Evaluation of the Efficacy of Deltamethrin Incorporated Polysack Bags for the Control of Stored Grain Pests of Maize during Storage

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Abstract
A study was conducted to evaluate the efficacy of insecticide (deltamethrin) incorporated bags (Zerofly) against the insect attacks during maize storage under Sri Lankan conditions. Maize sample in Zerofly sacks were stacked as the treatment and for control, untreated polysack bags were used. Maize samples that were collected before store and monthly intervals during the storage period were analysed for moisture content, weight loss due to insect damages, Thousand Grain Mass (TGM) and kernel colour. Data was analyzed using Analysis of Variance (ANOVA) by Statistical Analysis System (SAS). The moisture content of maize grains fluctuated between 11.9%-12.8% during storage period but any significant difference was not observed between bag types. The level of insect damages in control increased with storage from 0.44% to 9.60% while the initial level of insect damage of treated bags remained unchanged. The mass loss due to insect damages of grains was significantly higher ($p<0.05$) in untreated bags than treated bags. The insect damage was reduced by 9.06 % using Zerofly bags during maize storage. In addition, dead insect bodies were found on outer surface of the insecticide incorporated bags but no live or dead insects were found on untreated bag surface during storage. Mainly rice weevil (*Sitophils oryza*) and lesser grain borer (*Rhysopertha dominica*) were found in maize samples of untreated bags and number of insects increased with time. Figures of thousand grains mass and grain hardness of maize seeds of control were significantly lower compared to treated bags ($p<0.05$). The study revealed that deltamethrin treated bags are appropriate packaging material to protect stored maize from insect infestations.

Keywords: Grain quality, Insect damage, Maize storage, Zerofly bags
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Introduction
A major loss of grain in the postharvest system occurs during storage due to improper and inadequate storage facilities. The loss assessment studies conducted in Sri Lanka have shown that nearly 13 to 18% of maize was lost during post production operations of which a greater amount waste during storage period (Fernando *et al.,* 1988). Gunathilake and Thilakarathene (2013) have further reported that insect damage was one of the major reasons for weight loss of stored maize grains. Improving the proper storage techniques may help in increasing the income of farmers and traders not only by reducing these qualitative and quantitative losses but also through sale of produces during off season at higher prices. Application of insecticides and fumigation are main insect pest control methods practiced in Sri Lanka. Storing grains in a hermetic storage structures is another way of controlling insect control.

A novel and innovative tool, an insecticide-incorporated polypropylene sacks, is designed to protect commodities (grains and seeds) against destructive insect pest infestations during storage. Zerofly storage bags are a woven polypropylene bag of 35 kg size, developed for postharvest storage of grains. The active ingredient, Deltamethrin, is incorporated in the polypropylene yarns woven together, and the active ingredient is released on the surface of the material in a sustained manner so that the commodities stored in the sacks are continuously protected against insect infestation (Ravi, 2012). The deltamethrin concentration of bags material is $318 mg/m^2$ and it is effective for two years. Wasala *et al.* (2014) revealed that deltamethrin incorporated bags provide powerful killing action against the common insects found in Sri Lanka and insects were unsuccessful in boring this bag materials.

This study was carried out for evaluation of the efficacy of deltamethrin incorporated bags on maize storage under local condition.

Materials and Methods
Experimental setup: The study was conducted at grain storage section of Institute of Post Harvest Technology (IPHT), Anuradhapura under $29^0C \pm 4$ of ambient temperature and 67%, ±5 of relative humidity. Maize harvested at Maha: 2013/2014 season was purchased and dried to about 13% of moisture content. Then

the whole maize stock was fumigated to ensure that maize grains were total free from any insect infestations. Maize sample bagged in Zerofly sacks were stored at IPHT warehouse, and untreated polysack bags were used in same warehouse as control for five months of period. All the treatments and controls were replicated three times for the experiment.

Data collection and quality analysis: Composite maize samples were collected at initial stage and at each monthly intervals during the storage period and were analyzed for moisture content, weight loss due to insect damages, thousand grain mass, grain hardness and kernel colour. Ambient temperature and relative humidity were also recorded daily.

Moisture content of maize grains was measured according to AOAC method. Insect-damaged kernels were separated from good kernels in a sample of 50g of maize. Number and weight of damaged and undamaged kernels also were recorded, and mass loss due to insect damage was determined using following formula,

$$\text{Mass loss due to insect damage} = \frac{UNd - DNu}{U(Nd + Nu)} \times 100\%$$

Nd - Number of insect damaged grains
D - Weight of insect damaged grains
Nu - Number of undamaged grains
U - Weight of undamaged grains

Thousand grains mass (TGM) was obtained by measuring the mass of 1000 maize grains collected from each samples. Kernel colour was measured using colour difference meter (Model: Minolta 400), and colour was recorded as L, a, b values. Compression test (yield stress) was carried out to measure maize kernel hardness using grain harness tester.

Data analysis: The experimental design was Completely Randomized Design (CRD). Data gathered was analysed using Analysis of Variance (ANOVA) by Statistical Analysis System. Differences between treatment means were obtained by Duncan's multiple range test at 5% significance level.

Results and Discussion

Grain moisture content (MC): As can be seen in Fig.01, the moisture content of maize grains

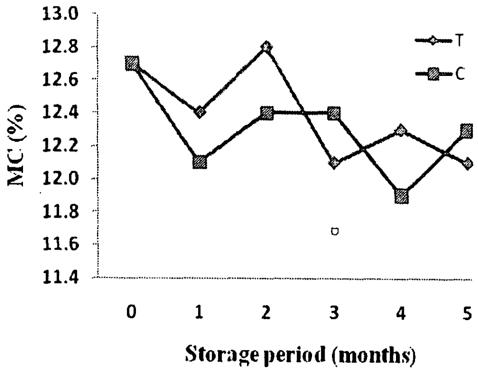

Figure 1: Change in moisture content of paddy grains during storage (T: Treated bags, C: Control)

fluctuated between 11.9%-12.8% during the storage period. However, any significant difference was not observed among storage bag types proving that moisture migration between grains and atmosphere is almost same of maize stored in both treated and conventional polysack bags.

Insect infestations: The level of insect damage increased in control while the level of insect damage of treated bags remained unchanged during the whole storage period (Table 1). Damage due to insect infestation was significantly higher ($p<0.05$) in maize samples drawn from untreated bags than to treated bags at every sampling time.

In addition, dead insect bodies were observed on outer surface of the insecticide incorporated bags but no live or dead insects were found on untreated bag surface during storage time. Any type of live insects were not present in treated bags during storage while few insect types; mainly rice weevil (*Sitophils oryza*) and lesser grain borer (*Rhysopertha dominica*) were found in maize samples drawn from untreated bags and number of insects increased with time. Therefore, it is obvious that deltamethrin incorporated polypropylene bags can prevent insect pest attacks to stored maize grains.

Table 1: Mass loss due to insect damage of maize grains during the storage

Treatments	Insect damage (%)					
	Initial	1 months	2 months	3 months	4 months	5 months
Treated bags	0.42^a	0.41^b	0.36^b	0.38^b	0.51^b	0.44^b
Control	0.42^a	1.66^a	3.37^a	5.94^a	7.28^a	9.60^a

Values with same letters in columns are not significantly difference ($p>0.05$)

Table 2: changes in grain quality parameters during the storage period

Grain quality parameters/ Treatments		Storage period					
		Initial	1 months	2 months	3 months	4 months	5 months
TGM (g)	T	156.3[a]	154.4[a]	156.5[a]	150.4[a]	151.8[a]	152.9[a]
	C	156.3[a]	148.2[a]	144.2[a]	140.3[b]	139.5[b]	134.7[b]
Hardness(N)	T	16.13[a]	16.30[a]	15.77[a]	14.69[a]	13.49[a]	12.80[a]
	C	16.13[a]	15.63[a]	14.23[a]	13.29[ab]	11.83[b]	10.70[b]

Values with same letters in column for each parameter are not significantly difference ($p>0.05$)
T1: Treated bags stored, C: Control

Wasala *et al.* (2014) reported that insecticide incorporated bags showed powerful killing action to insects and no insects can bore through this bag material.

Change in grain quality parameters: The changes in grain quality parameters; thousand grain mass (TGM) and grain hardness are shown in Table 2.

During the five months of storage period, TGM of maize stored in treated bags showed slight fluctuations which similar to pattern of grain moisture content. Kunze and Wratten (1985) reported that, there is a positive correlation relationship between TGM and MC of paddy. However, a significantly lower value of TGM was observed in maize samples drawn from untreated bags where higher level of insect infestation was resulted.

Significantly lower values grain hardness were observed for maize grains in control compared to treated bags three months after storing although this parameter declined with the storage period in both treatment and control. Maize kernel colour of grains that had been stored in treated bags became slightly lighter with the time of storage; however, the L value (lightness value) showed a high level of reduction, from 62.53 to 52.19 because kernel colour of insect infested grains gets deteriorated.

Conclusion

Deltamethrin incorporated polypropylene bags exhibits a complete protection against the insect pests during maize storage at ambient conditions. In addition, maize grains stored in treated bags with deltamethrin maintained the quality parameters comparatively at higher levels. Insecticide corporate bag type is an appropriate packaging material for long-term paddy storage to minimize the post harvest grain loss.

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References

Fernando MD, Palipane KB and Adikarinayake TB 1988. Improvement of farm level grain storage methods in Sri Lanka. Tropical postharvest technologist, 01:47-67.

Gunathilake DMCC and Thilakarathne BMKS 2013. Effect of modified atmosphereric conditions of hermitically seales large capacity cocoons for storage of maize seeds (*Zea maize)* Proceedings of International Symposium on Agriculture and Environment, Faculty of Agriculture, University of Ruhuna, Sri Lanka: 107-110.

Kunze OR and Wratten FT 1985. Physical and mechanical properties of rice. In: JuliamoBO, editor. Rice chemistry and technology AACC USA: p 28.

Ravi PE 2012. Stability of Deltamethrin incorporated polypropylene bags when exposed to different weather and residues in grains, Study report, Institute of Biotechnology and Toxicology, Tamil Nadu, India.

Wasala WMCB, Dissanayake CAK, Gunawardhane CR, Wijewardhane RMNA, Gunathilake DMCC and Thilakarathne BMKS 2014. Sensitivity and boring ability of Rice weevil (*Sitophilus oryzae*) and lesser grain borer *(Rhizopertha dominica)* for insecticide incorporated grain storage bags. Proceedings of ISAE, Faculty of Agriculture, University of Ruhuna; 51-54.