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Original Paper

Relationship Between Salinity and Crop Production in Different Hydrological Regimes Downstream of Muhuri Regulator

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Abstract

A large landmass was formed at the downstream of Feni river due to the construction of Muhuri regulator at a cross dam in Mirsaraiupazila of Chittagong district. But this land is more vulnerable to storm and tidal surges leading to saline water intrusion. The study site was selected from this area to investigate the relationship between salinity and crop production. Soil samples were collected from different hydrological regimes such as old protected area, new protected area, unprotected area and affected area from topsoil, subsoil and substratum in both wet and dry period. Crop yield of the sampling plots were recorded through farmer's interview. It was found that, salinity of the study area was less than 4 dS/m both in aman and rabi season. Rice is a semi-tolerant crop (it can tolerate salinity up to 4 dS/m). So no significant relationship between soil salinity and rice yield was observed. Farmers of this area mainly cultivate khesari crop in rabi season. A significant positive correlation (correlation coefficient 0.97) was found between the soil salinity and khesari yield in unprotected area. Water salinity inside the cross dam was around 0.1 dS/m (rabi season), which is considered excellent for irrigation. But outside the cross dam it ranged in between 4.8-5.4 dS/m in aman season and 12.4-20.8 dS/m in rabi season, which was extremely toxic for irrigation for the cultivation boro rice. Although soil salinity permits to cultivate HYV rice in a man season but water logging is the main constraint. HYV rice in boro season can be cultivated in old and new protected area by utilizing Feni river water inside the Muhuri regulator and closure dam for irrigation purpose. But in unprotected area, it can not be cultivated due lack of suitable irrigation water and tidal flooding. In the study area, non-irrigated

crop like khesari can be grown successfully just after aman season by utilizing residual soil moisture.

Keywords

landmass, salinity, crop production, irrigation, HYV rice

1. Introduction

Muhuri Irrigation Project (MIP) was proposed as a development plan in 1954-1963, commenced in 1977-1978 and was completed in 1985-1986 (Islam & Paul, 2004). It is one of the largest Flood Control, Drainage and Irrigation Projects (BWDB, 1999) in Bangladesh, which is situated in the confluence of the Muhuri, the Selonia and the Feni rivers to prevent tidal flooding during wet season (June-October). Due to construction of such closure dam and regulated river flow, there has been tremendous impact on the water dynamics and fresh-brackish water interface, both inside and outside the project area. As a result, it tremendously affects the hydrodynamics process at the Feni river estuary. There was only one embankment of Bangladesh Water Development Board (BWDB) on the eastern side of Feniriver before 1999. Agricultural production is hampered in the downstream of Muhuri regulator and closure dam. Also due to the effect of this regulator and closure dam the Feni river mouth was dramatically changed in its course and alignment. To protect this new char from the saline water intrusion a coastal embankment was constructed through Char Development and Settlement Project (CDSP)-II in 1999along eastern side of Feniriver downstream of the Muhuri regulator and closure dam. As a result, four types of hydrological regimes are observed in the downstream of the closure dam and Muhuri regulator. The hydrological regimes are (i) Old protected area (area inside the old embankment of BWDB) (ii) New protected area (area in between the old embankment of BWDB and new embankment of CDSP) (iii) Unprotected area (area in the western side, which is surrounded by the Feni river) and (iv) Affected area (area in between new embankment of CDSP and the Feni river). It is shown in Figure 1.

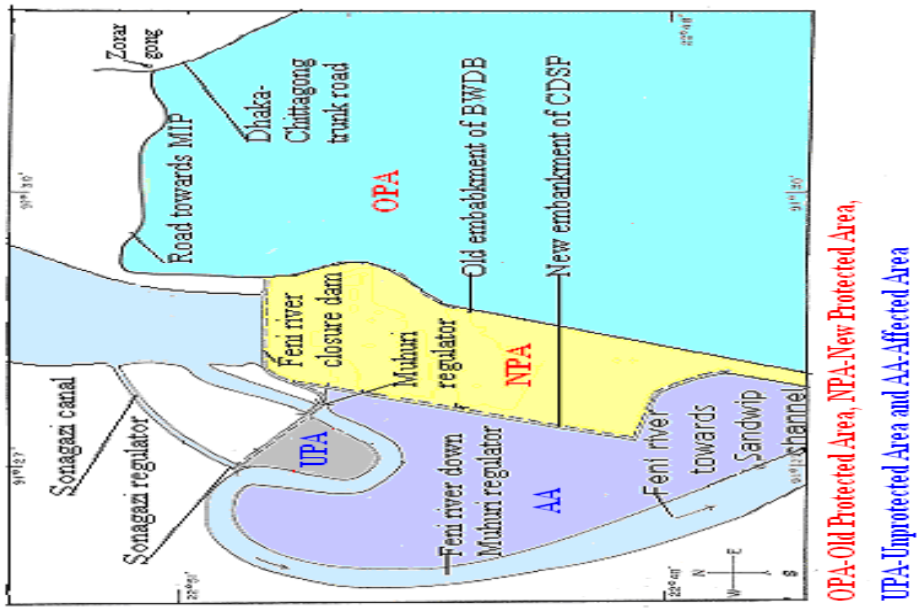

Figure 1. Different Hydrological Regimes of the Study Area at Mirsarai and Sonagaziupazilas

In the study area, the farmers cultivate local varieties of T. Aman rice in monsoon period and rabi crops (Khesari, Chilli, Lentil) in dry season. This study mainly focuses on different degree of salinity in different hydrological regime of the study area and its effect on crop production. It will provide information whether there is possibility to cultivate High Yielding Varieties (HYV) of crops under different salinity conditions.

2. Methodology

In the study area, agricultural problems were identified through farmer's interview. Soil sample was collected and analyzed in the soil laboratory of SRDI, Noakhali to determine salinity. Crop production data of the respective plot was recorded. Two crops, T. Aman rice for monsoon and Khesari for rabi season were considered. Relation between salinity and crop production was determined by statistical method. The methodology of the study is described below.

At first, each hydrological regime e.g. old protected area, new protected area, unprotected and affected area of the study area is subdivided into four blocks from north to south (towards sea) by eye estimation. So each block has possibilities of different range of salinity due to the distance from sea. In each of the blocks, the following works were done. (a) From interview, farmers of the area were selected. And representative soil samples were collected from topsoil (0-5 cm depth), subsoil (5-10 cm depth) and substratum (10-30 depth) during the harvesting period of T. Aman rice and Khesari (b)

Water samples both from inside and outside the regulator were collected at the same time of soil sampling from different locations of the Feni river at different distance. (c) Yield data of cultivated crops of the sampling plots were collected from the farmers of the respective plots(f) All collected soil and water samples were processed as per procedure and analyzed at SRDI laboratory, Noakhali immediately.

2.1 Measurement of the Salinity

United State Salinity Laboratory (1954) quantified salinity in terms of Electrical Conductivity, because Electrical Conductivity (EC) and total concentration of a saline solution is closely related as described by FAO (1999). So EC of the saturated soil extract (EC_e) for evaluating soil salinity or EC of the water (EC_w) for evaluating water salinity is based on average EC (Electric Conductivity) of saturated soil extract or water. EC_e is defined as the electrical conductivity of the soil water solution after the addition of a sufficient quantity of distilled water to bring the soil water content to saturation. EC_w is defined as the EC of water at 25^0 C. Salt concentration changes as the soil water content changes. EC_e/EC_w is typically expressed in deci-Siemens per meter (dS m^{-1}).

2.2 Crop Yield Record

Farmers harvested the crop in the field. Then threshed it in their homestead and measured the quantity of the crops. Yield data was collected from the farmers of the respective plots. It was verified with the yield of nearest crop fields.

3. Result and Discussion

3.1 Soil and Water Sampling Period

The soil (top, sub and substratum) in different hydrological regimes and water samples of Feni river at the downs near of Muhuri regulator were collected in aman season during harvesting of rice (3^{rd} December, 2005) and in rabi season during harvesting of khesari (3^{rd} March, 2006).

3.2 Soil Salinity in Aman Season

Topsoil salinity of the old protected, new protected, unprotected and affected areas varied between 0.40 to 2.3 dS/m, average of which were 0.73, 1.35, 1.03 and 1.33 dS/m, respectively. The average value of subsoil salinity in those areas were 0.68, 1.33, 0.98 and 1.25 dS/m, respectively and substratum were 0.68, 1.53, 1.03 and 1.25 dS/m, respectively in the old protected, new protected, unprotected and affected areas at the harvesting period of transplanted aman rice. Soil salinity at different hydrological regions indicated that soil remains non-saline in aman sea.

3.3 Soil Salinity in Rabi Season

Topsoil salinity of the old protected, new protected, unprotected and affected areas varied between 0.7 to 4.9 dS/m, average of which were 1.13, 1.98, 3.53 and 1.73 dS /m respectively. The average value of subsoil salinity in those areas were 0.78, 2.90, 2.15 and 1.18 dS/m, respectively and substratum were 0.86, 1.88, 2.53, 1.31 dS/m, respectively in the old protected, new protected, unprotected and affected areas at the harvesting period of khesari. Soil salinity in different hydrological regions indicated that

soil remains mostly non-saline in rabi season.

3.4 Water Salinity

Average water salinity outside the Muhuri regulator was found 5.48 dS/m with a range from 3.3-8.8 dS/m in aman season and 15.9 dS/m with a range from 12.4-20.8 dS/m in boro season (Table 1). Salinity of all water samples outside the regulator was more than 3 dS/m. These water samples were extremely toxic as per classification of water salinity by [3]. It was described that, water outside the embankment is brackish, moderately saline to saline, marginal to low quality. Similarly, SRDI rated the water as marginal to low quality. It was observed during field study that, farmers of the study area do not use water for irrigation purpose outside the Muhuri regulator of the Feniriver due to salinity problem. Water salinity reported by SRDI is higher than the present salinity result of study area which may be due to the fact that water sample were collected during critical dry period (second week of May/97). It was observed during field study that the farmers are using water inside the regulator for irrigation purpose.

Table 1. Water Salinity of Feniriver at Muhuri Regulator down

Sl. no.	Sampling location and condition Feni river and Muhuri regulator	Water salinity (EC, dS/m)	Average water salinity (EC, dS/m)
1	Outside the closed gates of the Muhuri regulator during high tide.	20.8	15.9 (water samples of the outside the closed gates)
2	Outside the closed gates of the Muhuri regulator during high tide.	14.5	
3	Outside the closed gates of the Muhuri regulator during high tide.	12.4	
4	Standing water inside the regulator during gate close condition.	0.1	0.1

3.5 Relation between Soil Salinity and Rice Yield

Relation between topsoil salinity (during harvesting time of T. Aman rice) and rice yield in aman season in old protected, new protected, unprotected and affected areas are shown in eq.1-4. The correlation coefficient in the study area varies from-0.4905to-0.4469, indicated a weak negative correlation between topsoil salinity and T. Aman rice yield in this area. This correlation is very weak (correlation coefficient< 0.50). Normally rice can tolerate salinity up to 4 dS/m but some studies indicate that, rice can tolerate much higher salinity. In the study area, soil salinity was found less than 4 dS/m during harvesting time of local T. Aman rice. Soil salinity decreases yield of T. Aman rice when soil salinity level exceeds the tolerance limit (4 dS / m). There will be no effect on the yield of T. Aman rice within soil salinity tolerance limit (4 dS/m).

In all the study locations, the relationship between rice yield and topsoil salinity and can be expressed

by the following equations.

For old protected area, RY= 3256.50-550.36(EC) ---R^2= 0.2406----R=-0.4905 (eq.-1)

For new protected area, RY= 2740.10- 151.74 (EC)---R^2=0.1985---R=-0.4469 (eq.-2)

For unprotected area,RY = 2467.70 – 350.71 (EC)----R^2= 0.1977--R= -0.4724 (eq.-3)

For affected area, RY = 2909.60 – 252.50 (EC) -----R^2 = 0.2378---R= -0.4877 (eq.-4)

where, RY = Rice yield and EC = Top soil salinity (dS/m)

Although the topsoil salinity was found less than 4 dS/m, i.e., below the tolerance limit of rice but it is not clear why the rice yield showed declining trend with the increase of soil salinity for 0.4 to 1.2 dS/m. The reasons for such decline in rice yield may be due to management, difference inheriting soil fertility, water logging in old and new protected area and frequency of tidal flooding in unprotected and affected area.

3.6 Relation between Soil Salinity and Khesari Yield

In all the study locations yield of khesari was positively correlated (correlation coefficient varies 0.6277 to 0.9422) with increase in topsoil salinity and can be expressed by the following equations. Highlypositive correlation (0.9422) between salinity and crop yield was found in unprotected area, which is shown in Figure 1.

For old protected area, KY =1254.70 + 52.71 (EC)---R^2 = 0.3924---R=0.6277 (eq.-5)

For new protected area, KY = 591.19 + 321.93 (EC)---R^2 =0.5175---R=0.7201(eq.-6)

For unprotected area, KY = 368.09 + 280. 68 (EC) -- R^2 = 0.9707---R= 0.9422 (eq-7)

For affected area, KY=1231.4 + 101. 08 (EC) ---------R^2 = 0.4879- R= 0.4879(eq.-8)

where, KY = Khesari yield, EC = Top soil salinity (dS/m)

The farmers broadcast khesari seeds during early November in rice field when soil retained sufficient residual moisture. At this time availability of residual soil moisture as well as soil salinity was higher in water-logged or tidal flooded areas. Although the topsoil salinity of the study area was found less than 4 dS/m, i.e., below the tolerance limit of khesari, it is not clear why khesari yield showed such inclined trend with the increase of soil salinity. The reason may be the difference of soil moisture content during germination time of khesari Relation between topsoil salinity (during harvesting time of khesari) and khesari yield in unprotected is shown in Figure 2.

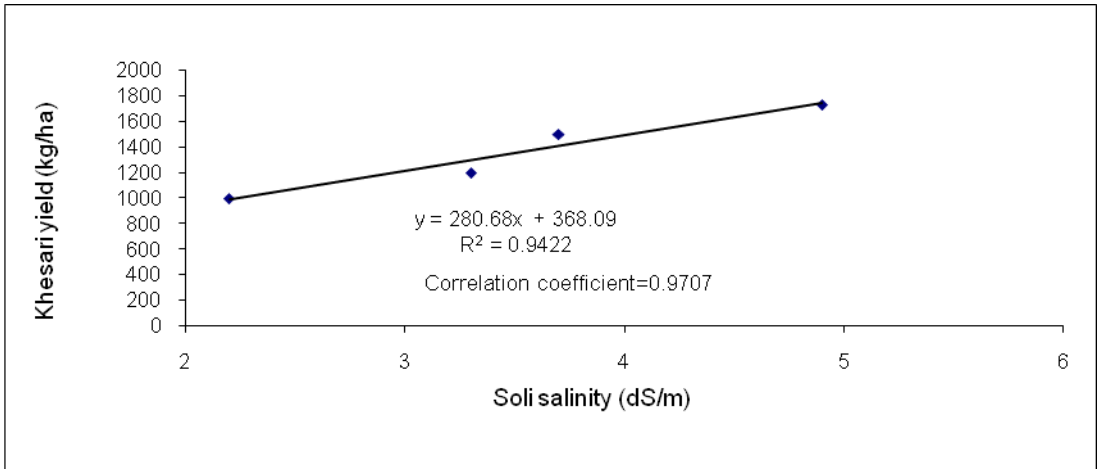

Figure 2. Relation between Topsoil Salinity and khesari Yield in Unprotected

4. Conclusion

The study area comprised of four hydrological regimes, e.g., old protected, new protected, unprotected and affected area of down Muhuri regulator. In the study area soil salinity was found to be less than 2 dS/m during aman season. Even a negative and very weak correlation (correlation coefficient < 0.50) was found between salinity and T. Aman rice yield. Soil salinity is not a problem to cultivate HYV rice in aman season. But the farmers do not cultivate HYV rice due to water logging and economic problems in old and new protected area, intrusion of tidal saline water in unprotected area and inundation by flood water in affected area.

Unlike rice, positive but not strong correlation (correlation coefficient < 0.75) was found between salinity and khesari yield in old protected, new protected and affected area. The main problem of cultivating HYV boro rice cited by the farmers was lack of irrigation water in old protected, new protected and affected areas. In unprotected area, the farmers, cited soil problem and for that they do not cultivate HYV of boro rice in this area in boro season.

Water samples collected from Feniriver down of Muhuri regulator both in aman and rabi season were found not to be suitable for irrigation.

5. Recommendations

The following recommendations can be drawn for the study.

In aman season, since soil salinity remains below 4 dS/m, HYV rice whether salt tolerant or not could be grown for improving productivity and farm income. But improvement of drainage is needed in old and new protected areas and tidal water protection is needed in unprotected area. Local representatives and related government department should take necessary steps to remove the constrains of Godasara canal of old protected area and CDSP should take strong measures to remove boundaries of fish pond in new protected areas. For the unprotected area, BWDB should take necessary measures to protect the lands from tidal water intrusion.

In Rabi season, HYV rice can be cultivated in old and new protected area by utilizing Feni river water inside the Muhuri regulator and closure dam for irrigation purpose. Related authority should take proper action for designing irrigation facilities in these areas. Khesarican be grown successfully inunprotected area and affected area. HYV boro rice can be grown in unprotected area if an embankment is constructed surrounding the unprotected area in east, north and west side and by using water inside the regulator for irrigation purpose. HYV boro rice can not be cultivated in affected area due to lack of irrigation water though soil salinity remains within tolerance limits (<4 dS/m) of rice.

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