Direct RESEARCH JOURNALS
Vol.5 (4), pp. 207-213, April 2017
ISSN 2354-4147
International Standard Journal Number (ISJN) e-ISJN: A4372-2604
Article Number: DRJA0679327
Copyright © 2017
Author(s) retain the copyright of this article
Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/aboutjournal/drjafs

Research Paper

Effects of pre-storage treatments and storage methods on sprouting and nutritional quality of Ginger (*Zingiber officinale* Rosc) Rhizomes

***[1]Olusoga Stephen Oluwaseyi, [2]Olaniyi Joel Oyekunle and [3]Babatola L. A.**

[1]Department of Agronomy, Ladoke Akintola University of Technology Ogbomoso , Oyo State, Nigeria.
[2]Department of Agronomy, Ladoke Akintola University of Technology Ogbomoso , Oyo State, Nigeria.
[3]Department of Agronomy, University of Ibadan, Ibadan, Oyo State, Nigeria.
*Corresponding author E-mail: ogooluwaseyi1985@yahoo.com .

Received 14 February 2016; Accepted 17 April, 2017

Ginger (*Zingiber officinale* Rosc) is an important spice crop throughout the world. Harvested ginger rhizomes are highly susceptible to damage during post-harvest storage due to soil-borne pathogens or pest attack. Improving the indigenous technology of pre-storage treatments and storage methods are necessary to achieve better and viable quality of ginger rhizomes. Field and laboratory experiments were conducted between December, 2014 and May, 2015 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The aim of this study was to determine the effects of pre-storage treatments and storage methods on sprouting and nutritional quality of ginger rhizomes.The pre-storage treatments were 5g of hydrated lime per 2½ litres of water, 100 ml of *Trichoderma harzianum*, 5g of Mancozeb per 2½ litres of water and control. The storage methods were refrigerator, clay pots, pit storage lined with sand layer, pit storage lined with sawdust and black polythene bag with twelve perforations. Data were collected on percentage sprouting, plant height, number of leaves, leaf area, percentage weight loss, diameter and nutritional quality of ginger rhizomes.Combination between pre-storage treatment and storage method combinations enhanced the percentage sprouting, growth .parameters and quality of ginger rhizomes at various storage periods. Ginger rhizomes treated with pit sawdust and *Trichoderma harzianum* as well as polythene and mancozeb recorded highest percentage sprouting of 100 % while rhizomes stored in refrigerator and the control recorded the least (21.00%) at various storage periods. In conclusion, the use of pit-sawdust in combination with *T. harzianum* proved to be most effective in sprouting and maintaining the quality of ginger rhizomes.

Key words: Ginger rhizomes, Pre-storage treatments, Storage methods, Rhizome yield, nutritional quality.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc) is among the important widely used spice crops worldwide (Archana et al., 2013). The economic part is the underground rhizome which is pungent and used for culinary purposes (Thankamani *et al.,* 2002). According to National Root Crop Research Institute (NRCRI, 2005), two varieties of ginger are popularly grown in Nigeria. These are yellow ginger (Taffingiwa) and black ginger (Yaltsunbiri).

The extents of damage of harvested rhizomes are highly required for sprouting and enhancing the quality of ginger rhizomes (Karuppaiyan et al., 2008), in pit storage methods, about 30% rhizomes rot and become useless

for sowing. Adopting various pre-storage treatment and storage method combinations are necessary to prevent seed borne pathogens, maintain the quality of ginger during postharvest storage and improve sprouting after sowing. Treatment of *Trichoderma harzianum* and zero energy cool chamber combinations gave greater protection against rhizome rot, and had a significant influence on the sprouting percentage in ginger (Shadap *et al.,* 2013). However, there is need to evaluate the indigenous technology of pre-storage treatment and storage methods combinations in order to obtain more viable and better performance of ginger rhizome. The aim of this study was to determine the appropriate pre-storage treatment and storage method combinations required for sprouting and maintaining the quality of ginger rhizomes.

MATERIALS AND METHODS

Field and laboratory experiments were conducted during December, 2014 –May 2015 at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Plant collection and preparation: Freshly and uniform sized yellow ginger variety (Ug1) was obtained from Ladoke Akintola University of Technology, Ogbomoso .and used as test crop. One kilogram of ginger rhizomejs were soaked in each pre-storage treatment for 30 min, air dried for 24 h and stored in different storage methods to improve sprouting and maintain quality. The pre-storage treatments include: 5 g of hydrated lime per 2½ litres of water, 100 ml of *Trichoderma harzianum*, 5 g of Mancozeb per 2½ litres of water and control. The storage methods include: refrigerator, clay pots, pit storage lined with sand layer, pit storage lined with sawdust and black polythene bag with twelve perforations to improve sprouting and maintain the quality of ginger rhizomes.

Experimental design

The 4×5 factorial experiment was arranged in a completely randomized design (CRD) for laboratory experiment and in a randomized complete block design (RCBD) for field experiment with three replicates. The experimental plots were cleared using cutlasses and tilled thoroughly with hoe to tilt the soil. Sixty beds were prepared on the field, each size of 1.2 m × 1.2 m with an inter-space of 0.5 m between beds. Harvested ginger rhizomes were stored in each of the storage method and Twenty samples of stored ginger rhizomes were taken at one month interval from each pre-storage treatment and storage method combinations and planted on raised bed to determine the viability of rhizomes.. Cultural practices such as mulching, watering and weeding were carried out for proper crop establishment.

Data collection

Data were collected on percentage sprouting, percentage weight loss, diameter and nutritional quality of ginger rhizomes (Shadap *et al.,* 2013). Weight and diameter of ginger rhizomes were measured and recorded before and at one month interval of storage to determine the percentage weight loss from the rhizomes (Thankamani *et al.,* 2002). The 4x5 factorial experiments were arranged in a CRD for laboratory experiment and in a RCBD for field experiment with three replicates. The percentages sprouting were calculated by the number of sprouted rhizomes divided by total number of rhizomes planted on each bed and multiplied with 100 (Shadap *et al.,* 2013). The percentage weight loss was also calculated by the weight after storage minus weight before storage divided by weight after storage multiplied with 100 (Shadap *et al.,* 2013).

Methods of analysis

Ca, Fe, crude protein, crude fibre, moisture, fat and ash contents were determined using the official method of analysis described by the Association of Official Chemist (AOAC, 2006). Data collected were also analyzed using Standard Analysis System (SAS, 2005) for analysis of variance (ANOVA). Difference among treatments means were computed using least significance differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

The pre-storage treatment and storage method combinations significantly ($P \leq 0.05$) influenced the percentage weight loss of ginger rhizomes at various storage periods as presented in (Table 1). At one month of storage percentage weight loss was minimum for rhizomes treated with clay pots and mancozeb (6.5%), while percentage weight loss was maximum for rhizomes stored inside the pit-sawdust and control (43.20%). At two months of storage periods percentage weight loss was minimum for rhizomes treated with pit-sand and *Trichoderma harzianum* (22.7%) followed by rhizomes stored inside pit-sawdust and mancozeb (15.4%) while percentage weight loss was maximum for rhizomes stored inside the refrigerator and control (60.3%). At three months of storage periods percentage weight loss was minimum for rhizomes treated with pit-sand and *Trichoderma harzianum* (23.8%) closely followed by rhizomes stored inside pit-sawdust and *Trichoderma harzianum* solution (23.9%) while percentage weight loss was maximum for rhizomes stored inside the refrigerator and control (77.4%). reconfirming the earlier work of Thankamani *et al*. (2002) on turmeric that low temperature provided by the environment during storage

Table 1. Effects of pre-storage treatments and storage methods combinations on the percentage weight loss of ginger rhizomes during different storage periods.

	Rhizome weight loss (RWL) (g) Storage periods (month)		
Treatment	**1**	**2**	**3**
Sand control	18.3	24.95	31.81
Mancozeb	12.8	15.4	30.8
Hydrated lime	7.5	11.4	18.4
Trichoderma	19.9	22.7	23.8
Polythene control	10.4	19.4	27.4
Maancozeb	16.4	39.5	52.3
Hydrated lime	27.7	28.5	33.8
Trichoderma	8.9	30.5	45.1
Pot control	19.8	27	32.5
Mancozeb	6.9	16.2	20.9
Hydrated lime	10.6	23.7	31.93
Trichoderma	9.6	17.7	25.8
Refrigerator control	29.6	60.3	77.4
Mancozeb	23	40.1	55.7
Hydrated lime	20	52.3	67.8
Trichoderma	812.3	31.5	54.4
Sawdust control	43.2	50.6	64.4
Mancozeb	16.2	31.6	36.2
Hydrated lime	16.6	20.9	28.7
Trichoderma	15.5	21.5	23.9
LSD 5%			
PRE STRGE TRT	0.72	3.06	1.61
STRGE MTDS	0.81	3.42	1.8
PRE TRT X STRG	0.58	10.47	2.91

affect the quality of produce.

The pre-storage treatments and storage methods combinations significantly (P≤0.05) maintained the diameter of ginger rhizomes at various storage periods as listed in (Table 2). At one month after storage minimum reduction in diameter (1.45 cm) was obtained in rhizomes stored inside pit-sand and mancozeb while maximum reduction in diameter (1.40 cm) was obtained for rhizomes inside refrigerator and control. At two months after storage minimum reduction of diameter (1.60 cm) was obtained in rhizomes stored inside pit-sawdust and *T. harzianum* while maximum reduction in diameter (1.30 cm) was obtained for rhizomes inside refrigerator and mancozeb. At three months after storage minimum reduction in diameter (1.40 cm) was obtained in rhizomes stored inside pit-sand and *T. harzianum*. This was in line with Thankamani *et al*. (2002) that quality of stored rhizomes are maintained due to reduced incidence of pathogens by the treatment.

The pre-storage treatment and storage method combinations significantly (P≤0.05) increased the percentage sprouting of ginger plant at various sampling periods as listed in (Tables 3, 4 and 5). At one month after storage more than 80% rhizomes recorded highest sprouting in all the treatment combinations applied except from rhizomes stored with refrigerator and mancozeb (78.00%) as well as refrigerator and control (33.00%) that recorded least percentage sprouting at 12 WAP. At two months after storage more than 70% rhizomes recorded highest sprouting in all the treatment combinations applied except for rhizomes stored inside pit-sand and control(56.00%), as well as polythene and control (44.00%) as well as refrigerator (Table 2). Mancozeb (44.00%), as well as refrigerator and control (22.00%)

Table 2. Effects of pre-storage treatments and storage methods combinations on the diameter of ginger rhizomes during storage periods.

Treatments	Rhizome diameter (cm) Storage periods (month) Before storage	1	2	3
Sand control	1.8	1.7	1.6	1.5
Mancozeb	1.45	1.45	1.4	1.3
Hydrated lime	1.6	1.5	1.45	1.35
Trichoderma	1.7	1.55	1.4	1.4
Polythene control	1.6	1.5	1.45	1.36
Mancozeb	1.5	1.4	1.3	1
Hydrated lime	1.7	1.6	1.6	1.35
Trichoderma	1.5	1.35	1.3	1
Pot control	1.7	1.6	1.45	1.4
Mancozeb	2.05	1.95	1.9	1.7
Hydrated lime	1.7	1.6	1.4	1.2
Trichoderma	1.75	1.65	1.5	1.4
Refrigerator Control	1.6	1.4	1.3	1
Mancozeb	1.7	1.6	1.3	1.3
Hydrated lime	1.5	1.4	1.3	1.05
Trichoderma	1.65	1.5	1.4	1.2
Sawdust control	1.85	1.75	1.7	1.65
Mancozeb	1.8	1.7	1.5	1.4
Hydrated lime	1.65	1.53	1.25	1.2
Trichoderma	1.8	1.6	1.6	1.2
LSD 5%				
PRE STRGE TRT	0.13	0.06	0.09	0.06
STRGE MTDS	0.14	0.06	0.1	0.07
PRE TRT X STRG	0.02	0.004	0.009	0.004

Table 3. Effects of pre-storage treatment and storage method combinations on the percentage sprouting of ginger rhizomes at different sampling periods after one month storage.

Treatments	Sprouted Rhizomes (%) weeks after planting (WAP) 4	6	8	10	12
Sand control	0	22	22	56	56
Mancozeb	11	67	67	67	89
Hydrated lime	11	22	22	44	78
Trichoderma	22	33	56	100	100
Polythene control	11	22	22	22	44
Maancozeb	44	100	100	100	100
Hydrated lime	0	11	33	78	100
Trichoderma	11	11	11	44	89
Pot control	0	11	12	33	33
Mancozeb	0	44	13	67	78
Hydrated lime	56	78	14	100	100
Trichoderma	11	33	15	56	78
Refrigerator control	12	16	16	22	22
Mancozeb	11	33	17	44	44

Table 3.Contd.

Hydrated lime	44	56	18	95	100
Trichoderma	0	78	19	100	100
Sawdust control	0	11	20	44	78
Mancozeb	44	89	21	100	100
Hydrated lime	44	78	22	95	98
Trichoderma	0	57	23	100	100
LSD 5%					
PRE STRG TRT	1.52	0.99	1.33	1.38	1.39
STRGE METDS	1.69	1.1	1.5	1.55	1.55
PRE x STORAGE	2.57	1.09	2	2.14	2.15

Table 4. Effects of pre-storage treatment and storage method combinations on the percentage sprouting of ginger rhizomes at different sampling periods after two month storage.

	Sprouted Rhizomes (%) weeks after planting (WAP)				
Treatments	**4**	**6**	**8**	**10**	**12**
Sand Control	0	22	22	56	56
Mancozeb	11	67	67	67	89
Hydrated lime	11	22	22	44	78
Trichoderma	22	33	56	100	100
Polythene control	11	22	22	22	44
Maancozeb	44	100	100	100	100
Hydrated lime	0	11	33	78	100
Trichoderma	11	11	11	44	89
Pot Control	0	11	12	33	33
Mancozeb	0	44	13	67	78
Hydrated lime	56	78	14	100	100
Trichoderma	11	33	15	56	78
Refrigerator control	12	16	16	22	22
Mancozeb	11	33	17	44	44
Hydrated lime	44	56	18	95	100
Trichoderma	0	78	19	100	100
Sawdust Control	0	11	20	44	78
Mancozeb	44	89	21	100	100
Hydrated	44	78	22	95	98
Trichoderma	0	57	23	100	100
LSD 5%					
PRE STRG TRT	1.52	0.99	1.33	1.38	1.39
STRGE METDS	1.69	1.1	1.5	1.55	1.55
PRE X STORAGE	2.57	1.09	2	2.14	2.15

treatment combinations recorded least percentage sprouting at 12 WAP. At three months after storage maximum percentage sprouting were recorded from rhizomes treated with polythene and mancozeb (100%) as well as pit-sawdust and *T. harzianum* solution (100%). combinations which was in line with the earlier work of Shadap *et al*. (2013) who reported that (5 g/kg) of *T. harzianum* gave highest percentage sprouting when used as pre-storage treatment which might be due to the favourable effects of the bio control agent on

Table 5. Effects of pre-storage treatments and storage methods combinations on the percentage sprouting of ginger rhizomes at different sampling period storage after three months storage.

	Sprouted Rhizomes (%) Weeks after planting (WAP)				
Treatment combinations	**4**	**6**	**8**	**10**	**12**
Sand control	0	0	22	22	38
Mancozeb	0	0	67	22	78
Hydrated lime	0	0	22	44	65
Trichoderma	0	0	56	33	67
Polythene control	0	0	22	33	56
Maancozeb	0	0	100	67	100
Hydrated lime	0	0	33	44	67
Trichoderma	0	11	11	33	67
Pot control	0	0	22	33	56
Mancozeb	0	0	44	44	67
Hydrated lime	0	0	78	22	78
Trichoderma	0	0	44	33	67
Refrigerator control	0	0	19	18	21
Mancozeb	0	0	44	31	40
Hydrated lime	0	0	67	52	65
Trichoderma	0	0	89	61	85
Sawdust control	0	0	33	56	78
Mancozeb	0	11	89	44	89
Hydrated lime	0	11	89	33	89
Trichoderma	11	22	67	56	100
LSD 5%					
PRE STRGE TRT	0.17	0.41	0.82	2.29	1.8
STRGE MTDS	0.18	0.45	0.91	2.56	2.02
PRE X STOROGE	0.03	0.18	0.75	5.86	3.64

Table 6. Effects of pre-storage treatments and storage methods combinations on the nutritional quality of ginger after storage.

Treatments	**Nutritional Quality (%)**							
	Crude protein	**Crude fibre**	**Fat**	**Ash**	**Moisture content**	**Calcium**	**Iron**	**Total starch**
Sand Control	1.45	2.36	2.35	3.48	56.30	16.55	2.81	2.68
Mancozeb	1.61	2.57	2.40	3.60	69.76	16.93	2.90	3.11
Hydrated lime	1.62	2.53	3.53	3.66	62.49	16.67	3.61	3.84
Trichoderma	1.65	2.59	2.54	3.62	64.30	18.24	3.41	4.25
Polythene Control	1.70	2.46	2.45	3.60	71.20	17.43	3.27	3.51
Maancozeb	1.72	2.55	2.52	3.64	78.49	17.45	3.74	3.85
Hydrated lime	1.76	2.47	2.51	4.17	85.47	17.84	3.81	4.75
Trichoderma	1.85	2.80	2.58	3.68	63.18	18.64	4.57	4.65
Pot Control	1.61	2.64	2.53	3.51	71.86	17.81	3.88	3.85
Mancozeb	1.68	2.75	2.52	3.74	59.89	17.94	4.20	4.14
Hydrated lime	1.73	2.74	2.57	3.65	63.91	18.85	4.61	4.39
Trichoderma	1.85	2.73	2.63	3.64	71.61	18.71	4.72	4.59
Refrigerator Control	1.43	2.47	2.45	4.92	62.20	17.50	3.64	3.61
Mancozeb	1.47	2.48	2.54	4.85	71.49	18.23	4.76	3.97
Hydrated lime	1.51	2.67	2.51	4.75	72.15	18.97	4.70	4.18
Trichoderma	1.62	2.56	2.48	4.13	68.95	17.66	4.59	4.11
Sawdust Control	1.44	2.32	2.52	3.56	79.87	16.85	3.68	3.16
Mancozeb	1.67	2.45	2.56	3.8	97.64	17.83	4.30	4.30
Hydrated lime	1.53	2.62	2.57	4.39	78.79	17.95	4.15	4.59
Trichoderma	1.64	2.58	2.65	4.36	75.73	18.67	3.93	4.63
LSD 5%								
PRE STRGE TRT	0.01	0.02	0.03	0.03	0.43	0.97	0.03	0.09
STRGE MTDS	0.01	0.02	0.03	0.03	0.48	1.08	0.03	0.10
PRETRT X STRG	0.0001	0.0004	0.0009	0.0009	0.21	1.05	0.0009	0.009

sprouting fungal attack by the treatment combinations. While rhizomes treated with refrigerator and control recorded least percentage sprouting of 21% at 12 WAP. This support the earlier work of Rashidi and Bahri, (2009)

who reported moisture loss increased with increased in storage period. The pre-storage treatments and storage methods combinations improved the nutritional quality of ginger rhizomes at three months of storage as shown in (Table 6). This support the work of Thankamani *et al*. (2002) on turmeric that quality of stored rhizomes is retained due to low temperature provided by the storage environment. In conclusion, sprouting of ginger rhizomes on the field and the quality of stored ginger rhizomes were significantly influenced by different pre-storage treatments and storage methods. Therefore, if viability and good quality of ginger rhizomes are to be produced, the use of pit-sawdust in combination with *T. harzianum* proved to be most effective in storing ginger rhizomes.

REFERENCES

AOAC (2006). Association of official analytical chemist. Final report and executives summaries on best practices in microbiological methodology

Archana CP, Geetha S, Pillai and Balachandran I (2013). *In vitro* micro rhizome induction in three highyielding cultivars of *Zingiberofficinale*Rose, and their phytopathological analysis. Int. J. Adv. Biotechnol. Res, 4(3):296-300.

Karuppaiyan RH, Rahman RK, Avasthe KA (2008). Farm implements and machineries suitablefor Sikkim, ICAR Research Complex for NEH Region, Sikkim Centre, Gangtok, pp 19-20).

NRCRI (2005).Physical properties of ginger, National root crop research institute,Umudike, Vol 14/1

Rashidi M, Bahri MH (2009). Interactive effects of coating methods and storage period on quality of carrot during ambient storage. ARPN J. Agric. and Biol. Sci, 4(3): 28 -35.

SAS (2005). Statistical Analysis System, Version 9 of SAS Institute. *Inc. cary*, NC.

Shadap A, Hegde MK, Lyngdoh YA, Rymbia H (2013). Effect of storage methods and seed rhizome treatment on field performance of ginger ,Indian Journal of hill farming , 27 (I) ; 219-228.

Thankamani CK, Sivaraman K, Kandiannan K (2002). .Evaluation of different methods for storage of turmeric rhizome (*Curucuma longa*). Plantation Crops Research and Development in the Millennium, Hydersbad.589-591.