

# PHYSICOCHEMICAL ANALYSIS OF KYLLINGA NEMORALIS ROOT ZONE SOIL

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## Abstract

Soil is the site of most biochemical reactions and interactions affecting the plant growth. It serves as a medium for the diffusion of substances released by plants. Sometimes the release of chemicals keeps other plants away from growing too close to them. The bioactivities of the allelochemicals are controlled by soil properties (pH, solute concentration, cation exchange capacity, fertility) and also by cultural practices such as tillage and crop rotations. The importance of micronutrients is to be viewed in connection with the allelopathic nature of a plant, since the plant produced allelochemicals get exuded and bound to the soil particles thus may change the composition of the micronutrient content in the soil. In view of this fact, study intended to analyze the physicochemical characters of the plants root zone soil (KNRZS) and compare it with normal soil (NS) devoid of the *K. nemoralis*. Along with this, a decomposed soil (DS) profiling was also done to detect whether the decayed organic matter from the *K. nemoralis* would change the normal physico- chemical properties of the normal soil. The soil profile appears to be different for NS, DS and KNRZS and is likely have a deterministic effect on the growth of other plants. The study clearly shows that *Kyllinga nemoralis* (KNRZS, DS) adds mineral nutrients to the soil. Although plant roots are usually responsible for obtaining mineral nutrients from the soil, microorganisms can also affect the efficiency of nutrient absorption. Most land plants have microbes colonizing their roots, which can change how the plants get nutrition. As a result, the soil becomes the site of intricate interactions between microorganisms and the soil's allelochemicals, which may aid in the development of the soil microflora's capacity to either stimulate or impede the growth of other plants.

**Keywords:** Interactions, *Kyllinga nemoralis*, Profiling

## Introduction

The principles of allelopathy can be effectively exploited to improve soil fertility. There are many instances wherein green manuring of soil is done to improve nitrogen use efficiency by plants; incorporation of neem for reducing nitrification rate (Lalljee and Facknath, 2000). Soil fertility evaluation of an area or region is an important aspect in the context of sustainable agricultural production.

Soil physico-chemical properties influence the behavior of soil and hence, knowledge of soil property is important (Sumithra *et al.*, 2013). Soil testing is the only way to determine the available nutrient status in soil and the only way we can develop specific fertilizer recommendations. Soil properties that are sensitive to change can be used as indicators to improve soil quality and cropping pattern.

Plants require 16 essential elements for growth. Carbon, hydrogen, and oxygen are derived from the atmosphere and soil water. The remaining 13 essential elements (nitrogen, phosphorus,

potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by organic or inorganic fertilizers. The macro nutrients govern the fertility of the soils and have a positive control on the yield of crops (Singh and Mishra, 2012). Major nutrients needed for the growth of a crop are Nitrogen (N), Phosphorus (P) and Potassium (K) (Cooke, 1972).

Green revolution has increased the demands of micronutrients by the high yielding varieties (especially rice and wheat) as well the adoption of various intensive cropping practices. The availability of micro nutrients is adversely affected by the use of fertilizers with low micronutrient level; decreased organic matter use and growing of crops in soil with low micronutrient content. Several anthropogenic factors also adversely affect phyto-availability of micronutrients (Takkur and Shukla, 2015). In this situation, there is the need for sustainable agricultural practices.

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The soil nutrient content influences the allelopathic properties of plants as has been evinced by many previous studies. The released allelochemicals are transformed to breakdown products which may or may not have the toxic nature. The transformation of ageratochromene, a type of terpene allelochemical, is controlled by soil nutrient content (Chuihua *et al.*, 2002). This allelochemical initially aggregates into a dimer and then decomposes into small molecules, which can be inactivated by high levels of soil nutrients.

The nutrients play an important role in agriculture. The importance of micronutrients is to be viewed in connection with the allelopathic nature of a plant, since the plant produced allelochemicals get exuded and bound to the soil particles thus may change the composition of the micronutrient content in the soil. In view of this fact, the present study intended to analyze the physicochemical characters of the plants root zone soil (KNRZS) and compare it with normal soil (NS) devoid of the *K. nemoralis*. Along with this, a decomposed soil (DS) profiling was also done to detect whether the decayed organic matter from the *K. nemoralis* would change the normal physico- chemical properties of the normal soil.

### Materials and Methods

Three soil samples were analyzed to identify their nutrient content. The physico-chemical characteristics of (i) root zone soil of the plant, *K. nemoralis* (KNRZS), (ii) the normal soil (NS) - devoid of the plant *K. nemoralis* and also (iii) the soil with decomposed plant, *K. nemoralis* matter (DS). The soil samples were collected following the method of classical Cone and Quarter technique (Carver, 1981). All the three soil samples [KNRZS, NS and DS] were collected from random sites.

### Collection of materials (soil samples, KNRZS, NS)

Both root zone and normal soil (KNRZS, NS) were collected from 10 locations each from within the same field located at Department of Botany, University of Kerala and mixed well for confirming the uniformity of individual samples. This is the most common design of sampling (Lohr, 1999). Soil samples were

collected from the field in which *Kyllinga nemoralis* were grown. Plants were uprooted along with the surrounding root zone soil. The collected root zone soil was transferred to plastic bags through gentle shaking of the plant roots. The plastic bags were brought to the laboratory for further processing. Normal soil (NS) samples were collected from the bare field where no *Kyllinga nemoralis* plants were seen. The soil samples were sieved (1mm mesh size) the remaining root residues were discarded from the soil and immediately processed for further analysis. The soil samples were collected during dry season and rainy season (August and February).

### Collection of decomposed soil (DS)

About 500 gm freshly collected *Kyllinga nemoralis* plants were chopped and mixed with 1kg soil (normal soil which is already profiled using standard Physico-chemical analysis) allowed to decompose for 120 days (Zhang *et al.*, 2015) and kept for decaying under controlled conditions up to three months. Later the soil samples were sieved to remove debris and prepared for the analysis.

### Methods

Standard procedures used by the Department of Soil Survey and Soil Conservation, Government of Kerala were used for analyzing different physical and chemical parameters of soil samples. The Physico chemical parameters were tested in two seasons accordingly for KNRZS and NS (August and February; Rainy and Dry season). Physico chemical properties were studied using the standard methods (methods followed by Department of Soil Survey and Soil Conservation Kerala Page *et al* (1982).

### Soil pH

Potentiometric analysis was used for a 1:2.5 soil water suspension using a pH meter.

**Electrical conductivity (EC):** (Minhas and Sharma,1986).

### Organic carbon (OC)

The organic matter present in the soil was

digested with excess of potassium dichromate and sulphuric acid and the residual unutilized dichromate was then titrated with ferrous ammonium sulphate.

Organic carbon was determined by the Walkley - Black chromic acid wet oxidation method. The organic carbon was oxidized by dichromate-sulphuric acid and the amount of dichromate remaining was determined by titration against a standard ferrous solution with ferroin as indicator.

### Water holding capacity and Bulk Density

Keen Rascowzkii method was employed and Bulk Density is expressed in g/cc.

### Cation exchange capacity

A weighed sub sample was leached with neutral normal ammonium acetate, the leachate being retained for determination of exchangeable bases. The ammonium saturated soil was washed with Ethanol to remove soluble ammonium. The ammonium absorbed on the soil exchange complex was released by distillation with alkali and absorbed in boric acid and titrated against standard acid.

### Exchangeable bases

Exchangeable cations are the base cations of

calcium, magnesium, potassium and sodium. The ammonium acetate leachate obtained during the determination of cation exchange capacity of soils was made up to volume and used for determination of exchangeable bases through atomic absorption spectrophotometry.

### Heavy metals

The heavy metals were extracted with DTPA. (Diethylene Triamine Penta Acetic acid). The extracted Pb, Cd, and Cr were determined using atomic absorption spectrophotometry.

### Available micronutrients

The available micronutrients were extracted with DTPA (Diethylene Triamine Penta Acetic acid). The extracted Cu, Fe, Mn, Zn were determined using atomic absorption spectrophotometry.

### Available boron (Bercher and Truog, 1939).

The boron in the extract was determined colorimetrically at 540 nm using Curcumine method.

### Available potassium (Black, 1965).

**Available phosphorus** (Bray and Kurtz., 1945; Olsen *et al.*, 1956).

**Available sulphur** (Williams and Steinberg, 1959).

Table .1 List of methods of soil physicochemical parameters analysed

Sl No	Name	Parameters	Method
1	Physical properties	pH Electrical conductivity (EC) Organic carbon content OC(%) Water holding capacity(WHC) Porosity (%) Bulk density(BD(g/cc)) Particle density (g/cc) Cation exchange capacity (CEC)	Potentiometry in a 1:2.5 soil : water suspension using pH meter Using Conductivity meter in a 1:2.5 soil water suspension Digested with excess of potassium dichromate residue then titrated with ferrous ammonium sulphate Using Keen Raczkowskii box Using Keen Raczkowskii box Using Keen Raczkowskii box Pycnometer method
2	Available primary nutrients	K(Potassium) P (Phosphorus)	Flame photometry using 1 N ammonium acetate as extractant Bray and Kurtz method using spectrophotometer
3	Available secondary nutrients	Ca (Calcium) Mg (Magnesium)	Flame photometry using 1 N ammonium acetate as extractant Using Atomic Absorption Spectrophotometer with 1 N ammonium acetate as extractant
4	Micronutrients	Na (sodium) S (Sulphur) Boron Iron, Manganese, Zinc, Copper	Using a Jenway PFP7 Flame Photometer Using spectrophotometer with Sodium Acetate Buffer as extractant Using spectrophotometer with Azomethine-H Using Atomic Absorption Spectrophotometer with 0.1NHydrochloric acid as extractant
5	Heavy metals	Lead,Chromium, and Cadmium	Using Atomic Absorption Spectrophotometer with 0.1NHydrochloric acid as extractant
6	Texture	Texture	Particle size analysis (PSA)

**Results**

The physicochemical characters of the root zone soil of the plant *K. nemoralis* (KNRZS), normal soil which is devoid of *K. nemoralis* plant (NS) and plant decomposed soil (DS) were analyzed using standard methods and the results are as follows.

**Table .2** Soil physical parameters analysed

Parameters	August		February	
	KNRZS	NS	KNRZS	NS
Porosity %	45.71	41.47	33.49	44.99
Water holding capacity(WHC)%	52.65	66.61	40.15	45.99
Bulk density(g/cc)	0.91	0.69	1.29	1.1
Particle density	1.4	1.04	1.97	1.8

**Table .3** Soil chemical parameters analysed

Characters	August		February	
	KNRZS	NS	KNRZS	NS
pH	5.9	6	6.4	6.41
EC(ds/m)	0.1	0.06	0.37	0.21
OC%	1.04	0.25	2.03	2.03

**Table .4** Amount of phosphorus (P) and potassium (K)

Sample name	P- Kg/ha		K -Kg/ha	
	August	February	August	February
KNRZS	126.56	41.98	107.86	179.87
NS	48.16	36.89	76.16	166.54

**Table .5** Available soil micro elements analysed

Micro elements (ppm)	August		February	
	KNRZS	NS	KNRZS	NS
B	0.62	0.59	1.45	2.40
S	9.60	5.50	13.54	16.22
Fe	102.54	91.52	92	50.00
Mn	9.21	9.66	9.12	9.15
Zn	6.36	4.43	18.00	21.00
Cu	3.27	2.94	4.00	1.50

Notes: Boron, S-sulphur, Fe-Iron, Mn-Manganese, Zn-Zinc, Cu-Copper

**Table .6** Soil heavy metals analysed

Heavy Metals(ppm)	August		February	
	KNRZS	NS	KNRZS	NS
Cd	0.49	0.32	0.12	Below detectable limit
Cr	3.62	2.22	0.17	Below detectable limit
Pb	6.78	5.7	3.13	3.82

Notes: Cd-Cadmium, Cr-Chromium, Pb-Lead

**Table .7** Available macro nutrients in soil (In ppm)

Macro elements	August		February	
	KNRZS	NS	KNRZS	NS
Ca	42.68	108.23	67.71	81.12
Mg	0.66	0.96	0.36	0.6
Na	0.39	0.32	6.02	5.10
K	3.76	3.56	4.5	4.1

Notes: Ca-Calcium, Mg-Magnesium, Na-Sodium, K-Potassium, S-Sulphur

All the soil samples showed high values for iron content is noted (102.54ppm). Except most of the soil parameters. The phosphorus lead, heavy metals were below detectable limit and potassium levels in the soil samples were in normal soil when compared to the found to be high during the study. A high value *Kyllinga nemoralis* root zone soil.

**Comparison of decomposed soil with Normal soil and *Kyllinga nemoralis* root Zone Soil** soil containing decomposed matter of the plant (DS), Normal soil (NS) and *Kyllinga nemoralis* root Zone Soil (KNRZS) were the samples. To identify the changes in the soil composition 23 parameters were analysed. The

**Table .8** Comparison of Normal Soil with *K .nemoralis* Decomposed Soil and Root Zone Soil

Sl No:	Parameters	NS (average of two readings)	DS	KNRZS(average of two seasons)
1	pH	6.205	6.72	6.15
2	Organic Carbon %	1.14	1.28	1.535
3	Electrical conductivity	1.357	0.44	0.235
4	Porosity %	43.23	45.61	39.6
5	Water Holding Capacity %	56.3	44.65	46.4
6	Bulk Density (g/cc)	0.895	1.23	1.1
7	Particle Density (g/cc)	1.42	2.15	1.685
8	Phosphorus (Kg/ha)	42.525	73.41	84.27
9	Potassium (Kg/ha)	121.35	1912.96	143.685
10	Boron (ppm)	1.495	1.85	1.035
11	Sulphur (ppm)	10.86	35.33	11.57
12	Iron (ppm)	70.76	47	97.27
13	Manganese (ppm)	50.58	24.8	50.205
14	Zinc (ppm)	12.715	15	12.18
15	Copper (ppm)	2.22	1.6	3.635
16	Calcium (Mol/Kg)	94.675	176.67	55.105
17	Magnesium (Mol/Kg)	0.78	0.46	0.51
18	Sodium (Mol/Kg)	0.4	0.51	0.42
19	Potassium (Mol/Kg)	3.83	4.9	14.3
20	Cadmium (ppm)	0.16	0	0.305
21	Chromium (ppm)	1.11	0	1.895
22	Lead (ppm)	4.545	3.82	4.955
23	Cation Exchange Capacity (Cmol/Kg)	0.75	0.5	0.65

**Note:** There is a definite shift in the soil parameter values tested and accordingly the growth of other plants would be affected in all the three soil samples (NS, DS and KNRZS).

Further the presence of macro and micro was provided by the Department of soil survey elements analysed were compared with the and conservation, Kerala). The results are as adequate level to be present in the soil (data follows.

**Table .9** Comparison of the desirable amount of soil nutrients and observed values

Sl no:	Elements	Adequate level in soil	NS	KNRZS	DS
1	B	> 0.5 ppm	2.40	1.035	1.85
2	S	5-10 ppm	16.62	35.33	11.57
3	Ca	>300 ppm	81.12	55.195	176.67
4	Fe	> 5ppm	50.00	47.00	97.27
5	Mn	>1ppm	91.50	24.80	50.205
6	Zn	>1ppm	21.00	15.00	12.18
7	Cu	>1ppm	1.50	1.60	3.635
8	Mg	>120ppm	0.78	0.51	0.46

(Courtesy: Department of Soil Survey and Soil Conservation Kerala)

Note: It appears that the macro-elements like Ca and Mg are well below sufficient quantities and should be verified, while the microelements are present in adequate amounts.

## Discussion

Mineral nutrients occur in the soil in both dissolved and bound form. Only a small fraction (less than 0.2%) of the mineral nutrient supply is dissolved in soil water. Among this, 98% is either bound in organic detritus, humus and relatively insoluble inorganic compounds. These constitute a nutrient reserve, which becomes available very slowly as a result of weathering and mineralization of humus. The remaining 2% is adsorbed on soil colloids. Adsorptive binding of nutrient ions offers a number of advantages. Nutrients liberated by weathering and the decomposition of humus are captured and protected from leaching. The concentration of the soil solution is kept low and relatively constant; so that the plant roots and soil organisms are not exposed to extreme osmotic conditions; when required by the plant, however, the adsorbed nutrients are readily available. The soil solution, the soil colloids and the reserves of mineral substances in the soil are in a state of dynamic equilibrium, which ensures continued replenishment of supplies of nutrient elements. When the

decomposed and normal soils were subjected to physicochemical profiling, it was observed that the potassium content is high in the *K. nemoralis* decomposed soil. Soils can be categorized on the basis of organic matter as mineral and organic soils. Mineral soil forms the world's most cultivated land and also contains up to 30% of organic matters. Soil organic matter consists of micro-organisms (10-40%) and resistant or stable organic matter also referred as 'humus' in relatively good quantity (40-60%). Most soil organic matter originates from plant tissue. Plant residues consist of 60-90% moisture. The remaining dry matter consists of Carbon (C), Oxygen, Hydrogen (H) and small amounts of Sulphur (S), Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (C) and magnesium (Mg) (Bot and Benites, 2005).

Decomposition is a biological process that includes the physical breakdown and biochemical transformation of complex organic molecules of dead material into simpler organic and inorganic molecules (Juma, 1998). The

continual addition of decaying plant residues to the soil surface contributes to the biological activity and the carbon cycling process in the soil. Carbon cycling is the continuous transformation of organic and inorganic carbon compounds by the plants and micro-organisms between the soil, plants and the atmosphere. Two types of soil organic matter can be found above ground and below ground, first one consists of plant and animal residues and second contains living soil fauna and microflora partially decomposed materials. The physical functions of organic matter includes soil structural stability, water retention, changes in the temperature and chemical functions includes nutrient holding, immobilization of heavy metals and pesticides. Soil organic carbon is a soil fertility indicator. It describes that the soil properties determines the soil health.

*Kyllinga nemoralis* root zone soil and normal soil were analysed for pH value and showed slight acidic nature. KNRZ sample pH was observed to be comparable during August and February (rainy season and dry season) (5.90 and 6.40), NS (6 and 6.41) and slightly higher for DS (6.7). The optimum pH range of plants is in between 5.5 and 7.5. However, the desirable range may vary among crops. The availability of plant nutrients such as nitrogen, phosphorus, and potassium are affected by soil pH, also micro-organisms living in and around the soil are affected by the pH variations. Seed germination can be affected by large number of factors, temperature being the most important (Probert, 2000). Seasonal variation may be caused by the different factors such as rain and weathering pattern of soil. Soil acidification is caused by many factors such as high rainfall, crop growth, and the use of fertilizers, acid rain and oxidative weathering. The pH of acidic soil can be increased using agricultural lime (lime stone), the amount to be supplemented depends on the buffering capacity of the soil and is directly linked to the amount of clay and organic matter present.

Electrical conductivity is a measure of the current carrying capacity which gives a clear idea about soluble salts present in the soil. It is expressed in deci Siemens per meter (dS/m).

Analysed soil samples were detected as sandy clay. Since sands have low conductivity and clays have high conductivity, soil electrical conductivity correlates very strongly with particle size and soil texture. Detected values showed slight difference during two seasons. In the February (dry season) the value for EC was higher than August (rainy season) for both KNRZ and NS. The electrical conductivity of DS was 0.44ds/m.

The 'Carbon' released is in both organic and inorganic (e.g.,  $\text{HCO}_3$ ) forms, however, the organic forms are the most varied and can have greatest influence on the chemical, physical and biological processes in the rhizosphere (Jones *et al.*, 2009). The composition and amount of the released compounds is influenced by many factors including plant type, climactic conditions, insect herbivory, nutrient deficiency or toxicity, and the chemical, physical and biological properties of the surrounding soil.

The organic carbon present in the soil means the measurable component of soil organic matter (OC). The soil samples analysed were found to have low OC%. The OC% of normal soil during August (rainy season) 0.25% for KNRZS it is 1.04% and same amount of OC% during February (dry season) for both samples (2.03%). Organic carbon content of DS is 1.28. OC is 2-10% of soil mass and plays an important role in the physical, chemical and biological functions of soil. Organic carbon contributes to the nutrient retention and turnover, soil structure carbon sequestration, pollutant degradation *etc.* OC consists of carbon, hydrogen and oxygen in addition to the other elements such as nitrogen, sodium, potassium, calcium and magnesium. Soil type, climate and rain fall influences the organic matter content. Soil having clay content retains more organic matters than sandy soil.

Knowing the number, size, configuration and distribution of soil pores is useful for assessing the physical condition and structure of the soil (Carter and Ball, 1993). Porosity percentage defines the quality of soil for good agricultural

practices. The porosity % of soil samples was almost equal in August (rainy season) (KNRZS is 45.71% and NS is 41.47%) and during February (dry season) (KNRZS is 33.49% and NS is 44.99%). Porosity of the DS was 45.61%. The texture and arrangement of solid soil particles determines porosity. Bulk density values generally reflect soil porosity. If the bulk density  $D_b$  is high, porosity % will be low. The availability of water to plants, water infiltration, storage capacity aeration status *etc.* depends on the percentage of porosity (Cary and Hayden, 1973).

The particle density ( $D_p$ ) of soil is the average density of all the particles that comprise the soil. It depends upon the minerals and composition. The density of minerals commonly found in soils varies from 2.6 to 2.75 g cm<sup>-3</sup>. Particle density of soil samples is almost equal in all seasons and ranges from 1.40 to 1.97. Particle density of decomposed soil sample is found to be 2.15g/cc. Any management practice that increases organic matter will increase the granular structure of soil, increase pore space and decrease the bulk density (Shaver *et al.*, 2003).

The dynamic soil property is represented by  $D_b$ . Bulk densities of the entire soil samples were almost equal during the study.  $D_b$  differs from  $D_p$  in that a measure of bulk density includes all pore space. It is strongly influenced by the quantity and size of the pore spaces as well as the composition of the solid materials. Sandy soils have relatively low total pore space and are often low in organic content and possess higher  $D_b$  values (Hao *et al.*, 2019).

Water holding capacity (WHC) simply defines the soil's water holding capacity. Bulk density of soil samples during August (rainy season) (KNRZS-0.91 and NS was 0.69 g/cc) and February (dry season) (KNRZS is 1.29 and NS 1.1 g/cc) was relatively similar but for decomposed soil the value was relatively very high (44.65 g/cc). Field capacity is the point where the soil water holding capacity has reached its maximum. Soil texture and organic matter content are the key factors that determine the soil water holding capacity. The WHC of saturated soil is generally 400-600mm

of water per metre of soil depth but this depends very much on the clay content or soil texture. A plant cannot use the available water from the soil.

When a plant is able to increase the bioavailable levels of a particular element and tolerate the levels better than its neighbors, it can produce an allelopathic effect. Elemental allelopathy has been implicated as the cause for the success of a number of invasive weeds, including *Acroptilon repens*, *Tamarix spp.*, *Halogeton glomeratus* and *Mesembrythemum crystallinum*. Allelopathy exhibited by *Kyllinga nemoralis* may also be due to elemental allelopathy. Phytoenrichment of elements can occur through hyper accumulation and litter deposition and by altering rhizosphere chemistry (Moris *et al.*, 2009). Plants can also excrete elements from leaves, which may result in faster phytoenrichment than mineralization of plant litter. Elements that are water soluble are easily moved from leaf surface to soil by rainfall (Vivrette and Muller, 1977).

The process of allelopathy provides some active compounds to the neighboring plant by means of leachates, root exudations, by decaying of plant parts and also by the help of plant growth promoting microbes which live in and around the plant. The mineral nutrients are taken up in the form of ions and incorporated into the plant structure or stored in the cell sap. Yield and quality of agricultural products increased with micronutrient application. Similarly, human and animal health would also be protected with feed enriched with plant materials (Tavakoli *et al.*, 2014).

### **Decomposed soil and normal soil**

The allelopathic effect of decomposed litter from trees interplanted with crops is a key problem in the intercrop agroforestry business that could influence the economic benefits and sustainable development of eco-agriculture (Zhang *et al.*, 2015).

The interaction of allelochemicals is more complicated in the presence of soil microbes and soil decomposition. Phenolic allelochemicals can be decomposed by soil

microbes, and thus they do not reach active concentrations (Yenish *et al.*, 1995) (Blum, 1998). Ceratiolin, a non allelopathic active substance secreted by *Ceratiolaericoides*, can be transformed into activated phenylpropionic acid and subsequently converted into a more poisonous chemical, hypnone (Walker *et al.*, 2003). The nutrients that are present in soil will influence the nature of allelopathy.

In the present study, decomposed soil was prepared using *Kyllinga nemoralis* plants. Fresh plants were allowed to decompose for a period of 120 days (Zhang *et al.*, 2015). Obtained soil were analysed for its physicochemical properties. The pH level of both normal soil and decomposed soils were observed to be the same. Available phosphorus (P in ppm), Potassium (K), Sulphur (S) and calcium (Ca) were observed to be high in the decomposed soil of *Kyllinga nemoralis*. Analysis of the physicochemical characters of both *K. nemoralis* decomposed soil and normal soil provides information regarding the benefits of using the plants for mulching process (to improve the soil quality for a better crop production). The pH of both soil samples are in between the required levels (KNRZS-6.72) (NS -6.41). Electrical conductivity in terms of soil and water salinity of KNRZS in august (rainy season) were 0.1ds/m (Calculated in general, water: soil=2:1), if it exceeds >0.90ds/m the soil is considered as sensitive. Normal soil has 0.06ds/m EC. In February (dry season) KNRZS has 0.37 and NS has 0.21ds/m EC. If the EC value is 0.25 some plants like Bermuda grasses are tolerant (Marcum and Murdoch, 1994). Porosity, bulk density, water holding capacity and particle density were comparatively same for both normal and decomposed soil.

The plant decomposed soil has more potassium levels (1912.96 kg/ha). Potassium (K) that is dissolved in soil water (water soluble) plus that held on the exchange sites on clay particles (exchangeable K) is considered readily available for plant growth. The exchange sites are found on the surface of clay particles. This is the form of K measured by the routine soil testing procedure. Plants readily absorb the K dissolved in the soil water. As soon as the K concentration in soil water drops, more is

released into this solution from the K attached to the clay minerals. The K attached to the exchange sites on the clay minerals is more readily available for plant growth than the K trapped between the layers of the clay minerals (Moris *et al.*, 2009).

The main ions associated with Cation Exchange Capacity in soils are the exchangeable cations calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), sodium ( $\text{Na}^+$ ) and potassium ( $\text{K}^+$ ) (Rayment and Higginson, 1992), and are generally referred to as the base cations. In this study, the potassium in plant decomposed soil was found to be higher than the normal soil. Except magnesium other elements were comparatively good for cropping in the plant decomposed soil.

Heavy metals exert toxic effects on soil microorganism hence results in the change of the diversity, population size and overall activity of the soil microbial communities (Ashraf and Ali, 2007). Elevated Pb in soils may decrease soil productivity and a very low Pb concentration may inhibit some vital plant processes *i.e.*, photosynthesis, mitosis and water absorption with toxic symptoms of dark green leaves, wilting of older leaves, stunted foliage and brown short leaves, stunted foliage and brown short roots (Bhattacharyya *et al.*, 2008). The metal plant uptake from soils at high concentrations may result in a greater health risk considering food-chain implications (Jordao *et al.*, 2006). Uptake of heavy metals by plants and subsequent accumulation along the food chain is a potential threat to human health (Sprynskyy, 2007).

The lead concentration of DS (Decomposed Soil of *Kyllinga nemoralis*) (3.82 ppm) was observed to be low when compared to the average of NS (Normal Soil) and KNRZS (4.54 and 4.95ppm). Cadmium and chromium levels were below detectable range in the soil sample of plant decomposed soil (KNRZS). The studied soil samples were found to have some relatively advantageous minerals and phytochemical parameters that support the growth of plants in soil. Plant growth and development largely depend on the combination and concentration of mineral nutrients available in the soil. Plants often face

significant challenges in obtaining an adequate supply of these nutrients to meet the demands of basic cellular processes due to their relative immobility. A deficiency of any one of them may result in decreased plant productivity and/or fertility. Symptoms of nutrient deficiency may include stunted growth, death of plant tissue, or yellowing of the leaves caused by a reduced production of chlorophyll, a pigment needed for photosynthesis.

### Conclusion

The soil profile appears to be different for NS, DS and KNRZS and is likely have a deterministic effect on the growth of other plants. From the study, it is evident that *Kyllinga nemoralis* (KNRZS, DS) enriches the soil with mineral nutrients. Mineral nutrients are typically taken from the soil *via* plant roots, however nutrient acquisition efficiency can be influenced by the presence of microbes also. Microbes colonize the roots of most land plants and may alter how the plants acquire nutrients.

Thus soil becomes the venue for complex interactions between microbes and allelochemicals present in the soil, which may help the soil micro flora to develop its potential to promote or inhibit the growth of other plants. Thus it becomes essential to identify the plant associated Rhizobacteria.

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