ANNUAL TECHNICAL REPORT

2016-17

SOIL SALNITY RESEARCH INSTITUTE,

PINDI BHATTIAN, DISTRICT HAFIZABAD

DIRECTOR:

Muhammad Ilyas

COMPILED BY:

Dr. Muhammad Sarfraz

Assistant Agricultural Chemist

REVIEWED BY:

Dr. Muhammad Anwar Zaka

Agricultural Chemist

1. RESEARCH STAFF POSITION

Sr. No	Designation	Sanctioned posts	Filled posts	Vacant posts
1	Director	One	One	-
2	Agricultural Chemist	Four	Two	Two
3	Economic Botanist	One	One	-
4	Agronomist	One	One	-
5	Agricultural Engineer	One	-	One
6	Assistant Agri. Chemist	Four	Two	Two
7	Assistant Botanist	One	One	-
8.	Assistant Agronomist	One	-	One
9	Assistant Agricultural Engineer	One	one	-
10	Assistant Research Officer	Twelve	Five	Seven

2. LIST OF RESEARCHERS

S.No	Name	Designation	Qualification	Duration
1	Dr. Ehsan-ul-Haq	Director	Ph. D (Soil Science)	01.06.2015-13.02.2017
2	Mr. Muhammad Ilyas	Director	M.Sc (Soil Science)	14.02.2017-todate
3	Mr. Ghulam Mustafa Wains	Agricultural Agronomist	M.Sc Agronomy	07.02.2014-12.04.2017
4	Dr. Muhammad Anwar Zaka	Agricultural Chemist	Ph. D (Soil Science)	10.11.2014-todate
5	Mr. Abdul Rehman Jami	Asstt. Agricultural Chemist	M.Sc (Soil Science)	15.10.2011-09.04.2017
6	Dr. Muhammad Sarfraz	Asstt. Agricultural Chemist	Ph. D (Soil Science)	12.02.1996-todate
7	Mr. Ghulam Shabbir	Asstt. Botanist	M.Sc (PB & G)	28.08.1993-todate
8	Mr. Amir Iqbal Saqib	Asstt. Research Officer	M.Sc (Soil Science)	29.10.2003-todate
9	Mr. Ghulam Qadir	Asstt. Research Officer	M.Sc (Soil Science)	24.05.2010-todate
10	Mr. Muhammad Rizwan	Asstt. Agri. Engineer	M.Sc (Water Resources Engineering)	10.12.2011-todate
11	Asifa Naz	Asstt. Research Officer	M.Sc (Soil Science)	25.04.2016-09.03.2017
12	Mr. Muhammad Qaisar Nawaz	Asstt. Research Officer	M.Sc Agronomy	12.07.2012-todate
13	Dr. Khalil Ahmed	Asstt. Research Officer	Ph. D (Soil Science)	23.07.2012-todate

3. BUDGET (18-Agriculture)

Major Object	**Allocation**(Rs.)	**Expenditure**(Rs.)
Pay of Officers	14002000	11585316
Pay of Staff	9249000	8478159
Regular allowances	15758000	13485383
Other allowances	594339	566741
Employment Related Expenses	**39603339**	**34115599**
Communication	65000	63307
Utilities	785000	773594
Occupancy cost	55000	21542
Travel & Transportation	2335000	2356427
General	800000	783863
Encashment of LPR	794000	-
Physical Assets	2624000	2574160
Repair and Maintenance	760000	759832
Operating Expenses	**8218000**	**7332735**
Grand Total	**47821339**	**41448334**

4. INTRODUCTION

Soil Salinity Research Institute, Pindi Bhattian was established in 1982-83 for conducting research to devise ways and means and proper technologies for economic utilization of salt affected soils and scientific use of brackish sub-soil water for agricultural purposes in the Punjab. The past work on salinity/sodicity was evaluated and found many deficiencies in the field. Many projects were launched to cover up such deficiencies. Since its establishment, many useful technologies have been developed for economic utilization of salt affected soils and brackish water and efforts are being made to achieve the objectives stated below:

1. Development of technology for reclamation of salt affected soil
2. Development of technology for management of brackish water
3. Development of crop production technology for salt affected soil
4. Management of plant Nutrition in salt affected soil
5. Screening of varieties of crops / fruit plants against Salinity/ sodicity
6. Advisory service to the farmers.

The scientists of the institute have got published 205 Research Articles on various aspects of soil salinity and sub-soil brackish water management in scientific journals of national and international repute. Ph.D. level research is also conducted at this institute. The results of research experiments are regularly being disseminated through radio talks in agricultural broadcasts of radio Pakistan Lahore and Faisalabad as well as publication through Ziraat Nama etc. Brochures in Urdu on different aspects are published and distributed free of cost to the farming community. Moreover, the electronic and print media are being utilized for dissemination and popularization of research findings / technologies developed.

The institute is comprised of seven divisions namely Soil Reclamation, Water Quality, Plant Nutrition, Soil Physics, Agronomy, Economic Botany and Agricultural Engineering. Each division is conducting its own experiments in Rabi and Kharif seasons to solve the problems of salt affected areas. The results are being presented in this report.

5. RESEARCH WORK

5.1 SOIL PHYSICS

01. LONG TERM EFFECT OF HIGH RSC WATER ON PHYSICAL PROPERTIES OF SOIL UNDER RICE-MUSTARD ROTATION

The experiment was designed in 2013 to study the deleterious effect of high RSC water on soil physical properties under rice-mustard (Raya) crop rotation. A moderately salt affected field (pH_s 8.82, EC_e 4.71 dS m^{-1}, SAR 26.82 (mmol $L^{-1})^{1/2}$, HC 0.67 cm hr^{-1} and BD 1.37 Mg m^{-3}) was selected, prepared and leveled. Composite soil samples were collected and analyzed for salinity/sodicity and GR. Experiment was laid out in RCBD with three replications. Tube-well water (EC 1.37 dS m^{-1}, SAR 8.40 (mmol $L^{-1})^{1/2}$ and RSC (7.85 me L^{-1}) was used for irrigation. Gypsum was applied on the basis of RSC of water with respect to number of irrigation. H_2SO_4 was also applied on the basis of RSC of water with respect to numberof irrigation. Guar was sown on 26-05-2017 and incorporated in soil before flowering. FYM was applied 15 days before transplanting of rice.The rice variety Shaheen Basmati was transplanted on 18-07-2016. Recommended dose of fertilizers (150-85-60 NPK kg ha^{-1}) was applied to rice. All the phosphorus and potassium was applied at transplanting, while nitrogen (N) was applied in three splits. All agronomic and plant protection practices were kept constant. The crop was harvested on 21-10-2016. Soil samples were collected after harvesting of crop. Paddy and straw yield data was recorded at maturity. The treatments tested along with paddy and straw yield are as under.

Table 1: Effect of treatments on paddy and straw yield

Treatments	**Paddy Yield** (t. ha^{-1})	**Straw Yield** (t. ha^{-1})
T_1 Tube well water	2.81 C	4.10 C
T_2 Gypsum application on the basis of RSC of water	3.53 A	7.51 A
T_3 H_2SO_4 application on the basis of RSC of water	3.50 A	7.53 A
T_4 Green Manuring with Guar	3.17 B	6.83 B
T_5 FYM @ 10 t. ha^{-1}	3.30 B	7.00 AB
LSD	0.1778	0.5532

Data presented in Table-1 revealed that paddy and straw yields were significantly higher in T_2 (gypsum application on the basis of RSC of water) and T_3 (H_2SO_4 application on the basis of RSC of water) followed by FYM @ 10 t. ha^{-1} and green manuring with Guar. The lowestyield wasrecorded in control (T_1).

Table 2: Soil analyses after rice harvest 2016

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	HC (cm hr^{-1})	BD (Mg m^{-3})
T_1 Tube well water	8.80	4.59	25.10	0.65	1.38
T_2 Gypsum application on the basis of RSC of water	8.60	3.50	17.00	0.75	1.27
T_3 H_2SO_4 application on the basis of RSC of water	8.60	3.90	17.70	0.72	1.28
T_4 Green Manuring with Guar	8.70	3.93	19.16	0.71	1.29
T_5 FYM @ 10 t. ha^{-1}	8.73	4.00	18.10	0.70	1.28

The result of soil analysis (Table 2) revealed that pH_s and SAR were above the safe limits in all the treatments but EC_e was above the safe limit in T_1 (control). Hydraulic conductivity of soil increased in all the treatments as compared to control. However, bulk density decreased in all the treatments when compared with control and minimum BD was recorded wheregypsum was applied on the basis of RSC of water.

In the same layout Raya crop was sown on 17-11-2016 after harvesting of rice and fertilizer was applied @ 70-70-60 N-P_2O_5-K_2O kg ha^{-1}. All the phosphorus and potassium was applied as basal, while N was applied in three splits. All agronomic and plant protection practices were applieduniformly.Yield data of Raya was recorded at maturity on 12-04-2017.

Table 3: Effect of treatments on Raya 2016-17

Treatments	Raya Yield (t. ha^{-1})	Plant height (cm)
T_1 Tube well water	0.60 C	120.00 C
T_2 Gypsum application on the basis of RSC of water	1.08 A	154.25 A
T_3 H_2SO_4 application on the basis of RSC of water	1.07 A	152.00 A
T_4 Green Manuring with Guar	0.83 B	137.00 B
T_5 FYM @ 10 t. ha^{-1}	0.82 B	137.25 B
LSD	0.2165	7.6943

Results presented in Table 3 revealed that grain yield and plant height of raya was at par in T_2 (Gypsum application on the basis of RSC of water) and T_3 (H_2SO_4 application on the basis of RSC of water) followed by green manuring with guar and FYM @ 10 t. ha^{-1}. Lowest grain yield and plant height was recorded in control.

Table 4: Soil Analysis after harvesting of Raya 2016-17

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	HC (cm hr^{-1})	BD (Mg m^{-3})
T_1 Tube well water	8.80	4.55	25.00	0.65	1.38
T_2 Gypsum application on the basis of RSC of water	8.58	3.48	16.80	0.76	1.26
T_3 H_2SO_4 application on the basis of RSC of water	8.59	3.87	17.65	0.72	1.27
T_4 Green Manuring with Guar	8.70	3.92	19.14	0.71	1.29
T_5 FYM @ 10 t. ha^{-1}	8.72	3.99	18.00	0.70	1.28

Soil analysis after harvesting of raya (Table 4) showed that pH_s and SAR were above the safe limits in all the treatments but EC_e was higher than safe limits except in T_1 only. Hydraulic conductivity of soil increased and bulk density decreased in all the treatments when compared with control and minimum bulk density was recorded in T_2 (gypsum application on the basis of RSC of tube well water) and T_3 (H_2SO_4 application on the basis of RSC of tube well water).

02. RESPONSE OF MAIZE-WHEAT ROTATION UNDER BRACKISH WATER MANAGEMENT STRATEGIES

Maize-2016

The experiment was designed in 2015 to assess the effect of brackish water for getting high yield under maize-wheat rotation in normal soils.A normal field (pHs 8.04, ECe 2.81 dS m-1, SAR 12.00 (mmol L-1)1/2, HC 0.87 cm hr-1 and BD 1.41 Mg m-3) was selected, prepared and leveled. Experiment was laid out in RCBD with three replications. Maize variety (FH-988) was sown on 31-08-2016. Tube-well water (EC 1.37 dS m-1, SAR 8.40 (mmol L-1)1/2 and RSC (7.85 me L-1) was used for irrigation. Gypsum was applied on the basis of RSC of water with respect to number of irrigations.PGPR was applied with tube well water alone and in combination with gypsum.according to the treatment plan. Recommended dose of fertilizers (125-90-60 NPK kg ha-1) was applied to maize. All the phosphorus and potassium was applied as basal, while N was applied in three splits. Slurry was made by mixing the PGPR and sugar. Maize seed @ 10 kg/ acre was mixed thoroughly with slurry and sown on ridges according to the treatment plan. All agronomic and plant protection practices were applied uniformly. Grain yield data was recorded at maturity on 24-11-2016. Treatments tested along with grain yield and plant height of maize are as under.

Table 5: Effect of brackish water on maize yield 2016

Treatments	Grain Yield (t. ha^{-1})	Plant height (cm)
T_1Canal water	2.20 A	194.00 A
T_2Tube well water	2.00 B	182.00 B
T_3 Gypsum application on the basis of RSC of tube well water	2.19 A	187.33 AB
T_4 Tube well water + PGPR	2.04 B	185.00 B
T_5Tube well water + PGPR + gypsum application on the basis of RSC of tube well water	2.22 A	189.00 AB
LSD	0.1381	8.7033

Results revealed that grain yield of maize was at par in T_5 (Tube well water + PGPR + gypsum application on the basis of RSC of tube well water), T_1 (Canal water) and T_3 (gypsum application on the basis of RSC of tube well water) (Table-5). As for as PGPR is concerned, no significant effect on crop yield was recorded. Lowest yield was recorded in T_2 (Tube well water). Same trend was observed in plant height. Soil samples were collected after harvesting of maize and analyzed. The results are as under:

Table 6: Soil analyses after maize harvest 2016

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	HC (cm hr^{-1})	BD (Mg m^{-3})
T_1 Canal water	8.02	1.06	10.00	0.90	1.34
T_2 Tube well water	8.30	1.72	13.47	0.85	1.42
T_3 Gypsum application on the basis of RSC of tube well water	8.02	1.39	10.00	0.91	1.36
T_4Tube well water + PGPR	8.10	1.58	11.15	0.86	1.37
T_5 Tube well water + PGPR + gypsum application on the basis of RSC of tube well water	8.00	1.25	10.18	0.91	1.35

The soil analysis data showed that pH_s, EC_e and SAR were within the safe limits in all the treatments. Hydraulic conductivity of soil in T_5 (Tube well water + PGPR + gypsum application on the basis of RSC of tube well water) and T_3 (gypsum application on the basis of RSC of tube well water)was increased as compared to all other treatments. However, bulk density decreased in all the treatments when compared with T_2 (Tube well water) and minimum BD was recorded in T_1 (Canal water) (Table 6). In the same lay out wheat variety Faisalabad 2008 was sown on 02-12-2016 and fertilizer was applied @ 120-110-70 NPK kg ha^{-1}. All the phosphorus and potassium was applied at sowing, while N was applied in three splits. Slurry was made by mixing the PGPR and sugar. Seed @ of 50 kg/acre

of wheat was mixed thoroughly with slurry and sown in lines by rabi drill according to the treatment plan. All recommended agronomic and plant protection practices were applied uniformly. Yield data of wheat was recorded at maturity and crop was harvested on 17-04-2017.

Table 7: Effect of brackish water on grain and straw yield of wheat 2016-17

Treatments	**Grain Yield** ($t.\ ha^{-1}$)	**Straw yield** ($t.\ ha^{-1}$)
T_1 Canal water	3.66 A	3.92 A
T_2 Tube well water	2.80 C	3.13 C
T_3 Gypsum application on the basis of RSC of tube well water	3.30 AB	3.50 B
T_4 Tube well water + PGPR	3.13 BC	3.35 BC
T_5 Tube well water + PGPR + gypsum application on the basis of RSC of tube well water	3.59 A	3.89 A
LSD	0.3615	0.3127

Results showed that grain yield of wheat was significantly higher in T_1 (canal water) and T_5 (Tube well water + PGPR + gypsum application on the basis of RSC of Tube well water) followed by T_3. While T_2(Tube well water) and T_4 (Tube well water + PGPR) were inferior (Table-7). Lowest grain yield was obtained from T_2 (Tube well water) Similar trend was observed in the case of straw yield. The Soil samples were collected after wheat and results are as under :

Table 8: Soil Analysis after wheat harvest 2016-17

Treatments	**pH_s**	**EC_e** ($dS\ m^{-1}$)	**SAR** $(mmol\ L^{-1})^{1/2}$	**HC** ($cm\ hr^{-1}$)	**BD** ($Mg\ m^{-3}$)
T_1 Canal water	8.01	1.05	10.00	0.91	1.33
T_2 Tube well water	8.30	1.73	13.50	0.84	1.43
T_3 Gypsum application on the basis of RSC of tube well water	8.00	1.37	10.00	0.91	1.35
T_4Tube well water + PGPR	8.10	1.57	11.10	0.86	1.37
T_5 Tube well water + PGPR + gypsum application on the basis of RSC of tube well water	8.00	1.20	10.10	0.92	1.34

In case of soil analysis pH_s, EC_e and SAR were within the safe limits in all the treatments. Hydraulic conductivity of soil in T_5 (Tube well water + PGPR + Gypsum application on the basis of RSC of Tube well water) increased as compared to all other treatments (Table 8). Bulk density decreased in all the treatments when compared with T_2 (Tube well water) and minimum bulk density was recorded where canal water was used for irrigation.

03. INTEGRATED USE OF SULPHUR AND ORGANIC AMENDMENT FOR RECLAMATION OF SALINE SODIC SOIL IN WHEAT-PEARL MILLET ROTATION

The experiment was designed in 2016 to study the effectiveness of combined use of sulphur and press mud for reclamation of saline sodic soil in wheat-pearl millet rotation. A salt affected field{pH_s8.97, EC_e4.52 dS m^{-1}, SAR 40.70 (mmol $L^{-1})^{1/2}$, HC 0.40 cm hr^{-1} and BD 1.68 Mg m^{-3} and GR = 2.50 (t. $acre^{-1}$)}was selected, prepared and leveled. Composite soil samples were collected and analyzed for salinity/sodicity.Experiment was laid out in RCBD with three replications. Sulfur was applied on the bases of 25%, 50% and 100% Gypsum requirement alone and in combination with press mud according to the treatment plan. Press mud was applied @ 20 tons per hectare alone and @ 15 and 20 tons per hectare in combination with sulphur. Sulfur was applied 30 days and press mud was applied 15 days before sowing followed by flooding. Field was ploughed and recommended dose of fertilizers @ 120-110-70 NPK kg ha^{-1} was applied. The wheat variety Faisalabad 2008 was sown on 21-12-2016 in lines by rabi drill.All the phosphorus and potassium was applied at sowing, while N was applied in three splits. Recomended agronomic and plant protection practices were kept constant.Yield data of wheat was recorded at maturity on 17-04-2017.

Table 9: Effect of sulphur and press mud on grain and straw yield of wheat 2016-17

Treatments	**Grain Yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})
T_1 Control	1.06 C	1.31 B
T_2 Sulphur on the basis of 50%GR	1.30 B	1.47 AB
T_3 Sulphur on the basis of 100%GR	1.32 AB	1.48 AB
T_4 Press mud @ 20 t ha^{-1}	1.50 A	1.68 A
T_5 Sulphur on the basis of 50% GR + Press mud @ 10 t ha^{-1}	1.40 AB	1.68 A
T_6 Sulphur on the basis of 25% GR + Press mud @ 15 t ha^{-1}	1.42 AB	1.57 A
LSD	0.1994	0.2332

Results revealed that grain yield of wheat was at par in T_4 (Press mud @ 20 t ha^{-1}), T_6 (Sulphur on the basis of 25% GR + Press mud @ 15 t ha^{-1}), T_5 (Sulphur on the basis of 50% GR + Press mud @ 10 t ha^{-1}) and T_3 (Sulphur on the basis of 100%GR). Lowest grain yield was obtained from T_1 (Control). Similar trend was observed in the case of straw yield. The soil samples were collected after harvesting of wheat and analysed. The data is as under :

Table 10: Soil Analysis after wheat harvest 2016-17

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	HC (cm hr^{-1})	BD (Mg m^{-3})
T_1 Control	8.94	4.40	38.50	0.40	1.68
T_2 Sulphur on the basis of 50%GR	8.92	4.34	36.00	0.40	1.67
T_3 Sulphur on the basis of 100%GR	8.85	4.18	33.00	0.44	1.66
T_4 Press mud @ 20 t ha^{-1}	8.86	4.15	32.60	0.44	1.65
T_5 Sulphur on the basis of 50% GR + Press mud @ 10 t ha^{-1}	8.85	4.12	31.90	0.43	1.66
T_6 Sulphur on the basis of 25% GR + Press mud @ 15 t ha^{-1}	8.86	4.13	32.00	0.43	1.67

In case of soil analysis (Table 10) pH_s, EC_e and SAR were above the safe limits in all the treatments. Hydraulic conductivity of soil increased in T_4 (Press mud @ 20 t ha^{-1}) as compared to control. However, bulk density decreased in T_4 (Press mud @ 20 t ha^{-1}) when compared with control.

04. LONG TERM EFFECT OF DIFFERENT ORGANIC MANURES AND GYPSUM ON PHYSICAL PROPERTIES OF SALINE SODIC SOIL IN WHEAT-RICE ROTATION

The experiment was designed in 2016 to study the effectiveness of different amendments on downward movement of salts and rehabilitation of soil health with passage of time. A salt affected field{pH_s9.91, EC_e10.95 dS m^{-1}, SAR 89.14 (mmol $L^{-1})^{1/2}$, HC 0.26 cm hr^{-1}, BD 1.75 Mg m^{-3} and GR 4.40 (t. $acre^{-1}$)} was selected, prepared and leveled. Composite soil samples were collected and analyzed for salinity/sodicity.Experiment was laid out in RCBD with three replications having plot size 6 x 54 m^2. Gypsum was applied @ 100% gypsum requirement while Poultry manure, FYM, Rice straw and Press mud were applied @ 20 tons per hacter. Gypsum was applied 30 days and organic amendments were applied 15 days before sowing followed by leaching. Field was prepared and recommended dose of fertilizers @ 120-110-70 NPK kg ha^{-1} was applied.Wheat variety Faisalabad 2008 was sown in lines by rabi drill on 21-12-2016. All the phosphorus and potassium was applied at sowing, while N was applied in three splits. All agronomic and plant protection practices were followed uniformly. Yield data of wheat was recorded at maturity on 17-04-2017.

Table 11: Effect of organic manures and gypsum on grain and straw yield of wheat 2016-17

Treatments	Grain Yield (t. ha^{-1})	Straw yield (t. ha^{-1})
T_1 Control	0.20 B	0.20 C
T_2 Gypsum @ 100% GR	0.30 A	0.40 A
T_3 Poultry manure @ 20 t. ha^{-1}	0.29 AB	0.39 AB
T_4 FYM @ 20 t. ha^{-1}	0.28 AB	0.40 AB
T_5 Rice straw @ 20 t. ha^{-1}	0.24 AB	0.30 BC
T_6 Press mud @ 20 t. ha^{-1}	0.27 AB	0.37 AB
LSD	0.0920	0.1020

The data revealed that wheat crop germination and growth was very poor due to high salinity/ sodicity (Table11) and response of amendments on crop yield might be visible on next crop.

Table 12: Soil Analysis after wheat harvest 2016-17

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	HC (cm hr^{-1})	BD (Mg m^{-3})
T_1 Control	9.41	7.76	85.10	0.26	1.75
T_2 Gypsum @ 100% GR	9.10	6.60	78.80	0.30	1.71
T_3 Poultry manure @ 20 t. ha^{-1}	9.20	6.80	80.90	0.29	1.73
T_4 FYM @ 20 t. ha^{-1}	9.22	7.12	81.10	0.29	1.73
T_5 Rice straw @ 20 t. ha^{-1}	9.25	7.88	83.60	0.26	1.74
T_6 Press mud @ 20 t. ha^{-1}	9.15	6.84	83.50	0.28	1.73

Soil analysis data showedthat pH_s, EC_e and SAR were above the safe limits in all the treatments. A minute change has been observed in all the treatments as compared to initial analysis (Table 12).

5.2 WATER QUALITY DIVISION

05. EFFECTIVENESS OF DIFFERENT MANAGEMENT STRATEGIES FOR BRACKISH IRRIGATION WATER

A field experiment was conducted to manage the deleterious effects of brackish water (BW) for sustainable production of wheat-rice in a normal soil at Rakh farm, Soil Salinity Research Institute, Pindi Bhattian. The treatments studied were: T_1 Control [Brackish Water], T_2 Continuous treated water with sulfuric acid on the basis of RSC of water, T_3 Two irrigations with H_2SO_4 on RSC basis + Two Irrigations without H_2SO_4, T_4 Alternate irrigations with H_2SO_4 on RSC basis and T_5 One irrigation with H_2SO_4 on RSC basis after two irrigations without H_2SO_4. Recommended dose of fertilizer @ 150-85-60 NPK kg ha^{-1} for rice (Shaheen Basmati) was applied. Transplantation and harvesting were carried out on 18-07-2016 and 18-10-2016 respectively. Weedicide Macheti was applied on 20-07-2016. Manual weed eradication was done as and when required. Off type plants were removed on 28-09-2016.. The initial soil analysis was pH_s 8.20, EC_e 3.89 dS m^{-1} and SAR 14.53 (mmol $L^{-1})^{1/2}$. The brackish irrigation water quality was EC_{iw} 1.33 dS m^{-1}, SAR 8.83 mmol L^{-1} and RSC 7.90, me L^{-1}. Results regarding plant height, number of plants/m^2, number of tillers/plant paddy and straw yield and post-harvest soil analysis is presented in Table 13. Results revealed that the highest paddy yield 3.40 t. ha^{-1} was recorded with T_2. The lowest yield was obtained in T_1 2.65 t. ha^{-1}. The treatments T_3, T_4 and T_5 were found non-significant with each other. In case of plant height, the highest plant height was on observed in T_2 and T_4 followed by T_5,$T_3$and T_1. Numbers of plants/m^2 were high in T_3 followed by T_2, T_4, T_5 and T_1. Number of tillers/plant differed non-significant in all treatments.

Table 13: Effect of Brackish irrigation water treatments on Paddy and Straw yield of Rice (2016)

Treatments	Paddy (t. ha^{-1})	Straw (t. ha^{-1})	Plant height (cm)	NO. of plants/m^2	NO. of tillers/plant
T_1 Control [Brackish Water]	2.65 C	6.25 C	91.44 B	16 B	17.11 A
T_2 Continuous treated water with sulfuric acid on the basis of RSC of water	3.40 A	8.21 A	97.54 A	18 AB	16.30 A
T_3 Two irrigations with H_2SO_4 on RSC basis + Two Irrigations without H_2SO_4	3.01 B	7.17 B	92.90 B	20 A	16.55 A
T_4 Alternate irrigations with H_2SO_4 on RSC basis	3.14 B	7.12 B	97.90 A	19 AB	19.21 A
T_5 One irrigation with H_2SO_4 on RSC basis after two irrigations without H_2SO_4	3.11 B	6.92 B	94.94 AB	17 B	18.84 A
LSD	0.2414	0.4014	0.8898	3.0165	4.5352

Table 14: Soil Analyses after Rice 2016

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
T_1 Control [Brackish Water]	8.29	3.94	14.22
T_2 Continuous treated water with sulfuric acid on the basis of RSC of water	8.08	2.86	10.55
T_3 Two irrigations with H_2SO_4 on RSC basis + Two Irrigations without H_2SO_4	8.12	3.44	12.04
T_4 Alternate irrigations with H_2SO_4 on RSC basis	8.13	3.60	11.22
T_5 One irrigation with H_2SO_4 on RSC basis after two irrigations without H_2SO_4	8.14	3.18	10.57

Post-harvest analysis, table 14depicted that application of H_2SO_4 reduced the pH_s, EC_e and SAR in all the treatments however they increased in control where H_2SO_4 was not used.

Wheat 2016-17:

In the same field, wheat, (Faisalababd-2008) was sown. Recommended dose of fertilizer @ 120-110-70 NPK kg ha^{-1} was applied. The date of sowing and harvesting was 17-11-2016 and 17-04-2017 respectively. Second dose of urea fertilizer was applied on 15-12-2016. Tribenuron and Sulfosulfuron were sprayed against broad and narrow leave weeds respectively on 21-12-2016 while Axial Penoxidan was sprayed against narrow leave weeds like dumbi siti on 12-01-2017. Results regarding plant height, spike length, number of tillers/m^2 grain and straw yield (table 15). Results revealed that the highest grain yield 3.96 t. ha^{-1} was recorded with T_2 followed by T_4, T_5 and T_3. The lowest yield 2.50 t. ha^{-1} was obtained in T_1. Spike length was highest in T_2 followed by T_4 while T_3, T_5 and T_1 were non-significant with one another. All treatments were non-significant for Plant height and number of tillers/m^2.

Table 15: Effect of Brackish irrigation water treatments on Grain and Straw yield of wheat

Treatments	**Grain** (t. ha^{-1})	**Straw** (t. ha^{-1})	**Plant height** (cm)	**Spike Length** (cm)	**NO. of tillers/**m^2
T_1 Control [Brackish Water]	2.50 D	2.63 C	86.6 A	9.13 B	221 A
T_2 Continuous treated water with sulfuric acid on the basis of RSC of water	3.96 A	3.93 A	94.3 A	10.20 A	234 A
T_3 Two irrigations with H_2SO_4 on RSC basis + Two Irrigations without H_2SO_4	2.86 CD	2.86 BC	84.3 A	9.10 B	241 A
T_4 Alternate irrigations with H_2SO_4 on RSC basis	3.53 AB	3.63 AB	86.0 A	9.40 AB	247 A
T_5 One irrigation with H_2SO_4 on RSC basis after two irrigations without H_2SO_4	3.26 BC	3.43 AB	86.3 A	9.20 B	252 A
LSD	0.5397	0.7698	1.0511	0.9160	40.39

Table 16: Soil Analyses after wheat 2016-17

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$
T_1 Control [Brackish Water]	8.28	3.92	14.00
T_2 Continuous treated water with sulfuric acid on the basis of RSC of water	8.00	2.80	10.00
T_3 Two irrigations with H_2SO_4 on RSC basis + Two Irrigations without H_2SO_4	8.10	3.40	11.50
T_4 Alternate irrigations with H_2SO_4 on RSC basis	8.11	3.50	11.00
T_5 One irrigation with H_2SO_4 on RSC basis after two irrigations without H_2SO_4	8.12	3.15	10.00

Post-harvest analysis indicated that application of H_2SO_4 reduced the pH_s, EC_e and SAR in all the treatments (table 4).

06. MANAGEMENT OF SALINE SODIC BRACKISH IRRIGATION WATER FOR SUCCESSFUL PRODUCTION OF WHEAT GRASS

An experiment was conducted to manage the deleterious effects of brackish water (BW) for sustainable production of wheat grass in a normal soil. Wheat Grass refers to the young grass of the common wheat plan (Thinopyrum intermedium) that is freshly juiced or dried into powder for animal and human consumption. Both provide chlorophyll, amino acids, minerals, vitamins, and enzymes. The treatments were: T_1 Control [Brackish water], T_2 Gypsum @ 100% GR on the basis of RSC of water, T_3 Gypsum @ 50% GR on the basis of RSC of water, T_4 H_2SO_4 @ 100% GR on RSC basis, T_5 H_2SO_4 @ 50% GR on RSC basis and T_6 Compost @ 10 t. ha^{-1}.A normal field was selected and gypsum was applied at the time of soaking irrigation on 15-11-2016 while H_2SO_4 was applied with each irrigation on RSC basis as per treatment plan. Fertilizer @ 120-110-70 NPK kg ha^{-1} for wheat grass was applied. The date of transplantation was 02-12-2016 while harvesting was in two cuttings i-e first cutting on 15-05-2017 and second on 28-07-2017. Results regarding fodder yield, plant height and post-harvest soil analysis are presented in table 17. Initial soil analysis was pH_s 7.95, EC_e 1.67 (dS m^{-1}) and SAR 15.51 (mmol $L^{-1})^{1/2.}$ Results revealed that for highest fodder yield treatments T_2 and T_3 were non-significant with each other. Treatments T_4, T_5 and T_6 were non-significant with oneanother followed by T_1. In case of plant height, maximum plant height (51.11 cm) was observed in the treatment T_3 followed by T_2, T_4 and T_5. However T_6 and T_1 were non-significant with each other.

Table 17: Effect of saline sodic water treatments on fresh fodder yield and plant height of wheat grass (2016-17)

Treatments	**Fodder Yield** (t. ha^{-1})	**Plant Height** (cm)
T_1Control [Brackish Water (B W)]	6.84 B	34.43 D
T_2 Gypsum @ 100% GR on the basis of RSC of water	10.08 A	47.11 AB
T_3Gypsum @ 50% GR on the basis of RSC of water	10.33 A	51.11 A
T_4 H_2SO_4 @ 100% GR on RSC basis	9.75 AB	43.11 BC
T_5 H_2SO_4 @ 50% GR on RSC basis	8.16 AB	41.55 C
T_6 Compost @ 10 t. ha^{-1}	7.90 AB	34.43 D
LSD	3.13	5.22

Post-harvest soil analysis table 18 showed a slight decrease in pH_s, EC_e and SAR of soil. Maximum decrease was in the treatment T_4. In case of control, there was an increase in pH_s, EC_e and SAR.

Table18: Soil analyses after wheat grass 2016-17

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$
T_1Control [Brackish Water (B W)]	8.00	1.70	16.27
T_2 Gypsum @ 100% GR on the basis of RSC of water	7.90	1.60	15.00
T_3 Gypsum @ 50% GR on the basis of RSC of water	7.92	1.63	15.10
T_4 H_2SO_4 @ 100% GR on RSC basis	7.88	1.59	14.78
T_5 H_2SO_4 @ 50% GR on RSC basis	7.91	1.61	14.96
T_6 Compost @ 10 t. ha^{-1}	7.98	1.68	15.30

07. TEMPORAL CHANGES IN THE QUALITY OF IRRIGATION WATER UNDER CLIMATE CHANGING SCENARIO

An experiment was conductedto monitor temporal changes in the quality of irrigation water with respect to $EC_{iw,}$ SAR and RSC. The temperature and rainfall data was also recorded fortnightly. It was observed that a total 498 mm rainfall was recorded from September 2015 to August 2016.

Table19: EC_{iw} (dS m^{-1})

Sr. No.	Date	TW 1	TW 2	TW 3	TW 4	Rainfall	Minimum Temp.	Maximum Temp.
		(1 Campus)	(2 Campus)	(1 Rakh Farm)	(2 Rakh Farm)	mm	(^{0}C)	(^{0}C)
1	September, 2015	0.83	1.23	1.36	1.38	75	18.0	35.5
2	October, 2015	0.76	1.21	1.40	1.37	9	15.5	32.0
3	November, 2015	0.72	1.16	1.27	1.28	-	7.5	24.0
4	December, 2015	0.71	1.14	1.30	1.28	-	7.0	19.0
5	January, 2016	0.72	1.13	1.26	1.25	79	3.5	18.5
6	February, 2016	0.68	1.14	1.34	1.33	-	4.5	25.5
7	March, 2016	0.75	1.19	1.33	1.36	93	12.0	25.0
8	April, 2016	0.77	1.20	1.34	1.36	29	16.5	34.5
9	May, 2016	0.80	1.24	1.36	1.33	20	18.0	39.0
10	June, 2016	0.80	1.18	1.43	1.32	49	28.3	40.0
11	July, 2016	0.76	1.17	1.42	1.28	230	26.1	34.9
12	August, 2016	0.81	1.26	1.43	1.32	144	25.4	35.4

Data depicted in table 19 showed that maximum EC_{iw} (0.83 dS m^{-1}), was observed in September, 2015 at maximum temperature 35.50 Centigrade while minimum EC_{iw} (0.68 dS m^{-1}), was observed in February, 2016 at minimum temperature 4.5 Centigrade for Tube Well NO. 1.Maximum EC_{iw} (1.26 dS m^{-1}), was observed in August, 2016 at maximum temperature 35.40 Centigrade while minimum EC_{iw} (1.13), was observed in January, 2016 at minimum temperature 3.5 Centigrade for Tube Well NO. 2.

Maximum EC_{iw} was observed in June (1.43 dS m^{-1}) & August(1.43 dS m^{-1}), 2016 at maximum temperature 40 & 35.40 Centigrade respectively while minimum EC_{iw} (1.26 dS m^{-1}), was observed in January, 2016 at minimum temperature 3.5 Centigrade for Tube Well NO. 3.

Maximum EC_{iw} (1.38 dS m^{-1}), was observed in September, 2015 at maximum temperature 35.40 Centigrade while minimum EC_{iw} (1.25 dS m^{-1}), was observed in January, 2016 at minimum temperature 3.5 Centigrade for Tube Well NO. 4.

Table20:SAR (mmol $L^{-1})^{1/2}$

S. NO.	Date	TW 1 (1 Campus)	TW 2 (2 Campus)	TW 3 (1 Rakh Farm)	TW 4 (2 Rakh Farm)	Rainfall (mm)	Minimum Temperature (^{0}C)	Maximum Temperature (^{0}C)
1	September, 2015	4.81	6.17	8.64	8.02	75	18.0	35.5
2	October, 2015	3.84	6.10	8.29	7.86	9	15.5	32.0
3	November, 2015	3.48	5.10	8.04	7.54	-	7.5	24.0
4	December, 2015	2.84	6.10	7.89	7.39	-	7.0	19.0
5	January, 2016	3.09	5.29	8.05	6.62	79	3.5	18.5
6	February, 2016	2.71	5.24	8.41	7.29	-	4.5	25.5
7	March, 2016	3.66	5.69	8.39	7.53	93	12.0	25.0
8	April, 2016	3.10	5.72	8.04	7.92	29	16.5	34.5
9	May, 2016	4.02	6.19	8.31	7.87	20	18.0	39.0
10	June, 2016	3.53	5.54	8.52	7.23	49	28.3	40.0
11	July, 2016	3.12	5.08	8.65	7.02	230	26.1	34.9
12	August, 2016	3.48	6.01	8.57	7.63	144	25.4	35.4

Data depicted in table 20 showed that maximum SAR 4.81(mmol $L^{-1})^{1/2}$, was observed in September, 2015 at maximum temperature 35.50 Centigrade while minimum SAR (2.71 (mmol $L^{-1})^{1/2}$), was observed in February, 2016 at minimum temperature 4.5 Centigrade for Tube Well NO. 1. Maximum SAR 6.19 (mmol $L^{-1})^{1/2}$, was observed in May, 2016 at maximum temperature 39.0 Centigrade while minimum SAR 5.24 (mmol $L^{-1})^{1/2}$, was observed in February, 2016 at minimum temperature 4.5 Centigrade for Tube Well NO. 2. Maximum SAR 8.65 (mmol $L^{-1})^{1/2}$, was observed in July, 2016 at maximum temperature 34.90 Centigrade while minimum SAR7.89 (mmol $L^{-1})^{1/2}$, was observed in December, 2015 at minimum temperature 7.0 Centigrade for Tube Well NO. 3. Maximum SAR 8.02 (mmol $L^{-1})^{1/2}$, was observed in September, 2015 at maximum temperature 35.50 Centigrade while minimum SAR6.62 (mmol $L^{-1})^{1/2}$, was observed in January 2016 at minimum temperature 7.0 Centigrade for Tube Well NO. 4.

Table21:RSC (me L^{-1})

Sr. No.	Date	TW 1 (1 Campus)	TW 2 (2 Campus)	TW 3 (1Rakh Farm)	TW 4 (2 Rakh Farm)	Rainfall (mm)	Minimum Temperature (^{0}c)	Maximum Temperature (^{0}c)
1	September, 2015	3.42	4.37	7.62	6.60	75	18.0	35.5
2	October, 2015	3.43	4.70	7.92	7.10	9	15.5	32.0
3	November, 2015	3.47	3.27	7.17	6.60	-	7.50	24.0
4	December, 2015	2.47	4.57	7.12	7.10	-	7.00	19.0
5	January, 2016	2.80	4.15	7.59	6.50	79	3.50	18.5
6	February, 2016	2.75	4.39	7.70	6.72	-	4.50	25.5
7	March, 2016	3.30	4.22	7.56	6.85	93	12.0	25.0
8	April, 2016	2.95	4.30	7.65	6.87	29	16.5	34.5
9	May, 2016	3.70	4.72	8.10	7.15	20	18.0	39.0
10	June, 2016	2.80	4.55	8.73	6.68	49	28.3	40.0
11	July, 2016	2.48	4.42	8.20	6.75	230	26.1	34.9
12	August, 2016	3.15	4.30	8.22	6.77	144	25.4	35.4

Data depicted in table 21 showed that Maximum RSC (3.70 me L^{-1}), was observed in May, 2016 at maximum temperature 39.0 Centigrade while minimum RSC(2.47 me L^{-1}), was observed in December, 2015 at minimum temperature 7.0 Centigrade for Tube Well NO. 1.Maximum RSC (4.72 me L^{-1}), was observed in May, 2016 at maximum temperature 39.0 Centigrade while minimum RSC(4.15 me L^{-1}), was observed in January, 2016 at minimum temperature 3.50 Centigrade for Tube Well NO. 2.Maximum RSC (8.73 me L^{-1}), was observed in June, 2016 at maximum temperature 40.0 Centigrade while minimum RSC(7.12 me L^{-1}), was observed in December, 2015 at minimum temperature 7.0 Centigrade for Tube Well NO. 3.Maximum RSC (7.15 me L^{-1}), was observed in May, 2016 at maximum temperature 39.0 Centigrade while minimum RSC(6.50 me L^{-1}), was observed in January, 2016 at minimum temperature 3.50 Centigrade for Tube Well NO. 4.

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Table21: EC_{iw}(dS m^{-1})

Sr. NO.	Date	TW 1	TW 2	TW 3	TW 4	Rainfall	Minimum Temp.	Maximum Temp.
		(1 Campus)	(2 Campus)	(1 Rakh Farm)	(2 Rakh Farm)	mm	(^{0}C)	(^{0}C)
1	September, 2016	0.80	1.26	1.43	1.31	-	23.7	38.0
2	October. 2016	0.76	1.24	1.40	1.32	-	19.0	33.0.
3	November, 2016	0.75	1.21	1.42	1.31	-	12.50	26.5
4	December, 2016	0.70	1.12	1.30	1.25	-	8.50	23.5
5	January, 2017	0.73	1.16	1.34	1.21	31.0	7.5	19.50
6	February, 2017	0.73	1.23	1.31	1.24	11.0	8.50	23.50
7	March, 2017	0.77	1.21	1.33	1.28	27.0	15.0	25.0
8	April, 2017	0.80	1.23	1.42	1.32	35.0	17.0	33.0
9	May, 2017	0.79	1.22	1.38	1.31	40.0	27.50	41.0
10	June, 2017	0.78	1.22	1.36	1.29	80.0	23.0	36.0
11	July, 2017	0.82	1.24	1.41	1.29	168	29.0	38.0

Data depicted in table 21 showed that Maximum EC_{iw} (0.82 dS m^{-1}), was observed in July, 2017 at maximum temperature 38.0 Centigrade while minimum EC_{iw} (0.70 dS m^{-1}), was observed in December, 2016 at minimum temperature 8.50 Centigrade for Tube Well NO. 1.Maximum EC_{iw} (1.26 dS m^{-1}), was observed in September, 2016 at maximum temperature 38.0 Centigrade while minimum EC_{iw} (1.12), was observed in December, 2016 at minimum temperature 8.50centigrade for Tube Well NO. 2.Maximum EC_{iw} was observed in September, 2016 (1.43 dS m^{-1}) , 2016 at maximum temperature 38.0 Centigrade while minimum EC_{iw} (1.30 dS m^{-1}), was observed in December, 2016 at minimum temperature 8.50 Centigrade for Tube Well NO. 3.Maximum EC_{iw} (1.32 dS m^{-1}), was observed in October, 2016 and April, 2017 at maximum temperature 33.0 Centigrade while minimum EC_{iw} (1.21 dS m^{-1}), was observed in January, 2017 at minimum temperature 7.5 Centigrade for Tube Well NO. 4.

Table22: SAR (mmol $L^{-1})^{1/2}$

Sr. No.	Date	TW 1 (1 Campus)	TW 2 (2 Campus)	TW 3 (1 Rakh Farm)	TW 4 (2 Rakh Farm)	Rainfall mm	Minimum Temperature (^{0}c)	Maximum Temperature (^{0}c)
1	September, 2016	3.61	6.05	9.14	7.41	-	23.7	38.0
2	October. 2016	3.67	5.86	8.90	7.28	-	19.0	33.0.
3	November, 2016	3.47	5.68	8.56	7.14	-	12.50	26.5
4	December, 2016	3.10	5.25	7.64	6.89	-	8.50	23.5
5	January, 2017	3.15	5.13	6.42	5.29	31.0	7.5	19.50
6	February, 2017	3.11	6.03	7.23	6.74	11.0	8.50	23.50
7	March, 2017	3.54	6.08	7.72	6.85	27.0	15.0	25.0
8	April, 2017	3.85	6.50	9.27	8.34	35.0	17.0	33.0
9	May, 2017	3.48	6.61	9.53	8.38	40.0	27.50	41.0
10	June, 2017	3.54	6.17	9.01	8.12	80.0	23.0	36.0
11	July, 2017	3.92	6.11	9.60	7.76	168.0	29.0	38.0

Data in table 22 showed amaximum SAR 3.92 (mmol $L^{-1})^{1/2}$ in July, 2017 at maximum temperature 38.0 Centigrade while minimum SAR 3.10 (mmol $L^{-1})^{1/2}$, was observed in December, 2016 at minimum temperature 8.50 Centigrade for Tube Well NO. 1.Maximum SAR 6.61 (mmol $L^{-1})^{1/2}$, was observed in May, 2017 at maximum temperature 41.0 Centigrade while minimum SAR 5.13 (mmol $L^{-1})^{1/2}$, was observed in January, 2017 at minimum temperature 7.50 Centigrade for Tube Well NO. 2.Maximum SAR 9.53 (mmol $L^{-1})^{1/2}$, was observed in May, 2017 at maximum temperature 41.0 Centigrade while minimum SAR(6.42 (mmol $L^{-1})^{1/2}$, was observed in January, 2017 at minimum temperature 7.50 Centigrade for Tube Well NO. 3.Maximum SAR 8.38 (mmol $L^{-1})^{1/2}$, was observed in May, 2017 at maximum temperature 41.0 Centigrade while minimum SAR5.29 (mmol $L^{-1})^{1/2}$, was observed in January 2016 at minimum temperature 7.50 Centigrade for Tube Well NO. 4.

Table23: RSC (me L^{-1})

Sr. No.	Date	TW 1 (1 Campus)	TW 2 (2 Campus)	TW 3 (1 Rakh Farm)	TW 4 (2 Rakh Farm)	Rainfall (mm)	Minimum Temperature (^{0}cv)	Maximum Temperature (^{0}c)
1	September, 2016	3.37	4.67	7.94	6.57	-	23.7	38.0
2	October. 2016	3.62	4.65	7.72	6.70	-	19.0	33.0.
3	November, 2016	3.60	4.47	7.40	6.40	-	12.50	26.5
4	December, 2016	2.37	4.58	7.00	6.30	-	8.50	23.5
5	January, 2017	2.35	3.82	5.65	5.42	31.0	7.5	19.50
6	February, 2017	2.50	4.43	5.85	5.57	11.0	8.50	23.50
7	March, 2017	3.22	4.67	5.70	5.62	27.0	15.0	25.0
8	April, 2017	3.08	5.25	6.35	7.62	35.0	17.0	33.0
9	May, 2017	3.00	5.40	7.45	7.55	40.0	27.50	41.0
10	June, 2017	3.30	5.40	8.02	7.45	80.0	23.0	36.0
11	July, 2017	3.70	5.10	9.00	7.70	168	29.0	38.0

Data depicted in table 23 showed that maximum RSC (3.70 me L^{-1}), was observed in July, 2017 at maximum temperature 38.0 Centigrade while minimum RSC(2.35 me L^{-1}), was observed in January, 2017at minimum temperature 7.50 Centigrade for Tube Well NO. 1.Maximum RSC (5.40 me L^{-1}), was observed in May and June, 2017 at maximum temperature 41.0 and 36.0 Centigrade while minimum RSC(3.82 me L^{-1}), was observed in January, 2017 at minimum temperature 7.50 Centigrade for Tube Well NO. 2.Maximum RSC (9.00 me L^{-1}), was observed in July, 2017 at maximum temperature 38.0 Centigrade while minimum RSC(5.65 me L^{-1}), was observed in January, 2017 at minimum temperature 7.50 Centigrade for Tube Well NO. 3.Maximum RSC (7.70 me L^{-1}), was observed in July, 2017 at maximum temperature 38.0 Centigrade while minimum RSC(5.42 me L^{-1}), was observed in January, 2017 at minimum temperature 7.50 Centigrade for Tube Well NO. 4.

08. STRATEGIES FOR UTILIZATION OF BRACKISH WATER FOR STRAWBERRY-MUNG ROTATION

An experiment was conducted to manage the deleterious effects of brackish water (BW) for sustainable production of strawberry (*Fragaria ananassa).* The treatments were: T_1 Control [Brackish Water (B W)], T_2 Poultry manure @ 5 t. ha^{-1}, T_3 Poultry manure @ 10 t. ha^{-1}, T_4 H_2SO_4 equivalent to 25% GR on the basis of RSC of water, T_5 H_2SO_4 equivalent to 50% GR on the basis of RSC of water. A normal field was selected and poultry manure was applied on 23-11-2016. H_2SO_4 was applied with each irrigation. Fruit yield was recorded. Soil samples were analyzed for pH_s, EC_e and SAR at the initiation of the experiment and after harvest of the crop. Fertilizer 53-45-75 N PK kg ha^{-1} (All PK+1/2 N at sowing & remaining ½ N at flowering stage) was applied. The strawberry plants were transplanted on 30-11-2016 on Ridges with Plant to Plant distance of 30 cm and Row to row 75 cm using RCB design. About 8 to 9 pickings were taken. Results regarding fruit yield,

number of strawberries and post-harvest analysis are presented in table 28 and 29. Results revealed that the highest fruit yield i.e. 1.23 t. ha^{-1} was recorded in T_5 followed by T_3, T_4, T_2 and T_1. The lowest yield was 0.73 t. ha^{-1} obtained in T_1. In case of number of strawberries t.ha^{-1}, maximum strawberries, (173316) were observed in the treatment T_4 followed by T_5, T_3 and T_2. Minimum strawberries, (97768) were observed in T_1. Strawberries yield potential for EC_{iw} and Ec_e are presented in tables 24 and 25 respectively. Initial soil, irrigation water and poultry manure analysis are presented in tables 26 and 16 respectively. Post-harvest soil analysis in table 27 showed a slight decrease in pH_s, EC_e and SAR of soil in all treatments while a slight increase in pH_s in control plot.

Table24: Salt tolerance potential of strawberry

Strawberry Yield Potential			
EC_{iw} mmhos cm^{-1}			
100%	90%	75%	50%
0.7	0.9	1.2	1.7
Ayers and Westcot, 1976			

Table:25

Strawberry Yield Potential			
EC_e mmhos cm^{-1}			
100%	90%	75%	50%
1.0	1.3	1.8	2.5
Ayers and Westcot, 1976			

Table:26 Soil and water analysis

Initial Soil Analysis:	**Irrigation Water Analysis:**
pH_s = 8.19 EC_e= 2.50 (dS m^{-1}) SAR = 19.89 (mmol $L^{-1})^{1/2}$	EC_{iw}= 1.23 (dS m^{-1}) SAR = 6.01 (mmol $L^{-1})^{1/2}$ RSC = 4.85 (me L^{-1})

Table: 27Poultry Manure Analysis (%)

Total N	**Total P**	**Total K**
1.59	1.0	0.53

Table:28 Effect of organic and inorganic amendments on brackish water

Treatments	**Fruit Yield** (t. ha^{-1})
T_1 Control [Brackish Water (B W)]	0.73 B
T_2 Poultry Manure @ 5 t. ha^{-1}	0.83 B
T_3 Poultry Manure @ 10 t. ha^{-1}	1.18 A
T_4 H_2SO_4 @ 25% GR on RSC basis	1.17 A
T_5 H_2SO_4 @ 50% GR on RSC basis	1.23 A
LSD	0.1205

Table:29 Post harvest soil analysis

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
T_1 Control [Brackish Water (B W)]	8.20	2.48	19.00
T_2 Poultry Manure @ 5 t. ha^{-1}	8.18	2.46	17.76
T_3 Poultry Manure @ 10 t. ha^{-1}	8.17	2.40	16.91
T_4 H_2SO_4 @ 25% GR on RSC basis	8.17	2.37	16.00
T_5 H_2SO_4 @ 50% GR on RSC basis	8.16	2.32	15.58

09. DISSEMINATION OF TECHNOLOGIES FOR SAFE UTILIZATION OF BRACKISH WATER AT PINDI BHATTIAN

An experiment was conducted to assess the level of brackishness of water samples collected from the farmers tube wells at Pindi Bhattian and disseminate technologies for its safe use. Farmer's tube wells at Pindi Bhattian were selected for determining quality of water with respect to EC_{iw}, SAR and RSC. Water samples of thirty eight tube wells were collected and analyzed. The farmers were advised to avoid ill effects of brackish water with suitable recommendations. Out of 38 Water Samples, 8 (21.05%) were fit, 21 (55.26%) were unfit and 9 (23.68%) were Marginally Fit. It was observed that tube well water samples were unfit in the following manner, EC= 4, RSC= 4, EC + RSC= 13 while Marginally Fit in the following manner EC= 1, RSC= 8, EC+SAR= Nil. The detail of the water samples analysis is as under.

Table: 30 Analysis of tube well waters collected from different farmers

Sr. No.	Name of Farmer	EC_{iw} (dS m^{-1})	SAR (mmol L^{-1})	RSC (me L^{-1})	Quality
1	Muhammad Hussain, Macho Nikka	1.20	4.38	2.00	M. Fit
2	Muhammad Hussain, Macho Nikka	1.17	4.48	2.30	M. Fit
3	Malik Manzoor, JotianWala	2.01	10.12	4.10	unfit
4	Malik Manzoor, JotianWala	1.57	6.74	1.15	unfit
5	Malik Manzoor, JotianWala	1.92	9.46	3.90	unfit
6	Malik Manzoor Hussain, JotianWala	1.73	7.92	2.65	unfit
7	Govt. Primary School, Ghabrika	1.19	8.81	3.80	unfit
8	Govt. Primary School, Ghabrika	2.44	13.22	3.90	unfit
9	RanaIrshad, Ghabrika	1.58	7.47	3.40	unfit
10	Rana Farooq, Ghabrika	0.78	1.47	1.35	M. Fit
11	Rana Farooq, Ghabrika	1.12	2.17	Nil	Fit
12	Farhat Abbas, JotianWala	1.60	7.19	2.75	unfit
13	Rai Ulfat Hussain, Ghabrika	1.89	8.36	1.90	unfit
14	Rai Ulfat Hussain, Ghabrika	0.78	2.91	2.35	M. Fit
15	Rai Ulfat Hussain, Ghabrika	1.91	9.51	2.10	unfit
16	RanaNaeem, Ghabrika	1.82	8.85	3.80	unfit
17	RanaNaeem, Ghabrika	1.56	7.60	2.55	unfit

18	RanaNaeem, Ghabrika	1.50	9.25	3.75	unfit
10	Rana Farooq, Ghabrika	0.78	1.47	1.35	M. Fit
19	Muhammad Zafar, Ghabrika	1.29	5.99	2.60	unfit
20	AbrarMunir, Mandal Khuh	1.40	4.17	1.25	M. Fit
21	Naseem Abbas, Mandal Khuh	0.98	1.63	Nil	Fit
22	Jazman, KhanniKhui	1.01	5.96	3.00	unfit
23	Rai Waseem, Thatha Ladai	0.75	2.37	0.60	Fit
24	Zafar Ali, ThathaLadai MauzaBadari	0.53	0.92	Nil	Fit
25	Zafar Ali, ThathaLadai MauzaBadari	1.05	2.55	0.40	Fit
26	Zafar Ali, ThathaLadai MauzaBadari	1.00	3.16	1.50	M. Fit
27	Zafar Ali, ThathaLadai MauzaBadari	1.08	3.51	1.30	M. Fit
28	Zafar Ali, ThathaLadai MauzaBadari	1.07	3.08	1.70	M. Fit
29	Shahbaz Hussain, Kot Badar Din	1.80	11.94	4.30	unfit
30	Muhammad Nawaz, Kot Badar Din	1.68	9.70	1.70	unfit
31	Sarfraz, Kot Badar Din	2.27	16.81	6.70	unfit
32	Aftab Hussain, Bhajne	2.25	14.47	5.10	unfit
33	Shabbeer, 12 Da Chakka	2.36	23.0	8.45	unfit
34	Majboor, Khan Chak 42	2.57	13.78	4.05	unfit
35	Muhammad Amjad, Adda Burjian	1.14	5.23	1.20	Fit
36	Haq Nawaz, Sahuke	0.69	3.62	1.95	M. Fit
37	Mumtaz Hussain, Mirza Bhattian	0.83	2.45	0.80	Fit
38	Nasir Hussain, Mirza Bhattian	0.70	0.70	Nil	Fit

5.3 SOIL RECLAMATION

10. RESPONSE OF CONOCARPUS ERECTUS SEEDLINGS TO DIFFERENT LEVELS OF SALINITY AND SODICITY

The experiment was designed to determine salinity/sodicity tolerance of *Conocarpus Erectus* (Button Wood), and suitability of its cultivation on waste salt affected soils. Performance of Conocarpus was tested on different salinity and sodicity levels in pots first and then performance will be evaluated under field conditions later on. In total 16 treatments were planned having different combination of salinity and sodicity levels i.e. $T_1 EC_e < 4$(dS m^{-1}), SAR<15 (mmol $L^{-1})^{1/2}$, T_2 EC_e20(dS m^{-1}) SAR 20(mmol $L^{-1})^{1/2}$, T_3 EC_e20(dS m^{-1}) ,SAR40 (mmol $L^{-1})^{1/2}$, T_4 Eked20 (dS m^{-1}), SAR60 (mmol $L^{-1})^{1/2}$,T_5 EC_e20 (dS m^{-1}) SAR80 (mmol $L^{-1})^{1/2}$,T_6 EC_e20(dS m^{-1}) SAR (mmol $L^{-1})^{1/2}$100,T_7 EC_e30(dS m^{-1})SAR20 (mmol $L^{-1})^{1/2}$, T_8 EC_e30(dS m^{-1})SAR40 (mmol $L^{-1})^{1/2}$, T_9 EC_e30 (dS m^{-1})SAR60 (mmol $L^{-1})^{1/2}$, T_{10} EC_e30 (dSm^{-1})SAR80 (mmol $L^{-1})^{1/2}$, T_{11} EC_e30 (dS m^{-1}) SAR100 (mmol $L^{-1})^{1/2}$,T_{12} EC_e40 (dS m^{-1}) SAR 20(mmol $L^{-1})^{1/2}$, T_{13} EC_e40 (dS m^{-1})SAR40 (mmol L^{-1})$1^{/2}$, T_{14} EC_e40(dS m^{-1}) SAR60 (mmol $L^{-1})^{1/2}$, T_{15} ECe 40 (dS m^{-1}) SAR (mmol $L^{-1})^{1/2}$ 80, T_{16} EC_e40(dS m^{-1}) SAR100 (mmol $L^{-1})^{1/2}$ A normal soil was selected, sieved on 03-02-2015. The desired salinity/sodicity levels were developed using salts NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ by Quadratic Equation. The initial soil analysis was pH_s8.17, EC_e0.85 dS m^{-1}, SAR 4.50 (mmol $L^{-1})^{1/2}$ and SP was 33.70%. After establishing the desired levels of EC_e and SAR, the soil was filled in the glazed pots as per treatment plan on 05-02-2015. Three seedlings of *Conocarpus erectus* were transplanted in each pot .After the establishment of plants only one healthy plant was maintained in each pot. Experiment was laid out in CRD with three replications. Fertilizer @ one liter of 1% urea, TSP and SOP was applied at the start and after every six months. The data regarding plant height, stem diameter, number of leaves and branches was recorded on 01-03-2017, the detail of which is given in table 31, 32, 33 and 34.

Table 31: Effect of different levels of EC_e and SAR on plant height (cm) of conocarpus erectus seedlings

EC (dSm^{-1})		SAR ($mmol\ L^{-1})^{1/2}$	Plant height at transplanting	Plant height after two years	% increase over initial value (after two years)	% decrease over control (after two years)
T_1	<4	<15	70.00	170.00	143.00	-
T_2	17.30	21.42	57.00	137.00	140.35	-1.85
T_3	16.89	38.18	58.00	139.00	140.00	-2.10
T_4	18.16	54.72	52.00	122.00	134.62	-5.86
T_5	17.86	71.46	58.00	129.00	122.00	-14.66
T_6	19.10	86.78	62.00	122.00	97.00	-32.53
T_7	26.47	18.36	66.00	155.00	135.00	-5.98
T_8	27.84	41.78	53.00	119.00	125.00	-13.18
T_9	25.94	56.88	62.00	142.00	129.00	-10.04
T_{10}	26.71	68.96	59.66	121.00	103.00	-28.31
T_{11}	27.34	81.52	58.00	103.00	78.00	-45.90
T_{12}	31.85	17.68	62.00	131.00	111.00	-22.41
T_{13}	33.27	37.46	64.00	132.00	106.00	-25.92
T_{14}	32.69	55.78	67.33	125.00	86.00	-40.28
T_{15}	34.39	72.86	70.00	110.00	57.00	-60.16
T_{16}	32.40	79.60	62.00	89.00	44.00	-69.64

Table 32: Effect of different levels of EC_e and SAR on stem diameter (cm) **of conocarpus erectusseedling**

EC (dSm^{-1})		SAR ($mmolL^{-1})^{1/2}$	stem diameter at transplanting	stem diameter after two years	% increase over initial value (after two years)	% decrease over control (after twoyears)
T_1	<4	<15	0.77	2.62	240.00	-
T_2	17.30	21.42	0.60	2.04	240.00	0.00
T_3	16.89	38.18	0.62	2.07	233.87	-2.55
T_4	18.16	54.72	0.57	2,08	235.00	-2.08
T_5	17.86	71.46	0.69	2.22	222.00	-7.50
T_6	19.10	86.78	0.70	2.09	199.00	-17.08
T_7	26.47	18.36	0.77	2.58	235.00	-2.08
T_8	27.84	41.78	0.53	1.85	240.00	0,00
T_9	25.94	56.88	0.63	2.07	229.00	-4.58
T_{10}	26.71	68.96	0.59	1.82	208.00	-13.33
T_{11}	27.34	81.52	0.76	1.93	153.00	-36.25
T_{12}	31.85	17.68	0.66	1.96	197.00	-17.92
T_{13}	33.27	37.46	0.63	1.96	211.00	-12.08
T_{14}	32.69	55.78	0.73	2.06	182.00	-24.17

T_{15}	34.39	72.86	0.79	1.85	134.00	-44.17
T_{16}	32.40	79.60	0.76	1.65	117.00	-51.25

Table 33: Effect of different levels of EC_e and SAR on No. of leaves ofConocarpus erectus seedlings

EC (dSm^{-1})		**SAR** ($mmolL^{-1}$)$^{1/2}$	**Plant height at transplanting**	**Plant height after two years**	**% increase over initial value (after two years)**	**% decrease over control (after two years)**
T_1	<4	<15	30	803	2576.67	-
T_2	17.30	21.42	29	785	2606.90	+1.16
T_3	16.89	38.18	32	845	2540.62	-1.40
T_4	18.16	54.72	27	700	2492.60	-3.26
T_5	17.86	71.46	24	548	2183.33	-15.29
T_6	19.10	86.78	27	590	2085.18	-19.09
T_7	26.47	18.36	33	864	2518.18	-2.29
T_8	27.84	41.78	29	729	2413.80	-6.33
T_9	25.94	56.88	25	604	2316.00	-10.31
T_{10}	26.71	68.96	26	491	1788.46	-30.59
T_{11}	27.34	81.52	35	480	1271.42	-50.65
T_{12}	31.85	17.68	26	611	2250.00	-12.69
T_{13}	33.27	37.46	24	570	2275.00	-11.72
T_{14}	32.69	55.78	27	488	1707.40	-33.76
T_{15}	34.39	72.86	25	340	1260.00	-51.11
T_{16}	32.40	79.60	42	362	761.90	-70.43

Table 34: Effect of different levels of EC_e and SAR on No. of branches of Conocarpus erectus Seedlings

EC (dSm^{-1})		**SAR** (mmol L^{-1})$^{1/2}$	**Plant height at transplanting**	**Plant height after two years**	**% increase over initial value (after two years)**	**% decrease over control (after two years)**
T_1	<4	<15	7	61	771.43	-
T_2	17.30	21.42	7	60	757.14	-1.85
T_3	16.89	38.18	8	65	713.00	-7.52
T_4	18.16	54.72	6	50	733.33	-4.93
T_5	17.86	71.46	7	52	643.00	-16.60
T_6	19.10	86.78	6	41	583.33	-24.38
T_7	26.47	18.36	7	60	757.00	-1.82
T_8	27.84	41.78	6	50	733.00	-4.93
T_9	25.94	56.88	8	57	613.00	-20.49
T_{10}	26.71	68.96	9	50	455.56	-40.86

T_{11}	27.34	81.52	6	30	400.00	-48.12
T_{12}	31.85	17.68	7	53	657.14	-14.79
T_{13}	33.27	37.46	9	55	511.11	-33.72
T_{14}	32.69	55.78	5	29	480.00	-37.74
T_{15}	34.39	72.86	7	34	385.71	-49.94
T_{16}	32.40	79.60	5	22	340.00	-55.90

Results revealed that increasing levels of salinity and sodicity had negative impact on all plant growth parameters i.e. stem diameter, plant height, number of leaves and branches. Data recorded at the end of study showed that maximal percent increase over initial value at transplanting time, in almost all growth parameters was observed in control having salinity and sodicity level within normal range. While owning to dual stress of salinity and sodicity minimal percent increase over initial status was noticed in T_{16} having EC 32.40 (dSm^{-1}) and SAR 79.60($m\ mol\ L^{-1})^{1/2}$.Numerical values of percent increase in growth parameters i.e. stem diameter, plant height, number of leaves and branches found highest in control were 240.00,143.00, 2576.67 and771.43 respectively and their minimum percent increase over initial value noticed inT16 having EC 32.40 (dSm^{-1}) and SAR 79.60($mmol\ L^{-1})^{1/2}$ was 117.00,44.00,761.90 and 340.00 respectively. Similarly intensity of depreciation in percent increase over initial value ,increases by increasing the salt stress and highest percent decrease in numerical value over control in all growth parameters was found inT_{16} having EC 32.40 ($d\ Sm^{-1}$) and SAR 79.60($m\ mol\ L^{-1})^{1/}$ while 50% reduction in growth over control was mostly observed inT_{11} EC 27.34 (dSm^{-1}) and SAR 81.52($mmol\ L^{-1})^{1/2}$. Generally negative impact on the growth of all parameters recorded was more intense at higher sodicity levels as compared to salinity.As earlier stated that different salinity and sodicity levels as per treatment plan were developed using four saltNaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ by quadratic equation. At the end of study, soil sampling was done and their laboratory analysis showed that salinity and sodicity levels in soil developed were not exactly same according to treatment plan. The salinity and sodicity levels mentioned in soil at harvesting are given in table 35.

Table 35: Levels of EC_e and SAR developed artificially and there actual status(According to lab. Analysis)

EC developed ($d\ Sm^{-1}$)		**EC actual status** (dSm^{-1})	**SAR developed** ($mmol\ L^{-1})^{1/2}$	**SAR actual status** ($mmol\ L^{-1})^{1/2}$
T_1	<4	<4	<15	<15
T_2	20	17.30	20	21.42
T_3	20	16.89	40	38.18
T_4	20	18.16	60	54.72
T_5	20	17.86	80	71.46
T_6	20	19.10	100	86.78
T_7	30	26.47	20	18.36
T_8	30	27.84	40	41.78
T_9	30	25.94	60	56.88
T_{10}	30	26.71	80	68.96
T_{11}	30	27.34	100	81.52
T_{12}	40	31.85	20	17.68

T_{13}	40	33.27	40	37.46
T_{14}	40	32.69	60	55.78
T_{15}	40	34.39	80	72.86
T_{16}	40	32.40	100	79.60

11. ENHANCING THE SOLUBILITY OF GYPSUM WITH H_2SO_4 RICE 2016

After harvesting of wheat 2015-16, rice 2016 was transplanted in the same field. Field was thoroughly prepared by repeated ploughing and planking. Experiment was laid out in RCBD with 3 replications. Recommended dose of fertilizers (150-90-60 NPK kg ha^{-1}) was applied to rice.The date of rice transplantation and harvesting was 19-07-2016 and 21-10-2016respectively. All agronomic and plant protection measures were applied uniformly.Paddy and straw yield data was recorded at maturity..

Table36: Yield data (Rice2016)

Treatments	**Paddy yield**	**Straw Yield**
		(t ha^{-1})
T_1 Control	1.42C	3.29C
T_2 Gypsum @ 100 % of GR	2.79B	6.45B
T_3 Gypsum @ 100 % of GR + 10 kg H_2SO_4 $acre^{-1}$	2.82B	6.43B
T_4 Gypsum @ 100% of GR + 50 kg H_2SO_4 $acre^{-1}$	3.39A	7.69A
T_5 Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$ -1	3.46A	7.87A
LSD	0.348	0.797

Results of3rd cropindicated that paddy yield **(**3.46 t.ha^{-1}) was highest in T_5 (Gypsum @ 100 % of GR + 100 Kg H_2SO_4 $acre^{-1}$) which was statistically at par withT_4 (Gypsum @ 100% of GR + 50 kg H_2SO_4 $acre^{-1}$) followed by T_3 (Gypsum @ 100 % of GR + 10 kg H_2SO_4 $acre^{-1}$) and T_2 (Gypsum @ 100 % GR). The lowest yield (1.42 t. ha^{-1}) was recorded in control. The same trend was observed for straw yield. Soil samples were collected after harvesting of crop and analysed for pH_s, EC_e and SAR.

Table37: Soil analysis after rice 2016

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$
T_1 Control	8.85	4.90	43.69
T_2 Gypsum @ 100 % of GR	8.65	3.87	24.55
T_3 Gypsum @ 100 % of GR + 10 kg H_2SO_4 $acre^{-1}$	8.65	3.88	24.41
T_4 Gypsum @ 100% of GR + 50 kg H_2SO_4 $acre^{-1}$	8.56	3.58	21.43
T_5 Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$	8.53	3.61	20.55

In case of soil analysis EC_e was within safe limit except T_1(control)while pHs and SAR were above the safe limits in all the treatments,However almost higher decrease in EC_e, pHsand SAR was observed in T_5 (Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$) as compared to control (table 37).

After harvesting of rice 2016, wheat 2016-17 was sown in the same field which was thoroughly prepared by repeated ploughing and planking. Experiment was laid out in RCBD with 3 replications.Recommended dose of fertilizer 160-114-60NPK kg ha^{-1} was applied.The date of wheat sowing and harvesting was 17-11-2016 and 18-04-2017 respectively. All agronomic and plant protection measures were applied uniformly. Grain and straw yield data was recorded at maturity. Soil samples were collected after harvesting of crop and were analyzed in laboratory for salinity and sodicity.

Table 38: Yield data (wheat 2016-17)

Treatments	**Grain yield**	**Straw Yield**
	(t. ha^{-1})	
T_1 Control	1.23C	1.66C
T_2 Gypsum @ 100 % of GR	2.86B	3.65B
T_3 Gypsum @ 100 % of GR + 10 kg H_2SO_4 $acre^{-1}$	2.90B	3.61B
T_4 Gypsum @ 100% of GR + 50 kg H_2SO_4 $acre^{-1}$	3.35A	4.25A
T_5 Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$	3.31A	4.32A
LSD	0.368	0.476

The results of 4th crop depicted in table 38 indicated that grain yield (3.35 t.ha^{-1}) was found maximum in T_4 (Gypsum@ 100 % of GR + H_2SO_4 50 Kg $acre^{-1}$) followed by T_5 (Gypsum @ 100% of GR + $H_2SO_4$100 kg $acre^{-1}$).However, bothtréatments were statistically non-significantwith each other. The lowest yield (1.23t. ha^{-1}) was recorded in control. The same trend was observed for straw yield.

Table 39: Soil analysis after wheat 2016-17

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$
T_1 Control	8.87	4.94	44.02
T_2 Gypsum @ 100 % of GR	8.62	3.68	22.18
T_3 Gypsum @ 100 % of GR + 10 kg H_2SO_4 $acre^{-1}$	8.60	3.68	21.68
T_4 Gypsum @ 100% of GR + 50 kg H_2SO_4 $acre^{-1}$	8.52	3.30	18.16
T_5 Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$	8.48	3.34	17.74

Regarding post-harvestsoil analysis table 39 showed that EC_e was within safe limit except T_1 (control),while pH_s and SAR were above the safe limits in all the treatments exceptT_5, However higher decrease in EC_e, $pH_s$and SAR was observed in T5 (Gypsum @ 100% of GR + 100 kg H_2SO_4 $acre^{-1}$) as compared to control.

12. USE OF HYACINTH COMPOST IN SALT AFFECTED SOILS

Theobjective of the experiment was to determine the effectiveness of hyacinth compost as an ameliorant for reclamation of saline sodic soil and crop production. Treatments included were T_1 Control, T_2 Gypsum @ 100 % GR, T_3Gypsum @ 50 % GR, T_4Hyacinth compost @ 15t. ha^{-1}, T_5 Gypsum @ 50 % GR+ hyacinth compost @ 5 t. ha^{-1}, T_6Gypsum @ 50 % of GR+ hyacinth compost @ 10 ha^{-1}, T_7,Gypsum @ 50 % GR+ hyacinth compost @ 15 t. ha^{-1}. At the start of study soil hadpH_s 8.91, EC_e5.02(dS m^{-1}), SAR 44.24(mmol $L^{-1})^{1/2}$, GR 4.12(t.$acre^{-1}$), BD 1.66 (Mg m^{-3}), HC 0.35 (cm hr^{-1}). Experiment was laid out in RCBD with 3 replications. The amendments (gypsum and

compost) were applied (once) at the start of study in the respective treatment plots followed by leaching. It was 2nd year of study, rice2016 was transplanted in the same layout. Recommended dose of fertilizers (150-90-60 NPK kg ha^{-1}) was applied to rice.The date of rice transplantation and harvesting was 19-07-2016 and 21-10-2016 respectively.Tube-well water (EC 1.54 dS m^{-1}, SAR 7.60 $(mmol\ L^{-1})^{1/2}$ and RSC 4.8 me L^{-1}) was used for crop production. All agronomic and plant protection measures were applied uniformly.Paddy and straw yield data was recorded at maturity. Soil samples were collected after harvesting of crop.

Table 39: Yield data (Rice2016)

Treatments	**Paddy Yield**	**Straw Yield**
		(t ha^{-1})
T_1 - Control	1.24D	3.10D
T_2 - Gypsum @ 100% of GR	2.92A	6.72A
T_3 - Gypsum @ 50 % of GR	2.32C	5.34C
T_4 -Hyacinth compost @ 15 t. ha^{-1}	2.35C	5.55C
T_5 - Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}	2.54BC	5.93BC
T_6 - Gypsum @ 50 % of GR + hyacinth compost @ 10 t. ha^{-1}	2.80AB	6.50AB
T_7 - Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}	3.03A	6.97A
LSD	0.2824	0.6613

Results revealed(Table 39)that maximum paddy yield (3.03 t.ha^{-1}) was found in T_7 (Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1})whichwas at par with T_2 (Gypsum @ 100 % GR)and T_6 (Gypsum @ 50 % of GR + hyacinth compost @ 10 t. ha^{-1}) followed by T_5 (Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}). The lowest yield (1.24t. ha^{-1}) was recorded in control.Same trend was also observed in straw yield. Soil samples were collected and analysed for pH, EC_e and SAR and results are depicted in table-40.

Table 40: Soil analysis after rice 2016

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** $(mmol\ L^{-1})^{1/2}$	**BD** (Mg m^{-3})	**HC** (cm hr^{-1})
T_1Control	8.93	5.02	44.29	1.70	0.35
T_2Gypsum @ 100% of GR	8.63	3.68	25.66	1.67	0.40
T_3 Gypsum @ 50 % of GR	8.74	3.90	31.51	1.69	0.38
T_4Hyacinth compost @ 15 t. ha^{-1}	8.77	3.65	32.27	1.68	0.39
T_5 Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}	8.71	4.06	28.53	1.69	0.38
T_6Gypsum @ 50 % of GR + hyacinth compost @ 10 t. ha^{-1}	8.67	3.76	26.71	1.69	0.39
T_7 Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}	8.62	3.53	25.37	1.67	0.41

Soil analysis data showed that EC_e was within safe limit except T_1(control) andT_4 (Hyacinth compost @ 15 t. ha^{-1}) while pH_s and SAR were above the safe limits in all the treatments.The higher value of BD and HC was recorded in control and T_2 respectively.

After harvesting of rice 2016, Wheat (FSD- 2008) was sown in the same layout plan. . Field was thoroughly prepared by ploughing and planking. Experiment was laid out in RCBD with 3 replications.Recommended dose of fertilizer 160-114-60NPK kg ha^{-1} was applied.The date of wheat sowing and harvesting was 17-11-2016 and 18-04-2017 respectively. All agronomic and plant protection measures were applied uniformly. Grain and straw yield data was recorded at maturity. Soil samples were collected after harvesting of crop and were analyzed for salinity and sodicity.

Table 41: Yield data (Wheat 2016-17)

Treatments	**Grain Yield**	**Straw Yield**
	(t ha^{-1})	
T_1Control	1.16D	1.53D
T_2 Gypsum @ 100% of GR	3.36A	4.33A
T_3 Gypsum @ 50 % of GR	2.37C	3.12C
T_4Hyacinth compost @ 15 t. ha^{-1}	2.40C	3.09C
T_5 Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}	2.92B	3.74B
T_6 Gypsum @ 50 % of GR + hyacinth compost @ 10 t. ha^{-1}	3.23A	4.14AB
T_7 Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}	3.41A	4.35A
LSD	0.279	0.407

Results of wheat grain data(Table-41) showed that maximum grain yield (3.41ha^{-1}) was found in T_7 (Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}) whichremained at par with T_2 (Gypsum @ 100 % GR) 3.36 t.$ha^{-1}$and T_6 (Gypsum @ 50 % of GR + hyacinth compost @ 10 t. $ha^{-1)}$ 3.23 t.ha^{-1} followed by T_5 (Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}). The lowest grain yield (1.16 t. ha^{-1}) was recorded in (control).Same trend was also observed for straw yield.

Table 42: Soil analysis after wheat 2016-17

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$	**BD** ($Mg\ m^{-3}$)	**HC** ($cm\ hr^{-1}$)
T_1 Control	8.92	5.05	44.38	1.66	0.34
T_2 Gypsum @ 100% of GR	8.56	3.49	23.24	1.62	0.46
T_3 Gypsum @ 50 % of GR	8.68	3.74	29.76	1.63	0.39
T_4 Hyacinth compost @ 15 t. ha^{-1}	8.73	4.02	31.48	1.60	0.40
T_5 Gypsum @ 50 % of GR + hyacinth compost @ 5 t. ha^{-1}	8.65	3.68	27.28	1.61	0.43
T_6 Gypsum @ 50 % of GR + hyacinth compost @ 10 t. ha^{-1}	8.62	3.59	25.62	1.59	0.44
T_7 Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}	8.54	3.47	22.32	1.59	0.45

Regarding soil analysis,EC_e was within safe limit except T_1(control) and T_4(Hyacinth compost @ 15 t. ha^{-1}) while pH_s and SAR were above the safe limits in all the treatments.However,maximum

decrease in Eked¸pHsand SAR was observed in T_7 (Gypsum @ 50 % of GR + hyacinth compost @ 15 t. ha^{-1}) as compared to control(table- 42).

13. RESPONSE OF SAPODILLA SEEDLINGS TO DIFFERENT LEVELS OF SALINITY AND SODICITY

The experiment was designed to determine salinity/sodicity tolerance potential of sapodilla seedlings. Performance of sapodilla will be tested on different salinity and sodicity levels in pots first and then performance will be evaluated under field conditions later on. In total 10 treatments were planned having different combination of salinity and sodicity levels i.e. $T_1 EC_e$< 4(dS m^{-1}), SAR<15 (mmol $L^{-1})^{1/2}$, T_2 EC_e8 (dS m^{-1}) , SAR 20 (mmol $L^{-1})^{1/2}$, T_3 EC_e8 (dS m^{-1}),SAR 25 (mmol $L^{-1})^{1/2}$, T_4 EC_e8 (dS m^{-1}), SAR 30 (mmol $L^{-1})^{1/2}$,T_5 EC_e12 (dS m^{-1}) SAR 20 (mmol $L^{-1})^{1/2}$,T_6 EC_e12 (dS m^{-1}) ,SAR 25 (mmol $L^{-1})^{1/2}$,T_7 EC_e 12 (dS m^{-1}),SAR 30 (mmol $L^{-1})^{1/2}$, T_8 EC_e 16 (dS m^{-1}),SAR 20 (mmol $L^{-1})^{1/2}$, T_9 EC_e16(dS m^{-1}),SAR 25 (mmol $L^{-1})^{1/2}$, T_{10}EC16(dSm^{-1}),SAR 30 (mmol $L^{-1})^{1/2}$.A normal soil was selected, sieved and the desired salinity/sodicity levels were developed using salts NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ by Quadratic Equation. The initial soil analysis was pH_s8.17, EC_e 1.32 dS m^{-1},SAR 11.32 (mmol $L^{-1})^{1/2}$ and SP was 33.70%. After establishing the desired levels of EC_e and SAR, the soil was filled in the glazed pots as per treatment plan. One seedling of sapodilla was transplanted in each pot. Experiment was laid out in CRD with three replications. Fertilizer @ one liter of 1% urea, TSP and SOP was applied after six months of seedlings transplantation. The data regarding plant height and stem diameter (first year) was recorded on 15-08-2017, the detail of which is given in table 43.

Table 43: Effect of different levels of EC_e and SAR on stem diameter (cm)**of sapodilla seedlings**

EC (dSm^{-1})		**SAR** (mmol $L^{-1})^{1/2}$	**stem diameter at transplanting**	**stem diameter after one year**	**% increase over initial value (after one year)**	**% decrease over control (after one year)**
T_1	<4	<15	1.34	1.78	32.84	-
T_2	8	20	1.17	1.49	27.35	-16.72
T_3	8	25	1.31	1.66	26.72	-18.64
T_4	8	30	1.34	1.66	23.88	-27.28
T_5	12	20	1.30	1.63	25.38	-22.72
T_6	12	25	1.15	1.44	25.22	-23.20
T_7	12	30	1.32	1.59	20.45	-37.73
T_8	16	20	1.25	1.50	20.00	-39.10
T_9	16	25	1.28	1.46	14.06	-57.19
T_{10}	16	30	1.18	1.26	6.78	-79.35

Table 44: Effect of different levels of EC_e and SAR on plant height (cm) of sapodilla seedlings

EC (dSm^{-1})		**SAR** (mmol$L^{-1})^{1/2}$	**Plant height (cm)at transplanting**	**Plant height(cm) after one year**	**% increase over initial value (after one year)**	**% decrease over control (after one year)**
T_1	<4	<15	121	132	9.09	-
T_2	8	20	92	100	8.70	-4.29

T_3	8	25	109	118	8.26	-9.13
T_4	8	30	90	97	7.78	-14.41
T_5	12	20	118	128	8.47	-6.82
T_6	12	25	109	117	7.34	-19.25
T_7	12	30	119	126	5.88	-35.31
T_8	16	20	104	111	6.73	-25.96
T_9	16	25	113	118	4.42	-51.38
T_{10}	16	30	107	111	3.74	-58.86

Data collected regarding plant height and stem diameter after one year of transplanting of sapodilla plants showed that increasing levels of salinity and sodicity had negative effect on plant growth parameters. Data revealed that maximum percent increase over initial value at transplanting time, in both growth parameters was observed in control having salinity and sodicity level within normal range. While owning to dual stress of salinity and sodicity minimum percent increase over initial status was noticed in T_{10}having EC 16 (dSm^{-1}) and SAR 30(mmol $L^{-1})^{1/2}$.Numerical values of percent increase in stem diameter and plant heightwas observed 32.84 and9.09 and minimum percent increased over initial value noted inT_{10} having EC 16 (dSm^{-1}) and SAR 30(mmol $L^{-1})^{1/2}$ was 6.78 and 3.74 respectively.Similarly intensity of depreciation in percent increased over initial value, increases by increasing the level of salt stress .Highest percent decrease in stem diameter 79.35 and plant height 58.86 as compared to control was depicted inT_{10} EC 16 (dSm^{-1}) and SAR 30(mmol $L^{-1})^{1/2}$ while 50% reduction in growth over control was almost observed inT_9 EC 16 (dSm^{-1}) and SAR 25(mmol $L^{-1})^{1/2}$.

5.4 PLANT NUTRITION DIVISION

14. FERTILIZER REQUIREMENT OF DIRECT SEEDED COARSE RICE IN SALINE SODIC SOIL

Soil fertility and productivity are inter-related factors for improving crop yield. High pH, high calcium carbonate contents, high exchangeable sodium percentage and high salt concentration are the important factors affecting plant nutrition management in salt affected soils. A field experiment was conducted in Kharif 2016 to determine optimum rate of NPK for better yield and nutrient uptake of direct seeded coarse rice in saline sodic soil. The field was prepared and leveled. Composite soil samples were collected and analyzed for salinity/sodicity. The field selected for study was saline sodic in nature having pH_s 8.54, EC_e 5.18 dS m^{-1},SAR=33.58 $(mmolL^{-1})^{1/2}$,O.M=0.39, available P7.40 $mgkg^{-1}$ and extractable K 106 mg kg^{-1}. The experiment consisted of eleven treatments i.e. T_1 (0-0-0), T_2 (0-86-60), T_3 (87-86-60),T_4 (174-86-60), T_5 (261-86-60), T_6 (174-0-60), T_7 (174-43-60)T_8 (174-129-60), T_9 (174-86-0), T_{10} (174-86-30) and T_{11} (174-86-90) as NPK kg ha^{-1}. The experiment was conducted in RCBD with three replications.. Sowing of direct seeded rice was done with hand drill in wattar condition. Test variety was KSK-133. Seed rate was 50 kg ha^{-1}. Whole P_2O_5 and K_2O and 1/3 N was applied at the time of sowing to rice crop. Remaining N was applied 20 and 40 days after sowing. Zinc sulphate (33%) @ 12.5 kg ha^{-1} was applied 15 days after sowing. Crop was harvested at maturity. Paddy and Straw yield data was recorded. Paddy and straw samples was analyzed for NPK concentration. Soil samples were collected after harvesting of rice and analysed for ECe, pHs, SAR, O.M., available P and extractable K. The results are presented as under:

Table 45: Effect of different fertilizer rates on paddy yield, straw yield and 1000 paddy weight of direct seeded coarse rice

Treatments NPK (kg ha^{-1})	**Paddy yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})	**1000 paddy weight** (g)
T_1 0-0-0	1.41 H	1.73 G	16.90 I
T_2 0-86-60	1.94 G	2.07 FG	17.80 H
T_3 87-86-60	2.35 EF	2.43 E	24.60 F
T_4 174-86-60	2.97 BC	3.12 BC	28.20 C
T_5 261-86-60	3.26 AB	3.38 AB	28.90 AB
T_6 174-0-60	1.88 G	1.96 G	17.20 I
T_7 174-43-60	2.16 FG	2.37 EF	22.50 G
T_8 174-129-60)	3.47 A	3.60 A	29.40 A
T_9 (174-86-0	2.56 DE	2.70 DE	26.00 E
T_{10} 174-86-30	2.82 CD	2.90 CD	27.30 D
T_{11} 174-86-90	3.14 B	3.23 BC	28.60 BC
LSD	0.3264	0.3498	0.5328

Effect of different rates of NPK fertilizer application on paddy yield, straw yield and 1000 paddy weight of coarse rice is given in Table 45. Data showed that different rates of NPK application have significant effect on paddy yield, Straw yield and 1000 paddy weight of coarse rice. Paddy yield of coarse rice with different combinations of NPK ranged from 1.41 to 3.47 (t. ha^{-1}). Maximum paddy yield of rice was observed in T_8 where NPK @ 174-129-60 kg ha^{-1} was applied and it remained statistically non-significant with T_5 (261-86-60) kg ha^{-1}. Minimum paddy yield (1.41 t. ha^{-1}) was observed in T_1 without NPK fertilizer application. Similar trend was observed for straw yield and 1000 paddy weight of coarse rice with different rates of NPK fertilizer application.

Table 46:Effect of different rates of fertilizer application on NPK concentration of paddy in direct seeded coarse Rice

Treatments NPK (kg ha^{-1})	**Total N** (%)	**Total P** (%)	**Total K** (%)
T_1 0-0-0	1.38 J	0.18 D	0.24 F
T_2 0-86-60	1.94 G	0.20 CD	0.28 E
T_3 87-86-60	2.05 FE	0.23 ABC	0.34 CD
T_4 174-86-60	2.16 BCD	0.26 AB	0.37B
T_5 261-86-60	2.22 AB	0.27 A	0.38 A
T_6 174-0-60	1.72 H	0.20CD	0.26 E
T_7 174-43-60	1.98 FG	0.22 BCD	0.32 D
T_8 174-129-60)	2.28 A	0.27 A	0.39 AB
T_9 (174-86-0	2.08 DE	0.24 ABC	0.36 AB
T_{10} 174-86-30	2.12 CDE	0.26 AB	0.36 BC
T_{11} 174-86-90	2.22 BC	0.26 AB	0.39 AB
LSD	0.0912	0.0428	0.0275

Effect of different rates of NPK application on NPK concentration of paddy in direct seeded coarse rice is given in Table 46. Nitrogen concentration in paddy ranged from 1.38 to 2.28%. Maximum

Nitrogen concentration (2.28%) was observed in T_8(174-129-60 NPK kg ha^{-1}) was applied and it remained statistically non-significant with T_5(261-86-60 NPK kg ha^{-1}). Minimum nitrogen concentration in paddy of coarse rice (1.38%) was observed in control treatment without fertilizer application. Total P concentration in paddy ranged from 0.18% to 2.27% in paddy of coarse rice. Maximum total P in paddy of coarse rice (0.27%) was observed in T_8 where NPK @ 174-129-60 kg ha^{-1} was applied and it remained statistically non-significant with T_5, T_4, T_3, T_9. T_{10} and T_{11} and differed significantly with all the remaining treatments. Minimum Total P concentration (0.18%) was observed in control where no NPK fertilizer was applied. Total K concentration in paddy of coarse rice ranged from 0.39 to 0.24%. Maximum total K concentration (0.39%) in paddy was observed in T_{11} which differed non-significantly with T_9, T_8 and T_5 and differed significantly with remaining treatments. Minimum K concentration in paddy (0.24%) of coarse rice was observed in control.

Table 47:Effect of different rates of fertilizer application on NPK concentration of rice Straw in direct seeded coarse rice

Treatments NPK (kg ha^{-1})	**Total N** (%)	**Total P** (%)	**Total K** (%)
T_1 0-0-0	0.28 H	0.06 E	0.88 F
T_2 0-86-60	0.34 FG	0.08 DE	0.94 EF
T_3 87-86-60	0.40 DE	0.10 BCD	1.02 CD
T_4 174-86-60	0.50 B	0.12 AB	1.10 AB
T_5 261-86-60	0.58 A	0.12 AB	1.14 A
T_6 174-0-60	0.30 GH	0.08 DE	0.92 EF
T_7 174-43-60	0.38 EF	0.09 CD	0.96 DE
T_8 174-129-60)	0.58 A	0.13 A	1.14 A
T_9 (174-86-0	0.44 CD	0.11 ABC	1.05 BC
T_{10} 174-86-30	0.47 BC	0.13 A	1.08 ABC
T_{11} 174-86-90	0.56 A	0.13 A	1.12 AB
LSD	0.0516	0.0262	0.0729

Effect of different rates of NPK application on NPK concentration of rice straw in direct seeded coarse rice is given in Table 47. Nitrogen concentration in rice straw ranged from 0.28 to 0.58%. Maximum nitrogen concentration (0.58%) was observed in T_8(174-129-60 NPK kg ha^{-1}) and it remained statistically non-significant with T_5(261-86-60 NPK kg ha^{-1}). Minimum nitrogen concentration in rice straw of coarse rice (0.28%) was observed in control treatment without fertilizer application. Total P concentration in rice straw ranged from 0.06% to 0.13% . Maximum total P in straw of coarse rice (0.13%) was observed in T_8(174-129-60 NPK kg ha^{-1}) and it remained statistically non-significant with T_5, T_4, T_9, T_{10} and T_{11} and differed significantly with all the remaining treatments. Minimum Total P concentration (0.06%) in rice straw was observed T_1 . Total K concentration in rice straw ranged from 0.88 to 1.14%. Maximum total K concentration (0.39%) in rice straw was observed in T_{11} which differed non-significantly with T_9, T_8 and T_5 and differed significantly with remaining treatments. Minimum total K concentration in straw (0.24%) of coarse rice was observed in control where no NPK was applied.

Table 48:Postharvest soil analysis

Treatments NPK (kg ha^{-1})	pH_s	EC (dS m^{-1})	SAR (mmol^{-1})$^{1/2}$	O.M. (%)	Available P (mg kg^{-1})	Extractable K (mg kg^{-1})
T_1 0-0-0	8.53	5.12	31.16	0.36	6.20	102.0
T_2 0-86-60	8.53	5.11	30.03	0.41	8.20	114.0
T_3 87-86-60	8.52	5.09	29.84	0.43	8.40	112.0
T_4 174-86-60	8.52	5.07	29.47	0.47	8. 42	110.0
T_5 261-86-60	8.51	5.06	29.12	0.51	8.60	107.0
T_6 174-0-60	8.51	5.05	29.02	0.45	5.80	116.0
T_7 174-43-60	8.51	5.03	28.90	0.41	7.20	114.0
T_8 174-129-60)	8.50	5.02	28.79	0.47	8.80	110.0
T_9 (174-86-0	8.50	5.02	28.57	0.45	8.40	98.6
T_{10} 174-86-30	8.49	5.02	28.51	0.47	8.42	108.0
T_{11} 174-86-90	8.49	5.01	28.41	0.49	8.60	118.0

Postharvest soil analysis was carried out for ECe, pHs, SAR, O.M., available P and extractable K. The results showed that salinity/sodicity parameters of soil decreased slightly after harvest of rice crop and there was better bulid up in organic matter content, available P and extractable K content of soil with higher rates of NPK fertilizer application (table48).

15. FERTILIZER REQUIREMENT OF DIRECT SEEDED FINE RICE IN SALINE SODIC SOIL

Fertilizer requirements of crops grown in salt affected soil vary depending upon salinity status of soil, soil texture and fertility status of soil. Nitrogen requirement of rice in salt affected soils is high due to high pH of soil, denitrification and volatilization losses of nitrogen are are high. The experiment was planned to determine optimum rate of NPK for better yield and nutrient uptake of direct seeded fine rice in saline sodic soil. The field was prepared and leveled. Composite soil samples were collected and analyzed for salinity/sodicity. The field selected for study was saline sodic in nature having pH_s 8.53, EC_e 5.16 (dS m^{-1}),SAR32.02 (mmol L^{-1})$^{1/2}$,O.M. 0.45 (%) ,Available P8.53 mgkg^{-1} and extractable K 110 mg kg $^{-1}$. The experiment consisted of eleven treatments i.e. T_1 (0-0-0), T_2 (0-86-60), T_3 (75-86-60),T_4 (150-86-60), T_5 (225-86-60), T_6 (15-0-60), T_7 (150-43-60)T_8 (150-129-60), T_9 (150-86-0), T_{10} (150-86-30) and T_{11} (150-86-90) NPK kg ha^{-1}. The experiment was conducted in RCBD with three replications. Sowing of direct seeded rice was done with hand drill in wattar condition. Test variety was Basmati 2000. Seed rate was 50 kg ha^{-1}. Whole P and K and 1/3 N was applied at the time of sowing to rice crop. Remaining N was applied 20 and 40 days after sowing. Zinc sulphate (33%) @ 12.5 kg ha^{-1} was applied 15 days after sowing. Crop was harvested at maturity. Paddy and Straw yield data were recorded. Paddy and straw samples was analyzed for NPK concentration. Soil samples were collected after harvesting of rice and analysed for ECe, pHs, SAR, O.M., available P and extractable K. The results are presented as under:

Table 49: Effect of different fertilizer application rates on paddy yield, straw yield and 1000 paddy weight of direct seeded fine rice

Treatments NPK (kg ha^{-1})	**Paddy yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})	**1000 paddy weight** (g)
T_1 0-0-0	1.27 I	1.51 I	16.50 G
T_2 0-86-60	1.89 GH	1.98 GH	17.20 G
T_3 75-86-60	2.28 EF	2.36 DE	21.40 E
T_4 150-86-60	2.87 BC	2.99 AB	24.10 C
T_5 225-86-60	3.10 A	3.25 A	28.10 A
T_6 150-0-60	1.72 H	1.80 GH	16.90 G
T_7 150-43-60	2.06 FG	2.18 EF	19.35 F
T_8 150-129-60	2.98 AB	3.10 AB	26.40 B
T_9 150-86-0	2.42 DE	2.53 CD	22.80 D
T_{10} 150-86-30	2.66 CD	2.72 BC	23.50 CD
T_{11} 150-86-90	2.89 BC	3.00 AB	25.60 B
LSD	0.3210	0.2872	0.9723

Effect of different rates of NPK fertilizer application on paddy yield, straw yield and 1000 paddy weight of fine rice is given in Table 49. Data depicted that different rates of NPK application have significant effect on paddy yield, Straw yield and 1000 paddy weight of fine rice. Paddy yield of fine rice with different combinations of NPK ranged from 1.27 to 3.10 (t. ha^{-1}). Maximum paddy yield of rice was observed in T_5(225-86-60 NPKkg ha^{-1}) and it remained statistically non-significant with T_8 (150-129-60 NPK kg ha^{-1}) . Minimum paddy yield (1.27 t. ha^{-1}) was observed in T_1 without NPK fertilizer application. Straw yield of fine rice ranged from 1.51 t. ha^{-1} to 3.25 t. ha^{-1}. Maximum straw yield of fine rice (3.25 t. ha^{-1}) was observed in T_5 which remained statistically at par with T_8 and T_{11} and differed significantly with remaining treatments. Minimum straw yield (1.51 t. ha^{-1}) was noted in control treatment i. e. without NPK fertilizer. Thousand paddy weight of rice is another parameter for improved paddy yield of rice. Thousand paddy weight of fine rice ranged from 16.50 to 28.10 g. Maximum 1000 paddy weight (28.10 g) was observed in T_5(225-86-60 NPK kg ha^{-1}) was applied which differed significantly with all the treatments. Minimum 1000 paddy weight 16.50 g was observed in control (T_1).

Table 50: Effect of different rates of fertilizer application on NPK concentration of paddy in direct seeded fine rice

Treatments NPK (kg ha^{-1})	**Total N** (%)	**Total P** (%)	**Total K** (%)
T_1 0-0-0	1.32 E	0.14 G	0.20 I
T_2 0-86-60	1.74 D	0.18 EF	0.26 GH
T_3 75-86-60	1.98 C	0.22 CD	0.31 F
T_4 150-86-60	2.20 AB	0.27 AB	0.39 CD
T_5 225-86-60	2.26 A	0.29 A	0.49 A
T_6 150-0-60	1.68 D	0.16 FG	0.24 HI
T_7 150-43-60	1.91 C	0.20 DE	0.29 FG

T_8 150-129-60	2.24 A	0.27 AB	0.46 AB
T_9 150-86-0	2.06 BC	0.23 CD	0.33 EF
T_{10} 150-86-30	2.18 AB	0.25 BC	0.36 DE
T_{11} 150-86-90	2.24 A	0.27 AB	0.42 BC
LSD	0.1634	0.0377	0.0468

Effect of different rates of NPK application on NPK concentration of paddy in direct seeded fine rice is given in Table 50.Nitrogen concentration in paddy ranged from 1.32 to 2.26%. Maximum nitrogen concentration (2.26%) was observed in T_5(225-86-60 NPK kg ha^{-1}) and it remained statistically non-significant with T_4 ,T_{10} and T_{11} and differed significantly with remaining treatments. Minimum nitrogen concentration in paddy of fine rice (1.32%) was observed in control treatment without fertilizer application. Total P concentration in paddy ranged from 0.14% to 2.29% in paddy of fine rice. Maximum total P in paddy of fine rice (0.29%) was observed in T_5 where NPK @ 225-86-60 kg ha^{-1} was applied and it remained statistically non-significant with T_4, T_8 and T_{11} and differed significantly with all the remaining treatments. Minimum Total P concentration (0.14%) was observed in control treatment without NPK fertilizer application. Total K concentration in paddy of fine rice ranged from 0.20 to 0.49%. Maximum total K concentration (0.49%) in paddy of fine rice was observed in T_5 which differed non-significantly with T_8 and differed significantly with remaining treatments. Minimum K concentration in paddy (0.20%) of fine rice was observed in control treatment without NPK fertilizer Application.

Table 51: Effect of different rates of fertilizer application on NPK concentration of rice straw in direct seeded fine rice

Treatments NPK (kg ha^{-1})	**Total N** (%)	**Total P** (%)	**Total K** (%)
T_1 0-0-0	0.24 I	0.05 D	0.68 J
T_2 0-86-60	0.28 HI	0.08 CD	0.89 HI
T_3 75-86-60	0.33 FG	0.12 AB	0.98 FG
T_4 150-86-60	0.42 CD	0.14 A	1.13 CD
T_5 225-86-60	0.51 A	0.14 A	1.27 A
T_6 150-0-60	0.27 HI	0.07 CD	0.86 I
T_7 150-43-60	0.31 GH	0.10 BC	0.94 GH
T_8 150-129-60	0.48 AB	0.14 A	1.23 AB
T_9 150-86-0	0.36 EF	0.12 AB	1.03 EF
T_{10} 150-86-30	0.39 DE	0.12 AB	1.09 DE
T_{11} 150-86-90	0.45 BC	0.14 AB	1.17 BC
LSD	0.0459	0.0350	0.0739

Effect of different rates of fertilizer application on NPK concentration of rice straw in direct seeded fine rice is given in Table 51.Nitrogen concentration in rice straw ranged from 0.24 to 0.51%. Maximum nitrogen concentration (0.51%) was observed in T_5(225-86-60 NPK kg ha^{-1}) and it remained statistically non-significant with T_8(150-129-60 NPK kg ha^{-1}). Minimum nitrogen concentration in rice straw of fine rice (0.24%) was observed in control treatment without fertilizer

application. Total P concentration in rice straw ranged from 0.05% to 0.14% in fine rice. Maximum total P in straw of fine rice (0.14%) was observed in T_5 ,T_4, T_3, T_8, T_9, T_{10} and T_{11}. Minimum Total P concentration (0.05%) in rice straw was observed in control T_1. Total K concentration in rice straw ranged from 0.68 to 1.27%. Maximum total K concentration (1.27) in rice straw was observed in T_5 which differed non-significantly with T_8 and differed significantly with remaining treatments. Minimum total K concentration in rice straw (0.68%) was observed in T_1.

Table 52: Post harvest soil analysis

Treatments NPK (kg ha^{-1})	**pH_s**	**EC** (dS m^{-1})	**SAR** $(mmol^{-1})^{1/2}$	**O.M.** (%)	**Available P** (mg kg^{-1})	**Extractable K** (mg kg^{-1})
T_1 0-0-0	8.53	5.14	31.03	0.42	7.60	106.0
T_2 0-86-60	8.53	5.14	30.56	0.46	8.60	118.0
T_3 75-86-60	8.52	5.13	30.24	0.48	8.80	118.0
T_4 150-86-60	8.52	5.12	29.97	0.51	8.80	116.0
T_5 225-86-60	8.52	5.12	29.67	0.53	8.92	116.0
T_6 150-0-60	8.52	5.10	29.51	0.44	7.20	120.0
T_7 150-43-60	8.52	5.09	29.42	0.47	8.40	118.0
T_8 150-129-60	8.52	5.02	28.93	0.58	9.60	114.0
T_9 150-86-0	8.51	5.01	28.68	0.52	9.20	102.0
T_{10} 150-86-30	8.51	5.00	28.57	0.54	9.00	116.0
T_{11} 150-86-90	8.51	4.99	28.42	0.56	9.00	118.0

After harvest of rice in 2016, soil samples were analysed for EC_e, pH_s, SAR, O.M., available P and extractable K. The results depicted in table 52revealed that salinity/sodicity parameters of soil decreased slightly after harvest of rice crop and there was better build up in organic matter content, available P and extractable K of soil with increasing rates of NPK fertilizer application.

16. EFFECT OF SEED PRIMING AND FOLIAR APPLICATION OF SALICYLIC ACID ON NUTRIENT UPTAKE OF DIRECT SEEDED RICE IN SALINE SODIC SOIL

Salicylic acid is a plant hormone of phenolic nature. It is synthesized in plants from Phenyl alanine. Salicylic acid reduces the uptake of sodium and chloride and promotes uptake of NPK when applied to crops in salt stress condition. The experiment was planned to study the effect of seed priming and foliar application of salicylic acid on nutrient uptake of direct seeded rice in saline sodic condition A moderately saline sodic field {pH_s 8.53, EC_e 5.20dS m^{-1}, SAR 31.40 (mmol $L^{-1})^{1/2}$, O.M 0.44%, Available P 7.53 mg kg^{-1}, Extractable K 102 mg kg^{-1}} was selected. Field was prepared and leveled. Different treatments of salicylic acid i.e. T_1 Control (Without Salicylic acid application), T_2 Seed priming of rice with 0.5 mM Salicylic acid, T_3 Seed priming of rice with 1.0 mM Salicylic acid, T_4 Seed priming of rice with 2.0 mM Salicylic acid, T_5 Seed priming and foliar application of rice with 0.5 mM Salicylic acid, T_6 Seed priming and foliar application of rice with 1.0 mM Salicylic

acid T_7 Seed priming and foliar application of rice with 2.0 mM. Salicylic acid was applied according to treatment plan. For seed priming 500 g seed of rice was soaked in 1000 mL solution of salicylic acid of different concentration for 12 hours. Seed was dried to its original moisture level under shade. Three foliar applications of salicylic acid were done stating from booting stage at 10 days interval. Test variety was Shaheen Basmati. Sowing of direct seeded rice was done with hand drill in wattar condition. Seed rate was 50 kg ha^{-1}. Recommended dose of fertilizer 150-86-60 NPK kg ha^{-1} was applied. Sources of NPK were Urea, SSP and SOP. Whole P, K and 1/3 N was applied at the time of sowing to rice crop. Remaining N was be applied 20 and 40 days after sowing. Zinc sulphate (33%) @ 12.5 kg ha^{-1} was applied 15 days after sowing. Crop was harvested at maturity. Paddy and straw yield data were recorded. Paddy and straw samples were analyzed for NPK concentration. Soil samples were collected after harvesting of rice and analysed for EC_e, pH_s, SAR, O.M., available P and extractable K. The results are described as under:

Table 53: **Effect of different treatments of salicylic acid on paddy yield, straw yield and 1000 paddy weight of rice**

Treatments	**Paddy yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})	**1000 paddy wt** (g)
T_1 Controlwithout SA application	2.85 D	2.97 E	23.10 D
T_2 Seed priming of wheat with 0.5 mM SA	2.91 CD	3.04 E	23.14 D
T_3 Seed priming of wheat with 1.0 mM SA	3.08 BC	3.18 DE	23.72 CD
T_4 Seed priming of wheat with 2.0 mM SA	3.18 B	3.35 CD	24.10 C
T_5 Seed priming and foliar application of wheat with 0.5 mM SA	3.20 B	3.51 BC	25.60 B
T_6 Seed priming and foliar application of wheat with 1.0 mM SA	3.42 A	3.72 AB	27.10 A
T_7 Seed priming and foliar application of wheat with 2.0 mM SA	3.46 A	3.78 A	27.16 A
LSD	0.2238	0.2341	0.7130

Effect of different treatments of salicylic acid on paddy yield, straw yield and 1000 paddy weight of direct seeded rice is given in Table 53. Paddy yield of rice ranged from 2.85 to 3.46 t. ha^{-1}.Maximum paddy yield of rice 3.46 t. ha^{-1} was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6. Minimum paddy yield was recorded in control treatment without SA application. Straw yield of rice ranged from 2.97 to 3.78 t. ha^{-1}.Maximum straw yield of rice 3.78 t. ha^{-1} was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6. Minimum straw yield (2.97 t. ha^{-1}) was recorded in control treatment without SA application. Similar trend was observed for 1000 paddy weight.

Table 54: Effect of different treatments of salicylic acid on NPK concentration of paddy

Treatments	Total N (%)	Total P (%)	Total K (%)
T_1 Control without SA application	2.05 D	0.22 B	0.36 C
T_2 Seed priming of wheat with 0.5 mM SA	2.07 CD	0.22 B	0.36 C
T_3 Seed priming of wheat with 1.0 mM SA	2.10 CD	0.24 AB	0.36 C
T_4 Seed priming of wheat with 2.0 mM SA	2.14 BC	0.24 AB	0.38 BC
T_5 Seed priming and foliar application of wheat with 0.5 mM SA	2.18 BC	0.26 AB	0.38 BC
T_6 Seed priming and foliar application of wheat with 1.0 mM SA	2.26 A	0.28 A	0.42 AB
T_7 Seed priming and foliar application of wheat with 2.0 mM SA	2.28 A	0.28 A	0.44 A
LSD	0.0747	0.0482	0.0482

Effect of different treatments of salicylic acid on total NPK concentration in paddy of direct seeded rice is given in Table 54. Total N concentration in paddy ranged from 2.05 to 2.28%. Maximum total N concentration (2.28%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6. Minimum total N concentration (2.05%) was recorded in control treatment without SA application. Total P concentration in Paddy ranged from 0.22 to 0.28%. Maximum total P concentration (0.28%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6. Minimum total P concentration (0.22%) was recorded in control treatment without SA application.Total K concentration in paddy ranged from 0.36 to 0.44%. Maximum total K concentration (0.44%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6. Minimum total K concentration (0.36%) was recorded in control treatment without SA application.

Table 55: Effect of different treatments of salicylic acid on NPK concentration of rice straw

Treatments	Total N (%)	Total P (%)	Total K (%)
T_1 Control without SA application	0.47 C	0.08 B	1.16 C
T_2 Seed priming of wheat with 0.5 mM SA	0.48 C	0.08 B	1.16 C
T_3 Seed priming of wheat with 1.0 mM SA	0.52 BC	0.10 AB	1.18 BC
T_4 Seed priming of wheat with 2.0 mM SA	0.56 AB	0.10 AB	1.18 BC
T_5 Seed priming and foliar application of wheat with 0.5 mM SA	0.58 A	0.10 AB	1.19 ABC
T_6 Seed priming and foliar application of wheat with 1.0 mM SA	0.61 A	0.12 A	1.21 AB
T_7 Seed priming and foliar application of wheat with 2.0 mM SA	0.61 A	0.12 A	1.22 A
LSD	0.0654	0.0368	0.0375

Effect of different treatments of salicylic acid on total NPK concentration in rice straw of direct seeded rice is given in Table 55. Total N concentration in rice straw ranged from 0.47% to 0.61%. Maximum total N concentration (0.61%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with $T_6$and T_5. Minimum total N concentration in rice straw (0.47%) was recorded in control. Total P concentration in rice straw ranged from 0.08 to 0.12%.Maximum total P concentration (0.12%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with T_6, $T_5$and T_4. Minimum total P concentration (0.08%) in rice straw was recorded in control. Total K concentration in rice straw ranged from 1.16 to 1.22%. Maximum total K concentration (1.22%) was observed in T_7 where seed priming and foliar application of 2.0 mM SA was done and it remained statistically at par with $T_6$and T_5. Minimum total K concentration (1.16%) was recorded in control.

Table 56: Post harvest soil analysis

Treatments	**pH_s**	**EC_e** ($dS\ m^{-1}$)	**SAR** $(mmol^{-1})^{1/2}$	**O.M.** (%)	**Available P** ($mg\ kg^{-1}$)	**Extractable K** ($mg\ kg^{-1}$)
T_1 Control without SA application	8.53	5.15	30.92	0.52	8.80	108.60
T_2 Seed priming of wheat with 0.5 mM SA	8.53	5.14	30.78	0.54	8.80	108.40
T_3 Seed priming of wheat with 1.0 mM SA	8.52	5.13	30.76	0.54	8.68	108.10
T_4 Seed priming of wheat with 2.0 mM SA	8.52	5.12	30.63	0.54	8.64	107.60
T_5 Seed priming and foliar application of wheat with 0.5 mM SA	8.52	5.12	30.60	0.54	8.60	107.20
T_6 Seed priming and foliar application of wheat with 1.0 mM SA	8.52	5.11	30.50	0.56	8.58	105.10
T_7 Seed priming and foliar application of wheat with 2.0 mM SA	8.51	5.11	30.48	0.56	8.58	104.70

After harvest of rice in 2016, soil samples were analysed for EC_e, pH_s, SAR, O.M., available P and extractable K. The results depicted in table 56 showed that salinity/sodicity parameters of soil decreased slightly after harvest of rice crop and there was slight change in fertility parameters of soil after harvest of rice crop.

17. EFFECT OF SEED PRIMING AND FOLIAR APPLICATION OF SALICYLIC ACID ON NUTRIENT UPTAKE OF WHEAT IN SALINE SODIC SOIL

Salicylic acid is a plant hormone of phenolic nature. It is synthesized in plants from Phenyl alanine. Salicylic acid reduces the uptake of sodium and promotes uptake of NPK when applied to wheat in salt stress condition. The experiment was planned to study the effect of seed priming and foliar application of salicylic acid on nutrient uptake of wheat in saline sodic condition. A moderately saline sodic field {pH_s 8.63, EC_e 5.91dS m^{-1}, SAR 26.89 (mmol $L^{-1})^{1/2}$, O.M 0.44%, Available P 8.46 mg kg^{-1}, Extractable K 111.10 mg kg^{-1}}was selected. Field was prepared and leveled. Different treatments of salicylic acid i.e. T_1 Control (Without Salicylic acid application), T_2 Seed priming with 0.5 mM Salicylic acid, T_3 Seed priming with 1.0 mM Salicylic acid, T_4 Seed priming with 2.0 mM Salicylic acid, T_5 Seed priming and foliar application with 0.5 mM Salicylic acid, T_6 Seed priming and foliar application with 1.0 mM Salicylic acid, T_7 Seed priming and foliar application of wheat with 2.0 mM. Salicylic acid was applied according to treatment plan. For seed priming 500 g seed of wheat was soaked in 1000 mL solution of salicylic acid of different concentration for 12 hours. Seed was dried to its original moisture level under shade. Three foliar applications of salicylic acid were done at booting stage at 10 days interval. Test wheat variety was Galaxy 2013. Fertilizers were applied @ 120-110-70 NPK kg ha^{-1}. Sources of NPK were Urea, SSP and SOP. Whole P, K and 1/3rd N was applied at the time of sowing, while remaining N was applied in two splits at second and third irrigation. Crop was harvested at maturity. Grain and straw yield data were recorded. After the harvest of wheat, soil samples were collected and analyzed for pH_s, EC_e, SAR, OM, available P and K. The results are described as under:

Table 57: Effect of different treatments of salicylic acid on grain and straw yield of wheat (2016-17)

Treatments	**Grain Yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})
T_1Control (Recommended dose of NPK)	2.31 E	2.49 C
T_2Seed priming with 0.5 mM Salicylic acid	2.37 DE	2.56 BC
T_3Seed priming with 1.0 mM Salicylic acid	2.43 CDE	2.60 BC
T_4Seed priming with 2.0 mM Salicylic acid	2.48 BCD	2.64 B
T_5Seed priming and Foliar application with 0.5 mM Salicylic acid	2.53 BC	2.67 B
T_6Seed priming and Foliar application with 1.0 mM Salicylic acid	2.61 AB	2.82 A
T_7Seed priming and Foliar application with 2.0 mM Salicylic acid	2.67 A	2.86 A
LSD	0.1385	0.1407

Different treatments of salicylic acid have significant effect on grain and straw yield of wheat. Results (Table 57) showed that maximum grain yield (2.67 t. ha^{-1}) and straw yield (2.86 t. ha^{-1}) was observed in the treatment where seed priming and foliar application with 2.0 mMsalicylic acid was done and it remained statistically non-significant with T_6 where seed priming and foliar application with 1.0 mM salicylic acid was done. Minimum grain (2.31 t. ha^{-1}) and straw yield (2.49 t. ha^{-1}) was recorded in control treatment i.e. without seed priming and foliar application of salicylic acid which remained statistically at par with T_2(Seed priming with 0.5 mM salicylic acid) and T_3 (Seed priming with 1.0 mM salicylic acid) and differed significantly with T_4, T_5, T_6 and T_7.

Table 58: Post harvest soil analysis wheat (2016-17)

Treatments	**pH_S**	**EC** (dS m^{-1})	**SAR** (mmol $L^{-1})^{1/2}$	**O.M.** (%)	**Available P** (mg kg^{-1})	**Extractable K** (mg kg^{-1})
T_1 Control (Recommended dose of NPK)	8.62	5.87	26.28	0.48	9.80	118.60
T_2 Seed priming with 0.5 mM Salicylic acid	8.62	5.85	26.10	0.48	9.60	118.20
T_3 Seed priming with 1.0 mM Salicylic acid	8.62	5.85	25.98	0.47	9.60	116.80
T_4 Seed priming with 2.0 mM Salicylic acid	8.62	5.84	25.72	0.47	9.20	116.20
T_5 Seed priming and Foliar application with 0.5 mM Salicylic acid	8.61	5.82	25.68	0.45	9.20	115.80
T_6 Seed priming and Foliar application with 1.0 mM Salicylic acid	8.60	5.81	25.62	0.45	9.20	115.20
T_7 Seed priming and Foliar application with 2.0 mM Salicylic acid	8.60	5.80	25.60	0.45	9.00	114.60

Soil analysis (Table 58) after wheat harvest showed slight decrease in salinity/sodicity parameters of soil with minor increase in fertility status of soil.

18. YIELD ENHANCEMENT BY IMPROVING PHOSPHORUS USE EFFICIENCY IN SALINE SODIC SOILS

A field experiment was conducted in 2016-17 to determine the response of humic acid and sulfur for yield improvement and phosphorus use efficiency for wheat in saline sodic soil. The experiment consisted of nine treatments i.e. T_1Control (without P_2O_5 application),T_2 Recommended dose of P (110 kg ha^{-1}),T_3Recommended dose of P + Humic acid @ 25 $kgha^{-1}$,T_4Recommended dose of P + Humic acid @ 25 $kgha^{-1}$ + Sulfur @ 10 $kgha^{-1}$,T_5Recommended dose of P+ 500 kg FYM ha^{-1}, $T_6$50% Recommended dose of P,$T_7$50% Recommended dose of P + Humic acid @ 25$kgha^{-1}$, $T_8$50% Recommended dose of P + Humic acid @ 25 $kgha^{-1}$ + Sulfur @ 10 $kgha^{-1}$, $T_9$50% Recommended dose of P + 500 kg FYM ha^{-1}, Sulfur and humic acid were broadcasted by mixing with seed or

TSP.A moderately salt affected field {pH_S8.56, EC_e6.31(dS m^{-1}),SAR 30.25 (mmol $L^{-1})^{1/2}$, O.M. 0.37%, available P7.80mg $kg^{-1}$and Extractable K115.13 mg kg^{-1}}was selected. Field was leveled and prepared. Wheatvariety Faisalabad 2008 was sown in wattar condition. NPK were applied @ 120-110-70 kg ha^{-1}. Whole P, K, humic acid, S and 1/3 N was applied at the time of sowing, while remaining N was applied at 1st and 2nd irrigation. TSP was mixed with FYM and incubated for 15 days before its application. Experimental design was RCBD with three replications. Crop was harvested at maturity. Grain and straw yield data were recorded. The results are described as under:

Table 59: Effect of different treatments of phosphorus application on grain and straw yield of wheat (2016-17)

Treatments	**Grain Yield** (t. ha^{-1})	**Straw yield** (t. ha^{-1})
T_1Control (without P application)	1.42 F	1.55 E
T_2Recommended dose of P(110 kg ha^{-1})	2.49 C	2.66 B
T_3Recommended dose of P + Humic acid @ 25 $kgha^{-1}$	2.55 BC	2.73 B
T_4Recommended dose of P+ Humic acid @ 25 $kgha^{-1}$ + Sulfur @ 10 $kgha^{-1}$.	2.76 AB	2.81 AB
T_5 Recommended dose of P+ 500 kg FYM ha^{-1}.	2.81 A	2.96 A
$T_6$50% Recommended dose of P	1.92 E	2.11 D
$T_7$50% Recommended dose ofP+ Humic acid @ 25$kgha^{-1}$	1.97 E	2.21 CD
$T_8$50% Recommended dose of P + Humic acid @ 25 $kgha^{-1}$ + Sulfur @ 10 $kgha^{-1}$.	2.04 DE	2.26 CD
$T_9$50% Recommended dose ofP + 500 kg FYM ha^{-1}.	2.19 D	2.40 C
LSD	0.2220	0.2065

Different treatments of phosphorus application have significant effect on grain and straw yield of wheat. Results showed that maximum grain yield (2.81 t. ha^{-1}) and straw yield (2.96 t. ha^{-1}) was observed in T_5 where recommended dose of P + 500 kg FYM ha^{-1} was applied and it remained statistically non-significant with T_4, where recommended dose of P + Humic acid @ 25 $kgha^{-1}$ + Sulfur @ 10 $kgha^{-1}$ was applied (Table 59). It was followed by T_3, where recommended dose of P + Humic acid @ 25 $kgha^{-1}$ was applied. Minimum grain (1.42 t. ha^{-1}) and straw yield (1.52 t. ha^{-1}) of wheat was recorded in control treatment.

Table 60: Post harvest soil analysis (2016-17)

Treatments	**pH_s**	**EC_e** (dS m^{-1})	**SAR** (m mol $L^{-1})^{1/2}$	**O.M.** (%)	**Available P** (mg kg^{-1})
T_1 Control (without P application)	8.56	6.28.	29.60	0.35	6.80
T_2 Recommended dose of P(110 kg ha^{-1})	8.56	6.25	29.45	0.39	8.60
T_3 Recommended dose of P + Humic acid @ 25 kg ha^{-1}	8.56	6.24	29.15	0.41	8.53
T_4 Recommended dose of P+ Humic acid @ 25 kg ha^{-1} + Sulfur @ 10 kg ha^{-1}.	8.55	6.22	28.90	0.43	8.66
T_5 Recommended dose of P + 500 kg FYM ha^{-1}.	8.55	6.22	28.40	0.45	8.73
T_6 50% Recommended dose of P	8.56	6.23	28.65	0.41	8.06
T_7 50% Recommended dose of P + Humic acid @ 25 kg ha^{-1}	8.56	6.25	28.70	0.41	8.13

T_8 50% Recommended dose of P + Humic acid @ 25 kg ha^{-1} + Sulfur @ 10 kg ha^{-1}.	8.56	6.25	28. 82	0.42	8.26
$T_9$50% Recommended dose of P + 500 kg FYM ha^{-1}.	8.55	6.24	28.85	0.41	8.26

After the harvest of wheat, Soil samples were collected and analysed for pH_S, EC_e,SAR, O.M. available P and extractable K.The results (Table 60) showed that salinity/sodicity parameters of soil decreased slightly and there was better buildup of P in treatment where recommended dose of P+ 500 kg FYM ha^{-1} was applied.

19. ENHANCEMENT OF WHEAT YIELD BY IMPROVING NITROGEN USE FFICIENCY IN SALINE SODIC SOIL

A field experiment was conducted in 2016-17to improve wheat yield and nitrogen use efficiency by using slow release urea in saline sodic soil.The experiment consisted of five treatments i.e. T_1control (without nitrogen), T_2 Recommended dose of N from urea, T_3 Recommended dose of N from slow release urea,$T_4$75% recommended dose of N from slow release urea and $T_5$50% recommended dose of N from slow release urea. A moderately salt affected field {pH_S8.54, EC_e 6.28 (dS m^{-1}),SAR30.81 (mmol $L^{-1})^{1/2}$, O.M. 0.35%, available P mg kg^{-1} and extractable K 116 mg kg^{-1}}was selected. Field was leveled and prepared. Wheat variety Galaxy 2013 was sown.NPK were applied @ 120-110-70 kg ha^{-1}.Whole Phosphorus, potassium and 1/2 N was applied at the time of sowing, while remaining 1/2 nitrogen was applied at first irrigation. Experimental design was RCBD with three replications. Crop was harvested at maturity. Grain and straw yield data were recorded. The results are described as under:

Table 61: Comparison of slow release and ordinary urea for improving grain and straw yield of wheat in saline sodic soil (2016-17)

TREATMENTS	**GRAIN YIELD** (t. ha^{-1})	**STRAW YIELD** (t. ha^{-1})
T_1 Control (Without nitrogen)	1.37 D	1.68 D
T_2 Recommended dose of N from urea	2.67 AB	2.90 AB
T_3 Recommended dose of nitrogen from slow release urea	2.94 A	3.18 A
T_4 75% recommended dose of nitrogen from slow release urea	2.43 B	2.67 B
T_5 50% recommended dose of nitrogen from slow release urea	1.96 C	2.11 C
LSD	0.2754	0.3971

Different treatments of nitrogen application have significant effect on grain and straw yield of wheat. Results showed that maximum grain (2.94 t. ha^{-1}) and straw yield (3.18 t. ha^{-1}) was observed in T_3 whererecommended dose of nitrogen from slow release urea was applied and it remained statistically non-significant with T_2, where recommended dose of N from urea was applied. It was followed by T_4,where75% recommended dose of nitrogen from slow release urea was applied(Table 61).Minimum grain (1.37 t. ha^{-1}) and straw yield (1.68 t. ha^{-1}) of wheat was recorded in control treatment.

Table 62: Post harvest soil analysis (2016-17)

Treatments	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	O.M. (%)	Available P (mg kg^{-1})
T_1 Control (Without nitrogen)	8.54	6.12.	29.94	0.33	8.80
T_2 Recommended dose of N from urea	8.53	6.07	28.78	0.41	8.20
T_3 Recommended dose of nitrogen from slow release urea	8.53	6.06	28.11	0.41	8.13
T_4 75% recommended dose of nitrogen from slow release urea	8.53	6.08	29.01	0.39	8.40
T_5 50% recommended dose of nitrogen from slow release urea	8.53	6.10	29.62	0.37	8.60

After the harvest of wheat, Soil samples were collected and analysed for pH_S, EC_e,SAR, O.M. available P and extractable K.The results (Table 62) showed that salinity/sodicity parameters of soil decreased slightly and there was better buildup of O.M. in treatments where N from urea and slow release urea was applied.

20. ZINC REQUIREMENT OF CANOLA IN SALINE SODIC SOIL

A field experiment was conducted in 2016-17 to determine zinc requirement of canola in saline sodic soil. Zinc is one of the essential micronutrient required by plants for optimum growth and yield. Zinc has ability to increase crop yield by improving K/Na and Ca/Na ratios under salt stress condition. The experiment was planned to determine optimum zinc requirement of Canola in saline sodic soil. A moderately salt affected field {pH_S 8.53, EC_e5.37(dS m^{-1}),SAR: 27.63(mmol $L^{-1})^{1/2,}$ O.M.: 0.45 (%), available P 8.5mg kg^{-1}, extractable K117mg kg^{-1} and AB-DTPA Zn 0.98 mg kg^{-1} was selected. The field was prepared and leveled and sowing of canola was done in wattar condition. The experiment consisted of seven treatments. i.e. T_1 Control (without Zn), T_2 Zinc @ 2.5 kg ha^{-1} , T_3 Zinc @ 5.0 kg ha^{-1}, T_4 Zinc @ 7.5 kg ha^{-1} , T_5 Zinc @ 10 kg ha^{-1}, T_6 Foliar spray of zinc (0.2%) 2 sprays before and after flowering andT_7 Foliar spray of zinc (0.3%) 2 sprays before and after flowering. Test variety wasPunjab canola. The recommended dose of NPK for canolawas80-60-60 kg ha^{-1}. Whole Phosphorus, potassium and ½ N was applied at the time of sowing , remaining ½ N and zinc was applied at 1st irrigation. Foliar sprays of zinc were done according to treatment plan. Experimental design was RCBD with three replications. The results are described as under:

Table 63: Effect of different treatments of zinc application on grain yield and 1000 grain weight of canola (2016-17)

Treatments	Grain Yield (t. ha^{-1})	1000 Grain weight (g)
T_1 Control (Without Zn)	1.225 D	2.958 D
T_2 Zinc @ 2.5 kg ha^{-1}	1.258 CD	3.105 CD
T_3 Zinc @ 5.0 kg ha^{-1}	1.291 BCD	3.246 BC
T_4Zinc @ 7.5 kg ha^{-1}	1.341 AB	3.371 AB
T_5 Zinc @10.0 kg ha^{-1}	1.370 A	3.496 A
T_6 Foliar spray of zinc (0.2%) 2 sprays before and after flowering	1.283 BCD	3.129 CD
T_7 Foliar spray of zinc (0.3%) 2 sprays before and after flowering	1.316 BC	3.238 BC
LSD	0.0668	0.2332

Effect of different treatments of zinc application on grain yield and 1000 grain weight of canola is depicted in Table 63. The results showed that different rates of zinc application have significant effect on grain yield and 1000 grain weight of canola in saline sodic soil. Maximum grain yield (1.370 t. ha^{-1}) and 1000 grain weight (3.496 g) was observed in the treatment where zinc was applied @ 10 kg ha^{-1} and it remained statistically non-significant with T_4(Zinc @ 7.5 kg ha^{-1}). Minimum grain yield 1.225 (t. ha^{-1}) and 1000 grain weight (2.958 g) of canola was recorded in control treatment where only recommended dose of NPK without zinc was applied.

Table 64: POST HARVEST SOIL ANALYSIS (2016-17)

TREATMENTS	**pHs**	**ECe** (dS m^{-1})	**SAR** (mmol L^{-1})1/2	**O.M.** (%)	**AB-DTPA** Zn (mg kg^{-1})
T_1Control (Without Zn)	8.53	5.34	26.69	0.47	0.92
T_2 Zinc @ 2.5 kg ha^{-1}	8.53	5.33	26.48	0.48	0.96
T_3Zinc @ 5.0 kg ha^{-1}	8.52	5.28	26.39	0.48	1.02
T_4Zinc @ 7.5 kg ha^{-1}	8.52	5.27	26.02	0.49	1.08
T_5Zinc @10.0 kg ha^{-1}	8.52	5.24	25.87	0.49	1.10
T_6Foliar spray of zinc (0.2%) 2 sprays before and after flowering	8.52	5.26	26.10	0.47	0.92
T_7Foliar spray of zinc (0.3%) 2 sprays before and after flowering	8.52	5.25	25.96	0.47	0.90

After the harvest of canola crop, Soil samples were collected and analysed for pH_S, EC_e,SAR, O.M. available P, extractable K and AB-DTPA Zn .The results (Table 64) showed that salinity/sodicity parameters of soil decreased slightly and there was better buildup of zinc in treatments where zinc was applied @ 10 kg ha^{-1}.

21. ALLEVIATION OF TEMPERATURE STRESS IN WHEAT WITH FOLIAR APPLICATION OF ORGANIC AND INORGANIC CHEMICALS IN SALT AFFECTED SOIL UNDER CLIMATE CHANGING SCENARIO

Wheat yield is affected adversely due to high temperature at grain filling stage in late sown wheat. The experiment was planned to alleviate temperature stress through foliar application of organic and inorganic chemicals in saline sodic soil under climate changing scenario.A moderately salt affected field {pH_S 8.55, EC_e5.37dS m^{-1}, SAR: 28.04 (mmol L^{-1})$^{1/2}$,O.M. 0.44 (%), available P 8.73mg kg^{-1}, extractable K114 mg kg^{-1} }was selected. Field was prepared and leveled. Wheat variety Faisalabad 2008 was sown in wattar condition. NPK were applied @ 120-110-70 kg ha^{-1}. The experiment consisted of six treatments i.e. T_1 Control (without foliar application), T_2Foliar application of salicylic acid (0.01%) 2 sprays starting from booting stage at 10 days interval, T_3Foliar application of thio-urea (0.05%) 2 sprays starting from booting stage at 10 days interval, T_4 Foliar application of oxalicacid (0.02%) 2 sprays starting from booting stage at 10 days interval,T_5Foliar application of KNO_3 (1%) 2 sprays starting from booting stage at 10 days interval and T_6Foliar application of $CaCl_2$(1%) 2 sprays starting from booting stage at 10 days interval.Foliar sprays of organic and inorganic chemicals were done according to treatment plan. Optimum temperature during grain

filling stage should be between 23-25^{o}C. Grain yield is affected when temperature during grain filling stage exceeds 31^{o}C. Average minimum and maximum temperature at booting stage ranged from 15-26^{o}C ,At flowering stage ranged from 18-30^{o}C and at grain filling stage ranged 20-32^{o}C . Crop was harvested at maturity. Grain and straw yield data were recorded. The results are described as under:

Table 65: Effect of inorganic and organic chemicals on grain and straw yield of wheat in climate changing scenario (2016-17)

TREATMENTS	**Grain Yield** (t. ha^{-1})	**Straw Yield** (t. ha^{-1})
T_1Control (without foliarapplication)	2.32 B	2.46 C
T_2Foliar application of salicylic acid(0.01%) 2 sprays starting frombooting stage at 10 days interval	2.72 A	2.85AB
T_3Foliar application of thiourea(0.05%) 2 sprays starting from booting stage at 10 days interval	2.63 A	2.75 AB
T_4Foliar application of oxalicacid (0.02%) 2 sprays starting from booting stage at 10 days interval	2.49 AB	2.61 BC
T_5Foliar application of KNO_3 (1%) 2 sprays starting from booting stage at 10 days interval	2.75A	2.88 A
T_6Foliar application of $CaCl_2$(1%) 2 sprays starting from booting stage at 10 days interval	2.69 A	2.81 AB
LSD	0.2756	0.2568

Effect of different inorganic and organic chemicals on grain and straw yield of wheat is given in Table 65. The results showed that different organic and inorganic chemicals affected grain and straw yield of wheat significantly. Maximum grain (2.75 t. ha^{-1}) and straw yield (2.88 t. ha^{-1}) was recorded in T_5 where foliar Application of KNO_3 (1%) 2 sprays starting from booting stage at 10 days interval were done and remained statistically at par with all other treatments except control. Minimum grain (2.32 t. ha^{-1}) and straw yield (2.46 t. ha^{-1}) was observed in control treatment.

Table 66: Post harvest soil analysis (Rabi 2016-17)

TREATMENTS	**pH_S**	**ECe** (dS m^{-1})	**SAR** (mmol L^{-1})$^{1/2}$	**O.M.** (%)	**Available P** (mg kg^{-1})	**Extractable K** (mg kg^{-1})
T_1 Control (without foliar application)	8.55	5.38	27.87	0.46	9.20	118.43
T_2 Foliar application of salicylic acid (0.01%) 2 sprays starting from booting stage at 10 days interval	8.54	5.32	27.52	0.46	8.93	117.33
T_3 Foliar application of thiourea (0.05%) 2 sprays starting from booting stage at 10 days interval	8.54	5.32	27.36	0.45	8.88	116.96
T_4 Foliar application of oxalic acid (0.02%) 2 sprays starting from booting stage at 10 days interval	8.54	5.28	27.07	0.45	8.73	116.60
T_5 Foliar application of KNO_3 (1%) 2 sprays starting from booting stage at 10 days interval	8.54	5.30	27.02	0.45	8.73	115.50
T_6 Foliar application of $CaCl_2$(1%) 2 sprays starting from booting stage at 10 days interval	8.54	5.30	26.85	0.42	8.73	115.13

After the harvest of wheat crop, soil samples were collected and analysed for $pH_{S,}$, EC_e,SAR, O.M. available P and extractable K.The results (Table 66) showed that salinity/sodicity parameters of soil decreased after wheat harvest and there was change in fertility parameters of soil.

5.5 AGRONOMY

22. MANAGEMENT OF SALINE SODIC WATER BY USING DIFFERENT AMENDMENTS AND SOWING TECHNIQUES

The study was planned to assess the role of organic & inorganic amendments by using different sowing techniques to mitigate the harmful effects of high RSC water on paddy yield through direct seeded rice. A normal field was selected with pH_s8.10, ECe2.88 dS m^{-1} and SAR17.90 (mmol $L^{-1})^{1/2}$. The study was laid out in split plot design with three replications. Rice varietyShaheen basmati was used as test variety. Sowing techniques were placed in main plots, whereas the soil amendments were applied in sub plots. The treatments included were: A; sowing techniques, Ridge & Broadcast sowing and B; Soil amendments Gypsum on the basis of RSC of water, Press mud @ 10 and 20 t ha^{-1} and Biogas slurry @ 10 and 20 t ha^{-1}. Recommended dose of fertilizer 110-90-60 NPK kg ha^{-1} was applied to rice crop. Only Tube well water having EC_{iw}1.44 dS m^{-1}, SAR8.06 (mmol $L^{-1})^{1/2}$ & RSC8.40 me L^{-1} was used for irrigation.

Table 67 :Effect of different amendments and sowing techniques on paddy yield (t. ha^{-1})

Treatments	**Sowing Methods**		**Mean**
	Ridge	**Broadcast**	
T_1 Gypsum on the basis of RSC of Water	2.68 de	2.49 e	2.58 C
T_2 Press-mud @ 10 t ha^{-1}	2.73 de	2.55 de	2.64 C
T_3 Press-mud @ 20 t ha^{-1}	3.06 bc	2.77 cd	2.91 B
T_4 Biogas slurry @ 10 t ha^{-1}	3.09 ab	2.79 bcd	2.94 B
T_5 Biogas slurry @ 20 t ha^{-1}	3.33 a	3.01 ab	3.20 A
Mean	2.98 A	2.73 B	

LSD for sowing methods = 0.2272 LSD for amendments = 0.1854
LSD for interaction = 0.2622

The results (table 67) indicated that the maximum paddy yield (3.33 t ha^{-1}) was recorded with ridge sowing where biogas slurry was applied @ 20 t ha^{-1} which was statistically at par with broadcast sowing with the same soil amendment. Among the sowing methods, ridge sowing gave more paddy yield (2.98 t ha^{-1}) when compared with broadcast sowing (2.73 t ha^{-1}). Similarly biogas slurry @ 20 t ha^{-1} produced higher paddy yield (3.20 t ha^{-1}) followed by biogas slurry applied @ 10 t ha^{-1}, 2.94 t ha^{-1} which was non-significant with press mud applied @ 20 t ha^{-1}. The minimum paddy yield (2.49 t ha^{-1}) was obtained with gypsum applied on the basis of RSC of water.Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop. The trial was sown on 18-06-2016 and harvested on 29-10-2016.

Table 68: Amendments Analyses (%)

	Total N	Total P	Total K
Press-mud	1.25	0.90	0.60
Bio-slurry	1.50	1.35	0.40

Table 69: Soil analyses after the harvest of rice

Treatments	Ridge Sowing			Broadcast sowing		
	pH_s	EC_e (dS m^{-1})	SAR (mmol L^{-1} $^{1/2}$)	pH_s	EC_e (dSm $^{-1}$)	SAR (mmol L^{-1} $^{1/2}$)
T_1 Gypsum on the basis of RSC of Water	8.18	3.44	14.63	8.18	3.42	13.59
T_2 Press-mud @ 10 t ha^{-1}	8.12	3.48	14.65	8.11	3.56	14.52
T_3 Press-mud @ 20 t ha^{-1}	8.14	3.45	14.53	8.14	3.46	14.48
T_4 Biogas slurry @ 10 t ha^{-1}	8.14	3.46	14.55	8.12	3.45	14.56
T_5 Biogas slurry @ 20 t ha^{-1}	8.14	3.41	14.35	8.14	3.45	14.53

23. YIELD IMPROVEMENT OF DIRECT SOWN RICE ON RAISED BEDS USING PRIMING TECHNIQUES IN SALT AFFECTED SOILS

The experiment was conducted to investigate the yield enhancement of direct sown rice with different seed priming agents using raised bed sowing method in salt affected soil. A salt affected field having pH 8.80, EC 5.46 (dS m^{-1}) and SAR 36.57 (mmol $L^{-1})^{1/2}$was selected. The experiment was laid out in RCBD design with three replications. Rice (KSK-133) was used as test variety. Treatments included in the study are givenunder inTable 71.

Table 71: Paddy yield (t ha^{-1})

Treatment	Paddy Yield (t. ha^{-1})
T_1Potassium dihydrogen phosphate (2%)	4.61 CD
T_2Zinc Sulphate (2%)	4.53 D
T_3Single super phosphate (1%)	5.23 A
T_4MgSO_4(2%)	4.83 BC
T_5Single super phosphate + Urea 1% (each)	4.92 B
LSD	0.2576

Results (table 71) indicated that the maximum paddy yield was obtained in T_3 (5.23 t ha^{-1}). However minimum paddy yield (4.53 t ha^{-1}) was obtained from T_2 which was statistically at par with T_1 (4.61 t ha^{-1}).Soil samples were collected and analyzed for pH_s,EC_e and SAR determination before and after the harvest of crop (table 72). The trial was sown on 19-06-2016 and harvested on 22-10-2016.

Table 72: Post-harvest soil analysis

Treatments	pH_s	EC_e ($dS\ m^{-1}$)	SAR ($mmol\ L^{-1})^{1/2}$
T_1Potassium dihydrogen phosphate (2%)	8.73	5.41	34.42
T_2Zinc Sulphate (2%)	8.69	5.38	33.50
T_3Single super phosphate (1%)	8.63	5.32	33.36
T_4MgSO_4(2%)	8.65	5.34	33.30
T_5Single super phosphate + Urea 1% (each)	8.68	5.36	33.48

24. UTILIZATION OF SALT AFFECTED LAND USING PIT PLANTING TECHNIQUE FOR SUGARCANE

After gone through the review it is revealed that there is little work done for the production technology of sugarcane crop for cultivation in salt affected soils. Keeping this view experiment was designed for utilization of highly salt affected soils. A saline sodic field having pH_s 8.96, EC 10.55 (dSm^{-1}) and SAR 41.37 $(mmol\ L^{-1})^{1/2}$ and G.R. 3.25 $tacre^{-1}$ was selected. The experiment was laid out in RCBD with three replications. The treatments included were T_1Pits without amendments,T_2 Pits with gypsum @ 50% GR, T_3 Pits with gypsum @ 100% GR,T_4 Pits with FYM @ 20 t ha^{-1}, T_5 Pits with gypsum @ 50 % GR + FYM @ 10 t ha^{-1}.

Table 73: Cane yield

Treatments	Cane yield (t. ha^{-1})
T_1Pits without amendment	48.73 C
T_2Pits with Gypsum @ 50 % GR	58.07 B
T_3Pits with Gypsum @ 100 % GR	67.08 A
T_4Pits with FYM @ 20 t ha^{-1}	53.89 BC
T_5Pits with gypsum @ 50% GR + FYM @ 10 t ha^{-1}	61.25 AB
LSD	7.8329

It was depicted from the yield (table 73) that the highest cane yield (67.08 t. ha^{-1}) was obtained in T_3, which was statistically at par with T_5 (61.25 t. ha^{-1}). Minimum cane yield (48.73 t ha^{-1}) was obtained from the T_1 which was statistically at par with T_4 (53.89 t ha^{-1}). Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop (Table 74). The trial was sown on 28-10-2015 and harvested on 17-11-2016.

Table 74: Post-harvest soil analysis

Treatments	pH_s	EC_e ($dS\ m^{-1}$)	SAR ($mmol\ L^{-1})^{1/2}$
T_1Pits without amendment	8.92	10.43	39.45
T_2Pits with Gypsum @ 50 % GR	8.50	8.62	37.91
T_3Pits with Gypsum @ 100 % GR	8.46	6.88	35.00
T_4Pits with FYM @ 20 t ha^{-1}	8.51	7.85	38.75
T_5Pits with gypsum @ 50% GR + FYM @ 10 tha^{-1}	8.47	7.27	36.65

25. PERFORMANCE OF NEW SUGARCANE CLONES/VARIETIES IN SALT AFFECTED SOILS

This study was planned to find out the best suitable sugarcane variety for salt affected soils. A salt affected field having pH_s 9.01, EC_e 5.69 (dSm^{-1}) and SAR 27.51 $(mmol\ L^{-1})^{1/2}$ was selected. The experiment was laid out in RCBD with three replications. The varieties included were: HSF-240, CPF-246, CPF-247, CPF-248, S-2003-us-127, S-2003-us-633, S-2003-us-704, S-2006-SP-93, S-2006-us-272 and S-2006-us-658. Recommended dose of fertilizer 170-112-112 NPK kg ha^{-1} was applied. Recommended seed rate used was 75000 DBS ha^{-1}.

Table 75: Cane yield

Treatments	Cane yield (t. ha^{-1})
T_1S-2003-us-704	56.34 BC
T_2CPF-248	50.99 CD
T_3S-2003-us-127	59.33 AB
T_4S-2006-us-272	42.49 EF
T_5S-2003-us-633	45.44 DEF
T_6HSF-240	49.35 CDE
T_7S-2006-SP-93	65.36 A
T_8S-2006-us-658	39.57 F
T_9CPF-247	55.59 BC
T_{10}CPF-246	61.95 AB
LSD	7.7496

Yield data (table 75) revealed that the highest cane yield (65.36 t. ha^{-1}) was obtained from the S-2006-SP-93 which was statistically at par with CPF-246 (61.95 t ha^{-1}) and S-2003-us-127 (59.33 t. ha^{-1}). However minimum yield (39.57 t. ha^{-1}) was obtained from the S-2006-us-658. Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop (table 76). The trial was sown on 28-10-2015 and harvested on 17-11-2016.

Table 76: Post-harvest soil analysis

Treatments	pH_s	EC_e ($dS\ m^{-1}$)	SAR ($mmol\ L^{-1}$)$^{1/2}$
T_1S-2003-us-704	8.96	5.51	25.35
T_2CPF-248	8.91	5.63	25.48
T_3S-2003-us-127	8.93	5.67	26.47
T_4S-2006-us-272	8.95	5.61	25.58
T_5S-2003-us-633	8.96	5.59	26.46
T_6HSF-240	8.92	5.63	25.65
T_7S-2006-SP-93	9.00	5.62	25.60
T_8S-2006-us-658	8.88	5.57	25.25
T_9CPF-247	8.90	5.61	24.97
T_{10}CPF-246	8.94	5.63	26.65

26. MANAGEMENT OF SALINE SODIC WATER BY USING DIFFERENT AMENDMENTS AND SOWING TECHNIQUES

The study was planned to assess the role of organic & inorganic amendments by using different sowing techniques to mitigate the harmful effects of high RSC water on yield of wheat crop. A normal field was selected with pH_s=8.10, EC_e=2.88 dS m^{-1} and SAR=17.90 (mmol $L^{-1})^{1/2}$. The experiment was laid out in split plot design having three replications. Wheat variety Faisalabad-2008 was used as test crop. The treatments included were: A. Sowing techniques (Ridge & Broadcast) and B. Soil Amendments i.e. gypsum on the basis of RSC of water, Press mud @ 10, 20 t. ha^{-1}, Biogas slurry @ 10, 20 t. ha^{-1}. Sowing techniques were placed in main plots while the soil amendments were applied in sub plots. Recommended dose of fertilizer 120-110-70 NPK kg ha^{-1} was applied to wheat crop.

Table 77: Effect of different amendments and sowing techniques on grain yield (t. ha^{-1})

Soil amendments	Sowing methods		Mean
	Ridge	Broadcast	
T_1Gypsum on the basis of RSC of Water	2.62 cde	2.37 ef	2.50 C
T_2Press-mud @ 10 t ha^{-1}	2.52 de	2.19 f	2.35 C
T_3Press-mud @ 20 t ha^{-1}	2.75 bcd	2.93 b	2.84 B
T_4Biogas slurry @ 10 t ha^{-1}	2.86 bc	2.72 bcd	2.79 B
T_5Biogas slurry @ 20 t ha^{-1}	3.23 a	3.02 ab	3.13 A
Mean	2.80 A	2.65 B	

LSD for sowing methods =0.1289 LSD for amendments =0.2159 LSD for interaction = 0.3054

The results (table 77) showed that the maximum grain yield(3.23 t. ha^{-1}) with biogas slurry applied @ 20 t ha^{-1} when crop was sown on ridges which is statistically with the same treatment applied with broadcast sowing (3.02 t. ha^{-1}) followed by press-mud @ 20 t $ha^{-1}$with broadcast sowing (2.93 t. ha^{-1}). It was also observed that the maximum grain yield(3.13 t. ha^{-1}) was obtained by biogas slurry when applied @ 20 t ha^{-1} followed by press mud (2.84 t. ha^{-1}) applied at same rate. However ridge sowing gave more grain yield (2.80 t. ha^{-1}) when compared with broadcast sowing(2.65 t. ha^{-1}). The trial was sown on 17-11-2016 and harvested on 17-04-2017.Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop(Table 79).

Table 78: Amendments Analyses (%)

Amendments	Total N	Total P	Total K
Press-mud	1.25	0.90	0.60
Bio-slurry	1.50	1.35	0.40

Table 79: Post-harvest soil analysis

Treatments	Sowing methods					
	Ridge			Broadcast		
	pH_s	**EC_e** ($dS\ m^{-1}$)	**SAR** $(mmol\ L^{-1})^{1/2}$	pH_s	EC_e (dSm^{-1})	SAR $(mmol\ L^{-1})^{1/2}$
T_1Gypsum on the basis of RSC of water	8.16	2.99	22.71	8.20	3.29	23.77
T_2Press-mud @ 10 t ha^{-1}	8.20	2.96	22.72	8.18	3.30	23.70
T_3Press-mud @ 20 t ha^{-1}	8.21	2.90	22.73	8.19	3.28	23.68
T_4Biogas slurry @ 10 t ha^{-1}	8.19	2.92	22.72	8.18	3.29	23.66
T_5Biogas slurry @ 20 t ha^{-1}	8.17	2.88	22.65	8.19	3.28	23.61

27. EFFECT OF PLANTING GEOMETRY ON YIELD OF QUINOA IN SALT AFFECTED SOIL

The experiment was designed to find out the best planting geometry for getting maximum grain yield of newly introduced quinoa crop in salt affected soils. A salt affected field was selected with pH_s8.54, EC_e7.26 dS m^{-1} and SAR32.10 $(mmol\ L^{-1})^{1/2}$was selected, leveled and well prepared for sowing the crop. The treatments included wereplant spacings i.e. 15cm x 30cm,22cm x 30cm, 30cm x 30cm, 15cm x 45cm, 22cm x 45cm and 30cm x 45 cm. The trial was laid out in RCBD with three replications. Recommended dose of fertilizer (75-60-0 NPK kg ha^{-1}) was applied**.** All other agronomic practices were kept constant.

Table 80: Effect of different planting geometry on quinoa grain yield

Planting geometry	**Grain yield** (t. ha^{-1})
15cm x30 cm	1.43 D
22cm x30 cm	1.65 C
30cm x30 cm	1.93 A
15cm x45 cm	1.73 BC
22cm x45 cm	1.77 B
30cm x45 cm	1.91 A
LSD	0.0858

Results indicated that maximum grain yield (1.93 t ha^{-1}) was obtained with 30cm x 30cm which was statistically similar to 30cm x 45cm (1.91 t. ha^{-1}) when compared with other plant spacing (Table 80). The lowest grain yield (1.43 t. ha^{-1}) was recorded by 15cm x 30cm. The trial was sown on 17-11-2016 and harvested on 23-04-2017. Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop (Table 81).

Table 81:Post harvest soil analysis

Planting geometry	**pH_s**	**EC_e** ($dS\ m^{-1}$)	**SAR** $(mmol\ L^{-1})^{1/2}$
15cm x30 cm	8.50	7.22	31.05
22cm x30 cm	8.52	7.24	32.00
30cm x30 cm	8.51	7.23	31.10
15cm x45 cm	8.49	7.20	31.03
22cm x45 cm	8.50	7.19	30.85
30cm x45 cm	8.50	7.18	31.60

28. IMPACT OF SOWING METHODS AND SEED RATES ON QUINOA YIELD IN SALT AFFECTED SOIL

The study was planned to determine the best sowing method and seed rates for quinoa crop in salt affected soils. A salt affected field having pH_s8.55, EC_e7.16 dS m^{-1} and SAR32.09 (mmol $L^{-1})^{1/2}$ was selected, leveled and well prepared for sowing the crop. Treatments included in the study were: Sowing methods (Ridge & Drill) and Seed rates (3.0, 5.0, 7.0 & 9.0 kg ha^{-1}). The experiment was laid out in split plot design with three replications. Sowing methods were kept in main plots and seed rates were placed in sub plots. Recommended dose of fertilizer (75-60-0 NPK kg ha^{-1}) was applied.

Table 82: Sowing methods and seed rates on quinoa yield (t. ha^{-1})

Seed rates	Sowing methods		Mean
	Ridge	Drill	
3.0 kg ha^{-1}	1.56 c	1.39 d	1.47 C
5.0 kg ha^{-1}	1.72 b	1.61 c	1.67 B
7.0 kg ha^{-1}	1.88 a	1.86 ab	1.87 A
9.0 kg ha^{-1}	1.88 a	1.86 a	1.87 A
Mean	1.76 A	1.68 B	

LSD for seed rate=0.0164 LSD for sowing methods=0.0702 LSD for interaction=0.0992

The data showed that maximum (grain yield 1.88 t. ha^{-1}) was recorded with ridge sowing when seed was used @ 9 kg ha^{-1} (table 82). It was statistically at par with 7 kg ha^{-1} seed in ridge sowing (1.88 t ha^{-1}) and 9 kg ha^{-1} seed with drill sowing (1.86 t ha^{-1}) and 7 kg ha^{-1} seed with drill sowing (1.86 t ha^{-1}). However the minimum grain yield (1.39 t ha^{-1}) was recorded when crop was sown with drill using seed @ 3 kg ha^{-1}. Results also indicated that the maximum (grain yield 1.87 t. ha^{-1}) was recorded in the treatment where seed was used @ 9 kg ha^{-1} and was statistically at par with the treatment where 7 kg ha^{-1} seed was used (1.87 t. ha^{-1}). Results also depicted that ridge sowing (1.76 t. ha^{-1}) perform better than drill sowing (1.68 t. ha^{-1}). Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop and depicted in table 83. The trial was sown on 17-11-2016 and harvested on 23-04-2017.

Table 83: Post harvest soil analysis

Treatments	Sowing methods					
	Ridge			Drill		
	pH_s	Eked (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
$T_1$3.0 kg ha^{-1}	8.50	7.10	31.81	8.52	7.11	32.10
$T_2$5.0 kg ha^{-1} (RD)	8.49	7.06	31.00	8.50	7.09	31.60
$T_3$7.0 kg ha^{-1}	8.48	7.05	30.60	8.50	7.13	31.40
$T_4$9.0 kg ha^{-1}	8.48	7.04	29.80	8.49	7.06	30.60

29. RESPONSE OF WHEAT VARIETIES TO CLIMATE CHANGE UNDER DIFFERENT SOWING DATES IN SALT AFFECTED SOIL

The study was planned to evaluate the effect of climate change on different varieties of wheat. A salt affected field having pH_s 8.73, EC_e 7.42dS m^{-1} and SAR29.50 (mmol L^{-1})$^{1/2}$ was selected, leveled and well prepared for sowing the crop. Treatments included in the study were: Sowing dates (10, 20, 30 November and 10 December) and wheat varieties (FSD 2008 and Galaxy 2013).The experiment was laid out in split plot design with three replications. Sowing dates were kept in main plots and wheat varieties were placed in sub plots. Recommended dose of fertilizer (120-90-60 NPK kg ha^{-1}) was applied.

Table84 : Grain yield (t.ha^{-1})

Treatments	FSD-08	Galaxy-13	Mean
10 November	2.63 bc	1.94 d	2.28 C
20 November	3.22 a	2.93 ab	3.08 A
30 November	2.93 ab	2.34 c	2.63 B
10 December	2.33 c	1.85 d	2.09 C
Mean	2.78 A	2.26 B	

LSD For varieties = 0.2825 LSD for Sowing dates = 0.4815 LSD for Interaction = 0.6810

The results depicted (table 84) maximum grain yield (3.22 t ha^{-1}) was observed in wheat variety FSD-08 when sown on 20 November. However, its yield was statistically similar to wheat variety Galaxy-13 with grain yield of (2.93 t ha^{-1})sown on same date and (2.93 t ha^{-1}) FSD-08 when sown on 30 November. Minimum grain yield of 1.85 t ha^{-1} was recorded in Galaxy-13 when sown on 10 December which was statistically at par with Galaxy-13 sown at 10 November (1.95 t ha^{-1}). With respect to varieties maximum yield (2.78 t ha^{-1}) was noted in FSD-08 as compared to Galaxy-13 (2.26 t ha^{-1}). In case of sowing dates maximum grain yield (3.08 t ha^{-1}) was observed with 20 November followed by 30 November (2.63 t ha^{-1}). The trial was sown on 17-11-2016 and harvested on 17-04-2017 Soil samples were collected and analyzed for pHs, ECe and SAR determination before and after the harvest of crop (Table 85).

Table 85: Post-harvest soil analysis

Treatments	FSD-2008			Galaxy-2013		
	pH_s	EC_e (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol L^{-1})$^{1/2}$
10 November	8.72	7.39	27.80	8.73	7.38	27.82
20 November	8.71	7.38	27.30	8.71	7.38	27.72
30 November	8.71	7.38	27.28	8.70	7.37	27.60
10 December	8.71	7.36	27.42	8.70	7.36	27.28

30. PERFORMANCE OF CAMELINA UNDER DIFFERENT SEED PRIMING AND SOWING TECHNIQUES IN SALT AFFECTED SOILS

The experiment was conducted to investigate the yield enhancement of camelina with different seed priming agents and sowing method in salt affected soil. A salt affected field having pH= 8.53, EC= 5.06 (dS m^{-1}) and SAR= 25.85 (mmol $L^{-1})^{1/2}$ was selected. Experiment was laid out in split plot design with three replications. Sowing methods were kept in main plots and seed priming agents in sub-plots. Treatments included in the study were: A) Seed priming agents (Canal water soaking), $CaCl_2$ (2% soln.), $MgSO_4$ (2 %), CAN (2% soln.) and K_2SO_4 (2% soln.). B) Sowing methods (Drill sowing, Ridge sowing and Broadcast sowing).

Table 86: Camelina Grain yield (t. ha^{-1})

Treatments	Sowing methods			Mean
	Drill	Ridge	Broadcast	
T_1Canal water soaking	0.45 g	0.64 f	0.34 h	0.48 E
T_2CaCl_2 (2% soln.)	1.07 a	1.11 a	0.88 c	1.02 A
T_3MgSO_4(2% soln.)	0.99 b	0.97 b	0.84 cd	0.93 B
T_4CAN (2% soln.)	0.76 e	0.72 e	0.42 g	0.63 D
$T_5K_2SO_4$(2% soln.)	0.88 c	0.97 b	0.78 de	0.87 C
Mean	0.83 B	0.88 A	0.65 C	

LSD For sowing methods = 0.0373 LSD for priming agents = 0.0441 LSD for Interaction = 0.0764

The results (table 86) indicated that the maximum grain yield (1.11 t. ha^{-1}) was recorded when camelina seeds were primed with $CaCl_2$ (2% soln.) in ridge sowing and was statistically at par with seed priming $CaCl_2$ 2% soln. sown with drill and ridge. Data also showed that minimum grain yield (0.34 t. ha^{-1}) was noted in broadcast sowing with canal water soaking. With respect to seed priming agents maximum grain yield (1.02 t. ha^{-1}) was observed with $CaCl_2$ (2% soln.) followed by $MgSO_4$ (2% soln.) and K_2SO_4 (2% soln.). Maximum grain yield (0.88 t ha^{-1}) was found with ridge sowing which was followed by drill sowing (0.83 t ha^{-1}). The trial was sown on 08-11-2016 and harvested on 22-03-2017. Soil samples were collected and analyzed forpH_s, EC_e and SAR determination before and after the harvest of crop Table 87).

Table 87: Post harvest soil analysis

Treatments	Sowing methods								
	Drill			Ridge			Broadcast		
	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
Canal water soaking	8.48	5.02	23.96	8.48	4.96	23.80	8.49	5.04	24.10
$CaCl_2$ (2% soln.)	8.47	5.00	23.38	8.48	4.94	23.48	8.48	5.02	23.92
$MgSO_4$ (2% soln.)	8.46	4.96	23.14	8.47	4.92	23.32	8.47	5.00	23.56
CAN (2% soln.)	8.46	4.94	22.92	8.46	4.92	22.80	8.47	5.00	23.18
K_2SO_4 (2% soln.)	8.46	4.94	22.86	8.45	4.90	22.62	8.45	4.96	22.92

31. YIELD IMPROVEMENT OF SUGARCANE CROP USING SINGLE BUD PLANTING WITH DIFFERENT SOWING TECHNIQUES IN SALT AFFECTED SOILS

While reviewing the literature it was revealed that a new technique of sugarcane planting is being used in India for cultivation in salt affected soils. Keeping this inview experiment was designed to investigate the best planting method using single bud for getting maximum cane yield. A saline sodic field having pH_s 8.63, EC_e 6.26 (dSm^{-1}) and SAR 29.85 $(mmol\ L^{-1})^{1/2}$ was selected. The experiment was laid out in RCB design having three replications. The treatments included were T_1 Ridge planting, T_2 bed planting, T_3 Hill planting,T_4 Pit planting and T_5 Conventional planting. Recommended dose of NPK was applied. The crop was harvested at maturity and yield data is presented in table 88.

Table 88: Cane Yield

Treatments	**Cane yield** ($t.\ ha^{-1}$)
Ridge planting	59.48 C
Bed planting	63.35 B
Hill planting	47.61 E
Pit planting	66.96 A
Conventional planting	56.36 D
LSD	1.6173

The highest cane yield (66.96 $t.\ ha^{-1}$) was obtained in T_4 which was followed by T_2 bed planting (63.35 $t.\ ha^{-1}$). Minimum cane yield (56.36 $t.\ ha^{-1}$) was obtained from the T_5. The trial was sown on 28-10-2015 and harvested on 17-11-2016. Soil samples were collected and analyzed for pH_s, EC_e and SAR determination before and after the harvest of crop (table 89).

Table 89: Post-harvest soil analysis

Treatments	**pH_s**	**EC_e** ($dS\ m^{-1}$)	**SAR** ($mmol\ L^{-1\ 1/2}$)
Ridge planting	8.58	5.42	26.14
Bed planting	8.57	5.42	26.38
Hill planting	8.56	5.82	26.96
Pit planting	8.56	5.36	24.92
Conventional planting	8.56	5.86	26.86

5.6 AGRICULTURAL ENGINEERING DIVISION

30. EFFECT OF TILLAGE AND NITROGEN ON WHEAT PRODUCTION IN SALT AFFECTED SOILS

The objective of this experiment was to study the effect of tillage practices on nitrogen use efficiency of salt affected soils for wheat crop. Four tillage implements cultivator, disc harrow, M.B plough, chisel plough and three nitrogen application methods broadcast, band placement, side dressing were used in this study. Moderately salt affected field{ pH_s 8.48, EC_e4.48(dS m^{-1}), SAR 27.36 (mmol $L^{-1})^{1/2}$, BD 1.55 Mg m^{-3}, HC 0.51 cm hr^{-1}, O.M 0.40%} was selected, leveled and prepared according to treatment plan. Recommended dose of fertilizer for wheat 120-110-70 kg ha^{-1} (NPK) was applied. Whole P, K and ½N was applied as basal dose whereas remaining ½N was applied with first irrigation. In Rabi season Wheat crop was sown on 19th November, 2016 and recommended dose of fertilizer for wheat 120-110-70 NPK kg ha^{-1} was applied. Crop was harvested at maturity andgrain yield data was recorded on 19th April, 2017 as shown in (table 90).

Table 90: Wheat Grain yield (t. ha^{-1})

Treatments	**Fertilizer application method**			**Mean**
	Broadcast	**Band Placement**	**Side dressing**	
T_1Cultivator	2.29 f	2.42 ef	2.41 ef	2.37 C
T_2Disk harrow	2.53 def	2.72 bcd	2.51 def	2.59 BC
T_3MB Plough	2.57 def	2.91 abc	2.78 bcd	2.75 AB
T_4Chisel plough	2.66 cde	3.09 a	2.92 ab	2.89 A
Mean	2.51 C	2.78 A	2.66 B	

LSD for Treatment = 0.2223 LSD for Methods = 0.1178, LSD for Treatment * Methods = 0.2356

Maximum wheat grain yield (3.09 t. ha^{-1}) was obtained where chisel plough was used with band placement fertilizer application method and it remained at par with side dressing fertilizer application method. Whereas minimum wheat grain yield (2.29 t. ha^{-1}) was obtained using cultivator with broadcast fertilizer application method. After the harvest of rice crop soil samples were collected to analyze the soil EC_e, pHs, SAR and O.M as shown in table 91. Results indicated that salinity / sodicity parameters were reduced after harvest experiment. Maximum organic matter was found in the treatment where chisel plough was used and fertilizer was applied by using band placement method.

Table 91:Soil analysis after harvesting of wheat crop 2016-17

Treatments	Broadcast				Band Placement				Side dressing			
	pH_s	EC_e (dS m^{-1})	SAR $(mmol\ L^{-1})^{1/2}$	O.M. (%)	pH_s	EC_e (dS m^{-1})	SAR $(mmol\ L^{-1})^{1/2}$	O.M (%)	pH_s	EC_e (dS m^{-1})	SAR $(mmol\ L^{-1})^{1/2}$	O.M. (%)
Cultivator	8.63	4.44	27.14	0.41	8.59	4.42	27.10	0.47	8.60	4.42	27.13	0.41
Disk harrow	8.59	4.37	27.04	0.51	8.57	4.34	26.42	0.55	8.58	4.34	26.51	0.53
MB Plough	8.59	4.36	26.84	0.57	8.55	4.34	26.36	0.59	8.57	4.36	26.55	0.57
Chisel plough	8.56	4.26	26.41	0.55	8.53	4.21	25.87	0.61	8.54	4.23	26.09	0.58

31. EFFECT OF DIFFERENT IRRIGATION FREQUENCIES ON DIRECT SEEDED RICE IN SALT AFFECTED SOIL

The trial was conducted to find out the delta of water and irrigation frequencies for direct seeded rice in salt affected soils. For this purpose four irrigation intervals 4 days, 6 days, 8 days and 10 days were studied. Moderately saltaffected field{ pH_s 8.80, EC_e4.33 (dS m^{-1}), SAR 30.15 (mmol $L^{-1})^{1/2}$, BD 1.53 Mg m^{-3}, HC 0.48 cm hr^{-1}} was selected, leveled and prepared. Irrigations were applied using cut-throat flume. The experiment was conducted for rice crop in RCB Design having three replications.In kharif season rice crop was sown on 28th June, 2016 and recommended dose of NPK for rice 110-90-60 kg ha^{-1} was applied. Data on paddy and straw yield was recorded on 31st October, 2016 and given in table 92.

Table 92:Effect of irrigation frequencies on paddy and straw yield (t. ha^{-1})

Irrigation Frequency	Paddy Yield (t. ha^{-1})	Straw yield (t. ha^{-1})	No. of Irrigations Applied	Delta of water (Inches)	Water use Efficiency (kg ha^{-1} mm^{-1})
4 Days	2.82 BC	5.32 B	24	87	1.28
6 Days	2.88 B	5.54 AB	16	63	1.80
8 Days	3.18 A	5.87 A	12	51	2.45
10 Days	2.60 C	5.17 B	09	42	2.44
LSD	0.2280	0.4038			

Note: Rainfall (15 inches) occurred during kharif-2016 is included in delta of water.

Results (table 92) showed that maximum paddy yield (3.18 t ha^{-1}) was obtained where irrigation was applied after 8 days interval and minimum paddy yield (2.60 t ha^{-1}) was obtained using irrigation interval of 10 days. However maximum water use efficiency (2.45 kg ha^{-1} mm^{-1}) was obtained in the treatment where irrigation was applied after 8 days interval which was followed by 10 days irrigation interval. After the harvest of rice crop soil samples were collected to analyze the soil EC_e, pH_s and SAR as shown in table 96. Results indicated that salinity / sodicity parameters have been reduced after harvest of rice crop (table 93).

Table 93:Soil analysis after harvest of rice crop

Irrigation Frequency	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
4 Days	8.77	4.01	29.50
6 Days	8.78	4.06	29.43
8 Days	8.78	4.09	29.22
10 Days	8.79	4.23	29.65

32. ROLE OF SEED COVERING TECHNIQUES AND TILLAGE PRACTICES ON YIELD PERFORMANCE OF DIRECT SEEDED RICE IN SALT AFFECTED SOILS

The objective of this experiment was to investigate the best seed covering technique and tillage implement for better performance of direct seeded rice. Implements used in the study were: T_1Cultivator , T_2Disk harrow + Cultivator, T_3Rotavator + Cultivator. Whereas three sowing techniques were used, F_1:Seed covering with planking 40 kg weight, F_2:Seed covering with planking 60 kg weight and F_3:Drill sowing. Moderately salt affected field{ pH_s 8.71, EC_e4.07 (dS m^{-1}), SAR 30.12 (mmol $L^{-1})^{1/2}$, BD 1.51 Mg m^{-3}, HC 0.49 cm hr^{-1}} was selected. Field was leveled and prepared according to treatment plan. Implements were kept in main plots whereas seed covering techniques were applied in sub plots. The experiment was conducted for rice crop in Split Plot Design having three replications. In Kharif season rice was sown on 24th June, 2016 and recommended dose of NPK for rice 110-90-60 kg ha^{-1} was applied. Crop was harvested at maturity.Data on paddy yield was recorded on 31st October, 2016.

Table 94: Effect of tillage practices and sowing techniques on paddy yield (t. ha^{-1})

Treatments	Seed covering with planking 40 kg	Seed covering with planking 60 kg	Drill sowing	Mean
Cultivator	2.08 c	1.95 c	2.06 c	2.03 B
Disk harrow + Cultivator	2.69 ab	2.65 b	2.84 ab	2.73 A
Rotavator + Cultivator	2.69 ab	2.75 ab	2.92 a	2.79 A
Mean	2.49 AB	2.45 B	2.61 A	

Results (table 94) showed that maximum paddy yield (2.92 t. ha^{-1}) was obtained where rotavator was used with drill sowing and minimum paddy yield (1.95 t. ha^{-1}) was obtained using cultivator and seed covering with 60 kg planking. After the harvest of rice crop soil samples were collected to analyze the soil EC_e, pH_s and SAR as shown in table 95. Results indicated that salinity / sodicity parameters have been reduced after harvest of rice crop. Trial was concluded with the findings that rotavator + cultivator is the best tillage practice among cultivator, disk harrow + cultivator and rotavator + cultivator. Whereas drill sowing is the best technique among seed covering with planking 40 kg weight, seed covering with planking 60 kg weight and drill sowing.

Table 95: Soil analysis after harvest of rice crop

Treatments	Seed covering with planking 40 kg			Seed covering with planking 60 kg			Drill sowing		
	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$	pH_s	EC_e (dS m^{-1})	SAR (mmol $L^{-1})^{1/2}$
Cultivator	8.69	3.82	28.38	8.70	3.87	28.63	8.70	3.81	28.52
Disk harrow + Cultivator	8.67	3.41	27.66	8.68	3.53	28.15	8.66	3.42	27.54
Rotavator + Cultivator	8.68	3.55	28.09	8.69	3.64	28.27	8.68	3.52	27.85

5.7 ECONOMIC BOTANY DIVISION

This division is engaged in conducting research for evolution/screening of rice, barley, and sunflower and wheat germplasm for salt tolerance potential. Following trials conducted during 2016-17.

33. YIELD EVUALTION TRIAL FOR ADVANCE RICE LINES/VARITES IN SALT AFFECETED SOIL

The experiment was laid out to find out the highest yield performing rice line in salt affected soil. A saline sodic field havingpH_S 8.71 EC_e 4.6-5.6 dS m^{-1} and SAR 32.2-37.6 (m mol $L^{-1})^{1/2}$. Tested varieties were PB-95. T-05, SRI-12, SRI-13, Basmati -515.Shaheen Basmati and Super Basmati. The nursery was raised in normal soil and was transplanted in moderately salt affected soil. The recommended dose of NPK fertilizer was applied. The experiment was laid according to RCBD .The recommended cultural practices were carried out till maturity. At maturity yield data was recorded.

Table: 96 Paddy yield under saline sodic soil

Sr. No.	Varieties/lines	Paddy yield(t. ha^{-1})
1	PB-95	3.24 A
2	T-05	2.80 C
3	SRI-12	2.60 C
4	SRI-13	2.84 B
5	Basmati-515	1.69 D
6	Shaheen Basmati	2.74 A
7	Super Basmati	1.53 E
LSD		0.0875

Results presented in table 96 showed that highest paddy yield (3.24 t ha^{-1}) was produced by advance line PB-95 which was statistically at par with Shaheen Basmati (2.74 t ha^{-1}) whereas the lowest paddy yield (1.53 t ha^{-1}) was found in Super Basmati in salt affected soil. Post-harvest soil analysis showed pH_S 8.69 EC_e 4.57-5.30 dS m^{-1} and SAR 30.3 -34.3 (m mol $L^{-1})^{1/2}$

34. MAINTENANCE OF SALT TOLERANT RICE VARIETY SHAHEEN BASMATI

Nursery of selected thirty single panicle true to type was raised and transplanted in the field on 21.07.2016. During growing season. Standard agronomic practices were followed. Off type plants were roughed out. The seed of 23 uniform progenies was harvested and bulked for next year. Fifty single panicles were selected to raise progeny lines for next year. Three kg BNS and Twelve kg pre-basic seed of Shaheen Basmati was produced.

35 NATIONAL UNIFORM RICE YIELD TRIAL

The trial was laid out according to RCBD with three replications having net plot size 3m x 5m. Twenty four entries were supplied by the RiceCoordinator NARC,Islamabad. Trial wastransplanted in moderately salt affected soil{ pH_s8.60, EC_e 5.55dS m^{-1}, SAR 31.35 (mmol L^{-1})$^{1/2}$}. Recommended agronomic practices were followed till maturity. Data on yield and yield components were recorded.

Table: 97 Paddy yield data (t ha^{-1})

Sr No	**Genotype**	**Plant height** (cm)	**No. of tillers/plant**	**No. of grain per panicles**	**1000 grain weight** (g)	**Yield** (t/ha)	**Maturity days**	**Days to 50% flowering**
1	FR16001	56	14	52	29.74	2.432	102	62
2	FR16002	49	15	63	30.69	2.741	101	61
3	FR16003	61	16	56	25.07	2.221	105	65
4	FR16004	63	12	61	25.94	2.113	104	64
5	FR16005	65	15	65	26.09	2.321	103	63
6	FR16006	61	13	59	30.07	2.531	102	62
7	FR16007	60	15	57	29.36	2.642	100	60
8	FR16008	59	17	62	31.79	2.921	104	64
9	FR16009	63	14	56	27.39	2.431	105	65
10	CR16010	65	13	59	22.07	2.831	99	59
11	CR16011	62	15	56	21.39	2.941	98	58
12	CR16012	59	13	52	27.33	2.314	97	57
13	CR16013	54	12	51	27.25	2.431	95	55
14	CR16014	58	14	54	24.6	21.71	98	58
15	CR16015	56	13	53	25.9	2.223	97	57
16	CR16016	58	11	55	26.91	2.341	98	58
17	CR16017	59	12	52	25.34	2.341	99	59
18	CR16018	61	11	57	25.77	2.341	98	58
19	CR16019	58	12	51	24.82	2.412	97	57
20	CR16020	56	14	49	27.72	2.413	96	56
21	CR16021	58	10	54	24.82	1.931	99	59
22	CR16022	60	13	51	27.02	2.341	97	57
23	CR16023	59	15	53	28.29	2.313	98	59
24	CR16024	57	14	49	27.61	2.132	99	59

Entry No. 11-CR. 16011 (table 97) out yielded by producing (2.941 t. ha^{-1}) paddy yield followed by entry No.8-FR 16008 along with(yield 2.921 t. ha^{-1}) under salt affected soil.

36. EVALUATION OF NUYT WHEAT LINES UNDER SALT AFFECTED SOIL

This experiment was designed to find out suitable wheat advance lines from NYUT material having better yield along with salt tolerance potential than existing commercial varieties.Soil sampling of salt affected field was done to monitor the desired salinity / sodicity levels for experiment initiation. Seed of NUYT lines were sown in Saline sodic field { pH_s 8.60, EC_e = 8.10 (dS m^{-1}),SAR = 29.58 (mmol $L^{-1})^{1/2}$}.in RCB design in 3 replications. All kind of recommended agronomic practices were followed. At maturity datafor grain yield was recorded.

Table: 98 Grain yield of NUYT lines (t. ha^{-1}) 2016-17

Sr.No	Entries	Grain yield	Sr.No	Entries	Grain yield
1	NUYT-24	2.33 A	21	NUYT-14	2.01 KLMN
2	NUYT -31	2.32 A	22	NUYT -10	2.01 KLMN
3	NUYT-02	2.30 AB	23	NUYT-04	1.99 LMNO
4	NUYT-12	2.29 AB	24	NUYT-19	1.98 MNOP
5	NUYT-36	2.27 ABC	25	NUYT -29	1.97 NOPQ
6	NUYT-40	2.24 BCD	26	NUYT -18	1.94 NOPQR
7	NUYT-39	2.21 CDE	27	NUYT -38	1.93 OPQR
8	NUYT -37	2.19 DEF	28	NUYT -17	1.92 OPQR
9	NUYT-08	2.16 EFG	29	NUYT-03	1.91 QRS
10	NUYT -28	2.15 EFGH	30	NUYT-15	1.89 RST
11	NUYT -23	2.14 EFGHI	31	NUYT -20	1.88 RSTU
12	NUYT -32	2.13 FGHI	32	NUYT -30	1.85 STUV
13	NUYT-11	2.12 FGHIJ	33	NUYT -25	1.83 TUVW
14	NUYT -26	2.11 GHIJ	34	NUYT-01	1.81 UVW
15	NUYT -33	2.10 GHIJ	35	NUYT-21	1.79 VW
16	NUYT-16	2.09 GHIJ	36	NUYT -34	1.77 W
17	NUYT -05	2.09 GHIJ	37	NUYT -22	1.65 X
18	NUYT-13	2.08 GHIJ	38	NUYT -35	1.65 X
19	NUYT -09	2.07 IJKL	39	NUYT -07	1.58 X
20	NUYT -06	2.05 JKLM	40	NUYT -27	1.45 Y
				LSD	0.0745

The data revealed (table 98) showed that entry Nuyt-24 out yielded (2.33 t. ha^{-1})among all the entries followed by Nuyt-31(2.32 t. ha^{-1}) under salt affected soil. The lowest yield (1.45 t. ha^{-1}) was recorded in Nuyt-27

37. YIELD TRIAL OF PROMISING WHEAT LINES/ GENOTYPES

This experiment was designed to see the performance and yield potential of promising lines of wheat in saline sodic soil. Pre and post analysis of selected field was carried out. The experiment was laid out in a saline sodic field{ pH_s= 8.54, EC_e = 7.85 (dS m^{-1}), SAR = 34.53 (m mol $L^{-1})^{1/2}$} according to randomize complete block design with three replications. The plot size was 2.5 m x5m. Recommended dose of fertilizer (120-110-70) NPK kg ha^{-1}) was applied. At maturity data for yield and yield components was recorded.

Table: 99 Grain yield of wheat (t. ha^{-1})

Sr.#	Entries	Grain yield
1	SIS-12	2.67 A
2	14 S1P1	2.56 A
3	Punjab 2011	2.28 B
4	SIS-13	2.25 B
5	SIS-27	2.17 B
6	Fsd 2008	1.95 C
7	BAH-2809	1.85 C
8	Galaxy	1.84 C
9	Gold	1.68 D
10	Johar	1.25 E
	LSD Value	0.1390

The data depicted in Table 99 showed that entry SIS-12 by producing (2.67 t. ha^{-1})out yielded all the entries followed by entry 14 S_1p_1 with yield (2.56 t.ha^{-1}) in salt affected soil. Lowest grain yield (1.25 t. ha^{-1}) was recorded in case of variety Johar.

38. SCREENING OF BARLEY GERMPLASM COLLECTED FROM NATIONAL & PROVINCIAL RESEARCH INSTITUTIONS ACROSS PAKISTAN UNDER SALINE-SODIC SOIL

This experiment was designed to find out suitable barley germplasm lines have better yield potentialthan existing varieties in salt affected soils. Experiment was conducted in Saline-Sodic soil{ pH_s 8.56, EC_e 8.66 (dS m^{-1}) and SAR 31.62(mmol $L^{-1})^{1/2}$}. Seed of eleven germplasm lines was sown in field according to RCB design with three replications. Field was irrigated according to crop requirement. At maturity and harvesting yield data was recorded. .

Table 100: Grain yield of barley 2016-17

The data presented in table 100 showed that entry B-9 produced maximum yield (2.27 t. ha^{-1}) followed by entry B-4 with yield (2.19 t. ha^{-1}) proved better under salt affected soil. The lowest yield (1.29 t. ha^{-1}) was recorded in case of line B-2.

Entries	Grain yield (t ha^{-1})
B-9	2.27 A
B-4	2.19 AB
B-1	2.10 B
B-7	1.92 C
B-8	1.90 C
B-11	1.89 C
B-3	1.85 CD
B-6	1.77 D
B-10	1.65 E
B-5	1.55 EF
B-12	1.47 F
B-2	1.29 G
LSD Value	0.0976

40 SCREENING OF SUNFLOWER GERMPLASM COLLECTED FROM NATIONAL & PROVINCIAL RESEARCH INSTITUTIONS ACROSS PAKISTAN UNDER SALT AFFECTED SOIL FOR HIGH YIELD POTENTIAL

This experiment was carried out to find out suitable germplasm lines have better yield along with salt tolerance potential than existing varieties. Experiment was conducted in saline-sodic soil{ pH_s 8.56, EC_e 6.58 (dS m^{-1}) , SAR 27.71 (mmol $L^{-1})^{1/2}$}. Seed of ten germplasm lines was sown in field according to RCB design in 3 replications. Plant to plant and ridge to ridge distance 22.5 and 60 cm was maintained respectively. All standard agronomic practices were followed during the crop season. At maturity yield data was recorded.

Table: 101 Grain yield of sunflower

Entries	**Achene Yield** (t. ha^{-1})
FH-17	1.62 A
FH-615	1.49 B
FH-572	1.47 BC
FH-612	1.41 CD
FH-614	1.36 D
FH-622	1.24 E
FH-620	1.22 E
FH-545	1.17 E
FH-331	1.07 E

FH-19	0.91 G
FH-16	0.84 G
LSD Value	**0.0795**

The data presented in table101 depicted that entry FH-17out yielded all the varieties by producing (1.62 t. ha^{-1}) in salt affected soil. The lowest yield 0.84 t ha^{-1}) was recorded in case of line FS-16.

6.0 LIST OF PUBLICATIONS

6.1 ResearchPaper Published

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6.2Radio Talks

تفصیل ریڈیو ٹاکس

۱۔ کلراٹھی زیناں وچ چاول دی فصل لئی کھاداں دا مناسب استعمال
۲۔ کلراٹھی زیناں دا موزوں تے مناسب استعمال
۳۔ کلراٹھی زیناں وچ مردی مونجی نوں بچانا
۴۔ زمین تے پانی دے تجزیے دی اہمیت
۵۔ کلراٹھی زیناں وچ کھارے پانی دا استعمال
۶۔ کلراٹھی زیناں وچ فصلاں دے ادل بدل دے فائدے
۷۔ کلراٹھی زمینوں میں پھل دار پودوں دی کاشت
۸۔ کلراٹھی زمینوں میں برسیم کی کاشت
۹۔ کلراٹھی زیناں دی اصلاح دے طریقے
۱۰۔ کلراٹھی زمینوں وچ کنک دی کاشت دے طریقے
۱۱۔ کلراٹھی زیناں وچ کاشت لئی کھاداں دا استعمال
۱۲۔ کلراٹھی زیناں وچ کنوادی کاشت
۱۳۔ کلراٹھی زیناں وچ کنک لئی کھاداں دا استعمال
۱۴۔ کلراٹھی زیناں لئی کھارے پانی دا استعمال
۱۵۔ کلراٹھی زیناں وچ چارہ جات دی کاشت
۱۶۔ کلراٹھی زیناں دا تجزیہ تے اوس دی اہمیت
۱۷۔ کلراٹھی زیناں وچ نامیاتی مادے دی اہمیت
۱۸۔ کلراٹھی زمینوں میں کاشتہ گندم کیلئے نائٹروجنی کھادوں کا استعمال
۱۹۔ کلراٹھی زمینوں میں گندم کیلئے کھارے پانی کا استعمال
۲۰۔ کلراٹھی زمینوں میں کماد کی کاشت
۲۱۔ کلراٹھی زیناں دا منافع بخش استعمال
۲۲۔ کلراٹھی میناں وچ نامیاتی مادے دی اہمیت
۲۳۔ کلراٹھی زیناں دی اصلاح دے طریقے
۲۴۔ کھارے پانی دا تجزیہ تے اوس دی اہمیت
۲۵۔ کلراٹھے پانی دا منافع بخش استعمال
۲۶۔ کلراٹھی زیناں دا بہتر استعمال
۲۷۔ کلراٹھی زیناں دا تجزیہ تے اوس دے اہمیت
۲۸۔ کلراٹھی زیناں وچ نامیاتی مادے دی اہمیت
۲۹۔ کلراٹھی زیناں دی طبعی خصوصیات
۳۰۔ کلراٹھی زیناں وچ کاشت لئی دھان دی قسماں دا چناؤ
۳۱۔ کلراٹھی زیناں وچ اصلاح دے طریقے
۳۲۔ کلراٹھی زیناں لئی نامیاتی تے غیر نامیاتی کھاداں دا استعمال
۳۳۔ کلراٹھی زیناں وچ مونجی دی کاشت

7.0 ADVISORY SERVICES

7.1 LIST OF FARMER'S BENEFITTED THROUGH SOIL ANALYSIS

S.No.	Date	Name of Farmers	Address	No. of Samples
1	04.07.2016	Muhammad Irshad	Naroz pur , Pindi Bhattian	01
2	04.07.2016	Muhammad Ali	M.B. Din	04
3	20.07.2016	Raees Abbas	Pindi Bhattian	04
4	12.08.2016	Faisal Nadeem	Qila Dedar Singh	02
5	15.08.2016	Mumtaz Ahamd	Pindi Bhattian	19
6	19.08.2016	Faisal Nadeem	Qila Dedar Singh	12
7	29.08.2016	Abaid Ullah	Chak. No. 30, S.B. Sargodha	16
8	01.09.2016	Qaisar Iqbal	Nishat Agri, Farm, P.B	15
9	06.09.2016	Mohsan Nawaz	Ghai Wala, P.B	02
10	27.09.2016	Syed Iqbal Shah	Pindi Bhattian	06
11	29.09.2016	Abid Mehmood	Sanghla Hill	02
12	07.10.2016	Arshad Ali	Chak.No. 02, Zakhira, P.B	02
13	10.10.2016	Mian Jhanzeb	Harsa Shaikh, P.B	02
14	18.10.2016	Ashiq Hussain	Harsa Shaikh, P.B	25
15	18.10.2016	Ghulam Murtaza	Kot Nakka, Pindi Bhattian	11
16	19.10.2016	Mumtaz Ahmad	Nestle Farm, P.B	34
17	20.10.2016	Ahsan Iqbal	Chak.No.103, S.B. Sargodha	03
18	31.10.2016	Tahir Shahzad	Pendorian, Sanghla Hill	01
19	03.11.2016	Farooq Haider	Dober, Shukhike Mandi, Pindi Bhattian	01
20	08.11.2016	Ashiq Hussain	Pindi Bhattian	06
21	14.11.2016	Zagham Abbas	Pindi Bhattian	04
22	14.11.2016	Muhammad Nasir	Berianwala, Pindi Bhattian	01
23	14.11.2016	Munwar Ali	Pesion Wala, P.B	01
24	14.11.2016	Asghar Ali	Kunda Bhattian, P.B	04
25	15.11.2016	Naimat Ali	Kot Sarwar	02
26	15.11.2016	Saqib Ali	Muzafar Nu, Hafizabad	04
27	17.11.2016	Ray Sakindar	Koli Wala, Pindi Bhattian	04
28	21.11.2016	Imran Hussain	Kot Nakka, Pindi Bhattian	04
29	21.11.2016	Muhammad Younas	Kot Dillawar, Pindi Bhattina	02
30	14.12.2016	Muhammad Jafir	Kot Nakka, Pindi Bhattian	02
31	14.12.2016	Muhammad Kaleem	Kot Nakka, Pindi Bhattian	02
32	20.12.2016	Abdul Qadous	Nawan Manikea, P.B	01
33	22.12.2016	Abid Hussain	Suber Shah, P.B	01
34	23.01.2017	Ghulam Hassan	Choki Sukhike, P.B	01
35	10.02.2017	Akhtar Hussain	Warburtan, Sheikiupura	05
36	13.02.2017	Sajjad Ali	Kot Nakka, Pindi Bhattian	03
37	13.02.2017	Muhammad Adil Faraz	Bemian Wala, P.B	10
38	27.02.2017	Zafar Iqbal	Hujar, Pindi Bhattian	01
39	12.04.2017	Aftakhar Ahmad	Chak. No. 03, Zakhira, P.B	01
40	14.04.2017	Majer Umair	Chah Wala, Bhawal	15
41	04.05.2017	Rizwan Ahmad	Mustafa Abad, P.B	04

42	15.05.2017	Talib Ali	Sahkna Burkan, P.B	02
43	17.05.2017	Hassan Dad	Nathain, Pindi Bhattian	06
44	22.05.2017	Zafar Iqbal	Sulangi Kharal, P.B	08
45	23.05.2017	Babar Shabir	Jhotian Wala, P.B	12
46	25.05.2017	Muhammad Nawaz	Ghari Wahab, P.B	04
47	29.05.2017	Sadar Khan	Thata Muna Salibat, P.B	01
48	29.05.2017	Nasir Mehmood	Chak No. 116, RB, Nankana	05
49	06.06.2017	Amir Ali	Bahoman, Pindi Bhattian	02
50	12.06.2017	Syed Wajid Raza	Dakho Shahna, P.B	02
51	14.06.2017	Ray Muhammad Tufail	Hussaekey, Pindi Bhattian	02
52	15.06.2017	Muhammad Abbas	Behlol Pur, Pindi Bhattian	02
53	19.06.2017	Khazir Ali	Chodo Khuda Yar, P.B	02
54	19.06.2017	Muhammad Ijaz	Chak. No. 118, RB, Sangla Hill	02
55	20.06.2017	Muhammad Mubasher	Thata Khero Matmal, P.B	05
56	21.06.2017	Shah Nawaz	Pindi Peeran, Nankana	07
57	23.06.2017	Muhammad Arshad	Khuram Jawaya, P.B	01
58	30.06.2017	Ahsan Arshad	Pindi Bhattian	01
			TOTAL	**304**

7.2 LIST OF FARMER'S BENEFITTED THROUGH WATER ANALYSIS

S.No.	Date	Name of Farmers	Address	No. of Samples
1	01.07.2016	Muhammad Yasin	Sukheki, Pindi Bhattian	01
2	01.07.2016	Shoukat Ali	Sukheki, Pindi Bhattian	01
3	12.07.2016	Shahadat Khan	Mian Bakish, Shukhike	01
4	19.07.2016	Sadiq Ali	Bhao Man, P.B	01
5	20.07.2016	Raees Abbas	Pindi Bhattian	01
6	25.07.2016	Hafiz Shafi Ullah	Pindi Bhattian	01
7	29.09.2016	Qaisar Iqbal	Nishat Agri. Farm Pindi Bhattian	01
8	29.09.2016	Abid Mehmood	Sanghla Hill,	01
9	06.10.2016	Arshad Ali	Zakhira, P.B	01
10	18.10.2016	Ashiq Hussain	Hirsa Shaikh, P.B	01
11	19.10.2016	Mumtaz Ahamd	Nestle Farm, P.B	34
12	19.10.2016	Muhammad Abu Sufian	Pindi Bhattian	01
13	31.10.2016	Tahir Shahzad	Chak Pendorian, Sanghala Hill	01
14	31.10.2016	Syed Sajjad Hussain	Popular Suger Mill, Sial Mor	01
15	08.11.2016	Ashiq Hussain	Pindi Bhattian	01
16	08.11.2016	Naimat Ali	Pindi Bhattian	01
17	14.11.2016	Sarfraz Ali	Popular Suger Mill, Sial Mor	01
18	23.11.2016	Shaikh Younas	Pindi Bhattian	02
19	05.12.2016	Zameer Ahmad	Kot Nakka, P.B	01
20	20.12.2016	Abdul Qadus	Nawan Manika, P.B	01
21	22.12.2016	Abid Hussain	Sabir Shah, P.B	01
22	10.01.2017	Qaisar Mehmood	Hujan , P.B	01
23	23.01.2017	Ghulam Hassan	Choki Sukhaeki, P.B	01
24	13.02.2017	Sajjad Ali	Kot Nakka, P.B	01
25	13.02.2017	Zafar Iqbal	Hujhan, P.B	01
26	27.02.2017	Abdul Aziz	Nawan Manika, P.B	01
27	03.03.2017	Allah Ditta	Pindi Bhattian	01
28	30.03.2017	Abdul Qadus	Nawan Manika, P.B	01
29	12.04.2017	Aftikhar Ahmad	Chak.03, Zakhira, P.B	01
30	19.04.2017	Ray Muhammad Khan	Beranwala, P.B	03
31	26.04.2017	Abdul Rasheed	Solangi Kharal,Hafizabad	01
32	27.04.2017	Manager (NAFP1)	Nishat Agri. Farm Pindi Bhattian	01
33	27.04.2017	Manager (NAFP2)	Nishat Agri. Farm	01

			Pindi Bhattian	
34	27.04.2017	Manager (NAFP3)	Nishat Agri. Farm Pindi Bhattian	01
35	27.04.2017	Manager (NAFP4)	Nishat Agri. Farm Pindi Bhattian	01
36	28.04.2017	Zulifqar Ali	Chak Sabu	02
37	04.05.2017	Rizwan Ahmad	Mustaf Abad, P.B	01
38	04.05.2017	Manager	Nishat Agri. Farm Pindi Bhattian	02
39	09.05.2017	Zulifqar Ali	Chak Sabu	01
40	15.05.2017	Muhammad Talib	Chak Burkan, P.B	01
41	16.05.2017	Raysat Ali	Pindi Bhattian	01
42	16.05.2017	Nafees Ahmad	Kot Nakka, P.B	01
43	23.05.2017	Muhammad Afzal	Kaleki, Hafizabad	02
44	24.05.2017	Basit Ali	Nestle Farm, P.B	01
45	29.05.2017	Sadar Khan	Thata Mona Salabit, P.B	01
46	29.05.2017	Nasir Mehmood	Chak.No.116 RB, Sangla Hill	01
47	12.06.2017	Wajid Raza	Dhaku Shahana, Pindi Bhattian	01
48	14.06.2017	Rai Tufail	Husaayki , Pindi Bhattian	02
49	15.06.2017	Mazhar Abbas	Bhalol Pur. P.B	01
50	22.06.2017	Muhammad Arshad	Khuram Javaia, P.B	02
51	29.06.2017	Imtiaz Ahmad	Pindi Bhattian	01
52	30.06.2017	Ahsan Arshad	Pindi Bhattian	01
			TOTAL	**93**

7.3 LIST OF FARMER'S BENEFITTED THROUGH FERTILIZER ANALYSIS

S.No.	Date	Name of Farmers	Address	No. of Samples
1	13.07.2016	Dildar Hussain	Mudhrian wala,Hafizabad	01
2	08.08.2016	Muhammad Qazafi	Chak.No. 02, P.B	01
3	10.08.2016	Sher Ajmal	Cristel Agro. P.B	01
4	22.08.2016	Asghar Ali	Chak.No. 03 P.B	01
5	01.09.2016	Muhammad Yasin	Chak.No. 03 P.B	01
6	10.10.2016	Muhammad Abrahim	Hassan Pura. P.B	01
7	30.10.2016	Tahir Shahzad	Chak No.122, RB. Sangla Hill, P.B	03
8	09.01.2017	Irshad Ali	Pindi Bhattian	01
9	09.01.2017	Sajid Ali	Nawan Manika, P.B	01
10	22.05.2017	Safdar Ali	Kot Nakka, P.B	01
11	13.06.2017	Aftab Ahmad	Dudhian wala, Khushab	01
12	19.06.2017	Qaisar Javad	Shah Jamal, Gujranwala	01
13	22.06.2017	Imran Hassan	Phero kay,Hafizabad	01
			TOTAL	**15**