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EFFECTS OF SOIL VISCOSITY, SOIL TEMPERATURE, AND SPECIFIC GRAVITY ON PLANTS GROWTH SOWN IN SOIL PREPARED FROM LABORATORY CHEMICAL WASTE

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Abstract

Purpose of the study: The primary purpose of this study is to find out the effect of change in soil viscosity, soil temperature, and specific gravity on growth of plants sown in the soil prepared from laboratory chemical waste collected from an educational institute and with the plants sown in average soil.

Methodology: Three-three pots with different soil combinations mixed with solid and liquid chemical waste have been used for growing *A. barbadensis Mill*, *Saussurea obvallata*, and *Lilium* plants. Observations were made every fifteen days for three months by checking plant height, the number of leaves, the color of leaves, and soil temperature for understanding and comparing plant growth with respect to variation in temperature. Later on, density and viscosity of soils have also been checked with specific gravity bottle and viscometer help.

Main Findings: Plants' growth differs with variation in soil viscosity, soil temperature, and soil density. All plants cannot grow potentially at the same temperature, viscosity, and density. *A. barbadensis Mill* **A4** has shown better growth with the least viscosity and highest particle density of soil. *Saussurea obvallata* **BK1** has shown better growth with the least viscosity and least particle density of soil. *Lilium* **L1** has shown better growth with all the moderate values of soil.

Applications of this study: This study helped to understand that all the plants have their requirements of nutrients, nutrition, and physical factors for their growth. The study also helped to understand that although the soil has taken initially is the same, viscosity and density of the soil changes due to the plants grown in it.

Novelty/Originality of this study: The use of chemical wastes is taken into consideration instead of fertilizers to reduce pollution.

Keywords: *A. barbadensis Mill, Saussurea obvallata, Lilium, soil temperature, soil viscosity, specific gravity, plant growth, photosynthesis.*

INTRODUCTION

Soil temperature depends upon the energy absorbed by the soil to the energy lost from the soil. Soil temperature varies daily and seasonally in accordance with the temperature of air and solar radiation. Radiation absorbed by soil effects on soil temperature, which directly or indirectly affects the physical, chemical, and biological processes of soil **(**Hillel et al. (2005), Martias et al. (2012)**,** Onwuka et al. (2018)**)**. Soil temperature effects on seed germination, sapling formation from seeds, plant root growth, movement and absorption of ions, microbial proliferation, soil aggregation, decomposition of organic matter, water transmission, water retention in soil and availability of water and minerals to plants **(**Onwuka et al. (2018), Sandor et al. (2012)**)**. The normal centigrade thermometer is used to measure the temperature of the soil. Soil temperature is high in dark-colored soil due to the absorption of more solar energy as compared to light-colored soil (Probert et al. (2000). In wet soil flow of heat is higher than the dry soil as in dry soil, empty pores are occupied by air. There is a reduction in soil moisture and soil water viscosity with an increase in temperature (Probert et al. (2000). With low-temperature water uptake decreases, viscosity increases as the rate of water absorption decreases, resulting in a reduced rate of photosynthesis. The optimum temperature for microbial proliferation and microbial activity is 25-35^{o}C. Low temperature is effective for root growth in succulent plants, and high-temperature increases are branching in plants. The highest, lowest, and optimum temperature varies from plant to plant for their growth rate.

Soil density consists of bulk, as well as particle density. Bulk density is mass per unit volume of dry soil that includes pore spaces, and it is expressed as g/cc, whereas particle density is the mass per unit volume of solid soil without pore spaces and expressed as g/cc. Soil texture, structure, organic matter content influences the bulk density of soil. The density of soil increases with the depth of the soil bulk. The bulk density of soil decreases with an increase in organic matter content. Bulk density decreases in swelling soil with an increase in moisture content and vice versa. An increase in porosity of soil decreases bulk density and vice versa. Therefore, for optimum growth of plants, soil with lower bulk density value is good. Lower bulk density promotes proper aeration in soil, the optimum proliferation of roots, and microbes in the soil that, in turn, increases nutrient and water absorption by plants **(**Cornish et al. (1984), Davies et al. (1991), Goodman et al. (1999)**).**

Soil temperature varies with the variation in weather conditions, so does the plant's growth. At high-temperature water contents in the soil deplete, which changes the conductivity of soil and availability of water to plants for growth. Soil temperature affects the physicochemical and biological processes as well as the gaseous exchange between the soil and

atmosphere. Soil temperature changes the rate of decomposition of organic matter present in soil (Hillel et al. (2005), Probert et al. (2000)). The specific gravity of soil helps to support water and solute movements present in soil and the aeration of the soil. Higher specific gravity than the required retards plant growth, which eventually influences the yield of the plant. High bulk density indicates low soil porosity, which causes restrictions in root growth, water infiltration reduction, and poor movement of water and air through the pores of the soil (Goodman et al. (1999). Soil temperature is inversely proportional to soil viscosity and directly proportional to the rate of photosynthesis. Therefore extreme changes in any of these factors affect plant growth. Moderate conditions are good for the growth of plants. Very high or very low temperature retards plant growth, changes in the size of leaves and flowers can also be seen in some plants.

Water plays an important role in all the mechanisms occurring for the plant's growth. Along with temperature, water, or moisture content also affects the viscosity of soil. Water dissolves the salts and nutrients in the soil and controls its transport for various purposes. Water facilitates microbial activity, photosynthesis, decomposition of organic matter, fixing, and releasing of soil nutrients for plant growth.

RESEARCH METHODOLOGY

Three-three pots with different soil combinations mixed with solid and liquid chemical waste have been used for growing *A. barbadensis Mill*, *Saussurea obvallata*, and *Lilium* plants. One-pot was taken with normal soil without the inclusion of any chemical waste obtained from the laboratory. The other two pots were taken with normal soil combined with liquid and solid laboratory waste separately in ratio 1:2. Observations were made every fifteen days for three months by checking plant height, number of leaves, the color of leaves, and soil temperature for understanding and comparison of plant growth with respect to variation in temperature. After a certain period and proper growth of a plant which can be compared for the study, 1100 C laboratory thermometers were used to measure the soil temperature. A specific gravity bottle was used for measuring density, and a viscometer was used to measure viscosity.

Plant Material: Saplings of Aloe Vera (A. *barbadensis Mill*), Brahma Kamal (*Saussurea obvallata*), and Lily (*Lilium*).

Soil Sample: Normal soil collected from the ground of Novel Junior College of Science & Commerce, Chinchwad, Pune. In A4, B4, L4 soil was mixed with liquid chemical waste, and in A1, B1, L1 soil was mixed with solid chemical waste in 1:2 ratios.

Apparatus and instruments used: Earthen pots, Trowel, Hoe, 110^0 C laboratory thermometer, Measuring tape, Measuring cylinder, beakers, Glass rod, Measuring balance, Specific gravity bottle, and Ostwald's Viscometer.

FINDINGS / RESULTS

Table 1: Comparative study of the growth of *A. barbadensis Mill* in different soil samples

Plant Name	A1 (Soil mixed with solid chemical waste)			A4 (Soil mixed with liquid chemical waste)			A7 (normal soil)		
No. of Days	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)
Day 1	4.5	5	27	5.5	5	26	5.5	3	22.5
Day 15	8.5	4	28.5	5.7	5	27.5	6.5	3	22
Day 30	11.5	4	27	12.6	4	28.5	13.6	4	23
Day 45	11.8	5	30	13.2	5	30	17.8	5	27.5
Day 60	12.7	6	32	15.2	6	31	18.5	6	34
Day 75	13.6	7	28.8	21.5	11	26.5	18.9	7	25
Day 90	16.5	6	29.5	26.4	17	28.5	19.3	8	28

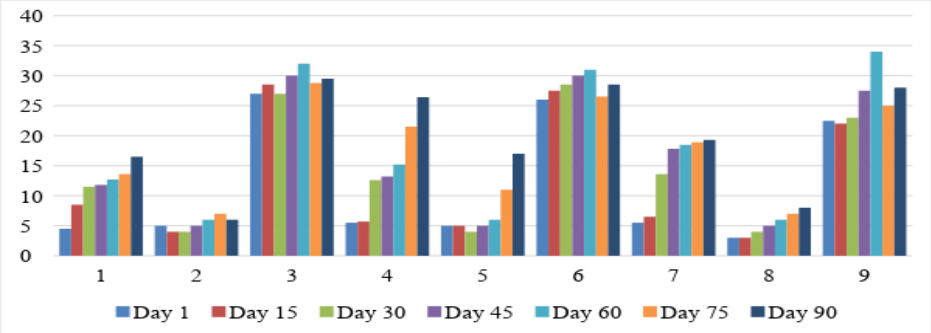

Figure 1: Comparative study of the growth of *A. barbadensisMill* in different soil samples

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Table 2: Comparative study of the growth of *Saussurea obvallata* in different soil samples

Plant Name	BK1 (Soil mixed with solid chemical waste)			BK4 (Soil mixed with liquid chemical waste)			BK7 (normal soil)		
No. of Days	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)
Day 1	8.5	1	24	13	1	23	15	1	22.5
Day 15	9	1	29	13.8	1	28	15.3	1	27.5
Day 30	9.2	1	29	14.5	1	31.5	15.7	1	28
Day 45	9.7	2	29.5	16.5	2	31.2	16.3	2	30
Day 60	10	2	33	16.1	2	35.9	16.5	2	34
Day 75	14.5	3	33.5	16.6	2	33.9	16.7	2	33.9
Day 90	17	4	32.2	16.6	3	35.9	16.7	3	34.8

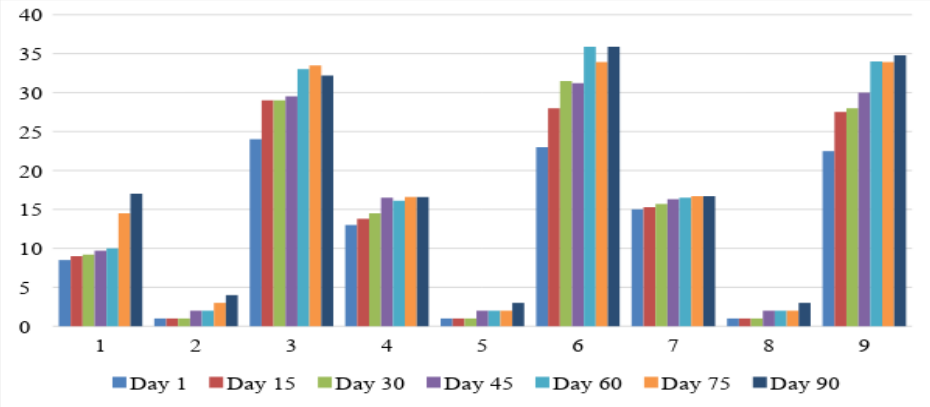

Figure 2: Comparative study of the growth of *Saussurea obvallata* in different soil samples

Table 3: Comparative study of the growth of *Lilium* in different soil samples

Plant Name	L1 (Soil mixed with solid chemical waste)			L4 (Soil mixed with liquid chemical waste)			L7 (normal soil)		
No. of Days	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil Temp (°C)
Day 1	0	0	26	0	0	23.5	0	0	20
Day 15	7.5	1	28.5	4	1	28.5	12	2	27.5
Day 30	11.9	4	28	12.4	2	29	12.4	3	28
Day 45	20.9	4	31	15	2	31	16.3	6	30.5
Day 60	27.9	5	32	16.8	2	33	20.4	8	31
Day 75	40.5	6	29	8	1	29	36.9	12	26.5
Day 90	43	8	30.2	11.5	1	29	38	13	29

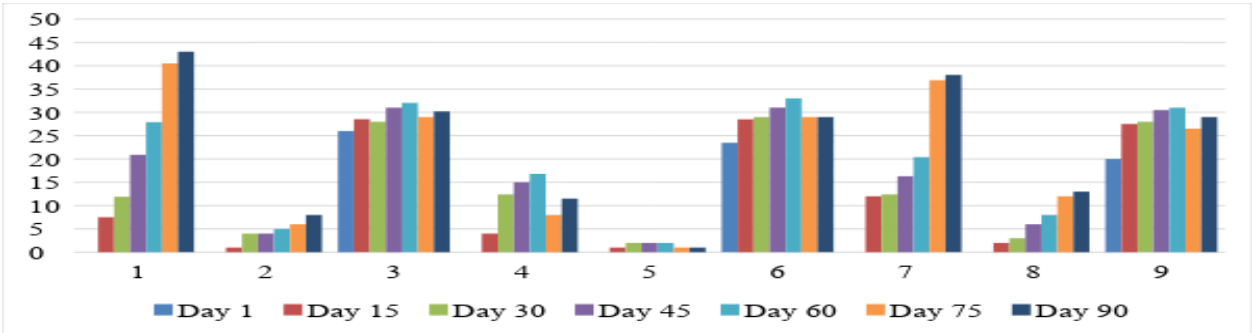

Figure 3: Comparative study of the growth of *Lilium* in different soil samples

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Table 4: Viscosity of Soil Samples

Plants Name	Viscosity
A1	70.35
A4	66.59
A7	67.47
BK1	69.2
BK4	70.36
BK7	75.37
L1	70.93
L4	60.896
L7	72.36

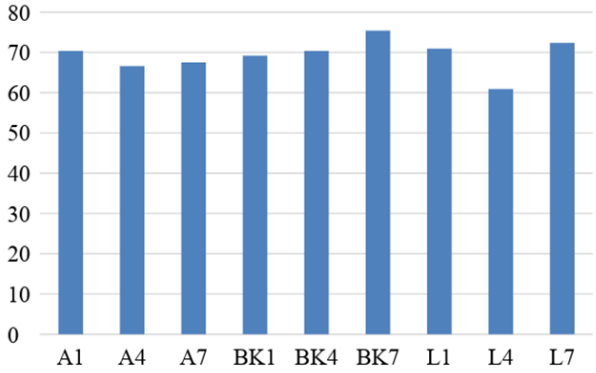

Figure 4: Viscosity

Table 5: Specific Gravity of Soil Samples

Plants Name	Specific Gravity
A1	1.004
A4	1.009
A7	1.007
BK1	1.003
BK4	1.005
BK7	1.005
L1	0.999
L4	0.998
L7	1.005

DISCUSSION/ ANALYSIS

As we can see from table 1 and graph 1, in-plant *A. barbadensis Mill* A4 plant height, number of leaves are highest with moderate temperature when compared with A1 and A7. The soil of the A4 plant has the least viscosity value, i.e., 66.59 and highest particle density 1.009 g/cc. Table 2 and graph 2 in plant *Saussurea obvallata* BK1 plant height and number of leaves are highest with least soil viscosity 69.2, least particle density of 1.003 g/cc and moderate temperature when compared with BK4 and BK7. From Tables 3 and 4, in-plant *Lilium* L1 shows the highest height with a moderate number of leaves and moderate temperatures. Soil viscosity is 70.93 intermediate of L4 and L7, and particle density is 0.999.

From these observations, we can say that temperature, viscosity, and density vary the growth of different plant species as well as these values also changes according to the plant grown in a particular soil. Soil A7, BK7, and L7 were collected from the same place, yet there is a slight variation in their density and viscosities. Same for the soils mixed with solid chemical waste A1, BK1, L1, and soil mixed with liquid chemical waste, i.e., A4, BK4, and L4. Variation in leaves length and width with slight variation in color has also been seen.

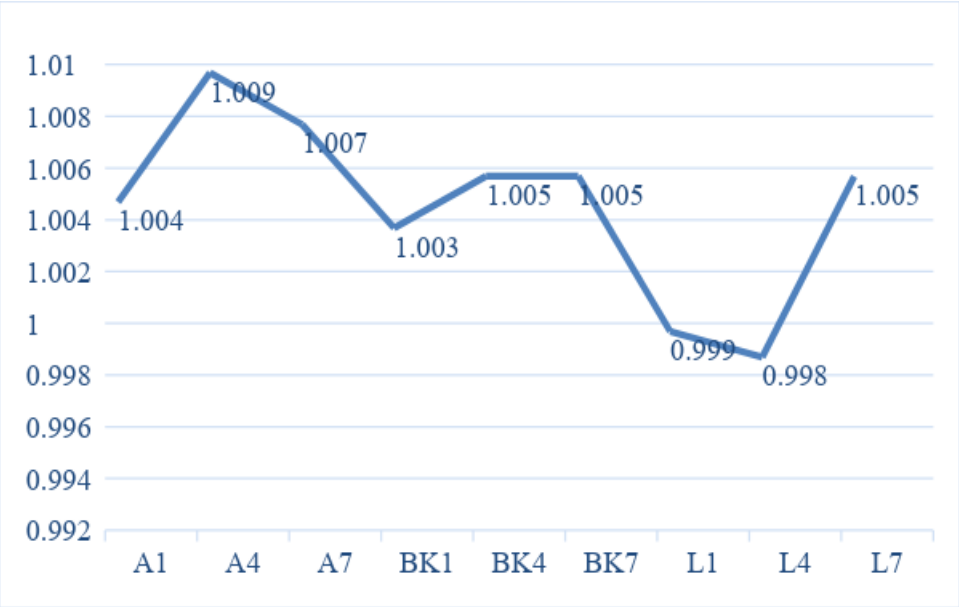

Figure 5: Specific Gravity of Soil Samples

CONCLUSION

This experiment helped to understand that solar radiation absorbed by soil effects the growth differently that we cannot understand by just looking at the plant. Different plants sown in different soil have shown variation in soil viscosity and density. In accordance with different seasons also plants growth differs; in winters or cold temperatures, flower size decreases, leaves and flowers shrink. Temperature above the optimum temperature for a particular plant also retards the growth of plants.

CONFLICT OF INTEREST AND ETHICAL STANDARDS

All the above experiments were conducted with the permission of the organization/ institute's authority. All ethical practices were followed during the study of these plants, and on the regular interval of time, all the data were collected by using the same instruments.

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ORIGINALITY

No work has been done on this topic before. This study will help to understand how chemical waste changes the viscosity, density of the soil, and which soil is better for the growth of the plants.

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