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QUALITY AND STORABILITY OF ONION (*Allium cepa* L.) AS INFLUENCED BY VARIETIES AND HOUSEHOLD ORGANIC MULCHES

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ABSTRACT

An experiment was conducted to study the effects of varieties and household organic mulches on growth and yield of onion at the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2020 to March 2021. The experiment consisted of three onion cultivars of Bangladesh viz. Taherpuri, BARI Piaz 1 and BARI Piaz 4, and five household organic mulches, viz. T_0 = Control (no mulching), T_1 = vegetables wastes, T_2 = rice straw, T_3 = banana leaf and T_4 = water hyacinth. The two-factor experiment was carried out in Randomized Complete Block Design with 3 replications. Results revealed that the parameters under study showed significant variation between onion varieties and mulching. Results showed that the highest percent of weight loss of bulbs (31.19%) was observed in V_3T_4 followed by V_3T_1 (29.89%) and the lowest percentage of weight loss of bulbs (24.66%) was observed in V_1T_1. The highest percentage of dry matter content of bulb (13.13%) was recorded in V_3T_4 followed by V_3T_1 (12.54%) and the lowest percent dry matter content of bulb (8.08%) was observed in V_1T_0. The highest percentage of splitted bulb (10.33%) was observed in V_3T_4 followed by V_3T_1 (9.33%) and the lowest percentage of splitted bulb (1.33%) was observed in V_1T_0 (Table 4). On the other hand, the highest percentage of rotten bulb (9.00%) was observed in V_3T_0 followed by V_2T_0 (8.33%) and the lowest percentage of rotten bulb (2.00%) in V_1T_2. Therefore, the combined use of water hyacinth along with Taherpuri was found to be better in respect of quality and storability of onion.

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INTRODUCTION

Onion (*Allium cepa L.*) belongs to the family Alliaceae is an integral part of Bangladeshi diet and popular food items (Hossain and Ismail, 1994). It is the second most frequently cultivated and consumed vegetable crops after tomato in the world (FAO, 2012; Brewster, 1994; McCallum, 2001). Due to its highly prized flavor, scent, and unique taste, it is popularly referred to as "Queen of the Kitchen" (Selvaraj, 1976; Griffiths et al., 2002). The bulb is the main edible part of the onion (Rashid et al. 2019) and is produced primarily from seeds (Jones and Mann, 1963). Onion can be eaten raw, sliced for salad, or cooked with other vegetables and meat. The onion bulb contains high amount of phosphorus, calcium, carbohydrates, and other nutrients. Protein and vitamin C are also present in onion. Onion is the most widely grown spice in Bangladesh, rank first in terms of both production and area (BBS, 2018). It's a low-latitude horticulture crop with a short growing season (Brewster, 1990). Onions are considered to be originated from Iran, Afghanistan, and Turkmenistan, Uzbekistan, and northern portions of Tajikistan (Purseglove, 1972; Brewster, 1994). India, China, the United States, Iran, Russia, Turkey, Egypt, Pakistan, Brazil, and Algeria are the world's top onion producers (FAOSTAT, 2016).

The climate of Bangladesh is ideal for onion cultivation. It can be grown both in the winter and the summer, though the summer onion yield is minimal. Onion seeds are typically planted in October to November for winter, with bulb harvesting taking place in February to March. In Bangladesh, onion is grown almost all the districts but commercially farmed in Faridpur, Dhaka, Mymensingh, Pabna, Comilla, Rahshahi, Jessore, Bogura and Rangpur (BBS, 2017). The overall area under onion farming in Bangladesh is 2,16,200 hectares, with a total production of 23.305 lakh tons (BBS, 2018) which is 60% of the total annual demand (3600 thousand tons) for onion. The average yield per hectare is about 9.76 tons which is much lower than other developed countries where average production is over 17.5 t ha^{-1} (FAO, 2018). As a result, Bangladesh's annual production gap is 1270,000 tons (Sobhan, 2019).

With Bangladesh's ever-increasing population, onion demand is on the rise. The price of onions remains quite high throughout the year, with the exception of a few months after harvest. However, due to land constraints, it is not possible to increase agricultural yield horizontally. The rise of onion farming will stifle the growth of other profitable crops, particularly rice, Bangladesh's major food grain. Improved management practices and increased yield per hectare is the only way to tackle the problem. This can be done by adopting new technology including selection of good varieties, better management practices, mulching, judicious application of manures and fertilizers, irrigation, etc.

Mulching is an old but very effective technology that can increases the production of onion in our country. Mulching is a key method that minimizes evaporation of soil water and conserves soil moisture, lowering irrigation requirements, improving root development, stimulating faster crop development, minimizing weed attack, and inducing earlier crop harvest (Mahajan et al., 2007). Mulching helps to conserve soil moisture by 2.1 to 2.8% more than a soil that is not mulched (Suh and Kim, 1991). In soil management relationships, mulch has been reported to influence organic matter content, activity of microorganisms, availability of soil nutrients, control of erosion and soil compaction and regulating soil temperature (Stowell, 2000). Mulching and irrigation have a big impact on onion growth and development (Rahman et al., 2013). Mulching may be natural or artificial. Organic mulches are natural materials that can be broken down by soil organisms through decomposition. Organic mulches are better for the environment than inorganic mulches. The user's choice of organic or inorganic mulch is largely subjective, however employing organic mulch means utilizing a substance that is readily available in the field and that may breakdown and decompose into organic matter. Organic mulch improves soil fertility by adding nutrients to the soil. By limiting light penetration to the soil surface, a mulched layer inhibits weed development. Reduced weed prevalence improves water efficiency dramatically (Ossom et al., 2001. Use of various mulches like vegetables waste, rice straw, saw dust, water hyacinth reported to conserve soil moisture (Anisuzzaman et al., 2009). Storage of onion bulbs is a serious problem for both growers and consumers in Bangladesh due to significant storage loss (Rashid and Mondal, 2010). Very limited work has been done related to quality and storability of onion (*Allium cepa* L.) as influenced by varieties and household organic mulches. Therefore, the current experiment was undertaken to study the effects of varieties and household organic mulches on quality and storability of onion.

METHODOLOGY

Experimental location

The current experiment was conducted at the Horticulture Farm and postgraduate laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October, 2020 to May, 2021 to study the effects of varieties and household organic mulches on quality and storability of onion.

Plant materials

For this experiment, one local onion cultivar, Taherpuri, and two BARI (Bangladesh Agricultural Research Institute) released varieties such as BARI Piaz 1 and BARI Piaz 4 were used. Onion seeds were acquired from Mymensingh's local markets and BARI's Spice Research Centre (SRC) in Bogura.

Application of treatments, design and layout of the experiment

The two-factor field experiment was set up using Randomized Complete Block Design with three replications. The experimental plot was divided into three blocks, with each block subdivided into 15 plots. There were 45 (3x5x3) treatment combinations in total. Each unit plot was 1m × 1m in size. To accommodate varied intercultural operations, the distance between the blocks was 50 cm and the distance between the plots was 30 cm, with plant spacing of 25 cm x 10 cm. In each blocks, treatments were applied at randomly. The entire quantity of cow dung was applied to the land @ 12 t/ha before land preparation during the month of November. Urea 21.8 g, TSP 17.5 g, MoP 20.0 g and Gypsum 8.4 g were also used at 25 days before planting of seedlings and incorporated into the soil carefully. After ploughing and laddering cow dung were mixed with the soil thoroughly. Then the soil was kept at that condition for a few weeks and after those fertilizers were applied into the plots by broadcasting followed by mixing with soil according to the recommended rate.

Intercultural operations

To ensure proper soil management, the transplanted seedlings were lightly watered up to 7 days. Plots with transplanted seedlings were checked on a regular basis for any damage or dead seedlings that needed to be replaced. After transplanting, only a few seedlings were injured, and these were replaced with new seedlings from the same stock. Weeding was done as needed throughout the growing season to keep the crop free of weeds, improve soil aeration, and break up the crust. It also aided in the preservation of soil moisture. Very few onion plants at the emergence stage attacked by cutworm (*Agrotis epsilon R.*) and field crickets attacked a few onion plants (*Brachytrypetens portosus L.*). The insects were mechanically controlled. Purple blotch disease caused by *Alternaria porii* was found in many plants in the experimental field at later stages of crop growth. It was controlled by spraying the crop with Rovral @ 2g in the 1 litre of water. Shortly after transplanting, the crop was watered with a watering can, and then every 7 days for the next 60 days. Watering was followed after each fertilization. When maximum tops had fallen over, the crop was harvested in March 2020. Before each variety's bulb was harvested, the size of the bulb was measured. By cutting off the pseudostem and keeping 2.5 cm of the bulb, the onion's top was removed. Pictorial views of various growth and development stages of onion have been shown in Plate 1. The yield per hectare was calculated by multiplying the gross weight of onion in kilograms (kg) by the number of bulbs developed in a plot (1m x 1m). The stem and bulb were cleaned in order to collect all of the necessary data. After harvesting onion bulbs were kept under a shade for 7 days for curing.

Collection of data

Percent weight loss

After harvesting the onion bulbs, they were maintained at room temperature in the Department of Horticulture's Laboratory. Three bulbs were chosen at random and stored in order to calculate the % weight loss of bulbs. For 70 days, bulbs were kept in the laboratory. At three-day intervals, data was collected. After 70 days, it was determined which combined impact produced the best result in terms of onion bulb weight drop in percent.

Percent dry matter content

10 g of sliced fresh onion bulbs from 5 sample plants from each plot were dried in an oven at 70°C to determine dry matter content. It took 48 hours for the weight to stabilize. The dry weight was measured in grams (g) and a mean value was determined. The following formula was used to compute the percent dry matter.

$$\% \text{ Dry matter content in bulb } = \frac{Dry\ weight\ of\ bulb}{Fresh\ weight\ of\ bulb} \times 100$$

Percent rotten bulb

After harvesting, rotten bulbs were counted from the total bulbs of each unit plot and their percentages were calculated by using the formula:

$$\% \text{ Rotten bulb} = \frac{Number\ of\ rotten\ bulb}{Number\ of\ total\ bulb} \times 100$$

Percent splitting of bulb

After harvesting, split bulbs were counted from the total bulbs of each unit plot and their percentages were calculated by using the formula:

$$\% \text{ Split bulb} = \frac{Number\ of\ split\ bulb}{Number\ of\ total\ bulb} \times 100$$

Statistical analysis

The data in respect of growth and yield characteristics were statistically analysed using MSTAT computer program to find out the statistical significance of the experimental results. The means of all the treatments were calculated and the analysis of variance was performed by F (Variance ratio) test (Gomez and Gomez, 1984). The differences among the treatment means were evaluated by Least Significant Difference (LSD) test at 1 and 5% levels of probability.

RESULTS AND DISCUSSION

Percent weight loss of onion

The variations in percentage of weight loss of onion bulbs were found significant due to the use of different varieties. Weight loss of bulbs was recorded highest (28.98%) at 70 days after storage (DAS) and it was recorded from (V_3) BARI Piaz 4, followed by BARI Piaz 1 (27.93%) and Taherpuri (25.95%) (Figure 1). Weight loss of bulbs was significantly influenced by mulches. Control treatment gave the maximum percentage of weight loss of bulbs (28.25%) and T_1 treatment gave the minimum percentage of weight loss of bulbs (25.64%) (Figure 2). The combined effects of variety and organic mulches were found significant in respect of percentage of weight loss of bulbs. Results showed that the highest percent of weight loss of bulbs (31.19%) was observed in V_3T_4 followed by V_3T_1 (29.89%) and the lowest percentage of weight loss of bulbs (24.66%) was observed in V_1T_1 (Table 1).

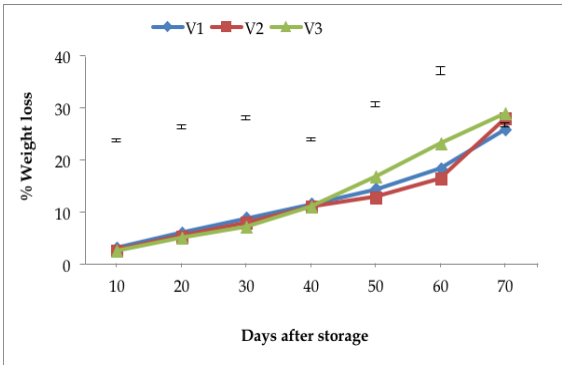

Figure 1. Main effects of variety on weight loss (%) at different days after storage (DAS). Vertical bars represent LSD at 1% level of significance. V_1 = Taherpuri, V_2 = BARI Piaz 1, V_3 = BARI Piaz 4.

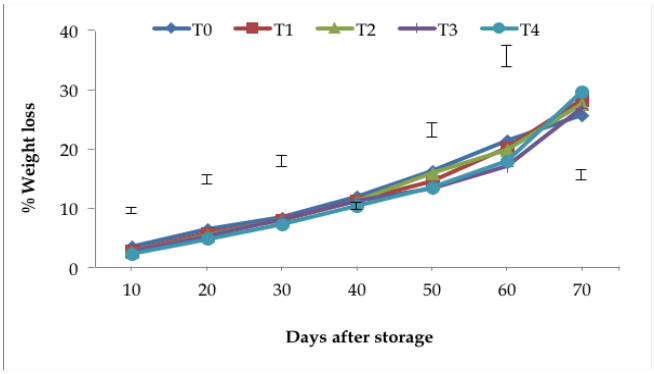

Figure 2. Main effects of organic mulches on weight loss (%) at different days after storage (DAS). Vertical bars represent LSD at 1% level of significance. T_0 = (Control, no mulches), T_0 = (Control, no organic mulches), T_1= Vegetable's waste, T_2 = Rice straw, T_3 = Banana leaf, T_4 = Water

Percent dry matter content of bulb

The percent dry matter content of the bulb varied significantly between varieties. V_3 (BARI Piaz 4) had the highest percentage of dry matter content of bulb (11.87%), while V_1 (Taherpuri) had the lowest percentage of dry matter content (9.41 %) (Figure.4). This could be because BARI Piaz 4 promoted maximum vegetative growth as well as leaf number, resulting in maximum photosynthesis and food material accumulation, which ultimately resulted in maximizing the percentage of dry matter content of onion bulbs. The dry matter content of onion bulb measured in percentage was significantly affected by the application of household organic mulches. The use of mulch had a positive impact on plants due to soil temperature, soil humidity, and water availability for plant growth and nutrient translocation from roots to leaves (Wiryanta BTW, 2006). However, T_4 gave the highest percent of dry matter content of bulb (11.86%) bulb followed by T_1 (11.53%), T_2 (10.94%) and T_3 (10.55%) and lowest percent of dry matter content of bulb (9.70%) was observed in control treatment (T_0) (Figure 4). Combined effect of variety and household organic mulches showed significant effect on percent dry matter content of bulb at 1% LSD. The highest percentage of dry matter content of bulb (13.13%) was recorded in V_3T_4 followed by V_3T_1 (12.54%) and the lowest percent dry matter content of bulb (8.08%) was observed in V_1T_0 (Figure 5).

Table 1. Combined effects of variety and household organic mulches on percent weight loss at different days after storage of onion

Treatment combination	Initial Weight (g)	Weight loss (%) at different days after storage						
		Day after storage						
		10	20	30	40	50	60	70
V_1T_0	89.33	3.37	4.56	6.89	9.22	12.79	19.36	26.66
V_1T_1	90.67	3.50	7.32	10.01	13.02	16.88	20.12	24.67
V_1T_2	109.33	2.76	5.53	8.29	11.05	13.82	17.50	25.84
V_1T_3	86.33	3.62	7.23	10.84	13.43	15.00	18.28	25.06
V_1T_4	111.00	2.77	5.53	8.31	11.07	13.84	17.53	27.55
V_2T_0	121.00	3.53	7.07	10.60	14.58	17.22	21.64	25.72
V_2T_1	190.83	2.13	4.26	6.38	8.78	10.37	13.54	28.18
V_2T_2	150.67	2.68	5.36	8.04	11.05	12.35	16.41	27.80
V_2T_3	167.67	2.45	4.90	7.34	10.10	11.94	15.00	27.52
V_2T_4	172.33	2.53	5.06	7.59	10.43	12.33	15.49	30.43
V_3T_0	161.67	3.54	7.44	7.65	11.91	18.60	26.09	26.56
V_3T_1	204.33	2.98	5.52	7.62	11.72	16.22	24.68	29.89
V_3T_2	235.17	2.35	5.12	7.84	11.65	21.67	25.64	29.08
V_3T_3	213.67	2.01	3.73	6.38	10.27	13.27	18.27	28.21
V_3T_4	278.67	1.82	3.94	6.14	9.81	14.52	21.11	31.19
$LSD_{0.05}$	13.09	0.42	0.64	0.78	0.44	1.00	1.54	0.67
$LSD_{0.01}$	17.63	0.57	0.87	1.05	0.60	1.35	2.07	0.90
Level of significance	**	**	**	**	**	**	**	**

** = Significant at 1% level of probability. V_1 = Taherpuri, V_2 = BARI Piaz 1, V_3 = BARI Piaz 4, T_0 = (Control, no organic mulches), T_1= Vegetable's waste, T_2 = Rice straw, T_3 = Banana leaf, T_4 = Water hyacinth.

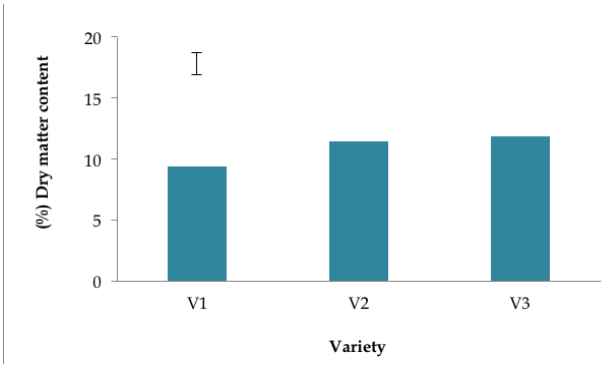

Figure 3. Main effects of variety on dry matter content (%) at harvest. Vertical bar represents LSD at 1% level of significance. V_1 = Taherpuri, V_2 = BARI Piaz 1, V_3 = BARI Piaz 4.

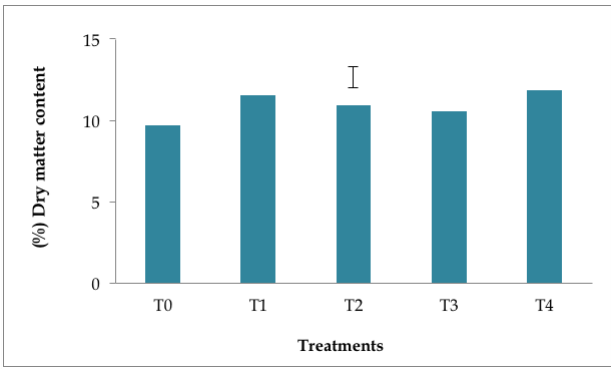

Figure 4. Main effects of organic mulches on dry matter content (%) at harvest. Vertical bar represents LSD at 1% level of significance. T_0 = (Control, no mulches)**,** T_0 = (Control, no organic mulches), T_1= Vegetable's waste, T_2 = Rice straw, T_3 = Banana leaf, T_4 = Water hyacinth

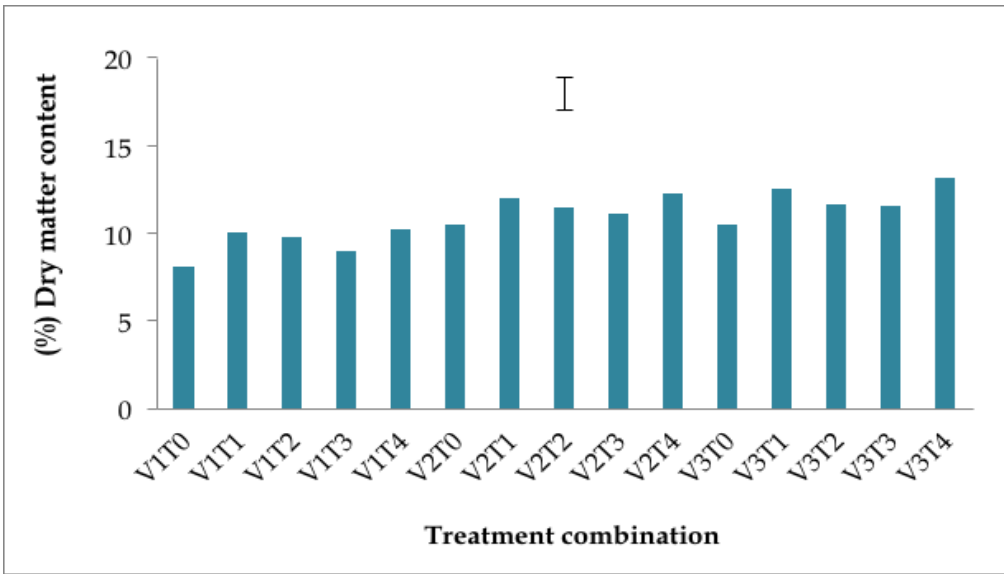

Figure 5. Combined effects of varieties and organic mulches on dry matter content (%) at harvest. Vertical bar represents LSD at 1% level of significance. T_0 = (Control, no mulches)**,** T_0 = (Control, no organic mulches), T_1= Vegetable's waste, T_2 = Rice straw, T_3 = Banana leaf, T_4 = Water hyacinth.

Percent rotten bulbs and percent splitting of bulbs during storage

The variations in percentage of rotten bulbs and highest number of split bulbs/non-split bulbs were observed to be significant due to different varieties. The highest number of splitted bulbs (7.20%) and highest percentage of rotten bulbs (5.87%) were recorded from V_3 (BARI Piaz 4) and the lowest number of splitted bulbs and lowest number of rotten bulbs (4.67%) was recorded from (Taherpuri) (Table 2). From the present research work, it was found that there was significant variation among the treatments in respect of rotten bulbs and numbers of splitted bulbs due to different household organic mulches. Control (T_0) treatment gave maximum percentage of rotten bulbs (8.11%) and T_4 treatment gave minimum percentage of rotten bulbs (5.44%) (Table 3). Whereas T_4 treatment gave maximum percentage of splitted bulbs (8.33%) and control treatment T_0 gave the minimum percentage of splitted bulbs (2.22%) (Table 3). The combined effects of variety and household organic mulches were found significant in respect of percentage of rotten bulbs and splitted bulbs. Results showed that the highest percentage of splitted bulb (10.33%) was observed in V_3T_4 followed by V_3T_1 (9.33%) and

the lowest percentage of splitted bulb (1.33%) was observed in V_1T_0 (Table 4). On the other hand, the highest percentage of rotten bulb (9.00%) was observed in V_3T_0 followed by V_2T_0 (8.33%) and the lowest percentage of rotten bulb (2.00%) in V_1T_2 (Table 4).

Table 2. Main effect of variety on rotten bulbs and splitting of bulbs at different days after transplanting

Variety	Splitting of Bulb (%)	Rotten Bulb (%)
V_1	3.20	4.67
V_2	4.33	5.27
V_3	7.20	5.87
$LSD_{0.05}$	0.61	0.56
$LSD_{0.01}$	0.83	0.76
Level of significance	**	**

** = Significant at 1% level of probability. V_1 = Taherpuri, V_2 = BARI Piaz 1, V_3 = BARI Piaz 4

Table 3. Main effect of treatment on rotten bulbs and Splitting of bulbs at different days after planting of onion

Treatments	Splitting of Bulb (%)	Rotten Bulb (%)
T_0	2.22	8.11
T_1	6.11	2.56
T_2	4.56	4.33
T_3	3.33	5.89
T_4	8.33	5.44
$LSD_{0.05}$	0.79	0.72
$LSD_{0.01}$	1.07	0.98
Level of significance	**	**

** = Significant at 1% level of probability. T_0 = Control, T_1 = Vegetables Waste, T_2 = Rice Straw, T_3 = Banana leaf, T_4 = Water hyacinth

Table 4. Combined effects of variety and household organic mulches on Splitting of bulbs and rotten bulbs at different days after planting

Treatment combination	Splitting of Bulb (%)	Rotten Bulb (%)
V_1T_0	1.33	7.00
V_1T_1	4.33	2.00
V_1T_2	2.67	4.67
V_1T_3	2.00	4.33
V_1T_4	5.67	5.33
V_2T_0	2.00	8.33
V_2T_1	4.67	2.67
V_2T_2	3.33	3.33
V_2T_3	2.67	6.67
V_2T_4	9.00	5.33
V_3T_0	3.33	9.00
V_3T_1	9.33	3.00
V_3T_2	7.67	5.00
V_3T_3	5.33	6.67
V_3T_4	10.33	5.67
$LSD_{0.05}$	1.37	1.25
$LSD_{0.01}$	1.85	1.69
Level of significance	**	**

** = Significant at 1% level of probability. V_1 = Taherpuri, V_2 = BARI Piaz 1, V_3 = BARI Piaz 4, T_0 = (Control, no household organic mulches), T_1= Vegetable's waste, T_2 = Rice straw, T_3 = Banana leaf, T_4 = Water hyacinth.

CONCLUSION

The current experiment was conducted at the Horticulture Farm and Postgraduate Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October, 2020 to May, 2021 to study the effects of varieties and household organic mulches on quality and storability of onion. It was observed that different treatments performed differently in terms of yield, quality and storability characters based on the outcomes of this investigation. The combined application of water hyacinth along with Taherpuri was found to be better for quality and storability of onion.

CONFLICT OF INTEREST

The authors did this research and wrote the article and there is no conflict of interest with other people.

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