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Establishment Techniques on Yield and Economics of Pigeon Pea [*Cajanus cajan* (L.)] in North Western Zone of Tamil Nadu

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ABSTRACT

Field experiments were conducted to study the effect of establishment techniques on yield and economics of red gram [*Cajanus cajan* (L.)] under irrigated condition at Regional Research Station, Tamil Nadu Agricultural University, Paiyur - 635 112, Tamil Nadu, India during *Kharif* season of 2013-14 and 2014-15 respectively in randomized block design with four replications. The treatments are line sowing/dibbling of seeds, sowing behind the country plough, sowing in polybag and transplanting at 25 and 40 DAS, sowing in portrays and transplanting in 25 and 40 DAS. The redgram variety LRG 41 was used for study. The results revealed that, dibbling of seeds in lines recorded higher grain yield of 2351 kg ha^{-1}, net income of Rs. 99495/- and B:C ratio of 3.39. Thus, dibbling of seeds in lines recorded 6% higher over sowing in poly bag and transplanting at 25 DAS and 27% higher yield over sowing behind the country plough. Considering yield and economics, line sowing seems to better option for the farmers followed by sowing in polybags and transplanted in 25 DAS. Under transplanted situation, transplanting of seedlings at 30 DAS was more suitable where the monsoon was delayed for 30 to 45 days under rainfed situation.

Key words: Dibbling seeds in lines, Labour requirement, Plough, Polybag seedlings, Protray seedlings, Redgram transplanting, Sowing behind country.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.)] is commonly known as red gram or Arhar or Tur. It is a tropical crop predominantly grown during the *Kharif* season both as a sole crop and as an intercrop. The farmers are growing redgram in marginal, less fertile and rainfed ecosystem. India accounts for 90 per cent of the pigeonpea areas and production of the world, which is grown in an area of 3.53 m ha with an annua production of 2.51 million tones with productivity of 711 kg ha^{-1}. It is mainly grown in states of Maharashtra, Uttar Pradesh, Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu and these states constitute 90 per cent of the area. It is the most important pulse crop of the Tamil Nadu having an area of 27,483 hectares with a production of 16,703 tonnes and productivity of 608 kg ha^{-1}.

The yield of pigeonpea is greatly influenced by a number of factors such as agronomic, pathogenic, entomological, and genetic and their interaction with environment. Among the different agronomic practices, the establishment techniques *viz*., direct sowing (dibbling) and transplanting are the important factors, which are limiting the yield. Though direct sowing / dibbling is a traditional practice in many crops, the transplanting techniques enable to increase the yield over direct sowing in maize (Dhane and Drennan,1997). The main objective of raising seedlings in plastic bags and transplanting in the main field is to provide optimum number of healthy vigorous seedlings when field start receiving rains. Transplanting enables optimum plant population in the field and in the nursery. It is possible to undertake pest and disease control measures very efficiently with onset of monsoon well-developed seedlings are made available which are able to utilize the soil moisture and nutrients and develop vigoursly as compare to the direct seeded plants and produce higher seed yield. During 2009-10, about 4000 hectares of area was under transplanted redgram in Bidar district (Anonymous, 2010). Direct sown pigeon pea with a spacing of 90 x 20cm recorded higher grain yield, net returns and B:C ratio over different spacing of transplanted pigeon pea(Pavan *et al*., 2009). Keeping the above facts in view an experiment was conducted to study the effect of different establishment methods on growth characteristics, yield components, seed yield and economics of red gram.

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MATERIALS AND METHODS

Field experiments were conducted to study the effect of establishment techniques on yield and economics of red gram *(Cajanus cajan)* under irrigated condition at Regional Research Station, Tamil Nadu Agricultural University, Paiyur, Tamil Nadu, India in *Kharif* seasons of 2013-14 and 2014-

15 respectively in randomized block design with four replications. The treatments were dibbling of seeds in lines (T_1), sowing behind the country plough (T_2), sowing in polybag and transplanting at 25 and 40 DAS (T_3 and T_5), sowing in portrays and transplanting in 25 and 40 DAS (T_4 and T_5). The redgram variety LRG 41 was used for study. Direct sowing of redgram was done through hand dibbling and behind the country plough as per the treatment schedule. All other cultivation practices are same for direct sown as well as transplanted redgram. Transplanting of 25 and 40 days old seedlings raised in polybag (T_3 and T_5) and protray (T_4 and T_6) nursery were done with a spacing of 150 × 60 cm. The recommended dose of NPK (25:50:25 kg ha^{-1}) was applied as basal, as well as top dressing during earthingup operation at the time of sowing/transplanting (Fig 1).

Nursery was raised in polybags as well as protray by using 1:1:1 soil mixture and cocopith respectively. Redgram sowing was taken in polythene bag size of 4 × 3 inches with 150 gauge thickness. About 11111 nos. poly bags are required to raise nursery for 1 ha. One kg of polybag contains 1620 nos. For raising seedlings for one hectare, 8 kg of polythene bags are required. Polythene bags are filled with mixture of vermicompost, soil and sand at 1:1:1 ratio. Two holes have been made at the bottom of the polbags to drain the excess water. The seeds are treated with P*seudomonas* and *Rhizobium.* Sowing was taken by using one seed per polybag. Watering was done daily by using rose can. The seedlings were kept under shade for producing healthy seedlings. About 25 and 40 days old seedlings were transplanted after removing the plastic by making incision in main field as per the treatment schedule. Protray nursery was raised by using cocopith as a medium. Each protray is having 50 cavities. For planting one hectare 222 nos of protrays were required. The seeds were sown one seed per cavity. The seedlings were transplanted on 25 and 40 days after sowing as per the treatment schedule.



Fig 1: Layout of field trial.



Fig 2: Dibbling of seeds in lines-Vegetative stage.

RESULTS AND DISCUSSION

Growth characters

A field experiment was conducted in *Kharif* seasons of 2013-14 and 2014-15. The pooled analysis was done for growth characters. The plant height was recorded at frequent intervals on 60, 90, 120, 150 and 180 DAS. Among different establishment techniques, dibbling of seeds in lines (T_1) recorded taller plants of 79.9, 137.0, 205.8, 234.1 and 251.2 cm on 60, 90, 120, 150 and 180 DAS respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded plant height of 72.2, 123.4, 197.9, 228.4 and 239.1 cm at 60, 90, 120, 150 and 180 DAS respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded lower plant height of 31.4, 82.6, 131.6, 181.6 and 205.4 cm at 60, 90, 120, 150 and 180 DAS respectively. Sowing of seeds in polybags and protrays and transplanted at 25 DAS (T_3 and T_4) recorded higher plant height as compared with sowing of seeds in polybags and protrays and transplanted at 40 DAS (T_5 and T_6) (Fig 2 and Table 1).

The yield parameters like number of pods per plant, pods weight per plant, seed weight per plant, seed recovery percentage were found highest for seedlings transplanted in inter row spacing of 150 cm.

Yield parameters

Among the different establishment techniques, dibbling of seeds in lines (T_1) recorded higher growth parameters like number of branches $plant^{-1}$ of 20.4 at harvesting stage, This was followed by sowing in poly bag and transplanting at 25 DAS (T_3) which recorded the growth parameters like number of branches $plant^{-1}$ of 18.4. Sowing of seeds behind the country plough (T_2) recorded lower number of branches $plant^{-1}$ of 14.5 at harvesting stage. Among the different establishment techniques, Dibbling of seeds in lines (T_1) recorded higher growth parameters like number of pods 1325 $plant^{-1}$. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded the growth parameters like number of pods 1266 $plant^{-1}$. Sowing of seeds behind the country plough (T_2) recorded lower number of pods $plant^{-1}$ of 876 at harvesting stage. Regarding 100 seed weight, Dibbling of seeds in lines (T_1) recorded higher 100 seed weight of 12.3 gram (Table 2).

Table 1: Effect of different establishment techniques on plant height of red gram.

Treatments	Plant height (cm)									
	60 DAS		90 DAS		120 DAS		150 DAS		180 DAS	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T_1	90.7	69.2	171.6	102.4	243.7	167.8	255.9	212.2	262.3	240.1
T_2	66.4	68.8	146.0	93.8	175.9	155.1	195.3	204.7	225.1	220.8
T_3	87.6	56.8	161.1	85.6	237.5	158.3	245.9	210.9	256.1	222.1
T_4	56.2	41.9	141.7	76.4	214.2	133.1	231.8	193.3	252.8	210.5
T_5	47.7	44.8	130.6	78.6	202.7	142.1	216.8	201.4	248.1	218.4
T_6	31.5	31.2	102.8	62.3	152.1	111.1	178.9	184.3	205.3	205.4
SEd	6.1	5.8	8.7	5.91	9.9	8.9	12.2	5.9	11.9	7.2
CD(P=0.05)	12.5	12.0	18.0	12.15	20.4	18.9	25.0	12.5	24.5	15.3

T_1 - Dibbling of seeds in lines, T_2 - Sowing behind the country plough,T_3 - Sowing in poly bag and transplanting at 25 DAS, T_4 - Sowing in protrays and transplanting at 25 DAS, T_5 - Sowing in polybag and transplanting at 40 DAS, T_6 - Sowing in protrays and transplanting at 40 DAS.

Table 2: Effect of red gram in establishment techniques on yield parameters 2013-15.

Treatments	Number of branches plant^{-1}		No. of pods plant^{-1}		100 seed weight (g)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T_1	20.2	20.6	1346.6	1302.3	12.3	12.2
T_2	14.0	14.9	908.5	842.8	11.7	11.6
T_3	17.4	18.9	1302.4	1229.5	12.3	12.1
T_4	16.4	17.5	1268.5	1168.8	12.1	11.7
T_5	18.1	18.4	1096.6	1081.3	12.1	11.9
T_6	15.9	15.8	1066.5	1074.3	11.7	11.6
SEd	1.3	1.6	92.8	89.4	0.5	0.5
CD(P=0.05)	2.7	3.3	190.7	190.4	0.9	1.0

T_1 - Dibbling of seeds in lines, T_2 - Sowing behind the country plough, T_3 - Sowing in poly bag and transplanting at 25 DAS, T_4 - Sowing in protrays and transplanting at 25 DAS, T_5 - Sowing in polybag and transplanting at 40 DAS, T_6 - Sowing in protrays and transplanting at 40 DAS.

Yield and economics (2013 -15)

The yield was recorded and economics was worked for the different establishment techniques. With respect to 2013-14, dibbling of seeds in lines (T_1) recorded higher grain and stalk yield of 2262 and 7401 kg ha^{-1} respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest grain and stalk yield of 1743 and 4720 kg ha^{-1} respectively. Dibbling of seeds in lines (T_1) recorded 5.0% higher over sowing in poly bag and transplanting at 25 DAS (T_3) and 19 % higher yield over sowing behind the country plough (T_2). Regarding economics, Dibbling of seeds in lines (T_1) recorded the highest net income and B:C ratio of Rs.94230/- and 3.3, respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded the higher net income and B:C ratio of Rs. 82495/- and 2.8 respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest net income and B:C ratio of Rs.58090/- and 2.3 respectively. Sowing of seeds in polybags and protrays and transplanted at 25 DAS (T_3 and T_4) recorded higher net income and B:C ratio as compared with sowing of seeds in polybags and protrays and transplanted at 40 DAS (T_5 and T_6).

During 2014-15, Dibbling of seeds in lines (T_1) recorded higher grain and stalk yield of 2438 and 7440 kg ha^{-1} respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest grain and stalk yield of 1509 and 4604 kg ha^{-1} respectively. Dibbling of seeds in lines (T_1) recorded 7.0% higher over sowing in poly bag and transplanting at 25 DAS (T_3) and 31.0% higher yield over sowing behind the country plough (T_2). Regarding economics, Dibbling of seeds in lines (T_1) recorded the highest net income and B:C ratio of Rs.104760/- and 3.52, respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded the higher net income and B:C ratio of Rs. 89440/- and 3.05 respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest net income and B:C ratio of Rs. 44770/- and 1.98 respectively. Sowing of seeds in polybags and protrays and transplanted at 25 DAS (T_3 and T_4) recorded higher net income and B:C ratio as compared with sowing of seeds in polybags and protrays and transplanted at 40 DAS (T_5 and T_6).

During 2014-15, dibbling of seeds in lines (T_1) recorded higher grain and stalk yield of 2438 and 7440 kg ha^{-1} respectively. Sowing of seeds in protrays and transplanting

at 40 DAS (T_6) recorded the lowest grain and stalk yield of 1509 and 4604 kg ha^{-1} respectively. Dibbling of seeds in lines (T_1) recorded 7.0% higher over sowing in poly bag and transplanting at 25 DAS (T_3) and 23.0% higher yield over sowing behind the country plough (T_2). Regarding economics, dibbling of seeds in lines (T_1) recorded the highest net income and B:C ratio of Rs.104760/- and 3.52, respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded the higher net income and B:C ratio of Rs. 89440/- and 3.05 respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest net income and B:C ratio of Rs. 44770/- and 1.98 respectively. Sowing of seeds in polybags and protrays and transplanted at 25 DAS (T_3 and T_4) recorded higher net income and B:C ratio as compared with sowing of seeds in polybags and protrays and transplanted at 40 DAS (T_5 and T_6) (Table 3).

Pooled analysis - Two seasons

Pooled analysis was done for grain yield and stalk yield. Regarding yield, dibbling of seeds in lines (T_1) recorded higher grain and stalk yield of 2351 and 7421 kg ha^{-1} respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3) which recorded the grain and stalk yield of 2220 and 6881 kg ha^{-1} respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded the lowest grain and stalk yield of 1627 and 4663 kg ha^{-1} respectively. Dibbling of seeds in lines (T_1) recorded 6% higher over sowing in poly bag and transplanting at 25 DAS (T_3) and 21% higher yield over sowing behind the country plough (T_2). Direct seeding/dibbling of seeds gave more yield as compared with polbag and portray seedlings as direct is not having transplanting shock. However, overall comparison of growth, it recorded high growth, yield parameters and yield Sunil Kumar and Jadgav (2007) recorded benefits of pigeon pea transplanting and seedling can be raised using polyethylene bags filled with soil, sand, FYM in 1:1:1 proportion recorded of seed yield 35-40 q/ha. The results are in accordance with the findings of Pavan *et al*. (2009) (Table 4).

With regard to economics, Dibbling of seeds in lines (T_1) recorded higher net income and B:C ratio of Rs.99495/- and 3.39 respectively. This was followed by sowing in poly bag and transplanting at 25 DAS (T_3), which recorded the higher net income and B:C ratio of Rs. 85967/- and 2.90 respectively. Sowing of seeds in protrays and transplanting at 40 DAS (T_6) recorded lower net income and B:C ratio of Rs. 51430/- and 2.13 respectively. Sowing of seeds in polybags and protrays and transplanted at 25 DAS (T_3 and T_4)

Table 3: Effect of different establishment techniques on yield and economics of red gram in 2013-15.

Treatments	Grain yield (kg ha^{-1})		Stalk yield (kg ha^{-1})		Gross income (ha^{-1}) (Rs)		Net income (ha^{-1}) (Rs)		B:C ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
T_1	2262	2438	7401	7440	135750	146280	94230	104760	3.3	3.52
T_2	1835	1868	5574	6070	110145	119595	68625	78075	2.7	2.88
T_3	2161	2277	6814	6948	129705	136650	82495	89440	2.8	3.05
T_4	1946	1779	6054	5659	116790	111270	71005	65485	2.6	2.43
T_5	1878	1714	5333	5118	112695	106845	65485	59635	2.4	2.26
T_6	1743	1509	4720	4604	104625	90555	58090	44770	2.3	1.98
SEd	129.8	86.4	462.3	247.4	-	-	-	-	-	-
CD(P=0.05)	266.8	184.4	950.4	527.2	-	-	-	-	-	-

T_1 - Dibbling of seeds in lines, T_2 - Sowing behind the country plough, T_3 - Sowing in poly bag and transplanting at 25 DAS, T_4 - Sowing in protrays and transplanting at 25 DAS, T_5 - Sowing in polybag and transplanting at 40 DAS, T_6 - Sowing in protrays and transplanting at 40 DAS.

Table 4: Effect of different establishment techniques on yield and economics of redgram (Two experiments) in 2013 -15.

Treatments	Grain yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	B:C ratio
T_1	2351	7421	141015	99495	3.39
T_2	1852	5822	114870	73350	2.76
T_3	2220	6881	133177	85967	2.90
T_4	1863	5857	114030	68245	2.49
T_5	1797	5226	109770	62560	2.32
T_6	1627	4663	97590	51430	2.13
SEd	109	251	-	-	-
CD(P=0.05)	233	534	-	-	-

T_1 - Dibbling of seeds in lines, T_2 - Sowing behind the country plough, T_3 - Sowing in poly bag and transplanting at 25 DAS, T_4 - Sowing in protrays and transplanting at 25 DAS, T_5 - Sowing in polybag and transplanting at 40 DAS, T_6 - Sowing in protrays and transplanting at 40 DAS.

Table 5: Particulars of labour requirement for different establishment techniques for red gram cultivation for one hectare.

Sl. No.	Particulars	Line sowing	Sowing behind country plough	Polybag tranplanting	Protray transplanting
I	Preparatory cultivation				
	Tractor ploughing	10 hrs	10 hrs	10 hrs	10 hrs
	Bund farmation	10 Nos.	-	10 Nos.	10 Nos.
II	Seeds and sowing	15 Nos.	5 Bullock pair	27 Nos.	27 Nos.
III	Manures and manuring	6 Nos.	6 Nos.	6 Nos.	6 Nos.
IV	Plant protection	6 Nos.	6 Nos.	6 Nos.	6 Nos.
V	Irrigation	25 Nos.	25 Nos.	25 Nos.	25 Nos.
VI	After cultivation	26 Nos.	26 Nos.	26 Nos.	26 Nos.
VII	Harvesting	45 Nos.	45 Nos.	45 Nos.	45 Nos.
	Total	**133 Nos.**	**108 Nos.**	**145 Nos.**	**145 Nos.**

recorded higher net income and B:C ratio as compared with sowing of seeds in polybags and protrays and transplanted at 40 DAS (T_5 and T_6). Malik Rehan (2009) found that transplanting of 28 days old seedling at a spacing of 120 cm recorded higher yield (24.3 q/ha) and net income (Rs 80565/ha. With regard to economics, transplanting of seedlings involves more cost as it has to be maintained upto 25 and 40 days respectively. The results are accordance with the findings of Pavan *et al*. (2008) and Priyanka *et al*. (2013) (Table 4).

Labour requirement

With respect to labour requirement, sowing behind the country plough ($T_{2)}$ recorded lower labour force of 108 number. as compared with other establishments as sowing of seed was taken up through country plough followed by dibbling of seedlings in lines (133 number.) (T_1). Polybag and portray establishment methods recorded higher labour force of 145 number. as it involves nursery maintenance, transporting of seedlings and digging of pits for transplanting (Table 5).

CONCLUSION

Dibbling of seeds in lines recorded higher growth and yield parameters like number of branches plant^{-1}, number of pods panicle^{-1}, number of seeds pod^{-1} and 100 seed weight resulting in higher grain yield of 2351 kg ha^{-1}, net income of Rs.99495/- and B:C ratio of 3.39. Dibbling of seeds in lines recorded 6% higher grain yield over sowing in poly bag and transplanting at 25 DAS and 27% higher grain yield over sowing behind the country plough. Dibbling of seeds in lines is suitable under irrigated condition. Sowing of seeds in polybags and transplanted in 25 DAS recorded a grain yield of 2220 kg ha^{-1}, net income of Rs. 85967/- and B: C ratio of 2.90.

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