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Effect of sodicity on biochemical traits of tolerant and susceptible rice (*Oryza sativa* L.) varieties

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Abstract
Present investigation entitled "Effect of sodicity on Biochemical traits of tolerant and susceptible rice (*Oryza sativa* L.) varieties" was conducted during *kharif* season 2016, at the experimental site (MES), Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad-224 229, (U.P.). The experiment was carried out in field with four varieties of rice *i.e.* CSR36, Narendra usar dhan-3(tolerant), IR-28 and Swaran *sub-1* (susceptible), three soil type *viz.* control (8.0-8.5pH) and (8.5-9.0pH) and (9.0-9.5pH). The experiment was laid under Randomized block design (Factorial) with three replications. Results of the experiment revealed that sodicity decreased Sodicity significant decreased the total chlorophyll content in leaves. Sodicity tolerant varieties showed higher total chlorophyll content as compared to susceptible ones at all the stage of observation (seedling established, 3rd, 6th, and 9th DAT) in all the rice varieties at all the stage of the observation. Sodicity tolerant varieties, CSR36 and Narendra user-3 showed minimum reduction in all traits under sodicity, however, susceptible, IR28 and Swarana *sub 1* sowed maximum reduction.

Keywords: Chlorophyll content, rice, biochemical, sodicity etc.

Introduction
Rice is the monocarpic annual plant belonging to genus *Oryza* of Poaceae family. The genus *Oryza* has 24 species of which, 22 are wild and two species viz., *Oryza sativa* and *Oryza glaberrima* are cultivated. All varieties found in Asia, America and Europe belonging to *Oryza sativa* and varieties found in West Africa belonging to *Oryza glaberrima*, further *Oryza sativa* rice varieties of the world are commonly grouped into three sub species *viz.*, Indica (India), Japonica (Japan) and Javanica (Indonesia). The largest rice cultivars are available at International Rice Research Institute (IRRI), Philippines, with over 100,000 rice accession held in International Rice Gene Bank. "Rice is life" this slogan of the International year of rice (2004) outlines the importance of rice. Rice is a most important staple food crop in the world as well as in India. It is the rich source of energy and contains reassemble amount of protein 6-10%, carbohydrate 70-80%, mineral 1.2-2% and vitamins (Riboflavin, thiamine, niacin and vitamin E).

In India, it is cultivated under varied situation like from below sea level (in Kerala) to about 2000 m altitude (in Himalayan region), from 8^0N latitude (in Kanyakumari) to 35^0 N latitude (in Kashmir), annual rainfall from 2,818 mm (Assam) to 25 mm (Rajasthan). As for as soil is concerned, it can be grown from sandy loam soil to heavy black cotton soils and from normal to saline alkaline soils.

Uttar Pradesh state is an important rice growing state in the country The area and production of rice in this state is about 25.86 million hectare with production of 13.83 million tonnes respectively with an average productivity of 2358 kg/ ha. (Anonymous, 2015-16). Though average productivity of rice in the state is nearly equal to national average, but ranks seventh after Punjab, Tamilnadu, Haryana, Andhra Pradesh, Karnataka and West Bengal. Rice is an excellent source of carbohydrate and to a certain extent it provides protein to regular human diet. So it is used as staple food crop by about half of the world population and eaten as cooked rice and also used for various preparations inhabiting in the humid tropics and subtropics. Further, rice has commercial and industrial importance also beside grains. Rice straw and rice hulls are used as fodder, mulching, packing and as insulation material etc. Globally, India stands first in rice area and second in rice production, after China.

It contributes about 40 to 43 % of total food grain production and is playing a vital role in the food and livelihood security system. Rice is cultivated world-wide over an area about 160.69 million ha^{-1} with an annual production of about 478.76 million metric tonnes. In Indian agriculture; rice is the main source of livelihood for more than 150 million rural households. The total area of rice crop in India is 42.77 million hectare, which produces 106.54 million tonnes with an average productivity is 2490 kg/ha (Anonymous, 2015-2016).

Salt affected soil are Identified by excessive levels of water-soluble salts especially sodium chloride (NaCl). Excess Na^+ in plant cells directly damages membrane systems and abnormal development prior to plant death. The toxic ions cause ionic and osmotic stress at the cellular level in higher plants, especially in susceptible germplasm. Salinity reduces plant growth through osmotic effects and reduces the water uptake, thereby causing a reduction in growth. Salinity can limit plant growth and yield by three ways including reduce osmotic potential, ions toxicity creation, uptake disarrangement and balance of ions and cause disorder in enzyme activities membrane and metabolic activity in plant Murphy and Durako, 2003) [16]. These process could affected morphological parameters and plant growth and will reduce vegetative growth active leaf area, chlorophyll content, plant height and consequently reducing plant dry weight and ultimately crop yield (Sairam and Tyagi, 2004) [21]. Growth and yield reduction of crops is a serious issue in salinity prone areas of the world. Water-deficit and salt affected soil are two major abiotic stresses which reduce crop productivity, especially that of rice, by more than 50% world-wide. Salinity is one of the important abiotic stresses limiting rice productivity.

Statistical Analysis

Data recorded on various growth and yield attributes were subjected to statistical analysis by Fisher method of analysis of variance.

Material and Method

The site has sub-humid climate and falls in the Indo-gangetic plains having an alluvial soil and lies between latitude 26.47^0 North and at a longitude 82.12^0 East with an elevation of about 113 meters from sea levels and is subjected to extremes of weather conditions. Present investigation entitled

"Physiological Effect of sodicity on Biochemical traits of tolerant and susceptible rice (*Oryza sativa* L.) Varieties" was conducted during *kharif* season 2016, at the experimental site (MES), Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad-224 229, (U.P.). The experiment was carried out in field with four varieties of rice *i.e*. CSR36, Narendra usar dhan-3 (tolerant), IR-28 and Swaran *sub-1* (susceptible), three soil type *viz.* control (8.0-8.5pH) and 8.5-9.0 and 9.0-9.5. The experiment was laid under Randomized block design (Factorial) with three replications. Results of the experiment revealed that sodicity decreased Sodicity significant decreased the total chlorophyll content in leaves. Sodicity tolerant varieties showed higher total chlorophyll content as compared to susceptible ones at all the stage of observation (seedling established, 3rd, 6th, and 9th DAT) in all the rice varieties at all the stage of the observation. Sodicity tolerant varieties, CSR36 and Narendra user-3 showed minimum reduction in all traits under sodicity, however, susceptible, IR28 and Swarana *sub 1* sowed maximum reduction.

Results and Discussion

Chlorophyll Content

The detrimental response of salinity on growth and yield of crops might be mediated through their effects on metabolism of the plants. In the present investigation, salt stress altered various metabolic aspects in rice varieties which included total chlorophyll content (SPAD) value, chlorophyll a/b ratio and proline content in leaves of rice. All varieties had lower total chlorophyll and chlorophyll a/b ratio in leaves under sodic soil than normal soil. The maximum reduction was observed in susceptible varieties IR28 and IR29, however, tolerant varieties CSR36 and CSR43 had less reduction. The reduction in chlorophyll content under salinity might be due to loosened binding between chlorophyll and chloroplast protein. The reduction in chlorophyll depends on the varietal tolerance to salinity. It is in accidence with suggested that chl is affected more than chl b under salinity and proposed chl a/b ratio as an indicator of leaf senescence. Reduction in total chlorophyll content under salt stress have also been advocated by many workers in different crops (Gill, 1987) [7]. According to the specific enzyme responsible for green pigment synthesis are suppressed under salt stress condition. Under saline condition there will be degradation in pigment, which induce decrease in chlorophyll content. Salinity stress may also led to destruction of fine structure of chloroplast and instability of pigment protein complex (Lapina and Papov, 1970) [15]. In the present study, the leaves of rice accumulated more proline content under sodic soil with respect to normal soil at all stages of observation

Table 1: Effect of sodicity on total chlorophyll SPAD (Value) in leaves of rice.

Varieties	Seedling stage	After transplanting stage			Mean
	Control	Control	8.5-9.0pH	9.0-9.5 pH	
CSR-36	12.34	10.42	11.30	10.3	10.66
NDR Usar Dhan-3	10.35	9.48	8.84	8.84	9.05
Swarna sub-1	8.0	8.41	8.29	8.19	8.30
IR-28	9.55	9.26	8.63	8.04	8.64
		V	**T**		**VXT**
Mean	10.06	9.39	9.25	8.84	9.39
SEm±	0.27	0.67	0.26		0.46
CD at 5%	0.80	NS	0.78		1.35

Cont…….

Varieties	At flowering stage			Mean	At physiological maturity stage			Mean
	Control	8.5-9.0	9.0-9.5		Control	8.5-9.0	9.0-9.5	
CSR-36	13.33	11.20	8.10	10.88	9.80	8.70	7.90	8.85
NDR Usar Dhan-3	11.48	10.50	7.90	9.94	8.80	7.90	7.10	7.96
Swarna sub-1	9.40	8.52	8.43	8.27	7.20	6.90	6.50	6.90
IR-28	10.62	9.26	7.60	9.16	8.20	7.40	6.80	7.52
	V	T		VxT	V	T		VxT
Mean	11.22	9.86	7.62		8.56	7.71	7.10	
SEm±	0.56	0.28		0.46	0.24	0.28		0.48
CD at 5%	1.65	0.83		1.35	0.70	0.81		1.40

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