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Research Article

Influence of Biochar and Variety on Growth, Yield and Quality of Onion (*Allium cepa L.*) at Abaya Wereda, West Guji Zone

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Abstract

A field experiment was carried out at Guji zone Abaya wereda during the 2022/23 cropping season. Onion is much needed almost in all Ethiopian daily dishes. However, the potential of onion production is found at Gololcha village of Abaya wereda, onion is imported from Batu (Ziway) and Shashemene to Sidama, Gedeo and Guji zone. This is happened due to lack of research output for the potential area for production of onion. Rather than improving productivity of a crop at an area through using inorganic fertilizer, it is better to use improved varieties and organic fertilizer to save the environment. Therefore, the first approach to mitigate this gap is to evaluate the best performing varieties and organic farming practice to the area. Thus, an experiment was conducted to evaluate for best performing Onion variety and biochar application rate in the study area. Treatments consisted of six onion varieties (Adama red, Bombay red, Nafis, Nasik red. robaf and Local Variety) and four biochar application rate (0, 5, 10, 15 tha^{-1}). The results of the study showed that Nafis and 10 tha^{-1} significantly ($p<0.05$) increased in growth and yield compared to other Variety and biochar application rate. As results from the study revealed, 10 tha^{-1} could be successfully used to obtain better growth, yield and quality of onion. However, further testing is required in different locations on different season.

Keywords

Biochar, Onion Varieties, Application Rate

1. Introduction

Onion (*Allium cepa L.*) is one of the most important warm-season vegetable crops cultivated in Ethiopia. It is grown largely by smallholder farmers and few commercial growers mainly under irrigation and lower share using rain. Onion provides business options from seed, dry bulb, and seedling production. It has a low risk of over-production than most other vegetables because it can withstand the rough handling from field harvesting to final delivery to consumers. Moreover, onion dry bulb can be stored for 2-3 months when properly cured [17].

In Ethiopia, onion planted to 36.4 million hectares with a total production of 273,859 tons. The total production and the total cultivated area for onion grew by 18.7% and 59.7% respectively between 2015 and 2020. The productivity of onion, however, declined by 25.7 percent over the same production period [5]. The Ethiopian Institute of Agricultural Research

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(EIAR) released improved onion varieties to growers. For instance, Adama Red and Bombay Red are popular onion varieties. Whereas, Nasik Red and Nafis are more recent varieties that have a higher yield than Bombay Red and Adama Red.

This low yield results indicate that the presence of a huge gap in production and productivity at the country because of the absence of improved cultivars, application of inappropriate agronomic practices and limited attention/awareness on the benefits of intensive production. One novel technology gaining interest world-wide is the application of biochar as a soil amendment for carbon sequestration and improved crop production. Biochar significantly increased total dry matter even at the lowest level of application (10 t ha^{-1}), and the yield increased with increased levels of biochar application to 50 t ha^{-1}. However, knowledge of the effect of biochar application on plant growth and yield is scarce as may adversely affect plant performance [22].

In spite of the potential found at Guji zone of Abay wereda which is the neighbor of Gedeo zone, most of the onion marketed at Dilla town and other town of Gedeo zone and Guji Zone are brought from Batu and Shashemene. This is due to research gap to find best performing varieties and optimum cultural practice for this area. Therefore, the approach to mitigate gap was evaluated the best performing varieties and biochar application rate.

2. Materials and Methods

2.1. Description of the study Area

The experiment was carried out in the rainy season of 2022 at Abaya Woreda West Gujji Zone, Oromia Regional State, western Ethiopia.. Abaya woreda is located in the Oromia regional states' west Gujii Zone. Situated 100 miles from the zone capital town of Bule Horaa and 366 km from the regional capital town of Finfinne. The woreda is bounded with SNNPR (Sidama zone) in the north, SNNPR (Gedeo) in the east, SNNPR (South Omo) in the west and Gelana woreda (Oromia) in the south direction. The name of the woreda town is called Guangua. The total area of the woreda is 1871.34 km^2 and consists of 26 rural administrative and 3 town kebeles. The Woreda has two main agro-ecological zone namely Kola (Lowland) and Weinadega (Mid highland), which covers 40 % and 60 % respectively. From those of administration Kebeles, 12 (40%) have a kola (Low land) agro-ecology, while the remaining 18 (60%) kebeles is characterized under Weinadega (Mid high land) agro-ecology.

The woreda has minimum annual temperature which ranges 16°C-28°C. The woreda experiences 1055 mm of rain on average each year, with an altitude that varies from 1200 to 2060 meters above sea level (m. a. s. l). There are two distinct rainy seasons in Belg. called arfasa starts from March and ends June which is long rain season; and Genna locally called hagaya starts from August and ends middle of November which is short rain season (Woreda Agriculture and Natural Resource Office, 2018).

2.2. Materials for Experiments and Design

Onion cultivars and biochar were utilized as experimental materials. In total, twenty four (24) treatment combinations (four application rate of Biochar combined with six onion varieties). The four (4) application rate of Biochar was consisting of 0, 5, 10 and 15 t /ha. While the six (6) varieties were comprise of Local variation, Robaf, Nasik Red, Bombey Red, Adama Red, and Nafis were utilized. Three replications of the experiment were set up in a Randomized Complete Block Design (RCBD). A total of 1.2 m2 made up each experimental plot, which measured 1 m long and 1.2 m broad. The width of a block was one meter, and there was a 0.5 meter gap between each plot inside a block. There were six rows in each plot, with ten plants per row. A plot comprised 60 plants in total, with 20 cm separating rows and 10 cm separating individual plants.

2.3. Experimental Materials Description

The following six enhanced onion cultivars were employed in the field experiment: Adama Red, Bombey Red, Robaf, Nasik Red, Nafis R, and Local. The dependable Melkassa Agricultural Research Center (MARC) provided the upgraded variety seeds.2.4. Biochar Preparation

Coffee husk was used to make biochar; this material was chosen because of its widespread availability in the area. Coffee husk biomass was obtained from coffee processing site. The process of biochar making steps was collected and dry coffee husk (biomass). The one can be preparation of cone pit, adding dried coffee husk to pit, cover it as soon as it was fired. For the physicochemical analysis of the biochar, a portion of the material was ground and sieved using a 0.25 mm square mesh.

2.4. Experimental Site Soil and Biochar Analysis

In order to investigate the nutritional quality of the soil and biochar, key chemical properties such as pH and EC were measured, as well as the percentage of organic matter (OM), available phosphorous (P), available potassium (K), and total nitrogen (N). For analysis, a biochar sample was air dried and powdered so that it could pass through a 0.25 mm sieve. Biochar and soil Using a glass electrode connected to a digital pH meter, the pH of the soil in water suspension was measured at a soil: water ratio of 1: 2.5. Using conductivity mater, the EC of the soil soluble salt was determined at a soil: water ration of 1: 5. Using the micro-Kjeldahl digestion method, total N was ascertained. Bray-1 extraction and molybdenum extraction were used to estimate available P. For determination of pH and EC, each 100 g of substrate was added only enough distilled water to wet the sample to saturation, shaken for 15 min and left for 60 min and was filtered before the measurements

were made using pH meter and EC meter.

Table 1. Lists the nutrients and chemical characteristics of the soil in the trial area and biochar.

Parameter	Biochar	Experimental soil	Unit
pH	9.8	6.7	
EC	2.12	0.38	dS/m
Total N	1.03	0.98	%
Available K	453	758	mg/Kg
Available P	543.06	115.33	mg/Kg
Organic mater	40.58	26.26	%

2.5. Seed Sowing and Experimental Field Management

Seed were sown in May, 2022 on a seed bed size of 1 x 5 m in rows of 10 cm wide on well prepared bed. The seed bed was covered with a dry grass until seedling emerged (2-5 cm) from the soil. Then, beds were covered by raised shade to protect the seedling from strong sun shine and heavy rainfall. Watering was done based on climatic conditions with a fine watering can, and weeds were hand weeded. The Seedlings was kept until ready for transplanting and hardened before transplanting to the field to enabling them withstands the field conditions.

Healthy and vigorous seedlings of 13-15 cm height or 45-55 days old were carefully uprooted for transplanting. The selected seedlings were transplanted with recommended spacing 20 cm × 10 cm between rows and plants respectively. After transplanting important cultural practices such as uniform application of weeding, cultivation and water were done manually and equally for all treatments as required (EARO, 2004)

3. Results and Discussion

3.1. Growth Parameters

3.1.1. Plant Height

Based on the selected parameters, an analysis of variance was found between biochar and varieties at ($p<0.05$). However, there was no interaction effect of biochar with varieties concerning Plant height. The data on Plant height following transplant of crop growth as influenced by biochar and variety are displayed in (Table 2). 10 t/ha^{-1} was found to be significantly superior over other treatments in terms of Plant height, while the control treatment was the least recorded in this regard. As a result, the variety Nafis had the highest recorded Plant height, while the local variety had the lowest Planthight.

Improvements in aeration, water retention, and nutrient availability in the biochar may be the primary cause of the plants' increased height. These factors also increase the plants' ability to absorb nutrients from the soil through varietal variability and increased cell division and elongation during vegetative growth [4]. According to Ellen's results, tomato plant heights were significantly higher in the 1 and 3% biochar treatments throughout all measurement times when compared to the control. This conclusion is consistent with her findings. Furthermore, the outcome is consistent with the findings of the person who reported utilizing wood biochar rates [14].

3.1.2. Number of Leaves per Plant

Based on the chosen parameters, a significant difference was found between biochar and varieties at ($p<0.05$); however, there was no interaction between biochar and varieties with regard to leaf count. The information regarding the number of leaves following crop transplantation and how variety and biochar affect growth is displayed in (Table). In terms of the quantity of leaves, 10 t/ha^{-1} was shown to be noticeably better than the other treatments. In contrast, the control treatment had the fewest leaves on file. As a result, variety Nafis was found to have the most leaves. Conversely, local variety produced the fewest amount of leaves.

The application of biochar increased the number of leaves, which in turn allowed for more translocation to the bulb due to increased assimilation. Since leaves are the plant's primary organ for photosynthetic processes, changes in their quantity would inevitably impact the plant's overall health. [8] Who worked on Pelargonium plants grown in pot biochar 70: 30 (v: v) was more effective in enhancing nitro-gen and chlorophyll leaf concentrations and leaf numbers. The same author also covered the possibility that improved plant nutritional condition is what's promoting leaf growth. Similarly [9] observed that properly fertilized crop by the addition of biochar made from coconut fiber showed an increase in leaf number, growth and productivity than the control.

The increase in leaves in Nafis is attributed to either the genetic makeup of the varieties or the direct role that biochar plays in plant nutrition. This finding is consistent with that of [1], who found that the highest number of leaves was obtained when 7 t of biochar was applied in conjunction with 50% inorganic fertilizer. Furthermore, [8] have documented that the highest leaf count, flower count, and floral clusters in pelargonium plants were obtained with the administration of varying concentrations of biochar in conjunction with 30% inorganic fertilizer.

3.1.3. Days to Maturity

Biochar and variety both had a substantial ($P < 0.05$) impact on days to maturity. Variety Nasik Red needed more days (140.75) to reach maturity than the other types, although variety Red had the shortest maturity period (126.92 days). The application of 10 tha^{-1} biochar resulted in noticeably early maturity days. Conversely, delayed maturity was achieved at a treatment rate of 0 t/ha^{-1}. Genetic variations may account for the disparity in maturity observed among onion cultivars. The

Bombay Red variety proved to be the earliest, maturing 23 days ahead of the Adama Red variety. Melkam followed suit, maturing 18 days ahead of the Adama Red variety [23]. In a similar vein, [3] likewise noted notable variations in the number of days to bulb maturation across eight onion types. According to [6], Bombay Red and Adama Red ripened in fewer than 120 days or in 110-130 days, respectively.

The observed variance in the number of days to maturity may therefore be the result of either direct or indirect effects of biochar on plant nutrition for early onion maturity that are caused by the soil. By strengthening the physical and biological characteristics of soils, such as their ability to retain water and nutrients, and by stimulating plant development, biochar can serve as a soil conditioner [18].

Table 2. *Mean values of plant height, Leaf number and days to maturity as affected by Biochar with Onion variety.*

Treatment	Plant height	Leaf number	Days to maturity
Biochar			
B0	44.12	9.41	136.78
B1	45.0	10.19	134.44
B2	53.76	11.91	132.17
B3	48.12	11.07	134.72
LSD (0.05)	2.5985	0.6284	1.1874
Variety			
V1	44.83	10.54	135.67
V2	47.68	10.35	126.92
V3	52.08	12.85	139.42
V4	49.06	12.03	140.75
V5	48.16	10.02	131.83
V6	41.7	8.08	132.58
LSD (0.05)	3.1825	0.7696	1.4543
CV (%)	8.21	8.81	1.32

V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5t /ha B3= 10t /ha B4= 15t /ha.

3.1.3. Leaf Length

The results of the analysis of variance showed that variety and biochar had a substantial ($P < 0.05$) impact on leaf length. The highest mean leaf length was found in Nafis (48.67 cm). On the other hand, local variety allowed for the tiny leaf length (36.87). In terms of leaf length, 10 tha^{-1} was shown to be significantly superior to the other treatments. Conversely, at the biochar rate of 0 tha^{-1}, the shortest leaf lengths were noted. Varieties may differ in their genetic composition, which could account for the variation in leaf length. According to [23], which concurs with the present findings, Melkam (37.83 cm) and Bombay Red (35.17 cm) displayed shorter leaves than Adama Red (40.75 cm). Likewise, cultivar-specific variations in leaf length were also documented by [16, 12]. While the shortest and narrowest leaves were observed in the control plot (44.3 cm).

3.1.4. Leaf Diameter

The study revealed that the main effects of both variety and biochar application had a significant ($P < 0.05$) influence on onion leaf diameter. The onion plants' leaf diameter increased significantly across the increasing rate of biochar application, almost paralleling the effect observed on leaf length. Consequently, plants treated with Biochar at rates of 10 t/ha^{-1} and Nafis produced the widest diameter leaves, while plants treated with 0 t/ha^{-1} and local variety apart produced the narrowest diameter leaves. The increased leaf diameter with the increase in the rate of biochar application and onion variety could be linked to a better supply of organic matter and less intense competition for other growth factors among the onion plants. [19] discovered that combining biochar made from green wastewith peat (50% each, by vol.) increased total biomass and leaf surface of Calathea rotundifola cv. Fasciata when compared to that of peat substrates alone.

Table 3. *Effect of biochar rate and Variety integrated on Onion Leaf length and diameter.*

Variety	Leaf length				Leaf Diameter			
	B0	B1	B2	B3	B0	B1	B2	B3
V1	37.43	38.33	44.73	40.53	0.75	1.01	1.04	1.21
V2	38.52	38.87	47.23	42.65	0.91	0.95	1.10	1.02
V3	41.10	43.65	48.67	47.88	1.22	1.12	1.53	1.42
V4	39.55	41.88	42.46	42.66	1.0	0.99	1.28	1.16

Variety	Leaf length				Leaf Diameter			
	B0	B1	B2	B3	B0	B1	B2	B3
V5	38.89	39.78	42.20	43.49	0.85	0.92	1.08	1.0
V6	36.87	38.45	40.25	40.66	0.71	0.82	1.02	0.89
LSD (0.05)	1.42	1.44	1.46	1.51	0.17	0.16	0.15	0.18
CV (%)	4.45	6.6	8.2	3.4	2.15	3.56	5.33	6.2

V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5t /ha B3= 10t /ha B4= 15t /ha.

3.2. Yield and Yield Component Traits

3.2.1. Bulb Diameter

The results of the analysis of variance showed that the application of biochar and the average bulb width of onions were strongly ($P<0.05$) influenced by both, and that their interaction was also significantly affected. The variety Nafis had the greatest average bulb diameter (5.18 cm), followed by Nasik red (4.59 cm) with a biochar application rate of 10 t/ha^{-1}. The local variety had the lowest average bulb diameter (4.51 cm) with a biochar application rate of 0 t/ha^{-1}. Large bulbs and short neck diameters are characteristics of onion genotypes with high bulb diameter, which are thought to hinder their ability to store. The bulb size and shape index is influenced by the bulb diameter. Our findings concurred with the outcome attained by [11], who stated that biochar addition enhanced stem growth.

3.2.2. Bulb Length

The analysis of variance revealed that the average bulb length of onion was significantly ($P> 0.05$) influenced by varieties and biochar application. The highest average bulb diameter (5.71 cm per ten taken plant) was recorded at a variety Adama Red with the time of nitrogen application at 10, 35 and 60 days after transplanting; and the lowest average bulb diameter after curing (4.11 cm) was recorded at variety Bombay Red with the time of nitrogen application at 15 and 45 days after transplanting. Similarly, it was related [13] where it was stated that the production of quality seed yield of onion depends on the genotype, locality, season, and method of seed production that have a vital role in crop yield production.

3.2.3. Average Bulb Weight

Onion bulb weight was significantly ($p<0.05$) affected by varietal and biochar effect. But, higher fresh bulb weights of (102.8 g) and (98.87 g) were observed from varieties Nafis and Bombay red respectively. The lowest bulb weight of (44.34 t/ha) was observed in local variety. The highest bulb weights (98.67 g) was obtained from onion plants grown at the biochar rate of 10 t/ha. On the other hand, the lowest total bulb weight (34.34 g) was obtained in response to no application of biochar and local variety.

The ideal nutrient supply has a favorable impact on yield components, which are among the most important aspects of yield. As the amount of biochar added to the soil increases, it is thought that this will balance the soil's C/N ratio, increase the amount of organic matter in the soil, and improve acidic soils. This may lead to improved nutrient translocation to specific plant sections, increased supply of available nutrients, and other substances that enhance yield and yield-related characteristics [15]. Inferring that dry bulb weight is a significant determinant of fresh bulb production in onions, Sirajo and Namo report that genotypes with higher bulb weight had higher overall bulb yields.

3.2.4. Total Bulb Yield

Biochar treatment and variety had a substantial ($p<0.05$) impact on total bulb production. The variety Nafis produced the best overall yield (30.03 t/ha), while it was statistically equal to the total yield of Nasik Red (27.25 t/ha). The local cultivar had the lowest overall bulb yield (19.94 t/ha). The variance in climate, cultural practices, genotypes, and their interactions determine the variation in the overall bulb yield of onion cultivars. The current conclusion is consistent with that of Simon et al., who found that variety Nafis produced the best total bulb output when compared to other varieties. But the total bulb output fell after applying 10 t/ha of biochar; this was the only time the rise happened.

The highest total bulb yield was obtained from onion plants grown at the biochar rate of 10 t/ha. On the other hand, the lowest total bulb yield was obtained in response to no application of biochar and local variety. Because biochar improves the retention of water and nutrients and encourages beneficial microbial activity, a high biochar input may boost the production of green lettuce. [18-21] studied various biochar contents in the soilless substrate in the greenhouse, ranging from 0% to 15%. They discovered that the amount of biochar increased the discharge of residual phosphate and nitrate. Experiments on cabbage, red lettuce, dill, and mallow plants have demonstrated high plant yields when rice husk biochar is applied both alone and in conjunction with perlite

[2, 9]. Biochar is said to improve tomato (Lycopersicum esculentum Mill.) and pepper (Capsicum annuum L.) growth and output. This can be linked to the enhancement of soil characteristics and plant growth parameters by the incorporation of biochar. Our result in line with [10], who reported that biochar enhanced growth and yield of plant.

Table 4. *Mean values of Bulb length, Bulb Diameter, Average bulb weight and Total bulb yield as affected by Biochar with Onion variety.*

Treatment	Bulb length (cm)	Bulb Diameter (cm)	Average bulb weight (g)	Total bulb yield (T/ha$^{-1)}$
Biochar				
B0	3.9	4.02	34.34	20.93
B1	4.56	4.41	70.77	23.67
B2	4.88	4.92	98.67	28.46
B3	4.62	4.83	82.55	24.58
LSD (0.05)	0.16	1.76	1.68	1.27
Variety				
V1	4.21	4.53	71.1	19.98
V2	4.33	4.37	98.87	26.83
V3	4.75	5.18	102.66	30.03
V4	4.51	4.59	82.53	27.25
V5	4.35	4.34	80.23	22.43
V6	4.1	4.22	44.34	19.94
LSD (0.05)	0.19	0.21	2.06	1.55
CV (%)	3.8	4.1	7.2	5.6

V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5 t /ha B3= 10t /ha B4= 15 t /ha.

3.2.5. Marketable Yield

The combined data analysis showed that the onion plants' varietal and Biochar effect had a substantial ($P<0.05$) impact on marketable yield. The Nafis cultivar yielded the maximum marketable yield (26.61 t/ha). At local variety, the lowest Marketable yield (17.63 t/ha) was observed. The onions grown at a biochar rate of 10 t/ha produced the highest total marketable yield. On the other side, the lowest overall bulb yield was obtained in response to no application of biochar and local variety.

Increases in bulb weight and diameter were responsible for the greater increase in marketable yield. According to Pardeshi and Waskar, enhanced plant growth in terms of height and leaf count resulted in an increase in marketable yield. Increased food material production from a higher rate of photosynthesis may have led to an increase in bulb size, as seen by the diameter and average bulb weight—two crucial characteristics that contribute to yield. Varieties' varying genetic compositions can also be ascribed to yield variations. Results comparable to the current ones had been published by [23, 7]. There have also been reports of notable variations in marketable bulb output between onion types.

3.2.6. Unmarketable Yield

The onion's varietal and biochar effect had a highly significant ($P<0.05$) influence on the unmarketable yield. While Nafis produced a substantially lower unmarketable yield of 0.78, the local variety produced a significantly larger unmarketable yield of 2.5. This suggested that Nafis performed better in terms of yield and flexibility. The onions grown at a biochar rate of 10 t/ha produced the highest total marketable yield. However, when biochar was not applied and local variety was used, the lowest overall bulb yield was achieved. This could be the consequence of variations in genetic traits leading to split, rotten, damaged, or discolored bulbs, or it could be the result of a few large or small bulbs that were deemed unmarketable. Nonetheless, the unmarketable bulb yield of the various treatments was unaffected by the interaction effect of biochar. [23] Variations in the cultivars' unmarketable bulb yield have been reported. On the other hand, Nafis, Bombay Red, and Adama Red achieved the highest

unmarketable bulb output, according to [20].

Table 5. Mean values of Bulb Marketable yield and Unmarketable yield as affected by Biochar with Onion variety.

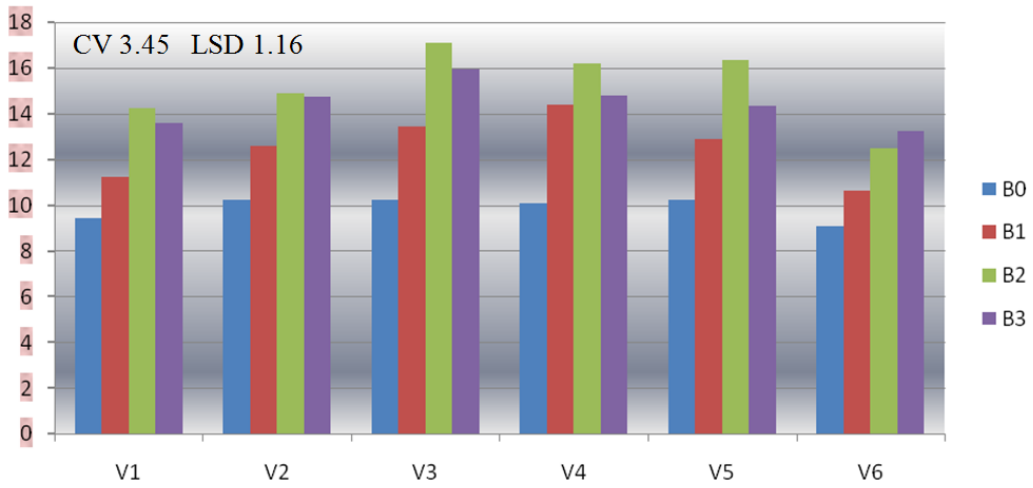
Treatment	Marketable yield	Unmarketable yield
Biochar		
B0	19.82	2.25
B1	22.27	1.85
B2	25.36	1.01
B3	22.84	1.22
LSD (0.05)	0.82	0.45
Variety		
V1	20.95	2.35
V2	21.98	2.1
V3	26.61	0.78
V4	24.35	0.96
V5	23.13	2.2
V6	18.33	2.5
LSD (0.05)	1.01	0.71
CV (%)	9.6	11.3

V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5t /ha B3= 10t /ha B4= 15t /ha.

3.3. Quality Parameters

3.3.1. Bulb Dry Matter

The results of the analysis of variance showed that the primary effects of variety and biochar had a substantial ($P < 0.05$) impact on the onion bulb's dry matter yield. When 10 t/ha^{-1} of biochar were applied, the cultivars Nafis showed the highest dry matter (17.55). On the other hand, the local variety with the 0 t/ha^{-1} treatment of biochar had the lowest bulb dry matter yield. Environmental factors, particularly the availability of nitrogen fertilizers, impact the amount of dry matter. They discovered that while lower biochar rates produce more fresh and dry weight, higher biochar rates can increase dry matter.

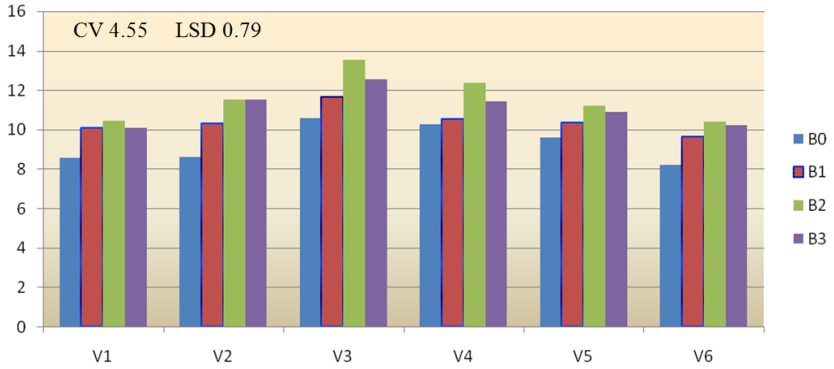


V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5 t /ha B3= 10 t /ha B4= 15 t /ha.

Figure 1. Dry matter contents as affected by Biochar and variety.

3.3.2. Total Soluble Solid

The Nafis variety yielded the highest total soluble solid (°brix) of onion (13.55), whereas the local variety yielded the lowest (8.22). When biochar was applied at a rate of 10 t/ha^{-1}, the cultivars Nafis showed the highest total soluble solid concentration. Conversely, the local variety with the 0 t/ha^{-1} application of biochar had the lowest total soluble solid concentration.



V1= Adama Red V2= Bombey Red V3= Nafis V4= Nasik Red V5= Robaf and V6= Local variety. B1=control B2= 5 t /ha B3= 10 t /ha B4= 15 t /ha.

Figure 2. *Total soluble solid content as affected by biochar and variety.*

4. Conclusion

Onion (*Allium cepa L.*) is one of the most important warm-season vegetable crops cultivated in Ethiopia. It is grown largely by smallholder farmers and few commercial growers mainly under irrigation and lower share using rain. However, the potential of onion production is found at Abaya wereda, onion is imported from Batu (Ziway) and Shashemene to Sidama, Gedeo and Guji zone. The current situation indicates that there is no research work on onion evaluation in the study area, which prevents growers from selecting the best performing varieties in the same produced area. As a result, one of the considerations to ease the existing problems of obtaining best adaptable varieties for which the output of the study area is Guji zone Abaya were da during the 2022/23 cropping season is the evaluation of selected varieties for their agronomic performance. This is because there has been a dearth of research output for the potential area for production of onions. Therefore, the approach to mitigate gap was evaluated the best performing varieties and biochar application rate.

The study's findings demonstrated that nearly every parameter taken into account was significantly impacted by the treatments; the variety of onion and the rate at which biochar was applied had a significant impact on plant height, leaf number, maturity date, bulb weight, bulb length and diameter, marketable yield, unmarketable yield, and total bulb yield of onion. Of the six varieties, Nafis produced the highest height and number of leaves when biochar was applied at a rate of 10 t/ha^{-1}; the lowest was observed at the local variety with a 0 t/ha^{-1} application of biochar. Variance analysis indicated that there were differences in the number of leaves among the varieties. Bombay Red's maturity period was shortened by applying biochar at a rate of 10 t/ha^{-1}. On the other hand, cultivars Nasik Red needed longer to mature after applying 0 t/ha^{-1} of biochar. Despite the 10 t/ha^{-1} biochar and Nafis rate. demonstrated promise for sustainable onion production; nevertheless, more research is needed to ascertain the long-term impacts of biochar under irrigation settings.

Abbreviations

EIAR	Ethiopian Institute of Agricultural Research
SNNPR	South Nation Nationality People of Republic

Author Contributions

Chemir Asume: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Methodology, Project administration, Supervision, Writing – original draft

Mitiku Muanenda: Data curation, Formal Analysis, Methodology

Fikru Kenea: Data curation, Formal Analysis, Methodology

Conflicts of Interest

The authors declare no conflicts of interest.

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