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Revealing effect of selected agrochemicals on salinity stress tolerance of rice cultivars at seedling stage

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ABSTRACT

Salinity is a major factor reducing plant growth and productivity in rice cultivation. The effect of selected Agro-chemicals named Imidacloprid 70% WS (Gaucho), Thiamethoxam 70% WS (Cruiser), Nitrophenolate 0.5% WS (Atonik) on salinity tolerance at the seedling stage of 8 rice varieties (Bg 250, Bg 305, At 302, Bg 352, Bg 357, Bg 358, Bg 360, Bg 379/2) were studied. Recommended dosage of each chemical was used for seed treatment in each case. Control seeds were germinated without any seed treatment. Germinated seedlings were planted in sterilized sand medium supplemented with nutrient solution. Experiment was carried out following randomized complete block design with 4 replication and 50 plants were included in each replication. After 12 days, plants were treated with 5 dS/m salinized solution and let them grow in the salinized medium for 8 days. Another set of plants treated with Agrochemicals were maintained without giving salinity stress. After 8 day salinity stress different seedling parameters were recorded. All the Agrochemicals significantly reduced the adverse affects of salinity stress in rice seedlings. Varieties Bg 250, Bg 352 and Bg 379/2 recorded most positive effects of the chemicals.

Keywords: Agrochemicals, salinity seed treatment and tolerance

Rice (*Oryza sativa* L.) is an important cereal crop in the world. It is the staple food for more than two third of the world's population as well as in Sri Lanka (Dowling *et al.*1998*)*. In Sri Lanka, the present annual paddy production is around 2.5 million metric tons. Some biotic and abiotic factors cause to reduce paddy yield. One of the major factors limiting paddy production is soil salinity. An estimated 54 million hectares of current and potential rice lands in the South and Southeast Asia are severely affected by salinity (Shereen *et al.* 2005). About 0.7 million hectares of rice lands in Sri Lanka are under the threat of salinity (Akbar and Ponnamperuma, 1982). Even in the dry zone of Sri Lanka, salinity has become a major factor limiting rice production in areas under irrigation schemes where drainage facilities are insufficient (Balasoouriya, 1987). Only a few systematic studies exist on the soil salinization problem in Sri Lanka, and there are no recent records of the actual extent of lands affected by salinity.

Rice is extremely sensitive to salinity during germination, young seedling and early developmental stages (Sing *et al.,* 2010). Salinity adversely affects seedling growth and the extent of damage depends on both salt concentration and time of exposure. Even at lower salinities, longer exposure time causes measurable effects (Zeng and Shannon 2000). The level of salinity in the areas have been categorized in to four *i.e.* S1 (< 4dS m-1), S2 (4-8 dS m-1), S3 (8-15 dS m-1) and S4 (> 15 dS m-1) and among these categories S1- S3 were used for rice cultivation (Islam and Gregorio 2013).

Various management options such as soil reclamation, excessive irrigation, and soil drainage are used to minimize soil salinity; they are always laborious and expensive. Other strategies such as varietal improvement have to be done for constant and profitable rice production (Yeo and Flowers , 1984; Koyama *et al.,* 2001). Also there is a new concept of using agro chemicals to overcome the salinity stress is upcoming. Chemical products that mediate crop stress responses are an untapped market with the potential for yield stabilization in areas prone to aberrant weather. Exogenously applied Pro has been found to reduce the inhibitory effects of NaCl on the growth of rice (*Oryza sativa* L.) (Krishnamurthy, 1991). The effect has been explained in two ways; chemical interact with enzymes to preserve protein structure and reduce the enzyme denaturation to abiotic stresses such as high NaCl (Rajendrakumar *et al.,* 1994) or protect proteins and membranes from damage by inactivating highly reactive Oxygen species (ROS) when abiotic stresses inhibit electron-transfer processes (Saradhi *et al.,* 1995). The present study was conducted to identify the effect of exogenous application of some selected agrochemicals on salinity stress tolerance of few rice varieties at early seedling establishment.

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MATERIALS AND METHODS

Study was conducted at the Faculty of Agriculture, University of Ruhuna, Sri Lanka. Eight rice varieties were used in the experiment (Bg 250, Bg 305, At 302, Bg 352, Bg 357, Bg 358, Bg 360, Bg 379/2).. For surface sterilization seeds were first dipped in 70% alcohol for 2 minutes and washed properly using distilled water. Then seeds were dipped in 1% chlorex for 30 minutes and washed with distilled water. Seeds were kept in an incubator at 35^{o}C under dark condition for 5 days for uniform germination. Sprouted seeds were treated using three selected agrochemicals such as - Imidacloprid 70% WS (Gaucho) an insecticidal seed dressing with systemic activity for the control of aphids, Thiamethoxam 70% WS (Cruiser), an insecticide for seed treatment Nitrophenolate 0.5% WS (Atonik) a biostimulant with systemic activated resistance. Recommended doses were used as the effective doses of the chemicals. Treated seeds were planted in sieved, washed out, sterilized sand with Hyponex (Toyoba, Japan) solution according to the randomized complete block design with 4 replicates and 50 plants per each replicate. Hyponex (N:P:K: 5:10:5) solution was used as hydroponic solution for both control plants and stressed plants. Untreated and unstressed control plants were also maintained separately (Fig.1A). Plants were grown under normal growth condition for 12 days after which a salinity level of 5ds/m was applied by adding NaCl in to the Hyponex solution to create stress (Fig.1B). Plants were evaluated for plant height, plant fresh weight, plant survival percentage and plant dry matter weight. Data were analyzed by ANOVA using SAS. Mean separation was done according to DMRT groupings.

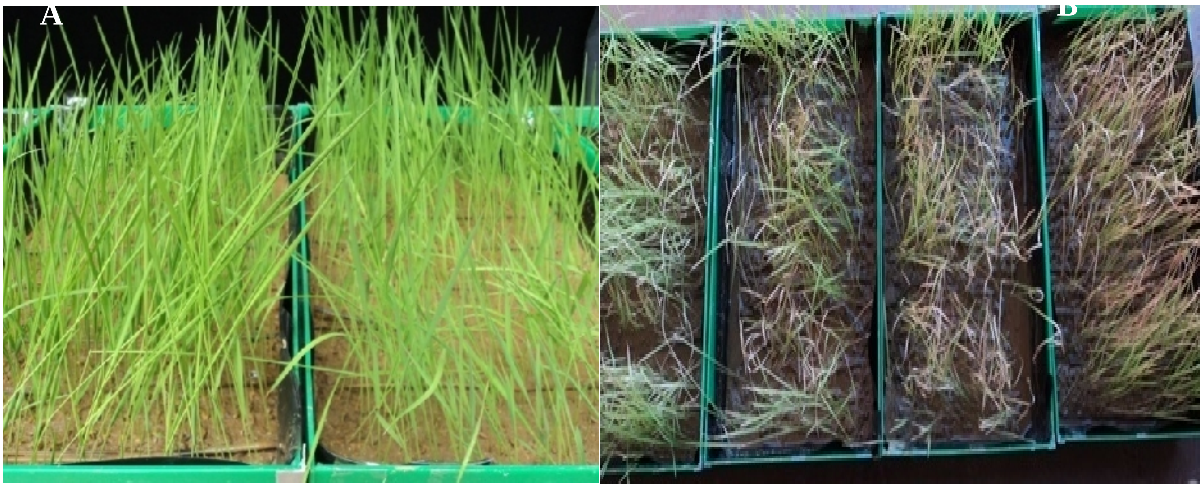

Fig. 1: Two steps of the methodology A, Rice plants before the salinity stress B, Rice plants after the salinity stress

RESULTS AND DISCUSSION

The results indicated significant effect of the chemicals on salinity stress tolerance in tested rice cultivars (Table 1). The significant differences were noted in all the parameters between stressed plants produced by treated seeds and those produced by untreated seeds. The variety and agrochemical interaction was also significant. Among tested cultivars each rice cultivar treated with any of the agro chemical, imidacloprid 70WS (Gaucho), thiamethoxam 70WS (Cruiser), or nitrophenolate 0.5WS (Atonik) was significantly tolerance for salinity stress in each parameter than that of in plants developed by untreated seeds. The treated seedlings of Bg 250, Bg 352 and Bg 379/2 showed significantly higher plant height under salinity stress than other verities (Table1) and Bg 250, Bg 305 and Bg 352 cultivars showed the highest plant fresh weight and highest dry matter weight while Bg 250, Bg 305, Bg 352 Bg 379/2 cultivars showed the highest plant survival percentage under treatment. Hence, rice cultivars Bg 250, Bg 352 and Bg 379/2 showed the highest tolerance for salinity after seed treatment.

Table 1: Effect of agrochemicals on plant height, plant fresh weight, plant dry matter weight and plant survival percentage in salinity stress

	Plant height (cm)					Plant fresh weight (g)					Plant dry matter weight(g)					Survival percentage				
Rice variety	Control	No chemical+Salinity	Gaucho+salinity	Cruiser+salinity	Atonik+salinity	Control	No chemical+Salinity	Gaucho+salinity	Cruiser+salinity	Atonik+salinity	Control	No chemical+Salinity	Gaucho+salinity	Cruiser+salinity	Atonik+salinity	Control	No chemical+Salinity	Gaucho+salinity	Cruiser+salinity	Atonik+salinity
Bg 250	26.9	21.5	25.2^{a}	23.4^{a}	26.0^{a}	0.88	0.57	0.70^{a}	0.68^{a}	0.82^{a}	0.13	0.101	0.116^{a}	0.112^{a}	0.12^{a}	94.0	65.6	77.0^{a}	70.0^{a}	80.6^{a}
Bg 305	22.3	18.7	20.2^{d}	20.1^{c}	21.3^{d}	0.73	0.49	0.60^{b}	0.57^{b}	0.71^{b}	0.100	0.083	0.091^{d}	0.089^{d}	0.096^{d}	95.6	60.3	$70.6b^{c}$	62.6^{c}	75.0^{b}
At 302	18.6	15.4	17.0^{e}	16.0^{e}	17.8^{e}	0.63	0.39	0.49^{d}	0.44^{de}	0.56^{d}	0.12	0.081	0.1^{b}	0.092^{c}	0.101^{c}	95.0	58.0	64.3^{e}	61.0^{c}	65.6^{d}
Bg 352	25.6	20.6	23.4^{b}	22.3^{b}	24.4^{b}	0.69	0.50	0.67^{a}	0.57^{b}	0.68^{b}	0.125	0.099	0.113^{b}	0.104^{b}	0.112^{b}	96.0	63.6	72.3^{b}	67^{ab}	73.0^{b}
Bg 357	23.4	17.1	20.9^{cd}	18.8^{d}	22.1^{d}	0.65	0.41	0.51^{d}	0.48^{cd}	0.60^{c}	0.106	0.08	0.098^{c}	0.09^{cd}	0.093^{de}	98.3	50.0	68.6^{cd}	56.0^{d}	69.3^{c}
Bg 358	15.6	12.2	13.4^{g}	13.0^{f}	14.1^{f}	0.55	0.32	0.46^{e}	0.40^{e}	0.49^{e}	0.091	0.064	0.08^{e}	0.071^{e}	0.085^{e}	97.3	48.0	56.3^{f}	52.6^{d}	59.6^{e}
Bg 360	15.4	12.4	14.6^{f}	13.8^{f}	14.2^{f}	0.62	0.44	0.51^{d}	0.50^{c}	0.59^{cd}	0.099	0.045	0.069^{f}	0.054^{f}	0.074^{f}	92.6	56.0	65.6^{de}	60.3^{c}	66.0^{d}
Bg 379/2	22.8	18.7	21.8^{c}	20.4^{c}	22.2^{c}	0.61	0.39	0.57^{c}	0.48^{cd}	0.58^{cd}	0.112	0.082	0.100	0.092^{c}	0.105^{c}	96.3	57.6	70.0^{bc}	64.3^{cb}	72.3^{cb}

Note: DMRT groupings were for different rice cultivars at the same seed treatment, The same letters within same column show non-significant variations

Atonik, Gaucho and Cruiser significantly minimized the adverse effects of salinity stress in rice at the seedling stage. Among 8 rice varieties examined, variety Bg 250, Bg 352 and Bg 379/2 showed the significantly highest value for all the parameter; under salinity stress after seed treatment. The present study indicated that agrochemicals like Gaucho, Atonik and Cruiser can be used effectively to minimize the salinity stress at seedling stage of rice.

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