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Research Article

THE EFFECTS OF ORGANIC AMENDMENTS AND SHADE LEVELS ON THE GROWTH PERFORMANCE OF ALOE VERA PLANTS

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Abstract

A field study was conducted at Sylhet Agricultural University, Sylhet, during the summer season from April to June 2019. The objective of the study was to assess the impact of organic amendments and shadow levels by changing light exposure on the growth contributing features of the aloe vera plant. The experiment was designed according to a factorial experiment in a Randomized Complete Block Design (RCBD) with various organic amendments and two levels of shadow. Organic amendments were cow dung, vermicompost, and Trichocompost. Two distinct degrees of light exposure were used in the experiment viz., complete shade (4×100 lux) and partial shade (125×100 lux). The growth performance of the plants was significantly affected by organic inputs as well as varying levels of shade. The maximum plant height (15.37 cm) and number of leaves (18.00) were bserved at110 days after transplanting (DAT) in the pots where Trichocompost semi-shed environment was employed. But the highest number of stems (10.47) was recorded at 110 days after transplanting (DAT) when combination of Trichocompost and complete shade were applied. The findings of the current study can be advisable to utilize Trichocompost as a growth medium for aloe vera cultivation in partially shaded environments in order to achieve optimal growth.

Introduction

The term "Aloe vera" derives from its etymological roots in both Arabic and Latin. The term "Alloeh" in Arabic is translated as "shining bitter substance," whereas the Latin term "vera" signifies "true" (Christaki and Florou-Paneri, 2010). The Aloe vera plant was regarded as a universal medicine by Greek scientists approximately 2000 years ago (Surjushe et al., 2008). Aloe vera was referred to as "the plant of immortality" by the ancient Egyptians. The botanical nomenclature for the plant is commonly known as Aloe vera is *Aloe barbadensis*. The plant is a perennial, succulent shrub with xerophytic characteristics. It exhibits a pea-green coloration and is classified within the Liliaceae family (Surjushe et al., 2008). Currently, in the field of commercial production, there are only two varieties of Aloe vera that are widely recognized as the most popular (Manvitha and Bidya, 2014), despite the existence of over 400 different species (Moghaddasi and Verma, 2011). The two species under consideration are *Aloe barbadensis* and *Aloe arborescens*, as mentioned by Manvitha and Bidya in their study conducted in 2014. The origin of aloe vera may be traced back to the northern regions of Africa. Due to its favorable cultivation conditions, it has rapidly disseminated over the globe (Grundmann, 2012). According to Moghaddasi and Verma (2011), aloe vera exhibits a reduced water requirement for sustenance and demonstrates the ability to thrive in coastal environments, saline soils, and displays resistance against various insects and illnesses.

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The historical utilization of this botanical species for traditional and folk medicinal purposes can be traced back to ancient civilizations such as the Assyrians, Egyptians, and Mediterranean societies, including references in biblical texts. According to Grundmann (2012), Aloe vera predominantly thrives in arid environments across the continents of America, Europe, Asia, and Africa, as documented by Surjushe et al. (2008). The utilization of this botanical specimen has been recognized for numerous millennia due to its therapeutic, dermatological attributes, as well as its contributions to physical well-being, aesthetics (Surjushe et al., 2008), and the preservation of food items (Manvitha and Bidya, 2014). Multiple research have demonstrated that the aloe vera leaf possesses numerous medicinal properties, including anticancer, antioxidant, antibacterial, antiulcer, antidiabetic, hepatoprotective, immunomodulatory, and various other actions (Manvitha and Bidya, 2014). The plant in concern is characterized by its short stem, with the most valuable component being the modified stem. This modified stem is composed of an outer layer of dark green parenchyma that encloses a dense, colorless gel with a thick mucilaginous consistency. The substance exhibits a high concentration of both macro and micronutrients. According to a recent study conducted by Sabat et al. (2018), the moisture content of aloe vera gel was found to be approximately 98.5-99%. The dry substances included in the gel consisted of 55% polysaccharides, 17% sugars, 16% minerals, 7% proteins, 4% lipids, and 1% phenolic compounds. Additionally, the gel possessed abundant in several essential vitamins and antioxidants, which are considered to be of significant importance. The demand for aloe vera products has exhibited a significant level of popularity in both local and international markets owing to its many applications in promoting human health. According to Lavakumaran and Seran (2014), the United States accounted for approximately 60-65% of the global market in 2004. Latin American nations contributed approximately 20-25%, while India, China, and Australia collectively held a market share of under 10%. The plant has the ability to thrive in various soil types, encompassing sandy coastal soils as well as loamy soils. Sodium (Na) and potassium (K) salts, together with elevated pH levels, exhibit tolerability. According to Motaleb (2011), the pH range of 8.5 to 9.5 is observed in well-drained soils with a composition ranging from loam to coarse sandy loam. Nevertheless, a study carried out in the Golan Heights region of Israel in 1995 demonstrated that aloe plants have the capacity to reach commercially viable dimensions even when exposed to extremely low temperatures, with a minimum threshold of 3°C. Furthermore, these plants have been found to exhibit resilience in enduring cold conditions for a duration of up to two months (Saks and Ish-Shalom-Gordon, 1995). The growth and development of plants are significantly influenced by the level of irradiance (Pedroza-Sandoval & Gómez-Lorence, 2006). According to a study conducted by Paez et al. (2000) in Chile, it was observed that cultivating young plants under partial shade conditions, with 30% exposure to full sunshine, resulted in a 27% higher yield compared to plants grown under full sunlight. Aloe cultivation utilizes soil varieties that possess a substantial concentration of organic matter (Kent, 1980). In order to prevent the accumulation of water and the transmission of diseases that impact the root system, such as tracheomycosis produced by *Fusarium oxysporum* and *Verticillum* sp., it is imperative to maintain proper soil drainage (Ayodele and Ilondu, 2008). In order to mitigate the impact of surface water accumulation during the rainy season, it is necessary to divert drainage water away from surface puddles. According to Fazeel et al. (2019), chemical fertilizers pose risks to both human health and the environment. The release of nutrients in organic manure occurs at a slower and more gradual rate. The plants are retained in the soil for an extended duration, resulting in increased longevity of their effects, enhanced crop productivity, and improved growth of the root system. In their study, Saha et al. (2005) discovered that the utilization of organic fertilizers, specifically vermicompost and vermiwash, yielded equivalent and beneficial results when compared to the use of inorganic fertilizers. These organic sources of fertilizer were found to significantly enhance the levels of gel moisture, gel ash, and aloin content. It is anticipated that the organic Aloe vera generated will possess enhanced marketability as a product. According to the study conducted by Patke et al. (2018), it was shown that utilizing a planting spacing of 60 x 30 cm, in combination with the application of 2.5 t ha^{-1} vermicompost, resulted in significantly increased leaf production and gross monetary returns in Aloe vera. The objective of this experiment was to compare the growth performance of five commercial medicinal plants under different shade conditions.

Materials and Methods

The study was carried out at the experimental field of the Department of Agroforestry and Environmental Science, located at the Agriculture Faculty building of Sylhet Agricultural University in Sylhet. The research took place during the summer season, April to June in the year 2019.

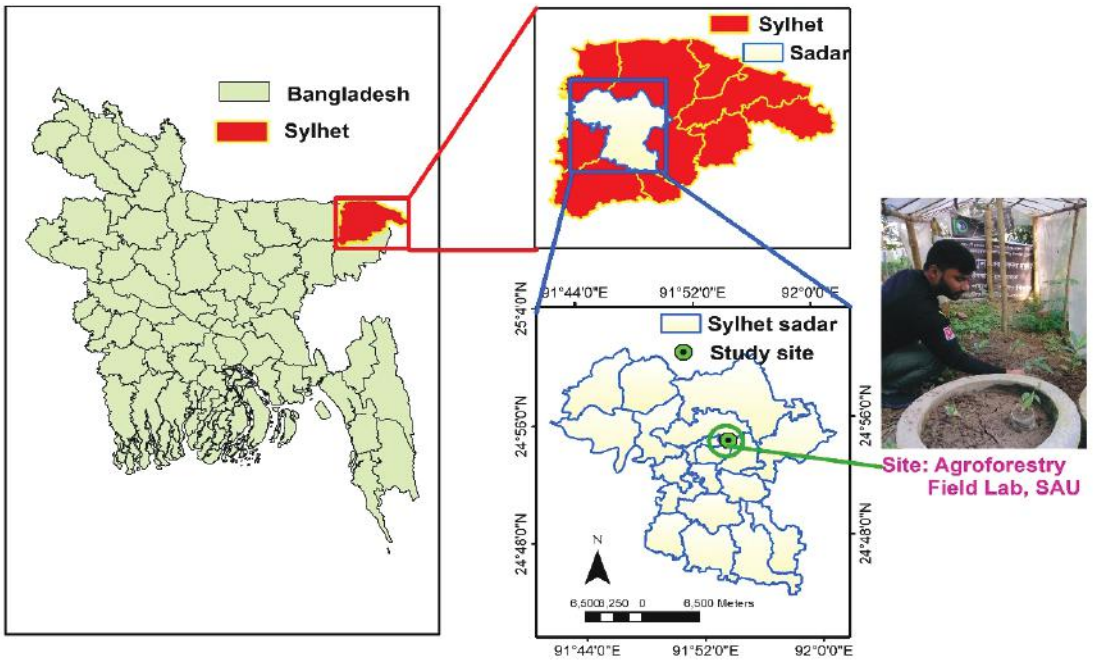

Figure 1. Experimental site map using ArcMap 10.3

The site is located approximately 5 kilometers northeast of Sylhet city, at a latitude of 24°54'N to 24°54.33"N and a longitude of 91°54'E to 91°54.95"E. The elevation of the site is 88 feet above sea level. The research was carried out according to a factorial experiment in a Randomized Complete Block Design (RCBD) with three replications. Different organic amendments and shade levels were used in this experiment. Cowdung, vermicompost and Trichocompost were used as organic amendments and shade levels- full shade (4×100 lux) and semi-shade (125×100 lux) were used in the experiment. Altogether 18 plants; nine plants for each replication were transplanted after four weeks under two distinct shade levels where the intensity of full sunlight was 790×100 lux. Pot size dimension was 37 cm surface diameter × 22 cm bottom diameter × 31 cm depth per height. Plant characteristics such as plant height, number of leaves and stems of each plant were recorded at 50 DAT, 80 DAT and 110 DAT, respectively. The means of the experimental data were separated by DMRT at a significance level of 5% for analysis of variance (ANOVA) using Microsoft Excel and Statistics 10 software.

Results and Discussion

Effect of organic substances on the growth of Aloe vera

The effect of organic substances significantly influenced plant height (Table 1). The results showed that the maximum plant height (12.18 cm), number of leaves (17.35), and maximum number of stems (9.22) were produced at 110 DAT using Trichocompost and cowdung, respectively. The lowest plant height (8.17 cm) was produced with cowdung. It was noted that utilizing cowdung resulted in the lowest total number of leaves (12.50), a similar pattern was found at 50 and 80 DAT, and the lowest number of stems produced (7.89) with the same. The findings demonstrated that Trichocompost (O_3) produced the highest growth characteristics. It might be due to producing plant growth regulatory material and phytohormones such as Indole acetic acid (IAA) is a prominent active chemical auxin that is produced by a number of microorganisms, including PGPR (Plant Growth Promoting Rhizobacteria) (Lynch, 1985). Roy et al. (2010) found that plant height and shoot weight were highest in the vermicompost treatment. Rahman and Asad. (2013) observed that the plant height, No. of branch/plant, No. of leaf/plant, leaf length, 1000- fresh leaf weight, and fresh yield were highest with cow dung application and lowest without manures applied (control).

Table 1. Effect of organic substances on growth of Aloe vera

Treatment	Plant height(cm)			No. of leave/plan			No. of stem/plant		
Organic substances	**50DAT**	**80DAT**	**110DAT**	**50DAT**	**80DAT**	**110DAT**	**50DAT**	**80DAT**	**110DAT**
O_1	4.90a	6.10 b	8.17c	7.33a	9.67b	12.50b	5.60a	7.36a	9.22a
O_2	3.83b	7.17a	9.83b	5.95b	10.03b	13.00b	4.13b	6.73b	9.05a
O_3	3.15b	7.77a	12.18a	8.05a	12.30a	17.35a	5.53a	7.60a	7.89b
Level of significance	**	*	**	**	**	**	**	**	*
$LSD_{(0.05)}$	0.86	0.99	1.13	0.79	0.50	1.04	0.80	0.34	0.85

Note: Figures similar to the letters do not differ significantly. * Significant at 5% level, ** Significant at 1% level, O_1 = Cow dung, O_2 = Vermicompost, O_3 = Trichocompost; DAT = Days after transplanting, LSD = Least significant difference. NB: Generally foot note be always smaller in font (to authors)

Shade level's impact on growth of Aloe vera plants

With the exception of 110 DAT, the effect of shade level was strongly correlated with plant height . (Table 2). Higher plant height (10.21 cm), no. of leaves (15.12) and no. of stems (9.30) were produced at 110 DAT from full shade condition. The lower plant height (9.91 cm), no. of leaves (13.44) and no. of stems (8.13) were produced for semi-shade. The results revealed that, mint? grow well in Semi-shade (S_2) condition. In Chile, Paez et al. (2000) found a direct link between yield and partial shade (30% full sunshine), with plants in partial shade producing 27% more leaves.

Table 2. Shade level's impact on growth of Aloe vera plants

Treatment	Plant height(cm)			No. of leave/plant			No. of stem/plant		
Shade level	**50DAT**	**80DAT**	**110DAT**	**50DAT**	**80DAT**	**110DAT**	**50DAT**	**80DAT**	**110DAT**
S_1	4.79a	7.97a	10.21	8.03a	12.011a	15.12a	5.62a	7.74a	9.30a
S_2	3.13b	6.06b	9.91	6.19b	9.322b	13.44b	4.56b	6.71b	8.13b
Level of significance	**	**	NS	**	**	**	**	**	**
$LSD_{(0.05)}$	0.72	0.81	0.92	0.64	0.40	0.85	0.66	0.28	0.69

Note: Figures similar to the letters do not differ significantly. * Significant at 5% level, ** Significant at 1% level, S_1 = Full shade, S_2 = Semi-shade, DAT = Days after transplanting, LSD = Least significant difference.

The combined effects of organic substances and shade levels on growth of Aloe vera plants

The combined impact of various organic substances and shade levels on growth of Ale vera was prominant. It was found that, the highest plant height was produced (15.37 cm) at 110 DAT for the interaction between Trichocompost and semi-shade (O_3S_2), where the lowest plant height was produced (6.37 cm) for the combined effect of cowdung and semi-shade (O_1S_2) (Table 3). It was found that, the highest no. of leaves were produced (18.00) at 110 DAT for the combined effect of Trichocompost and semi-shade (O_3S_2), that identical to Trichocompost and full shade (O_3S_1) where the lowest no. of leaves were produced (10.33) for the combine effect of cowdung and full shade (O_1S_2) (Table 3). Maximum no. of stems were produced (10.47) at 110 DAT for the combined effect of Trichocompost and full shade (O_3S_1) and the lowest was observed (7.63) for the combined effect of vermicompost and semi-shade (O_2S_2), which was similar to the condition of Trichocompost and full shade (O_3S_2) (Table 3). The combined effect of trichoderma (O_3) with semi-shade level (S_2) condition had increased the entire plant growth contributing parameters at higher level. Similar results were observed for *Gynura procumbens* by Robi et al. (2023) and reported that Trichocompost and semi-shade produced a highly significant maximum number of leaves and stems at 110 DAT.

Table 3. The combined effects of organic substances and shade levels on growth of Aloe vera plants

Treatment Interaction	Plant height(cm)			No. of leave/plant			No. of stem/plant		
	50DAT	80DAT	110DAT	50DAT	80DAT	110DAT	50DAT	80DAT	110DAT
O_1S_1	7.80a	8.87a	9.97c	10.00a	13.00a	14.67b	6.53	7.72b	9.30ab
O_1S_2	2.00d	3.33c	6.37e	4.67 d	6.33d	10.33d	4.67	7.00c	9.13b
O_2S_1	4.07b	8.97a	11.67b	4.00d	10.10c	14.00b	4.27	6.83cd	8.13bc
O_2S_2	3.60bc	5.37b	8.00d	7.90b	9.97c	12.00c	4.00	6.63cd	7.63c
O_3S_1	2.50cd	6.07b	9.00cd	10.10a	12.93a	16.70a	6.07	8.68a	10.47a
O_3S_2	3.80b	9.47a	15.37a	6.00c	11.67b	18.00a	5.00	6.50d	7.63c
Level of significance	**	**	**	**	**	**	NS	**	*
$LSD_{(0.05)}$	1.24	1.39	1.59	1.11	0.70	1.47	1.14	0.48	1.20
CV(%)	17.18	10.93	8.71	8.62	3.61	5.65	12.28	3.63	7.57

Note: Figures similar to the letters do not differ significantly. * Significant at 5% level, ** Significant at 1% level, O_1 = Cowdung, O_2 = Vermicompost, O_3 = Trichocompost; S_1 = Full shade, S_2 = Semi-shade, DAT = Days after transplanting, CV = Co-efficient of variation, LSD = Least significant difference.

Conclusion

Different organic amendments and shade levels can influence the growth performance of Aloe vera. Based on the findings of this study, it can be suggested that Trichocompost can be used to grow Aloe vera under semi-shade conditions for maximum growth.

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