Fundamental and Applied Agriculture
Vol. 7(4), pp. 298–307: 2022
doi: 10.5455/faa.123513

HORTICULTURE | ORIGINAL ARTICLE

Effects of organic mulches on growth and yield of winter onion (*Allium cepa* L.) cultivars

Tangida Akter, Md Harun Ar Rashid*

Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ARTICLE INFORMATION

Article History
Submitted: 12 Oct 2022
Accepted: 12 Dec 2022
First online: 30 Dec 2022

Academic Editor
Md Rezaul Karim
mrkarim1996@yahoo.com

**Corresponding Author*
Md Harun Ar Rashid
harun_hort@bau.edu.bd

ABSTRACT

An experiment was conducted to study the effects of cultivars and 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 winter onion cultivars of Bangladesh viz. Taherpuri, BARI Piaz-1 and BARI Piaz-4, and five organic mulches, viz. Control (no mulching), vegetables wastes, rice straw, banana leaf and water hyacinth. The two-factor experiment was carried out in Randomized Complete Block Design with three replications. Results revealed that the parameters under study showed significant variation among onion varieties and organic mulching. BARI Piaz-4 gave the highest plant height, number of leaves, fresh weight and gross yield of bulb compared to BARI Piaz-1 and Taherpuri. The application of water hyacinth increased plant height, number of leaves, fresh weight of bulb, bulb length and diameter, and bulb yield compared to other treatments. Mulching with water hyacinth showed the best results in respect of on all the parameters under study. The highest bulb yield (12.72 t ha^{-1}) was recorded in T4 and the lowest bulb yield (8.97 t ha^{-1}) was found in T0. The effect of organic mulches on yield were in order of water hyacinth> vegetables wastes> rice straw> banana leaf> control (no mulching). Among the treatment combinations water hyacinth mulch in combination with BARI Piaz-4 gave the highest plant height (47.85 cm), number of leaves (14.01), fresh weight of bulb (52.87 g) and gross yield of onion (18.24 t ha^{-1}), whereas, the lowest plant height (36.13 cm), number of leaves (6.53), fresh weight of bulb (17.08 g) and gross yield of onion (5.74 t ha^{-1}) were was obtained from Tahepuri caultivar having no mulch. Therefore, the combined application of water hyacinth along with BARI Piaz-4 was found to be the best in respect of growth and yield of onion.

Keywords: Onion, organic mulching, cultivars, growth, yield

Cite this article: Akter T, Rashid MHA. 2022. Effects of organic mulches on growth and yield of winter onion (*Allium cepa* L.) cultivars. Fundamental and Applied Agriculture 7(4): 298–307. doi: 10.5455/faa.123513

1 Introduction

Onion (*Allium cepa* L.) belongs to the family Alliaceae is an integral part of Bangladeshi diet and popular food items (Hossain and Islam, 1994). It is the second most frequently cultivated and consumed vegetable crops after tomato in the world (FAO, 2021; Brewster, 1994; McCallum et al., 2001). Due to its highly prized flavor, scent, and unique taste, it is popularly referred to as 'Queen of the Kitchen' (Selvaraj, 1976). The bulb is the main edible part of the onion (Rashid and Islam, 2019) and is produced primarily from seeds (Jones and Mann, 1964). 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. It's a low-latitude horticulture crop with a short growing season (Brewster, 1994).

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). Onion is the most widely grown spice in Bangladesh, rank first in terms of both production and area (BBS, 2018). The overall area under onion farming in Bangladesh is 216.20 thousand hectares, with a total production about 2330.50 thousand tons which is 60% of the total annual demand (3600 thousand tons) (BBS, 2018). As a result, Bangladesh's annual production gap is 1270,000 tons (Sobhan, 2019).

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). 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.

Lion share of onion is grown in Bangladesh during the winter season, when rainfall is limited and irrigation is required to provide adequate moisture to the growing crop. However, only 20% of crops have access to irrigation. Frequent irrigation is required for successful onion production, but irrigation facilities are scarce. Furthermore, irrigation raises the cost of production. In this case, mulching such as water hyacinth, rice straw, vegetables waste, banana leaf and other materials were deemed to be beneficial.

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 by 2.1 to 2.8% more than a soil that is not mulched, lowering irrigation requirements, improving root development, stimulating faster crop development, minimizing weed attack, influence organic matter content, increase activity of microorganisms and availability of soil nutrients, control of soil erosion, soil compaction and regulating soil temperature, and inducing earlier crop harvest (Mahajan et al., 2007; Ossom et al., 2001; Stowell, 2000; Suh and Kim, 1991). 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 and improves soil fertility by adding nutrients to the soil. Organic mulches are better for the environment than inorganic mulches. Inorganic mulches, such as plastic sheets, are convenient to handle and appear to be an excellent choice due to their longevity, however they are non-recyclable and environmentally unfriendly. For the past decades people are more concern about the organically produced foods. Organic mulch improves the soil environment for increasing crop growth, development and yield. Use of various organic mulches like vegetables waste, rice straw, saw dust, water hyacinth reported to conserve soil moisture (Anisuzzaman et al., 2009). Very limited work has been done related to variety and organic mulches on onion cultivars in Bangladesh. Therefore, the current experiment was undertaken to study the effects of varieties and organic mulches on growth and yield of onion.

2 Materials and Methods

2.1 Study location

The current experiment was conducted at the Horticulture Farm of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2020 to March 2021 to study the effects of varieties and organic mulches on growth and yield of onion. The experimental area is located at 26° 46'N latitude and 90° 24'E longitudes. The elevation of the area is approximately 18 m from average sea level. During Rabi season, the experimental site was in a sub-tropical climatic zone with low rainfall, low humidity, low temperature, and short-day periods (October to March) and heavy rainfall, high humidity, high temperature and relatively long day during Kharif season (April to September). According to Edris et al. (1979), this experimental site has a sub-tropical climate with three distinct seasons: the monsoon or rainy season, the winter season, the pre-monsoon period and duration of each season are May- October, November-February, March- April respectively. Onion cultivation is best during the winter (Rabi season) and the early part of the hot season. The experimental area was on a medium high land in AEZ-9 belonging to the soil series of the Old Brahmaputra Flood Plain Alluvial Tract having non-calcareous dark gray floodplain soil (UNDP, 1988). The soil had a silty loam texture and the pH was 6.85, and the organic matter content was low.

2.2 Plant materials

For this experiment, one local onion cultivar, Taherpuri, and two BARI (Bangladesh Agricultural Research Institute) released varieties such as BARI Piaz

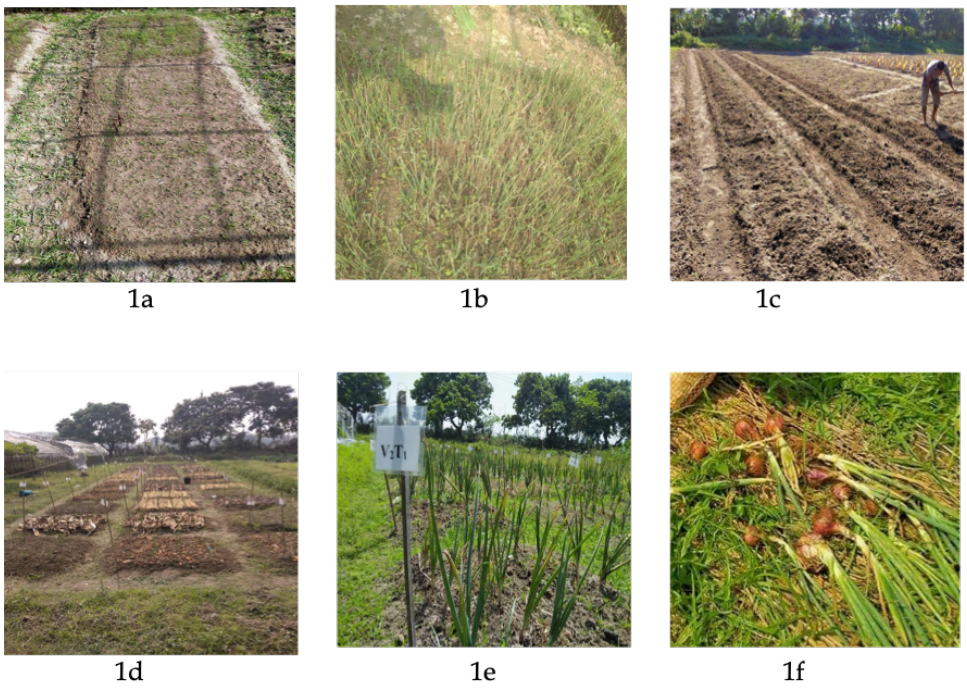

Figure 1. Pictorial view of various growth and development stages of onion. (a) Onion seedbed, (b) Raising of seedlings, (c) Preparation of main plot, (d) Transplanting of seedlings and application of organic mulches, (e) Vegetative growth stage, and (f) Harvested onion

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.

2.3 Experimental design and layout

The two-factor 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 ($3 \times 5 \times 3$) treatment combinations in total. Each unit plot was 1 m $\times$ 1 m 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 $\times$ 10 cm. In each blocks, treatments were applied at randomly.

2.4 Methods of onion Cultivation

The land was first ploughed with power tiller and clods were broken by ladder. Weeds and stubbles were removed from the land. Three seedbeds were prepared for three varieties of onion. Each of the beds was used for each variety. The experimental field's land was first ploughed with the use of a power tiller. After that, it was exposed to the sun for 15 days before being ploughed again. The field was then ploughed and cross-ploughed to achieve good tilth. After each ploughing, leveling is done to break up the soil clods into little pieces. The field was cleared of all weeds and stubbles. According to the experimental design, the experimental field was divided into unit plots. Then TSP, MoP and sulphur fertilizers were applied to the experimental plots with N @ 100 kg ha^{-1}, P @ 35 kg ha^{-1}, K @ 96 kg ha^{-1} and S @ 15 kg ha^{-1} under investigation according to BARC (2010). Cowdung was applied to the land @ 12 t ha^{-1} before land preparation during the month of November at 25 days before planting of seedlings and incorporated into the soil carefully. 35-days-old, healthy, disease-free, and uniform seedlings were plucked from the seedbeds and transplanted to the main field after minor leaf trimming, with a spacing of 25 cm $\times$ 10 cm and 40 plants per unit plot. The planting depth was 2.5 cm below the soil's surface. Before uprooting the seedlings, the seedbeds were watered in the morning. The seedlings were gently plucked from the seedbed to avoid causing damage to the root system. For better establishment, transplanting was done in the afternoon and lightly irrigated with a watering can shortly afterward. For gap filling, a number of seedlings were planted throughout the experimental plot's perimeter.

To ensure proper soil management, the transplanted seedlings were lightly watered up to 7 days. After transplanting, only a few seedlings were injured, and these were replaced with new seedlings from the same stock. Weeding and irrigation was done as needed throughout the growing season. 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 @ 2 g in the 1 L of water. When maximum tops had fallen over, the crop was harvested in March 2021. Before each cultivar'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 Fig. 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 (1 m $\times$ 1 m). The stem and bulb were cleaned in order to collect all of the necessary data.

2.5 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.

3 Results and Discussion

3.1 Plant height

Plant height at different stages of growth was recorded at 30, 45, 60, 75 and 90 days after planting (DAP). There was statistically significant difference across the onion cultivars (Fig. 2). The results showed that plant height grew progressively during the growing period and all varieties showed maximum plant height at 90 DAP. The maximum plant height (48.94 cm) was obtained from the cv. BARI Piaz 4 and the lowest plant height (38.67 cm) was found in cv. Taherpuri (Fig. 2). This difference in plant height might be due to the genotypic and phenotypic differences among the onion cultivars. The influence of organic mulches on onion plant height at various growth stages was substantial (Fig. 2). The highest plant height (47.72 cm) at 90 DAP was recorded from application of water hyacinth (T4) followed by vegetable waste (T1), rice straw (T2), banana leaves (T3), while the lowest plant height (42.10 cm) was recorded from control (T0) (Fig. 2).

In case of combined effects, the maximum plant height (52.33 cm) at 90 DAP was observed from V3T4 followed by V2T4 (48.93 cm) and the minimum plant height (36.13 cm) was observed from V1T0 (Table 1). 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, 2006).

3.2 Number of leaves per plant

The effect of onion variety in respect of number of leaves per plants was found to be significant (Fig. 2). The varieties showed significant difference in respect of number of leaves at 30, 45, 60, 75 and 90 DAP (Fig. 2). BARI Piaz-4 produced significantly higher number of leaves per plant (11.55) at 90 DAP compared to the number of leaves per plant (40.10) of Taherpuri (Fig. 2). This difference in number of leaves per plant might be due to the genotypic and phenotypic differences among the onion cultivars. Application of organic mulches exhibited a significant influence on number of leaves per plants at 30, 45, 60, 75 and 90 DAP (Fig. 2). However, T4 treatment (water hyacinth) gave the maximum number of leaves (11.73) followed by 10.98 in vegetable waste (T1) and the minimum (9.09) in control treatment (T0) at 90 DAP (Fig. 2). The soil moisture percentage in the control plot was lower than in the other mulches, which may have hampered plant growth and development, resulting in a smaller bulb size. The combined effect of variety and treatment on number of leaves was significant at 30, 45, 60, 75 and 90 DAP (Table 1). The results showed that maximum number of leaves (13.05) was observed from V3T4 at 90 DAP followed by V2T4 (12.10) and the minimum number of leaves (7.97) was observed from V1T0 (Table 1). Mulching improves plant growth and increase number of leaves per plant (Rashid and Islam, 2019).

3.3 Length of bulb

Varieties showed significant variation on onion bulb length (Table 2). The variety (V3) BARI Piaz 4 was recorded the maximum bulb length (4.89 cm), and the lowest bulb length (2.84 cm) was found in Taherpuri (V1) (Table 2). This difference in bulb length might be due to the genotypic and phenotypic differences among the onion cultivars. The result of the present study measured that there was significant effect of organic mulches on length of the onion bulb (Table 2). T4 (water hyacinth) had the largest bulb length (4.47 cm), followed by T1 (4.16 cm), T2 (3.96 cm), and T3 (3.70 cm), with T0 having the shortest bulb length (3.24 cm) (Table 3). However, the combined effect of variety and organic mulches on bulb length was insignificant (Table 4). The highest bulb length (5.34 cm) was observed in V3T4, followed by V3T1 (5.15 cm), and the shortest bulb length (2.08 cm) was observed in V1T0 (Table 4).

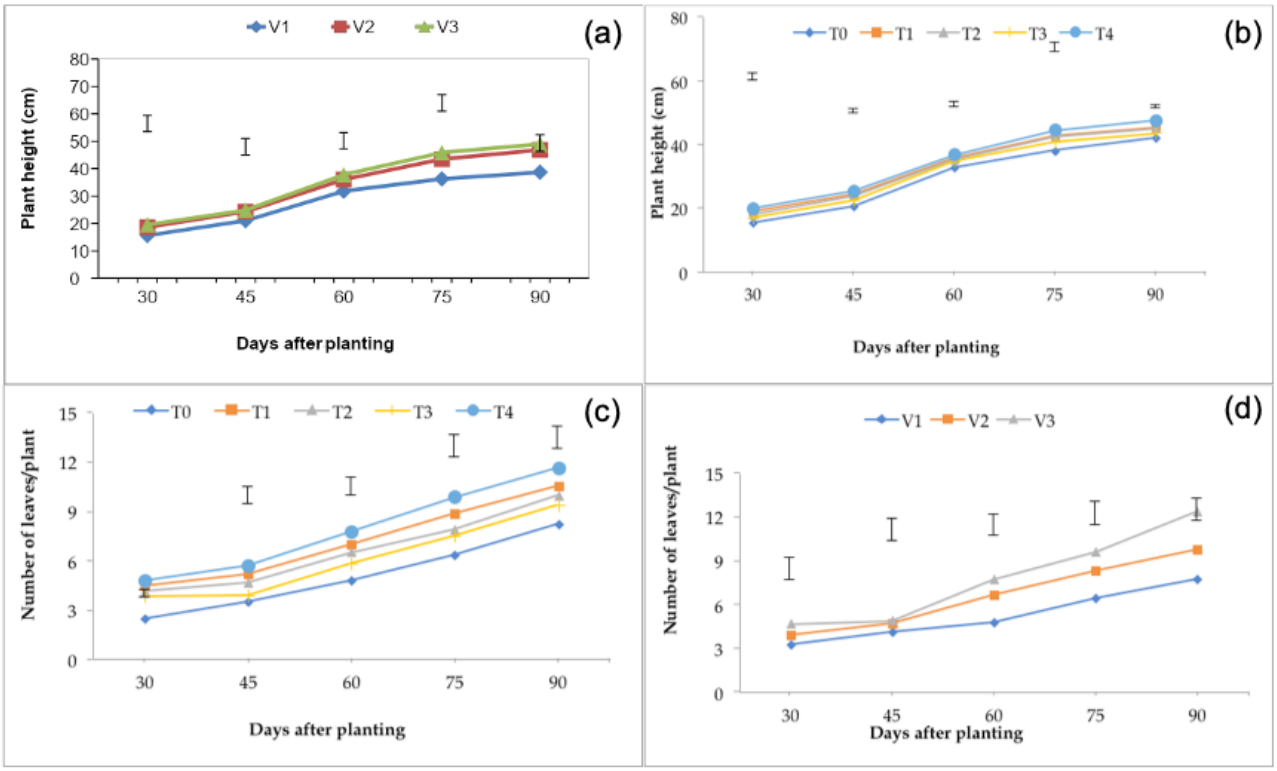

Figure 2. Effects of (a) variety and (b) organic mulches on plant height at different days after planting (DAP), and (c) variety and (d) organic mulches on number of leaves per plant at different DAP. Vertical bars represent LSD at 1% level of significance. V1 = Taherpuri, V2 = BARI Piaz 1, V3 = BARI Piaz 4

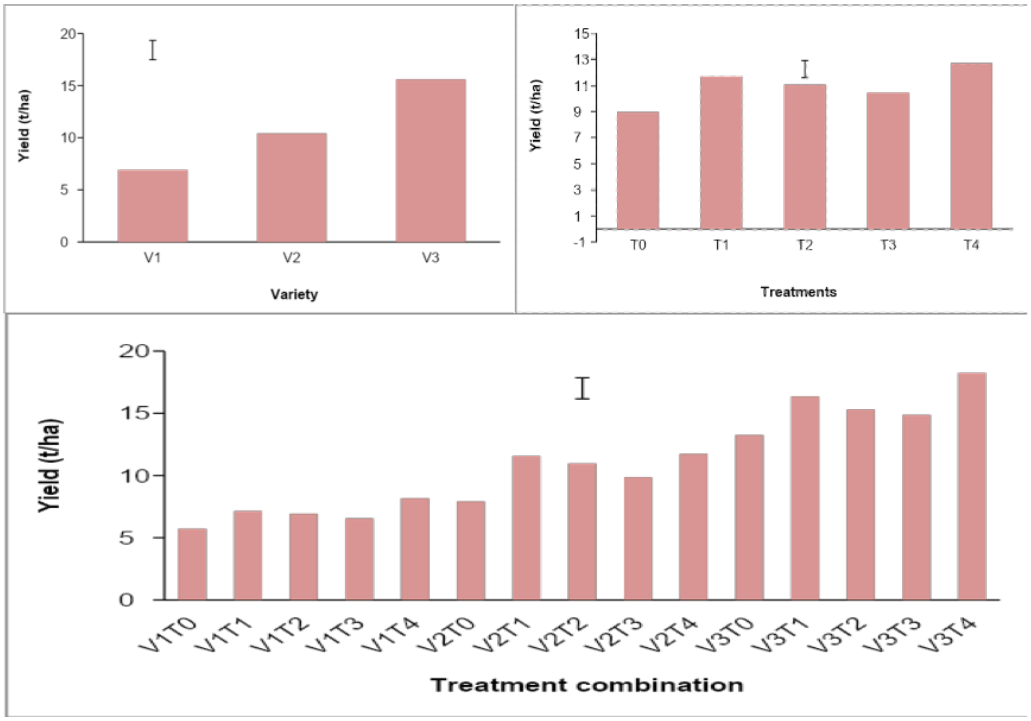

Figure 3. Effects of variety, organic mulches and their interaction on gross yield of onion bulb. Vertical bars represent LSD at 1% level of significance. V1 = Taherpuri, V2 = BARI Piaz 1, V3 = BARI Piaz 4

Table 1. Combined effects of variety and household organic mulches on plant height at different days after planting (DAP) of onion

Treatment combination	Plant height (cm) at different DAP					No. of leaves per plant at different DAP				
	30	45	60	75	90	30	45	60	75	90
V1T0	13.13	19.33	28.67	32.47	36.13	2	3.53	4.07	5.93	6.53
V1T1	16.93	21.47	32.93	37.9	39.33	4	4.7	5.17	7.04	8
V1T2	15.53	21.37	32.4	36.73	38.9	3.27	4.03	4.55	5.5	7.27
V1T3	14.67	20.47	31.73	35.27	37.07	3	3.47	4.02	5.53	7.04
V1T4	17.73	22.47	33.27	38.87	41.9	4.02	5	6.05	8.25	9.79
V2T0	15.87	21.33	34.27	41.67	44.53	2.33	3.53	4.2	6.03	8.04
V2T1	19.33	25.33	36.47	44.07	47.8	4.43	5.17	7.43	9.01	10.46
V2T2	19.13	24.93	36.33	43.93	46.93	4.4	5	7.02	8.15	10.1
V2T3	17.8	23.27	35.33	42.6	45.93	3.44	4.02	6.45	8.02	9.02
V2T4	21	26.6	37.67	45.07	48.93	5.02	5.93	8.02	10.19	11.17
V3T0	17.53	21.4	35.8	40.2	45.63	3.15	3.57	6.2	7.13	10.11
V3T1	20.67	26.33	38.07	47.4	49.53	5.01	5.75	8.4	10.58	13.15
V3T2	19.27	25.6	37.73	46.8	49.33	4.88	5.01	8.02	10.12	12.58
V3T3	18.67	23.53	37.53	45	47.85	5.01	4.23	7.03	9.03	12.08
V3T4	21.6	27.27	39.73	49.87	52.33	5.29	6.2	9.18	11.18	14.01
LSD0.05	0.83	0.41	0.51	1.2	0.48	0.14	0.35	0.37	0.45	0.47
LSD0.01	1.12	0.56	0.68	1.62	0.64	0.19	0.47	0.5	0.61	0.63
Sig. level	NS	**	**	**	**	**	**	**	**	**

** Significant at 1% level of probability, V1 = Taherpuri, V2 = BARI Piaz 1, V3 = BARI Piaz 4, T0 = (Control, no mulches), T1 = Vegetable waste, T2 = Rice straw, T3 = Banana leaf, T4 = Water hyacinth

Table 2. Main effects of variety on yields and yield contributing characters of onion at different days after planting (DAP)

Variety	Bulb length (cm)	Bulb dia. (cm)	Fresh wt. of bulb (g)	Splitted bulb (%)	Rotten bulb (%)
V1	2.84	2.35	19.18	3.2	4.67
V2	3.99	3.01	37.21	4.33	5.27
V3	4.89	4.12	47.16	7.2	5.87
LSD0.05	0.04	0.17	0.48	0.61	0.56
LSD0.01	0.06	0.23	0.65	0.83	0.76
Sig. level	**	**	**	**	**

** = Significant at 1% level of probability, V1 = Taherpuri, V2 = BARI Piaz 1, V3 = BARI Piaz 4

Table 3. Combined effects of variety and household organic mulches on yields and yield contributing characters of onion at different days after planting (DAP)

Treatment	Bulb length (cm)	Bulb dia. (cm)	Fresh wt. of bulb (g)	Splitted bulb (%)	Rotten bulb (%)
T0	3.24	2.62	30.37	2.22	8.11
T1	4.16	3.32	35.61	6.11	2.56
T2	3.96	3.27	34.47	4.56	4.33
T3	3.7	3	32.64	3.33	5.89
T4	4.47	3.59	39.49	8.33	5.44
LSD0.05	0.05	0.22	0.63	0.79	0.72
LSD0.01	0.07	0.29	0.84	1.07	0.98
Sig. level	**	**	**	**	**

** = Significant at 1% level of probability, T0 = Control, T1 = Vegetables Waste, T2 = Rice Straw, T3 = Banana leaf, T4 = Water hyacinth

Table 4. Combined effects of variety and household organic mulches on yields and yield contributing characters of onion at different days after planting (DAP)

V × T	Bulb length (cm)	Bulb dia. (cm)	Fresh wt. of bulb (g)	Splitted bulb (%)	Rotten bulb (%)
V1T0	2.08	2.03	17.08	1.33	7
V1T1	3.17	2.49	20.11	4.33	2
V1T2	2.84	2.34	19.22	2.67	4.67
V1T3	2.7	2.26	17.27	2	4.33
V1T4	3.39	2.62	22.2	5.67	5.33
V2T0	3.36	2.06	33.17	2	8.33
V2T1	4.15	3.41	38.17	4.67	2.67
V2T2	3.99	3.32	37.15	3.33	3.33
V2T3	3.77	2.79	34.16	2.67	6.67
V2T4	4.7	3.49	43.39	9	5.33
V3T0	4.28	3.77	40.85	3.33	9
V3T1	5.15	4.06	48.55	9.33	3
V3T2	5.04	4.15	47.03	7.67	5
V3T3	4.63	3.96	46.49	5.33	6.67
V3T4	5.34	4.67	52.87	10.33	5.67
LSD0.05	0.09	0.37	1.08	1.37	1.25
LSD0.01	0.12	0.5	1.46	1.85	1.69
Sig. level	**	**	**	**	**

** = Significant at 1% level of probability, V1 = Taherpuri, V2 = BARI Piaz 1, V3 = BARI Piaz 4, T0 = (Control, no mulches), T1= Vegetable waste, T2 = Rice straw, T3 = Banana leaf, T4 = Water hyacinth

3.4 Diameter of bulb

A significant variation was found in respect of diameter of bulb due to the effect of different varieties (Table 2). Variety BARI Piaz 4 (V3) recorded the highest diameter (4.12cm) compared of bulb diameter (2.35 cm) in Taherpuri (V1) (Table 2). This difference in bulb diameter might be due to the genotypic and phenotypic differences among the onion cultivars. The current study found that organic mulches had a significant effect on the diameter of the onion bulb (Table 3). The highest diameter of bulbs (3.59 cm) was observed at T4 followed by T1 (3.32 cm), T2 (3.27 cm) and T3 (3.00 cm) and the lowest bulb diameter (2.60 cm) were found in T0 (Table 3). However, the combined effect of variety and treatment on bulb diameter was significant (Table 4). Results showed that highest bulb diameter (4.67 cm) was observed in V3T4 followed by V3T1 (4.15 cm) and the minimum bulb diameter (2.03 cm) was observed from V1T0 (Table 4). Mulches increased bulb length and diameter and hence total bulb yield (Rahman et al., 2013).

3.5 Fresh weight of bulb

A significant variation in weight of individual between different varieties of onion was observed at

present study (Table 2). The highest individual bulb weight (47.16 g) was gained from V3 and the lowest mean weight (19.18 g) was obtained from V1 (Table 3). This difference in fresh weight of bulb might be due to the genotypic and phenotypic differences among the onion cultivars. Naher et al. (2017) reported that the onion crop variety BARI Piaz 3 was treated with 120 kg K ha^{-1} from the Sulphate of Potash (SOP) fertilizer and yielded the maximum plant height, leaves $plant^{-1}$, length of leaf, length of bulb, diameter of bulb, average bulb weight, number of bulbs per m^2 and yield of bulbs. The experiment showed that there was significant effect of organic mulches on mean weight of bulb (Table 3). The maximum fresh weight of bulb (39.49 g) was obtained from the application of T4 followed by T1 (35.61 g) while the minimum weight of bulb (30.37 g) was recorded in control treatment (T0) (Table 3). Many onion researchers (Anisuzzaman et al., 2009; Islam et al., 2013; Rahman et al., 2013) found similar results, indicating that the use of mulches increased bulb yield through the increase in bulb length and diameter. Combined effect of variety and organic mulches on mean bulb weight was significant (Table 4). Results showed that maximum mean bulb weight (52.87 g) was observed from V3T4 followed by V2T1 (48.55 g) and the minimum mean bulb weight (17.08 g) was observed from V1T0 (Table 4).

3.6 Split bulbs

The variations in percentage of split bulbs and non-split bulbs were observed to be significant due to different varieties (Table 2). The highest number of split bulb (7.20%) was recorded from V3 (BARI Piaz 4) and the lowest number of splitted bulb (3.2%) was recorded from (Taherpuri) (Table 2). This difference in split bulb might be due to the genotypic and phenotypic differences among the onion cultivars. Splitting of bulbs was significantly influenced by organic mulches (Table 3). T4 treatment gave maximum percentage of split bulbs (8.33%) and control treatment T0 gave the minimum percentage of split bulbs (2.22%). The combined effects of variety and organic mulches were found significant in respect of percentage of split bulbs (Table 4). Results showed that the highest percentage of split bulb (10.33%) was observed in V3T4 followed by V3T1 (9.33%) and the lowest percentage of split bulb (1.33%) was observed in V1T0 (Table 4).

3.7 Rotten bulb

The variations in percentage of rotten bulbs were observed to be significant due to different varieties (Table 2). The highest percentage of rotten bulbs (5.87%) was recorded from V3 (BARI Piaz 4) while the lowest number of rotten bulb (4.67%) was recorded from V1 (Taherpuri) (Table 2). From the present research work, it was found that there was significant variation among the treatments in respect of rotten bulbs due to different organic mulches (Table 3). Control treatment gave maximum percentage of rotten bulbs (8.11%) and T4 treatment gave minimum percentage of rotten bulbs (5.44%). Two diseases, bacterial soft rot (*Erwinia caratovora*) and black mold (*AspergiLlus niger*) manifested as water-soaked, sunken, and brownish areas on the external scale, following the veins, were observed in onion bulbs in all treatments, attacking on different places from the base to the neck. Srinivasan et al. (2002) discovered that *Aspergillus niger* was the most common pathogen linked with black mold rot of onions during storage, and they obtained similar results. The combined effects of variety and organic mulches were found significant in respect of percentage of rotten bulbs (Table 4). Results showed that the highest percentage of rotten bulb (9.00%). was observed in V3T0 followed by V2T0 (8.33%) and the lowest percentage of rotten bulb (2.00%) in V1T2 (Table 4). From the above result it was observed that vegetable waste gives the least number of rotten blubs and the controlled treatments gave the highest number of rotten bulbs in percentage.

3.8 Gross yield of onion bulbs

The variations in bulb yield of onion per hectare were found be significant due to the use of different varieties (Fig. 3). The maximum yield (15.60 t ha^{-1}) was recorded from BARI Piaz 4 (V3) followed by 10.41 t ha^{-1} in BARI Piaz 1 (V2) whereas Taherpuri (T0) showed the minimum gross yield (6.91 t ha^{-1}) (Fig. 3). From the present research work, it was found that there was significant variation among the treatments in respect of bulb yield of onion per hectare due to different organic mulches (Fig. 3). T4 treatment (water hyacinth) gave the highest yield (12.72 t ha^{-1}) and control treatment gave the lowest yield of bulbs (8.97 t ha^{-1}) (Fig. 3). The result showed that, the organic mulches improved onion plant growth by enhancing soil fertility and nutrient availability, resulting in maximum gross yield. According to a research of water hyacinth as biomanure, the introduction of water hyacinth into a soil agricultural system boosted the output and quality of potato tubers (Alam et al., 2017). The combined effects of variety and organic mulches were found significant in respect of bulb yield of onion per plot (Fig. 3). Results showed that the highest yield of onion bulbs per hectare (18.24 t ha^{-1}) was observed in V3T4 followed by V3T1 (16.34 t ha^{-1}) and the lowest yield of onion bulbs per hectare (5.74 t ha^{-1}) was observed in V1T0 (Fig. 3). According to the findings of this study, the combined action of organic mulches improved onion plant growth by boosting soil fertility and nutrients availability, resulting in a maximum gross output per hectare.

4 Conclusion

The current experiment was conducted at the Horticulture Farm and Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2020 to March 2021 to study the effects of varieties and organic mulches on growth and yield of onion. It was observed that different treatments performed differently in terms of yield and yield contributing characters based on the outcomes of this investigation. Most of the treatments showed significant variations in growth and yield metrics. The experimental result revealed that, combining water hyacinth treatment with BARI Piaz-4 was shown to be more effective in increasing onion production. Therefore, the combined application of water hyacinth along with BARI Piaz-4 was found to be better in respect of growth and yield and Taherpuri for quality of onion.

Acknowledgments

The authors are thankful to the Ministry of Science and Technology, Peoples Republic of Bangladesh for Providing National Science and Technology (NST) Scholarship.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Alam A, Srivastava SK, Anand K, Sinha PB, Mishra PK. 2017. Response of water hyacinth as a source of potassium in the production of potato. International Journal of Innovative Research in Science, Engineering and Technology 6:10.

Anisuzzaman M, Ashrafuzzaman M, Ismail MR, Uddin MK, Rahim MA. 2009. Planting time and mulching effect on onion development and seed production. African Journal of Biotechnology 8:412–416.

BBS. 2017. Yearbook of Agricultural Statistics. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

BBS. 2018. Statistical Pocket Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Brewster JL. 1994. Onions and other vegetable alliums. volume 15. CABI.

Edris KM, Islam ATMT, Chowdhury MS, Haq AKMM. 1979. Detailed Soil Survey. Bangladesh Agricultural University, Mymensingh, Bangladesh.

FAO. 2018. FAO Production Year Book. Food and Agricultural Organization of the United Nations, Rome, Italy.

FAO. 2021. World Onion Production. Food and Agricultural Organization of the United Nations, Rome, Italy.

Gomez KA, Gomez AA. 1984. Statistical Procedures for Agricultural Research. John wiley & sons.

Hossain AKMA, Islam MJ. 1994. Status of Allium production in Bangladesh. Acta Horticulturae :33–36doi: 10.17660/actahortic.1994.358.3.

Islam KS, Miah MHA, Ahmed SU. 2013. Effect of mulch and different levels of N and K on the growth and yield of onion. Progressive Agriculture 21:39–46. doi: 10.3329/pa.v21i1-2.16747.

Jones HA, Mann LK. 1964. Onions and their allies. Soil Science 98:68.

Mahajan G, Sharda R, Kumar A, Singh KG. 2007. Effect of plastic mulch on economizing irrigation water and weed control in baby corn sown by different methods. African Journal of Agricultural Research 2:19–26.

McCallum J, Leite D, Pither-Joyce M, Havey MJ. 2001. Expressed sequence markers for genetic analysis of bulb onion (*Allium cepa* L.). Theoretical and Applied Genetics 103:979–991. doi: 10.1007/s001220100630.

Naher MS, Brahma S, Islam MA, Sarkar MB, Hasan MM, Fahim AHF. 2017. Productivity of summer onion to different sources and levels of potash. Bangladesh Agronomy Journal 20:37–43. doi: 10.3329/baj.v20i1.34881.

Ossom EM, Pace PF, Rhykerd RL, Rhykerd CL. 2001. Effect of mulch on weed infestation, soil temperature, nutrient concentration, and tuber yield in *Ipomoea batatas* (L.) Lam. in Papua New Guinea. Tropical agriculture 78:144–151.

Rahman MAMJA, Mahmud JA, Islam MM. 2013. Influence of mulching on the growth and yield of onion. Technical Journal of Engineering and Applied Sciences 3:3497–3501.

Rashid MHA, Islam MT. 2019. Effects of micronutrients on bulb growth, yield and quality of local and high yielding onion (*Allium cepa* L.)

cultivars in Bangladesh. Archives of Agriculture and Environmental Science 4:281–287. doi: 10.26832/24566632.2019.040304.

Selvaraj S. 1976. Onion: Queen of the Kitchen. Kisan World 3:32–34.

Sobhan MA. 2019. Prospects of onion production & marketing in Bangladesh. The Daily Observer, October 24, 2019.

Srinivasan R, Shanmugam V, Kamalakannan A, Surendran M. 2002. Influence of fertilisers, host factors and storage conditions in relation to disease severity: a case study of black mould rot of onion. Acta Phytopathologica et Entomologica Hungarica 37:119–135. doi: 10.1556/aphyt.37.2002.1-3.13.

Stowell B. 2000. Organic kiwifruit production–maintaining soil fertility and yields. Kiwifruit 139:18–21.

Suh JK, Kim YB. 1991. Study on improvement of mulching culture method in onion (*Allium cepa* L.), 1; Influence of mulch materials and times on growth and yield. In: The Research Reports of the Rural Development Administration (Korea Republic). Horticulture 33:31–36.

UNDP. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development Report 2: Agro-ecological Region, of Bangladesh. United Nation Development Program and Food and Agriculture Organization, Rome, Italy.

Wiryanta BTW. 2006. Bertanam Cabai pada Musim Hujan. Bahasa Indonesia Agromedia Pustaka, India.

The Official Journal of the **Farm to Fork Foundation**
ISSN: 2518–2021 (print)
ISSN: 2415–4474 (electronic)
http://www.f2ffoundation.org/faa