International Scholars Journals

Frontiers of Agriculture and Food Technology Vol. 2 (1), pp. 001-004, January, 2012. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Comparative study of storage methods of maize grains in South Western Nigeria

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Accepted 23 September, 2011

Laboratory experiment was conducted to assess the efficacy of different storage methods of maize grains in Ibadan (a humid tropical ecology) between year 2002 and 2003. The results shows that storage methods (SM), treatment (Tr), SM x Variety (V) and Tr x V interactions were highly significant for numbers of undamaged maize grains (P<0.05). Second order interaction (SM x Tr x V) was highly significant for undamaged maize grains, while first and second order interaction were also highly significant for initial kernel weight, kernel weight loss, remained kernel weight (RKW), percentage weight loss, tolerance level, as well as number of insects pest responsible for the damage.

Key words: Storage method, Remain kernel weight, Tolerance level, storage treatment.

INTRODUCTION

Insect pests are one of the major organisms that are responsible for decline in quantity, quality and germination potential of maize seeds in storage. Adequate and effective storage of maize grains is therefore a major research thrust for enhanced maize productivity in order to reduce the huge economic loss. Similarly, Boxall (1998) reported that common strategy in many African countries is to sell maize grains immediately after harvest, to avoid losses to insect pests. Although, in traditional storage system, losses are usually well contained at about 5% (Tyler and Boxall 1984), National Stock Product Research Institute (1988) reported an effective maize storage using fumigated maize, stored in gourds for a period of ten months as against non-fumigated maize, stored in similar containers, but, were badly damaged three months after. Birkinshaw and Hodges (2000), on the other hand reported a high degree of protection in mud silo and traditional cob-storage structures when pesticides application is reduced by 50 and 80% respectively.

Reports from Zimbabwe have demonstrated the value of diatomaceous earth as alternative grain protectant to organophosphate insecticides for sorghum, maize and cowpea. It was also observed to be effective as the conventional insecticides for a period of 40 weeks (Stathers, 2000). The objectives of this study therefore were (i) to evaluate the efficacy of different storage methods of maize grains (ii) and, to recommend suitable storage methods for maize stake holders especially in South western humid environment of Nigeria.

MATERIALS AND METHODS

A laboratory experiment was set up to investigate the efficacy of various storage methods of maize grains using different containers under different treatment effects. The trial which lasted for 12 months (September 2002-2003) was designed as a factorial experiment with two treatments (Phostoixn and non-Phostoxin effects). Three maize varieties (DMR-LSR-W, DMR- LSR- Y and Local maize variety as check), four storage methods (Tin, Nylon bag, Plastic containers and earthen clay pots) resulting in the following twenty four treatments:

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Table 1. Agronomic parameters of maize under various storage systems.

Source of variation	Df	Number of seed damaged	% weight loss	% tolerance level	No of insect responsible for damage
Storage method (SM)	3	6.36**	4.16**	6.40**	9.83**
Treatment (Tr)	1	18.64**	26.96**	13.83**	62.61**
Variety (V)	2	25.98**	26.29**	21.30*	66.54**
SM x Tr	3	1.92	4.69**	1.84	7.71**
SM x V	6	3.10**	5.09**	2.89**	6.32**
Tr x V	2	29.44**	20.69**	23.32**	59.01**
SM x Tr x V	6	5.14	5.45**	5.55**	8.50**
Error	48	4.76	1.09	5.00	0.12
Total	74				

*,** Significant at P<0.05 and 0.01 respectively. SM: storage method. Tr: treatment. V: variety.

TP Y: Tin container with phostoxin and yellow seeded maize.
TP^oY: Tin container without phostoxin having yellow seeded maize.
TP W: Tin container with phostoxin and white seeded maize grains.
TP^oW: Tin container without phostoxin having white seeded maize.
TP C: Tin container with phostoxin and with local maize variety.
TP^oC: Tin container without photoxin having local maize variety.

The other eighteen treatments were coded in similar manner by substituting *pl* for plastic container, *N* for Nylon container, and *E* for earthen pots. P and P^o similarly denote phostoxin and non-phostoxin treatment effects, While Y and W represents yellow and white maize seeds respectively (Table 2).

Each container consists of 100 non-infested clean maize grains. The trial was replicated four times and was arranged in a randomized complete block design. The containers were placed on the benches of the Seed Testing Laboratory of the Institute of Agricultural Research and Training (IAR&T), Ibadan at room temperature.

The following data were taken from each of the treatment on monthly basis and were pooled for statistical analysis: Number of seed damaged by pests, weight loss (%), percentage pest tolerance (%) (by counting number of undamaged seed from non phostoxin treatment), and number of insect pest responsible for the damage.

Data were subjected to statistical analysis using SPSS package for the analysis of variance (ANOVA), while separation of pertinent means were done for the significant parameters. First and second order interactive means were computed to determine the level of interaction among the significant factors. Similarly, Pearson correlation coefficients of maize seed parameters were computed to determine relationship among these factors.

RESULTS AND DISCUSSION

The results from ANOVA showed that storage method (SM), treatment (Tr), as well as storage method x variety (V) and treatment x variety were highly significant for number of maize grain damaged and number of undamaged maize grains (P<0.05). Similarly, second order interaction (SM x Tr x V) was also highly significant for number of undamaged seeds (Table 1). Storage method, treatment, and variety as well as their first and second order interactive means were also highly significant for kernel weight loss, showing differences in the reaction of treatment effects on maize grain parameters. These sources of variation (SM, Tr and V) as well as the first and second order interactions were also highly significant for weight loss, tolerance level as well as number of insect pests responsible for the damage, suggesting their influence on grain weight or losses during storage. SM x Tr was however not significantly different for tolerance level (Table 1), suggesting that pest tolerance level was not directly influenced by storage methods or treatments, but might be genetically controlled.

Number of seed damaged recorded means of 12.20 while TP^oW, TP^oC, PlP^oC, and EP^oC (with means of 34.0, 100.0, 66.30 and 58.33) were markedly different from one another (Table 2). Numbers of undamaged maize seed were also significantly different from one another. Initial kernel weight differed significantly between varieties.

Kernel weight loss was not significantly different in almost all treatments (0.29 to 3.67%) except TP^oC and PlP^oC which differed significantly from all others with means of 13.44 and 11.07%, respectively. TP Y, TP^oY and TP W differed significantly from others probably showing superiority of the DMR-LSR-W and DMR-LSR-Y over other varieties tested, much so that DMR-LSR-Y maize stored in tin without phostoxin weighs as much as those treated with phostoxin. The three treatments weighed 25.56, 26.34 and 25.54 g respectively after storage (Table 2). Percentage tolerance in all treatments were generally high (92.33 and 100.00%) except for TP^oW, PlP^oC and EP^oC with tolerance levels of 66.00, 33.33 and 62.67% respectively (Table 2).

Weight loss was positive and only significantly correlated with number of insect responsible for damage(r=0.93**) and % weight loss (0.99**), while it was negative and significantly correlated with number of insects responsible for the damage (r=-0.75**, -0.76**). Percentage weight loss, however, was positive and significantly correlated with number of insect responsible for damage (r=0.93**) and negatively correlated with tolerance level (r=-0.76*). Prakash et al. (1985) earlier

Table 2. Means of seed agronomic characters for storage method x treatment x variety interaction.

Treatment	No of seed damaged	No of undamaged seed	Initial kernel weight (g)	Kernel eight loss (g)	Remain kernel eight (g)	% weight loss	Weevil tolerant level	No of insect responsible for loss
TP Y	1.33a	98.67a	25.85bcdef	0.29b	25.56ab	1.11c	98.67a	0.67c
$TP^{o}Y$	1.67d	98.33a	27.20b	0.86b	26.34a	3.16c	98.67a	0.33c
TP W	1.67d	98.33a	25.15cdefgh	0.93b	24.22abcde	3.70c	98.33a	1.33c
$TP^{o}W$	34.00c	66.00b	24.07h	0.53b	25.54abcde	2.21c	66.00b	0.67c
TP C	1.67d	98.33a	24.74efgh	0.75b	24.00abcde	3.01c	98.33a	0.67c
$TP^{o}C$	100.00d	0.00d	24.8.defgh	13.44a	14.78f	54.09a	2.13d	-2.00a
PIP Y	0.33d	99.67a	25.86bcdef	1.24b	24.61abcd	4.75c	99.66a	0.001c
$PIP^{o}Y$	2.67d	97.33a	24.44gh	1.34b	23.10cde	5.59c	96.67a	2.00c
PIP W	3.33d	96.66a	24.44gh	1.34b	23.10cde	5.59c	96.67a	2.00c
$PIP^{o}W$	1.33d	98.67a	25.64cdefg	0.75b	24.89abcd	2.92c	98.67a	0.67c
PIP C	0.33d	99.67a	24.43gh	0.79b	23.63bcde	3.22c	99.67a	0.33c
$PIP^{o}C$	66.67b	33.33c	27.07b	11.07a	15.99f	41.00b	33.33c	19.00a
NP Y	1.33c	98.67a	25.15cdefgh	0.15b	24..98abcd	1.54c	98.67a	1.00c
$NP^{o}Y$	1.33d	98.67a	26.14bcde	1.50b	24.63abcd	5.75c	98.67a	1.00c
NP W	0.33d	99.67a	24.02h	0.50b	23.45bcde	2.37c	99.67a	1.00c
$NP^{o}W$	1.00d	99.00a	25.39cdefgh	0.17b	25.22abc	0.68c	99.00a	1.00c
NP C	1.00d	99.00a	24.02h	0.40b	23.62bcde	1.67c	99.00a	0.33c
$NP^{o}C$	3.33d	97.33a	26.22bcd	2.40b	23.62bcde	9.07c	96.67a	2.67c
EP Y	0.00d	100.0a	26.13bcde	1.34b	24.79abcd	5.11c	100.0a	0.0c
$EP^{o}Y$	7.67d	92.33a	26.35bc	1.53b	24.8abcd	5.80c	92.33a	1.00c
EP W	0.33d	99.67a	25.34cdefg	1.47b	23.87bcde	5.79c	99.67a	0.33c
$EP^{o}W$	1.00d	99.00a	28.64c	3.67b	24.97bcd	12.39c	99.00a	1.0c
EP C	2.67a	97.33a	2.63fgh	2.47b	22.16e	9.74c	98.00a	1.33c
EP^{o} C	58.33bc	62.67b	26.03bcdef	3.47b	2.55de	13.34c	62.67b	9.33b
Means	12.22	88.68	25.56	2.19	23.59	8.48	88.68	2.69
SE	8.73	8.95	0.42 1.06	0.71	0.71	4.17	8.95	1.31

Figures not followed by the same letter(s) in the same column are significantly different from one another.

Table 3. Correlation coefficients of seed agronomic parameters under different storage methods.

		No of seed damage	% weight loss	% tolerance level	No of insects responsible for damage
Kernel Wt (8 WA)	-	-0.22	-0.28*	0.17	-0.32**
No of seed damaged		-	0.75**	-0.79**	0.85**
% weight loss			-	0.76**	0.93**
% tolerance level				-	0.83*
No of insects responsible for damage					-

*, ** Significant at P< 0.05 and 0.01 respectively.

reported that kernel hardness in rice and ratio of length and breadth of grain were positively correlated with the number of adult insects emerged, and, rice grain damaged. This shows the importance of some seed agronomic traits such as length, breadth and texture for tolerance to storage pests. It also implied that, the more damage suffered by maize grains the higher the % weight loss. Tolerance level was negatively correlated with number of insects' pest responsible for the damage (Table 3). Farmers in the sub-saharan Africa generally store their unhusked maize on wooding post. Thapa and Dhakal (1997) estimated 11-25% grain loss due to storage pests using this system. This probably suggests the need for cheaper, more effective and affordable storage methods that may give higher value to stored maize grains.

Generally, kernel weight loss was less than 5% in almost all treatments except TP C, PlP C and EP Y with kernel weight loss of more than 10%. TP C and EP C suffered % seed damage of between 40 and 100%. Any of the storage container used in this study appears good for maize storage especially under fumigation. The use of tin, plastic and earthen pots in storing local maize variety without fumigation should be discouraged. On the other hand, post-harvest handling of local maize varieties should be improved to enhance grain quality.

ACKNOWLEDGEMENT

The contributions of the following technical support staff are dully acknowledged. Mr J.A. Ayanwole and Mrs V.I. Obasemola.

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