Net Journal of Agricultural Science
Vol. 11(2), pp. 19-24, May 2023
ISSN: 2315-9766
Full Length Research Paper

Effect of different natural storage conditions on keeping quality of potato at Munshiganj Region of Bangladesh

M. Salim*, M. K. Alam and R. Akter

Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute, Munshiganj, Bangladesh.

Accepted 27 February, 2023

ABSTRACT

The experiment was conducted at Tuber Crops Research Sub-Centre (TCRSC), Munshiganj to find out the suitable natural storage conditions and to minimize post-harvest losses of potatoes at farmers' fields immediately after harvesting. This experiment was made for two consecutive years 2018-19 and 2019-2020 production seasons. Six treatments viz. T_1 (rice straw), T_2 (dried water hyacinth), T_3 (dried potato herbs), T_4 (rice straw + shade), T_5 (dried water hyacinth + shade) and T_6 (dried potato herbs + shade) with a view to observe the performance of these treatments in regards to weight loss and potato rottage loss at different dates e.g. 30, 60 and 90 DAS (Days After Storage). The experiment was carried out in a randomized complete block design with three replications. The treatment T_4 (rice straw + shade) performed the best considering the total loss percentage for all recording dates followed by T_5 (dried potato herbs + shade) whereas the worst performance was observed in the case of T_3 (dried water hyacinth) in all dates. All the treatments combined with shade showed higher gross return, net income and marginal benefit-cost ratio (MBCR) than all treatments without shade. Among the treatments combined with shade, rice straw + shade was the most profitable in respect of gross return (Tk. 1633.4), gross margin (Tk.1433.4) and marginal benefit-cost ratio (14.33), respectively.

Keywords: Potato, natural storage, keeping quality, benefit-cost.

*Corresponding author. E-mail: salim072498@gmail.com. Tel: 01916901743.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the most important vegetable crop extensively grown all over the world and is called the king of vegetables (Mustafa, 1997; Agbolosoo and Anaman, 2021). Potato (*Solanum tuberosum* L.) is considered the fourth most important crop in the world after wheat, rice and maize (Bajracharya and Sapkota, 2017). They also added that potato is an important cash crop to address food insecurity and reduce poverty among smallholder farmers in developing countries. Potatoes belong to the group of semi-perishable goods, that is, a product with high natural moisture content (Kibar, 2012). Most of the harvested potatoes are put into storage for a while before being used or distributed in the market (Ghazavi and Houshmand, 2010). Loss of moisture leads to quality loss and finally to non-marketable produce (Singh and Kaur, 2016). In addition to the overall health condition of the tuber, variety, growth condition in the field and maturity level of tubers and storehouse temperature are the major factors influencing the respiration rate and weight loss of the tuber during storage (Ghazavi and Houshmand, 2010). Potato is one of the main food crops in Bangladesh after rice and wheat (Rahim et al., 2023). Potato is an important contributor in terms of food security and poverty alleviation as a substitute for staple food (Sawicka et al., 2018). Munshiganj is famous as a

potato-growing district in Bangladesh. The area coverage is 39,000 ha and the total production is 12, 48,000 M.T. which is almost 13% of the total production of the country (DAE, Munshiganj). Under ordinary conditions, potatoes cannot be easily stored, particularly in the plains and tropical areas where high temperatures and dry weather prevails following harvest. Therefore, proper storage facilities are essential to maintain the potatoes' quality. Pringle et al. (2009) also stressed that storage conditions must be well-controlled to guarantee a top-quality product. Post-harvest losses occur during storage and this loss can be varied with different factors like temperature, humidity, carbon-di-oxide and air movement (Harbenburg *et. al*. 1986) and (Maldegem, 1999). There are more than 400 cold storages with some 20 lakh tonnes of potato preservation capacity in the country (Al Amin, 2022). He also added that out of them, 74 alone are in Munshiganj and can preserve only 5 lakh tonnes against average yearly production of about 13 lakh tonnes. Despite the huge number of cold storages in Munshiganj, farmers of that region are facing space shortages in the cold storages due to unfair practices imposed by intermediaries. Since cold storage spaces are rented on the basis of first come first serve. Intermediaries are cashing in on the artificial shortage of cold storage by renting huge spaces, forcing the farmers in Munshiganj to sell potatoes at a loss even after bumper production. On the contrary, it is quite difficult for potato growers to rent storage space during the cultivation period as they spend a huge amount on production. By the time they complete the harvest, they find that little space is left with the storage. Hajong and Moniruzzaman (2014) also agreed that the growers have to sell a major part of their produces immediately after harvesting at a very low price due to a lack of storage facilities. However, they could get more economic return in any way they could store their potatoes for three months to avoid the market glut. Accordingly, potato farmers at Munshiganj are looking for an alternate option like a traditional storage method to store their potatoes for a couple of months and get better economic returns. On-farm storage in heaps (unventilated clamps) and pits is common in some parts of India and Holland. According to Sparenberg (1987) and Schouten (1987) potatoes stored in this manner often contain low levels of reducing sugars and hence can be used for processing. Traditional storage method using locally available materials like those that triple, dried rice straw and water hyacinth, etc. are used with various thicknesses is a common practice in the Munshiganj region for storing potatoes immediately after harvesting at the potato growing field. However, the effectiveness of those materials in traditional storage methods has not been studied yet. So, to minimize post-harvest losses of potatoes immediately after harvest for almost three months, a study was carried out to select temporary suitable natural storage conditions at farmers' fields.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Tubers Crops Research Sub-Centre, Munshiganj for two consecutive years 2018-19 and 2019-2020, respectively. The trial was set in RCBD design with three replications. There were six treatments viz. T_1 :(rice straw), T_2 :(dried water hyacinth), T_3 :(dried potato herbs), T_4 :(rice straw + shade), T_5 :(dried water hyacinth + shade) and T_6 :(dried potato herbs + shade). Haulm pulling of the potato crop was done at the end of the last week of February in both the 2019-2020 and 2020-2021 production periods. After a gap of 10 to 12 days of haulm pulling (period for the maturation of tuber skin) potato crop was harvested. For suberization and skin maturation for damage done during harvesting, tubers were heaped to allow the curing for another 10 days and they were stored by heap method by the second week of March. Approximate 0.2 m to 0.25 m high a raised platform of soil was prepared at the site of storage so that rainwater cannot reach the bottom of the potato heap. Before the loading of potatoes spraying of Mancozeb (0.3 to 0.5 % solutions) on the soil was done at the storage site period which helped in the reduction of rotting during storage. At the time of loading; cut, cracked, bruised, damaged, green and rotted tubers were removed. The potatoes were loaded early in the morning when the temperatures are relatively low as it helped in maintaining the temperature of loaded potatoes relatively low throughout the storage period. At night time to protect from uncertain heavy rainfall, a transparent polythene sheet was used for covering the heap which was removed in the morning. The polythene sheet was also used in day time due to heavy rains but removed once the rains stop to avoid the build-up of heat due to lack of aeration. In each case of storage, for each treatment, 100 kg of potato was used. Storage materials like rice straw, dried water hyacinth and dried potato herbs with shade and rice straw, dried water hyacinth and dried potato herbs without shade were used in the experiment. Data on rottage loss of potato due to BSR (bacterial soft rot), FDR (fusarium dry rot), water loss and total loss at different DAS (days after storage) as influenced by different natural storage conditions were recorded and analyzed with Statistics 10 software. Marginal Benefit Cost Ratio (MBCR) analysis was also done.

RESULTS

The data (Table 1) shows that at 30 Days After Storage (DAS), the minimum Bacterial Soft Rot (BSR) (0.88%) was observed in rice straw + shade which was statistically identical to dried potato herbs + shade and

Table 1. Loss of potato at 30 days after storage as influenced by different natural storage conditions (pooled data of 2018-2019 and 2019-2020).

Treatments	Loss (%) at 30 DAS			
	BSR	FDR	Water	Total
T_1 (Rice Straw)	4.33[a]	4.49	5.85[c]	14.85[bc]
T_2 (Dried potato herbs)	3.58[ab]	5.58	8.31[b]	17.01[ab]
T_3 (Dried water hyacinth)	5.02[a]	5.10	10.48[a]	20.40[a]
T_4 (Rice Straw+ Shade)	0.88[c]	5.82	2.75[d]	9.21[d]
T_5 (Dried potato herbs+ Shade)	0.91[c]	4.92	5.19[c]	11.12[cd]
T_6 (Dried water hyacinth+ Shade)	1.99[bc]	4.63	5.37[c]	12.11[cd]
CV (%)	49.77	27.43	18.16	22.18
LSD	**	**	*	*

Means bearing the same letter (s) do not differ significantly at 1 or 5% level of probability by DMRT
**= Significant at 1% level of probability, **= Significant at 5% level of probability.

dried water hyacinth + shade whereas poor performance (5.02%) was found from dried water hyacinths. In the case of Fusarium dry rot percentage, the best performance (4.49%) was obtained from rice straw whereas the poor performance (5.82%) was noticed in rice straw + shades (Table 1). The minimum water loss (2.75%) was also found in rice straw + shade whereas dried water hyacinth showed the maximum water loss percentage (10.48%) (Table 1).

In the case of total loss percentage, at 30 DAS, the best performance (9.21%) was obtained from rice straw + shade followed by dried potato herbs + shade and dried water hyacinth + shade, respectively. Whereas, the maximum (20.40%) total loss percentage occurred in dried water hyacinth at 30 DAS (Table 1).

The data from (Table 2) shows that at 60 DAS, rice straw + shade caused the minimum bacterial soft rot (2.35%) which was statistically identical to dried potato herbs + shade whereas dried water hyacinths caused the maximum (9.50%) bacterial soft rot. In the case of Fusarium dry rot percentage, at 60 DAS, dried potato herbs showed the best performance (6.20%) to cause Fusarium dry rot whereas the poor performance (8.73%) was noticed in rice straw (Table 2). At 60 DAS, the minimum water loss (4.25%) was found in rice straw + shade whereas the dried water hyacinth showed a maximum water loss percentage (16.55%) (Table 2). In the case of total loss percentage, the best performance (12.73%) was obtained from rice straw + shade followed by dried potato herbs + shade at 60 DAS whereas, the maximum (32.77%) total loss percentage was found in dried water hyacinth (Table 2).

Table 2. Loss of potato at 60 days after storage as influenced by different natural storage conditions (pooled data of 2018-2019 and 2019-2020).

Treatments	Loss (%) at 60 DAS			
	BSR	FDR	Water	Total
T_1 (Rice Straw)	6.87[b]	8.73[a]	8.61[c]	22.91[b]
T_2 (Dried potato herbs)	5.73[b]	6.20[b]	12.06[b]	23.56[b]
T_3 (Dried water hyacinth)	9.50[a]	6.91[b]	16.55[a]	32.77[a]
T_4 (Rice Straw + Shade)	2.35[d]	6.37[b]	4.25[d]	12.73[d]
T_5 (Dried potato herbs + Shade)	2.66[cd]	6.40[b]	7.16[c]	16.02[cd]
T_6 (Dried water hyacinth + Shade)	4.15[c]	6.21 [b]	7.29[c]	17.24[c]
CV (%)	18.32	15.39	12.96	11.37
Lsd	*	**	*	**

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability by DMRT
**= Significant at 1% level of probability, **= Significant at 5% level of probability.

The data from (Table 3) shows that storage conditions like rice straw + shade at 90 DAS caused the minimum bacterial soft rot (5.00%) which was statistically identical to dried potato herbs + shade and dried water hyacinths

Table 3. Loss of potato at 90 days after storage as influenced by different natural storage conditions (pooled data of 2018-2019 and 2019-2020).

Treatments	Loss (%) at 90 DAS			
	BSR	FDR	Water	Total
T_1 (Rice Straw)	14.11^{a}	11.29^{a}	11.05^{c}	34.76^{ab}
T_2 (Dried potato herbs)	9.26^{bc}	9.17^{ab}	17.23^{b}	34.55^{b}
T_3 (Dried water hyacinth)	12.10^{ab}	7.88^{b}	20.71^{a}	40.34^{a}
T_4 (Rice Straw + Shade)	5.00^{d}	7.93^{b}	5.75^{d}	18.33^{c}
T_5 (Dried potato herbs + Shade)	5.34^{d}	8.17^{b}	9.28^{c}	22.35^{c}
T_6 (Dried water hyacinth + Shade)	7.19^{cd}	8.88^{b}	8.61^{cd}	23.56^{c}
CV (%)	23.28	17.27	16.22	12.55
LSD	*	**	*	*

Means bearing the same letter (s) do not differ significantly at 1 or 5% level of probability by DMRT
**= Significant at 1% level of probability, **= Significant at 5% level of probability.

+ shade whereas, the maximum (14.11%) bacterial soft rot was found from rice straw. At 90 DAS, the minimum (7.88%) Fusarium dry rot percentage occurred in storage conditions like dried water hyacinths whereas the maximum (11.29%) was noticed in rice straw (Table 3). At 90 DAS, the minimum water loss (5.75%) was observed in rice straw + shade whereas dried water hyacinth caused the maximum water loss percentage (20.71%) (Table 3). Related to total loss percentage the best performance (18.33%) was found from rice straw + shade followed by dried potato herbs + shade and dried water hyacinth+ shade). Whereas, dried water hyacinth caused the maximum (40.34%) total loss percentage at 90 DAS (Table 3).

Cost and return

Economic analysis showed that the highest gross margin (Tk. 1633.4 treatment^{-1}) was found in rice straw + shade (Table 4), which was followed by dried potato herbs+ shade and dried water hyacinth + shade. The lowest gross margin (Tk. 1193.2 treatment^{-1}) was observed in the dried water hyacinth.

Input price: Rice straw = Tk. 100/ treatment, Dried potato herbs = 100 tk./treatment, Dried water hyacinth = 100 tk./treatment, Bamboo and Tripple = Tk. 100/treatment

Output price (at 90 DAS): Potato = Tk. 20.00/ kg

Marginal benefit-cost ratio (MBCR) varied from 10.93 to 14.33. The highest MBCR (14.33) was recorded in rice straw + shade whereas the lowest MBCR (10.93) was observed in dried water hyacinth (Table 4).

Table 4. Cost and benefit analysis for the mean of different natural storage conditions of potatoes at Munshiganj Region during two consecutive years.

Variety	Amount of potato at 90 DAS	Gross margin at 90 DAS	Input cost (TK/Treat.)	Net income	MBCR
Rice Straw	65.24	1304.8	100	1204.8	12.05
Dried potato herbs	65.45	1309.0	100	1209.0	12.09
Dried water hyacinth	59.66	1193.2	100	1093.2	10.93
Rice Straw+ Shade	81.67	1633.4	200	1433.4	14.33
Dried potato herbs+ Shade	77.65	1553.0	200	1353.0	13.53
Dried water hyacinth+ Shade	76.44	1528.8	200	1328.8	13.29

*DAS = Days after Storage.

DISCUSSION

From the above results, the common phenomenon was found that all the natural storage conditions like rice straw, dried water hyacinths and dried potato herbs performed better with shade than that without shade. The

reason behind all the natural storage materials namely rice straw, dried water hyacinths and dried potato herbs for performing better with shade may be temperature, relative humidity, carbon dioxide, etc remaining lower than ambient conditions. At the same time, the air movement may remain favorable for potato storage under shade. This phenomenon is in agreement with the findings of (Harbenburg et al., 1986; Maldegem, 1999). For all the DAS namely 30, 60 and 90 days after storage this was in agreement with the findings of Pinhero et al. (2009) who stated that the pile is made as long as necessary and is made of straw. Clamps can be used in areas where the temperatures are low enough, e.g., in the mountains or on high plateaux in the tropics or in winter in the subtropics. Shade provided by triple at the storage site for providing additional protection against the hot sun and rains may be favorable for storage.

From the above-mentioned results, it may be discussed that if farmers adopt this technology they will be able to store their potatoes very cheaply and no energy input will be needed for 3 to 4 months. The technology will allow them to sell the potatoes at their own will which will be helpful in avoiding distress sales and they can get a better returns by selling from May to July when the availability of potatoes is limited. This is parallel to the findings of Paul et al. (2002) who stated that thatched roof, which was made with locally available materials like wooden pillars, straw material and rope reduce weight loss. This provided additional protection to stored potatoes against the hot sun and unseasonal rains, usually after 60 days of storage (during May and June). These methods are also paralleled to Paul et al. (2002) who mentioned that in terms of economics, the potatoes stored by traditional methods fetched higher prices when sold (after desprouting) in May or June in comparison with its disposal during February or March (harvesting time). At the crisis moment for the farmers, these traditional methods will be attractive in the future at small or large scales for the cost-effectiveness of these traditional methods. In view of the growing importance of the processing industry in near future, to cope with frequent gluts, much fluctuation in potato price was observed from year to year or during the same year, to solve the problem of storing this semi-perishable commodity and for its effective and timely post-harvest utilization. These methods can be adopted not only by small farmers but big farmers can also be benefited from this indigenous technology. Storing potatoes with these locally traditional methods certainly minimizes or breaks the ill-motive syndicate of cold storage owners.

Conclusion

Based on the above results and discussion of the present experiment it can be concluded that the natural storage condition like rice straw + shade, dried water hyacinth + shade, and dried potato herbs + shade performed very well at all dates like 30, 60 and 90 DAS compared to natural storage condition without shade to store potato at farmers' field natural condition. But considering the different rottage percentages like bacterial soft rot (BSR), Fusarium dry rot (FDR), water loss and total loss percentage best performance was obtained from the rice straw + shade. Storing potatoes by heap method using natural storage materials with shade allows farmers to store their potatoes for short-term (up to 90 days) at their own level with acceptable levels of losses. The methods provide the farmer a more flexible opportunity to take his own decisions and also offer the opportunity to sell the potatoes as ware or for processing at a better price after 30, 60 or 90 days of storage.

ACKNOWLEDGEMENT

We would like to acknowledge Bangladesh Agricultural Research Institute (BARI) for providing the source of the budget for research.

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Citation: Salim M, Alam MK, Akter R, 2023. Effect of different natural storage conditions on keeping quality of potato at Munshiganj Region of Bangladesh. Net J Agric Sci, 11(2): 19-24.