

Variation of Physical Parameters of Different Combination of Soil with Laboratory Waste and Plant Morphology

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ABSTRACT

Purpose of the study: Basic purpose of the study is utilization of laboratory wastes generated from science laboratories of educational institutes for plant growth. Plants growth differs according to the climatic conditions, nature of plant, nature of soil, minerals and microbes present in soil. Some plants were grown in different combinations of soil sample with addition of solid and liquid waste obtained from chemistry and biology laboratories of educational institutes.

Methodology: Carrot (*Daucus carota*), Spinach (*Spinacia oleracea*) and Tomato (*Solanum lycopersicum*) were grown with two sets each, moistened with tap water and chemical waste water. After few months again Aloe vera (*A. barbadensis* Mill), Hedge (*Berberis thunbergii*), Periwinkle (*Catharanthus roseus*) and Tomato (*Solanum lycopersicum*) were grown with different combinations of soil with chemical waste to see the difference in the plant growth which includes observations of soil pH, soil temperature, plant morphology, deformities observed with leaves, flowers and fruits, time took for flowering and many more physical property parameters after certain period of time.

Main Findings: Different plants exhibited different variation in their growth such as height, size of leaves and thickness of leaves. In case of Aloe vera the one which is grown in soil combined with liquid waste has shown measurable growth. In case of Hedge, the one which is grown in soil combined with liquid waste has shown the fastest growth in height.

Applications of this study: These experiments enabled us to understand the morphology of plants and rate of growth of plants in different soil combinations. We were able to analyse the specific requirements of the plant in terms of ions and minerals and the effect of climatic conditions on growth of plant.

Novelty/Originality of this study: In place of fertilizers, chemistry and biology laboratories wastes have been used which has reduced the pollution and the garbage collection created due to chemical waste in the campus.

Keywords: *A. barbadensis* Mill, *Berberis thunbergii*, *Catharanthus roseus*, *Solanum lycopersicum*, laboratory's solid chemical waste, laboratory's liquid chemical waste

INTRODUCTION

The experimental station of National Research Centre, Beheira Governorate (North of Egypt) conducted two field experiments in 2010 and 2011 for two season to compare the growth of spinach with bio and chemical fertilizer (NPK) in different combinations as well as separately. It has been found that combined fertilizers showed good effect in number of leaves, leaf area and total chlorophyll content and overall growth. (3)

Field trials have been done by using different fertilizers with equal concentration of nutrients. It was done to determine the growth parameters of tomato plant. Six plots have been made using different fertilizers, Chemical fertilizers, Farm Yard Manure (FYM), Vermicompost. Farm Yard Manure mixed with Chemical fertilizers and Vermicompost mixed with Chemical fertilizers. Observations have been made and it has been found that the tomato plant which is grown in the plot added with Vermicompost and Chemical fertilizers has shown 73% better yield with respect to growth of fruits than tomato plants planted on controlled plot in which these fertilizers were not added. Plot with Farm Yard Manure mixed with Chemical fertilizers showed better results with respect to weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant. (4)

In a private farm at El Nagah Village, South El-Tahrir Province, El Behaira Governorate, two field trials were conducted during the two successive summer seasons of 2005 and 2006. This was done to investigate partial replacement of NPK chemical fertilizers by bio-organic fertilizers on Sesame yield. It was tried with

seven different treatments where bio fertilizer was combined with organic and inorganic fertilizers in different combinations and better results were seen. (7)

One of the studies has been conducted to investigate the optimum combination of nutrient for enhanced yield and nutrient composition for Aloe Vera. The study was done on 72 pots for trial, each contained 2 kg washed beach sand, the effect of nutrient application on the nutritional value and nutrient uptake by Aloe Vera plant was determined at 6 months after transplanting. Analysis of Leaf Length (LL), Leaf Width (LW), Leaf Thickness (LT), Leaf Volume (LV), Number of Suckers (NS), Number of Leaves (NL), Weight Gain (WG), Plant Dry Matter (PDM), Nutrient Uptake (NU), Nutritive Value (NV) and proximate composition were done with the help of statistics and ANOVA at $p = 0.05$. (9)

The main aim of this study is to prepare different combinations of soil with laboratories waste which mainly consists of various radicals, minerals and organic components and to study the plant morphology of the plants grown in these soils. We also want to study the variation in the physical properties of soil with growth of plant and change of season. Different ratio of soil combinations can be made with solid and liquid waste obtained from laboratories to understand which combination of soil is more effective for proper growth of a particular plant.

Healthy growth of plants takes place in the soil which is enriched with the ions and minerals present in the chemical waste obtained from the laboratories of educational institutes. This will reduce the addition of inorganic fertilizers available in the market and will also be highly economical for the institutes. These days due to climatic changes, heavy rainfall, leaching of soil, soil erosion plants are not getting the required minerals that are good for their gradual growth. These wastes will help to increase soil fertility and reduce environmental pollution to some extent. Soil combined with solid and liquid waste will help to understand as to which combinations of soil is best for the proper growth of particular type of plant. How plant is responding towards different soil environment can be studied from different aspects.

METHODOLOGY

In winter season Carrot (*Daucus carota*), Spinach (*Spinacia oleracea*) and Tomato (*Solanum lycopersicum*) were planted in earthen pots two set each. One set was watered with tap water and the other set was watered with chemical waste (1:1 and 1:2 ratio of water with laboratory waste) obtained from the chemistry laboratory of educational institute Novel Junior College of Science and Commerce, Chinchwad, Pune 19, on regular interval of time. It was done for almost two and a half month. Plant height, leaf colour and size, soil colour, fruiting and time taken for ripening of fruit were observed in that period. After compiling data differences had been observed with respect to the plant growth. The procedure was repeated with different combinations of soil i.e. normal soil from the ground was taken, a part of soil was mixed with liquid waste obtained from chemistry laboratory and another part of soil was mixed with solid waste obtained from chemistry and biology laboratories of educational institutes. This experiment was conducted with Aloe Vera (*A. barbadensis* Mill), Hedge (*Berberis thunbergii*), Periwinkle (*Catharanthus roseus*) and Tomato (*Solanum lycopersicum*) plants; each with three sets different sets of soils combinations. Plants were watered everyday with tap water.

Variation in the soil parameters and plant growth were recorded after a fortnight. Soil pH, soil temperature, soil colour, plant height, number of leaves, time taken for flowering, temperature of that particular day etc. have been observed and recorded for further study. The procedure has been repeated every fifteenth day for recording variation in various parameters of soil and plant growth. The recorded data has been used for the comparative study of the growth of plants under different soil conditions. Pictures were taken on the day of observations. Soil temperature and room temperature of the date of observation was measured with the help of 110 °C laboratory thermometer. Soil pH was measured with the help of 3-way pH meter, which helped in measuring the soil moisture and light intensity absorbed by plant. Measuring tape was used for measuring the height of the plants.

For these studies the Plants of Aloe Vera (*A. barbadensis* Mill), Hedge (*Berberis thunbergii*) and Periwinkle (*Catharanthus roseus*) were taken from garden of Junior college Chinchwad, Pune. Carrot (*Daucus carota*), Spinach (*Spinacia oleracea*) saplings and Tomato (*Solanum lycopersicum*) seeds were purchased from vegetable market of Pune.

Plant Material: Aloe Vera (*A. barbadensis* Mill), Carrot (*Daucus carota*), Hedge (*Berberis thunbergii*), Periwinkle (*Catharanthus roseus*), Spinach (*Spinacia oleracea*) and Tomato (*Solanum lycopersicum*) seeds.

Water: Normal tap water, Chemical waste water of chemistry laboratory.

Soil Sample: Normal soil obtained from the college ground consists of nitrogen, phosphorus, potassium, calcium, magnesium and calcium carbonate. This Soil was mixed with different proportions of liquid and solid chemical and plant waste (1:1 and 1:2 ratio of soil with laboratory waste) which were obtained from chemistry and biology laboratories.

Apparatus and instruments used: Measuring cylinder, beakers, Glass rod, Earthen pots, Trowel, Hoe, three way pH meter, 110 °C laboratory thermometer, Measuring tape.

The physical properties i.e. soil pH, soil temperature, room temperature, plant height, number of leaves, soil colour, were determined by using three way pH meter which helps to determine pH, soil moisture and light intensity absorbed by plants as well as by the soil. Temperature was measured by using 110 °C thermometer and height was measured with the help of measuring tape. The following results were obtained for each plant.

FINDINGS / RESULTS

Figure: 1

Figure: 2

Figure: 3

Figure: 4

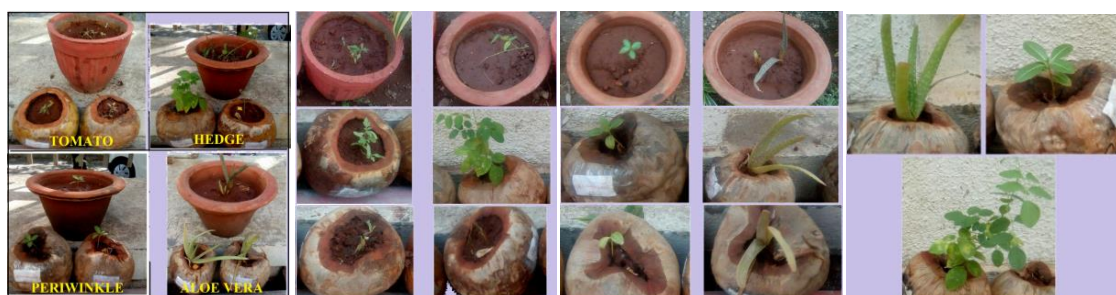
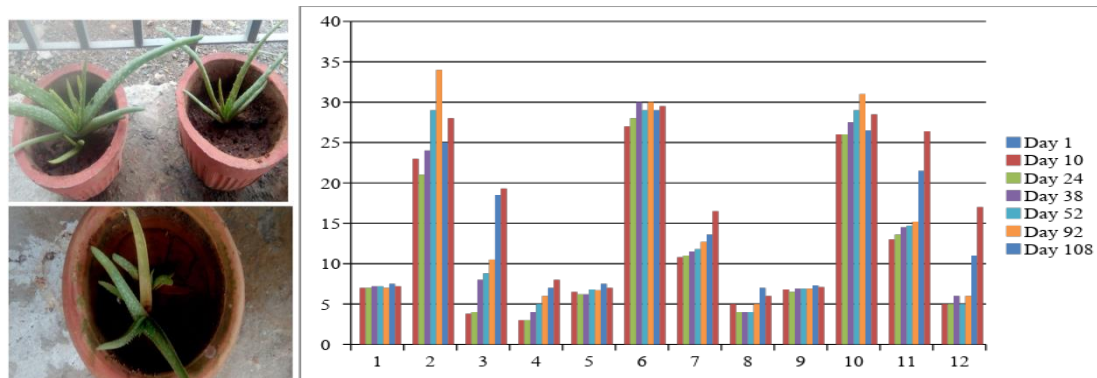


Table 1: Comparative study of soil and plant growth parameters for Aloe vera

Plant Name	Aloe vera in Normal Soil				Aloe vera in Normal Soil with Solid Waste (Fe ²⁺ , Cu ²⁺ , NH ₄ ⁺ , Al ³⁺ , K ⁺ , Na ⁺ , Cl ⁻ , SO ₄ ²⁻ , PO ₄ ³⁻)				Aloe vera in Normal Soil with Liquid Waste (K ⁺ , Na ⁺ , Cu ²⁺ , Zn ²⁺ , MnO ₄ ⁻ , SO ₄ ²⁻ , Cl ⁻ , Br ⁻ , NO ₃ ⁻ , Fe ³⁺)			
No. of Days	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves
Day 1	7	23	3.8	3	6.5	27	10.8	5	6.8	26	13	5
Day 10	7	21	4	3	6.2	28	11	4	6.5	26	13.6	5
Day 24	7.2	24	8	4	6.2	30	11.5	4	6.9	27.5	14.5	6
Day 38	7.2	29	8.8	5	6.8	29	11.8	4	6.9	29	14.7	5
Day 52	7	34	10.5	6	6.7	30	12.7	5	6.9	31	15.2	6
Day 92	7.5	25	18.5	7	7.5	29	13.6	7	7.3	26.5	21.5	11
Day 108	7.2	28	19.3	8	7	29.5	16.5	6	7.1	28.5	26.4	17

Figure: 5**Graph 1: Variation in physical properties of soil and Aloe vera plant****Table 2: Comparative study of soil and plant growth parameters for Hedge**

Plant Name	Hedge in Normal Soil				Hedge in Normal Soil with Solid Waste (Fe ²⁺ , Cu ²⁺ , NH ₄ ⁺ , Al ³⁺ , K ⁺ , Na ⁺ , Cl ⁻ , SO ₄ ²⁻ , PO ₄ ³⁻)				Hedge in Normal Soil with Liquid Waste (K ⁺ , Na ⁺ , Cu ²⁺ , Zn ²⁺ , MnO ₄ ⁻ , SO ₄ ²⁻ , Cl ⁻ , Br ⁻ , NO ₃ ⁻ , Fe ³⁺)			
No. of Days	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp (°C)	Plant Height (cm)	No. of Leaves
Day 1	6.8	23	15.5	10	6.5	25	8.5	15	6.5	24	8.5	24
Day 10	7	21.5	15.5	8	6.9	28.5	8.5	0	6.9	27.2	9.5	29
Day 24	7	23	16	14	5.8	30	8	0	6	27.5	16	42
Day 38	6.9	23	16.7	24	6.8	30.5		Dried	7.1	29	20.2	50
Day 52	7	33	17.6	37	6.9	32			7.1	31	30	73
Day 92	7.2	25.5	26.3	112	6.3	30.5			7.3	29.5	30	Dried

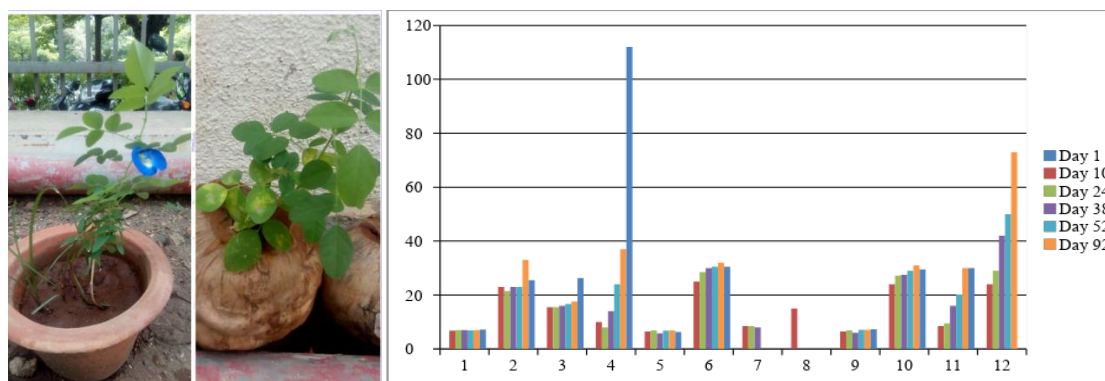
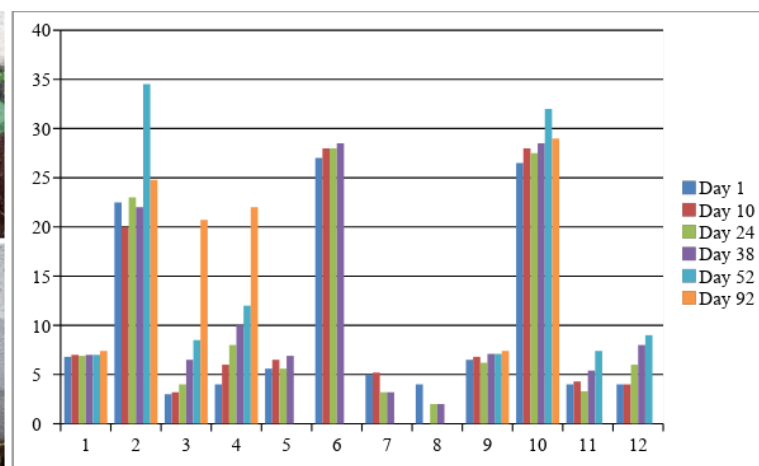
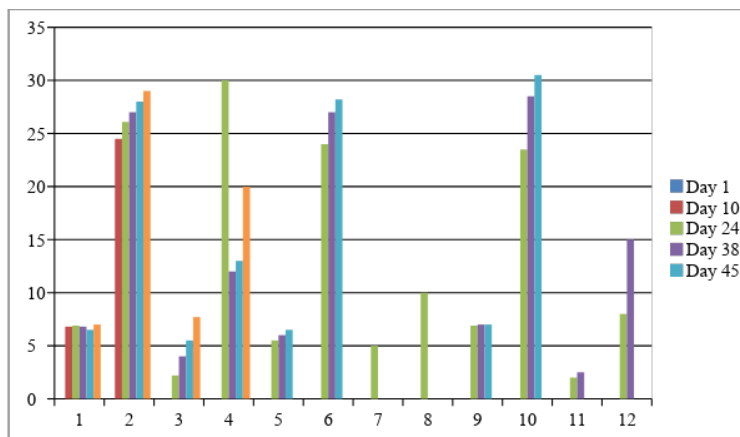
Figure: 6**Graph 2: Variation in physical properties of soil and Hedge plant**

Table 3: Comparative study of soil and plant growth parameters for Periwinkle

Plant Name	Periwinkle in Normal Soil				Periwinkle in Normal Soil with Solid Waste (Fe^{2+} , Cu^{2+} , NH_4^+ , Al^{3+} , K^+ , Na^+ , Cl^- , SO_4^{2-} , PO_4^{3-})				Periwinkle in Normal Soil with Liquid Waste (K^+ , Na^+ , Cu^{2+} , Zn^{2+} , MnO_4^- , SO_4^{2-} , Cl^- , Br^- , NO_3^- , Fe^{3+})			
No. of Days	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves
Day 1	6.8	22.5	3	4	5.6	27	5	4	6.5	26.5	4	4
Day 10	7	20	3.2	6	6.5	28	5.2	0	6.8	28	4.3	4
Day 24	6.9	23	4	8	5.6	28	3.2	2	6.2	27.5	3.3	6
Day 38	7	22	6.5	10	6.9	28.5	3.2	2	7.1	28.5	5.4	8
Day 52	7	34.5	8.5	12				Dried	7.1	32	7.4	9
Day 92	7.4	24.8	20.7	22					7.4	29		Dried

Figure: 7**Graph 3: Variation in physical properties of soil and Periwinkle plant****Table 4: Comparative study of soil and plant growth parameters for Tomato**

Plant Name	Tomato in Normal Soil				Tomato in Normal Soil with Solid Waste (Fe^{2+} , Cu^{2+} , NH_4^+ , Al^{3+} , K^+ , Na^+ , Cl^- , SO_4^{2-} , PO_4^{3-})				Tomato in Normal Soil with Liquid Waste (K^+ , Na^+ , Cu^{2+} , Zn^{2+} , MnO_4^- , SO_4^{2-} , Cl^- , Br^- , NO_3^- , Fe^{3+})			
No. of Days	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves	Soil pH	Soil Temp ($^{\circ}\text{C}$)	Plant Height (cm)	No. of Leaves
Day 1	6.8	24.5	0	0	0	0	0	0	0	0	0	0
Day 10	6.9	26.1	2.2	30	5.5	24	5	10	6.9	23.5	2	8
Day 24	6.8	27	4	12	6	27	5	0	7	28.5	2.5	15
Day 38	6.5	28	5.5	13	6.5	28.2		Dried	7	30.5	2.5	0
Day 45	7	29	7.7	20								Dried

Figure: 8**Graph 4: Variation in physical properties of soil and Tomato plant**

DISCUSSION / ANALYSIS

Differences in growth were recorded for Aloe Vera, Hedge, Periwinkle and Tomato after every 15 days and compared with the data of plants growing in different soil combinations. Normal soil was reddish brown in colour and soil with combination of laboratory waste was found to be brown in colour due to variation in the ions present in it.

Aloe Vera (table 1, graph 1) in normal soil and soil combined with solid waste showed normal growth with light green colour leaves with less thickness in size. Aloe Vera grown in soil combined with liquid waste showed faster growth with longer and thicker leaves with dark green colour along with more number of leaves, which is not seen with normal soil and soil combined with solid waste. From table 1, it's seen that minerals or ions present in solid and liquid waste is almost same except few. But assimilation of nutrients by each plant from soil is different. It is easy to take up nutrients from soil in soluble form than solid form. The main minerals present in Aloe Vera plant is calcium, chromium, copper, iron, magnesium, manganese, potassium, phosphorus, sodium and zinc along with many other. As most of these minerals are present in its ionic form in liquid chemical waste, it helped for faster growth of Aloe Vera plant. In figure 5, the first plant of Aloe Vera is clearly seen with more number of leaves which are thicker in size, which is grown in soil combined with liquid chemical waste.

Hedge (table 2, graph 2) in normal soil showed gradual growth with flowers. In soil combined with liquid waste was showing faster growth as compared to normal soil, but couldn't survive at very high temperature up to 46.5°C in summer season. Plant in soil combined with solid waste died after two weeks due to excessive accumulation of ions around the roots which stopped the movement of ions around the roots, resulted into plant death.

Periwinkle (table 3, graph 3) in normal soil showed normal growth with flowers after 2 months and more number of leaves. Plant with soil combined with liquid waste also showed gradual growth, but later on died due to extensive heat and plant in soil with solid waste was replanted again after two weeks but it didn't survive.

Tomato (table 4, graph 4) needs soil pH 6.0 to 6.8. Sometimes 7.0 pH also works but if it is more than 7.0, growth in tomato plants gets stunted. Only tomato grown in normal soil survived for longer period of time but later on it also died due to excessive heat in summer season.

Excess of anything is harmful; same is applicable for plant growth as well. Excessive heat, high temperature, excessive nutrients reduced plant growth in the above cases. Plant growth was affected by change in temperature which was clearly seen. The results showed differences in plant growth and helped us to know which is the best soil condition and temperature for the proper growth of particular plant. Further chemical and microbial analysis will be done to find out which chemicals and microbes which are responsible for plant growth or in reduction of plant growth.

CONCLUSION

This research will definitely be useful for understanding the plant morphology with respect to different soil combinations. Using Laboratory waste of educational institute will help to reduce the pollution and will help to improve fertility of soil.

LIMITATION AND STUDY FORWARD

More variety of plants can be taken for this research purpose, but with increase in number of plants the number of tests and analysis will increase for each plant. Chemical, microbial or morphological analysis will require more time for extensive study of these plants. Different ratio of soil combinations can be made with solid and liquid waste obtained from laboratories to understand which combination of soil is more effective for plant growth.

CONFLICT OF INTEREST AND ETHICAL STANDARDS

With the permission of the organization/ institute's authority all the above work was done. No unethical practices were followed during the study of these plants and all the data were collected on regular interval of time by using the same instruments.

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ORIGINALITY

No work has been found on utilization of science laboratories chemical waste and biology laboratory waste in combination with soil to understand the morphology of plants. The basic concern of this work is to improve soil fertility with the help of different soil combinations with wastes obtained from laboratories. This study will motivate students and staffs for small scale plantation which will not only enhance the greenery and beauty of the campus, but will also help to reduce aquatic as well as soil pollution. People will get easily available wastes from the laboratories that will be helpful for the plants growth.

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