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Pot Culture Analysis in Waterlogged Saline Soil (Pre and Post Leaching) and Water (Stagnant and Leached) samples to Evaluate Salt-Stress Conditions

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Abstract:

Salt stress is an increasingly global problem which affects major parts of the global agricultural lands. Investigation pertaining to a concise and clear profile about chemical status of the soil and water and marginal amelioration of the soil quality to extraction of chemical compounds from the canal command area. This would be made evident by conducting pot experiment investigations with scrapped and unscrapped, pre and post leaching soil samples. An attempt will also be made in this study to highlight the analysis of the parameters with reference to their significance in wheat crop yield.

Keywords: Salinity, waterlogging, nutrients, crop yield

Introduction:

The twin problems of waterlogging and soil salinity are of great concern since the introduction of irrigated agriculture in semi-arid and arid regions all over the World. The salt affected soils occur in almost all continents and under varied soil and climatic conditions. However, the problems of salinity in its severity are encountered where the irrigation practices by canal and surface and underground drainage is poor; results in rise of water table. Consequently substantial areas are going out of cultivation. Such a situation is detrimental to wheat crop growth as the land is rendered uncultivable or loses productivity. A high amount of salinity may affect the plant in several ways such as water stress, reduction and expansion of cell division, oxidative stress, and nutritional

disorders. The long-term exposure of plants to salinity makes plants experience ionic stress, which may lead to a premature deterioration of adult leaves, affecting the photosynthetic area available to support the continued growth. In fact, excess sodium and more importantly chloride have the potential to affect plant enzymes and cause cell swelling, resulting in reduced energy production and other physiological changes. Hence, arid and semiarid areas of Indian agro ecosystems are often deficient in important minerals including phosphorus, potassium, and zinc. For a proper growth and development, plants need several macro- and micronutrients. The macronutrients including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and the micronutrients including iron (Fe), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), and copper (Cu) are supplemented through inorganic or organic forms when taken up by the plant roots along with water.

Materials and Methods: -

The author has chosen the drastic summer season, when the severity of the problem mounted on peak. When all the salt protrudes and accumulates on the surface of land due to evaporation of water. So I have chosen Rawatsar (Dist. Hanumangarh, Rajasthan state), which was severely, affected village by soil salinity has chosen and investigation showed in the month of May-2018 end. Status of soil: The soil samples were collected from Rawatsar at the top crust (0-5 cm.), Unscrapped (0-20 cm) and scrapped (5-20cm.) depth. The reference soil (Normal Ghaggar bed soil) was collected from a field near Hanumangarh town, where good biomass wheat crop were reportedly standing. The present study consolidates the analysis of physical (pH, EC) and chemical characteristics (OC, N, P, K, Ca^{+2}, Mg^{+2}, Zn^{+2}, Fe^{+2}, Cu^{+2}, Mn^{+2}, SO_4^{-2}, Cl^-) of normal and waterlogged soil (pre and post leaching).

Status of water: Stagnant water samples and samples from leached soil were collected and evaluate the critical parameters like pH, Electrical conductivity (EC) and total soluble soilids (TSS).

Wheat crop Impact Studies: The unscrapped and scrapped soil crust (before and after leaching) were analyzed under the parameters a) Germination of seeds, b) Shooth Growth, c) Wheat crop yield, by pot culture analysis.

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Results and Discussion:-

Table 01: -Water quality parameters status

S. no.	Chacteristics	Unit	Stagnant water	Leached Water		Reference water
				Unscrapped crust (0-20 cm)	Scrapped crust (5-20 cm)	
01	pH		7.7	7.98	8.93	6.9
02	EC	mmhos/cm	07	5.4	1.3	0.7
03	Total soluble salt	mg/ltr.	4.5	3.51	0.84	0.5-1.5

It is apparent that pH values of stagnant and leached water are very high, while the pH values of leached water are slightly higher than that of the stagnant water. The degradation of alkalization may be due to contamination or bacterial growth in the stagnant water. Due to this growth the biological oxygen demand (BOD) of the water is enhanced. The acidic gases like CO_2, SO_2 etc. present in the atmosphere. It has been reported that these gases fulfilled the demand of biological oxygen to some extent, while these gases show slow reactivity towards solid-state i.e. unleached soil. On being leached such a soil, alkaline are dissolved or washed out in the leached water.

The higher values of EC can be understood on the basis of higher alkalinity/salinity of the effected site samples.

Table 02: - Soil samples (unscrapped and scrapped) status

S.No.	Components/Cha-cteristics		Reference soil		Soil quality			
					Unscrapped Soil		Leached Soil	
			Unscrapped (0-5 cm.)	Scrapped (5-20 cm.)	Unscrap-ped (0-5 cm)	Scrapped (5-20 cm.)	Unscrap ped (0-20 cm.)	Scrapped (5-20 cm.)
PHYSICAL		Unit						
01	pH		7.95	7.9	8.40	8.55	8.10	8.24
02	EC	mmhos/cm	0.7	0.4	3.75	0.90	0.64	0.59
CHEMICAL		Unit						
01	O.C.	%age	0.53	0.34	0.56	0.48	0.56	0.50
02	Nitrogen	%age	45.69	29.31	48.27	41.38	48.27	43.1
03	Phosphorous	kg/ha	30	29.5	40	27.5	56	47.5
04	Potassium	kg/ha	384	389.5	380	403	390	411.5
05	Calcium	ppm	60	40	331	133	183	45
06	Magnesium	ppm	30	18	168	33	114	27
07	Zinc	ppm	0.61	0.99	0.23	0.65	--	--
08	Ferrous	ppm	6.8	10.96	7.12	6.43	--	--
09	Manganese	ppm	3.45	2.89	7.07	5.51	--	--
10	Copper	ppm	1.02	0.78	0.73	0.45	--	--
11	Sulphate	ppm	34.5	--	--	--	60.15	65.4
12	Chloride	ppm	93.7	--	--	--	266.5	84.3

Summarized results show that the OC contents did not show a marked change with leaching due to the presence of decayed bacterial organism in the samples. These materials are usually water insoluble and are not further decomposed in presence of high concentration of preserving salts which are already present in the soil. The trend of Nitrogen contents may be attributable to the possibility of bacterial growth prevailed in the waterlogged areas. These species absorb the nitrogen from atmospheric air and supply to soil composition. The nitrogen contents are known to contribute to enhance the plant growth. As far as the results of P and K contents are concerned the plausible

reason is that on leaching various felsparic polyphosphate are hydrolysed. This improves the free phophate/K^+ ion concentration in the samples. These materials are very essential for plant growth.

The reduced value of Ca and Mg contents after leaching the soil may be due to their exchangeable chacteristics (Ca^{+2}, Mg^{+2} etc.). In turns these ions are replaced by Na^+ ions. This makes the soil quality saline/sodic.

Due to waterlogging the effective concentration of micronutrients (Zn^{+2}, Fe^{+2}, Cu^{+2}, Mn^{+2}) reduced in the region as micronutrients form soluble aquo complexes with water etc. molecules, which keep on transmigrating or diffusing due to sublayer hydrostatic conditions. Accordingly concentration levels of such ions like Fe^{+2}, Mn^{+2} etc. in the soil samples are quite comparable to that of the reference. Higher sulphate contents of scrapped soil due to the scrapped soil (sublayer soil) is never in direct contact with saline water. However this sublayer is situated on the sulphatic rocks (selenite or gypsum). Hence, due to moisture catalysed weathering of these deeply situated sulphatic beds, soluble sulphates gradually effloresce upwards. Thus higher sulphate contents in sublayers of scrapped soil are expected.

Table 03: - Wheat crop Impact status

S. No.	Characteristics/ Investigations	Unit	Soil Quality				
			Reference/ control soil	Unleached Soil		Leached Soil	
				Unscrapped (0-5 cm.)	Scrapped (5-20 cm.)	Unscrapped (0-20 cm.)	Scrapped (5-20 cm.)
01	Germination	days	07	ND	08	07	08
02	Shoot Growth	In cm					
	20^{th} Day		19.9	--	19.5	17.5	19.5
	45^{th} Day		42.9	--	39.3	40.4	45.3
	70^{th} Day		81.7	--	78.3	70.3	80.3
03	Wheat crop Yield	In gm	1.75	--	1.11	0.65	1.18
04	Biomass	In gm	8.47	--	7.81	6.16	8.16
05	Wt. of fodder (4-3)	In gm	6.72	--	6.7	5.51	6.98

On the basis of the analysis of soil and water samples (mentioned in Table 01 and 02) it was found that the status of scrapped and leached soils should be improved sufficiently. Because scrapping and leaching are so prominent that the soil processed so attains EC/TSS/pH values quite comparable to those of the reference soil.

Due to waterlogging and salinity playing their harmful role and impede the furtherance of the contributing factors. The better results of scrapped soil reveals, because scrapping eliminates harmful concentrates to a great extent. The sub layer appears to be richer in micronutrients, humus and facilitating microbes. Initially the rate of growth is fast and then slowed down (during 45-70th days) than that of the reference soil. It is attributable to the fact that during the period (30-45th days) some growth promoting and fruit forming hormones are formed. Such hormonal changes stimulate the growth relatively more in the reference soil for obvious reasons. Due to more salinity wheat crop yields are also slightly reduced, which function as defoliant/depressant.

Conclusion:

Salt stress adversely affects plant nutrient acquisition, especially in the root, resulting in a significant decrease in shoots dry biomass. Crop productivity is decreasing due to climatic changes. Moreover, human populations are increasing daily, which results in starvation problems in the developing countries. Nowadays, research is more focused on enhancing crop yields in spite of various unfavorable environmental conditions. Such change has been correlated with variation in the antioxidant enzymes such as catalase and peroxidase activity, photosynthesis rate, leaf greenness, and other growth-promotion parameters including plant height, dry weight, etc. Further studies may be take place on plants inoculated with Zn-mobilizing bacteria (ZMB) have an enhanced growth and acquired a better capacity for salt tolerance, correlated with the regulation of ion concentrations. To grow food for all, the use of such biofertilizers, especially ZMB, may be a beneficial means for the enhancement of plant growth and yield for the growing populations.

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