Research Journal of Agriculture and Forestry Sciences _____ ISSN 2320-6063
Vol. **2(3),** 1-6, March **(2014)** *Res. J. Agriculture and Forestry Sci.*

Maximizing Red Gram yield through Integrated Agronomic Management Practices under alkali soil

K. Venkata lakshmi
Krishi Vigyan Kendra, Vridhachalam-606001, Tamil Nadu, INDIA

Available online at: www.isca.in, www.isca.me
Received 30th November 2013, revised 20th January 2014, accepted 4th February 2014

Abstract

The experiment was conducted Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirapalli on red gram with the objective of to study the effect of various management techniques on red gram yield under alkali soil. The treatments included in this experiment are Daincha as green manure incorporated at 45 DAS @6.25 t ha^{-1}, 125 % Recommended dose of N, Daincha + 125 % N, sub soiling at 45 cm depth. TNAU micro nutrient mixture @ 12.5 kg ha^{-1}, 125 % N + sub soiling + TNAU micronutrient mixture and 125 % N + Sub soiling + TNAU micronutrient mixture + Daincha were compared with control. The results of pooled analysis revealed that that 125 % Recommended dose of N + Sub soiling + TNAU micronutrient mixture @ 12.5 kg ha^{-1} + Daincha recorded higher biometric characters, yield attributes (number of pods plant^{-1}, number of seeds pod^{-1} , test weight) and yield (456 kg ha^{-1}) with higher soil organic carbon content (0.24 per cent) and available N (282.5 kg ha^{-1}). The B: C ratio (1.63) was also recorded higher under the same treatment.

Keywords: Red gram, alkali soils, green manure, micronutrient and sub soiling.

Introduction

Nearly 6.73 million hectare soils in India are salt affected. Out of this Tamil Nadu state alone has 0.43 million tonnes of salt affected soils. Recent estimates indicate that more than 1.85 million ha salt affected area has been reclaimed which is contributing about 15 million tonnes additional food grains every year to the central pool. Balasubramanian, 2012 reported that current Agriculture production is very low in sodic soil[1]. The red gram is the most important pulse crop in India. India is the largest producer (81 percent) and consumer (90 percent) of red gram in the world. But at national level the average productivity is very low (675 kg ha^{-1}). There are several constraints in the red gram cultivation; one of them is problematic soil.

In 2025A.D.India's food grain requirement is 301 million tonnes. This can be done by multible cropping and brining additional area under food production. But the possibilities for the above mentioned is very limited. The only feasible alternative is bringing the wastelands and problem soils under cultivation. There are multiple choices are available to increase the productivity of alkali soils. Swarp, 2004 found that instead of following any particular method, by adopting combination of methods like practising appropriate tillage methods, application of micro nutrient and organic manures will certainly increase the productivity of alkali soils[2]. Hence the present experiment has been carried out with the aim is to quantify the incremental effect of various management techniques on red gram growth, yield and on soil properties under alkali soil and to find out the economic viability of the different agronomic practices under alkali soil.

Material and Methods

The Present investigation was carried out during summer season, 2011 and 2012 at Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirapalli. The experimental material consist of red gram CO (RG 7).The experiment was laid out in randomised block design with three replications. The initial soil nutrient status are low in soil organic carbon (0.19 per cent), low in soil available nitrogen (278 kg ha^{-1}), medium in soil phosphorus (11kg ha^{-1}) and low available potassium (100 kg ha^{-1}). The treatments viz.,T_1 - Control (Recommended dose of N,P_2O_5, K_2O ha^{-1}), T_2 –Daincha as green manure incorporated at 45 DAS @6.25t ha^{-1}, T_3 – 125 % Recommended dose of N (31 kg of N ha^{-1}),T_4 – Daincha as green manure incorporated at 45 DAS @ 6.25 t ha^{-1}+ 125 % Recommended dose of N (31 kg N ha^{-1}),T_5 – Sub soiling at 45 cm depth at 0.5 m interval at every year,T_6 – TNAU micro nutrient mixture @ 12.5 kg ha^{-1}, T_7 – 125 % Recommended dose of N (31 kg N ha^{-1}) + sub soiling at 45 cm depth at 0.5 m interval at every year + TNAU micronutrient mixture @ 12.5 kg ha^{-1} ,T_8 – 125 % Recommended dose of N (31 kg N ha^{-1}) + Sub soiling at 45 cm depth at 0.5 m interval at every year + TNAU micronutrient mixture @ 12.5 kg ha^{-1}+ Daincha as a green manure incorporated at 45 DAS@6.25 t ha^{-1}. The recommended dose 25:50:25:20 kg N, P_2O_5, K_2O and S per hectare were uniformly applied all the treatments. The crop was raised under irrigated condition with 45 cm as inter row spacing and 15 cm is followed as intra row spacing. The green manure sowing was done on 15.2.2011 and 17.2.2012 during 2011 and 2012 respectively. The red gram sowing was done on 17.3.2011 and 15.3.2012 during 2011 and 2012 respectively. The crop was harvested after 120 days. Data were recorded on biometrical

characters viz., plant height(cm), number of pods per plant, number of seeds per pod, test weight (g), seed yield (kg ha^{-1}), post harvest nutrient status and economics were worked out. The statistical analysis was done with AGRES package.

Table-1
Chemical properties of the experimental field (2011 and 12)

Properties	2011	2012
PH	8.1	8.1
EC (dS m^{-1})	0.15	0.15
Organic carbon (%)	0.19	0.21
Available N (kg ha^{-1})	278	280.5
Available P (kg ha^{-1})	11	11
Available K (kg ha^{-1})	100	100.5

Results and Discussion

Growth parameters of pigeon pea: The data on plant growth characters like plant height, dry matter production (DMP), leaf area index (LAI), root length and root-shoot ratio are given in table 1. The results showed significant differences due to different agronomic management practices on pigeon pea under alkali soils. During the year 2011, the plant growth characters like plant height ,dry matter production (DMP), leaf area index (LAI), root length and root - shoot ratio of pigeon pea were recorded significantly higher under application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1}+ Daincha as a green manure incorporated at 45 days after sowing (T8) which was comparable with application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1}(T7). The lowest plant growth characters (plant height ,dry matter production (DMP), leaf area index (LAI), and root -shoot ratio) were recorded under control (T1) (table 1). Significant response on the root volume could be attributed in T7 due to the positive influence of sub-soiling and micro nutrients application positively influences elongation of root cells which could have resulted in proliferation of root cells in pigeon pea. The similar findings[3] was reported by Nitant and Pratap singh, 1995 who reported that elongation of root is positively influenced by the deep tillage which in turn reflect growth characters of in red gram under dry land situation[3].

Table 1 shows that plant growth characters like plant height, dry matter production (DMP), leaf area index (LAI), root length and root - shoot ratio (table 1) of pigeon pea were recorded significantly higher under application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) which was comparable with the application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7). The increased in root volume of the plant could have foraged widely and enabling more uptake of nutrients leading to more accumulation of dry matter production. These results were supported by Shinde and Saraf, 1994 in chickpeas[4]. The inferior plant growth characters (plant height, dry matter production (DMP), leaf area index (LAI) and root-shoot ratio) were recorded under control (T1) (table 1)

Yield attributes of pigeon pea: During the first year of study the number of primary branches plant $^{-1}$, number of seeds pod^{-1} and test weight (g) were recorded higher under application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) (table 2) which was comparable with application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7).The lowest number of primary branches $plant^{-1}$, number of seeds pod^{-1} and test weight were recorded under control (T1) followed by sub soiling at 45 cm (T5). Application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) recorded significantly higher no. of pods $plant^{-1}$ which was on par with application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7). The lowest number of pods $plant^{-1}$ was recorded under control (T1) (table 2). Reddy et al. found the similar result by the integrated application of organic and inorganic nutrients sources for increase in yield attributes because of increase in nutrient uptake correspondingly increases the yield attributes[5].

Table-1
Effect of different agronomic practices on growth characters of pigeon pea under alkali soil

Treatments	Plant height (cm)		Dry matter production (kgha^{-1})		LAI		Root :shoot ratio	
	2011	2012	2011	2012	2011	2012	2011	2012
T1	112.0	111.3	4842	4885	1.56	1.60	0.32	0.34
T2	116.8	116.5	5107	5113	1.67	1.71	0.41	0.42
T3	119.2	118.6	5221	5228	1.72	1.76	0.47	0.49
T4	120.0	119.4	5256	5261	1.77	1.81	0.50	0.52
T5	114.5	113.7	4961	4994	1.62	1.65	0.54	0.57
T6	115.2	114.9	4978	5012	1.64	1.68	0.38	0.39
T7	120.9	120.9	5379	5440	1.83	1.89	0.58	0.62
T8	122.1	121.8	5432	5493	1.87	1.91	0.61	0.66
SED	0.40	0.5	47	27.63	0.04	0.03	0.02	0.03
CD (P=0.05)	0.9	1.1	102	59.27	0.08	0.06	0.04	0.05

The yield attributes like no. of primary branches plant^{-1} , no of seeds pod^{-1} and test weight (10.3 g) were recorded higher under application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) (table 2) which was comparable with application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7).The lowest number of primary branches plant $^{-1}$, number of seeds pod $^{-1}$ and test weight (9.2 g) were recorded under control (T1) followed by sub soiling at 45 cm (T5).Application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) recorded significantly higher number of pods plant^{-1} (81.2) which was on par with application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7) (80.5). The lowest number of pods plant $^{-1}$(72.9) was recorded under control (T1) (Table 2) during the year 2012.

Yield of pigeon pea: Application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) recorded significantly superior seed yield of 426 kg ha^{-1}during the year of 2011 (table 2) this was followed by application of 125 % recommended dose of N+ sub - soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7) (396 kg ha^{-1}). The lowest seed yield of 216 kg ha $^{-1}$was registered under control (T1) (table 3). Significant increase in harvest index was observed with the application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) (15.78). The lowest harvest index of 15.21 was registered under control (T1).

During the year 2012, significantly superior seed yield of 486 kg ha^{-1} was recorded in the application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1}+ Daincha as a green manure incorporated at 45 days after sowing (T8) this was followed by application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1}(T7) (442 kg ha^{-1}) in 2012. The inferior seed yield of 275 kg ha^{-1} was recorded under control (T1) (table 2). Significant increase in harvest index (15.90) was observed with the application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha $^{-1}$+ Daincha as a green manure incorporated at 45 days after sowing (T8). The lowest harvest index of 15.32 was registered under control (T1) (table 2). The increase in yield due to increased yield attributes which in turn resulted from more effective translocation of photosynthates from source to sink .Raja rajan and Sabrinathan, 2006 and Zaka, 2005 were found that the effect of integrated nutrient management in red gram under alfisols[6,7].

Among the different management practices, significantly highest haulm (straw) yield 5562 kg ha^{-1} and 5648 kg ha^{-1} was recorded under application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) during 2011 and 2012 respectively (figure 1).

Table-2
Influence of various agronomic practices on No. of pods plant^{-1} No. of seeds pod^{-1} Test weight and seed yield of pigeon pea under alkali soils

Treatments	No. of pods plant^{-1}		No. of seeds pod^{-1}		Test weight (g)		Seed yield (kg ha $^{-1}$)	
	2011	2012	2011	2012	2011	2012	2011	2012
T1	72.9	72.5	3.4	3.2	9.2	9.0	275	216
T2	76.7	75.9	3.8	3.7	9.6	9.4	348	284
T3	78.1	77.0	4.0	3.9	9.8	9.6	383	322
T4	79.3	78.2	4.1	4.0	9.8	9.7	407	348
T5	75.4	74.8	3.7	3.6	9.5	9.3	314	259
T6	76.0	75.3	3.7	3.6	9.6	9.4	331	273
T7	80.5	79.2	4.2	4.2	10.2	10.0	442	396
T8	81.2	80.4	4.3	4.3	10.3	10.2	486	426
SED	0.3	0.9	0.2	0.2	0.1	0.3	17	6
CD (P=0.05)	0.6	2.0	0.3	0.4	0.2	0.6	37	14

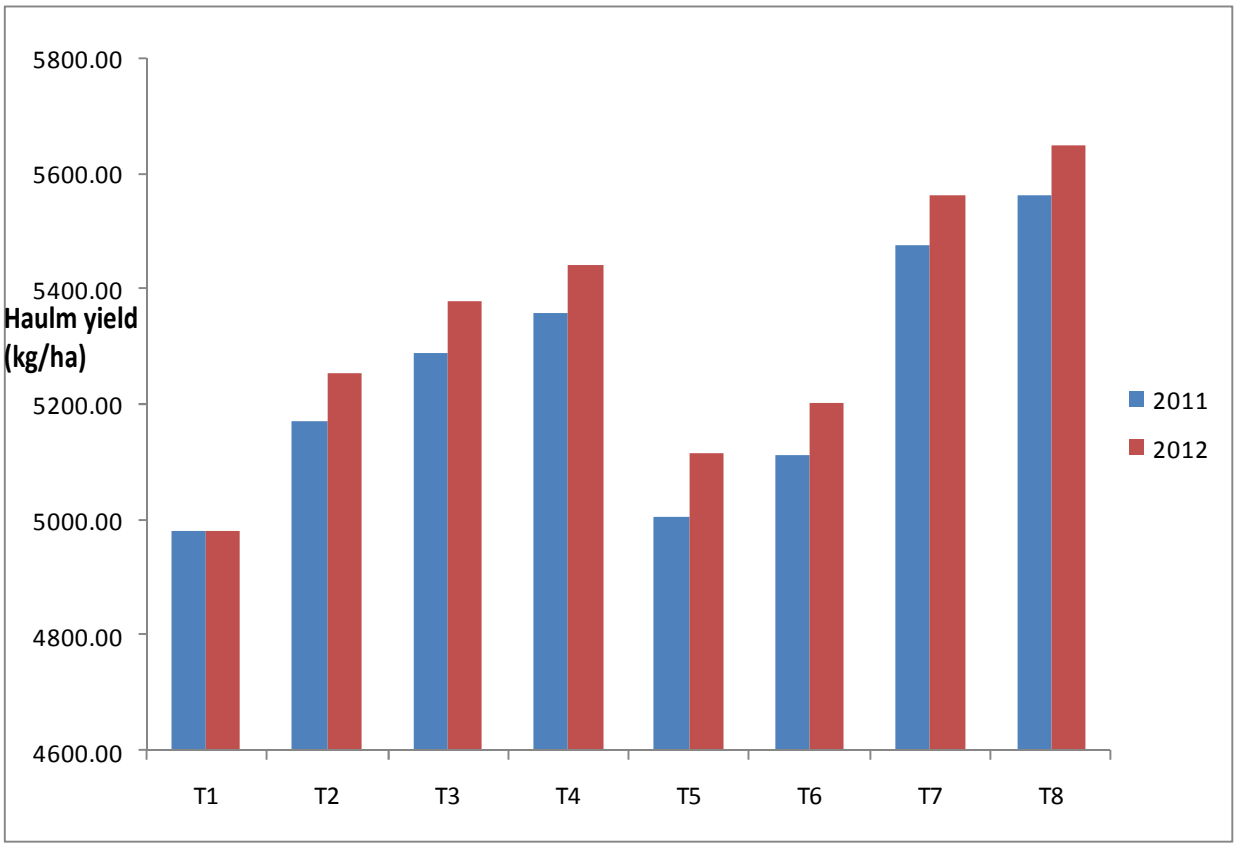

Figure-1
Influence of various agronomic practices on haulm yield (kg ha^{-1}) of red gram

Post harvest nutrient status of soil: During the year 2011, initial soil sample was taken for soil analysis. The pH, EC and available nitrogen and potassium were recorded as below. pH 8.1, EC 0.15 ds m $^{-1}$, Organic carbon 0.19 %, available nitrogen 278 kg ha^{-1} (low), available phosphorus 11 kg ha^{-1} (medium), available potassium:100 kg ha^{-1} (low).

Based on the first year experiment it was observed that that application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) at post harvest soil sample was recorded significantly higher soil organic carbon content (0.23 %) and over control (0.16 %) (table 3).

Post harvest soil available N was recorded higher under application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) which were comparable with 125 % recommended dose of N + Sub soiling at 45 cm depth + TNAU micronutrient mixture @ 12.5 kg ha^{-1}(T7). Both were significantly superior to control (T1).The soil fertility status was improved over the initial status of soil in both (T8 and T7) the treatments.

Initial soil sample was taken during the year of 2012 for soil analysis. The pH, EC and available nitrogen and potassium were recorded as below. pH 8.1, EC 0.15 ds m $^{-1}$, organic carbon 0.21 %, available nitrogen 280.5 kg ha^{-1} (low), available phosphorus 11 kg ha^{-1} (medium) , available potassium: 100.5 kg ha^{-1} (low).

The application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) at post harvest soil sample was recorded higher soil organic carbon content (0.24) which was on par with T7and T4 and these were significantly higher over control (0.16) (table 3) was observed in the second year of study. Post harvest soil available N was recorded higher under application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) which were comparable with 125 % recommended dose of N + Sub soiling at 45 cm depth + TNAU micronutrient mixture @ 12.5 kg ha $^{-1}$ (T7). Both were significantly superior to control (T1). The soil fertility status was improved over the initial status of soil in both (T8 and T7) the treatments. Azhar et al, 2001 and Zaka, 2006 reported the improvement of soil properties under alkali soil by the different management practices[7,8].

Economics: The data on economics of integrated agronomic management practices for alkaline soil were given in table 6. The net income (Rs.11,891) and benefit :cost ratio (1.66) was obtained due to application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha $^{-1}$ + Daincha as a green manure incorporated at 45 days after sowing (T8) (table 4) followed by application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7).This indicates that the above mentioned (T8) is more effective and economical with higher benefit :cost ratio in pigeon pea. The additional income obtained by this treatment over the control was Rs.12,465. The higher benefit : cost ratio was lowest in pigeon pea with control followed by sub soiling was 0.96 and 1.10 respectively which was due to poor yield obtained in above mentioned treatments.

The net income (Rs.11,865/-) and benefit : cost ratio (1.60) was obtained due to application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) (table 4) followed by application of 125 % recommended dose of N+ sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} (T7). This indicates that the above mentioned treatment (T8) is more effective and economical with higher benefit : cost ratio in pigeon pea. The additional income obtained by this treatment over the control was Rs. 11,482/- . Raja Rajan and Sabarinathan, 2006 also confirm the similar kind of results under alkali soils[4]. The benefit : cost ratio was lowest in pigeon pea with control followed by sub soiling were 1.02 and 1.12 respectively which was due to poor yield obtained in above mentioned treatments.

Table-3
Effect of various agronomic practices on pigeon pea organic carbon and soil available nitrogen (kg ha^{-1}) on economics of under alkali soil

Treatments	Organic carbon (%)		Soil available N (kg ha $^{-1}$)	
	2011	**2012**	**2011**	**2012**
T1	0.16	0.16	272.5	274.5
T2	0.19	0.21	278.0	279.0
T3	0.19	0.21	280.0	281.0
T4	0.22	0.23	280.5	281.5
T5	0.17	0.19	277.0	278.5
T6	0.17	0.19	277.0	279.0
T7	0.19	0.22	280.5	282.5
T8	0.23	0.24	281.5	283.5
SED	0.01	0.01	1.4	0.9
CD (P=0.05)	**0.02**	**0.03**	**3.0**	**1.9**

Table-4
Influence of various agronomic practices on economics pigeon pea under alkali soil

Treatments	Net income* (Rs.)		B:C ratio*	
	2011	**2012**	**2011**	**2012**
T1	383	-574	1.02	0.96
T2	4328	3386	1.24	1.21
T3	7333	6781	1.42	1.43
T4	8093	7801	1.44	1.47
T5	2118	1636	1.12	1.10
T6	3460	2846	1.19	1.18
T7	9805	10,591	1.52	1.62
T8	11865	11,891	1.60	1.66
SED	-	-	-	-
CD (P=0.05)	-	-	-	-

* Data is not statiscally analyzed.

From the two years of experiment it was observed that that application of 125 % recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) is more effective in increasing the seed yield over control and economical with higher profit in pigeon pea under alkali soil.

Conclusion

It is concluded that the substantial sodic soil area can be economically utilized by the application of 125% recommended dose of N (31 kg N ha^{-1}) + sub soiling at 45 cm depth at 0.5 m interval at every year + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing @ 6.25 t ha^{-1} (T8) recorded significantly highest average seed yield of 456 kg ha^{-1} when compared to other treatments. This is 46 % of higher yield over control. The same treatment improved the soil organic carbon content (%) as well as available soil nitrogen which is also recorded the higher average net income and B: C ratio of Rs.11,893 and 1.63 respectively were registered by the application of 125% recommended dose of N + sub soiling at 45 cm depth + TNAU micro nutrient mixture @12.5 kg ha^{-1} + Daincha as a green manure incorporated at 45 days after sowing (T8) in both the years when compared to control (T1).Red gram can be profitably adopted under alkali soil with the above management practices.

Acknowledgement

The author is thankful to the Dr.K.Annadurai, Dr.M.Kavimani, Dr.S.Sarvanan for their valuable guidance throughout the study. Special thanks to Ms.Puvilla for the help rendered by her. The author are also Obliged to Department of Agronomy, ADAC&RI, Trichy for their constant support in the entire research work.

References

1. Balasubramanian V., Jayakumar M. and Manickam T.S., Energy Land, WUE and biosynthates production in rice based cropping system under partially reclaimed sodic soils of North western zone of Tamil Nadu, *Madras Agricultural Journal*, **99(10-12),** 693-697 **(2012)**

2. Swarp A., Chemistry of Sodic Soils and Management, *In*: *Advances in Sodic Land Reclamation International Conference on Sustainable Management of Sodic Lands,* Lucknow, **9–14,** 27–52 **(2004)**

3. Nitant H.C. and Pratap Singh, Effects of deep tillage on dry land production of red gram (*Cajanus cajan L.*) in central India, *Soil and Tillage Research*, **34(1),** 17-26 **(1995)**

4. Shinde V.S. and Saraf C.S., Pattern of dry matter accumulation and distribution in chickpeas influenced by P and S, *Indian Journal of Pulses Resesearch,* **7,** 76-79 **(1994)**

5. Subba Rami Reddy, Sateesh Babu J, Chandra Sekhar Reddy M., Mujeeb Khan Md and Murali Rao M., Integrated nutrient management in pigeonpea *(Cajanus cajana), Indian Journal of Applied Biology and Pharmceutical Technogy,* **2(2),** 467-470 **(2011)**

6. Raja Rajan and Sabarinathan R., Effect of *in situ* Moisture Conservation and Nutrient Management Practices on Soil Properties and Yield of Redgram in a Rainfed Alfisol, *In: The 18th World Congress of Soil Science*, July 9-15 **(2006)**

7. Zaka M.A., Obaid-ur-Rehman H.U., Rafa and A.A. Khan, Integrated Approach for Reclamation of Salt Affected Soils, *Journal of Agriculture and social sciences*, **1(2),** 94-97 **(2005)**

8. Azhar M., Iqbal M., Khan M.A. and Ashraf M., Effects of Tillage Implements in Combination with Gypsum Applications on the Reclamation of Saline-Sodic Soils, *International Journal of Agriculture & Biology*, **3(3)**, 301–304 **(2001)**