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Effect of spacing and age of seedlings for transplanted Redgram on economics under protective irrigation for central and transitional zone Karnataka

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Abstract
A field experiment was conducted to study the influence of planting methods, geometry and age of seedlings on growth and productivity of pigeonpea at AHRS, Kathalgere, UAHS, Shivamogga, Karnataka, India, during 2017-18 and 2018-19. The experiment was laid out in randomized complete block design with twelve treatment combinations and replicated thrice. Transplanted pigeonpea at 150cm × 45cm geometry with 30 days age seedlings produced significantly higher values of plant growth parameters and pigeon pea grain yield (2515 kg ha^{-1}), gross returns (Rs. 1,30,780), net returns (Rs.90,990) and B:C (3.29) as compared to other planting geometry and age of seedlings.

Keywords: Pigeon pea, transplanting, yield

Introduction
It is well known that the crop production is unstable and at times uneconomic due to vagaries of monsoon in dry land areas of scarcity zone. Appropriate cropping systems besides meeting the varied requirements of farmer, provide stability in rainfed agriculture and improve the total productivity through better utilization of natural resource. Pigeonpea (*Cajanus cajana* L.) is one of the major grain legume crops of tropical and subtropical regions and it is grown predominantly under rainfed conditions. India accounts for 90 per cent of world's pigeonpea growing area and 85 per cent of world's production of pigeonpea. In India, it is grown in an area of 3.47 M ha with an annual production of 2.55 MT and productivity of 711 kg ha^{-1} (Anon., 2015) [1]. As a soil ameliorant, pigeonpea is known to provide several benefits to the soil in which it is cultivated. When pigeonpea is grown as a sole crop, it is relatively inefficient because of its slow initial growth rate and low harvest index (Willey *et al.*, 1980) [10]. Moreover, terminal moisture stress during reproductive stage further declines pigeonpea productivity. In order to ensure timely sowing due to late onset of monsoon and to overcome the competitive suppression of transplanting pigeonpea seedlings may be one of the agronomic measures to overcome delayed sowing. This technique involves raising of seedlings in the polythene bags in nursery and transplanting these seedlings in the main field after certain age. As established seedlings, these pick up growth quickly under field condition and can be more competitive.

Materials and Methods
The experiment was conducted at Agricultural and Horticultural Research Station, Kathalagere, University of Agricultural and Horticultural Research Station, Shivamogga, Karnataka, India, during under rainfed condition during *Kharif* (June-September) and Rabi (October - January) seasons of 2017-18 and 2018-19. During the crop growth period, a total rainfall of 643.1 mm was received which was optimum for good growth and higher yield. The soil of the experimental site is Typic Hapstaurt with pH of 6.8 and electrical conductivity of 0.18 dS m^{-1}. The soil is medium in organic carbon (0.61%) and low in available nitrogen

(358.6 kg ha^{-1}) and medium in available P (22.5 kg ha^{-1}) and available K (237 kg ha^{-1}). The experiment was laid out in a randomized complete block design involving 12 treatments in 3 replications. The details of the treatments included transplanted pigeonpea at 90 X 30 cm + 15 Days, 90 X 45 cm + 30 Days, 90 X 60 cm +45 Days,120 X 30 cm + 15 Days,120 X 45 cm + 30 Days,120 X 60 cm + 45 Days, 150 X 30 cm + 15 Days,150 X 45 cm + 30 Days, 150 X 60 cm + 45 Days,180 X 30 cm + 15 Days, 180 X 45 cm + 30 Days, 180 X 60 cm + 45 Daysplanting geometry. In order to raise seedlings of pigeonpea healthy bold treated seeds were sown in black polythene bags (size 15cm x 6cm) filled with soil and vermicompost in the last week of May. Regular watering was then done to raise the seedlings for a period of 4 weeks in the nursery. Transplanting of pigeonpea seedlings, direct sowing of pigeonpea and intercrops seeds were done at the onset of the rains during the last week of June. Marking with the help of marker was done as per the row and intra row spacing of respective treatments and at each hills small pits were opened with the help of pickaxe to a depth of 15-20 cm and then pigeonpea seedlings were transplanted after removing the polythene cover without disturbing the soil at the root zone of the pigeonpea seedling. The recommended quantity of FYM (6 t ha^{-1}) was applied two weeks before sowing and transplanting of the crop. The entire quantity of recommended dose of fertilizer for pigeonpea (25:50:0 kg N:P_2O_5:K_2O ha^{-1}) was applied in the form of urea, diammonium phosphate (DAP) and muriate of potash were applied at the time of sowing and transplanting as basal dose at 5 cm deep and 5 cm away from the seeds and seedlings, then covered with soil. Observations on growth parameters such as plant height, number of primary and secondary branches $plant^{-1}$, number of root nudules, leaf area $plant^{-1}$, leaf area index and total dry matter production were recorded on five tagged plants selected from the net plot area. Pigeonpeacrop was harvested and threshed from the net plot area and produce was dried and recorded as net plot yield from which yield per hectare was computed. Fisher's method of analysis of variance was used for analysisand interpretation of the data (Panse and Sukhatme, 1967). The level of significance used in F and t tests was P=0.05. Critical differences were calculated wherever F tests were significant.

Results and Discussion

Transplanted pigeonpea planting geometry of 150 cm × 45 cm geometry with 30 days age seedlingsrecorded significantly higher plant height (267.3 cm), number of primary branches per plant (8.49) and secondary branches per plant (26.0) as compared to planting geometry of 90 cm × 30 cmalong with 15 days age seedlings (Table 1). Same trend was followed with respect to number of primary branches per plant (8.49), secondary branches per plant (26.0). This might be due to the advantage of transplanting 3 weeks old seedlings with well-established root system and exposure of the plants to relatively longer days required for optimum growth of the plants. In addition, the vigorous root system of the transplanted seedlings improved the utilization of natural resources such as solar radiation, soil moisture, space and nutrients more efficiently. These results are in accordance with the findings of Malik (2009) [2], Praharaj *et al.* (2015) [8] and Mohanadas (2016) [4] in pigeonpea. Pavan *et al.* (2011) [6] reported that transplanted pigeonpea at 150 cm x 30 cm spacing recorded significantly higher plant height (197.00 cm). Transplanted pigeonpea at 120 cm x 90 cm row spacing recorded significantly higher number of primary branches $plant^{-1}$ (37.40) at harvest which was significantly superior when compared to 90 cm x 20 cm row spacing with dibbled pigeonpea (28.27). Similarly planting geometry of 150 cm × 45 cm geometry with 30 days age seedlingsrecorded significantly higher number of pods (1187.2), stem girth (9.92 cm), and hundred seed weight (10.04 g) as compared to planting geometry of 90 cm × 30 cm along with 15 days age seedlings (Table 2). This might be due to higher growth attributes and total dry matter productions. These findings are in conformity with the results of Goud and Andhalkar (2012). This may be attributed to better acquisition of growth resources by the well-established transplanted seedlings which ultimately reduced the intensity of competition and more nutrient extraction from deeper layers. These findings are in conformity with the findings of Poornima *et al.* (2009) [7] in transplanted pigeonpea. Murali *et al.* (2014) [3] revealed that transplanting of 5 weeks old seedlings of pigeonpea as intercrop with finger millet produced significantly higher pigeonpea plant height (177 cm) and number of primary branches $plant^{-1}$ (17.2) as compared to direct sown pigeonpea as intercrop (163 cm plant height and 9.2 primary branches).

Table 1: Effect of spacing and age of seedlings for transplanted Red gram on growth and yield parameters under protective irrigation for transitional zone Karnataka. (2017 and 2018 years Pooled data)

Treatment	Plant height (cm)	No. primary branches/pl	No. of secondary branches/pl	No. of pods/plant	Stem girth (cm)	100 Seed weight (gm)
90 X 30 cm + 15 Days	226.0	5.69	17.50	500.09	8.65	10.39
90 X 45 cm + 30 Days	237.0	6.38	18.67	729.20	8.53	9.75
90 X 60 cm +45 Days	229.1	5.71	18.83	581.93	8.28	9.74
120 X 30 cm + 15 Days	221.6	6.05	17.33	671.67	8.94	9.62
120 X 45 cm + 30 Days	232.6	6.77	17.00	758.74	8.66	9.62
120 X 60 cm + 45 Days	252.3	7.74	17.83	719.39	9.27	9.76
150 X 30 cm + 15 Days	239.1	7.28	23.50	1044.17	8.86	9.65
150 X 45 cm + 30 Days	267.3	8.49	26.00	1187.25	9.92	10.04
150 X 60 cm + 45 Days	260.5	7.99	21.33	1104.61	9.46	9.90
180 X 30 cm + 15 Days	238.1	7.79	18.67	1029.52	9.15	9.72
180 X 45 cm + 30 Days	255.5	8.06	20.00	1053.19	8.66	9.79
180 X 60 cm + 45 Days	257.0	7.41	23.00	1079.33	8.84	9.81
S.Em+	15.5	0.46	1.50	33.78	0.57	0.66
CD @5%	46.2	1.31	4.45	100.03	1.61	1.92

Table 2: Effect of spacing and age of seedlings for transplanted Redgram on economics under protective irrigation for transitional zone Karnataka. (2017 and 2018 years pooled data)

Treatment	Yield (kg/ha)	Gross return (Rs.)	Cost of cultivation	Net return (Rs.)	B:C
90 X 30 cm + 15 Days	1858	96590	37250	59340	2.59
90 X 45 cm + 30 Days	1929	100308	37725	62583	2.66
90 X 60 cm +45 Days	2000	104000	38175	65825	2.72
120 X 30 cm + 15 Days	2058	106990	38710	68280	2.76
120 X 45 cm + 30 Days	2200	114400	39540	74860	2.89
120 X 60 cm + 45 Days	1879	97708	37625	60083	2.60
150 X 30 cm + 15 Days	2020	105040	38775	66265	2.71
150 X 45 cm + 30 Days	2515	130780	39790	90990	3.29
150 X 60 cm + 45 Days	2065	107380	38840	68540	2.76
180 X 30 cm + 15 Days	2119	110188	39105	71083	2.82
180 X 45 cm + 30 Days	1998	103913	38655	65258	2.69
180 X 60 cm + 45 Days	1800	93600	36940	56660	2.53
S.Em+	66.28	1772.1		1772.1	
CD @5%	195.4	5197.3		5197.3	

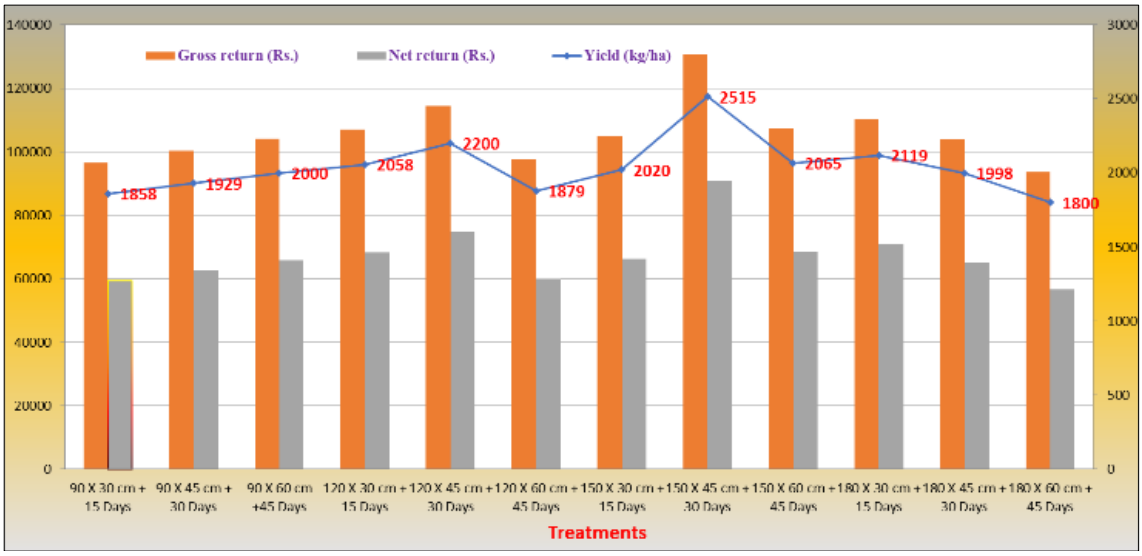

Fig 1: Effect of spacing and age of seedlings for transplanted Redgram on economics under protective irrigation for transitional zone of Karnataka

Conclusion

From the above results it can be concluded that, Transplanted pigeonpea at 150 cm × 45 cm geometry with 30 days age seedlings produced significantly higher values of plant growth parameters and pigeon pea grain yield (2515 kg ha^{-1}), gross returns (Rs. 1,30,780), net returns (Rs.90,990) and B:C (3.29) as compared to other planting geometry and age of seedlings.

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