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Impact of detergents on soil nutrients, morphology, growth and minerals in leaves of *Amaranthus Dubius*

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Abstract
Detergents containing anionic surfactants were used to prepare the irrigation solutions. The irrigation solutions were prepared by dissolving 40% of liquid detergents with 60% of water. Five different detergents used for the study are Surf Excel, Pril, Comfort, Lizol and Vivel. Plant growth studies were carried out using six polyethylene bags filled with soil among which one served as the control. The results of the growth studies revealed that the presence of certain detergents reduced the shoot height, number of leaves and shoot size of the plant. Mineral estimation studies in the leaves of the plant also showed that detergents Lizol and Pril increased the mineral nutrient content in plants. Increased concentration of detergents like Lizol increased pH 7.8, decreased soil Nitrogen content 168Kg/ha, increased Electrical conductivity 0.98mhos/cm, Phosphorus 201Kg/ha, Potassium 152kg/ha and Organic carbon content of the soil 2.53%. Therefore, it can be concluded that detergents with high concentration of salts and surfactants like Lizol and Pril are unhealthy for plant growth and brings about unfavourable changes in the mineral nutrient content of the plant and soil physiochemistry.

Keywords: detergents, soil pollution, minerals, soil nutrients, plant growth

1. Introduction
Detergents are materials which aid in the removal of dirt or other foreign matters from contaminated surfaces. They have the ability to remove dirt from porous surfaces (such as fabrics and clothes) and non-porous surfaces (such as metals and plastics). Because of this, detergents are widely used in both industrial and domestic purposes. They are used to wash clothes, vehicles, equipment, installations and heavy-duty machines. They are also used in dispersing oil spills at sea and in pesticide formulations for agricultural purposes. Many of the detergents are phosphate based. Detergents with phosphate are a sustainable component. Phosphorus (P) is an essential element for all living organisms including plants. In plants, phosphorus plays an essential role in photosynthesis and all energy recovering processes. Phosphates are also one of the main nutrients in almost all agricultural and garden fertilizers, because they are crucial for plant growth. If it increases in the land and enter the river or sea then it causes eutrophication leading to algal bloom and further destruction of the aquatic ecosystem. When these surfactant bearing detergents are absorbed by a plant, these molecules cause cell membranes to disintegrate and membranes to lose their primary functions. Surfactants have been reported to distress a variety of effects in plant activities like photophosphorylation, protoplasmic streaming and mitosis. The present study was carried out to evaluate the effects of different detergents with different concentrations on soil nutrients, morphology, growth and minerals in leaves of *Amaranthus dubius*.

2. Materials and Methods
In the present study, entitled "Impact of Detergents on the soil Nutrients, Morphology and Growth of *Amaranthus dubius*", the effect of different detergents on soil nutrients, mineral content in leaves and growth of *Amaranthus dubius* was investigated.

2.1 The plant material
The plant used for the study was *Amaranthus dubius*. The plant was selected because of their short life cycle and because they are commonly cultivated tropical leafy vegetable. Amaranth leaves is recommended as a good food with medicinal properties for young children, lactating mothers and for patients with fever, anaemia, haemorrhage, constipation or kidney complaints.

2.2 Detergents used for the study
Five different commonly used detergents are selected for the study. The information label of the detergents showed that it contains surfactants, sodium sulphate, sodium carbonate, sodium silicate, sodium aluminosilicate, clay, enzymes, perfume, polycarbonates, optical brighteners and polycarboxylates. 20 ml detergent solution was added to the plants for 3 weeks at a concentration of 40% detergent and 60% water. Different types of liquid detergents used are:

- Surf Excel (Laundry detergent)
- Pril (Dishwash liquid-cleansing agent)
- Comfort (Fabric softner)
- Lizol (Disinfectant-Surface Cleaner)
- Vivel Bodywash

Water without detergent was applied to crops to serve as control.

2.3 Methods

2.3.1 Growth of plant material

15-20 cm lengths of *Amaranthus dubius* plants were planted in six different grow bags filled with soil and bags were numbered from 1 to 6. First bag was served as the control and the remaining bags were treated with detergent solutions. The plants were observed for a time period of 3 weeks. Each day 20 ml of normal water was added to the control and 20 ml of detergent solutions for the plants which were grown in remaining five different grow bags (table 1).

Table 1: Concentrations of different detergents used for the study.

Sl. No	Detergents Used	Concentration of detergents
1 (Control)	Normal water	100%
2	Surf Excel	40%
3	Pril	40%
4	Comfort	40%
5	Lizol	40%
6	Vivel Bodywash	40%

Every week shoot height and number of plant leaves were observed and noted. After 3 weeks had passed, the plant and the soil samples from six bags were taken for analysing the physicochemical properties of soil and the mineral nutrient components of leaves. (Ten different soil parameters were checked to determine the nutrient composition in the soil. Mineral contents in the plants were tested to determine the nutritional value of plant).

2.3.2 Soil quality parameters

Soil testing is an important tool for determining the nutrient needs of plants. The soils from different sample points are characterized by measuring a number of soil properties. On the basis of these data, the soils are compared, and differences in properties are measured. In this study ten different parameters were checked for understanding the physiochemical properties of soil. It include pH (S D Sawarkar (2012) [16], EC (S D Sawarkar (2012) [16], Nitrogen (Bremner (1965) [5], Phosphorus (Bray and Kurtz (1945) [4], Potassium (Ghosh *et al.*, (1983), Organic carbon (S D Sawarkar (2012) [16], Water holding capacity (Viji and Prasanna P Rajesh (2012) [19], Bulk density (Viji and Prasanna P Rajesh (2012) [19], Particle density (Viji and Prasanna P Rajesh (2012) [19] and Porosity (Viji and Prasanna P Rajesh (2012) [19].

2.3.3 Estimation of minerals in leaves of *Amaranthus dubius*

Minerals play a vital role in plant and animal metabolism. Plants need macro and micronutrients, each of which is essential for a plant to complete its life cycle. Adequate provision of nutrients have negative impacts on plant growth and it is of crucial importance in the context of agriculture. Soil act as the source of nutrient elements, and so the availability of nutrients is determined by soil properties. Minerals are taken up from the soil solution by plant roots in ionic form which is mediated by specific transport proteins. In this study seven different nutrients were checked to analyse the nutritional value of the plant after detergent treatment. Estimation of minerals were done by using Nitric-perchloric acid digestion method. Seven different mineral nutrients taken for the study are Calcium (Pinto *et al.*, (2010) [10], Potassium (Sawadogo, B *et al.*, (2014) [15], Iron (Naegele, J. A. (1974) [8], Manganese (Sawadogo, B *et al.*, (2014) [15], Magnesium (Pinto *et al.*, (2010) [10], Phosphorus (Sam Kundu *et al.*,2015) [14] and Zinc (Pinto *et al.*, (2010) [10].

3. Results and Discussions

3.1 Observation of morphological parameters

The effects of different detergent concentrations on shoot height and number of leaves per plant are given below:

Table 2: Shoot height and number of leaves before the addition of detergents.

Sl No	Shoot Height (IN CMS)	Number of Leaves
1	22	15
2	20	10
3	18	10
4	18	8
5	20	10
6	20	9

2-3 weeks old *Amaranthus dubius* plants were planted in six different grow bags filled with soil and bags were numbered from 1 to 6. The shoot height of the plants varied from 18-22 centimeters. The highest number of leaves was observed in sample 1(fifteen) and the least number was observed in sample 4 (eight).

3.2 Effects of different detergents on plant growth

During the 1st week, plant height and number of leaves increased progressively. In comparison to other plant samples control showed the highest growth rate in the number of leaves whereas plant which was subjected to treatment with Vivel showed highest growth rate in terms of shoot height. Rafat Saeed *et al.*, (2015) detected significant increase in growth parameters (root length, shoot length, fresh and dry weights of root, shoot and leaves) with application of soap water solutions over control. Naegele *et al.*, (1974) [8] reported that plants responded differently to pollution effects due to an innate genetic response of the plant system as modified by environmental influences

Table 3: Observation of morphological parameters during 1st week (after the addition of detergents)

Sl No	Different Detergents Added	Shoot Height (In CMS)	Number of Leaves
1	Control	32	45
2	Surf	29	18
3	Pril	28	22
4	Comfort	22	15
5	Lizol	29	24
6	Vivel	35	23

During the 2nd week plant height and number of leaves increased progressively. In comparison to other plant samples control showed the highest growth rate in the number of leaves whereas Vivel showed highest growth rate in terms of shoot height. Plant sample subjected to detergent Pril showed the least growth rate. 16 leaves fell off from the plant and 1 leaf fell off from the plant which was subjected to comfort. Ehilen, O.E *et al.*, (2017) [6] detected significant reduction in shoot height, leaf area, number of leaves per plant and fresh and dry weights of roots and shoots after the addition of laundry detergent solution of 5.0g/l concentration. Pinto *et al.*, (2010) [10] in a study involving silver

beet plants reported that irrigation with high detergent concentrations could have negative effects on plant production and health.

Table 4: Observation of morphological parameters during the 2nd week

SL No	Different Detergents Added	Shoot Height (In CMS)	Number of Leaves
1	Control	53	83
2	Surf	46	36
3	Pril	34	20 (16 leaves fell off)
4	Comfort	44	26 (1 leaf fell off)
5	Lizol	58	58
6	Vivel	65	66

During the 3rd week plant height and number of leaves increased in all plant samples except the sample which was subjected to detergent Pril. In comparison to other plant samples control showed the highest growth rate in the number of leaves whereas plant which was subjected to Vivel showed highest growth rate in terms of shoot height. Five leaves fell off from the plant and a pale red to yellowish colour was observed in the plant sample which was subjected to Pril. Alifyah Y Kagalwala *et al.*, *(*2012) [1] detected significant effect of sodium lauryl sulphate on plants morphology (browning of shoots, fragmentation and leaf shedding), chlorophyll and protein content. Ehilen, O.E *et al.*, (2017) [6] detected significant reduction in shoot height, leaf area, number of leaves per plant and fresh and dry weights of roots and shoots after the addition of laundry detergent solution of 5.0g/l concentration.

Table 5: Observation of morphological parameters during 3rd week.

SL No	Different Detergents Added	Shoot Height (In CMS)	Number of Leaves
1	Control	80	147
2	Surf	57	75
3	Pril	36	37
4	Comfort	57	63
5	Lizol	72	92
6	Vivel	82	95

3.3 Effect of different detergents on soil parameters

The disposal of different detergents into the soil has several adverse effects on their composition. In this study, an attempt was made to find out the effect of different detergents on ten soil parameters. The main soil parameters taken into consideration during the study were pH, EC, Nitrogen, Phosphorus, Potassium, Organic carbon, Water holding capacity, Bulk density, Particle density and Porosity. The results are given in the table below:

Table 6: Observation of Physiochemical Properties of soil samples used for the experiment

Soil parameters/soil samples	pH	EC (mhos/cm)	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Organic Carbon (%)	Water holding capacity (%)	Bulk Density (g/cc)	Particle Density (g/cc)	Porosity (%)
Control soil without any treatment	6.1	0.35	265	112	72	1.62	55.70	1.18	2.98	62.47
Soil with Surf	6.4	0.62	217	137	134	1.58	50.07	1.05	1.97	47.91
Soil with Pril	7.1	0.87	212	174	125	2.09	48.61	1.02	2.29	47.46
Soil with Comfort	6.7	0.84	194	142	152	1.81	49.49	0.98	1.83	56.74
Soil with Lizol	7.8	0.98	168	201	152	2.53	46.86	1.07	3.02	46.79
Soil with Vivel	6.4	0.76	220	166	99	1.41	50.53	0.93	2.18	55.52

3.3.1 Soil pH

The pH range for optimum plant growth varies among crops. Amaranthus grows in every type of soil. Detergents can increase the pH level in the irrigated soil. For the present study soil samples were taken from humid region so that the control showed a pH range of 6.1. The soil sample treated with Lizol showed the highest pH value 7.8 which indicates that that the acidity of the soil decreased and the soil became neutral. Soil sample treated with normal water (control) showed the least pH value (6.1). A study conducted by Ehilen O.E *et al.*, (2017) [6] detected that detergents brought about increase in the pH and salinity of soil and adversely affect the plant growth. Another study conducted by R.M Mohammed *et al.*, (2014) detected changes in the soil characteristics, which included saturated hydraulic conductivity, EC, pH, exchangeable sodium percentage, cation exchange capacity (CEC), and sodium adsorption. The results revealed that the pH of soil increased from 3.85 to 4.42 and 4.09 after irrigation by PLD and LLD grey water respectively.

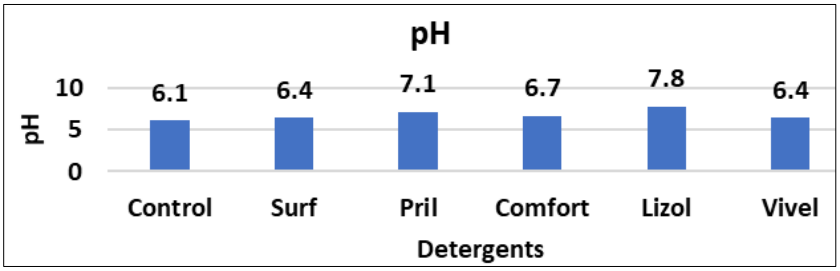

Fig 1: Effect of Different Detergents on Soil pH

3.3.2 Electrical Conductivity

Electrical conductivity is the amount of soluble (salt) ions in soil. Electrical conductivity of the soil increase with the increase in the concentration of detergents or the addition of heavy-duty detergents on to the soil. EC is calculated in mhos/cm. In this study the soil sample treated with Lizol showed the highest Electrical conductivity rate (0.98 mhos/cm) and the control showed the least value (0.35 mhos/cm).A study conducted by

R.M. Mohammed *et al*., (2014) detected changes in the soil characteristics, which included saturated hydraulic conductivity, EC, pH, exchangeable sodium percentage, cation exchange capacity (CEC), and sodium adsorption. The EC of the irrigated soil increased. These findings highlighted the negative effects of laundry grey water discharge on soil properties. Similar studies conducted by Sawadogo *et al*., (2014) [15] and Saeed *et al*., (2015) reported that the detergent solutions brought about increase in the pH value (alkalinity) and electrical conductivity of irrigation solution. This could be explained by the fact that the detergent composed of alkalis and several salts.

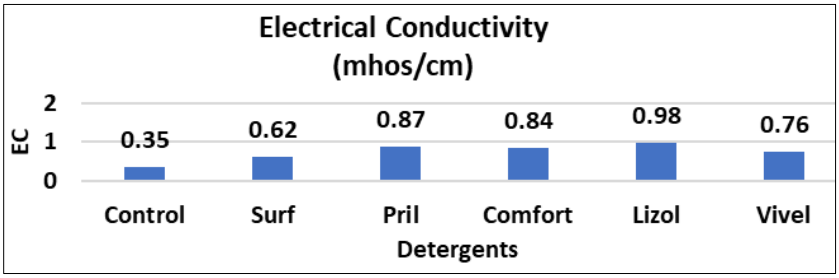

Fig 2: Effect of Different Detergents on Electrical Conductivity of Soil

3.3.3 Soil Nitrogen

Nitrogen is important for plant growth and development. Soil nitrate (NO3) and ammonium (NH4) are two forms of inorganic nitrogen that are readily available for use by plants. They are formed from the mineralization of organic forms of Nitrogen such as soil organic matter, crop residue, and manures. It is calculated in kg/ha. In this study control showed the highest Nitrogen content (265kg/ha) whereas the soil sample treated with Lizol showed the least nitrogen value (168kg/ha). Nitrogen content of the soil decreased when detergents where added to the soil. A study conducted by Sergey Chuchkalov *et al.*, (2019) [17] detected stimulations in the nitrogen content of the soil when heavy duty detergents where added to the soil.

3.3.4 Soil Phosphorus

Phosphorus is an essential plant nutrient. Phosphorus helps in capturing and converting the sun's energy into useful plant compounds. Phosphorus deficiency is very difficult to diagnose. Crops usually display no symptoms of phosphorus deficiency other than a general stunting of the plant during early growth. It is measured in (kg/ha). In this study, the soil sample treated with detergent Lizol showed the highest phosphorus content (201kg/ha) and the control showed the least (112kg/ha). Phosphorus content of the soil increased when detergents where added to the soil. A study conducted by Wybe Kroontje *et al*., (1973) [20] detected stimulations in growth of plant in Davison soil while using heavy duty enzyme detergent. These stimulations were attributed to responses to phosphorus contained in the detergents. Sam Kundu *et al.*, (2015) [14] reported that the main sources of phosphate in environment, is through household sewage water containing detergents and cleaning preparations, agricultural run-off containing fertilizers, as well as, industrial effluents from fertilizer, detergent and soap industries which can cause stimulations in the growth of plants.

3.3.5 Soil Potassium

Potassium is an essential nutrient for plant growth. It is classified as a macronutrient because plants take up large quantities of K during their life cycle. It is the only nutrient which remains in the plant fluids in a soluble state. It is also measured in Kg/ha. In the study, the soil samples treated with detergents Lizol and Comfort showed the highest potassium content (152kg/ha) and the control showed the least (72kg/ha). Potassium content of the soil increased when detergents where added to the soil. A study conducted by Branislav R Javanic *et al*., (2009) [3] detected that increased concentration of washing powder solution increased the soils potassium content. Another study conducted by Sergey Chuchkalov *et al.*, (2019) [17] detected stimulations in the NPK content of the soil when heavy duty detergents where added to the soil.

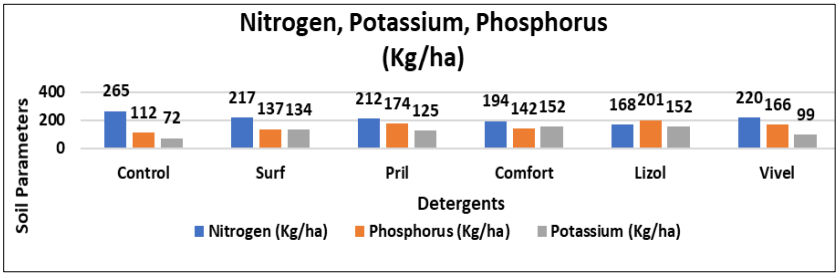

Fig 3: Effect of different detergents on Nitrogen, Phosphorus and Potassium content of soil.

3.3.6 Soil Organic Carbon

Soil organic carbon is concentrated in the topsoil. It is measured in %. In this study, the soil sample treated with detergent Lizol showed the highest organic carbon % (2.53%) and the sample treated with Vivel body wash showed the least % (1.41%). A study conducted by Hassan Heidari *et al*., (2012) [7] detected that the organic carbon content of soil changes with the addition of contaminated water with cloth detergent. Another study

conducted by Wybe Kroontje *et al.*, (1973) [20] detected that increased concentration of detergents caused stimulations in the organic carbon content of soils.

3.3.7 Soil Water holding Capacity

Water holding capacity is the amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased. It is measured in %. In this study the control showed the highest water holding capacity (55.70%) and the sample treated with detergent Lizol showed the least % (46.86%). A study conducted by Ehilen O.E *et al.*, (2017) [6] detected increase in electrical conductivity, water holding capacity, pH and salinity of the soil which adversely affected plant growth. The study showed that high detergent concentration is unhealthy for plant growth and brings about unfavorable changes in soil physiochemistry. Another study conducted by Rafat Saeed *et al.*, (2015) detected that the water holding capacity of the soil decreased with the addition of grey water on the soil.

3.3.8 Soil Porosity

Porosity is the portion of soil volume occupied by pore spaces. It can be calculated by using values for bulk density and particle density. In this study control showed the highest % of porosity (62.47%) and soil sample treated with detergent Lizol showed the least value (46.79%). Study conducted by Wybe Kroontje, *et al.*, (1973) [20] detected that the porosity of the soil decreased when detergent laden water was added to the corn plant. Study conducted by Rafat Saeed *et al.*, (2015) detected that the porosity of the soil decreased with the addition of grey water on the soil.

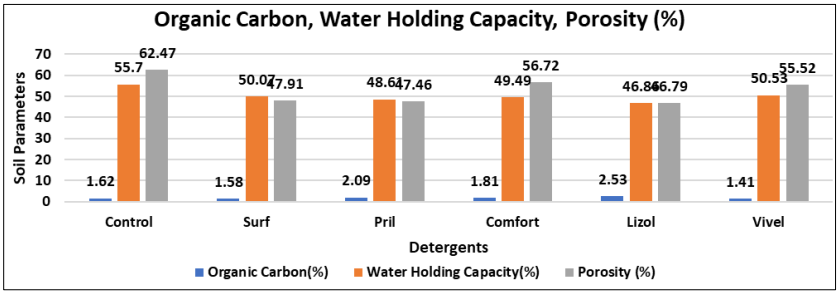

Fig 4: Effect of different detergents on Organic carbon, Water Holding Capacity and Porosity of soil.

3.3.9 Soil Bulk Density

Bulk density (BD) of a soil is the ratio of the mass of dried soil to its bulk volume, which includes the volume of the soil particles and the pore spaces between the particles. Soils with a bulk density higher than 1.6 g/cm3 can restrict root growth. It is calculated in g/cc. In this study the highest bulk density rate was observed in the control (1.18g/cc) whereas the least value was observed in soil sample treated with Vivel body wash (0.93g/cc). A study conducted by Boukary Sawadogo *et al.*, (2014) [15] detected that increased concentration of detergents decreased the soils bulk density. A study conducted by R.M. Mohammed *et al.*, (2014) detected changes in the soil characteristics, which included saturated hydraulic conductivity, EC, pH, exchangeable sodium percentage, cation exchange capacity (CEC), and sodium adsorption on ratio were examined after the irrigation with laundry wastewater.

3.3.10 Soil Particle Density

Particle density of mineral soils commonly ranges from 1.1 to 3.5 g/cm3 in surface horizons. It is calculated in g/cc. In this study the soil sample treated with detergent Lizol (3.02g/cc) showed the highest rate of particle density whereas soil sample treated with Comfort showed the least value (1.83g/cc). Study conducted by Rafat Saeed *et al.*, (2015) detected that the particle density of the soil decreased with the addition of grey water on the soil. Another study conducted by P.O Fatoba *et al.*, (2011) detected that the particle density of the soil increased with the addition of high concentration of detergents on to the soil.

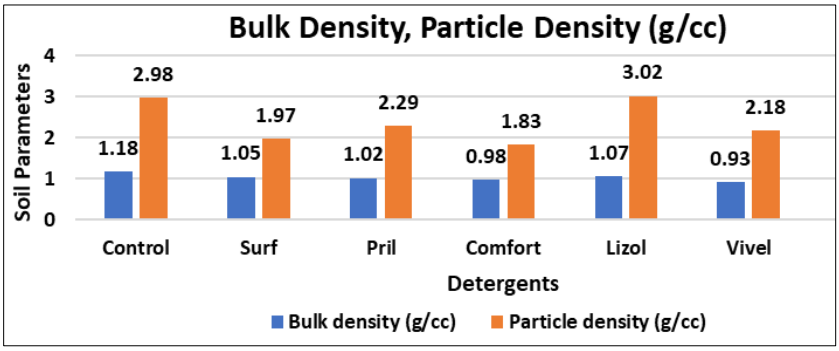

Fig 5: Effect of Different Detergents on Bulk Density and Particle Density of soil.

3.4 Estimation of minerals in leaves

Minerals play a vital role in plant and animal metabolism. Plants require macro and micronutrients, which is essential for a plant to complete its life cycle. Minerals are taken up from the soil solution by plant roots in ionic form which is mediated by specific transport proteins. In this study seven different nutrients were

checked to analyse the nutritional value of the plant after detergent treatment. Estimation of minerals was done by using Nitric-perchloric acid digestion method. Seven different mineral nutrients taken for the study are Calcium, Potassium, Iron, Manganese, Magnesium, Phosphorus and Zinc. The results are given in the table below:

Table 7: Estimation of mineral content of leaves.

Plant Materials	Calcium (mg/100g)	Potassium (mg/100g)	Iron (mg/100g)	Manganese (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)	Zinc (mg/100g)
Control	198	538	1.64	0.73	3	42	0.84
Surf	199	517	1.63	0.74	52	43	0.70
Pril	201	523	1.65	0.75	56	45	0.61
Comfort	199	519	1.63	0.74	55	42	0.67
Lizol	201	526	1.65	0.78	56	46	0.53
Vivel	198	512	1.62	0.73	52	44	0.72

3.4.1 Estimation of Calcium

Calcium is considered a secondary plant nutrient. Calcium is an essential macronutrient in plants. It is calculated in (mg/100g). In this study, the plant samples treated with detergents Lizol and Pril showed the highest calcium content (201mg/g). Leaves of plant samples which was served as the control and which was treated with Vivel showed the least Ca content (198mg/g). At higher EC levels the uptake of Ca is increased. Excess of Ca in plants can reduce a plants uptake of other nutrients such as P, K, Mg, Zn etc. It can also lead to increase in pH making the soil alkaline which affect the absorption of macronutrients. A study conducted by Pinto *et al.*, (2010) [10] detected an increase in soil pH and EC after grey water application.

3.4.2 Estimation of Potassium

Potassium is an essential plant nutrient which is required in large amounts for proper growth and reproduction of plants. Potassium is considered as the "quality nutrient". Plants absorb potassium in its ionic form, K+. It is calculated in (mg/100g). In this study, leaves of plant sample which was served as the control showed the highest Potassium content(538mg/g) and the sample which was treated with Vivel showed the least Potassium content(512mg/g). As EC of the soil decreases, the K content of the plant increases. Anwar *et al.*, (2011) studied the effects of reused laundry greywater on local soil in Toowoomba where the EC results of soil after irrigation with tap water and laundry greywater were higher, which indicate that the presence of detergents in the water is associated with the increase of soil EC.

3.4.3 Estimation of Iron

Iron (Fe) is classified as a micronutrient because it is required by plants in lesser amounts than primary or secondary macronutrients. It is calculated in (mg/100g). In this study, the plant samples treated with detergents Lizol and Pril showed the highest Iron content (1.65mg/g). Sample treated with Vivel showed the least Fe content (1.62mg/g). Excess Fe content can lead to toxicity that results in the lowering of the pH level. It also leads to leaf discolouration, bronzing and stripping of leaves. High concentration (5.0g/l) of detergent solution significantly reduced leaf area, chlorophyll content, fresh and dry biomass of roots and stems and total plant biomass. The reduction in the chlorophyll contents of the leaves at high detergent concentration might have been due to inhibitory effects of toxicants on chlorophyll synthesis in exposed plants (Singh *et al.*, 2013). Another study conducted by Naegele J.A *et al.*, (1974) [8] also detected higher concentration of detergent lead to reduction of chlorophyll content in leaves.

3.4.4 Estimation of Manganese

Manganese (Mn) is an important plant micronutrient that is required by plants in the second greatest quantity compared to Iron. It is calculated in (mg/100g). In this study, the plant sample treated with detergent Lizol showed the highest Mn content(0.78mg/g). Samples that was served as Control and which was treated with Vivel showed the least Mn content(0.73mg/g). Excess of Mn in plants can lead to necrosis, chlorosis and spotting in plants. A study conducted by Naegele J.A *et al.*, (1974) [8] also detected that higher concentration of detergent lead to reduction of chlorophyll content in leaves. Sawadogo *et al.*, (2014) [15] reported similar observations in lettuce and okra plants.

3.4.5 Estimation of Magnesium

Magnesium is a macronutrient that is necessary for both plant growth and health. It is calculated in (mg/100g). In this study, samples treated with Lizol and Pril showed the highest Mg content (56mg/g) and samples treated with detergents Surf and Vivel showed the least Mg content (52mg/g). The concentration of Mg is higher at lower EC levels. Excess amount of Mg can lead to stunted growth, dark coloured vegetation and presence of excess salts in plants. Study conducted by Naegele J.A *et al.*, (1974) [8] detected that higher concentration of detergent lead to stunted growth in plants.

3.4.6 Estimation of Phosphorus

Phosphorus has a major role in capturing and converting the sun's energy into useful plant compounds. It is calculated in (mg/100g). In this study plant sample treated with detergent Lizol showed the highest P content (46mg/g) and the samples that was served as the control and which was treated with Comfort showed the least value (42mg/g). The uptake of P is increased at higher EC levels. Excess amount of P in plants can lead to yellowing of leaves and poor health of plants. High concentration (5.0g/l) of detergent solution significantly reduced leaf area, chlorophyll content, fresh and dry biomass of roots and stems and total plant biomass. Sawadogo *et al.*, (2014) [15] reported similar observations in lettuce and okra plants.

3.4.7 Estimation of Zinc

Zinc (Zn) is one of the essential micronutrients. It is needed by plants in small amounts, but it is crucial in plant development. It

is calculated in (mg/100g). In this study, plant sample that was served as the control showed the highest Zn content (0.84mg/g) and the sample that was treated with detergent Lizol showed the least value (0.53mg/g). Study conducted by Heidari *et al.*, (2013) [7] and Sawadogo *et al.*, (2014) [15] detected that deficiency of zinc in plants can lead to chlorosis, stunted growth and even death of plants.

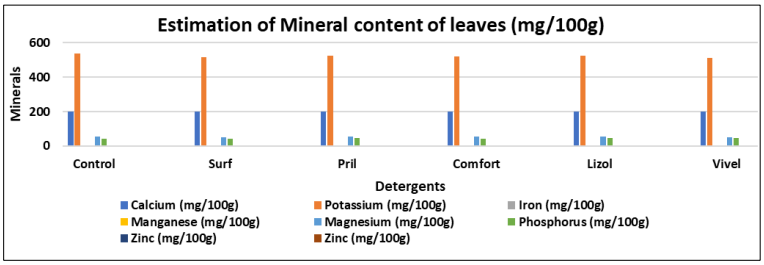

Fig 6: Estimation of Mineral content of leaves.

4. Summary and Conclusion

A detergent is a surfactant or a mixture of surfactants having cleansing properties in dilute solutions. The principal applications of detergents are dishwashing and laundering of clothing. Detergents also are used as emulsifiers for many applications. The aim of the present study was to evaluate the impact of detergent on the soil nutrients, morphology and the growth of *Amaranthus dubius* plant. The results of the growth studies revealed that the presence of certain detergents reduced the shoot height of plant, number of leaves and shoot size. The study showed that certain detergents are unhealthy for plants and also inappropriate for soil as it alters the physical and chemical properties of the soil. Mineral estimation studies in the leaves of the plant also showed that detergents Lizol and Pril increased the content of mineral nutrient in plants. Excess amount of mineral in plants leads to deteriorative growth of plant. The results obtained from the present study revealed that increased concentration of salts and surfactants in detergents like Lizol increased the pH, EC, P, K, Organic carbon content of the soil and also brought about phytotoxicity necessitated by changes in the properties of soil. As EC of the soil decreases the mineral nutrient content of the plant (K, Mg) increases. At higher EC levels the uptake of Ca and P was increased. After 3 weeks of detergent treatment it was observed that the plant treated with detergent Pril died off. The soil treated with this detergent showed high concentration of Potassium, Phosphorus and EC content. The soil sample that served as the control had the Nitrogen content, water holding capacity bulk density and porosity. High amount of Potassium which is necessary for proper root function and growth of the plant was found in the soil sample which was treated with Vivel. Therefore, the results obtained from the present study showed that certain detergents which contain high concentration of salts and surfactants like Lizol reduced the plant growth, altered the mineral nutrient content in the plant and also the physicochemical properties of soil.

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