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Standing water salinity and depth effects on dry season rice yield of Godavari delta

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ABSTRACT

*Influence of standing water salinity and depth on dry season rice yields were assessed in a typical Salt affected and water logged areas of Godavari Western Delta. Crop yield standing water depth (cm) and salinity (EC, dSm^{-1}) were monitored at weekly intervals in 48 locations at 100 x 100 m grid. Mean surface water salinity and depth of water were correlated with respective crop yields. Standing water salinity and depth were highly correlated (- 0.57 **) for dry season rice yield than standing water depth (-0.30*). Regression equations were developed for prediction of reduction in rice crop yield based on standing water salinity and standing water depth. Critical levels for 10%, 25% and 50% crop yield reduction for both standing water salinity and depth were established for dry season rice yield.*

Keywords: *standing water depth, salinity, rice yield, Godavari delta*

In many canal commands, there has been a rise in the water table and consequent degradation of soils through water logging and secondary salt build-up and the impact of irrigation over many years have caused the ground water table to rise into root zones in these command areas, which led to reduction in crop yields. This problem is found to be aggressive along the coastal line of Andhra Pradesh. The soils of Godavari Western delta nearer to sea are experiencing a problem of salinity and water logging due to seawater intrusion and improper drainage facilities. The relation between crop production and soil salinity is often derived from controlled experiments in laboratories, pot experiments, lysimeter studies or experimental fields (Kessler and Oosterbaan, 1980),where all growth factors, except the factor under study, are maintained constant, often at optimum level. Under farmers' and field conditions, relations are subjected to a large degree of variation and they need not be the same.

Rice is rated as an especially salt-sensitive crop (Shanon *et al.*, 1998). The response of rice to salinity varies with growth stage. In the most commonly cultivated rice cultivars, young seedlings were very sensitive to salinity (Lutts *et al.*, 1995). Yield components related final grain yield were severely affected by salinity. Panicle length, spikelet number per panicle, and grain yield were significantly reduced after salt treatments (Cui *et al.*, 1995; Khatun *et al.*, 1995). Salinity also delayed the emergence of panicle and flowering (Khatun *et al.*, 1995) and decresed seed set through reduced pollen viability (Khatun *et al.*, 19995). In contrast, rice was more salt tolerant at germination than at other stages (Khan *et al.*, 1997). The suppression of germination at high salt levels might be mainly due to osmotic stress (Heenan *et al.*, 1988).

Although there are extensive studies of standing water salinity and depth effects on rice, our understanding of the quantitative effects of salinity on rice yields and critical thresholds of responses with respect to modern, commonly used cultivars of India, is still limited. The objectives of this study were to determine the effects of standing water salinity and depth on dry season rice yield.

MATERIALS AND METHODS

Kalipatnam drainage pilot area is located in Godavari Western Delta near east coast of Peninsular India. These soils are waterlogged and saline sodic. Soils are alluvial and adjacent to salt stream (Upputeru) which is confluence sea at 9 km distance. Tidal fluctuations in

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the salt stream greatly influence on the ground water quality. The water table fluctuated between the soil surface in the monsoon season and 0.9 m below the ground level during dry season. The mean annual, dry season and winter temperatures are 26.9^{0}C, 30.1^{0}C and 23.8^{0}C, respectively and the mean annual rainfall is 853 mm. The soils of the pilot area are saline sodic with ECe of 4.03 to 16.00 dSm^{-1} during dry season 2005. The main crop at the pilot area is paddy followed by paddy with a fallow period of three months. The pilot area receives irrigation water from Kalipatnam main channel of Godavari Western Delta with an average EC of 0.3 dS m^{-1}. Flooding method of irrigation is adopted and water is allowed to flow from field to field. The excess water from the fields is drained to Upputeru through a separate drain called Magaleru drain.

Crop yields were monitored at 100m x 100m grid from 48 grid locations from 18 ha study area (Fig. 1). For dry season, 2007 MTU-1010 (Cottondora sannalu) was used as test variety. The crop yield was determined in sample plots of 2m x 2m. Standing water depth was measured and standing water samples were collected and analysed for EC (Richards, 1968) from

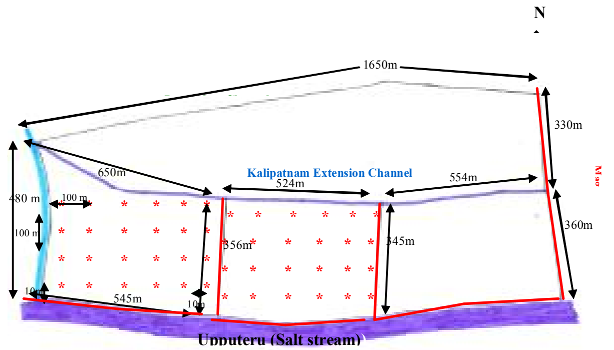

Fig 1. Grid points for monitoring crop yield, water depth and EC

the same 48 grid points at 100 m X 100 m spacing used for crop cut data. Linear regression equations were developed between crop yield and standing water salinity and depth and regression coefficients were tested for significance.

RESULTS AND DISCUSSION

Mean standing water salinity ranged from 0.60 dSm^{-1} to 3.95 dSm^{-1} with an average of 2.03 dSm^{-1}. Correspondingly, yield ranged from 4.41 t ha^{-1} to 8.93 t ha^{-1} with an average of 6.67 t ha^{-1} (Table 1). The relation between dry season rice yield and standing water salinity (Figure. 2) was highly correlated (r = -0.57**) and presented below:

$$Y = -0.85x + 8.39 \qquad (1)$$

Table 1. Grid Wise dry season, 2007 crop yield and average surface water Salinity (dS m^{-1})

Grid No	Standing Water Salinity (dS/m)	Yield (t/ha)
1	2.1	8.66
2	2.3	5.91
3	2.7	8.66
4	2.2	5.25
5	2.8	4.73
6	2.1	7.88
7	2.0	7.35
8	1.4	7.35
9	1.1	6.83
10	1.9	6.83
11	1.5	6.83
12	1.7	5.25
13	1.5	7.09
14	1.1	8.66
15	0.7	8.66
16	0.7	8.93
17	0.6	8.01
18	0.8	8.66
19	1.2	8.66
20	1.7	7.35
21	1.9	7.09
22	1.5	8.01
23	1.2	7.09
24	1.1	6.83
25	1.1	6.93
26	1.5	6.04
27	2.8	6.41
28	2.4	6.41
29	2.4	6.09
30	2.2	6.62
31	1.7	6.09
32	2.4	6.41
33	3.3	4.73
34	2.4	6.51
35	2.7	6.93
36	2.8	5.99
37	3.4	5.57
38	2.4	6.72
39	3.2	6.93
40	2.8	4.41
41	2.5	5.36
42	2.6	6.09
43	3.6	5.88
44	4.0	5.36
45	2.4	5.25
46	2.1	5.99
47	2.0	6.20
48	1.2	4.73

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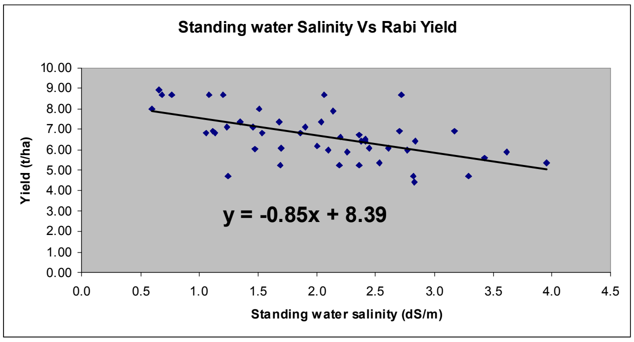
Fig.2. Relationship between dry season rice yield (t ha-1) and surface water salinity (dS m-1)

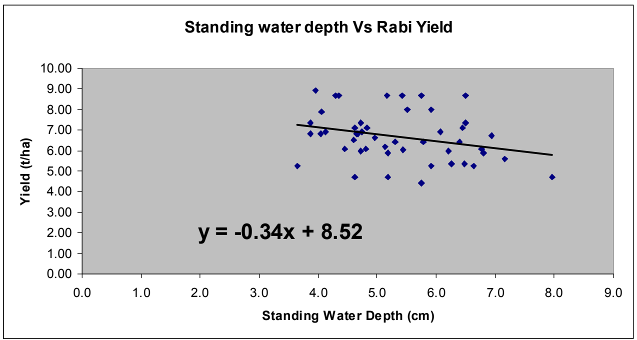


Mean standing water salinity ranged from 3.70 cm to 8.00 cm with an average of 5.40 cm (Table 2). Similarly, strong positive correlation was also noticed between dry season rice yield and standing water depth (cm) (Figure.3) was highly correlated (r= -0.30*) and presented below:

$$Y = -0.34x + 8.52 \qquad (2)$$

Similar kind of salinity effects on reduction in yield of rice was also studied by Zeng and Shannon (2000).

Fig. 3. Relationship between dry season rice yield (t ha-1) and surface water depth (cm)



Bernstein (1974) determined the salinity levels causing yield reduction of 10%, 25% and 50% in field experiments with some principal crops. Similarly, from the above developed regression equations critical levels for 10%, 25% and 50% yield reduction were computed (table 3) for both standing water salinity and depth were established for dry season rice yield of Godavari Western Delta. In dry season rice crop of Godavari Western delta in salt affected and water logged soils,

Table 2. Grid Wise wet season, 2007 crop yield (t ha-1) and standing water depth (cm)

Grid No	Standing Water Depth(cm)	Yield (t ha-1)
1	5.4	8.66
2	5.2	5.91
3	5.2	8.66
4	5.9	5.25
5	5.2	4.73
6	4.1	7.88
7	4.7	7.35
8	3.9	7.35
9	4.0	6.83
10	4.7	6.83
11	3.9	6.83
12	3.7	5.25
13	6.5	7.09
14	4.3	8.66
15	4.4	8.66
16	4.0	8.93
17	5.9	8.01
18	6.5	8.66
19	5.8	8.66
20	6.5	7.35
21	4.8	7.09
22	5.5	8.01
23	4.6	7.09
24	4.7	6.83
25	4.7	6.93
26	5.4	6.04
27	5.8	6.41
28	6.4	6.41
29	4.8	6.09
30	5.0	6.62
31	4.4	6.09
32	5.3	6.41
33	4.6	4.73
34	4.6	6.51
35	4.1	6.93
36	4.7	5.99
37	7.2	5.57
38	6.9	6.72
39	6.1	6.93
40	5.7	4.41
41	6.3	5.36
42	6.8	6.09
43	6.8	5.88
44	6.5	5.36
45	6.6	5.25
46	6.2	5.99
47	5.1	6.20
48	8.0	4.73

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Table 3. Regression equations and critical levels for yield reduction in *Rabi* rice

S.No.	Parameter	Equation	Threshold level		
			10% Yield loss	25% Yield loss	50% Yield loss
1.	Standing water salinity (dS m^{-1})	Y = -0.85x + 8.39	2.8	4.0	5.9
2.	Standing water depth (cm)	Y = -0.34x + 8.52	7.40	10.3	15.0

strong negative (P=0.01) relation was observed between rice yield and standing water salinity than water depth (P=0.05). Linear regression equations developed for predicting rice yield based on standing water salinity and depth.

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