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Effect of Improved Agronomic Approaches on Growth and Yield of Redgram [*Cajanus cajan* (L.) Millsp.] under Rainfed Ecosystem

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ABSTRACT

Background: Redgram is an important food legume which is largely cultivated under rainfed condition. In India rainfed agriculture contributes 80% of the total pulses production and the projected requirement will be 39 million tons by 2050 which necessitates an annual growth rate of 2.2%. The productivity has to be increased from the present level of 834 kg ha^{-1} to 1200 kg ha^{-1}. With adoption of suitable agronomic management strategies the productivity could be increased to meet our demand and achieve self sufficiency in production. Hence the current study was carried out to increase the productivity of redgram under rainfed condition.

Methods: Field experiment was conducted in farmer's field in Madurai district, Tamil Nadu during North East Monsoon season of 2019 to study the effect of improved agronomic manipulations on growth and yield of redgram under rainfed ecosystem. Agronomic management approaches *viz*., nipping of primary branches at 45 and 60 days after receipt of soaking rain, high density planting at 30 cm × 30 cm in addition to recommended spacing of 60 cm × 30 cm and foliar application of 1% PPFM spray were compared with farmer's practice in the redgram variety Co (RG) 7. Pre monsoon sowing has been taken up and the rainfall received during the cropping period was 521.7 mm received in 31 rainy days.

Result: The field experimental results revealed that adoption of agronomic manipulation at the appropriate stage of the crop has increased the productivity of redgram. Nipping of primary branches at 45th day of the crop significantly increased the total number of productive branches, number of pods plant^{-1} and recorded the maximum seed yield of 1512 kg ha^{-1} (72 per cent increase over farmer's practice) under rainfed condition.

Key words: Agronomic manipulations, Rainfed ecosystem, Redgram.

INTRODUCTION

Rainfed agriculture plays a major role in Indian economy, food and livelihood security. The net sown area in India is 141.40 M ha out of which 73.20 M ha (52%) is under rainfed condition and contribute to 40% of the food grain production, 2/3rd of livestock population and 80% of the total pulse production.

Pulses are the important group of food crops considered as a protein source for both human as well as animal nutrition (Bhatt and Karim, 2009) and it play a vital role in national food and nutritional security. Globally, India is the largest producer and consumer of pulses accounting for about 25% of production, 27% of consumption and 34% of food use (Pooniya *et al*., 2015). India's population will be expected to touch 1.68 billion by 2030 and the pulses requirement will be 32 million tones with the required annual growth rate of 4.2% (Sarkar *et al*., 2018).

In India redgram [*Cajanus cajan* (L.) Millsp.] is commonly known as Tur or Arhar and it is the second most important pulse crop in the country next to chickpea. Redgram is considered as an important food legume which contains 20-22 % protein. So, it is a principle crop in South India to meet out the protein requirement of vegetarian people and hence referred as 'poor man's meat'. Redgram can fix around 40 kg ha^{-1} N (Domoguen *et al*., 2010). The deep root system of redgram breaks the hard pan of the soil hence it is known as "biological plough". Redgram have the ability to withstand the extreme drought condition and is an important rainfed pulse crop in South India. Though India contributes more than 90% of world's redgram cultivation area and production, India imports around 3.09 million tones of redgram and it contributes 6.60% share in India's import basket during 2018 (Sarkar *et al*., 2018). This is mainly because of low productivity of redgram in India.

Redgram largely cultivated in rainfed condition and farmers employ to faulty agro techniques is a reason for low productivity in India. Timely sowing of crops, optimum

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plant population and suitable agronomic practices are the main key factors to determine the crop growth and enhance the yield of rainfed crop. Rainfall is the prime source for water resource in rainfed farming. Sowing immediately after the receipt of rainfall leads to difficulties in sowing operation and reduce the availability of soil moisture during crop growth period. To avoid these difficulties pre monsoon sowing technique is adopted for rainfed farming to enhance better crop growth and yield.

Plant population plays a major role in determining dry matter production and yield of the crop. Nipping is an important agronomic approach to arrest the apical bud dominance and enhance the lateral growth which will ultimately increase the number of productive branches and ultimately yield (Reddy and Narayanan, 1987). However while practicing nipping; the time of nipping should be optimized to enhance the yield. Application of 1% Pink Pigmented Facultative Methylotroph (PPFM) increases the drought tolerance in plants and its application helps to mitigate drought occurring during crop growth period and also increase the crop yield. From the last 3 years the redgram production is declined in India due to occurrence of drought (Fig 1). The yield of rainfed redgram can be increased through improved agronomic management practices.

Considering all these factors above, the main objective of this investigation is to study the impact of improved agronomic approaches to increase the productivity of redgram under rainfed condition.

MATERIALS AND METHODS

Experimental site and soil analysis

Field experiment was designed at Department of Agronomy, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai and was carried out in a progressive farmer's field in Vadippatti Taluk of Madurai district, Tamil Nadu, India. The experiment was conducted during North East Monsoon season of 2019 to study the effect of improved agronomic manipulations on growth and yield of redgram under rainfed ecosystem. The experimental field was geographically situated between 10° 10′ N latitude and 77° 99′ E longitude with an altitude of 144 meters above the mean sea level, which will comes under the southern agro climatic zone of Tamil Nadu. The soil was sandy loam in nature with pH of 7.85. The initial soil available N, P and K were 324, 16 and 295 kg ha^{-1} respectively. The organic carbon content of the soil was 0.52%.

Experiment details

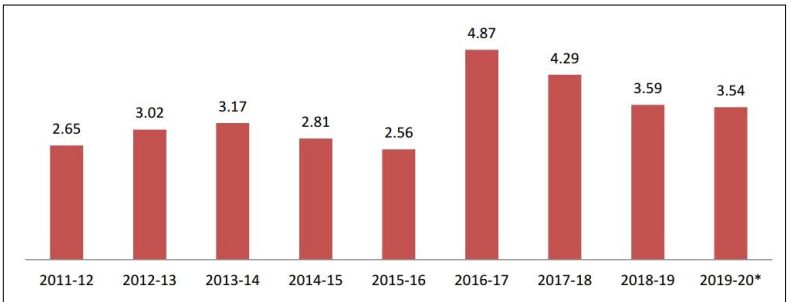
The experiment was laid out in randomized block design with three replications. The gross plot size of the experimental site was 24 m^2 (4 m × 6 m). The treatments comprised of Control (Farmer practice - T_1), Sowing at 60 cm × 30 cm (Recommended spacing - T_2), High Density Planting at 30 cm × 30 cm (T_3), Sowing at 60 cm × 30 cm + Nipping at 45 days after receipt of soaking rain (T_4), Sowing at 60 × 30 cm + Nipping at 60 days after receipt of soaking rain (T_5), Sowing at 60 × 30 cm + 1% PPFM spray (T_6), High Density Planting at 30 × 30 cm + 1% PPFM spray (T_7), Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain +1% PPFM spray (T_8), Sowing at 60 × 30 cm + Nipping at 60 Days after receipt of soaking rain +1% PPFM spray (T_9).

Agronomic practices

The test crop is redgram [*Cajanus cajan* (L.) Millsp.], a food legume. The variety used for the experimentation is Co (RG) 7. The ideal pre monsoon sowing period for the region is 35th standard week, hence the pre monsoon sowing was carried out on 31.08.2019 for all the treatments (T_1-T_9) and the crop was raised fully under rainfed condition. In sowing, broadcast was done for control (Farmer practice - T_1) and dibbling was done for remaining all other treatments (T_2-T_9). In broadcast seeds were sown randomly and in dibbling the seeds were inserted into the soil. The recommended doses of fertilizers for rainfed condition (12.5:25:12.5 kg NPK ha^{-1}) were applied in the form of urea, SSP, Muriate of potash. The entire doses of fertilizers were applied basally at the time of sowing the crop. As per TNAU Crop Production Guide 2019 all the recommended agronomic practices were followed to successfully cultivate the crop. Nipping was done manually on 45 and 60 days after receipt of soaking rain for the respective treatment plots. Foliar application of 1% PPFM was carried out at 50 per cent flowering of crop which occurs on 85 days after receipt of soaking rain in respective treatments plots.

Biometrics observation and statistical analysis

The crop was raised under rainfed condition, all growth and yield parameters were recorded. The crop was harvested



Source: Directorate of Economics and Statistics (DES). *1st Advance Estimates.

Fig 1: Production of redgram in India (million tonnes).

at its full maturity stage. The seed yield and yield attributing parameters were recorded and the economics were workout. The data on different parameters were analyzed statistically by adopting Fisher's method of ANOVA suggested by Gomez and Gomez (1984).

Rainfall distribution

The first soaking rain (15.6 mm) was received on 10.09.2019. The rainfall received during the cropping period was 521.7 mm in 31 rainy days and is presented in Fig 2. The rainfall is well distributed and the crop did not suffer any moisture stress during its entire growing period.

RESULTS AND DISCUSSION

Growth parameters

The data on plant growth parameters such as plant height, leaf area index (LAI) and dry matter production (DMP) at harvest are presented in Table 1. The results showed that significant differences were recorded in plant growth parameters due to improved agronomic manipulations on redgram grown under rainfed condition. In the present investigation significantly higher the plant height (193.5 cm) was recorded in T_3 at harvest and on par with T_7 (192.7 cm). Increased plant height was noticed in high density planting due to competition between the plants for sunlight, water and space. This similar kind of results was also observed by Nagarjun *et al.* (1980), Rasul *et al.* (2012) and Manjesh *et al.* (2019). Among the nipping treatments, T_8 recorded the significant reduction in plant height (155.6 cm) which was on par with the treatments of T_4 (157.1 cm), T_9 (160.0 cm) and T_5 (161.2 cm) respectively. Nipping of primary branches resulted reduced plant height and increased number of secondary branches compare to no nipping. This was in line with Dhaka *et al.* (2020).

The agronomic manipulations alter the plant physiology attributes such as LAI and DMP (Table 1). Significantly higher the leaf area index (5.17) at 50% flowering of the crop was recorded in T_3 which was found at par with T_7 (5.02). This can be attributed to the increased plant population. Treatments involving nipping of primary branches at 45 and 60 days significantly higher LAI (3.73) was recorded in T_4 which was found at par with T_8 (3.71), T_9 (3.54) and T_5 (3.50) compared to other treatments (T_1, T_2 and T_6). Nipping induced the lateral growth with more number of branches and subsequently recorded increased LAI values. Similar findings were reported by Sarkar and Paul (2005) in sesame and Jaidka *et al.* (2020) in soybean. Significantly higher dry matter production (5057 kg ha^{-1}) was recorded in T_3 on par with T_7 (4997 kg ha^{-1}) at harvesting stage due to higher plant populations compared to other treatments (Table 1). This

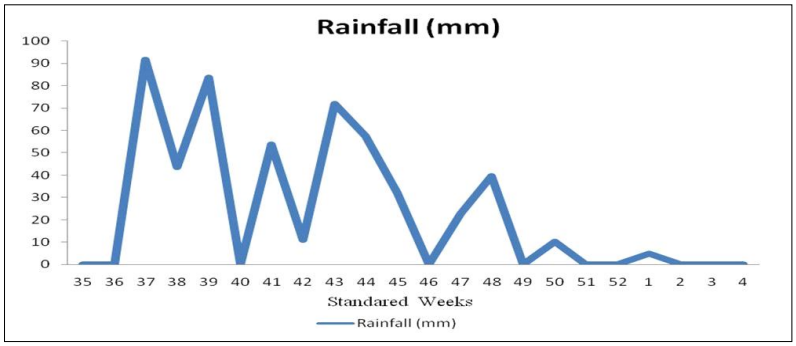


Fig 2: Rainfall received during the cropping season (2019-2020).

Table 1: Effect of improved agronomic manipulations on growth parameters.

Treatments	Plant height at harvest (cm)	LAI at 50% flowering	DMP at harvest (kg ha^{-1})
T_1 - Control (Farmer practice)	171.6	2.84	3770
T_2 - Sowing at 60 × 30 cm (Recommended)	176.4	3.23	4026
T_3 - High density planting at 30 × 30 cm	193.5	5.17	5057
T_4 - Sowing at 60 × 30 cm + Nipping at 45 Days after receipt of soaking rain	157.1	3.73	4559
T_5 - Sowing at 60 × 30 cm + Nipping at 60 Days after receipt of soaking rain	161.2	3.50	4229
T_6 - Sowing at 60 × 30 cm + 1% PPFM spray	175.9	3.32	4076
T_7 - High density planting at 30 × 30 cm + 1% PPFM Spray	192.7	5.02	4997
T_8 - Sowing at 60 × 30 cm + Nipping at 45 Days after receipt of soaking rain + 1% PPFM spray	155.6	3.71	4488
T_9 - Sowing at 60 × 30 cm + Nipping at 60 Days after receipt of soaking rain + 1% PPFM spray	160.0	3.54	4166
SEd	7.12	0.186	184.7
CD(P=0.05)	15.10	0.394	391.6

PPFM- Pink pigmented facultative methylotroph; LAI- Leaf area index; DMP- Dry matter production.

result is accordance with the earlier findings of Sathyamoorthi *et al.* (2008) in greengram.

Yield parameters

The yield parameters (Total number of productive branches plant^{-1}, number of pods plant^{-1}, pod length (cm), number of seeds pod^{-1}, 100 seed weight (g) and seed yield) were recorded and presented in Table 2. The recorded experimental results showed nipping significantly increases the number of productive branches, number of pods plant^{-1} and the seed yield over control. Among the nipping treatments, T_4 recorded significantly higher number of productive branches (16.8) which was found to be at par with T_8 (16.4). This was followed by nipping at 60 days (14.6 for T_5 and 14.3 for T_9). Lowest number of productive branches was observed in T_3 (8.4) on par with T_7 (8.7) and followed by the farmer's conventional practice of broadcasting of seeds (Table 2). At closer spacing the plants adopt for self thinning of branches and enhance the vertical growth rather than horizontal growth. This may be attributed for the increased plant height and reduced total number of productive branches in high density planting. These results are in agreement with Joshi *et al.* (2019); Rajeshkumar *et al*. (2017); Murad *et al*. (2014); Kumar and Badiyala (2005).

Treatments with nipping of primary branches at 45 days, T_4 was recorded significantly higher number of pods plant^{-1} (234.6) which was on par with T_8 (231.4). Early Nipping at 45 days increased the number of productive branches and subsequently contributed for the increased number of pods per plant and the seed yield. This was in line with Dhaka *et al*. (2020). The other yield parameters such as number of seeds pod^{-1}, 100 seed weight (g), pod length (cm) are genetic characters of the variety and are not significantly influenced by the agronomic manipulations (Table 2).

Yield

The seed yield of redgram was significantly influenced by the various agronomic manipulations. Sowing at 60 × 30 cm

Table 2: Effect of improved agronomic manipulations on yield parameters and yield.

Treatments	Total number of productive branches plant^{-1}	Number of pods plant^{-1}	No of seeds pod^{-1}	100-seed weight (g)	Pod length (cm)	Seed yield kg ha^{-1}
T_1 - Control (Farmer practice)	10.8	165.5	4.07	9.71	5.5	878
T_2 - Sowing at 60 × 30 cm (Recommended)	12.6	188.1	4.13	9.97	5.9	1103
T_3 - High Density Planting at 30 × 30 cm	8.4	156.2	4.27	10.46	6.1	1253
T_4 - Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain	16.8	234.6	4.13	10.2	6.0	1512
T_5 - Sowing at 60 × 30 cm + Nipping at 60 days after receipt of soaking rain	14.6	205.8	3.93	10.34	6.1	1295
T_6 - Sowing at 60 × 30 cm + 1% PPFM spray	12.9	189.7	4.07	9.83	6.0	1132
T_7 - High Density Planting at 30 × 30 cm + 1% PPFM spray	8.7	153.2	4.27	10.19	5.8	1209
T_8 - Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain + 1% PPFM spray	16.4	231.4	4.13	9.94	6.0	1451
T_9 - Sowing at 60 × 30 cm + Nipping at 60 days after receipt of soaking rain + 1% PPFM spray	14.3	210.6	4.07	10.25	5.9	1297
SEd	0.63	9.71	0.197	0.450	0.28	71.4
CD(P=0.05)	1.34	20.58	NS	NS	NS	151.3

PPFM - Pink Pigmented Facultative Methylotroph.

Table 3: Effect of improved agronomic manipulations on economics.

Treatments	Gross monetary return (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	B:C ratio
T_1 - Control (Farmer practice)	50901	27831	23070	1.83
T_2 - Sowing at 60 × 30 cm (Recommended)	63981	31831	32150	2.01
T_3 - High Density Planting at 30 × 30 cm	72660	35881	36779	2.03
T_4 - Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain	87710	33081	54629	2.65
T_5 - Sowing at 60 × 30 cm + Nipping at 60 days after receipt of soaking rain	75103	34331	40772	2.19
T_6 - Sowing at 60 × 30 cm + 1% PPFM Spray	65638	32781	32857	2.00
T_7 - High density planting at 30 × 30 cm + 1% PPFM spray	70108	36831	33277	1.90
T_8 - Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain + 1% PPFM spray	84183	34031	50152	2.47
T_9 - Sowing at 60 × 30 cm + Nipping at 60 days after receipt of soaking rain+ 1% PPFM spray	75211	35281	39930	2.13

PPFM- Pink Pigmented Facultative Methylotroph.

+ Nipping at 45 days after receipt of soaking rain (T_4) was resulted in significantly higher the seed yield of 1512 kg ha^{-1} and it is on par with Sowing at 60 × 30 cm + Nipping at 45 days after receipt of soaking rain + 1% PPFM spray (T_8) which recorded a seed yield of 1451 kg ha^{-1} (Table 2). The yield increase was 72 per cent over farmer's practice (T_1) (878 kg ha^{-1}). Nipping of primary branch will arrest the apical bud dominance and will induce more number of secondary branches, growth increases the accumulation of photosynthates which will ultimately increase the seed yield. Similar findings were reported by Lakshmi *et al*. (2015) and Sharma *et al*. (2003).

High density planting at 30 cm × 30 cm (T_3) recorded a seed yield of 1253 kg ha^{-1} which is 42.7 per cent and 13.5 per cent over farmer's practice (T_1) (878 kg ha^{-1}) and with recommended spacing (T_2) (1103 kg ha^{-1}) respectively. Even though the number of branches plant^{-1} and number of pods plant^{-1} were lower in high density planting compared with other treatments, it was compensated with the increased plant population. The rainfall received during the cropping period was 521.7 mm in 31 rainy days. The rainfall is well distributed and the crop did not suffer any moisture stress during its entire growing period. Hence the effect of PPFM in mitigating the drought could not be capitalized in this experiment.

Economics

Among the agronomic manipulations sowing at 60 cm × 30 cm + nipping at 45 days (T_4) recorded highest gross return of Rs. 87,710 ha^{-1}, net return of Rs. 54,629 ha^{-1} with a benefit cost ratio of 2.65 (Table 3).

CONCLUSION

From the experimental results it can be concluded that sowing at 60 cm × 30 cm + nipping at 45 days after the receipt of soaking rain (T_4) recorded the maximum seed yield and higher benefit cost ratio in redgram raised under rainfed condition.

REFERENCES

Bhat, R. and Karim, A.A. (2009). Exploring the nutritional potential of wild and underutilized legumes. Comprehensive Reviews in Food Science and Food Safety. 8(4): 305-331.

Dhaka, A.K., Kumar, S., Singh, B., Singh, K., Kumar, A. and Kumar, N. (2020). Nitrogen use efficiency, economic return and yield performance of pigeonpea [*Cajanus cajan* (L.) Millsp.] as influenced by nipping and fertility levels. Legume Research. 43(1): 105-110.

Domoguen, R.L., Saxena, K.B., Mula, M.G., Sugui, F. and Dar, W.D. (2010). The multiple uses of pigeonpea. Available at http://www.sunstar.com.ph/baguio/multiple-uses-pigeonpea.

Gomez, K.A., Gomez, A.A. (1984). Statistical Procedures for Agricultural Research with Emphasis on Rice. John Wiley and Sons, New York. pp. 680.

Jaidka, M., Deol, J.S., Kaur, R. and Sikka, R. (2020). Source-sink optimization and morpho-physiological response of soybean (*Glycine max*) to detopping and mepiquat chloride application. Legume Research-An International Journal. 43(3): 401-407.

Joshi, E., Sasode, D.S., Sikarwar, R.S., Gupta, V. and Kasana, B.S. (2019). Optimizing crop geometry and nutrient management for yield, water productivity and economics of *kharif* groundnut (*Arachis hypogaea* L.). Legume Research-An International Journal. 42(5): 676-679.

Kumar, J. and Badiyala, D. (2005). Effect of seed rate, row spacing and sowing time on yield and yield attributes of soybean. Legume Research. 28(4): 288-290.

Lakshmi, J., Gowda, R., Narayanaswamy, S. and Shivanandam, V.N. (2015). Influence of pre-flowering pinching and Maleic hydrazide spray on plant growth, seed yield and quality attributes in fenugreek. Legume Research-An International Journal. 38(3): 353-357.

Manjesh, M., Adivappar, N., Srinivasa, V. and Girijesh, G. K. (2019). Effect of plant densities and different environments on productivity and profitability of yardlong bean (*Vigna unguiculata* sub sp. sesquipedalis). Legume Research-An International Journal. 42(3): 348-353.

Murade, N.B., Patil, D.B., Jagtap, H.D. and More, S.M. (2014). Effect of spacing and fertilizer levels on growth and yield of urdbean. The Bioscan. 9(4): 1545-1547.

Nagarjun, P., Radder, G.D. and Patil, V.S. (1980). Effect of foliar application of maleic hydrazide on seed quality and seedling vigour in bunch groundnut. Seed Research. 8(2): 121-126.

Pooniya, V., Choudhary, A.K., Dass, A., Bana, R.S., Rana, K.S., Rana, D.S. and Puniya, M.M. (2015). Improved crop management practices for sustainable pulse production: An Indian perspective. Indian Journal of Agricultural Sciences. 85(6): 747-758.

Rajeshkumar, S., Durairaj, S. Nalliah and Kannan, V. (2017). Effect of crop geometry and foliar nutrition on growth and yield of irrigated blackgram (*Vigna mungo* L.). Int. J. Curr. Microbiol. App. Sci. 6(11): 4084-4094.

Rasul, F., Cheema, M. A., Sattar, A., Saleem, M. F. and Wahid, M. A. (2012). Evaluating the performance of three mungbean varieties grown under varying inter-row spacing. J. Anim. Plant Sci. 22(4): 1030-1035.

Reddy, K.B. and Narayanan, A. (1987). Dry Matter Production and Nutrient Uptake. In: Sesame (*Sesamum indicum* L.) Genotypes, The Center of Agrarian Research and Development, CIDA of Cordoba, Spain. 3: 35.

Sarkar, R.K. and Pal, P.K. (2005). Effect of crop geometry, fertility level and nipping on physiological parameters in relation to productivity of sesame (*Sesamum indicum*). Indian Journal of Agricultural Science. 75(3): 143-146.

Sarkar, S., Panda, S., Yadav, K.K. and Kandasamy, P. (2018). Pigeon pea (*Cajanus cajan*) an important food legume in india scenario- A review. Legume Research. 40(2): 1-10.

Sathyamoorthi, K, Amanullah, M.M., Vaiyapuri, K. and Somasundaram, E. (2008). Physiological parameters and yield of greengram *Vigna radiata* (L.) Wilczek as influenced by increased plant density and fertilizer levels. Indian Journal of Crop Science. 3(1): 115-122.

Sharma, A., Potdar, M.P., Pujari, B.T. and Dharmaraj, P.S. (2003). Studies on response of pigeonpea to canopy modification and plant geometry. Karnataka Journal of Agricultural Sciences. 16(1): 1-3.