Evaluation of Ginger Storage Methods to Minimize Insect Pest Infestation and Retention of Rhizome Quality

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Abstract

An experiment was carried out to evaluate storage methods of ginger at Ginger Research Programme, Kapurkot, Salyanin2014 and 2015. Five different ginger storage methods T1) modified pit storage ;T2) indoor storage on raw brick Bhakari);T3) outdoor storage on raw brick Bhakari;T4) indoor room storage on bamboo mat Bhakari and T5) crate storage in cemented pitswere evaluatedinthe randomized complete block design with four replications. Seven days cured rhizomeswere used for storage. Ginger was stored from last week of November to first week of Mayfor both the consecutive year. Highest healthy rhizome recovery ranging 95.49 to 96.75% were found both in indoor and outdoor raw brick Bhakari as well as indoor storage made of bamboo mat. The lowest sprout length (0.43 cm) was found in indoor Bhakari made of raw bricks followed by bamboo mat bhakari (0.65 cm).Both indoor and outdoor brick Bhakaries as well as indoor bamboo mat Bhakaries showed lowest weight loss ranging 2.75 to3.12%, lowest fly infected rhizomes (0.90 – 1.2%) and minimum rhizome scale infected rhizome (0.10 – 0.32%). Considering the economic status of mid hill farmers Bhakaries made of bamboo mat at indoor and Bhakaries made of raw bricks either indoor or outdoor conditions were found the most effective, adaptive and low cost for ginger storage.

Keywords: *Ginger, healthy rhizome, rhizome fly, rhizome scale, storage methods*

Introduction

Ginger (*Zingiberofficinale*Rosc.) is one of the major spice grown in Nepal and has been popularized as commercial crop in hilly region. Its cultivation is spreading from east to west covering inner terai, foot hills to mid hills up to an altitude of 1600 masl. In Nepal ginger is being grown in about 42% (24,226 ha) of total major spices cultivated area (57, 479) and the production of ginger was recorded 2,76,150mt with the productivity of 11.40 t/ha (ABPSD 2014). Ginger is long duration crop of 8-9 months after planting. Generally ginger is harvested on November with moisture level of about 85 percent (GRP, 2001).

In general, good rhizomes are selected for seed purpose and then second grade rhizomes or excess produce other than seed are sold to the local collection centers. Seed rhizomes are traditionally stored in pits or in rooms. Problems encountered during storage are; losses due to rots caused by various fungi and insects because of raised temperature and relative humidity inside stores.

The main purpose of storage is to keep the seed rhizomes safely for the coming season. The storage problem of the seed rhizome from harvesting to next planting season is faced by many farmers. Fresh rhizomes with high moisture level are susceptible to many fungi and insects, thus need to be stored appropriately (GRP, 2016). Poor storage causes sprouting, rooting, shriveling and dehydration problems. Improper storage of ginger rhizomes may result up to 20 % storage loss (Baral*et al*., 2016). Heavy loss during storage is mainly associated with the storage methods and the insect pests prevailing in the rhizomes to be stored.At temperature around 15^{0}C and 75% relative humidity fresh ginger rhizome could be stored at least for four months (November to February) but temperature below 10 ^{0}C at storagecausechilling injury to the rhizome (GRP 2001). Rhizome fly, shoot borer, mites, and white grub were found associated with the rhizome rot complex of ginger (Sah*et al*, 2001). Rhizome fly is a serious devastating insect pest of ginger. The damaging stage is maggot and found both in storage as well as in field condition.The rhizome scale (*Aspidiellahartii*) is a minor ginger pest infests rhizomes in the field (at later stages) and in storage. They

feed on rhizome and in severely infested condition it become shriveled and desiccated affecting its germination (Sasikumar*et al,* 2008). In addition to this heavy weight loss, rotting due to insect pests and diseases, long sprout are the major problems during storage. With the objective of minimizing storage losses due to insects and improve the recovery of healthy rhizome this experiment was conducted.

Materials and Methods

An experiment was conducted at Ginger Research Programme, Kapurkot, Salyan during the two consecutive years of 2014/15 and 2015/16. Five different ginger storage methods wereevaluated using several parameters;freshness of ginger, rotten ginger, number of sprouts/rhizomes, sprout length, weight loss and infestation of rhizome fly and rhizome scale and recovery of healthy rhizomes at two storage periods up to 1stweek of April and 1st week of May. The five different storage methods used were described as follows.

Modified pit store

A pit of 1m x1mx1m dimension was dug and left open for seven days for sun drying. Then burning and cleaning of pit was done for killing harmful soil micro organisms. Lower 10cm of pit was filled with rice husk then ginger rhizomes were piled in pit leaving 6 inch on top. Pit was covered with wooden plank with the provision of 2 inch diameter poly pipe for providing proper aeration. A layer of dry grasses was placed on the top and finally covered with soil in conical shape.Temporary thatch of straw material was prepared to protect pit from direct sunlight and to avoid rain water (Fig 1). About 350-400 kg of seed rhizome were stored in each pit.

Figure 1 Modified pit storage method

Indoor raw brick *Bhakari*

In this method the raw bricks of size 25 x 12.5 x 10 cm^3 were used to construct the raw brick *Bhakari* of 1mx1mx1m size inside the room. About 10-15 cm thick layer of sandlaid at the bottom and thenrhizomeswere piled leaving 20-25 cm spaceon top. Thin layer of dry grass were kept above the rhizomes. Above grasses a layer of sand 20-25 cm was placed to cover the piled rhizomes. Rhizome filled *Bhakaris* were covered with plastic sheet at the top. About 300kg-350 kg of seed rhizomes were stored in each pit.

Outdoor raw brick *Bhakari*

In this method the raw brick of size 25x 12.5x10 cm^3 was used to construct the raw brick *Bhakari* of 1mx1mx1m size in the open shed. Rhizome filling procedures was similar to indoor raw brick *Bhakari.* A temporary tin shed was provided to protect from rain.

Figure 2 Raw brick *Bhakari* storage method

Indoor Bamboo mat *Bhakari*

In this method two bamboo mat, outer mat of 1m x 1mx 1m size and inner mat of 0.6mx0.6mx1m size were used leaving gap of 20 cm between two mats. The gap between the mats was filled with mixture of mud with cow dung. Gap was filled gradually 10 cm in each alternate day until the complete filling of gap of one meter height. Rhizome filling method was similar as of indoor raw brick *Bhakari*. About 120kg-150 kg of seed rhizome were stored in each *Bhakari*.

Figure 3 Bamboo mat *Bhakari* for ginger storage

Crate storage in cemented pit

Cemented pit was constructedin such a way that two crates were adjusted at the bottomof pit. Depth of pit was maintained about 1m in which three crates were piled up. Crates filled with ginger rhizomes were piled one above another.Rhizome filledpits were coveredwith wooden planks then dry grasses and finally covered with soil giving conical shape. About 20 kg ginger rhizomeswerestored in each crate.

The experiment was executed at Randomized Complete Block Design and each treatment was replicated four times. Seven days cured ginger rhizomes were used for storage. The storing period was about 5 months (last week of Nov to first week of May). Midterm dada was recorded during the first week of April. The observation was based on counting and weighting the rhizome, analysis of data was done using statistical tool GENSTAT discovery.

Results and Discussion

1. Effect of storage methods to healthy rhizome recovery

Statistically significant result was found in healthy rhizome recovery and minimized rotten ginger percent up to 1st week of May. Healthy rhizome recovery percentage was found highest ranging 95.49 – 96.00% in 1st week of May both in indoor and outdoor brick *Bhakari*es as well as indoor bamboo mat *Bhakari* method. These methods of storage showed minimum rotting of rhizomes (0.41-0.56%)at 1st week of May.

Comparing to this brick *Bhakari* and bamboo mat method of ginger storage modified pit storage method were found inferior (healthy ginger rhizome recovery 95.75% in 1st week of April and 94.52% in 1st week of May and rotten ginger 3.46% in 1st week of April and 4.79% in 1st week of May). The lowest (88.62% in 1st week of April and 85.19% in 1st week of May) healthy rhizome recovery percentage and highest (6.12% in 1st week of April and 7.30% in 1st week of May) rotten ginger percentage were found in crate storage in cemented pit.

Table 1. Effect of storage methods to healthy rhizome recovery and rotten ginger at Kapurkot, Salyan during 2014/15 – 2015/16.

S.N.		Treatments	Stored up to April 1st week		Stored up to May 1st week	
			Healthy rhizome recovery (%)	Rotten ginger (%)	Healthy rhizome recovery(%)	Rotten ginger (%)
Year	2014		95.53	1.88	93.86	2.50
	2015		93.96	2.43	93.01	2.93
	1	Modified pit storage	95.75	3.46	94.52	4.79
	2	Indoor raw brick *Bhakari*	96.75	0.35	95.99	0.41
	3	Outdoor raw brick *Bhakari*	96.10	0.41	95.49	0.56
	4	Indoor Bamboo mat*Bhakari*	96.50	0.43	96.00	0.52
	5	Crate storage in cemented pit	88.62	6.12	85.19	7.30
CV%			1.40	15.50	0.9	22.70
F-test			**	**	**	**
LSD (p=0.05)			1.90	0.95	1.267	1.43

*=Significant **=Highly significant

2. Effect of storage methods to sprout performance and weight loss

The number of sprouts/rhizome, sprout length and weight loss up to 1st week of April and 1st week of May of storage were found highly significant among the treatments. Highest sprout numbers/rhizome (2.75)was found in modified pit storeup to 1st week of May. Ginger stored in crate in cemented pit produced the long sprout (1.43 cm) followed by modified pit storage method (1.39 cm) up to 1st week of May. The lowest sprout length (0.65 cm) was found in indoor bamboo mat *Bhakari*.Sprout length was found at par inindoor and outdoor raw brick *Bhakari* storage. Storage weight loss was insignificantly low ranging 2.75 to 3.12% in indoor and outdoor brick *Bhakari* as well as indoor bamboo mat Bhakari as compared to rest of the storage methods (Table 2).

Table 2. Effect of storage methods to sprout performance and weight loss % at Kapurkot, Salyan during 2014/15 – 2015/16.

S.N.		Treatments	Stored up to April 1st week			Stored up to May 1st week		
			Sprout no./ rhizome	Sprout length, cm	Weight loss%	Sprout no./ rhizome	Sprout length, cm	Weight loss%
Year		**2014**	1.25	0.62	3.40	1.59	1.44	4.36
		2015	1.61	0.60	4.56	1.75	0.68	4.79
	1	Modified pit store	2.27	0.63	4.60	2.75	1.39	5.17
	2	Indoor raw brick *Bhakari*	1.05	0.43	2.85	1.15	0.82	3.11
	3	Outdoor raw brick *Bhakari*	1.15	0.55	2.95	1.34	0.98	3.12
	4	Indoor Bamboo mat *Bhakari*	0.89	0.57	2.75	1.17	0.65	2.81
	5	Crate storage in cemented pit	1.71	0.86	6.96	1.95	1.43	8.67
CV%			14.70	19.30	12.00	14.50	10.20	13.60
F-test			**	**	**	**	**	**
LSD (p=0.05)			0.30	0.17	0.69	0.35	0.15	0.90

**=– Highly significant

3. Effect of storage methods to rhizome fly (*Calobatasp*) and rhizome scale (*Aspidiellahartii*) infestation

Both rhizome fly (*Calobatasp*) and rhizome scale (*Aspidiellahartii*) were found in all the storage methods and their occurrences showed highly significant difference. The level of rhizome fly damage was found to be increased with the increasing in storage time from first week of April to first week of May. The infestation of rhizome fly was found significantly minimum (0.95 -1.2%)in indoor and outdoor raw brick *Bhakari* as well as indoor bamboo mat stores, which was higher (4.38%)in modified pit store (Table 3). Similarly rhizome scale infestation was also minimum (0.10-0.32%) in above mentioned brick storage methods as compared to modified pi store (1.35%). There was no increase in rhizome scale damage with increasing storage time from first week of April to first week of May.

Table 3. Effect of storage methods to rhizome fly and rhizome scale infected rhizome (%) at Kapurkot, Salyan during 2014/15 – 2015/16.

S.N		Treatments	Stored up to April 1st week		Stored up to May 1st week	
			Rhizome fly infected rhizome %	Rhizome scale infected rhizome %	Rhizome fly infected rhizome %	Rhizome scale infected rhizome %
Year	**2014**		1.76	0.42	1.89	0.53
	2015		1.91	0.46	2.14	0.46
Storage methods	1	Modified pit storage	3.88	1.35	4.38	1.35
	2	Indoor raw brick *Bhakari*	1.18	0.32	1.20	0.32
	3	Outdoor raw brick *Bhakari*	0.90	0.31	1.00	0.31
	4	Indoor Bamboo mat *Bhakari*	0.95	0.10	1.08	0.10
	5	Crate storage in cemented pit	2.26	0.12	2.35	0.36
CV%			26.5	21.10	26.60	71.40
F-test			**	**	**	**
LSD (p=0.05)			0.70	0.13	0.77	0.50

* – Significant ** – Highly significant

Modified pit storage method of ginger rhizome storage was one of the popular method developed by Ginger Research Programme, Kapurkot, Salyan since 15 years. This study revealed that the storage loss and rotting were further minimized in *Bhakari* storage method constructed either indoor or outdoor under the open shed.In addition to this chances of more sproutings were minimized in this method. Ginger storage in crate in cemented pit was not desirable due to the heavy weight (>8%) loss due to shriveling and dehydration problem. Although the ginger rhizome can be stored safely in indoor bamboo matBhakaributit is more expensive, tedious and time consuming during construction phase. Results revealed that indoor or outdoor raw brick Bhakaries were better storage methods in minimizing storage weight loss and less infestation of rhizome fly and rhizome scale insects during the 5 months storage period under mid hill conditions.

Conclusion and Recommendation

One cubic meter (1m x1m x 1m) structure made of raw mud bricks, with the wall thickness of 12.5 cm joined with mud mortar either in room or under open shed was found effective as well as easy to construct under mid hills farmer's conditions to minimize the weight losses with very low infestation of rhizome fly and rhizome scale infestation. Placing ginger rhizome in crate and storage in cemented pit was found not suitable as it had highest weight loss, insect infestation and rotting. Since size of *Bhakari* storage structure is small with a capacity of storing about 300-350 kg fresh rhizomes per store.It could be most useful for storing ginger only for seed purpose required for about 5 months from harvest to planting. The differences between the treatment effects were very narrow maximum of 5% so it is recommended that experiment needs to be further verified along with cost of constructing large size brick structures and its benefit cost analysis.

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