ISSN: 2617 – 8338 (Online)
: 2617 – 832X (Print)

EBAUB Journal
An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Effects of Soil Texture on Growth, Yield and Quality of Beetroot (*Beta vulgaris* L.)

Mehedi Hashan Sohel[1*], Md. Rifat Shahriar[2], Md. Abu Sufian[2], Mst. Eshita Khatun[2], Nowrin Tabassum[2], Mst. Nazmin Khatun[2], SK. Mohammad Ali Jenna[2], Kusal Kumar Shil[2], Md. Al Amin[2], Most. Dil Afrose[2], Most. Fatema Khatun[2]

[1]Department of Soil Science, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh
[2]Faculty of Agriculture, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

ARTICLE INFO

Received date: Sep 18, 2024
Accepted date: Dec 15, 2024

ABSTRACT

The present study was to investigate the effect of soil texture on the growth, yield and quality of beetroot (*Beta vulgaris* L.). The rooftop of EXIM Bank Agricultural University Bangladesh served as the experimental site for the study. The experiment was implemented with five distinct soil treatments: T_1 (Sandy Loam), T_2 (Loam), T_3 (Sandy Clay Loam), T_4 (Clay Loam), and T_5 (Clay). At 60 days after sowing, the significant variations observed in plant height among the different treatments. T_1 (Sandy Loam) resulted in the tallest plants, reaching an average height of 26.57 cm. T_2 (Loam) followed closely with an average height of 24.20 cm. On the other hand, T_5 (Clay) exhibited the shortest plants, with an average height of only 16.17 cm. A similar trend was evident for leaf number, leaf length, and leaf breadth indices, with T_1 consistently displaying the highest values and T_5 the lowest. T_1 (Sandy Loam) yielded the highest average beetroot weight of 104.10 g, significantly outperforming the other treatments. In contrast, T_5 (Clay) had the lowest average beetroot weight of 65.13 g. Furthermore, the study examined the correlation between plant growth parameters and beetroot weight. The positive correlations found within plant height, leaf number, leaf length, and leaf breadth when beetroot weight evaluated. The findings highlight the considerable influence of soil texture on the growth and quality of beetroot. The use of sandy loam (T_1) as a soil treatment showed the most favorable results, promoting greater plant height and beetroot weight. Overall, the study provides valuable insights into optimizing soil conditions for beetroot cultivation on rooftop, potentially benefiting agricultural practices by enhancing crop productivity and overall quality.

Keywords: Beetroot, Growth, Rooftop, Soil texture, Yield

*CORRESPONDENCE
mehedibau113@gmail.com
Department of Soil Science, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

1. INTRODUCTION

Beetroot (*Beta vulgaris* L.) belongs to the Chenopodiaceae family. Red beetroot is a rich source of minerals like magnesium, manganese, sodium, potassium, iron, copper (Reimann et al., 2018; Mlakar and Bevec, 2009). In contrast to other vegetables, beetroot contained mainly sugar as sucrose form and only small amount of glucose and fructose also present (Bangar et al., 2022; Peter et al., 2011). Beetroot revealed significant tumor inhibitory effects in skin and lung cancer (Kapadia and Rao, 2013). Beetroot is known to be a powerful antioxidant (Singh & Hathan, 2013; Winkler et al., 2005). The growth, yield, and quality of plants are intricately linked to the properties of the soil in which beetroot was

To Cite: Sohel, M. H., Shahriar, M. R., Sufian, M. A., Khatun, M. E., Tabassum, N., Khatun, M. N., Jenna, S. M. A., Shil, K. K., Amin, M. A., Afrose, M. D. & Khatun, M. F. (2025). Effects of soil texture on growth, yield and quality of Beetroot (*Beta vulgaris* L.). *EBAUB J.*, 7, 32-36.

cultivated vastly (Rantao & State, 2013). One such property that significantly influences plant performance is soil texture, which refers to the relative proportions of sand, silt, and clay particles in the soil (Shete et al., 2019; Well, 2017; Yaalon, 1989). Soil texture directly impacts the physical and chemical characteristics of the soil, thereby influencing plant growth, nutrient availability, and water-holding capacity. Successful beetroot cultivation requires a thorough understanding of the soil conditions, including soil texture (Nassar et al., 2023).

The effect of soil texture on beetroot growth, yield, and quality has been the subject of scientific inquiry due to its practical implications for optimizing agricultural practices (Reimann et al., 2018). Soil texture influences beetroot through various mechanisms. Firstly, it affects water retention capacity and drainage properties, thereby influencing water availability and preventing waterlogging (Wootton-Beard et al., 2014). Secondly, soil texture influences nutrient availability, with clay soils generally exhibiting higher cation exchange capacities and better nutrient retention compared to sandy soils. Additionally, soil texture impacts root penetration and aeration, which in turn affect root development and nutrient uptake efficiency (Tuchkova et al., 2022; Cao et al., 2019).

Despite the widespread cultivation of beetroot in various soil types, including sandy, loamy, and clayey soils, the specific influence of soil texture on beetroot growth, yield, and quality warrants further investigation (Cao et al., 2019; Vali et al., 2007). This study aims to explore the effects of varying soil textures on the growth, yield, quality and correlations of beetroot, highlighting the importance of optimizing soil management practices to enhance crop productivity.

2. MATERIALS AND METHODS

The experiment was conducted during the period from 15 February 2023 to 22 June 2023.

2.1. Experimental Site

The study was conducted on the rooftop of EXIM Bank Agricultural University Bangladesh.

2.2. Experimental Treatments

The experiment consisted of 5 treatments each with 3 replications and the total number of pots was 15.

Table 1 Treatments combination

Treatments	Description
T_1	Sandy Loam (74% sand, 9% silt, and 17% clay)
T_2	Loam (45% sand, 30% silt, and 25% clay)
T_3	Sandy Clay Loam (51% sand, 19% silt, and 30% clay)
T_4	Clay Loam (43% sand, 30% silt, and 27% clay)
T_5	Clay (21% sand, 34% silt, and 45% clay)

2.3. Soil Sampling and Analysis

Soil samples were collected from different sites of Chapainawabganj district at a uniform depth (0-15 cm). The textural classes of soil samples were determined by using finger feel method, international pipetting method and USDA soil textural triangle (Ritchey et al., 2015; Curcio, et al., 2013; Franzmeier & Owens, 2008; Shirazi & Boersma, 1984).

2.4. Cultural Practices and Plant Protection

Different intercultural operations such as irrigation, weeding, mulching, pest management, fertilizer management were practiced in the experiment for successful plant growth and development and suitable fertilizer doses were used following Fertilizer Recommendation Guide (BARC, 2012). Proper integrated weed management was done to control the weed infestation in the pots. The modified and adapted weed control practice from early observation was scheduled in our present study according to Swanton and Murphy (1996).

2.5. Assessment of Yield and Yield Parameter

The physical and yield parameters: plant height (cm), number of leaves, leaf length (cm), leaf breadth and beetroot weight (g), were obtained during vegetative and reproductive stages, following the standard methods.

2.6. Statistical Analysis

The recorded data on various parameters were statistically analyzed using Statistix-10 statistical package program. The mean for all the treatments were calculated and analysis of variance for all characters was performed by F (variance ration) test. Correlations between parameters were investigated using SPSS. Difference between treatment means were determined by LSD according to Gomez and Gomez (1984) at 5% level of significance.

3. RESULTS

3.1. Effect of Soil Texture on Vegetative and Reproductive Parameters of Beetroot

3.1.1. Plant Height (cm)

Significant variation was observed on plant height 60 days after sowing as influenced by different treatments. Results showed the highest plant height to be 26.57 cm was recorded in T_1 (Sandy loam soil) followed by T_2 (loamy soil) 24.20 cm whereas the lowest 16.17 cm plant height was found in treatment T_5 (Clay) (Table 2).

3.1.2. Leaf Number

Significant variations in leaf number were observed among the different treatments. The treatment T_1 (Sandy loam) resulted in the highest leaf number value of 13.33, while the lowest leaf number of 10.33 was obtained from the clay treatment T_5 (Table 2).

3.1.3. Leaf Length (cm)

Variation in leaf length was observed among the different soil texture treatments, resulting in significant differences. Treatment T_1 (sandy loam) exhibited the highest leaf length of 29.23 cm, while the clay treatment (T_5) had the lowest leaf length of 18.50 cm (Table 2).

Table 2 Effect of soil texture on vegetative and reproductive parameters of Beetroot

Treatment	Plant height (cm)	No. of leaf	Leaf length (cm)	Leaf breadth (cm)	Beetroot weight (g)
T_1	26.57	13.33	29.23	6.97	104.1
T_2	24.20	11.33	25.70	6.97	100.3
T_3	21.47	11.00	24.50	5.97	91.36
T_4	20.13	10.67	22.43	5.53	76.46
T_5	16.17	10.33	18.50	5.23	65.13
CV	4.01	6.03	2.99	9.72	5.12

3.1.4. Leaf Breadth (cm)

The leaf breadth was significantly impacted by different soil texture treatments. The treatment T_1 (sandy loam) resulted in the widest leaf of 6.97 cm, whereas the clay treatment (T_5) exhibited the narrowest leaf breadth of 5.23 cm (Table 2).

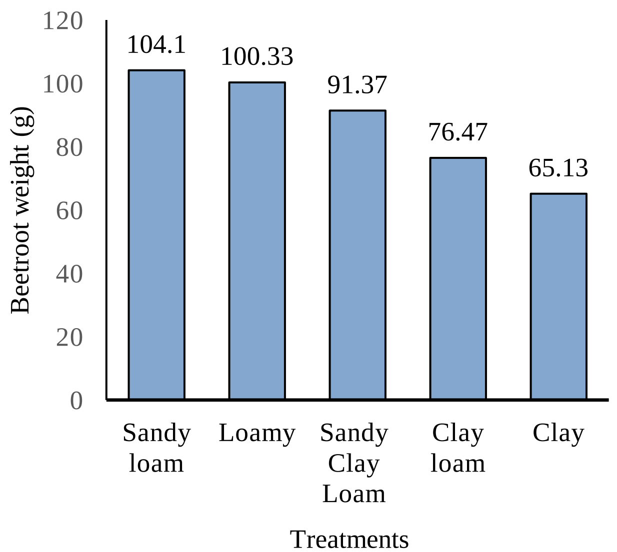

Fig. 1 Effect of soil texture on weight of beetroot.

3.1.5. Beetroot Weight

Significant variations in the weight of beetroot were observed among the different soil treatments, as shown in Fig 1. The treatment T_1 (sandy loam) resulted in the highest beetroot weight of 104.10 g, which was significantly higher than the beetroot weight obtained from the other treatments. Conversely, the clay treatment (T_5) displayed the lowest beetroot weight of 65.13 g. Moreover, the weights of fresh beetroot for the remaining treatments were as follows: T_2 for 100.33 g, T_3 for 91.37 g, and T_4 for 76.47 g. Similar findings were found by Abbas et al., (2018) and El-Karamany et al. (2015) in sugar beet.

3.2. Relationship between the Vegetative Characteristics of Beetroot and Yield

The relationship between the vegetative characteristics of beetroot such as plant height, leaf number, leaf length, and leaf breadth, and its yield was significant because these factors directly influence the plant's ability to photosynthesize, uptake nutrients, and allocate resources to root development.

Table 3 Relationship between the growth parameters of beetroot and yield

Parameters	Co-efficient of correlation (r)	P value
Plant height and yield	0.971**	0.006
Number of leaves and yield	0.797	0.107
Leaf length and yield	0.962**	0.009
Leaf breadth and yield	0.895*	0.040

** Significant at 0.05 level of probability and * Significant at 0.01 level of probability.

3.2.1. Plant Height and Yield

The correlation between plant height and weight is 0.971** (Table 3), which is very close to 1. This indicates that there is a strong positive relationship between the two variables. In other words, as the plant height increases, beetroot yield also increases. Science the P value (0.006) is less than 0.01. So, there is a significant relation between the variables.

3.2.2. Leaf Number and Yield

The correlation between leaf number and weight is 0.797 (Table 3). This indicates that there is a positive relationship between the two variables. In other words, as the plant height increases, yield also increases. Science the P value (0.107) is greater than 0.05. So, there is an insignificant relation between the variables. The similar result was found by Khan et al. (2020).

3.2.3. Leaf Length and Yield

The correlation between leaf length and weight is 0.962** (Table 3), which is very close to 1. This indicates that there is a strong positive relationship between the two variables. In other words, as the leaf length increases, yield also increases. Science the P value (0.009) is less than 0.01. So, there is a significant relation between the variables.

3.2.4. Leaf Breadth and Yield

The correlation between leaf breadth and weight is 0.895* (Table 3). This indicates that there is a strong positive relationship between the two variables. In other words, as the leaf breadth increases, yield also increases. Since the P value (0.040) is less than 0.05. So, there is a significant relation between the variables.

4. DISCUSSION

The present study aimed to investigate the effects of soil texture on beetroot growth, yield and quality that explored the intricate relationship between beetroot cultivation and soil texture. The findings from our study, combined with insights from previous research, contribute to a nuanced understanding of how soil texture influences beetroot performance.

Our observations align with the existing body of knowledge, emphasizing the significance of soil texture in determining beetroot growth and quality. Sandy loam soil emerged as the optimal substrate for beetroot cultivation, corroborating previous studies that have reported improved yields and quality in such conditions (Petek et al., 2019). The well-drained and loamy characteristics of sandy loam soil likely provide an ideal environment for root development and nutrient uptake, fostering enhanced beetroot growth (Shete et al., 2019).

Conversely, our results highlight the challenges posed by clay soil for beetroot cultivation, which corroborate findings from Plante et al. (2006). The compact nature of clay soil can hinder root expansion and restrict water and nutrient movement, leading to suboptimal beetroot growth. These findings emphasize the importance of considering soil texture when selecting cultivation sites and implementing crop management strategies (Nassar et al., 2023).

It is worth noting that while soil texture significantly influences beetroot growth, other factors such as irrigation, fertilization, and climate also play crucial roles in determining crop performance. The similar result was found by Kumar (2015), where different irrigation methods and fertilization practices were shown to impact sugar beet growth and yield under varying soil water levels. Similarly, the study by (Sapkota et al., 2021) demonstrated the combined effects of nitrogen sources on beetroot growth and yield.

The integration of microbial fertilizers, as explored by Agic et al. (2018) had shown potential for enhancing beetroot yield and quality. This underscores the complexity of factors influencing crop productivity and suggests that a holistic approach encompassing multiple agricultural practices is essential for optimal results.

In conclusion, our study underscores the pivotal role of soil texture in influencing beetroot growth and productivity. The preference for sandy loam soil as an ideal substrate for beetroot cultivation emphasizes the need for site-specific soil management practices. By integrating our findings with the existing literature, we contribute to the collective knowledge aimed at optimizing agricultural practices for sustainable and productive beetroot cultivation.

5. CONCLUSION

Sandy loam soil emerged as the most favorable soil texture for beetroot growth and yield. The research demonstrated that beetroot plants cultivated in sandy soil exhibited superior growth quality and achieved higher yields compared to other soil types. Loamy soil showed a moderate response in supporting beetroot growth and yield. The study revealed that clay soil exhibited a poor response in promoting beetroot growth and yield. Beetroot plants grown in clay soil struggled to thrive and resulted in lower yields and suboptimal growth quality. Based on these findings, it is recommended that sandy loam soil be preferred for beetroot cultivation to maximize crop productivity and overall quality. Choosing the right soil texture can significantly impact the success of beetroot cultivation and enhance overall agricultural productivity.

REFERENCES

Agic, R., Zdravkovska, M., Popsimonova, G., Dimovska, D., Bogevska, Z., & Davitkovska, M. (2018). Yield and quality of Beetroot (*Beta vulgaris ssp. esculenta L.*) as a result of microbial fertilizers. *Contemporary Agriculture, 67*(1), 40-44.

Abbas, M., Soliman, A. S., Moustafa, Z. H., & El-Reheem, K. M. A. (2018). Effect of some soil amendments on yield and quality traits of sugar beet (*Beta vulgaris L.*) under water stress in sandy soil. *Egyptian Journal of Agronomy, 40*(1), 75-88.

Bangar, S. P., Chaudhary, V., Singh, A., & Sharma, N. (2022). Beetroot as a novel ingredient for its versatile food applications. *Critical Reviews in Food Science and Nutrition, 36*(3), 456-466.

BARC, (2012). *Fertilizer Recommendation Guide*. Bangladesh Agricultural Research Council, Dhaka.

Cao, Y., Liu, F., Guo, S., Shui, Y., & Xue, H. (2019). Portable colorimetric detection of copper iron in drinking water via red beet pigment and smartphone. *Microchemical Journal,15*(3), 289-296.

Curcio, D., Ciraolo, G., D'Asaro, F., & Minacapilli, M. (2013). Prediction of soil texture distributions using VNIR-SWIR reflectance spectroscopy. *Procedia Environmental Sciences*, *19*, 494-503.

El-Karamany, M., Waly, A., Shaaban, A., & Bakry, B. A. (2015). Effect of hydrogel on yield and yield components of sugar beet in sandy soil. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 6*(2),1025-1032.

Franzmeier, D. P., & Owens, P. R. (2008). Soil texture estimates: A tool to compare texture-by-feel and lab data. *Journal of Natural Resources and Life Sciences Education, 37*, 111–116.

Gomez, K. A., & Gomez, A. A. (1984). *Statistical Procedure for Agricultural Research.* John Wiley and Sons, Inc. Singapore.

Kapadia, G. J., & Rao, G. S. (2013). Red Beet Biotechnology. *Food and pharmaceutical application*, *9*(2), 143-165.

Khan, S. U., Gurmani, Z. A., Ahmed, W., Ahmed, S., & Gul, A. (2020). Production and salinity tolerance of fodder beet (*Beta vulgaris L. ssp. Maritima*). *International Journal of Engineering Studies and Technical Approach*, *1*(3), 1047-1060.

Kumar, Y. (2015). Beetroot: A super food. *International Journal of Engineering Studies and Technical Approach*, *1*(3), 980-993.

Mlakar, S. G., & Bevec, M. (2009). Biodynamic agriculture research progress and priorities. *Renewable Agriculture and Food Systems, 24(2),* 146-152.

Nassar, M. a. A., El-Magharby, S. S., Ibrahim, N. S., Kandil, E. E., & Abdelsalam, N. R. (2023). Productivity and quality variations in sugar beet induced by soil application of K-Humate and Foliar application of biostimulants under salinity condition. *Journal of Soil Science and Plant Nutrition*, *46*(1), 147-153.

Peter, C., Wootton, B., & Ryan, L. (2011). A beetroot juice shot is a significant and convenient source of bioaccessible antioxidants. *Journal of Functional Food, 3*, 329-334.

Plante, A. F., Conant, R. T., Stewart, C. E., Paustian, K., & Six, J. (2006). Impact of soil texture on the distribution of soil organic matter in physical and chemical fractions. *Soil Science Society of America Journal*, *70*(1), 287-296.

Petek, M., Toth, N., Pecina, M., Karaz, T, Lazarević, B., & Palčić, I. (2019). Beetroot mineral composition affected by mineral and organic fertilization. *PLOS ONE*, *14*(9), e0221767.

Rantao, G., & State, U. O. T. F. (2013). Growth, yield and quality response of beet (*Beta vulgaris l.*) to nitrogen. *Journal of Soil Science and Plant Nutrition, 7*(1), 59-65.

Reimann, C., Fabian, K., Brike, M., Filzmoser, P., Demetriades, A., Negrel, P., Oorts, K., Matschullat, J., & Caritat, P. (2018). GEMAS: Establishing geochemical background and threshold for 53 chemical elements in European agricultural soil. *Applied Geochemistry*, *88*(2), 302-318.

Ritchey, E. L., McGrath, J. M., & Gehring, D. (2015). Determining Soil Texture by Feel. *Agriculture and Natural Resources Publications*, 139. University of Kentucky, College of Agriculture, Food and Environment, Lexington, KY, 40546, USA.

Sapkota, A., Sharma, M. D., Giri, H. N., Shrestha, B., & Panday, D. (2021). Effect of organic and inorganic sources of nitrogen on growth, yield, and quality of beetroot varieties in Nepal. *Nitrogen*, *2*(3*)*, 378-391.

Shirazi, M. A., & Boersma, L. (1984). A Unifying quantitative analysis of soil texture. *Soil Science Society of America Journal, 48* (1), 142-147.

Shete, P. P., Deshmukh, R. R., Kayte, J. N., & Student, P. (2019). Determination of Soil Texture Distribution (Clay, Sand and Silt) by using Spectral Measurement: A Review. *Earth and Environmental Science, 12*(3), 239-246.

Singh, B., & Hathan, B. S. (2013). Optimization of osmotically dehydrated beetroot candy using response surface methodology. *International Journal of Food and Nutritional Sciences, 2*(1), 15-21.

Swanton, C.J., & Murphy, S. D. (1996). Weed science beyond the weeds: The role of integrated weed management (IWM) in agro-ecosystem health. *Weed Sci. 44*, 437-45.

Tuchkova, L. E., Verkhovets, I. A., & Tikhoykina, M. (2022). Evaluation of impact beetroot pulp obtained as a by-product of sugar production has on quality of grey forest soil. *Earth and Environmental Science, 7*(3), 111-120.

Vali, L., Tefanovits-Banyai, E., & Szentmihalyi, K. (2007). Liver protecting effects of table beet *(Beta vulgaris var.* rubra*)* during ischemia-reperfusion. *Nutrition, 23*(2), 172-178.

Well, R. R. (2017). *The Nature and Properties of Soils.*15th Ed. Library of Congress Cataloging.

Winkler, B. W. C., Schroecksnadel, K., Schennach, H., & Fuchs, D. (2005). In vitro effects of beet root juice on stimulated and unstimulated peripheral blood mononuclear cells. *The American Journal of Biochemistry and Biotechnology, 3*(1), 180-185.

Wootton-Beard, S, P. C., Brandt, K., Fell, D., Warner, s., & Ryan, L. (2014). Effects of a beetroot juice with high neobetanin content on the early-phase insulin response in healthy volunteers. *Journal of Nutritional Science ,39*(5), 689-701.

Yaalon, D., (1989). Comments on "A unifying quantitative analysis of soil texture". *Soil Sci. Soc. Am. J, 53,* 595.