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Relationship between Soil Chemical Properties and Regression Analysis Affected Continuous Rice (*Oryza sativa* L.) Cultivation and Cropping Pattern

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RESEARCH ARTICLE

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ABSTRACT

This research was conducted to assessment effect of planting system and management practices on soil chemical traits via a combined analysis factorial experiment based on randomized complete blocks design with three replications. The treatments included depth of soil sampling (d_1= 0-10 cm, d_2= 10-30 cm, d_3= 30-60 cm), Rice cultivation year (t_1: 0, t_2: 10, t_3: 25 year) and place of cultivation (P_1: Shavoor Research Station, P_2: Shavoor rice fields). Result indicated nitrogen variation is proportional with depth of soil sampling and in both place (Shavoor agricultural rice research station and its rice fields) has similar trend so until surface depth (0-30 cm) concentration of nitrogen increased but until lower depth (30-60 cm) significantly decreased. Phosphorus (P) concentration according with depth of soil sampling has decreasing trend. Also considered P concentration with past year of cultivation increased. Evaluation trend of potassium concentration variation according depth of soil sampling in the Shavoor agricultural rice research station and its rice fields revealed until mid-depth increased and after until lower depth (30-60 cm) decreased. Variation trend of iron and magnesium (Mg) concentration proportion with depth of soil sampling and year of cultivation was similar and by increasing depth of and past year of cultivation increased. Organic matter with increasing soil depth significantly decreased but with increasing year of cultivation increased. In the agricultural fields of the Shavoor area, due to the presence of heavy texture, high level of soil salinity and high groundwater level, it is necessary to create underground drainage network or open-air drainage; otherwise the continuation of cultivation in these lands in the long run will lead to higher levels of water underground and non-use for other crops cultivation. Rotational crops must be observed in rice fields, so that leguminous crops are arranged alternately with rice. It is recommended to restore the remains of legume crops to soil to increase organic matter and improve soil structure. In order to evaluate the soil quality of Shavoor agricultural rice research station and its rice fields, the role of the management is clearly seen and the soil condition of the station due to optimal management has better soil quality. Correlation coefficients indicated strong relationship between organic carbon and nitrogen (0.89^{**}) and P contents (0.79^{**}) but with K, Fe and Mg didn't have significant relation.

Keywords*:* *Correlation, Flood field, Organic carbon, Phosphorus.*

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INTRODUCTION

Today, it is possible to achieve sustainable agriculture, food security and more production through agricultural engineering. It is also necessary to conduct applied research for optimal use of inputs in the production of basic products. The Influence of continuous rice cultivation and different waterlogging periods on the morphology, clay mineralogy, pH and nutrient concentration are important and need to evaluation. Land is the major non-renewable resource and faces the biggest threat of degradation. Land resources of the country are degrading at an alarming rate and causing environmental problems (Sarwar *et al.*, 2008). Soil has critical role for crop growth rate because it provides the growth environment and indispensable nutrients, and any degradation of soil quality may result in decreased productivity, quality, and thus profitability of the crop (Juhos *et al.*, 2016; Obade and Lal, 2016). The soil properties can be determined primarily from the physical, chemical, and the biological aspects (DFPJA, 2011; Bouma, 2002). The chemical properties typically relate more directly to the sustainability of the agro-ecosystem, in addition to variability in crop yield (Qi *et al.*, 2009). These properties can also be more easily improved than others, through proper fertilization and other farm management practices (Gray and Morant, 2003). Soil is one of the most important environmental factors and is considered as the main source in providing essential plant nutrients, water reserves and a medium for plant growth. Soil quality is defined as the capacity of a soil to function within an ecosystem and land-use boundaries, to sustain biological activity, maintain environmental quality, and promote plant, animal, and human health (Doran and Parkin, 1994). Soil quality indices are considered the most common methods for the soil quality evaluation due to ease of use, flexibility and quantification. These indices represent the cumulative effects of different soil properties (physical, chemical and ecological) as an index from the role of each indicator in soil quality (Drury *et al.,* 2003; Singh and Khera, 2009). Agricultural management practices, such as reduced tillage and crop rotations, have a direct effect on the quantity, quality, and rate of decomposition of the crop residues returned to the soil. In turn, these residues are directly related to the soil organic carbon content (Amezketa, 1999), which is a key indicator of soil health and quality (West and Post, 2002). Agronomists and soil scientists see a clear relationship between crop rotations and sustainability of the agricultural production systems (Munkholm *et al*., 2013). Conventional crop production technologies are not that cost-effective (Jat *et al*., 2014), are less water efficient (Bhushan *et al*., 2007) and reduce soil health compared to conservation practices. Earlier studies showed that conservation-based management practices are effective for increasing crop and water productivity, and economic sustainability in different cropping systems (Das *et al*., 2014). Crop rotations can help in controlling weeds, supplying soil nutrients, improving soil tilth, and reducing soil erosion (Santos *et al*., 1993). The positive effect of long term rotations on crop yields has been recognized and exploited for centuries. Although in the last few decades its benefits in terms of yield seem to have been ignored by many farmers, it is now evident that crop rotation increases yield and that the practice is essential in sustainable agricultural systems (Crookston, 1984). For example, a legume crop can lower the fertilizer needs for the following crop.

A generally proposed cause for such effects is increased nitrogen availability for the cereal crop from symbiotic N_2-fixation of the preceding legume which can lead to significant increases in the available soil nitrogen pool (Baldock *et al.*, 1981; Pierce and Rice, 1988). Cereal yield increases after legumes were also reported without significant legume effects on the levels of total soil nitrogen (Hesterman *et al.*, 1987). Berzsenyi *et al.* (2000) have also found that the yields of maize and wheat were lower in all cases in a mono cropping system than the crop rotation. The benefits of crop rotation for land and water resource protection and productivity have been identified, but many of the rotation factors, processes and mechanisms responsible for increased yield and other benefits need to be better understood (Berzsenyi *et al.*, 2000). Popovici and Bucurean (2009) have reported that wheat in rotation with corn produced 48% yield more than in rotation with wheat. Organic matter is regarded as a very important parameter of soil productivity. It has number of important roles to play in soils, both in their physical structure and as a medium for biological activity. Organic matter makes its greatest contribution to soil productivity. It provides nutrients to the soil, improves its water holding capacity, and helps the soil to maintain good tilth and thereby better aeration for germinating seeds and plant root development (Zia *et al.*, 1993). The initial soil organic carbon content can also influence the results as soils with high initial soil organic carbon are more likely to be at equilibrium levels and be resistant to change (Kumar *et al.*, 2012) and physical properties are also less likely to display differences due to more stable aggregates in these soils (Hill, 1990; Kumar *et al.*, 2012). Each species can affect the concentration and quality of soil organic matter by differential contribution of phytomass, the intrinsic characteristics of crop residues, the root system, and the influence on the microbial community, which are fundamental components of soil organic matter accumulation (Tivet *et al.*, 2013). Sarwar *et al.* (2008) by evaluate the use of compost for the improvement of soil parameters reported farmers can be formulated that they should compost the crop residues and apply in their soils for the increased sustainable crop production. So the soil fertility can be improved with a net improvement in land productivity. Use of compost can be beneficial to improve organic matter status. Compost is rich source of nutrients with high organic matter content. Physical and chemical properties of soil can be improved by using compost, which may ultimately increase crop yields. So use of compost is the need of the time. Physical properties like bulk density, porosity, void ratio, water permeability and hydraulic conductivity were significantly improved when farm yard manure (10 $t.ha^{-1}$) was applied in combination with chemical amendments, resulting in enhanced rice and wheat yields in sodic soil (Hussain *et al.*, 2001). Other organic materials like rice straw, wheat straw, rice husk and chopped salt grass also improved these physical properties of a saline sodic soil. The tillering, plant height, biomass and paddy yield were significantly increased (Hussain *et al.*, 1998). Cultivation of high yielding crop varieties and multiple cropping is depleting the fertility of soils at a rapid pace. The soils, which were, once well supplied with available nutrients, are now gradually becoming deficient (Zia *et al.*, 1993). Intensive rice cultivation in paddy soils may be leaded to diminish soil quality and productivity over a long time. Loss of organic matter due to rice cultivation without restoration may initiate physical degradation processes. Very often, the process of depleting the soil of its natural resources when submitted to any given agricultural production system is put and what is taken out of the soil. To evaluate the effects of repeated traditional cultivation, fence line comparisons between different adjacent land use systems, have been done for a number of chemical, physical and morphological soil properties (Paz Gonzalez *et al*., 2000). Zuber *et al*. (2015) by assess the effect of rotation and tillage on soil physical and chemical properties in soils typical of Illinois reported tillage was more influential on soil organic carbon than crop rotations after 15 year since establishment. Potassium levels were greater in corn–soybean–wheat and sequences of continuous corn compared to continuous soybean, and despite no differences in soil organic carbon among rotations, water aggregate stability, and total nitrogen were greater under the three year corn-soybean-wheat rotation and Sequences of continuous corn than in corn-soybean or continuous soybean rotations. Their results suggested the shift toward continuous corn in the Midwest related to increasing corn prices has not been detrimental to soil quality; however, high initial soil organic carbon levels and finer soil textures may make it difficult to detect changes even after 15 year of management. Nishida *et al*. (2013) by investigate the current available nitrogen and chemical properties of paddy soils affected by crop rotation between irrigated paddy rice and upland soybean reported regardless of organic material application, a significant negative correlation was found between available soil nitrogen and an increase in the proportions of upland seasons to total crop seasons after the initiation of paddy-upland rotation. Soil total nitrogen and total carbon also tended to decrease with an increase in upland frequency. In fields with repeated applications of cattle manure compost, the soil available nitrogen was higher than in fields where only crop residue was applied. In order to sustain available soil nitrogen over the minimum suitable level of the 80 $mg.kg^{-1}$, upland frequency should not exceed 65% when only crop residues and no other organic materials are applied. The upland frequency can be raised by repeated application of organic materials which maintain a higher level of available soil nitrogen. The results imply that care should be taken to maintain nitrogen fertility of paddy soil at a suitable level in paddy-upland rotation, and that upland frequency and organic materials applied are important factors to do this. The objective of this study was to determine the effect of cropping pattern, field management and continues cultivation on soil chemical characteristics in rice field and evaluate correlation between traits.

MATERIALS AND METHODS

Field and Treatments Information

This research was conducted to monitoring effect of planting system and field management on soil chemical properties via a combined analysis factorial experiment based on randomized complete blocks design with three replications. The treatments included depth of soil sampling (d_1= 0-10 cm, d_2= 10-30 cm, d_3= 30-60 cm), Rice cultivation history (t_1: 0, t_2: 10, t_3: 25 year) and place of cultivation (p_1: Shavoor Research Station, p_2: Shavoor rice fields). Place of research was located in Shavoor Research Station at longitude 48 27′33″E and latitude 32"37' 0 N in Khuzestan (Southwest of Iran). The average annual rainfall, temperature, and evaporation in the region are 240 mm, 22 C and 3000 mm, respectively.

Measured Traits

Soil texture: Fifty grams of dry and sieved soil and was placed in a container and 50 ml of Calgon solution and 300 ml of distilled water were added to it and were mixed with electric mixer for 5 minutes. The resulting mixture was transferred to a one-liter graduated cylinder and was brought to 1 liter of distilled water. Then it was mixed by manual mixer and after 40 seconds and in different times (5 hours) the particles were read by hydrometer. Then, by doing the necessary corrections the percentage of sand, silt, and clay was calculated (Gee and Bauder, 1986).

Soluble calcium and magnesium: To determine the amount of these two elements, 2ml of extract of soil saturated are used. The reagent used to determine calcium, ammonium purpurate and for determining magnesium, EBT applied. Titration volumes are NaoH and versin, respectively (Heald, 1965).

Measurement Sodium and potassium soluble by flame photometer method: To determine the amount of sodium and potassium elements from normal ammonium acetate and a flame photometer was used (Churchman and Whitten, 1987).

Soil Organic Carbon: 10 ml of normal potassium dichromate I as well as 10 ml of concentrated sulfuric acid were added to 1 g of soil and were left for half an hour. Then 100 ml distilled water and 15 drops of phenanthroline reagent were added and titrated with ferrous ammonium sulfate (0.25 M) to achieve the red color. Then the sample was oxidized by potassium dichromate and sulfuric acid, and after 30 minutes the reaction was stopped through diluting with water. Additional dichromate was titrated to ferrous sulfate, and finally the organic carbon content was reported based on the oven dry weight of soil (Walkely and Black, 1934).

The Nitrogen concentration: Kjeldahl method was used to measure nitrogen concentration (Sutten *et al.*, 1978).

Concentration of soil phosphorus: Soil extract was prepared with normal sodium bicarbonate 0.5. The phosphorus of this extract was measured through Olen method and using ascorbic acid as the regenerative material and calorimeter at the wavelength of 880 Nm (Olsen and Sommers, 1982).

Measurement iron and magnesium concentration: By extracts of DTPA solution (pH= 7.3) and readings by atomic absorption were measured (Lindsey and Norwell, 1978).

Statistical Analysis

Analysis of variance and mean comparisons were done with MSTAT-C software and Duncan multiple range test at 5% probability level.

RESULT AND DISCUSSION

Soil nitrogen concentration

Nitrogen was predicted by the different biochemical properties (Trasar-Cepeda *et al.*, 1998), However, biochemical properties are also closely related to physical and especially chemical soil properties because of the dynamic and interactive nature of the soil process (Schoenholtz *et al.*, 2000). According result of combined analysis of variance effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil nitrogen concentration was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated that maximum soil nitrogen concentration (435 ppm) was noted for $P_1Y_1D_2$ and minimum of that (163.3 ppm) belonged to $P_2Y_1D_3$ treatment (Table 2). Nitrogen availability in flood soils is more common than non-flood soils. Even though the organic matter is less inert in non-chemical conditions, the amount of mineral nitrogen is even higher because the amount of nitrogen is less inorganic; of course, this is less evident in land with drainage conditions. The above result was mentioned by comparing two locations at the Shavoor Agricultural Research Station (with drainage conditions). Comparison of soil nitrogen concentration at the Shavoor Agricultural Research Station showed that the amount of nitrogen in each three years of cultivating from the soil surface layer (0 to 10 cm) to the middle depth (10 to 30 cm) has increasing trend. Then from the middle depth to the deep depth (30 to 60 cm) the soil has a decreasing trend due to the fact that middle depth there is an impermeable layer due to clay accumulation.

Table 1. Combination analysis of variance of measured traits

S.O.V	df	Nitrogen	Phosphorus	Potassium	Iron	Magnesium	Organic carbon
Place	1	24911.36**	40.196**	96.694**	1.425**	1.071**	0.312**
Place × Replication	4	182.194^{ns}	0.060**	5.639**	0.001^{ns}	0.0003^{ns}	0.0023^{ns}
Depth of sampling	2	96852.194**	30.876**	2042.021**	0.003**	0.040**	1.412**
Depth of sampling × Place	2	13275.528**	4.268**	44.924**	0.002**	0.0001**	0.032**
Year	1	15334.694**	9.040**	13072.111**	0.001**	0.007**	0.168**
Year × Place	1	6588.028**	0.41**	367.361**	0.006**	0.00004**	0.080**
Depth of Sampling × Year	2	20189.694**	1.935**	253.757**	0.004**	0.0002**	0.022**
Place × Depth of sampling × Year	2	17738.028**	0.704**	124.882**	0.005**	0.01009^{ns}	0.056**
Error	20	591.694	0.090	0.256	0.0001	0.01203	0.0023

^{ns}, * and ** are non-significant and significant at 5 and 1% probability levels, respectively

Table 2. Mean comparison interaction effect of treatments on measured traits

Treatment	Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)	Iron (ppm)	Magnesium (ppm)	Organic Carbon (%)
P1Y1D1	350^{e}	9.233^{b}	116.5^{g}	2.045^{l}	2.457^{l}	1.049^{b}
P1Y2D1	350^{e}	11.17^{a}	165.8^{b}	2.051^{j}	2.483^{k}	1.553^{a}
P1Y1D2	435^{a}	7.633^{d}	131.2^{e}	2.050^{k}	2.553^{j}	0.8317^{g}
P1Y2D2	390^{bc}	8.667^{c}	172.3^{ab}	2.054^{i}	2.573^{i}	0.9151^{e}
P1Y1D3	173.3^{f}	6.133^{f}	111^{h}	2.055^{h}	2.583^{h}	0.5510^{j}
P1Y2D3	423.3^{b}	5.533^{g}	151^{d}	2.061^{g}	2.603^{g}	0.6553^{i}
P2Y1D1	305^{e}	6.100^{f}	121^{f}	2.410^{f}	2.813^{f}	1.041^{d}
P2Y2D1	317.7^{de}	7.533^{d}	156^{c}	2.431^{e}	2.853^{e}	1.046^{c}
P2Y1D2	413.3^{d}	5.520^{g}	131^{e}	2.450^{d}	2.883^{d}	0.7610^{h}
P2Y2D2	423.3^{c}	6.900^{e}	176^{a}	2.461^{c}	2.903^{c}	0.8517^{f}
P2Y1D3	163.3^{g}	4.400^{i}	116^{g}	2.471^{b}	2.917^{b}	0.3540^{l}
P2Y2D3	183.3^{e}	5.233^{h}	131.2^{e}	2.481^{a}	2.953^{a}	0.3853^{k}

*Similar letters in each column show non-significant difference at 5% probability level via Duncan.

Y_1= 10 years planting, Y_2= 25 years planting, D_1= 0-10 cm depth, D_2= 10-30 cm depth, D_3= 30-60 cm depth, P_1= Station, P_2= Field.

Therefore, nitrogen after leaching transferred from the surface layer to the middle depth and due to this impermeable layer it is not movement to lower depths and accumulates in the middle depth (Fig. 1).

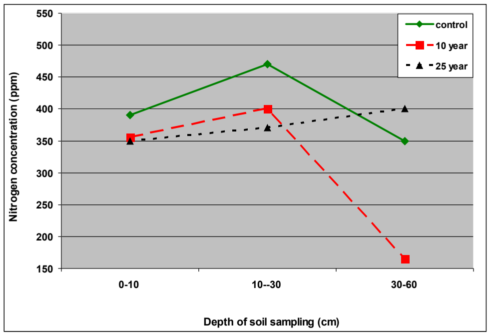

Fig.1. Trend of soil nitrogen concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice research station

It should be noted that in treatment with 25 years of rice cultivation experience, the nitrogen content from the middle to lower depth has increasing trend, because of increased cultivation and leaching, the accumulated clay is transported from middle depth to lower depth so the nitrogen due to leaching accumulates in lower depth. In flood lands under rice cultivation, a large part of nitrogen is out of available of rice crop, which may reach up to 60%. Of the total nitrogen lost, the share of leaching is about 30 to 50 percent as nitrate, Denitrification is about 10 to 30 percent as nitrogen oxides, and sublimation is about 2 to 30 percent as ammonia. In general, the amount of nitrogen has decreased due to increased rice cultivation history, which is due to continuous cultivation and the presence of drainage at the station, which leads to nitrogen excretion from the soil. Investigating the trend of decreasing the amount of nitrogen concentration in the soil in proportion to the sampling depth indicates that leaching and nitrogen accumulation are not done at lower depth of soil profile, and a large amount of nitrogen in form of sublimated and denitrification is released from the rice crop. Comparison of soil nitrogen concentration in Shavoor rice fields shows that with increasing cultivations from 10 to 25 years, nitrogen content increased significantly. Because of shavoor farms have not been used for drainage during all ages, so nitrogen is not released by leaching, and the amount of consumed fertilizer compensated amount of nitrogen lost. Also, the trend of nitrogen changes proportional to the soil depth until middle depth increased, but until lower depths had decreased trend, so the reasons are consistent with situation of the area station (Fig.2).

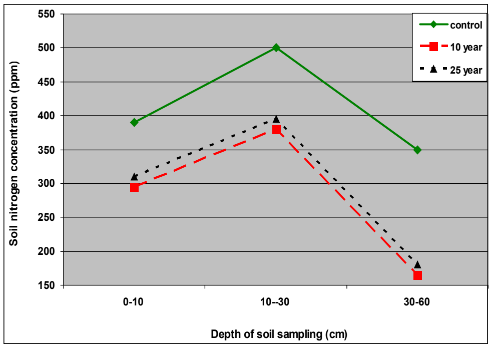

Fig. 2. Trend of soil nitrogen concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice fields

Khalilzade *et al*. (2016) reported changes in soil nitrogen and electrical conductivity was against each other and correlation results showed that soil nitrogen could be estimated via measurement of soil electrical conductivity. Changes of pH and soil nitrogen were similar and there was a significant correlation between them. Also soil water and nutrient content are of the most important factors in determining soil EC. There is a significant and negative correlation between soil electrical conductivity and seed yield and it seems that in this region seed yield of maize can be estimated via measurement of soil electrical conductivity.

Soil phosphorus concentration

Result of combined analysis of variance showed effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil phosphorus concentration was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments revealed maximum of soil phosphorus concentration (11.17 ppm) was obtained for $P_1Y_2D_1$ and minimum of that (4.40 ppm) was for $P_2Y_1D_3$ treatment (Table 2). Increasing the solubility of the P element is one of the beneficial effects of flooding on rice. The initial increase in soluble phosphorus in the floodplain soils is due to the resuscitation of soluble iron phosphate. Also, a small amount of phosphorus is also introduced into the soil solution as a result of the replacement of anion phosphate with organic anions in tri-substituted iron phosphates and aluminum phosphate. Reducing the amount of phosphorus due to the re-absorption of phosphate on adsorption levels, such as clays and hydroxides, is due to increased acidity. Mean comparison of the soil phosphorus concentration at the Shavoor Agricultural Research Station shows that with increasing cultivation years in the surface and middle depths, the amount of phosphorus has increased significantly, also the process of phosphorus changes with depth of soil is a decreasing trend (Fig. 3). Comparison of soil phosphorus concentration in the farmland has a similar trend with agricultural research station and by increasing the number of cultivation years from 10 to 25, the phosphorus concentration significantly increased.

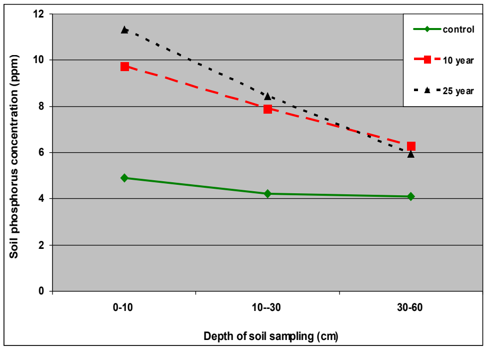

Fig.3. Trend of soil phosphorus concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice research station

The trend of variation in soil phosphorus concentration proportional to sampling depth (similar to the station) had decreasing trend, so with increasing sampling depth, soil phosphorous concentration decreased significantly (Fig. 4). It should be noted that at both locations, Shavoor research stations and fields, due to the return of straw to the soil surface and the use of phosphate chemical fertilizers, as well as phosphorus immobilization in soil, led to increase the soil phosphorus concentration by past the years of cultivation. Also by increasing the soil depth amount of phosphorus (due to low mobility) decreases and it's accumulate in the soil surface layer. Tamin (2014) and Hylta (2016) reported similar result.

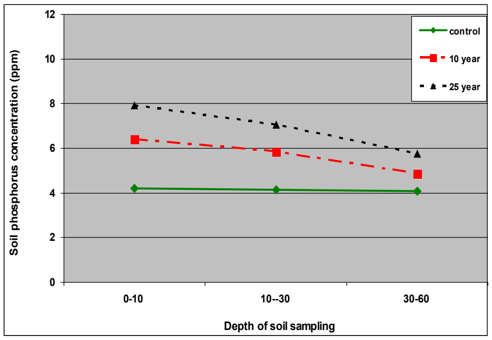

Fig.4. Trend of soil phosphorus concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice fields

Soil potassium concentration

According result of combined analysis of variance effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil potassium concentration was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated the maximum soil potassium concentration (176 ppm) was observed in $P_2Y_2D_2$ and the lowest one (111 ppm) was found in $P_1Y_1D_3$ treatment (Table 2). The change in the amount of potassium during the flooding is incremental and the soil potassium concentration will be higher in soils that added more iron content into the soil solution. With the flooding of the soil, the Fe^{+3} and Mn^{+3} ions substitutes the exchanged K^+, therefore, increasing the soil solubility of potassium depends to amount of Fe^{+3} concentration, and the potassium leaching are remarkable for well-drained fields. The comparisons of soil potassium concentration in Shavoor agricultural research station showed that by increasing the cultivation years from 10 to 25, the growth of potassium concentration increased as a result of reduction conditions. The trend of changes in soil potassium concentration proportional to the depth of sampling during all three cultivation years led to increase amount of potassium from the surface depth (0 to 10 cm) to the middle depth (10 to 30 cm), then from the middle depth to the bottom depth (30 to 60 cm) has a similar trend. Because of potassium is leached by drainage and due to accumulation of a clay layer in the middle depth and CEC is greater in middle depth, potassium is stabilize at this depth and accumulated (Fig.5). Mean Comparison of soil K concentration in Shavoor rice fields revealed that by increasing year of cultivation from 10 to 20 amount of potassium increased.

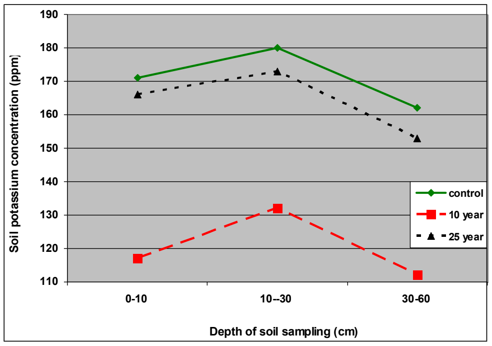

Fig.5. Trend of soil potassium concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice research station

Brinkmam (1970) believes in his results that this increase is due to the type of cultivation and regenerative conditions. The trend of potassium changes is proportional to the depth of soil sampling in the shavoor rice fields, which is similar to the station, so the relative accumulation of potassium in the middle depth (10 to 30 cm) is observed (Fig.6).

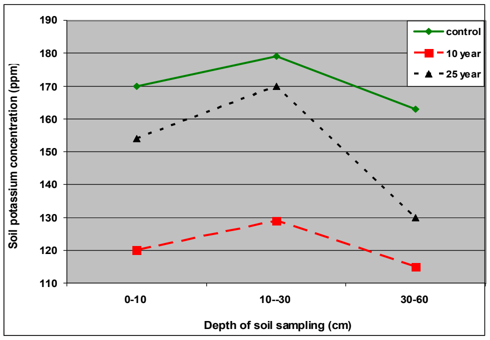

Fig.6. Trend of soil potassium concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice fields.

The relative depletion of K^+ in upper layers of soil and accumulation in depth of soil profile due to movement of potassium from surface layer of soil to depth of profile in previous cultivation. The movement of cations accumulated in the middle layer of the soil profile due to the higher amount of clay and cation exchange capacity of this layer.

Mentioned result is consistent with the results of Kirk *et al.* (1998).

Soil iron concentration

Result of combined analysis of variance showed effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil iron concentration was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated that maximum soil iron concentration (2.481 ppm) was noted for $P_2Y_2D_3$ and minimum of that (2.045 ppm) belonged to $P_1Y_1D_1$ treatment (Table 2). Ponnamperuma (1965) believes that by creating a flooding situation, ration Fe^{+3}/Fe^{+2} concentrations in the soil solution will be increase. In the reduction process Fe^{+3} to Fe^{+2}, the organic matter is the emitter and the higher organic matter led to release more Fe^{+2} from iron oxides. Mean comparisons of the soil iron concentration of the shavoor agricultural rice research station showed that, in all three soil sampling depths, the amount of exchangeable iron increased with increasing cultivation years. Also, during the 25-year period of cultivation, amount of iron exchange declined from the surface depth (0-10 cm) to the middle depth (10-30 cm) (Fig.7).

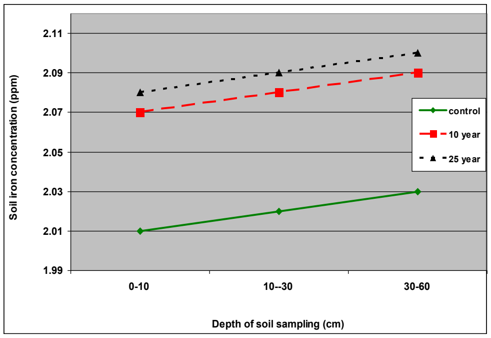

Fig.7. Trend of soil iron concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice research station.

Mean comparisons amount of exchangeable iron in shavoor rice fields indicated that, like agricultural rice research station at three depths, amount of exchangeable iron increased with increasing cultivation years (Fig. 8).

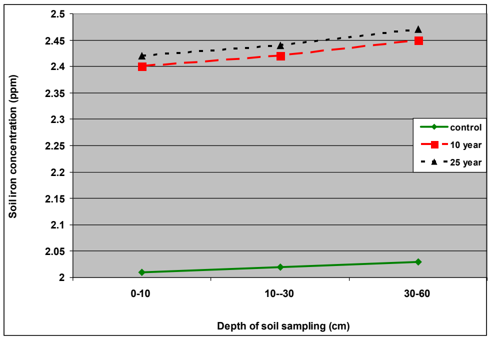

Fig.8. Trend of soil iron concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice fields.

According on the profile, it was observed that due to the high humidity in the bottom depths of the soil, there were blue crests caused by regenerative conditions indicating high amounts of soluble iron under flood conditions. At Shavoor rice research station and its rice fields, the amount of iron is increasing because of prolonged regenerative conditions due to increasing cultivation years. Also, with increasing crop cultivation, the amount of organic matter is also increased, so the higher amount of iron will be chelate and the amount of soluble iron increased. Also Due to regenerative conditions and high groundwater level, the iron is mobile and its solubility is increased and penetrates into the deep soil. Ponnamperuma (1965) has achieved similar results.

Soil manganese concentration

According result of combined analysis of variance effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil manganese concentration was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments showed maximum of soil manganese concentration (2.953 ppm) was obtained for $P_2Y_2D_3$ and minimum of that (2.457 ppm) was for $P_1Y_1D_1$ treatment (Table 2). In flooded soil, reduction of manganese oxides, especially Mn_3O_4, occurs at the same time as the DE nitrification. Reduction of manganese to soluble compounds is more readily available than iron, so it will have a higher concentration of iron than iron. Mean comparisons of the Shavoor agricultural research station indicated that with the increase in cultivation years, amount of exchange manganese has increased. The trend of manganese variation at different sampling depth was that the exchange manganese increased from the surface depth (0-10 cm) to the mid-depth (10-30 cm) and increased again in the lower depth (30-60 cm) (Fig.9).

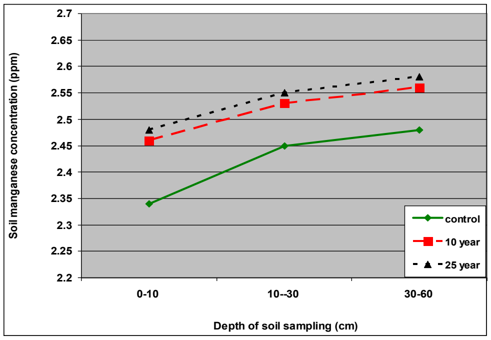

Fig.9. Trend of soil manganese concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice research station.

Mean comparison of soil exchangeable manganese in Shavoor rice fields revealed that by increasing cultivation year, the amount of exchangeable manganese in the soil increased. The process of variation in the amount of soil manganese concentration is proportional to the sampling depth in rice fields same to the Shavoor agricultural rice research station has an increasing trend (Fig.10).

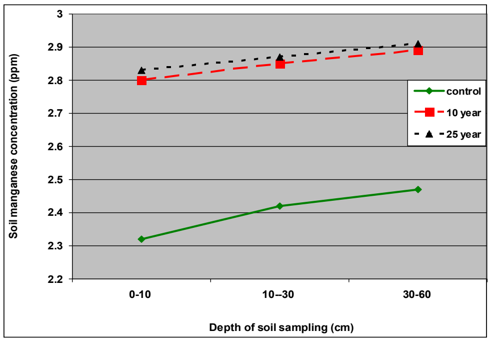

Fig.10. Trend of soil manganese concentration variation in different depth of soil sampling and year of cultivation in Shavoor rice fields.

At Shavoor rice research station and its fields, the increasing of cultivation years (due to prolonged reduction conditions) led to increase manganese content. In addition, by increasing of cultivation years the amount of organic matter is also increased, so more manganese is chelated and the amount of soluble manganese increased. Due to reduction conditions and high groundwater levels manganese is mobile and its solubility is increased and penetrates into the depths of the soil.

Soil organic matter

Result of combined analysis of variance showed effect of place of planting, depth of soil sampling, year and interaction effect of treatments on soil organic matter was significant at 1% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated the maximum soil organic matter (1.55%) was observed in $P_1Y_2D_1$ and the lowest one (0.38%) was found in $P_2Y_2D_3$ treatment (Table 2). The major electrochemical changes that affect soil fertility include reducing the oxidationreduction potential and changing the acidity of the soil solution, mentioned process controlled by the amount of organic matter and reduction iron. Mean comparison of soil organic matter attributes of Shavoor agricultural rice research station revealed with increasing soil depth the soil organic matter decreased significantly, which indicates the higher organic matter in the soil surface. It is also noted that in all three sampling depths, the amount of organic matter in the 25 years of cultivation is higher than that of 10 years of cultivation, which indicates the return of more organic residues to soil during 25 years (Fig. 11).

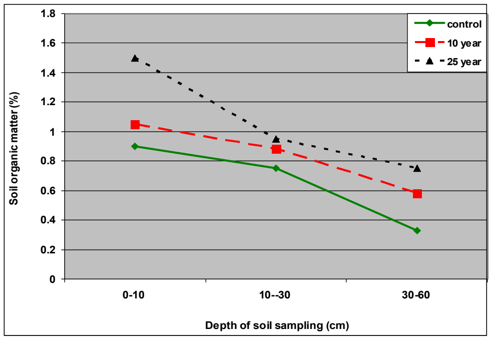

Fig.11. Trend of soil organic matter variation in different depth of soil sampling and year of cultivation in Shavoor rice research station.

Mean comparisons of soil organic matter for Shavoor rice fields showed a similar trend with agricultural rice research station, so the amount of organic matter decreased with increasing soil sampling depth. It is observed that the highest amount of organic matter was related to 25 years of cultivation and soil surface depth (0-10 cm) (Fig.12), which is confirmed by the results of Bolt and Braggen (1976). Soil organic matter encourages the granulation, increases cation exchange capacity and is responsible for adsorbing power of the soils up to 90%. Cations such as Calcium, Magnesium and Potassium are produced during decomposition (Brady, 1990). Soil organic carbon benefits soil by lowering bulk density, increasing nutrient availability, increasing cation exchange capacity and improving water holding capacity; in addition, soil organic carbon increases water aggregate stability making soils less susceptible to erosion (West and Post, 2002; Varvel and Wilhelm, 2010).

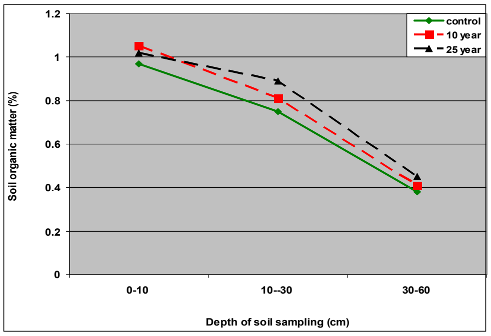

Fig.12. Trend of soil organic matter variation in different depth of soil sampling and year of cultivation in Shavoor rice fields.

Relationship between measured traits

Correlation coefficients in Table 3 show a strong relationship between organic carbon and nitrogen (0.89^{**}) and phosphorus contents (0.79^{**}) but with potassium, iron and magnesium didn't have significant relation. As the soil carbon and nitrogen cycle are tightly coupled, a change in one has a direct influence on the other (Gol, 2009). Another researcher such as Jafarian and Kavian (2013); Cerri and Magalhaes (2012) reported same result. Regression relation between Organic carbon and nitrogen and phosphorus concentration was mentioned in Fig.13 and Fig.14. Regression relation between soil organic matter and another measured traits was describe with Equ. 1.

Equ. 1. O.C= 4.16+0.00506 K + 0.000238 N + 0.0359 P + 4.13 Fe -5.03 Mg.

Table 3. Correlation between measured traits

Traits	Potassium	Nitrogen	Phosphorus	Iron	Magnesium
Nitrogen	0.56*				
Phosphorus	0.45^{ns}	0.39^{ns}			
Iron	-0.05^{ns}	-0.29^{ns}	-0.59*		
Magnesium	-0.03^{ns}	0.31^{ns}	-0.70**	0.97**	
Organic Carbon	0.45^{ns}	0.89**	0.79**	-0.34	-0.49^{ns}

^{ns}, * and ** are non-significant and significant at 5 and 1% probability levels, respectively.

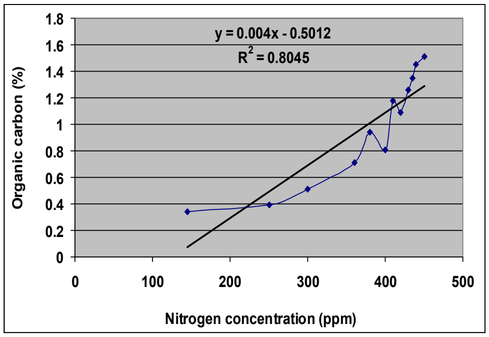

Fig. 13. Correlation relationship between organic matter and nitrogen concentration.

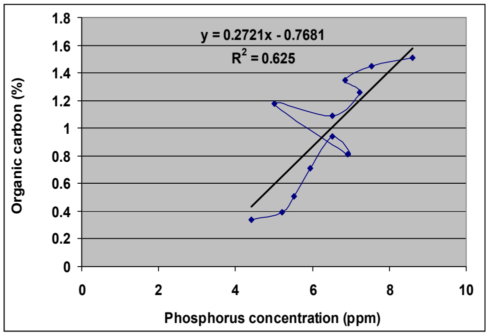

Fig. 14. Correlation relationship between organic matter and phosphorus concentration.

CONCLUSION

Crop rotation has many benefits for agro-eco-systems production. Information of soil characteristics is a basic component of agricultural development programs and environmental regulation. In the agricultural fields of the Shavoor area, due to the presence of heavy texture, high level of soil salinity and high groundwater level, it is necessary to create underground drainage network or open-air drainage; otherwise the continuation of cultivation in these lands in the long run will lead to higher levels of water underground and non-use for other crops cultivation. Rotational crops must be observed in rice fields, so that leguminous crops are arranged alternately with rice. It is recommended to restore the remains of legume crops to soil to increase organic matter and improve soil structure. In order to evaluate the soil quality of Shavoor agricultural rice research station and its rice fields, the role of the management is clearly seen and the soil condition of the station due to optimal management has better soil quality. Soil organic matter is most influenced by the factor of cultivating years and the amount of it increases with past time. Correlation coefficients indicated strong relationship between organic carbon and nitrogen (0.89**) and phosphorus contents (0.79**) but with potassium, iron and magnesium didn't have significant relation. In the area of the studied region, due to the heavy texture, high salinity and high groundwater level, it is necessary to create ground drainage or open-air drainage. So, continued cultivation in these lands in the long run will lead to higher levels of groundwater and non-use for other crops.

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