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IMPACT OF TAMARIND ON GERMINATION AND YIELD OF RICE IN SALINE SOIL

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Response of Purbachi variety of rice to application of tamarind (@ 0, 3, 6 g pot^{-1}) and brackish water (Eciw 0.7, 2.5, 5.0 dSm^{-1}) in saline soil of Satkhira, Khulna have been observed in a green house experiment. Results revealed that percentage of germination of seeds increased significantly when the seeds were treated with tamarind (100 mg petridish^{-1}) in the presence of low as well as high levels of brackish water. Height and root length increase of seedlings also corresponds with percentage of germination both in low and high brackish irrigation water. In low brackish water irrigated pots, addition of tamarind showed a positive and significant impact on yields of grain, straw and height of plants. Tamarind treated plants showed as a deterrent to the harmful effect of salt concentration of irrigation water and subsequently helped rice plants to yield more as compared with untreated ones. The yield increased overall by the use of tamarind was 15.7% irrespective of brackishness of irrigation water. The content of Na, Ca, S, P and N in straw of rice remained statistically unaffected with respect to individual treatments of tamarind except by degree of brackishness of irrigation water.

Key words: Tamarind, Brackish water, Germination, Growth, Seedlings, Yield, Minerals, Rice.

Introduction

About 1 m ha of coastal saline soils occurs in Bangladesh covering about 52.8% of the net cultivable area of the 13 southern districts[12]. The entire area is much too under use and almost traditionally monocropped during monsoon under rainfed with local rice having moderate to poor yield. Attempts have been made in recent years to mitigate the salinity problem by both organic and inorganic amendments[3,4] together with improved irrigation and drainage [5,8]. Under the above circumstances, a green house experiment with Purbachi variety of rice as index was conducted with the objective to counter the yield deterioration due to brackishness of water with the help of tamarind, an indigenous locally available organic amendment.

Materials and Methods

Preparation of Tamarind Mixture with Brackish Irrigation Water

For germination of rice seeds in petridish

Initially fifty percent of tamarind (0, 50, 100, 150 and 200 mg petridich^{-1}), locally collected was mixed thoroughly and separately with 20 ml of water per treatment for each grade of brackish water (ECiw 0.7 and 5.0dSm^{-1}) for the use of seed germination of rice in petridish. After seven days, tamarind mixture was made with the remaining tamarind in respective grade of brackish water in similar way for second time use.

For pot culture

3g of tamarind was mixed with 75 ml of respective brackish irrigation water (ECiw 0.7, 2.5 and 5.0 dSm^{-1}) to form 75 ml of tamarind mixture. The tamarind mixed suspension was in the ratio of 0.1 and 2 for 0.3 and 6g of tamarind pot^{-1} respectively in each grade of brackish irrigation water. This operation was done for three times for the application of entire treatment.

Germination of Rice Seeds in Petridish Irrigated with Tamarind Mixed Water.

A germination test of Purbachi variety of rice in petridish was done using tamarind treated brackish water. The petridishes were washed, dried and made ready for experiment. Five levels of tamarind (0, 50, 100, 150 and 200 mg petridish^{-1}) and two levels of water (ECiw 0.7 and 5.0 dS^{m-1}) were used. Fifty percent of the tamarind was applied as basal dose and the rest 7 days after sowing (DAS). Initially one hundred seeds of rice were uniformly placed in the medium and were allowed to germinate and grew for 2 weeks. A total of ten treatments, in triplicate, were arranged randomly and water of respective quality was added in equal amount in each petridich as required for rest of the growing period. Percentage of germination, seedlings height and root length were record.

Potted Rice Irrigated with Tamarind Mixed Water

Each earthen pot (35 cmx30 cm) packed with 12 kgs of processed soil (0-15 cm) of Benerpota, Khulna mixed with TSP, MP and urea (at the rate of 0.7, 0.35 and 0.9g each) and was soaked with normal water and wetted. One third of N (80 kg ha^{-1}) and all PK (60, 40 kg ha^{-1}) were applied as basal dose. The rest of N was applied in two equal splits at tillering and before panicle initiation. Three levels of each of the following grade of brackish water and three levels of tamarind suspension (tamarind (T), T =0g, T_1=3g

and T_2 =6g pot^{-1}) were applied. Brackish irrigation water grades were (ECiw), low = W_0 (0.7dSm^{-1}), medium = W_1 (2.5dSm^{-1}) and high = W_2 (5.0dSm^{-1}). Desired levels of brackish irrigation waters were prepared by diluting the saline water as per treatment with fresh water collected from the shallow tube wells. Each level of tamarind was applied thrice at an interval of 15 days in equal splits, initially, one third of each one a day before plantation starting. Thirty day old seedlings of Purbachi variety of rice were transplanted in four hills of each pot at the rate of 3 seedlings per hill. Total nine treatments, in triplicate, were arranged into randomized complete block design. The height of plant, grain and straw yields were recorded and straw was analyzed chemically for Na, K, Ca, Mg, N, P, Cl and S contents.

Results and Discussion

Germination of Rice Seeds in Petridish Irrigated with Tamarind Mixed Water

An experiment was conducted using Purbachi variety of rice as index at low (ECiw 0.7dSm^{-1}) and high (ECiw5.0 dSm^{-1}) brackish waters, with five levels of tamarind (0 50, 100, 150 and 200mg petridish^{-1}) to help see the combating influence of tamarind against brackish water, firstly on seed germination and secondly on seedling height and root length. The results thus obtained are presented in Table 1. From the Table 1, it is noticed that the percent of germination of rice increased significantly when seeds of rice were treated with tamarind in low brackish water (ECiw 0.7dSm^{-1}). Low level of tamarind (50mg pot^{-1}) could not make any countable headway, though there is some insignificant increase in percentage of germination. Nevertheless, at higher levels of tamarind (100-200 mg) the increases were highly significant (6 to 9% higher over 50mg). Of course, the increases among the higher levels are not much of difference (not significant). Moreover, it is noticed that there is a tendency to give lower percentage of germination (95 to 92%) with increasing tamarind concentration (above 50mg). So, it seems that at all probability, 100 mg tamarind petridish^{-1} is good enough to get higher percentage of germination.

In high brackish water without tamarind, the percentage of germination decreased due to the added salt through irrigation water (23%). Addition of tamarind at level T_2 (100 mg petridish^{-1}), the percentage of germination Increased significantly, and the datum is comparable with low brackish water control and the petridish treated with T_1 (50 mg tamarind). At higher level of tamarind, the percentage declined again significantly. From the data it appears that possibly tamarind at the rate of 100 mg as is the critical level so far the germination of seed is concerned. Height and root length increase of seedlings corresponds with the percentage of germination both in low brackish and high brackish irrigation waters (Table 1).

Table1. Impact of tamarind and brackish water on germination of seed, height and root length of rice seedlings.

T_0, T_1, T_2, T_3 and T_4 indicate 0, 50, 100, 150 and 200 mg tamarind petridish^{-1}. W_0= Low (0.7 dSm^{-1}) and W_1 = High (5.0 dSm^{-1}) brackish water used. DAS =Days after sowing.

Treatments	Germination (%)	14 DAS	
		Seedlings height (cm)	Root length (cm)
T_0W_0	85	13	9.4
T_1W_0	86	15.6	14.4
T_2W_0	95	15.8	15.3
T_3W_0	94	15.2	13.9
T_4W_0	92	15.1	12.1
T_0W_1	62	9.8	16.6
T_1W_1	70	13.9	11.2
T_2W_1	89	13.6	10.1
T_3W_1	77	11.4	8.3
T_4W_1	68	6.3	2.7
LSD(P=0.05)	4.14	1.33	1.28

Tamarind mainly contains dextrorotatory tartaric acid, which is highly soluble in water (139/100 g of water). It may be presumed that probably the tartarate dissociates into its acid tartaric to form acid Na-salt, which is the abundance in water, leaving K in the water solution causing an increase in percentage of germination. Notwithstanding the fact, at higher doses of tamarind much too concentration of tartarate prevented hydrolysis and thus becomes ineffective in low as well as high brackish waters.

Table 2: deterrent impact of tamarind on the affect of brackish water on yield of grain and straw and mineral content of rice straw.

Treatments	Yield (g pot-1)		Plant height (cm)	Minerals (%)							
	Grain	Straw		Na	K	Ca	Mg	Cl	S	P	N
W_0 T_0	42.9	39.1	84.2	0.25	0.66	0.22	0.19	0.26	0.12	0.09	0.42
W_0 T_1	53	45.8	87	0.15	0.6	0.23	0.18	0.24	0.11	0.08	0.35
W_0 T_2	53.5	45.6	88.9	0.14	0.59	0.23	0.18	0.18	0.11	0.07	0.35
W_1 T_0	40.3	38.7	80.6	0.66	0.6	0.2	0.2	0.68	0.14	0.1	0.46
W_1 T_1	45.9	41.8	81.1	0.62	0.6	0.22	0.2	0.61	0.13	0.09	0.42
W_1 T_2	49.1	44.3	84.3	0.59	0.56	0.21	0.21	0.54	0.14	0.08	0.41
W_2 T_0	31.3	28.3	77.7	0.89	0.56	0.16	0.21	0.17	0.16	0.11	0.53
W_2 T_1	33.2	28.9	79.4	0.88	0.54	0.19	0.25	1.02	0.15	0.1	0.48
W_2 T_2	34.3	33.5	80.1	0.84	0.54	0.17	0.24	0.91	0.18	0.1	0.46
LSD (P=0.05)	3.59	3.57	2.3	0.08	NS	0.03	NS	0.13	0.02	0.02	0.08

W_0 Low (0.7 dSm^{-1}); W_1 Medium (2.5 dSm^{-1}); W_2 High (5.0 dSm^{-1}) brackish irrigation water; T_0 0; T_1 3 and T_2 6 g tamarind pot^{-1}.

Potted Rice Irrigated with Tamarind Mixed Water

Application of three levels of tamarind (0, 3 and 6g pot^{-1}) under three grades of brackish water (low 0.7; medium 2.5 and high 5.0 dSm^{-1}) influenced grain and straw yields and mineral content of straw of rice (Table 2). It is established fact that the yield of rice decreased with the increase of brackishness of irrigation water. In all levels of brackish irrigation water (low, medium and high) the tamarind treated pots prevented the harmful effect of salt concentration of irrigation water and helped rice plants to yield more than usual.

In low brackish water irrigated pots, addition of tamarind showed a positive impact on yield of grain, straw and height of plants (Table 2). Tamarind alone at T_1 level (3g tamarind pot^{-1}) exhibited a very promising impact on yield of rice while irrigated with low brackish water. The yield went up to about 23% and the increase is statistically very significant. However, increased amount of tamarind over T_1 could not make any significant difference. In medium brackish water, the high dose of tamarind (T_2, 6 g tamarind pot^{-1}) gave a very significant increased yield (49.1 g pot^{-1}) which was even more than the control under low brackish water (42.9 g pot^{-1}). It seems probable that higher dose of tamarind is more effective in increased brackishness of irrigation water. In fine, it is apparent from the data that the tamarind has the capacity to counter balance the effect of brackish irrigation water. The effectiveness of tamarind is not much pronounced in high brackish water. The beneficial influence of tamarind may haply be explained taking the chemical composition. It may be of interest to explain how tamarind may help to solve the brackish problem of irrigation water. Tamarind fruit contains free tartaric acid ($C_4H_6O_6$ or HOOC (OH)HCCH(OH)COOH, and acid potassium salt ($KHC_4H_4O_6$). Tartaric acid may be dextro, levo, meso and dextro-Levo isomer but tamarind contains dextrotartaric acid. The free tartaric acid is highly soluble in water (139/100g of water) whereas acid K-tartarate is springly soluble in water. As the acid is dibasic can form two series of salts-acid salts and neutral salts. The soluble tartaric acid reacts with water containing charged Na^+ to form neutral Na salt or Na tartarate. In both type of salt formation, Na is bounded up. Moreover, acid K-salt in course of time may react with Na to form acid Na salt. Here again the Na is locked up and K is released to the soil. In short, probably this is the way of tamarind (tartaric acid dextro) protect the injury of rice plant caused by Na. The mineral content in straw of rice as influenced by tamarind was determined (Table 2). It is evident from the result that the content of Na, Ca, Cl, S, P and N in straw of rice remained statistically unaffected with respect to the individual treatments of tamarind except by the degree of brackishness of irrigation water.

Tamarind was thought to be effective in protecting the root from injury in the salt ravaged soil. Hence, the yield might be increased. It is interesting to note that the results were up to the expectations. The percentage of germination

increased in all cases significantly but more in low brackish water irrigated petridish. Even in high brackish water, addition of tamarind caused the percent of germination increase (89%), but the percent is comparable with the low brackish water (85%) and more than the control using only high brackish water (62%). Same was in the case of seedling height and root growth. In low brackish water, root growth was found as per sequence but in high brackish water, in combination with tamarind, the short root length was observed whereas without tamarind in the high brackish water gave longest root length. This may be due to the fibrous spongy growth in high saline concentration spreading with its all might but contributing nothing to the plumule growth. These lanky roots cannot uptake nutrients sufficient enough to transmit to the plumule. Lanky roots are crisis crossed and that hinders the translocation of nutrients.

The intractable and baffling problem in this soil with respect to crop production is not only the soil alone (the salinity of the soil), but the problem gets aggravated by the second factor i.e. the incorporation of Na salt through irrigation water (unavoidable). Being halted by the situation, it is thought to wise to add correcting materials to the soil directly or along with irrigation water to counter balance the added disastrous factors. Tamarind is thought wise to be the one to make use of it for the purpose.

Reference to Table 2. It is apparent at a glance the beneficial impact of tamarind on yield of rice. The yield increased overall by the use of tamarind was 15.7% and this increase was statistically significant irrespective of brackishness of irrigation water. Notwithstanding the fact, in case of low brackish water irrigation gave most promising result (tamarind 24%). Tamarind appeared to be very effective. In medium brackish irrigation tamarind was found effective. In high brackish irrigation water tamarind acted positively, but the efficiency was much less (low brackish water, 24%, medium brackish water, 15.3%; high brackish water, 7.8%).

In view of the above, it may be concluded that in medium and high brackish water, tamarind has shown promising for counter balancing salts in irrigation water if not reclamation of the saline soil. No reference is available in the literature regarding the use of tamarind for better yield. So, this experiment haply be said as an entirely new approach.

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