LR-4935
[1-5]

RESEARCH ARTICLE

Legume Research- An International Journal, Volume Issue : ()

Evolving Promising Redgram (*Cajanas cajan* L.) Transplanting Techniques for Better Crop Establishment under Resource Constraint Dryland Areas of Southern India

R. Durai Singh[1], Syed Abul Hassan Hussainy[1], B. Bhakiyathu Saliha[1], V.K. Paulpandi[1]

10.18805/LR-4935

ABSTRACT

Background: Redgram a predominant dryland crop is vulnerable to the whims of rainfall at initial stages of crop growth. Moreover, the wider spacing promotes transplanting over conventional method but, appropriate nursery technique is yet to be standardised to prevent root coiling which leads to poor plant stand under main field conditions.

Methods: A field experiment was conducted during 2020-21 at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai to identify suitable nursery techniques for raising redgram seedlings. Redgram was raised in poly bag, 98 cone protray, 50 cone protray and high density poly ethylene (HDPE) woven fabric mat for 20 and 30 days before transplanting. The experiment was laid out in randomized block design replicated thrice.

Result: The results revealed that, raising redgram seedlings in HDPE woven fabric mat and transplanting at 20 DAS resulted in lesser root length, root volume but with lesser root coiling coefficient which is highly favourable. Moreover, after being transplanted the seedlings recorded higher plant height, leaf area index with increased photosynthetic activity, respiration andchlorophyll content. Similarly, higher yield and benefit cost ratio was attained over the conventional line sowing. Therefore, raising red gram seedlings in HDPE woven fabric mat can be considered as a cost-effective technology to attain higher yields and with the possibility to gap fill under poor seedling establishment without differential harvest maturity under the dry land tracts of southern Tamil Nadu, India.

Key words: Nursery techniques, Pro-tray, Redgram transplanting, Root coiling, Weed mat.

INTRODUCTION

Redgram (*Cajanas cajan* L.) is the most important rainfed pulse crop and a major dietary protein source grown under various cropping systems in India. Nearly 90% of the world production with nearly 20% of the pulse productivity of the country (Vanaja *et al*., 2010). In Tamil Nadu, redgram is cultivated in an area of 35,800 hectare with a production of 31,300 tonnes with an average productivity of 662 kg ha^{-1} (INDIASTAT, 2019).

Increased area and productivity under redgram must be prioritised in order to meet the demand for pulses, especially redgram, as a result of rising per capita consumption and population. But, soil moisture limitation and delayed planting due to late onset of rainfall are the major constraint in higher productivity of redgram. The economic losses due to aberrant weather conditions have discouraged farmers from further cultivation leading to decreased productivity of pulses causing aggravated malnutrition (Hussainy and Vaidyanathan, 2019).

Furthermore, expansion in the irrigated area has pushed forwarded a shift toward more profitable high yielding cereal crops which has displaced pulses production to marginal lands, consequently potential for growth of pulse area is limited (Praharaj and Blaise, 2016). Red gram has the potential to increase the productivity and is more remunerative among all pulses.

Transplanting red gram seedling will be a potential agronomic measure for enhancing the productivity under both irrigated and rainfed conditions. Transplanting is a strategy for maintaining good initial plant stand during early season wherein seedlings are raised in the nursery and transplanted in the main field after a certain age (Sajjan, 2018). In addition, the wider spacing and slow establishment at initial phase of crop growth has made transplanting essential. Healthy established seedlings pick up growth quickly under field condition and can be more competitive (Priyanka *et al*., 2013). Moreover, raising seedlings well in advance and transplanting in the field later receipt of good rains would help in better plant stand thereby reaping the benefits of early sowing with higher yield on comparison with direct sown (or) direct seeded redgram (Khadtare *et al*., 2017).

[1]Department of Agronomy, Agricultural College and Research Institute, Madurai-625 104, Tamil Nadu, India.

Corresponding Author: Syed Abul Hassan Hussainy, Department of Agronomy, Agricultural College and Research Institute, Madurai-625 104, Tamil Nadu, India. Email: thesyedhussainy@gmail.com

How to cite this article: Singh, R.D., Hussainy, S.AH., Saliha, B.B. and Paulpandi, V.K. (2023). Evolving Promising Redgram (*Cajanas cajan* L.) Transplanting Techniques for Better Crop Establishment under Resource Constraint Dryland Areas of Southern India. Legume Research. doi: 10.18805/LR-4935.

Submitted: 05-04-2022 **Accepted:** 23-02-2023 **Online:** 03-04-2023

In India, redgram seedlings are mostly raised in the polythene bags in nursery whereas in Tamil Nadu, redgram seedlings are raised in pro-tray. The failure of redgram transplanting in Tamil Nadu is due to root coiling under pro-tray nursery. Root coiling affects the absorption of nutrients and moisture from the deeper layer of the soil, consequently leads to poor establishments of seedlings in main field.

Therefore, an attempt was made to study various nursery platforms and promote an appropriate transplanting strategy to avoid root coiling coupled with better establishment under main field conditions.

MATERIALS AND METHODS

An experimental trial was conducted during 2020-21 at Central Farm, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India to evaluate different nurseries for transplanted redgram. The station is geographically located at 9°96′N and 78°20′E and 147 m above sea-level. During the crop period average minimum and maximum temperature ranged between 21.2°C to 32.1°C with RH of 69.4% and rainfall of 703.4 mm was received in 32 rainy days. The soil is sandy clay loam with 32.5%, 30.6%, 11.1% and 25.8% respectively of sand, fine sand, silt andclay respectively.

The experiment was laid out in Randomized Block Design (RBD) with nine treatments *viz*., polybag transplanting at 20 DAS and 30 DAS, 98 cone pro-tray at 20 DAS and 30 DAS, 50 cone pro-tray at 20 DAS and 30 DAS, HDPE woven fabric mat nursery at 20 DAS and 30 DAS and conventional line sowing/ dibbling (control) replicated thrice. Redgram *var*. Co (Rg) 7 was used as test variety.

In polybag nursery of size 15 × 10 cm, red soil and vermicompost (2:1 v/v) was properly mixed was filled and single seed was sown. In pro-trays, each cone of 50 cones (55 cm × 30 cm) and 98 cones (53.3 cm × 27.9 cm) were filled with coco-pith and single seed was dibbled and kept under open conditions. In HDPE woven fabric mat nursery, sheet was laid down on the ground (to prevent the penetration of roots) and used fertilizer gunny bag was placed, on which red soil and vermicompost (2:1 v/v) mix was heaped to form a raised bed of 5 cm. The seeds were sown at a spacing of 5 × 5 cm to avoid seedling competition at initial stage. Under conventional method seeds were dibbled at 45 × 30 cm under field conditions.

As per the recommendation, all seeds were treated 24 hours prior to sowing with carbendazim @ 2 g kg^{-1} of seed. Need based watering was done to all the treatment combinations, using a rose can.

Seedlings were subjected to root-based observations during transplanting to the main field which included root length (cm), root volume (cm^3), root dry weight (g) and root shoot ratio. Similarly, root coiling coefficient (RCC) was estimated based on the below formula.

$$RCC = \frac{RL \times VS}{RLd \times VSd}$$

Where,

RL = Root length under nursery (cm).

RLd = Root length of direct sown seedling.

VS = Root volume under nursery (cm^3).

VSd = Root length of direct sown seedling (cm^3).

As per treatment schedule, seedlings were transplanted to the main field. All the standard package of practices were carried out as per the crop production guide released from Tamil Nadu Agricultural University.

In each plot 5 plants were randomly tagged for recording various growth parameters *viz*., plant height (cm) and leaf area index followed by days taken for maturity (days) and yield (kg ha^{-1}). The physiological parameters *viz*., photosynthetic rate (μmol m^{-1} s^{-1}), respiration rate (μmol s^{-1}) and chlorophyll content were estimated on 5 days after transplanting (DAT) using IRGA Photo synthesis system (LCpro T).

The collected data was economically examined by using standard methods formulated by CIMMYT (1988). For each method of transplanting, partial budgeting was calculated to determine the expenses incurred and the net profit earned. The cost of cultivation (CoC) was calculated based on the present prices of all the inputs prevailing in the market during 2020 were used to calculate the partial budget and benefit cost ratio (BCR) for different transplanting methods.

Analysis of variance (ANOVA) was performed with the STAR IRRI package of released from the International Rice Research Institute, Philippines. The critical difference (CD) at 5% level of probability and P values were used to examine differences among the treatment means.

RESULTS AND DISCUSSION

Analysis of the results indicated that, higher root length (28.3 cm), root volume (54.1 cm^3) and root dry weight (1.55 g) was recorded with 50 cones pro-tray transplanted at 30 days followed by 50 cones pro-tray transplanted at 20 DAS and 98 cones pro-tray transplanted at 30 DAS. While lower root attributes were recorded with HDPE woven fabric mat transplanted at 20 DAS (10.4 cm, 24.3 cm^3, 0.73 g) and 30 DAS (11.3 cm, 26.2 cm^3, 0.77 g) for root length, root volume and root dry weight respectively (Table 1). This could be because raising seedlings under coir pith facilitates free movement (Malar *et al*., 2020) and aeration for roots (Prabhu *et al*., 2002; Krishnapillai *et al*., 2020) which might have increased the root length and root volume. Moreover, coir pith promotes faster rooting and profuse branching of roots (Singh *et al*., 2015) which thereby increases the root growth.

Root coiling coefficient assess the impact of smaller rhizosphere area on the root phenology. This evaluation could be used to standardise the transplanting media since the majority of farmers in Tamil Nadu complain about root coiling in redgram as a major factor for crop establishment after transplanting. Among the combinations evaluated in Table 1, lower root coiling coefficient was noted with HDPE woven fabric mat transplanted at 20 DAS (0.64) followed by 30 DAS (0.74) while higher RCC was noted with 50 cones pro-tray transplanted at 30 DAS (3.85) followed 98 cones pro-tray transplanted at 30 DAS (2.85) and by 50 cones pro-tray transplanted at 20 DAS (2.81). The possible reason that coir pith promotes root spiralling when placed under container nursery (Mohanan and Sharma, 2005). Due to the limited space in the pro-trays, the excessive root growth causes root coiling, which is made worse by the decreased size of the pro-trays (98 cone pro-trays). Similar root coiling issues in seedlings due to cultivation in smaller container bags have been earlier reported in crops like rubber (*Hevea Brasiliensis* Mull. Arg.) by Sumesh *et al*. (2015), Salisu *et al*. (2018) and Shobha *et al*. (2019), coffee (*Coffea arabica* L.) by Srigandha (2017) and Arjun tree (*Terminalia arjuna* Roxb.) by Nayagam and Varghese (2015).

Analysis of the transplanted crops in the main field, redgram raised under HDPE woven fabric mat transplanted at 20 DAS recorded higher plant height (128 cm), leaf area index (3.01) with a yield of 1390 kg ha^{-1} (Table 2). Similarly lower growth parameters were recorded with 98 and 50 cones pro-trays transplanted at 30 days. These results do not favour raising red gram under pro-trays either of 50 cones or 98 cones due to root coiling or root spiralling in nursery which considerably influences the establishment, anchorage andgrowth of seedlings in main field. Under these circumstances, coir pith media causes higher transplanting shock (Nayagam and Varghese, 2015) than over woven fabric mat. Moreover, root coiling is observed higher under flat bottomed, smooth walled polythene containers over which polybag nurseries are advantageous (Mohanan and Sharma, 2005).

Further the crops were analysed for the physiological aspects which revealed lower photosynthetic rate (μmol m^{-1} s^{-1}), respiration rate (μmol s^{-1}) and chlorophyll content under 98 cones pro-tray and 50 cones pro-tray irrespective of when the crop was transplanted (Fig 1a and 1b). Similarly higher values were obtained when sown under HDPE woven fabric mat followed by polybags. However, comparing the conventional (direct sown) redgram on 20 and 30 DAS, transplanting on 20 DAS was comparatively higher for all the physiological aspects over transplanting on 30 DAS. Due to root coiling, root deformity, root strangling, an incorrect root shoot ratio, a lack of lateral root development anda resultant limitation on post-planting root growth potential under containerization, the crop's photosynthetic activity and respiration may have decreased (Terblanche, 2000; Khurram, 2015).

The cost of cultivation was in support of conventional line sowing/ dibbling (Rs. 28,900) while it was followed by cultivating in HDPE woven fabric mat with lower CoC (Rs. 29,450) while 50 cones pro-tray were identified as costlier (Table 2). The economic analysis for the BCR revealed in favour of HDPE woven fabric mat with 2.83 times output per rupee invested despite this combination being costly over conventional method (2.64) due to higher yield and net return. The reduced cost of cultivation signifies that raising of

Table 1: Effect of various transplanting techniques on the root parameters and root coiling effect of redgram during transplanting.

Treatment details	Root length (cm)	Root volume (cm^3)	Root dry weight (g)	Root coiling coefficient
T_1: Polybag transplanting at 20 DAS	12.4 d	27.9 d	0.88 e	0.87 d
T_2: Polybag transplanting at 30 DAS	15.6 d	32.8 d	1.05 d	1.29 d
T_3: 98 cone pro-tray at 20 DAS	19.5 c	38.0 c	1.23 c	1.86 c
T_4: 98 cone pro-tray at 30 DAS	24.1 b	47.0 b	1.36 b	2.85 b
T_5: 50 cone pro-tray at 20 DAS	23.7 b	47.2 b	1.36 b	2.81 b
T_6: 50 cone pro-tray at 30 DAS	28.3 a	54.1 a	1.55 a	3.85 a
T_7: HDPE Woven fabric mat nursery at 20 DAS	10.4 de	24.3 de	0.73 ef	0.64 de
T_8: HDPE Woven fabric mat nursery at 30 DAS	11.3 de	26.2 de	0.77 e	0.74 de
LSD @ 5%	3.70	5.41	0.120	0.490

Table 2: Effect of various transplanting techniques on the growth, physiology, yield and economics of transplanted redgram.

Treatment details	Plant height (cm)	Leaf area index	Maturity (days)	Yield (kg ha^{-1})	CoC (USD)	Benefit cost ratio
T_1: Polybag transplanting at 20 DAS	117 b	2.79 b	123.3	1210 b	30750	2.36
T_2: Polybag transplanting at 30 DAS	116 b	2.79 b	125.7	1150 bc	30750	2.24
T_3: 98 cone pro-tray at 20 DAS	113 bc	2.72 b	125.7	1120 bc	31450	2.14
T_4: 98 cone pro-tray at 30 DAS	97.5 d	2.32 d	128.3	740 de	31450	1.41
T_5: 50 cone pro-tray at 20 DAS	106 c	2.49 c	127.0	885 cd	32300	1.64
T_6: 50 cone pro-tray at 30 DAS	96.3 d	2.34 d	124.3	830 c	32300	1.54
T_7: HDPE Woven fabric mat nursery at 20 DAS	128 a	3.01 a	125.7	1390 a	29450	2.83
T_8: HDPE Woven fabric mat nursery at 30 DAS	107 c	2.59 c	128.0	1020 c	29450	2.08
T_9: Conventional line sowing/ dibbling (Control)	119 b	2.85 b	122.7	1270 b	28900	2.64
LSD @ 5%	4.70	0.14	NS	92.0	NA	NA

NS- Not significant; NA- Not analysed.

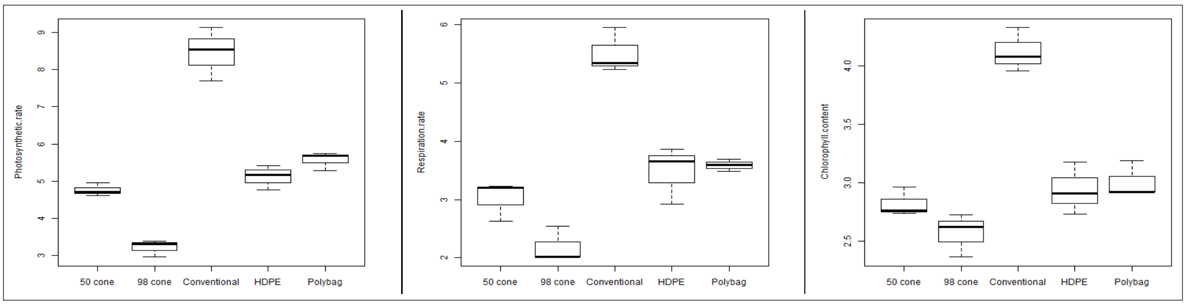

Fig 1a: Effect on the physiological characteristics of redgram at 5 DAT maintained under different nursery techniques for 20 days.

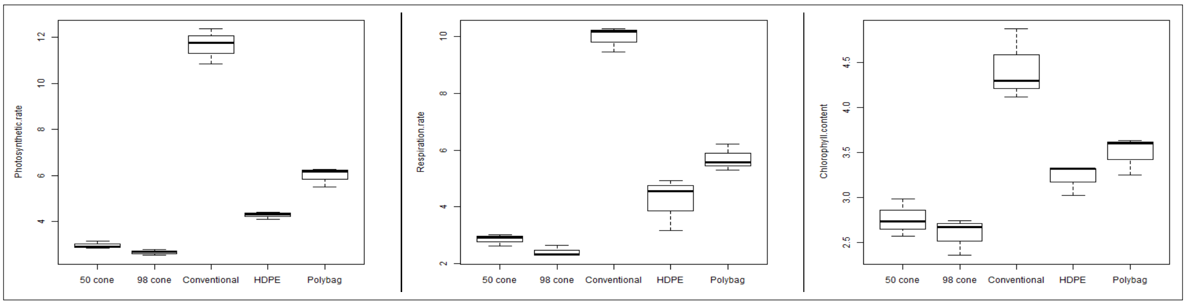

Fig 1b: Effect on the physiological characteristics of redgram at 5 DAT maintained under different nursery techniques for 30 days.

seedlings in containers under large scale should be cost effective, eco-friendly and promote easiness in transportation from nursery to main field and other planting practices.

CONCLUSION

Based on the study, it could be concluded that, raising red gram seedling under HDPE Woven fabric mat and transplanting at 20 DAS is a suitable cost-effective technology to attain higher yields for the farmers of the dry land tracts of southern Tamil Nadu, India. Moreover, this can be even used for gap filling under poor seedling establishment under dryland areas which is of major concern nowadays. Additionally, research may be done to improve the establishment of crops in dryland areas through transplantation, as improving the productivity from drylands should be the main priority to raise the overall productivity.

ACKNOWLEDGEMENT

The author(s) thank the Fund for Improvement of SandT Infrastructure (FIST) scheme (2019-2023) sponsored by the Department of Science and Technology, Government of India for laboratory and equipment support.

Conflict of interest: None.

REFERENCES

CIMMYT. (1988). An Economic Training Handbook. Economic Programme. CIMMYT, Mexico.

Hussainy, S. A. H. and Vaidyanathan, R. (2019). Relative performance of groundnut (*Arachis hypogaea*) based intercropping systems under different irrigation levels. International Journal of Agriculture and Biology. 22(5): 841-848.

INDIASTAT. (2019). Area, production and productivity of Arhar in Tamil Nadu (https://www.indiastat.com/tamil-nadu-state/data/agriculture/arhar-tur-19566/data-year/2019).

Khadtare, S.V., Takate, A.S. and Rajguru, A.B. (2017). Comparative evaluation of pigeonpea (*Cajanus cajan* L.) under different planting techniques in dryland conditions of Maharashtra. Research on Crops. 18: 35-41.

Khurram, S. (2015). Use of plastic bottles as an alternative container type for propagation of forest tree seedlings in restoration programs (Doctoral dissertation, Purdue University).

Krishnapillai, M.V., Young-Uhk, S., Friday, J.B. and Haase, D.L. (2020). Locally produced cocopeat growing media for container plant production. Tree Plant. Notes. 63: 29-38.

Malar, A., Suresh, J., Rajamani, K., and Boomiga, M. (2020). Effect of different growing media on growth and development of rooted cuttings of Indian sarsaparilla (*Hemidesmus indicus* L.). Medicinal Plants-International Journal of Phytomedicines and Related Industries. 12(1): 11-14.

Mohanan, C. and Sharma, J.K. (2005). Improvement of seedling production system in forestry sector and its impact on seedling health. Kerala for Research Institute. 11: 77-82.

Nayagam, J.R. and Varghese, K.I.M. (2015). Germination pattern and root trainer performance of *Terminalia arjuna*: A troublesome tree species in plantation trials. Open Access Library Journal. 2: e2167. http://dx.doi.org/10.4236/oalib.1102167.

Prabhu, S.R. and Thomas, G.V. (2002). Biological conversion of coir pith into a value-added organic resource and its application in agri-horticulture: Current status, prospects and perspective. Journal of Plantation Crops. 30(1): 1-17.

Praharaj, C.S. and D. (2016). Blaise. Intercropping: An Approach for Area Expansion of Pulses. Indian Journal of Agronomy. 61, no. 4th IAC Special issue S113-S121.

Priyanka, K., Suresh, S., Patil, G.M., Amrutha, H., Joshi, T. and Sunil, A., Kulkarni. (2013). Comparative analysis of transplanted and dibbled method of redgram cultivation in Bidar district of Karnataka. Karnataka Journal of Agricultural Sciences. 26(2): 238-242.

Sajjan, A.S. (2018). Response of red gram cultivars to transplanting and planting geometry under rainfed conditions of Northern dry zone of Karnataka. Indian J. Agric. Res. 52(5): 518-523.

Salisu, M.A., Sulaiman, Z., Samad, M.Y.A. and Kolapo, O.K. (2018). Effect of various types and size of container on growth and root morphology of rubber (*Hevea Brasiliensis* Mull. Arg.). IJSTR. 7: 21-27.

Singh, S., Dubey, R.K. and Kukal, S.S. (2015). Performance of cocopeat amended media mixtures on growth and flowering of chrysanthemum. Journal of Applied Horticulture. 17(3): 230-235.

Sobha, S., Rekha, K. and Uthup, T.K. (2019). Biotechnological Advances in Rubber Tree (*Hevea brasiliensis* Muell. Arg.) Breeding. In: Advances in Plant Breeding Strategies: Industrial and Food Crops (pp. 179-236). Springer, Cham.

Srigandha, D., Venkatesha, J., Shetty, G.R., Biradar, I., Manjunath, G. and Kulkarni, S. (2017). Study of suitability of containers and rooting media for growth and rooting of coffee seedlings (*Coffea arabica* cv. Chandragiri). Int. J. Curr. Microbiol. App. Sci. 6(10): 527-530.

Sumesh, K.V., Sonam, S.K., Annamalainathan, K. and Jacob, J. (2015). Physiological comparison of root trainer and polybag plants of *Hevea brasiliensis*. J. Plant. Crops. 43(3): 204-211.

Terblanche, A.L. (2000). Root development of *P. patula* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Vanaja, M., Reddy, P.R.R., Lakshmi, N.J., Razak, S.K.A., Vagheera, P., Archana, G., Yadav, S.K., Maheswari, M. and Venkateswarlu, B. (2010). Response of seed yield and its components of red gram (*Cajanus cajan* L. Millsp.) to elevated CO_2. Plant Soil Environment. 56, 10: 458-462.