Increasing cropping intensity in saline coastal zone soils of Bangladesh: the challenges of fitting maize between wet soils at establishment and saline, dry soils after silking

Enamul Kabir[1], Yadul Islam[1], Sarwar Jahan[1], Richard W Bell[2]

[1] Agrotechnology Discipline, Khulna University, Khulna, 9208, Bangladesh (ekabir73@yahoo.com; atsujonku@gmail.com; mjahan70@yahoo.com)

[2] School of Veterinary and Life Science, Murdoch University, Murdoch, Western Australia, 6150, (R.Bell@murdoch.edu.au)

INTRODUCTION

The prevalence of a single rice (transplanted, t) crop each year in southwestern Bangladesh can be attributed to two factors: (i) soil remains saturated until after the ideal sowing window for winter crops and (ii) lack of fresh irrigation water in the dry period of winter despite abundant availability of saline water in the canals and rivers. Maize has been emerging as a new winter crop in this region but its yield is reduced significantly when irrigated with saline canal water (particularly irrigation at reproductive stage) (Kabir and Jahan 2015). While small ponds, adjacent to farmers' fields, are available they contain insufficient fresh water to fully irrigate winter field crops. We hypothesized that mixture of this pond water with saline water can be used for irrigating maize to increase yield. We also hypothesized that the early establishment of maize in the wet soil might minimize the need for saline water irrigation.

METHODS

Hybrid maize cv. Pacific 984 was sown as a late winter crop in 2015 (February to May) and in 2016 (early January to May) in Pankhali, Dacope, Khulna, Bangladesh. In both years, the previous t. *aman* rice was harvested in mid-December when the land was saturated by standing water. In 2015, land drying to field capacity (FC) took almost two months and maize was sown on 15 February after cultivation by full tillage using a two-wheel tractor. In 2016, the seed was dibbled in saturated soil on 2 January (draining out the surface water and without land preparation) and on 15 February after drying the field to FC. In both years, the treatments were four types of irrigation water: pond water (control), canal water, mixture of pond water and canal water (1:1), mixture of pond water and river water (1:1). Four irrigations were given in each year. The irrigation timing and electrical conductivity (EC) of water during each irrigation are given in Table 1. In both years, soil salinity was measured before and after irrigation. Fertilizers were applied at the recommended rate and time for the variety used. Plants were harvested ~97 days after sowing (DAS) in 2015 and 2016 in full tillage plots and 115 DAS in 2016 in dibbled plots. Data on the yield and yield attributes were taken following standard procedures. For each year's data, analysis of variance (ANOVA) was performed for randomized complete block design and the treatment means were separated by Duncan's multiple range test at 5% level of significance.

RESULTS AND DISCUSSION

In general, grain yield in 2016 (in dibbled plots) was higher than that of 2015 in all treatments (Table 2). The grain yield in all irrigations in the plots prepared by full tillage in 2016 was similar to that of 2015 (data not shown). Thus, the results of dibbled plots in 2016 were compared to 2015 below. The early sowing (~1.5 months) in wet soil in 2016 apparently enabled the plants to acquire relatively fresh water and nutrients (sodium and nitrogen in Table 2) for a longer time before the saline water exceeded the threshold for dry matter production (other nutrients data not shown) and grain yield (Table 2). Nevertheless, irrigation with saline water reduced grain yield (compared to the control, pond water) in both 2015 and 2016. In both years, mixture of pond and canal water

produced ~80% of control and mixture of pond and river water produced 55% of grain yield of the control. Canal water-only produced 55% of the grain yield of control in 2016 while it killed the plants in 2015 at the beginning of silking. The increase of soil salinity due to saline water irrigation was slow in dibbled plots (in 2016) compared to those of full tillage and late sown plots in 2015 and 2016 (data not shown). Despite high irrigation water salinity in pond plus river water in 2015, plants survived (produced 55% grain yield of control). This might be due to early summer rainfall in between 3rd and 4rth irrigation (data not shown).

Table 1. Electrical conductivity of irrigation water at each irrigation of field-grown maize. Canal or river water were mixed with pond water at 1:1 ratio. One-third of urea was applied during seed sowing: two-third was applied in two equal splits at 1st and 2nd irrigation. 'DAS' refers to days after sowing, 'Feb and 'Mar' denote for February and March, respectively.

Irrigation water source	1st irrigation, 1/3rd urea		2nd irrigation, 1/3rd urea		3rd irrigation		4th irrigation	
	2015: 21 DAS, 8 Mar	2016: 42 DAS, 13 Feb	2015: 42 DAS, 29 Mar	2016: 56 DAS, 27 Feb	2015: 56 DAS, 12 April	2016: 77 DAS, 19 Mar	2015: 70 DAS, 26 April	2016: 84 DAS, 30 Mar
	Electrical conductivity (EC, dS/m) of irrigation water							
Pond	0.6	0.5	0.8	0.6	1.0	0.8	1.2	0.9
Canal	6.2	3.8	8.0	4.9	10	6.8	12.0	8.2
Pond + canal	3.4	2.2	4.4	2.8	5.5	4.4	6.6	4.6
Pond + river	5.3	3.3	6.6	2.8	8.5	6.4	10.1	8.0

Table 2. Grain yield, nitrogen (N) and sodium (Na) concentration of field grown maize under different saline water irrigations. Different letters in a column indicate significant differences across treatments. Nitrogen and Na was measured from ear leaf at silking in both years.

Irrigation water source	2015			2016		
	Grain yield (t/ha)	N (%)	Na (%)	Grain yield (t/ha)	N (%)	Na (%)
Pond	7.4a	2.5a	0.25c	9.4a	2.8a	0.20c
Canal	0	1.2c	0.60a	5.2c	1.8b	0.45a
Pond + canal	5.8b	2.1b	0.45b	7.6b	2.5a	0.32b
Pond + river	4.1c	1.8d	0.52b	5.4c	2.0b	0.42a

CONCLUSION

The result the study indicates that maize can be grown as a late winter crop in the southwestern saline region of Bangladesh by early planting in wet soil and irrigating the crop with mixture of relatively fresh pond water and saline water (canal water). As the number of ponds in this region is small, interventions are needed to keep the canal water salinity at a lower limit (<5 dS/m) for irrigating the winter crops including maize. One of the interventions is in effect from 2016 by blocking the entry of saline river water to a canal after the rainy season. Salinity of the confined water in the canal has been using for irrigation in several winter crops including maize. Following the approach outlined for maize in the current study (dibbling the wet soil and irrigation with mildly saline water), cropping intensity of this region is increasing.

ACKNOWLEDGEMENT

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Reference

Kabir, E. and Jahan, S. (2015). Addressing low cropping intensity by fitting crops in rice-based cropping pattern in south-western Bangladesh. Project Report, Ministry of Education, Peoples' Republic of Bangladesh: Dhaka.