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Research Article

IMPROVISATION AND DEMONSTRATION OF RECLAMATION TECHNOLOGIES FOR ALKALI SOILS OF GUNTUR DISTRICT IN ANDHRA PRADESH

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Abstract- An experiment was conducted in farmers fields during *kharif* season from 2012 and 2014 with paddy crop in P.B.V. Palem village of Guntur district. Implemented and demonstrated the technologies like land leveling, adequate drainage provision for removal of excess water, application of amendments, leaching, selection of crops and cropping sequence and nutrient management. Powdered gypsum was added along with organic manures, SSP for efficient reclamation. The green manure crop dhaincha was incorporated at 50% flowering stage. The paddy variety NLR 145 was transplanted with a 50% more nitrogen than recommended and application of Zinc Sulphate @ 50 kg ha^{-1}. After three years of implementation of package, farmers got good yields with paddy crop compared to control and yields were increased from 25 to 47%. The exchangeable sodium percentage was drastically decreased from 26.93 to 17.58. Soil pH value also decreased from 8.85 to 8.10 and EC had showed little change. Soil nutrient availability increased slightly from initial to final.

Keywords- Paddy, Alkali soils, Reclamation, Yield

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Introduction

In Andhra Pradesh a total of about 18.5 million hectares (19.6%) are reported to be subjected to soil degradation such as soil erosion, salinization, alkalization, laterization and inundation. Salt Affected soils called "Choudu Bhumulu" constitute more than 2% of the state's area. The department of Agriculture during 2003 on reconciliation of NRSA estimated salt affected soils area to be 8.18 Lakh ha. Out of which 7.0 lakh hectares are alkaline in nature. The area is expected to be increase further due to increasing use of poor quality ground water, water logging and sea water intrusion in coastal areas. Further continuous use of high RSC waters especially in heavy textured soils resulted in low permeability, increased pH and deficiency of zinc and iron is oftenly observed phenomena in the state. Several pilot projects on reclamation of waterlogged saline soils with provision of sub-surface drainage have been taken up in Andhra Pradesh. The attempts have been proved to be successful in reducing soil salinity in 2-3 years of time and found to be economically viable.

Reclamation of alkali soils using chemical amendments has been found to be successful and large tract have been converted in to highly productive lands in Punjab, Haryana and Uttar Pradesh. In Andhra Pradesh soil testing laboratories are advising the farmers for gypsum application and this programme needs to be accelerated with technical support of the centrally sponsored schemes.

These alkali soils either exist in large patches or interspersed with good soils. Practically no crop could be grown on these soils. The crops died because the soils had high exchangeable sodium, poor aeration and poor available nitrogen and zinc. The average yields of different crops were very poor. The presence of salinity and sodicity were sporadic and spread in large areas and number of villages. These soils are confined to the small and marginal farmers whose subsistence with their own resources is always questionable due to their poor and fragile resource based agricultural practices. Good management practices & techniques have to be followed to reclaim their soils with low input technology. So, the study was undertaken in this aspect.

Materials and Methods

The selected Pinnaboinavari Palem village is located at Bapatla mandal in Guntur district with an average elevation of 10m above MSL. A field experiment was conducted for three years (2012- 2014) during *kharif* season in five farmer's fields of Pinnaboinavari palem village of Bapatla Mandal in Guntur district. The initial soil samples were analyzed and found that the soils are sandy clay loam with highly alkaline (pH 8.5 to 8.85), EC was normal (0.40 to 0.51 dSm^{-1}), available nitrogen 145-180 kgha^{-1}, available phosphorus was 18.0–24.2 kgha^{-1} and available potassium was 180-258 kgha^{-1} [Table-1]. Demonstrated the technologies developed at CSSRI, Karnal and its sub centre AICRP on SAS & USW, Bapatla *viz.,* land leveling, adequate drainage provision for removal of excess water, application of amendments, leaching, selection of crops and nutrient management. Powdered gypsum was added with purity more than 80 per cent, along with organic manures, SSP for efficient reclamation. The green manure crop dhaincha was incorporated at 50% flowering stage. Since alkali soils are generally rich in P and K, their application could be normal. Normal recommended dose of fertilizer for rice crop during *kharif* is 120-60-40 kg NPK ha^{-1} but applying 50% extra nitrogen only than the RDF i.e., 150-60-40 kg NPK ha^{-1} to meet the nutrient requirement of the crop due to more nitrogen losses occurred in alkali soils

compared to normal soils. The paddy variety (NLR 145) was transplanted with 50% more nitrogen than recommended. Application of $ZnSO_4$ @ 50kg ha^{-1} was done at basal to avoid the Zn deficiency in crop due to high exchangeable sodium content in the soil. Entire Phosphorus and half of nitrogen was applied as basal dose and remaining nitrogen and potassium fertilizers were applied in two equal splits at active tillering and panicle initiation stages. The initial soil samples were collected and analyzed for pH, EC, available nitrogen, phosphorous and potassium and ESP following standard procedures Tandon [8]. The Cation Exchange Capacity (CEC) of soil was determined by using neutral normal ammonium acetate method given by Bower *et al.,* [2]. The detailed reclamation procedure was given below.

Table-1 *Physico-chemical properties of initial soil samples at PBV Palem (2012)*

Sl.No.	Location	pH	EC (dS m^{-1})	Available nutrients (kg ha^{-1})			CEC (meq L^{-1})	ESP (%)
				N	P_2O_5	K_2O		
1	Sri D. Gopaiah	8.76	0.42	145	19.8	180	22.50	20.53
2	Sri P.S. Reddy	8.52	0.43	170	20.5	220	20.10	27.08
3	Sri D. Venkaiah Reddy	8.83	0.40	165	18.0	245	19.87	23.90
4	Sri D.Krishna Rao	8.85	0.51	180	24.2	225	22.58	24.72
5	Sri P.Bikshalu	8.80	0.46	195	22.8	258	23.40	26.93

Results and Discussion

Precipitation received during crop period of *kharif* season 1011.6, 1460.9 and 657.4mm in 2012, 2013 and 2014 years respectively. During 2013 in the months of September(335.2 mm) and October (497.9 mm) high amount of rainfall received and where as in the 2014 year 40.8 % deficit rainfall (657.4 mm) was received than the normal, due to this reason lower yields were recorded in 2013 and 2014 compared to 2012 year [Fig-1].

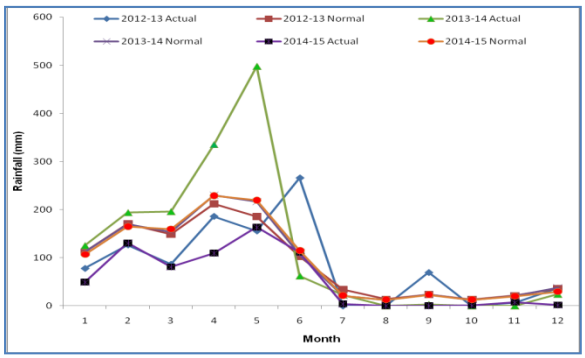

Fig-1 Distribution of rainfall during crop period (2012 to 2014)

Grain Yield

Paddy grown in salt affected soils recorded very low yields. Application of chemical amendment, organic manures with good management practices and techniques to reclaimed alkali soils is a low cost input technology. Adoption of reclamation technologies and implementation after three years the paddy yield was increased from 15 to 47 percent more than the control plots. Farmers got good yields with paddy crop compared to control and average yield of three years increased from 3375 to 5375 kg ha^{-1} [Table-3]. During the First year of reclamation, the highest yield (6200kg ha^{-1}) was recorded in Sri. P. Bikshalu field but in the years 2013 and 2014 lower yields were recorded due to erratic distribution of rainfall. The average highest and statistic yield was recorded in Sri. P.S. Reddy (5424 kg ha^{-1}) farmer field [Fig-2 & 3]. This might be due to application of powdered gypsum, which has replaced the sodium ion from exchangeable sites with calcium, and removal of soluble salts from root zone depth through leaching reduced the SAR values. Addition of organic matter through in-situ green manuring improves the soil physical properties and availability of nutrients to the crop. Prapagar *et al.,* [5] and CSSRI annual reports [3] reported that adoption of package of practices for reclamation of alkali soils gave higher yield over control.

Table-2 *Year wise yield of rice as influenced by adoption of reclamation technologies*

Sl.No.	Name of the farmer	Yield (kg ha^{-1})					% increase after three years
		Control	2012	2013	2014	Mean	
1	Sri D. Gopaiah	3562	5135	4500	5250	4962	39.3
2	Sri P.S. Reddy	4200	5585	5062	5625	5424	29.1
3	Sri D. Venkaiah Reddy	3937	6075	4687	5250	5337	35.6
4	Sri D. Krishna Rao	3375	5850	4312	4688	4950	46.7
5	Sri P. Bikshalu	4312	6200	4875	5063	5379	24.8

Fig-2 Poor establishment of paddy crop

Fig-3 Establishment of paddy crop after reclamation

Physico- chemical properties of the soil:

Soil pH

Soil pH is the most important parameter which shows the overall changes in soil chemical properties. The pH values of soil were decreased due to adoption of reclamation technology. The initial soil having pH ranges from 8.52 to 8.83 and after three years of reclamation it has been decreased to 8.10 to 8.48 [Table-2]. The decrease in soil pH due to gypsum application was probably due to the replacement of sodium by calcium. The decrease in soil pH may be due to decrease in sodium concentration. Besides, large quantities of CO_2 must have been evolved during leaching process, some of which would become soluble in soil solution giving carbonic acids. These results are in agreement with Trilok *et al.,* [7] and Prapagar *et al.,* [5].

Soil Electrical Conductivity

The EC values of soil were decreased after three years of reclamation. Initially the EC values ranged from 0.40 to 0.51 dSm^{-1} and decreased to 0.30 to 0.40 dSm^{-1} [Table-2]. This might be due to leaching followed by in situ incorporation of dhaincha. Leaching was effective in decreasing soil salinity. This may be due to addition of organic matter through insitu incorporation of green manure of dhaincha which can accelerate the leaching of Na^+, decreased the ESP, EC, and increased the water infiltration, water holding capacity and aggregate stability. Rai *et al.,* [6] revealed that the electrical conductivity of sodic soil was reduced due to application of gypsum. These results are in agreement with Mohamed [4] and Trilok *et al.,* [7].

Soil Exchangeable Sodium Percentage (ESP)

The exchangeable sodium percentage after reclamation was drastically decreased compared to initial soil. The initial soil having ESP ranged from 20.53 to 27.08, adoption of reclamation technology decreased to 14.8 to 18.60. ESP values were decreased considerably by leaching of the soil, the leached solution coming from the upper soil layer caused an increase in the SAR values of the percolating solution, which in turn reduced the replacement of exchangeable sodium with calcium either present in the applied water or solubilized from the added amendments. Similar results were given by Trilok *et al.,* [7].

Soil Cation Exchange Capacity (CEC)

The CEC of the experimental soil increased after three years of reclamation. The initial soils having CEC ranges from 19.87 to 23.40 and increased to 23.0 to 28.0 C mole (+) / kg soil in final soil analysis. It might be due to soil organic matter encourages granulation which has increased cation exchange capacity (CEC) and is responsible up to 90% adsorbing power of the soils. Cations such as Ca^{+2}, Mg^{+2} and K^+ are produced during decomposition. Organic amendments decreased soil sodicity and increased exchangeable Ca^{+2} and Mg^{+2}. These results are in agreement with Mohamed [4] and Trilok *et al.,* [7].

Macro nutrient availability

Initial soil having nitrogen content ranges from 145 to 195 kg ha^{-1} and final soil having 125 to 178 kg ha^{-1} [Table-3]. Soil available nitrogen was significantly decreased compared to initial soil analysis and it may be due to losses of nitrogen thorough various methods and removal by crop. Yeresheemi *et al*., [9] reported that in salt affected soils nitrogen content was decreased due to high pH, Low Organic carbon favouring higher ammonia volatilization losses and reduced nitrification and subsided activity of N- fixing microbes. Initial soil available phosphorous content ranges from 18.0 to 24.2 kg ha^{-1} and increased to 22.7 to 28.2 kg ha^{-1} in final soil analysis. Initial soil available potassium content ranges from 180 to 258 kg ha^{-1} and increased to 238 to 280 kg ha^{-1} in final soil analysis. This might be due to addition of organic matter improves the availability of nutrients in the soil. Archana Singh and Jitendra Kumar Singh [1] reported that application of gypsum significantly influenced the soil available macronutrients such as (N.P, K, S and micronutrients Fe, Cu, Zn and Mn).

Table-3 *Physico- chemical properties data of soils after three years (2012-14)*

Sl.No.	Name of the farmer	pH	EC (dSm^{-1})	Available nutrients (kg ha^{-1})			CEC (meq L^{-1})	ESP (%)
				N	P_2O_5	K_2O		
1	Sri D. Gopaiah	8.32	0.35	125	22.7	242	25.0	14.80
2	Sri P.S. Reddy	8.10	0.32	155	25.4	238	28.0	18.60
3	Sri D. Venkaiah Reddy	8.48	0.30	140	22.9	284	23.0	15.58
4	Sri D.Krishna Rao	8.47	0.40	145	28.2	255	27.5	16.45
5	Sri P.Bikshalu	8.20	0.36	178	27.6	280	26.0	18.20

Conclusion

Reclamation of alkali soils through chemical amendment is low input technology, with high use efficiency of fertilizers for getting maximum yields. Adoption of technology developed at AICRP Centre on Salt Affected Soils and Use of Saline Water at Karnal and Bapatla increased the paddy grain yield 15 to 47 % than control plot, improved the physical properties of the soil and benefited the farmers to restore their soil health status to normal with increased yields.

Conflict of Interest: None declared

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