Effect of Seedling Age and Density on Growth and Yield of Rice in Saline Soil

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Abstract
Two field experiments were carried out in saline soil receiving fertilizers NPK @ 130-75-75 kg ha⁻¹, respectively, to see the effect of seedling age and number of seedling hill⁻¹ on rice growth and yield. Rice seedlings of 25-, 35- and 55-day-old were transplanted in puddled field. Results revealed that seedlings of 25- to 35-day-old produced significantly higher number of tillers and productive tillers hill⁻¹, paddy and straw yields compared with 55-day-old seedlings. In the second experiment, transplanting of two and three seedlings hill⁻¹ of 35-day-old gave more promising results compared with one and four seedlings. Two seedlings hill⁻¹ caused maximum increase in plant height, straw and paddy yield while more number of tillers and productive tillers were recorded with three seedlings hill⁻¹.

Introduction
Better crop stand establishment is one of the key prerequisites for achieving desired level of rice production. Presently, rice occupies an area of 2.2 million ha in Pakistan (Zia et al., 1998). Among the factors responsible for low yield of rice, salinity has a special relevance to Pakistan and is a well recognized as a major concern because it accounts for 40 to 70 per cent yield reduction (Muhammad et al., 1991; Aslam et al., 1995). Qayyum and Malik (1985) reported an annual loss of about fourteen billion rupees due to soil salinity in Pakistan. This situation demands for reclaiming such degraded soils for economic crop production to meet ever-increasing challenge of food supply.

The proper care of salt affected soils is of course its reclamation that involves the use of chemical amendments. Certain factors like insufficient supply of good quality irrigation water, shallow ground water table, low permeability of soils, high cost of amendments and use of problem ground water, are limiting the success of tackling this problem (Muhammad et al., 1990). Therefore, we have to learn to live with salinity and manage such soils for sustainable and profitable agriculture.

Seeding age and plant population in rice are the important factors affecting growth and yield of rice (Hossain and Haque, 1988; Raju et al., 1989; Mahnan and Siddique, 1991; Bassi et al., 1994). Rice plant being photosensitive may respond well to variation in day length and intensity of light in different periods. Studies also showed a positive relationship between plant population and yield of rice (Singh, 1982; Chaudhry and Iqbal, 1986). Keeping the above discussion in view, the present study was undertaken with the following objectives i) determine the most appropriate seedling age of rice for transplanting in saline soil ii) determine the number of seedlings per hill to maintain optimum population of rice in saline environment.

Materials and Methods
Two field experiments were conducted on rice crop at Haveli Reclamation Research Farm Shorkot Cantt., during 1996-97. The soil was saline in nature having shallow water table; ECw 9.4 dS m⁻¹; pH 7.7 and SAR 11.3 (mmol L⁻¹). In the first experiment, seedlings of rice variety Basmati 385 of three different ages (i.e. 25-, 35- and 55-day-old) were transplanted in the puddled field with two seedling per hill. Fertilizers: NPK were applied @ 130-75-75 kg ha⁻¹, respectively. Whole dose of P, K and half of N was applied at the time of puddling while remaining half nitrogen was applied at the time of panicle initiation.

In the second experiment, thirty five-day-old seedlings of rice (Var. Basmati-385) were transplanted at the rate of one, two, three and four seedlings per hill in puddled soil. Fertilizers rate and method of application were the same as mentioned in experiment No.1.

Both the experiments were laid out in randomized complete block design with four replications. Canal water was used for irrigation. The following growth and yield parameters were recorded at different stages: a) plant height b) number of tillers hill⁻¹ c) number of productive tillers hill⁻¹ d) panicle length e) number of kernels panicle⁻¹ f) 100 kernels weight g) straw yield h) paddy yield. The data collected was analyzed statistically and means were compared by using LSD-Test according to Steel and Torrie.

Results
Effect of Seedling Age on Growth and Yield of Rice in Saline Soil: Results revealed that maximum plant height (124.7 cm) was found in 35-day-old seedlings but it was statistically alike to those produced by 25- and 55-day-old seedlings (Table 1). As regards the number of tillers per hill and number of productive tillers per hill (Table 1), 25-day-old seedlings stood superior in performance attaining 2
Table 1: Growth and yield characteristics of Basmati-385 as affected by seedling age under saline conditions. (Average of four replicates)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of tillers hill⁻¹</th>
<th>No. of productive tillers hill⁻¹</th>
<th>1000-kernel weight (g)</th>
<th>Paddy Yield (kg ha⁻¹)</th>
<th>Straw yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 day old seedlings</td>
<td>121.3 NS</td>
<td>20.40 a</td>
<td>18.75 a</td>
<td>20.67 NS</td>
<td>4525 a</td>
<td>11280 a</td>
</tr>
<tr>
<td>35 day old seedlings</td>
<td>124.7</td>
<td>18.75 a</td>
<td>17.23 a</td>
<td>20.30</td>
<td>4475 a</td>
<td>9675 ab</td>
</tr>
<tr>
<td>55 day old seedlings</td>
<td>122.8</td>
<td>13.45 b</td>
<td>12.25 b</td>
<td>20.28</td>
<td>3650 b</td>
<td>8850 b</td>
</tr>
</tbody>
</table>

Table 2: Growth and yield characteristics of Basmati-385 as affected by number of seedlings hill⁻¹ under saline conditions. (Average of four replicates)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>No. of tillers hill⁻¹</th>
<th>No. of productive tillers hill⁻¹</th>
<th>1000-kernel weight (g)</th>
<th>Paddy Yield (kg ha⁻¹)</th>
<th>Straw yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One seedling hill</td>
<td>119.1 ab</td>
<td>11.20 b</td>
<td>9.95 c</td>
<td>21.85 NS</td>
<td>3825 c</td>
<td>8268 b</td>
</tr>
<tr>
<td>Two seedlings hill</td>
<td>120.3 a</td>
<td>18.55 a</td>
<td>16.38 b</td>
<td>21.17</td>
<td>4550 a</td>
<td>9300 a</td>
</tr>
<tr>
<td>Three seedlings hill</td>
<td>117.7 b</td>
<td>18.92 a</td>
<td>18.63 a</td>
<td>22.0</td>
<td>4400 ab</td>
<td>9100 a</td>
</tr>
<tr>
<td>Four seedlings hill</td>
<td>118.0 ab</td>
<td>16.58 a</td>
<td>15.13 b</td>
<td>22.42</td>
<td>4175 b</td>
<td>9200 a</td>
</tr>
</tbody>
</table>

Means sharing similar letters do not differ significantly at p = 0.05

and 18.75 tillers per hill, respectively, and differed significantly with 55-day-old seedlings which produced lowest number of tillers per hill. Number of tillers of 35-day-old seedlings was statistically similar with those produced by 25-day-old seedlings. Data showed that though maximum 1000-kernel weight (20.67 g) was found in 25-day-old seedlings but it was statistically similar to those produced by 35- and 55-day-old seedlings.

Data (Table 1) showed that seedling age had significant effect on paddy yield and maximum yield (4525 kg ha⁻¹) was observed in case of 25-day-old seedlings while 35- and 55-day-old seedlings ranked second and third producing average yields of 4475 and 3650 kg ha⁻¹, respectively. Paddy yield of 25- and 35-day-old seedlings was statistically at par with each other but differed significantly with 55-day-old seedlings. Similarly, significantly higher straw yield (11280 kg ha⁻¹) was produced by 25-day-old seedlings followed by 35- and 55-day-old seedlings.

Effect of Number of Seedlings per Hill on Growth and Yield of Rice in Saline Soil: Varying number of seedlings per hill had significant effect on rice yield and its contributing parameters. The difference between per hill seedlings of the variety Basmati-385 for plant height was significant (Table 2). Maximum plant height of 120.3 cm was observed in case of transplanting two seedlings per hill while minimum plant height was recorded with transplanting of three seedlings per hill. Number of seedlings had significantly affected the number of tillers per hill and productive tillers and highest tillers were recorded with three seedlings per hill (18.9 and 18.6, respectively). Minimum tillers were found in case of one seedling per hill and differed significantly with all other treatments. Effect of seedling age on 1000-kernel weight was statistically significant. Maximum value (22.42 g) was recorded in seedlings per hill.

Data revealed that paddy yield was significantly affected by number of seedlings per hill (Table 2). Treatment; two seedlings per hill gave maximum paddy yield of 4550 kg ha⁻¹ and differed significantly with one and four number of seedlings per hill but non significantly with the yield of three seedlings. Minimum paddy yield was recorded in case of one seedling per hill. Similarly, two seedlings per hill produced maximum straw yield (9300 kg ha⁻¹) but it remained statistically similar to three and four seeds per hill and different from one seedling per hill.

Discussion

Most rice crops are produced from flooded, anaerobic soils that are chemically highly reduced (Ponnampuruma, 1984.) Such conditions are fatal to the majority of species especially in saline soils, and rice is the only major crop plant that can survive or even thrive in these soils. Soil salinity affects plant growth and yield by upsetting water and nutritional balance of the plants due to the deterioration of physical and chemical properties of soil as well as by the toxic effect of individual ions (Yeo and Flowers, 1984). Biological approaches may play vital role in reclaiming such soils as well as in increasing yields.

Seeding age affects growth and yield of rice and in our study 25 to 35 day old seedlings significantly affected number of tillers and productive tillers hill⁻¹, paddy and straw yield. Our results are in accordance with the findings of many workers. Raju et al. (1989) found that transplanting 30-, 45- or 60-day-old seedlings gave yields of 4.85, 4.40 and 4.19 tones, respectively. They further observed higher values of number of panicles m⁻², number of filled grains panicle⁻¹ and 1000-grain weight with 30-day-old seedlings. Hossain and Haque (1988) reported that basal tillers were greater with 30-day-old than 60-day-old seedlings. Higher number of tillers, panicles and grain yield were observed when young seedlings were planted compared with more aged seedlings (Mannan and Siddique, 1991; Bassi et al., 1994; Kim and Lee, 1989).

Results revealed that, effect of seeding number hill⁻¹ was
also significant on growth and yields of rice. Our results are
also similar to the findings of Hossain and Haque (1988)
who reported highest grain yield with 2 seedlings hill¹ but
the number of basal tillers increased with increasing
seedling number. Many other workers also confirmed the
effects of seedling number on growth and yields of rice
(Singh and Singh, 1992; Banerjee et al., 1992).
Optimum seedling age and plant populations are important
factors to be considered for increasing paddy yields.
Genetic differences among genotypes in the ability of
seedlings to establish after transplanting might cause
differences in growth and yield (Bassi et al., 1994). Being
a photo-period sensitive crop, too low or high temperature
adversely affects the spike fertility in rice. So rice may
respond to variation in day length and intensity of light in
different periods (Mannan and Siddique, 1991). Positive
response to more population density per unit area could be
due to better seedling establishment and dilution effects at
root level causing less entry of saline ions into the shoot.
However, low response to four seedlings hill¹ may be due
to more competition for nutrients.

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