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Influence of integrated Agronomic Management practices on Physiological and Nutrient uptake of red gram under Alkali soil

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Abstract

The experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirapalli during 2011 and 2012 with the aim to study effect of various agronomic management techniques on nutrient uptake and physiological growth parameters viz., Crop growth rate (CGR), Relative growth rate (RGR) and Net assimilation rate (NAR) and nutrient uptake (nitrogen, phosphorus and potassium) of red gram. The experiment was laid out on randomised block design with three replications. The treatments consisted in these experiment are green manure (daincha) incorporated at 45 DAS @6.25 t/ha, 125 % Recommended dose of N (31 kg of N/ha), green manure (daincha) incorporated at 45 DAS + 125 % Recommended dose of N, 45 cm depth of sub soiling at 0.5 m interval at every year, 12.5 Kg/ha of TNAU micro nutrient mixture, 125 % Recommended dose of N + sub soiling at 45 cm depth + 12.5 Kg/ha of TNAU micro nutrient mixture and 125 % Recommended dose of N + 45 cm depth of sub soiling +12.5 Kg/ha of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 DAS were compared with control. The results of the study revealed that 125 % Recommended dose of N + sub soiling at 45 cm depth at 0.5 m interval at every year + TNAU micronutrient mixture @ 12.5 kg/ha + green manure (daincha) incorporated at 45 DAS@ 6.25 t/ha recorded higher growth attributes (CGR,RGR and NAR) and nutrient uptake (available N, available P and available K and yield of red gram under alkali soil(426 kg/ha and 486 kg/ha)during the year of 2011 and 2012 respectively.

Keywords: Red Gram, Alkali Soils, Green Manure, Micronutrient and Sub Soiling, CGR, RGR and NAR.

Introduction

Red gram, also known as pigeon pea, is an important as well as protein rich pulse crop as well as staple food of India and is being cultivated on 35.60 lakh hectares of land with the production of 2.75 million tones across the country.

India is the largest producer and consumer of red gram in the world. But its average productivity is very low in India.

During, 2025 food grain requirement will be 301 million tonnes. The crop yields and productivity of the 'favoured agricultural regions' have plated out, it is essential to reclaim and utilize the problem soils like alkali soils. So that such lands has to be rendered cultivable and hence it is helpful to achieve the mentioned food grain production. In India, about 6.73 million hectare soils are salt affected.

The cultivation of crops under salt affected soil has so many physical and chemical constrains to give higher yield. So considering these facts, present experiment was carried out with the aim to determine suitable combination of methods to maximize the nutrient uptake and physiological parameters of red gram in the different agronomic practices under alkali soils.

Materials and Methods

The Present investigation was conducted during summer season, 2011 and 2012 at Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirapalli. The experimental material consist of red gram CO(RG7). The experiment was laid out in randomised block design with three replications. The treatments viz., T_1 - Control (recommended dose of 25:50:25:20 kg of N,P_2O_5, K_2O and S per ha), T_2 – Green manure (daincha) incorporated at 45 DAS @ 6.25 t/ha, T_3 – 125 % recommended dose of N (31 kg of N/ha), T_4 –green manure (daincha) incorporated at 45 DAS @ 6.25 t/ha + 125 % recommended dose of N (31 kg of N/ha), T_5 – 45 cm depth of sub soiling at 0.5 m interval at every year, T_6 - 12.5 Kg ha^{-1} TNAU micro nutrient mixture, T_7 – 125 % recommended dose of N (31 kg N/ha) + 45 cm depth of sub soiling at 0.5 m interval at every year +12.5 Kg ha^{-1} TNAU micronutrient mixture, T_8 – 125 % recommended dose of N (31 kg N/ha) + 45 cm depth of sub soiling at 0.5 m interval at every year + 12.5 Kg ha^{-1} TNAU micronutrient mixture + green manure (daincha) incorporated at 45 DAS@ 6.25 t /ha.

The recommended dose (blanket) of 25:50:25:20 kg of N, P_2O_5, K_2O and S per hectare were uniformly applied to all the treatments. The crop was raised under irrigated condition with a spacing of 45 cm in between the rows and 15 cm is followed as

intra row spacing. The sowing of green manure was carried out on 15.2.2011 and 17.2.2012 during 2011 and 2012 respectively. The red gram sowing was carried out on 17.3.2011 and 15.3.2012 during 2011 and 2012 respectively and it was incorporated in the soil 45 days after sowing. The crop was harvested after 120 days. Data were recorded on biometrical characters viz., LAI, CGR, RGR and NAR were worked out and plant nitrogen uptake, phosphorus uptake and potassium uptake of red gram were estimated. The initial soil sample analysis was done and furnished in the Table-1. The statistical analyses were done with AGRES package.

The CGR defines the dry matter accumulated per unit l and area per unit time (g m^{-2} day^{-1})

$$CGR = \frac{(W2 - W1)}{\rho\ (t2 - t1)}$$

where: W1 and W2 are whole plant dry weight at time t1 – t2 respectively ρ is the ground area on which W1 and W2 are recorded.

Relative growth rate (RGR) is explained as the rate of dry matter accumulation per unit of existing dry matter. RGR-expressed as unit dry weight / unit dry weight / unit time (g g^{-1} day-^{1})

$$RGR = \frac{\log_e W2 - \log_e W1}{(t2 - t1)}$$

where: W1 and W2 are whole plant dry weight at t1 and t2 respectively t1 and t2 are time interval in days.

The net assimilation rate is a measure of net photosynthesis of leaves in crop community. NAR is expressed as the grams of dry weight increase per unit dry weight or area per unit time (g g^{-1} day^{-1})

$$NAR = \frac{(W2 - W1)}{(t2 - t1)} \times \frac{(\log_e L2 - \log_e L1)}{(L2 - L1)}$$

where: W1 and W2 is dry weight of whole plant at time t1 and t2 respectively L1 and L2 are leaf weights or leaf area at t1 and t2 respectively t1 – t2 are time interval in days

Results and Discussion

The leaf area index (LAI) of pigeon pea was recorded significantly higher 1.87 during 2011 and 1.91 during 2012 under T_7- application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) which was comparable (1.83 during 2011 and 1.89 during 2012) with the application of 125 % recommended dose of N+ 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7). The lowest leaf area index of 1.56 and 1.60 (LAI) was recorded under T_1- Control in both the years of 2011 and 2012 respectively.

Table-1
Chemical analysis of initial soil sample 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

Dry matter production was recorded significantly higher (5432 kg ha^{-1} in 2011 and 5493 kg ha^{-1} in 2012) in application of 125 % recommended dose of N + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) which was comparable with the application of 125 % recommended dose of N + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7). The lowest dry matter production (DMP) of 4842 kg ha^{-1} and 4885 kg ha^{-1} were recorded (Table-2) under control (T1) during 2011 and 2012 respectively.

Nutrient uptake: Nitrogen uptake: The nitrogen uptake of red gram was significantly influenced by the various agronomic management practices of alkali soil. In the both years the highest nitrogen uptake of 114.6 kg ha^{-1} and 121.6 kg ha^{-1} were recorded in the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) during 2011 and 2012 respectively which was followed by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7). Where as the lowest nitrogen uptake of 101.3 in 2011 and 102.41 ka/ha in 2012 recorded under control (T1) (Table-3). Significant increase in the uptake of nitrogen by plants was recorded by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) might be due to the greater availability of nitrogen in soil due to improved soil physical and chemical properties[1-3].

Phosphorus uptake: The highest phosphorus uptake of 12.4 kg ha^{-1} and 92.4 kg ha^{-1} were found in the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) during 2011 and 2012 respectively and this was significantly superior to the all other treatment (Table-3).The lowest

phosphorus uptake of 9.1 kg ha^{-1} in 2011 and 9.6 kg ha^{-1} in 2012 were recorded under control. The greater uptake of phosphorus might be due to application of daincha, when it undergoes decomposition it releases organic acid, which helps to release the fixed P in soil [4].

Table-2
Influence of different agronomic practices on leaf area index and dry matter accumulation of pigeon pea under alkali soil

Treatments	Leaf Area Index (LAI)		Dry matter production (kg ha^{-1})	
	2011	**2012**	**2011**	**2012**
T1	1.56	1.60	4842	4885
T2	1.67	1.71	5107	5113
T3	1.72	1.76	5221	5228
T4	1.77	1.81	5256	5261
T5	1.62	1.65	4961	4994
T6	1.64	1.68	4978	5012
T7	1.83	1.89	5379	5440
T8	1.87	1.91	5432	5493
SED	0.04	0.03	47	27.63
CD (P=0.05)	0.08	0.06	102	59.27

Table-3
Influence of various agronomic management practices on nutrient uptake of red gram at harvest stage under alkali soil

Treatment	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	2011	**2012**	**2011**	**2012**	**2011**	**2012**
T_1	101.3	102.4	9.1	9.6	100.4	100.6
T_2	106.1	111.6	10.8	11.4	104.5	104.9
T_3	108.3	113.9	10.9	11.5	106.7	107.3
T_4	109.5	115.5	11.2	11.8	107.2	108.0
T_5	102.9	107.8	10.2	10.8	102.6	103.1
T_6	103.7	108.1	10.4	11.1	103.1	104.3
T_7	112.4	118.3	12.0	12.4	109.4	110.1
T_8	114.6	121.6	12.4	12.7	110.8	111.4
SED	0.96	1.4	0.1	0.1	1.8	1.0
CD (P=0.05)	2.07	2.9	0.3	0.3	3.8	2.1

Potassium uptake: The potassium uptake by red gram was influenced by the different treatments. The highest potassium uptake of 110.8 kg ha^{-1} in 2011 and 111.4 kg ha^{-1} in 2012 were found in the treatment that received the application of 125 % recommended dose of N (31 kg of N ha^{-1}) +45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) and which was followed by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7) with a value of 109.4 kg ha^{-1} in 2011 and 110.1 kg ha^{-1} in 2012. Lowest potassium uptake was recorded in the control plot (T1) (Table-3). Highest uptake of potassium in this treatment may be achieved by the higher nitrogen uptake correspondingly increased the uptake of potassium and also this particular treatment could have increased the exchangeable and water soluble potassium and there by supply of potassium[5].

Physiological parameters: Crop growth rate: At 90 DAS-harvest stage, the Crop Growth Rate (CGR) was significantly influenced by the various agronomic management practices during both of the years of 2011 and 2012. The significantly highest CGR of 7.15 g m^{-2} day^{-1} in 2011 and 7.23 g m^{-2} day^{-1} in 2012 were recorded at 90 days after sowing at harvest stage, was observed in the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) and which was followed by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7) with a value of 6.94 g m^{-2} day^{-1} in 2011 and 7.01 g m^{-2} day^{-1} in 2012.The lowest CGR 5.86 g m^{-2} day^{-1} in 2011 and 5.91 g m^{-2} day^{-1} in 2012 were recorded in the control (T1) (Table-4). The increase might be due more leaf area and which in turn might lead to higher photosynthate accumulation and thus to increased CGR. In paddy, increases in leaf area index, photosynthesis, CGR and NAR were obtained by the application of balanced nutrient[7].

Relative Growth Rate: At 90 DAS- harvest stage, the Relative Growth Rate (RGR) was significantly influenced by the various agronomic management practices during the year of 2012. The significantly highest RGR of 0.016 g^{-1} day^{-1} in 2012 was recorded at 90 DAS-harvest stage, in the treatment of the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) and which was followed by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture (T7) with a value 0.015 g g^{-1} day^{-1} during 2012. The increase in RGR might be due to higher CGR achieved combined with higher dry matter production. In the year of 2011 the RGR was not significantly influenced by the various agronomic management practices. Soil application of any microelement improved NAR[8,9].

Table-4
Influence of various agronomic management practices on CGR, RGR and NAR at 90 days -harvest stage of red gram under alkali soil

Treatment	Crop Growth Rate (g m^{-2} day^{-1})		Relative Growth Rate (g g^{-1} day^{-1})		Net Assimilation Rate (g m^{-2} day^{-1})	
	2011	2012	2011	2012	2011	2012
T_1	5.86	5.91	0.002	0.002	1.84	1.92
T_2	6.40	6.46	0.006	0.006	2.21	2.28
T_3	6.62	6.70	0.009	0.010	2.38	2.45
T_4	6.70	6.78	0.010	0.011	2.46	2.53
T_5	6.05	6.14	0.005	0.006	2.01	2.09
T_6	6.18	6.23	0.005	0.006	2.10	2.16
T_7	6.94	7.01	0.013	0.015	2.61	2.71
T_8	7.15	7.23	0.014	0.016	2.68	2.79
SED	0.09	0.10	NS	0.001	0.06	0.07
CD (P=0.05)	0.19	0.21	0.002	0.003	0.13	0.15

Net assimilation rate: The Net Assimilation Rate (NAR) was significantly influenced by the various agronomic management practices during both the years of 2011 and 2012 at 90 DAS - harvest stage. The significantly highest NAR of 2.68 g m^{-2} day^{-1} in 2011 and 2.79 g m^{-2} day^{-1} in 2012 were recorded at 90 DAS-harvest stage, in the treatment of the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) and which was followed by the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha $^{-1}$ of TNAU micro nutrient mixture (T7) with a value of 2.61 g m^{-2} day^{-1} in 2011 and 2.71 g m^{-2} day^{-1} in 2012. The lowest value of NAR was recorded in the T_1 – control with a value of 1.84 g m^{-2} day^{-1} in 2011 and 1.92 g m^{-2} day^{-1} in 2012. The increased in leaf area observed with the application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling +12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) could have resulted in the enhanced nutrient uptake, helped in the proliferation of the leaf which is clear from increased efficiency of photosynthetic surface and higher dry matter accumulation ultimately resulting in maximum NAR[10].

Yield of pigeon pea: Significantly superior yield (426 kg ha^{-1}) was obtained in the application of 125 % recommended dose of N + 45 cm depth of sub soiling +12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) during the year of 2011. This was followed by application of 125 % recommended dose of N+ 45 cm depth of sub soiling + 12.5 kg ha $^{-1}$ of TNAU micro nutrient mixture (T7) (396 kg ha^{-1}). The lowest seed yield of 216 kg ha^{-1} was registered under control (T1) (Figure-1). In the year 2012 significantly superior seed yield of 486 kg ha^{-1} was recorded in the application of 125 % recommended dose of N+45 cm depth of sub soiling + 12.5 kg ha $^{-1}$ of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing (T8) this was followed by application of 125 % recommended dose of N + 45 cm depth of sub soiling + 12.5 kg ha $^{-1}$ of TNAU micro nutrient mixture (T7) (442 kg ha^{-1}). This may be due to that increased nutrient uptake and physiological traits which in turn resulted from more effective translocation of photosynthates from source to sink[11,12].

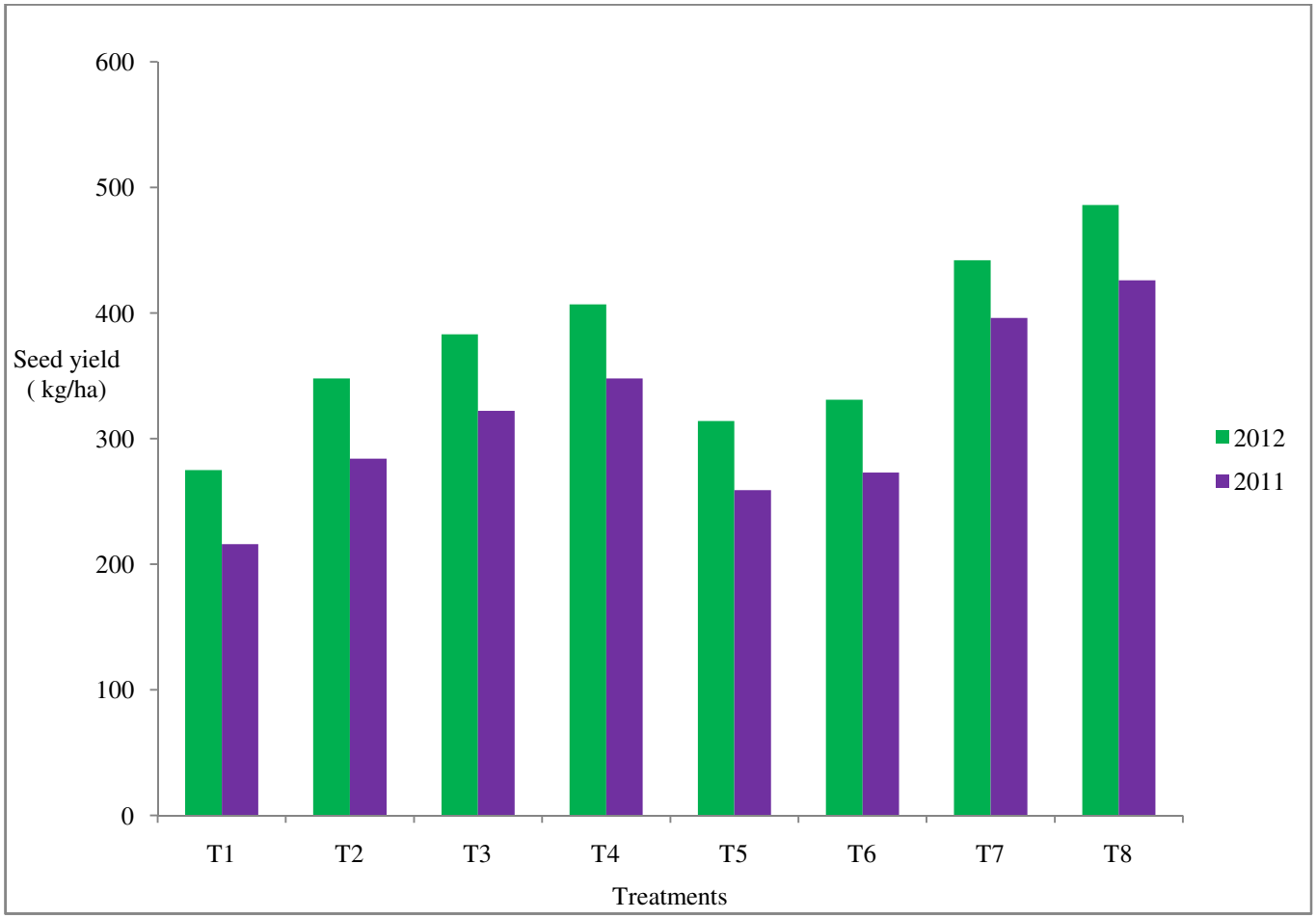

Figure-1
Effect of different agronomic practices on red gram yield under alkali soil

Conclusion

As the results of this study indicated the application of application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha^{-1} of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing has positive effect on nutrient uptake (nitrogen, phosphorus and potassium uptake), physiological parameters (CGR, RGR and NAR) and yield of red gram under alkali soil. Thus, in order to increasing the yield and physiological parameters, it can be recommended application of 125 % recommended dose of N (31 kg of N ha^{-1}) + 45 cm depth of sub soiling + 12.5 kg ha $^{-1}$ of TNAU micro nutrient mixture + green manure (daincha) incorporated at 45 days after sowing to red gram under alkali soil.

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