**Title: Improving farm productivity through sustainable use of alkali waters at farmer’s field in rice-wheat production system**

**Description: Analysed data**

**Treatment details:** The field experiment was started in *Kharif* 2014. A total of eight treatments were laid out in split-plot design with three replications. Two varieties [one salt tolerant (CSR 30 Basmati and KRL 210) and another traditional (Pusa 1121 and HD 2967) as rice and wheat cultivars in respective seasons] were taken in the main plot treatments while RSC neutralizing ameliorants [available RSC water/unamended control; gypsum at 7.5 t ha-1 (Gyp); pressmud at 10 t ha-1 (PM) and gypsum at 3.75 t ha-1 + pressmud at 5 t ha-1 (Gyp+PM)] were super imposed as sub-plot treatments at both the experimental sites.

**Experimental location:** Farmer’s Field, village Munfdri, Kaithal, Haryana

**Duration:** 2014-2018

**Table 1.** Initial soil analysis and composition of irrigation waters at the experimental site(s)

|  |  |  |
| --- | --- | --- |
| Parameters | Site 1 | Site 2 |
| Soil properties |
| Soil pH (1:2) | 9.04 | 9.69 |
| Electrical conductivity, EC (1:2) (dS m-1) | 0.52 | 0.43 |
| Electrical conductivity of saturation extract ECe (dS m-1) | 2.08 | 1.96 |
| Bulk density (Mg m-3) | 1.44 | 1.54 |
| CaCO3 (%) | 2.58 | 3.14 |
| Organic carbon (g kg-1) | 7.2 | 4.3 |
| Cation exchange capacity (CEC) cmolp+ kg-1 | 23.8 | 11.9 |
| Exchangeable sodium percentage (ESP) (%) | 22.9 | 25.1 |
| Sodium adsorption ration of saturation extract (SARe) (mmol1*/*2 L−1*/*2) | 17.5 | 16.4 |
| Available N (kg ha-1) | 112.0 | 86.0 |
| Available P (kg ha-1) | 26.1 | 19.0 |
| Available K (kg ha-1) | 254.0 | 365.2 |
| DTPA extractable Zn, mg kg-1 | 0.37 | 0.84 |
| Water quality parameters |
| pH | 7.56 | 7.48 |
| Electrical conductivity EC (dS m-1) | 1.12 | 1.32 |
| Soluble salts (me L-1) |  |  |
| Ca2+ + Mg2+   | 0.93 | 3.80 |
| CO32- + HCO3- | 6.10 | 10.73 |
| Na+ | 6.1 | 13.3 |
| Cl- | 1.40 | 0.90 |
| Residual sodium carbonate, RSC (me L-1) | 5.13 | 6.93 |
| Sodium adsorption ration (SAR) mmol1*/*2 L−1*/*2 | 8.9 | 10.4 |

RSC = (CO32- + HCO3-) - (Ca2+ + Mg2+);SAR = ([Na+])/√(0.5([Ca2+] +[Mg2+])) all cations and anions in me L-1

**Table 2.** Composition of pressmud

|  |  |
| --- | --- |
| Parameters | Value |
| pH (1:5) | 5.2 ± 0.08 |
| EC (1:5)(dS m-1) | 1.1 ± 0.06  |
| Moisture (%) | 48.8 ± 1.5 |
| Carbon (%) | 30.7 ± 1.1 |
| Nitrogen (%) | 2.31 ± 0.5 |
| Sulphur (%) | 1.44 ± 0.07 |
| Calcium (%) | 2.17 ± 0.05 |
| Magnesium (%) | 1.08 ± 0.0 |

**Table 3.** Catalogue of cultivation practices for the field experimentation

|  |  |  |
| --- | --- | --- |
| Field operations | Rice | Wheat |
| CSR 30 Basmati | Pusa 1121 | KRL 210 | HD 2967 |
| Sowing/harvesting schedule |  |  |  |  |
| 2014-15 | 11Jul/30 Oct | 11Jul/22 Oct | 6 Nov/3 Apr | 6 Nov/10 Apr |
| 2015-16 | 9 Jul/26 Oct | 9 Jul/17 Oct | 1 Nov/28 Mar | 1 Nov/4 Apr |
| 2016-17 | 3 Jul/22 Oct | 3 Jul/14 Oct | 29 Oct/31 Mar | 29 Oct/5 Apr |
| 2017-18 | 12 Jul/2 Nov | 12 Jul/24 Oct | 11 Nov/1 Apr | 11 Nov/7 Apr |
| Sowing method | Puddled transplanted | Puddled transplanted | Zero till drill | Zero till drill |
| Spacing | 30-35 plants/sqm | 30-35 plants/sqm | 22.5 cm RxR | 22.5 cm RxR |
| Fertilization (kg ha-1)\* N:P:K:Zn | 60:26:50:5 | 120:26:50:5 | 150:26:50:0 | 150:26:50:0 |
| Fertilizer scheduling | Full P, K, and Zn at the time of transplanting; half N at 3 WAT and remaining half 6 WAT | Full P, K, and Zn at the time of transplanting; half N at 3 WAT and remaining half 6 WAT | Full P, K and 1/3rd N at sowing, remaining N in 2 splits at first and second irrigation | Full P, K and 1/3rd N at sowing, remaining N in 2 splits at first and second irrigation |

*\*Neutralization ameliorants as per treatments; WAT-Weeks after transplanting, RxR-Row to Row*

**Table 4.** Change in crop physiological parameters in response to continuous irrigation with high RSCiw

|  |  |  |
| --- | --- | --- |
| Parameters | Rice | Wheat |
| RSC≈5 me L-1 | RSC≈7 me L-1 | RSC≈5 me L-1 | RSC≈7 me L-1 |
| CSR 30 Basmati | Pusa 1121 | CSR 30 Basmati | Pusa 1121 | KRL 210 | HD 2967 | KRL 210 | HD 2967 |
| Relative Water Content, RWC (%) | 88.91a | 83.57b | 81.30b | 75.58c | 76.14a | 73.57b | 70.68c | 68.25d |
| Membrane Injury index, MII (%) | 35.60d | 38.11c | 44.35b | 49.37a | 28.80d | 30.45c | 33.37b | 39.30a |
| Photosynthetic rate, Pn (µmol CO2 m-2s-1) | 17.32b | 20.16a | 16.37c | 15.14d | 16.20a | 14.29b | 13.65c | 11.99d |
| Stomatal Conductance, gS (m mol H2O m-2s-1) | 1.829a | 1.793b | 1.567c | 1.470d | 1.135a | 1.108b | 0.819c | 0.652d |
| Transpiration Rate, E (m mol H2O m-2s-1) | 7.652a | 6.883b | 6.429c | 5.460d | 2.215a | 1.962b | 1.764c | 1.510d |
| Chlorophyll Fluorescence, Fv/Fm | 0.593a | 0.585b | 0.576c | 0.547d | 0.537c | 0.498d | 0.598a | 0.569b |
| Photon Quantum Yield, Y(II) | 0.536a | 0.526b | 0.527b | 0.503c | 0.545a | 0.531b | 0.537ab | 0.512c |
| Shoot Na+/K+ ratio  | 0.908b | 1.253a | 0.591d | 0.771c | 0.177c | 0.245b | 0.265b | 0.381a |
| Root Na+/K+ ratio | 1.386d | 1.825c | 1.986b | 2.712a | 0.433d | 0.544c | 0.597b | 0.766a |

*Data followed by different lowercase letters differ significantly according to LSD (P=0.05) for separation of means within varieties in response to particular RSC level.*

**Table 5.** Description of yield attributing characters for rice and wheat crop in response to neutralization treatments and RSC levels

|  |  |
| --- | --- |
| RSC levels | Neutralization treatments |
| RSC water | Gyp | PM | Gyp + PM | Mean | RSC water | Gyp | PM | Gyp + PM | Mean |
|  | Rice |
| Productive tillers per hill | Tillers sterility (%) |
| RSCiw≈5 me L-1 | 15.4d | 17.6b | 18.6ab | 19.2a | 17.7A | 8.45d | 5.65a | 5.48a | 5.43a | 6.25B |
| RSCiw≈7 me L-1 | 12.7e | 16.0c | 16.8bc | 16.5c | 15.5B | 9.93e | 6.43c | 6.11b | 6.05b | 7.13A |
| Mean | 14.1C | 16.8B | 17.7A | 17.8A |  | 9.19B | 6.04A | 5.80 A | 5.74 A |  |
|  | Grains per panicle | Chaffy grains per panicle |
| RSCiw≈5 me L-1 | 60.9c | 67.7b | 68.1b | 72.7a | 67.3A | 12.4c | 10.5a | 10.3a | 10.1a | 10.8A |
| RSCiw≈7 me L-1 | 53.2d | 62.2c | 64.6bc | 66.2bc | 61.5B | 15.5d | 13.9b | 13.5b | 13.3b | 14.0B |
| Mean | 57.0D | 65.0BC | 66.3B | 69.4A |  | 14.0D | 12.2BC | 11.9B | 11.7A |  |
|  | Earhead filling ratio | 1000-grain weight (g) |
| RSCiw≈5 me L-1 | 0.63c | 0.69a | 0.69a | 0.71a | 0.68A | 25.2d | 26.7ab | 26.9a | 26.7ab | 26.4A |
| RSCiw≈7 me L-1 | 0.59c | 0.68b | 0.68b | 0.70a | 0.66B | 24.2a | 25.9c | 26.1bc | 26.6ab | 25.7B |
| Mean | 0.61B | 0.69A | 0.69A | 0.70A |  | 24.7B | 26.3A | 26.5A | 26.6A |  |
|  | Wheat  |
|  | Productive tillers per mrl | Spikelets per spike |
| RSCiw≈5 me L-1 | 57.7cd | 67.7ab | 68.1ab | 71.1a | 66.1A | 17.3c | 18.8b | 19.4a | 19.4a | 18.7A |
| RSCiw≈7 me L-1 | 53.3d | 58.9cd | 63.9bc | 64.5bc | 60.1B | 15.1f | 15.8e | 16.2de | 16.5d | 15.9B |
| Mean | 55.5B | 63.3A | 66.0A | 67.8A |  | 16.2B | 17.3A | 17.8A | 17.9A |  |
|  | Grains per earhead | 1000-grain weight (g) |
| RSCiw≈5 me L-1 | 45.3e | 59.9b | 63.1a | 62.5a | 57.7A | 40.33b | 42.07a | 42.92a | 42.77a | 42.02A |
| RSCiw≈7 me L-1 | 44.6f | 53.7d | 55.1c | 55.1c | 52.1B | 37.10c | 40.12b | 40.86b | 40.45b | 39.64B |
| Mean | 44.9C | 56.8B | 59.1A | 58.8AB |  | 38.73B | 41.10A | 41.89A | 41.61A |  |

*Data followed by different lowercase letters (neutralization amendments x RSC levels) and capital letters within same row (neutralization amendments mean values across different RSC levels) or column (RSC mean values across neutralization amendments) for a particular parameter differ significantly according to LSD (P=0.05) for separation of means.*

**Table 6.** Interactive effect of RSC irrigation water neutralization ameliorants and varieties on the crop’s productivity at two sites (mean of 4 years)

|  |  |
| --- | --- |
| Varieties | Yield (t ha-1) |
| RSCiw≈5 me L-1 | RSCiw≈7 me L-1 |
| RSC water | Gyp | PM | Gyp + PM | Mean | RSC water | Gyp | PM | Gyp + PM | Mean |
| Rice  |  |  |  |  |  |  |  |  |  |  |
| CSR 30 Basmati | 2.73 | 3.19 | 3.32 | 3.43 | 3.17b | 2.40 | 2.79 | 2.94 | 3.01 | 2.78b |
| PB 1121 | 3.23 | 3.71 | 3.87 | 3.94 | 3.68a | 2.64 | 3.08 | 3.22 | 3.31 | 3.06a |
| Mean | 2.98d | 3.45c | 3.59b | 3.68a |  | 2.51d | 2.93c | 3.08b | 3.16a |  |
| Wheat |  |  |  |  |  |  |  |  |  |  |
| KRL 210 | 3.87 | 4.43 | 4.61 | 4.74 | 4.41a | 3.43 | 4.03 | 4.21 | 4.30 | 3.99a |
| HD 2967 | 3.56 | 4.01 | 4.16 | 4.29 | 4.00b | 2.99 | 3.58 | 3.71 | 3.84 | 3.53b |
| Mean | 3.71d | 4.22c | 4.38b | 4.52a |  | 3.21d | 3.80c | 3.96b | 4.07a |  |

*Data followed by different lowercase letters within same row (neutralization amendments mean across varieties) or within column (variety mean across neutralization amendments) differ significantly at P=0.05 according to LSD (P=0.05) for separation of means.*