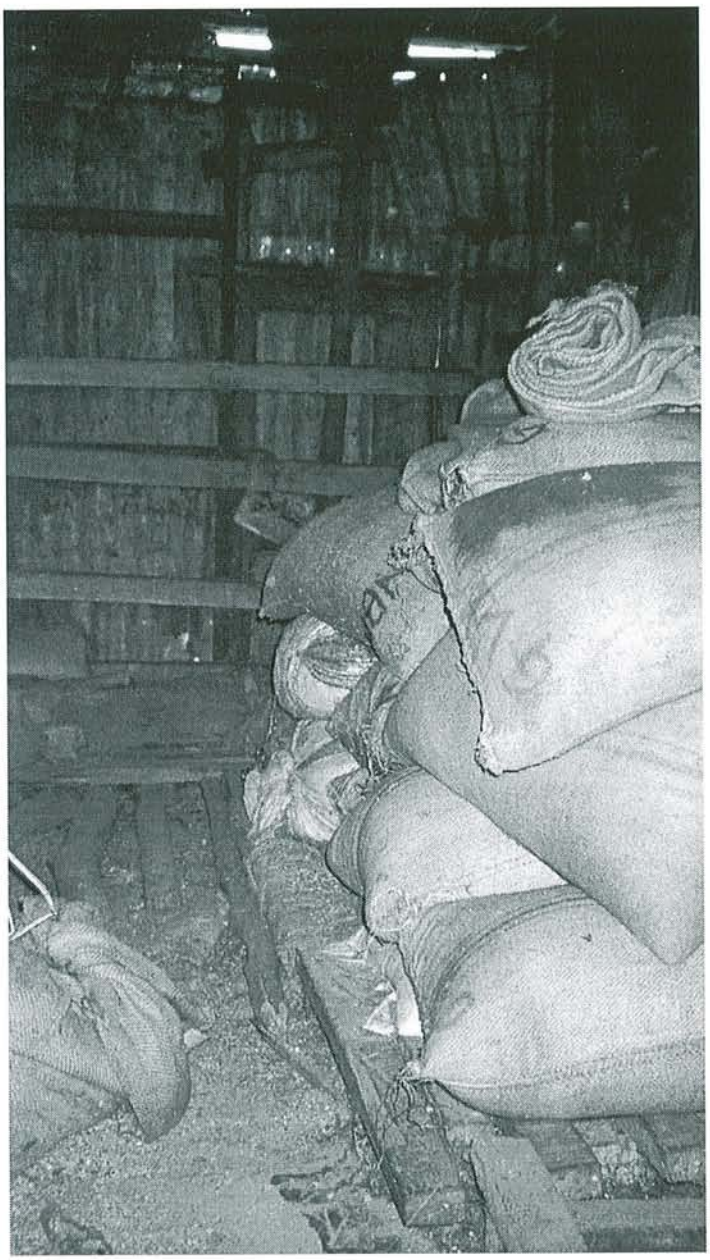


Figure 4. Internal view of typical trader's store showing a corrugated metal wall, broken concrete floor with exposed earth surface, and very poor stock maintenance.

The grain market functions at minimal operational and storage cost. The labour-intensive bag handling system is possible because of the abundance of very cheap, casual, manual workers. Competition for grain is strong so minimising overheads is a

major consideration in profitability. There is widely expressed concern that insect pest infestation is a problem that cannot be ignored if financial losses are to be avoided. However, the task of improving individual stores and the market overall is daunting both for the municipal authority, the Tamale District Council, and the individuals involved. The total number of places in the market used for the storage of durable grains is said to be well over 350. Of these many are shared by four or more traders so the total number of people actually handling and storing grains and pulses in whole bags is probably as many as 1000. The number of bags a trader will hold at any one time ranges from 2-5 bags, up to 300 or more, most appearing to have 20-80 bags. In the main buying season there are daily deliveries and collections frequently using articulated lorries with a carrying capacity of over 400 bags (40T). Orders placed for large consignments are rare unless made by NGO's. There is an understandable reluctance by traders to discuss and disclose personal business information.

Those who attempt any pest control use a variety of methods. These include:

- laying grain out in the sun (but limited to few areas where there is space),
- employing women to winnow out insects (and foreign matter),
- inserting camphor tablets in the bags,
- admixing insecticides (Actellic, Dursban and carbaryl),
- using aluminium phosphide tablets (up to two tablets per bag or sprinkled loose in the store). Old tarpaulins, rather than gas proof sheets are sometimes used as covers.

The understanding of what they are using or mis-using and the implications and risks are not appreciated. Winnowing insects out of grain for them then to fly into your neighbour's store is inconsiderate, in the least. But much more hazardous is the indiscriminate use of aluminium phosphide in very densely populated work areas; the smell of phosphine was frequently detected. Similarly some of those admixing insecticide had no concept of correct dosage.

The solutions: the Fumigation Centre

The poor storage conditions make the use of phosphine both immaterial in terms of efficacy and extremely dangerous. To overcome the problems and to enable a good standard of store management to be introduced, the market premises need to be comprehensively overhauled. However, even when this is completed traders will still be unable to carry out successful fumigation because of the limited room available and the close proximity to people working in the area.

One way to overcome some of these problems is to provide traders with a communal treatment facility rather than to attempt to improve each individual's storage structure. The UK Department for International Development (DFID) Crop Post-Harvest Programme (CPHP) in consultation with the Tamale Traders Association and the Tamale Municipal Assembly, who provided land, designed and constructed a small Fumigation Centre immediately adjacent to the market. Funds to construct the Centre were donated by the British High Commission in Accra. The site is approximately 120 x 30 m. It comprises a raised concrete hardstanding for under sheet fumigation (capacity approximately 250 t), half of which is covered, a 20 t container for use as a

fumigation chamber, a small office and a large area for loading/unloading trucks and hand carts. The perimeter is surrounded by a chain link fence for security.

The management of the site and the fumigation work is conducted by trained personnel employed by the Ministry of Food and Agriculture and the CPHP. Traders pay a small fee for each bag fumigated, which covers the running costs of the centre and includes a small profit, which is ploughed back into maintenance and improvements. Once the Centre has been functioning efficiently for 2-3 years it will be handed over to the Traders Association and Municipal Assembly in order to assure sustainability.

To date, the Centre has operated through one storage season. Over 1000 bags of grain have been fumigated. However, traders have been reluctant to use the facility because they do not wish to exposure disinfested commodity to the insect populations that are dormant within their own stores. Some traders have overcome this risk by storing their grain at the Fumigation Centre. This is a service provided for a small fee but is only temporary as the storage capacity of the Centre is relatively limited. The remaining priority is to renovate and upgrade the market stores so that they are safe for storage.

The solutions: residual protection

Fumigation will not, of course, provide long-term protection to the grain. As soon as the fumigation has terminated after five days (average ambient temperature 32°C) the commodity can be reinfested. In order to provide long lasting protection trials were conducted by the CPHP to assess a variety of alternative procedures.

Three, small, retail lock-up shops were rented in the market in which the trials, which became demonstrations, were conducted. Each lock-up was approximately 4 x4 x 2.5m, constructed of cement rendered concrete walls and with a concrete floor. In each shop 2-4 small bag stacks of cowpea (about 20 bags per stack) were constructed, each being a treatment replicate. All of the commodity was fumigated initially with phosphine (Gastoxin: aluminium phosphide tablets @ 3 tablets/tonne) with the exception of a few bags kept as a control. Some were placed in a room in which the walls and floor had been painted with a slurry of a diatomacious earth, Dryacide® @ 6 g of dust/m^2, others were put into an untreated store. Stacks surfaces were either treated with Dryacide® or covered with cotton or polythene sheeting, which was or was not treated with conventional insecticide. Details of treatments tested each year are shown in table 2. Sacks of cowpea (50 kg) were provided by local traders and remained in store until the trader wished to sell, which in general was after 4-5 months. Grain was examined for insect damage at monthly intervals. This trial was repeated a second year.

All treatments effectively protected the grain against insect attack, including those stacks that were only fumigated (figures 5 and 6). Presumably, immigrating insect populations did not have sufficient time to build up before the grain was sold off. Untreated controls were very heavily damaged. Where storage may be extended or where the insect infestation pressure is severe the use of any one of the simple procedures will provide a cheap effective means of grain protection.

Table 2. Treatments applied to cowpea bag stacks

Treatment	Year 1	Year 2
Untreated	✔	✔
Fumigated only and put into untreated store	✔	✔
Fumigated only and put into store treated with Dryacide slurry @ 6 g dust / m^2		✔
Fumigated and stack surface dusted with Dryacide dust @ 6 g dust / m^2	✔	✔
Fumigated and stack covered with polythene sheet	✔	✔
Fumigated and stack covered with untreated cotton sheet	✔	✔
Fumigated and stack covered with cotton sheet sprayed with Actellic e.c. to give 1 g a.i. /m^2		✔

The future

Traders were very impressed by these demonstrations and clamoured to be allowed to provide grain for follow-up trials. The demonstrations clearly illustrated not only the benefits of the individual treatments tested but also the advantages to be gained by maintaining a good level of hygiene and management. Traders now know what can be achieved and are anxious to acquire improved facilities for their own use. However, the acquisition of new or improved stores will not be suficient to uprade the quality of stored grain. It is absolutely essential that traders themselves undergo comprehensive training so that they understand and can practice good stock and pest management. Funds are currently being sought to enable a training programme to be initiated and also to renovate a small area of the market.

The municipal authority, the Tamale District Council, which owns the market is fully supportive of the need to make improvements and similar enthusiasm has been shown by various trader associations operating at the market. The will to change is present, it is only the funding that is lacking.

Use of improved stores in conjunction with the Fumigation Centre will inevitably result in an improvement in quality of marketed grain. Increased prices, which are dependent on quality, will be passed back to farmers to ensure they supply traders with the requisite type of grain. Farmers living in rural northern Ghana are among the poorest people in Ghana. Any opportunity for increasing income, which will result in an improvement of their standard of living, must be welcome as it will have a significant impact on poverty reduction.

Figure 5 Residual protection provided by different treatments on small bag stacks of cowpea in small enclosed traders-type stores in tamale market: year 1

Note: Grain was provided by traders in the market as the experimentation was used as a demonstration as well. Each treatment consisted of one stack of 20 100 kg bags, except for the grain which was only fumigated for which there were two stacks. Only two sacks of untreated grain were used as this was predicted to be unfit for sale by the end of the storage pweriod Samples were analysed separately for each sack and the mean and SDs are recorded on the graph for each stack.

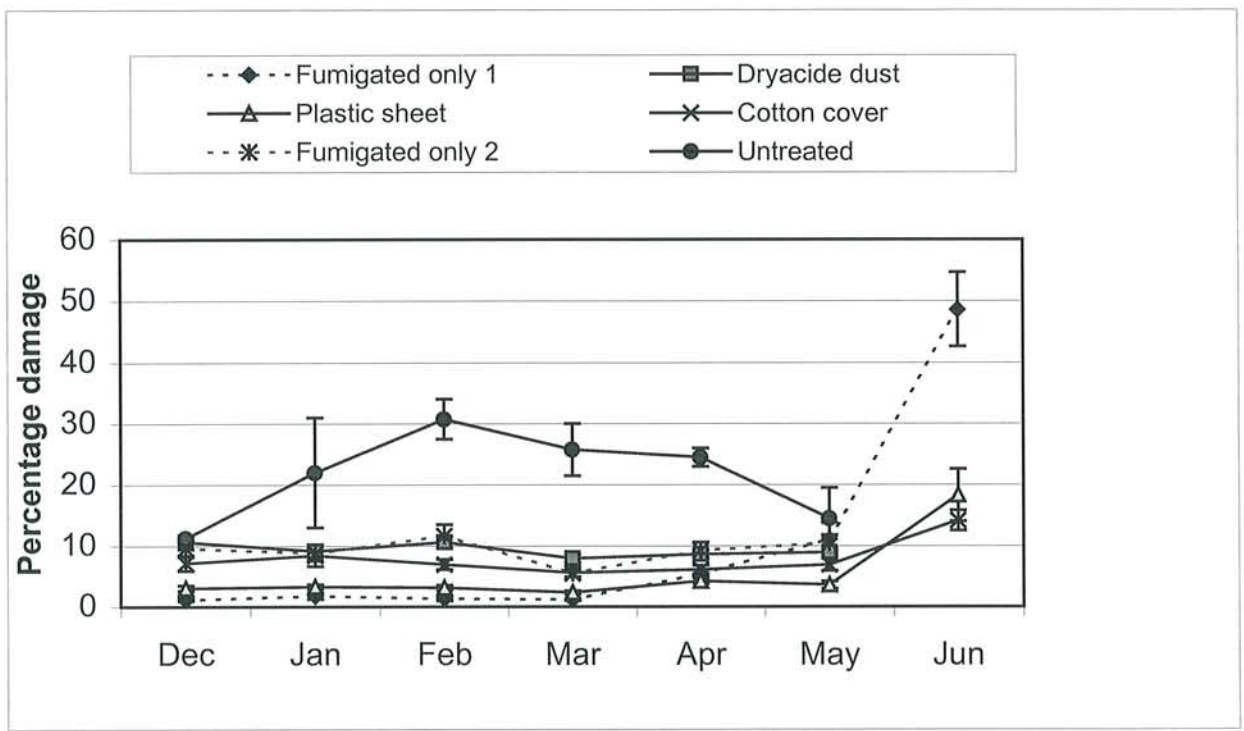
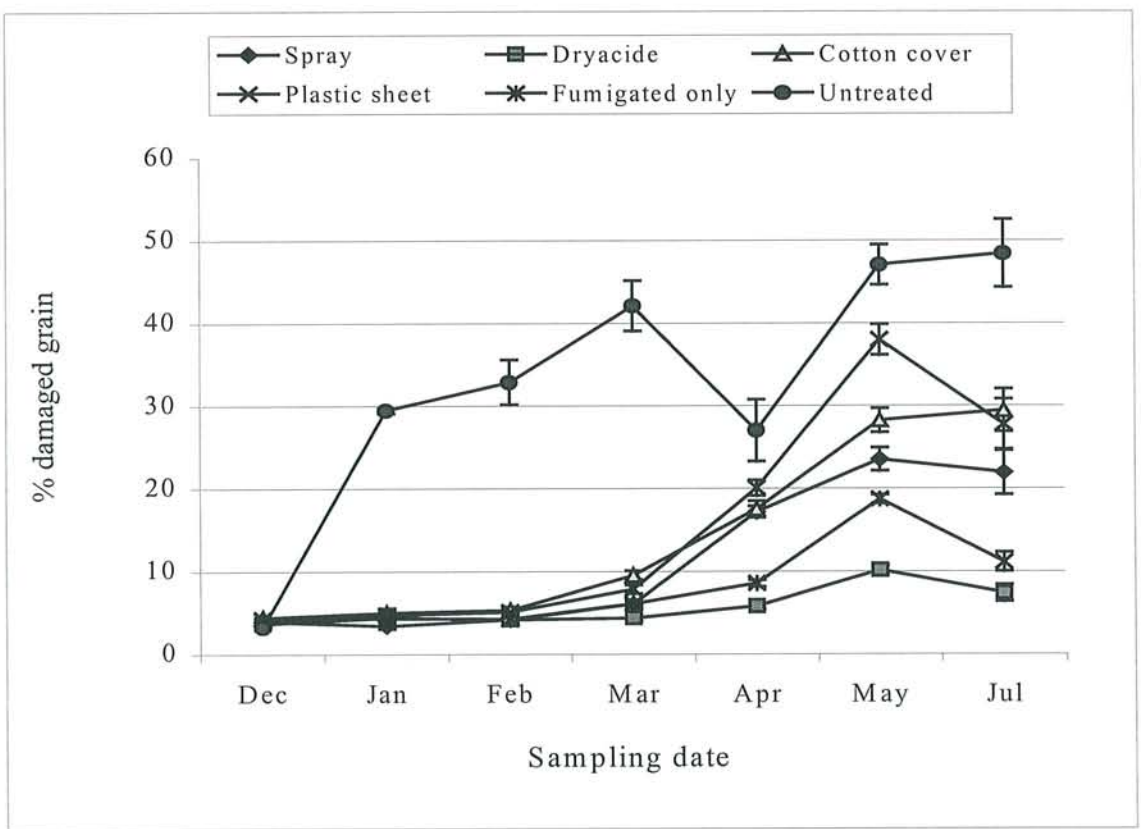


Figure 6 Residual protection provided by different treatments on small bag stacks of cowpea in small enclosed traders-type stores in tamale market: year 2

Note: This was a similar experiment to that conducted in year 1 except that two stacks of 20 bags were used for each treatment. As there was no difference in damage levels between stacks placed in the store treated with Dryacide slurry and that not treated the results of the other treatments were combined for the two stores.



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