Efficient Use of Jute Agrotextile Mulch on Onion Development

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Abstract

Jute agro textile that are naturally available, eco-friendly and biodegradable products that acts as surface cover materials and useful amelioration to eliminare soil-related constraints to crop production. Plants that are mulched are protected from harsh temperatures which keep the soil cooler. Mulching saves time and labor for a farmer and improves soil fertility. It loosens the soil and minimizes the extent of cultivation. A field trial was conducted at the Crop Botany Research Farm, Bangladesh Agricultural University to see the effect of jute agro textile mulches on onion growth and bulb size. It was revealed by the study that jute agro textile mulches had a significant impact on several parameters. Onions planted on the 21st of November exhibited superior agronomic characteristics leading to higher yields. Mulches of different GSM jute agro textile significantly enhanced growth and production and the highest crop yield of 2.50 kg was recorded from 600 GSM variant. The total yields from 600 GSM were higher as compared yarns from polythene or 400 GSM (which costs more to produce 600 GSM). As rains during the production season impede manual weeding, the use of herbicides is essential for effective weed control. Research indicates that use of mulching material reduces labor, pesticide and weedicide cost, water utilization and production cost and improved crop output. The enhanced output value resulted in greater returns over cost of production.

Keywords: *Allium cepa, Jute agro textile, Plant growth, Total yield*

1. Introduction

Genus Allium cepa L. is one of the important bulb crops grown in the world. It is an important vegetable as well as a cash crop. Second only to tomato in global production and consumption. In Bangladesh, onion is one of the most important as well as economic spices. Almost every meal at home contains onion. The domestic production of the country still fails to meet the national demand with respect to consumption (Gelaye et al. 2024). Onions yields in Bangladesh are less than that of other onion-producing countries. Inadequate agronomic practices, low fertility of soil, water stress, and weed infestation are responsible for low yields. These causes hamper productivity and post-harvest (Mila & Parvin, 2019).

An age-old agricultural practice that assists in retaining moisture in the soil, low down the temperature of the soil, suppress weed growth, and increasing crop yield is mulching. Plastic or polythene mulches are the most widely used mulching materials because of their capabilities to minimize water loss and to improve the performance of crops (Ngosong et al.,

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2019). This makes them extremely hazardous to the environment, as it degrades soil and creates waste disposal issues (Fayshal, 2024) In light of this, there is a great need to identify biodegradable eco-friendly mulching alternatives, which can offer similar or even better agronomic benefits without any environmental harm.

Jute agro-textile, made from 100% natural jute fibers, offer an environmentally sustainable solutions as they are biodegradable, renewable, and locally available in Bangladesh. According to Moniruzzaman et al. (2024), these materials help to control the temperature, hold moisture in the soil and decompose over time. Although jute-based mulching has been reported to perform well in crops like potato and tomato, very little information is available on its use in onion. Furthermore, no reported data exist on the effect of varying thickness of jute fabric (GSM measure) on onion growth, bulb parameters, and yield (Park et al., 2025). The optimum level of GSM for best soil moisture conservation, temperature regulation and crop yield is not well-studied under the local agro-ecological conditions (D. S & Srinath, 2014).

As a result, the present research was carried out to fill the gap by assessing the effect of various GSM of jute agro-textile mulches on onion growth and productivity. The objective of the work is to study the study different jute mulch thickness on plant height tiller formation bulb diameter and yield over polythene and unmulched control. The findings of study will generate scientific evidence for the effective large scale usage of jute agro-textiles in sustainable agriculture. This approach supports sustainable crop management practices and investigates modern applications of agriculture to upgrade jute business in Bangladesh.

2. Methodology

2.1 Experimental Site and Design

- The experiment was carried out at Crop Botany Research Farm, Bangladesh Agricultural University, Mymensingh (24°43′19.2"N, 90°25′36.12"E) The subtropical climate of the area of study has an average annual temperature ranging from 10°C to 38°C with average rainfall of about 1500-1600 mm. The experimental field is slightly acidic, has low organic carbon content and is moderately fertile. A Completely Randomized Design (CRD) was utilized to evaluate the impact of jute agrotextile mulch on the growth and yield of onion. Three replications were performed for a total of five treatments. The treatments that were done:
- T_1: 800 GSM jute agrotextile mulch
- T_2: 600 GSM jute agrotextile mulch
- T_3: 400 GSM jute agrotextile mulch
- T_4: Polythene mulch (commercial control)
- T_5: Control (no mulch)

2.2 Planting Materials and Growth Conditions

Seeds of certified onion (*Allium cepa* L.) were collected from the Bangladesh Wheat and Maize Research Institute, (BWMRI), Dinajpur. After soil preparation, healthy seedlings were transferred to experimental tubs. A total of fifteen kilograms of soil which has a medium-

fertility was taken in each tub which measures 60 cm in length and 30 cm width. Rows were spaced at 10 cm from one another. Before transplanting, light irrigation was given to soil for uniform moisture content. One week after seedling raising, the jute agrotextile and polythene mulch sheets were laid down on the soil surface without any tearing.

2.3 Mulch Characteristics

The physical characteristics of the jute agrotextile used in the study are summarized below in (*Table 1*).

Table 1 The Physical Characteristics of the Jute Agrotextile

Mulch Type	Nominal GSM	Thickness (mm)	Open Area (%)	Water Holding Capacity (% on Dry Weight)
Jute Agrotextile	800	4	30	500
	600	3	40	400
	400	2	50	300

2.4 Crop Management

Throughout the experiment, all plots were managed with consistent agronomic practices. We applied fertilizers at the recommended rates, sticking to the standard methods for onion cultivation. Irrigation was done as needed to keep the soil moisture just right. We handled weeding and pest control manually to ensure there was no chemical interference with our results.

2.5 Data Collection

Growth and yield-related data were recorded at regular intervals. The following parameters were observed and analyzed:

- Plant height (cm) – measured from the base to the tip of the tallest leaf at 10-day intervals.
- Number of tillers per plant – counted manually for each treatment.
- Number of umbels per plant – recorded during the reproductive phase.
- Length of scape (cm) – measured at full flowering stage.
- Number of leaves per plant – counted at 45, 60, and 75 days after planting (DAP).
- Bulb diameter (mm) – measured with a vernier caliper at harvest.
- Bulb weight (g) – determined after cleaning and removing surface soil.
- Yield per tub (kg) – calculated by weighing all bulbs harvested from each tub.

2.6 Statistical Analysis

The data we gathered underwent a thorough statistical analysis using the Analysis of Variance (ANOVA) method, as outlined by Steel and Torrie back in 1980. To determine the significance of the treatment means, we applied the Least Significant Difference (LSD) test at

both the 1% and 5% probability levels. All of these analyses were carried out using standard statistical software.

3. Results and Discussion

3.1 Effect of Jute Agro-textile Mulches on Plant Height

The height of the plants varied quite a bit across different treatments (see Figure 1). The tallest onion plants, reaching 43.95 cm, were found in plots that were mulched with 600 GSM jute agrotextile. They were closely followed by those with 800 GSM mulch at 42.53 cm, while the non-mulched control recorded a height of 38.56 cm (refer to Table 2). The boost in plant height seen with jute mulch is likely due to better soil moisture retention and a more stable soil temperature, which together promote healthier root growth and nutrient absorption (Demo & Tsehai, 2024; Gadissa & Chemeda, 2009).

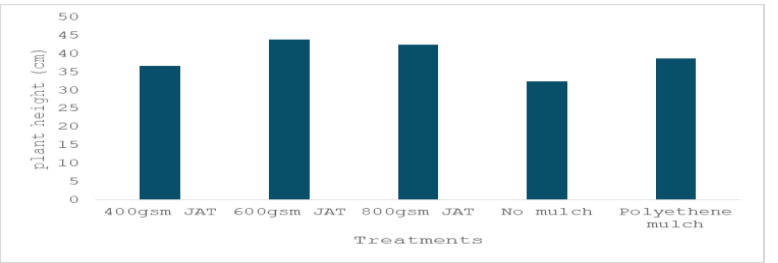

Figure 1 Effect of Jute Agrotextile Mulches on Plant Height

3.2 Effect of Number of Tillers per Plant

The type of mulch used had a significant impact on the number of tillers produced per plant (see Figure 2). The highest number of tillers recorded was 4.16 with 600 GSM jute mulch, followed closely by 800 GSM at 3.75. In contrast, the control treatment showed the lowest count at just 2.94 (refer to Table 2). Onions struggle against weeds because of their shallow root systems and limited canopy coverage. However, jute mulching does a great job of keeping weed growth in check, which helps reduce competition for soil moisture and nutrients. This, in turn, leads to a boost in tiller production (Manna et al., 2024; Shamsul Arefin et al., 2022).

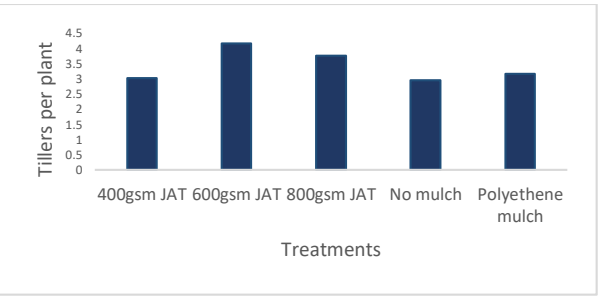

Figure 2 Effect of Jute Agrotextile Mulches on Tillers per Plant

3.3 Effect on Number of Umbels per Plant

We noticed a notable difference in the number of umbels per plant (see Figure 3). The highest count we recorded was 4.89 with the 600 GSM jute mulch, while the control group had the lowest at 2.78 (refer to Table 2). This boost in reproductive growth with jute mulch likely stems from better nutrient availability and consistent soil moisture, both of which are essential for bulb initiation and flowering (Kaur et al., 2020; M.M., 2025).

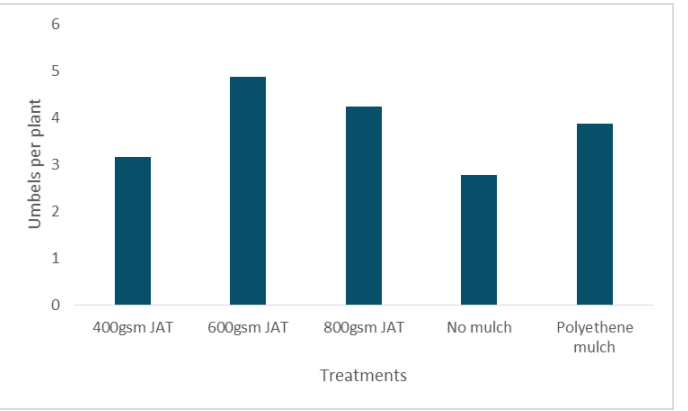

Figure 3 Effect of Jute Agrotextile Mulches on Number of Umbels per Plant

Table 2 Effect of Jute Agrotextile Mulches on Agronomic Traits of Onion

Treatment	Plant Height (cm)	Tillers per Plant	Umbels per Plant	Length of Scape (cm)
800 GSM Jute Agrotextile	42.53^{b}	3.75^{b}	4.24^{b}	52.75^{b}
600 GSM Jute Agrotextile	43.95^{a}	4.16^{a}	4.89^{a}	54.16^{a}
400 GSM Jute Agrotextile	36.79^{d}	3.02^{cd}	3.16^{d}	42.75^{d}
Polythene Mulch	38.75^{c}	3.16^{c}	3.89^{c}	48.63^{c}
Control (No Mulch)	32.56^{e}	2.94^{d}	2.78^{e}	40.75^{e}
$LSD_{0.05}$	1.019	0.152	0.081	0.630
Significance Level	**	**	**	**
CV (%)	1.44	2.38	1.26	0.73

Means followed by the same letter in each column are not significantly different at $p \leq 0.05$ according to LSD test.

** = *significant at 1% level of probability.*

Table 3 Analysis of Variance (mean square) of the data for *****

Source of Variation	*df*	*Plant Height (cm)*	*Tillers per Plant*	*Umbels per Plant*	*Length of Scape (cm)*
Treatment	4	62.498**	0.836**	2.121**	105.599**
Error	10	0.314	0.007	0.002	0.120
Total	14				

** = *Significant at 1% level of probability*

3.4 Effect of Scape Length

The length of the scapes showed a similar pattern, with the longest one measuring 54.16 cm found under 600 GSM jute mulch, while the shortest, at 40.75 cm, was observed without any mulch (see Figure 4). The jute mulch creates a favorable soil environment that promotes healthier vegetative growth, resulting in longer scapes (Vyas et al., 2025).

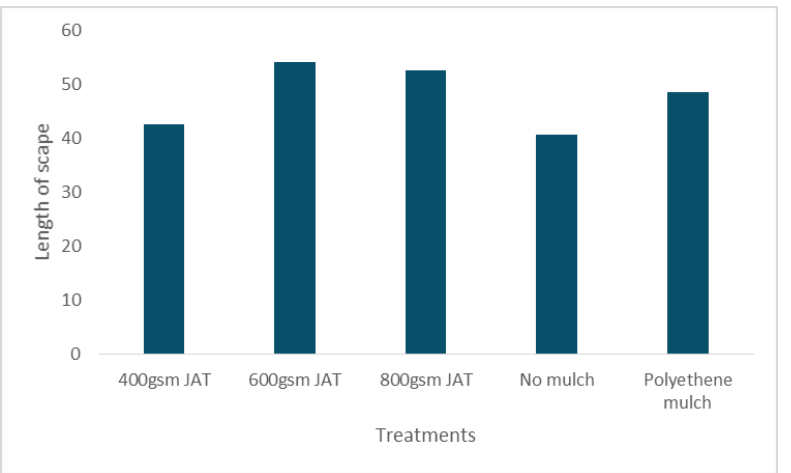

Figure 4 Effect of Jute Agrotextile Mulches on Scape Length

3.5 Effect of Leaf Number

The number of leaves per plant saw a steady increase from 45 to 75 days after planting (DAP) across all treatments (Figure 5). By 75 DAP, the highest leaf count recorded was 34.67 under the 600 GSM jute mulch, with the 800 GSM following closely at 30.33. Meanwhile, the control group had the lowest leaf count at 29.00. This gradual rise in leaf numbers suggests a consistent vegetative growth, which is likely supported by better water retention and nutrient mineralization from the decomposing jute fibers (Acharyya et al., 2020).

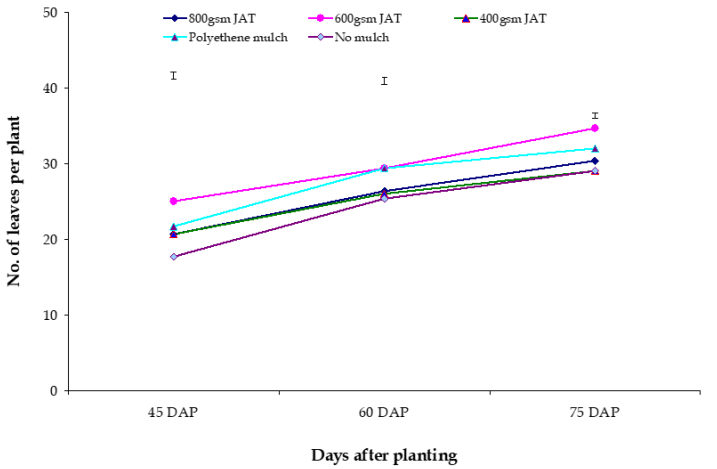

Figure 5 Effect of Jute Agrotextile Mulches on Leaf Number

3.6 Effect of Bulb Diameter and Weight

The diameter and weight of bulbs are key factors that indicate the quality of onion yield, and they were notably influenced by mulching (see Figure 6). The biggest bulbs, measuring 55.50 mm across and weighing in at 83.08 g, were found under the 600 GSM jute agrotextile mulch. In contrast, the smallest bulbs, at 35.01 mm and 33.37 g, were observed in the plots without any mulch (refer to Table 4). The increase in bulb size with jute mulching can be linked to better soil aeration and moisture retention, which help maintain a consistent supply of nutrients during the bulb's growth (Islam et al. 2002; Magar et al., 2024; R & K, 2028).

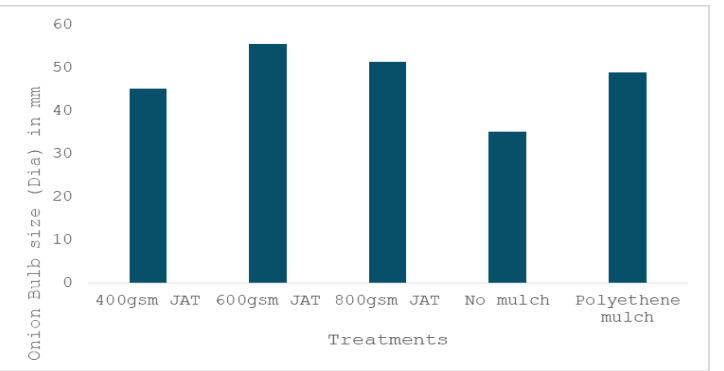

Figure 6 Effect of Jute Agrotextile Mulches on Bulb Diameter and Weight

Table 4 Effect of Mulching Treatments on Productive Development of Onion

Treatment	Leaves per Plant (45 DAP)	Leaves per Plant (60 DAP)	Leaves per Plant (75 DAP)	Bulb Diameter (mm)	Yield per Tub (kg)	Bulb per Weight (g)
800 GSM Jute Agrotextile	20.67	26.33	30.33[b]	51.25[b]	2.00[b]	66.23[b]
600 GSM Jute Agrotextile	25.00	29.33	34.67[a]	55.50[a]	2.50[a]	83.08[a]
400 GSM Jute Agrotextile	20.67	26.00	29.00[b]	45.06[d]	1.25[d]	42.13[d]
Polythene Mulch	21.67	29.33	32.00[b]	48.90[c]	1.50[c]	50.54[c]
Control (No Mulch)	17.67	25.33	29.00[b]	35.01[e]	1.00[e]	33.37[e]
$LSD_{0.05}$	5.30	5.10	3.61	0.282	0.036	0.081
Significance Level	NS	NS	*	**	**	**
CV (%)	13.77	10.29	6.40	0.33	1.19	0.08

*DAP = Days After Planting; NS = Not significant; * = significant at 5% level; ** = significant at 1% level.*

Table 5 Analysis of Variance (mean square) of the data for*****

Source of Variation	df	Leaves per Plant			Onion Bulb Size (Dia) in (mm)	Onion Yield per Tub in (kg)	Onion Bulb per Weight in (gm)
		45 DAP	60 DAP	75 DAP			
Treatment	4	20.77NS	11.06NS	17.16*	181.04**	1.089**	1175.853**
Error	10	8.467	7.86	3.93	0.024	0.0004	0.002
Total	14						

*** = significant at 1% level of probability, * = significant at 5% level of probability, NS = Not significant*

3.7 Effect of Yield per Tub

The total onion yield per tub was notably affected by the type and thickness of the mulch used (see Figure 7). The highest yield, reaching 2.50 kg per tub, came from using 600 GSM jute mulch, followed by 800 GSM jute mulch at 2.00 kg, and polythene mulch at 1.50 kg. The unmulched control group had the lowest yield at just 1.00 kg (refer to Table 4). The impressive yield from the 600 GSM jute mulch can be attributed to its ideal balance of porosity, water retention, and biodegradability, which together foster a perfect

microenvironment for onion growth. While the 800 GSM jute mulch did hold a bit more water, its lower aeration might have limited root respiration, which could explain why its yield was slightly less than that of the 600 GSM variety (Igbadun et al., 2012).

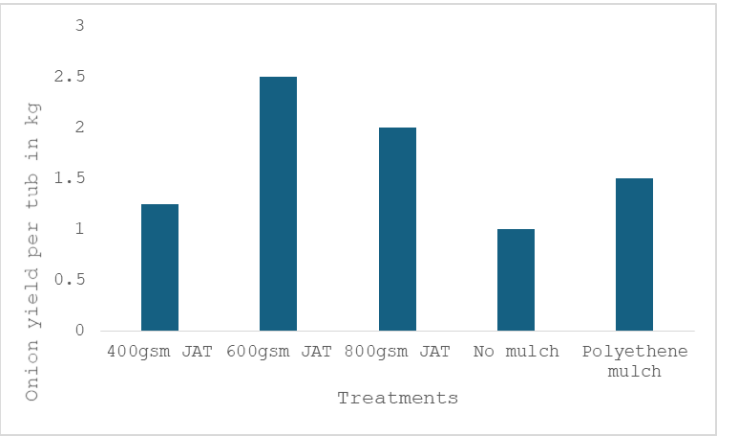

Figure 7 Effect of Jute Agro-textile mulches on Yield per Tub

Using jute mulch with a density of 600 GSM resulted in the highest onion weight, reaching 83.08 grams. In contrast, the lowest onion weight recorded was 33.37 grams, which occurred in the no-mulch scenario (Table 4).

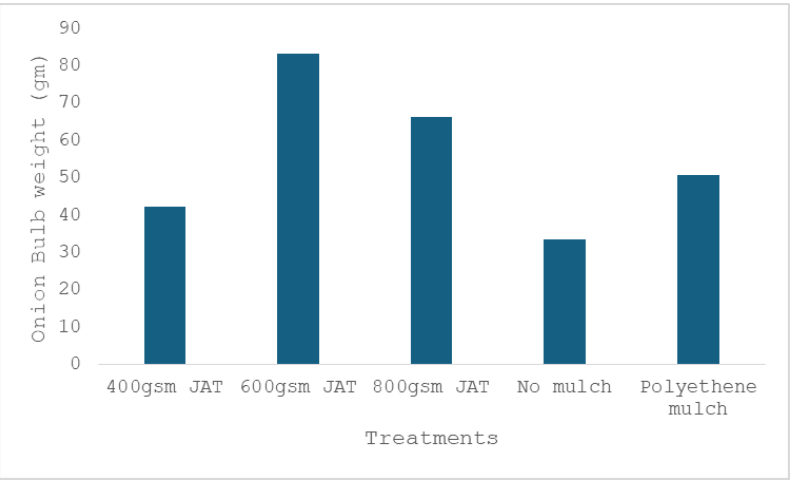

Figure 8 Effect of Jute Agro-textile Mulches on Onion Bulb Weight

The data clearly indicates that using Jute Mulch is highly beneficial for growing onions, as it retains moisture for a longer time and keeps it close to the surface. In particular, the 600 GSM

jute mulch has shown remarkable results for onion farmers. The size of the onion bulbs is quite satisfactory as well.

3.8 Comparative Performance and Sustainability Perspective

When we look at it from both an economic and environmental perspective, 600 GSM jute agro-textile mulch stands out as the best choice for onion farming. It not only yields more while keeping input costs lower than synthetic mulch, but it also brings the added perks of being biodegradable and enriching the soil. As the jute fibers break down over time, they add organic matter to the soil, boosting fertility for future crops. This makes jute agro-textile a sustainable and regionally suitable alternative to plastic mulching in Bangladesh.

4. Conclusion

The current study revealed that using jute agro-textile mulch significantly enhanced onion growth and productivity compared to both polythene mulch and areas without any mulch at all. Among the various thicknesses of jute mulch, we tested, the 600 GSM jute agro-textile really stood out, outperforming the others in every category we looked at—like plant height, tiller formation, scape length, bulb diameter, bulb weight, and overall yield per unit area. This specific thickness struck a fantastic balance by keeping the soil moist, ensuring good aeration, and regulating temperature, which created an ideal environment for root growth and bulb development.

Not only do these mulches help to deduct environmental pollution, but they can also maintain or even enhance crop yields. Also jute fibers decompose, they contribute valuable organic matter to the soils. For onion farming in similar agro-climatic conditions in Bangladesh, we recommend using the 600 GSM jute agro-textile mulch.

Conflict of interest

No conflict of interest was reported by the authors.

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