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# Production Potential of Short Duration Red Gram [*Cajanus cajan* (L.) Millsp.] in the Southern Laterites of Kerala

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## ABSTRACT

Red gram [*Cajanus cajan* (L.) Millsp.] is a new introduction in the southern laterites of Kerala. The field experiment was laid out in factorial RBD to assess the performance of the short duration varieties of red gram, APK 1 and Vamban (Rg) 3 under two spacings (40 cm x 20 cm and 60 cm x 30 cm) and three nutrient levels (40:80:40, 30:60:30 and 20:40:20 kg NPK ha$^{-1}$) in the Instructional Farm, College of Agriculture, Vellayani, Kerala during November 2018 to March 2019. Significant variations were recorded in growth and yield attributes and among the varieties, APK 1 was found to be superior with a seed yield of 997.78 kg ha$^{-1}$. The closer spacing of 40 cm x 20 cm and the highest dose of 40:80:40 kg NPK ha$^{-1}$ recorded the significantly highest seed yields of 1195.00 kg ha$^{-1}$ and 1055.83 kg ha$^{-1}$, respectively. The three factor interaction also revealed APK 1 and Vamban (Rg) 3 to record superior seed yields at the closer spacing and higher nutrient dose. The short stature, lower branching tendency, early flowering nature and higher yields in APK 1, proved its suitability for cultivation in southern laterites of Kerala and the agronomic package would involve sowing seeds at a spacing of 40 cm x 20 cm with an NPK dose of 40:80:40 kg ha$^{-1}$.


**Key words:** Growth parameters, Nutrient levels, Red gram, Spacing, Yield, Yield attributes.

Red gram [*Cajanus cajan* (L.) Millsp.], also known as pigeon pea, arhar and tur, belonging to the family Fabaceae, is the second most important pulse crop after chickpea in India and is grown in an area of 4.19 million ha with a productivity of 785 kg ha$^{-1}$ (DACFW, 2018). The crop is very much valued for its dietary protein of 21.5 per cent, high nitrogen fixing ability and ability to withstand severe drought on account of its deep roots and osmotic adjustment in the leaves.

In Kerala, although red gram is an integral component of the diet, commercial cultivation of the crop is meagre. Introduction of the crop on a large scale calls for the standardisation of its management practices so that it can be successfully grown by the farmers of the region. Optimum plant density and spacing have significant influences on crop yields (Shah *et al.* 2014). Increased seed yield, nutrient uptake and quality in red gram with balanced application of major nutrients have been documented (Balpande *et al.* 2016). According to Sultana *et al.* (2018), planting red gram at narrow spacing (180 cm × 20 cm) and application of higher nitrogen level (60 kg ha$^{-1}$) resulted in higher seed yields. Kaur *et al.* (2018) observed that short duration varieties and efficient nutrient management practices can improve the production potential of pulses. This assumes significance in red gram as majority of the varieties grown are of long duration. It is in this background that the present study was attempted to assess the suitability and production potential of the short duration varieties of red gram under varying levels of nutrients and spacing in the southern laterites of Kerala.

The field experiment was conducted in the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram coming under the agroecological unit of southern laterites, during November 2018 to March 2019. The site is located at 8°30′ N latitude, 76°54′ E longitude and at an altitude of 29 m above mean sea level. Soil is sandy clay loam belonging to the order Ultisols with extremely acidic pH (4.21), medium organic C (0.81%), low available N (100.35 kg ha$^{-1}$), high available P (47.14 kg ha$^{-1}$) and medium available K (215.04 kg ha$^{-1}$) status. The experiment was laid out in factorial RBD (2 × 2 × 3) with three replications. The treatments comprised of three factors-two varieties ($v_1$: APK 1 and $v_2$: Vamban (Rg)3), two levels of spacing ($s_1$:40 cm × 20 cm and $s_2$: 60 cm × 30 cm) and three nutrient levels ($n_1$: 40:80:40 kg NPK ha$^{-1}$, $n_2$: 30:60:30 kg NPK ha$^{-1}$ and $n_3$: 20:40:20 kg NPK ha$^{-1}$). Lime was applied @ 850 kg ha$^{-1}$ based on soil test data and farm yard manure @ 12.5 t ha$^{-1}$ uniformly in all plots before sowing with and gap of 10 days was maintained between the applications. A seed rate of 15 kg ha$^{-1}$ was adopted and seeds were inoculated with *Rhizobium* isolated from root nodules of red gram plants grown in the farm @ 500 g per 10 kg seed. Urea, Rajphos and Muriate of Potash were used as the sources of N, P and K, respectively. The entire dose of P was applied as

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basal, N and K, in two splits, basal and 30 DAS. Cultural operations were carried out as per recommendations and the crop was harvested when the pods turned reddish brown and shedding of leaves were noticed. Threshing and winnowing were done manually to separate seeds.

The growth and yield attributes were recorded and the seeds weighed after harvest. Yield per net plot area was used to compute the per hectare yields and data were statistically analysed using the F-test (Gomez and Gomez, 1984). Critical differences were calculated wherever the treatment effects were found to be significant.

The variations exerted by the varieties, spacing and nutrient levels and their interactions on plant height and number of branches plant$^{-1}$ at 30, 60 and 90 DAS are given in Tables 1a, 1b and 1c. The tallest plants and the highest number of branches plant$^{-1}$ were observed for the variety Vamban (Rg) 3 at 60 and 90 DAS. The wider spacing $s_2$ (60 cm x 30 cm) and the nutrient level $n_3$, 20:40:20 kg NPK ha$^{-1}$ resulted in greater number of branches plant$^{-1}$. The number of branches plant$^{-1}$ recorded in nutrient level $n_3$ was on par with $n_1$ (40:80:40 kg NPK ha$^{-1}$). Among the first order interactions, $v_2s_2$ and $v_2n_3$ recorded higher values for plant height and number of branches plant$^{-1}$. In S × N interaction, $s_2n_3$ revealed taller plants at 90 DAS and the interaction, $s_2n_1$, the higher number of branches plant$^{-1}$ at 60 and 90 DAS. In V × S × N interaction, plant height was maximum in $v_2s_2n_3$ and $v_2s_2n_1$ the higher number of branches plant$^{-1}$. The values recorded in the combination $v_2s_2n_3$ were on par with $v_2s_2n_1$.

It is interpreted that the wider spacing of 60 cm × 30 cm encouraged vegetative growth resulting in production of more number of branches. The better availability of growth factors, *viz*., soil moisture, nutrients, sunlight and space under wider spacing would have contributed to the better growth. The results are in accordance with Mula *et al.* (2011).

Singh (2007) documented that application of 50 per cent RDF + 5 t FYM ha$^{-1}$ increased plant height and number of branches plant$^{-1}$ but remained at par with 10 t FYM ha$^{-1}$ and 100 per cent RDF. In the present study, the combination, Vamban variety at the dose of 20:40:20 kg NPK ha$^{-1}$ recorded taller plants, but the number of branches were higher for the highest dose.

The variations in the yield attributes presented (Table 2a, 2b and 2c) revealed the significant variations due to varieties in the number of days taken for 50 per cent flowering. APK 1 recorded early flowering (58.22 days) compared to Vamban (Rg) 3 (69.33 days). Gardner *et al.* (1988) reported that floral induction occurs in response to a specific number of favourable photo induction cycles that varies with plant species and varieties. The individual effects of spacing and nutrient levels and interactions were non-significant.

Varietal differences in the number of pods plant$^{-1}$ were not significant. However, it varied significantly with spacing and nutrient levels. Wider spacing 60 cm x 30 cm and NPK dose of 40:80:40 kg ha$^{-1}$ resulted in higher number of pods plant$^{-1}$. Amongst the first order interaction, $v_1s_2$, $v_2n_1$ and $s_2n_1$ recorded the highest number of pods plant$^{-1}$. In V × S × N interaction, $v_1s_2n_2$ recorded maximum number of pods plant$^{-1}$ (49.7). The average pod weight was significantly the highest for the variety APK 1 ($v_1$). Among V × S × N interactions, $v_1s_1n_1$ recorded the highest average pod weight (0.43 g) and $v_2s_2n_3$, the lowest (0.32 g).

The 100 seed weight was significantly higher for the variety APK 1 (9.04 g). The attribute is mostly regulated by the genetic makeup of varieties, hence the management practices of spacing and nutrient levels have no significant influence on it.

**Table 1a:** Effect of varieties, spacing and nutrient levels on plant height and number of branches plant$^{-1}$.

| Treatments | Plant height (cm) | | | Number of branches plant$^{-1}$ | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| **Varieties (V)** | | | | | | |
| $v_1$: APK 1 | 50.06 | 93.99 | 96.09 | 2.9 | 5.4 | 6.8 |
| $v_2$: Vamban (Rg)3 | 47.80 | 106.55 | 121.26 | 3.3 | 7.1 | 9.1 |
| SEm ± | 1.34 | 2.02 | 2.39 | 0.30 | 0.27 | 0.28 |
| CD (0.05) | - | 5.91 | 7.02 | - | 0.79 | 0.82 |
| **Spacing (S)** | | | | | | |
| $s_1$: 40 cm × 20 cm | 49.66 | 99.03 | 105.97 | 3.0 | 5.7 | 7.0 |
| $s_2$: 60 cm × 30 cm | 48.20 | 101.51 | 111.39 | 3.3 | 6.9 | 8.8 |
| SEm ± | 1.34 | 2.02 | 2.39 | 0.30 | 0.27 | 0.28 |
| CD (0.05) | - | - | - | - | 0.79 | 0.82 |
| **Nutrient levels (NPK) kg ha$^{-1}$** | | | | | | |
| $n_1$: 40:80:40 | 48.43 | 97.57 | 105.02 | 2.9 | 6.3 | 7.8 |
| $n_2$: 30:60:30 | 49.26 | 100.24 | 107.85 | 3.1 | 5.6 | 7.2 |
| $n_3$: 20:40:20 | 49.10 | 103.01 | 113.17 | 3.3 | 6.9 | 8.8 |
| SEm± | 1.64 | 2.47 | 2.93 | 0.37 | 0.33 | 0.34 |
| CD (0.05) | - | - | - | - | 0.97 | 1.00 |

**Table 1b:** Interaction effect of varieties, spacing and nutrient levels on plant height and number of branches plant$^{-1}$.

| Treatments | Plant height (cm) | | | Number of branches plant $^{-1}$ | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| **V × S interaction** | | | | | | |
| $v_1s_1$ | 51.85 | 95.01 | 96.49 | 3.2 | 5.0 | 6.3 |
| $v_1s_2$ | 48.27 | 92.98 | 95.69 | 2.7 | 5.8 | 7.2 |
| $v_2s_1$ | 47.47 | 103.06 | 115.44 | 2.8 | 6.3 | 7.8 |
| $v_2s_2$ | 48.14 | 110.04 | 127.09 | 3.8 | 7.9 | 10.4 |
| SEm± | 1.89 | 2.85 | 3.39 | 0.43 | 0.38 | 0.39 |
| CD (0.05) | - | 8.36 | 9.93 | - | 1.12 | 1.16 |
| **V × N interaction** | | | | | | |
| $v_1n_1$ | 50.94 | 92.77 | 94.95 | 3.2 | 5.7 | 6.9 |
| $v_1n_2$ | 49.96 | 95.31 | 95.21 | 2.6 | 4.7 | 5.9 |
| $v_1n_3$ | 49.27 | 93.91 | 98.13 | 3.0 | 6.0 | 7.4 |
| $v_2n_1$ | 45.91 | 102.37 | 115.09 | 2.7 | 6.9 | 8.8 |
| $v_2n_2$ | 48.56 | 105.17 | 120.48 | 3.5 | 6.6 | 8.3 |
| $v_2n_3$ | 48.93 | 112.12 | 128.22 | 3.6 | 7.8 | 10.2 |
| SEm ± | 2.33 | 3.49 | 4.15 | 0.52 | 0.47 | 0.48 |
| CD (0.05) | - | 10.24 | 12.16 | - | 1.37 | 1.42 |
| **S × N interaction** | | | | | | |
| $s_1n_1$ | 48.47 | 94.43 | 98.69 | 2.4 | 4.5 | 5.9 |
| $s_1n_2$ | 49.86 | 99.43 | 106.29 | 3.2 | 5.8 | 7.2 |
| $s_1n_3$ | 50.63 | 103.24 | 112.92 | 3.4 | 6.6 | 8.1 |
| $s_2n_1$ | 48.38 | 100.70 | 111.35 | 3.5 | 8.1 | 9.7 |
| $s_2n_2$ | 48.66 | 101.05 | 109.40 | 2.9 | 5.4 | 7.1 |
| $s_2n_3$ | 47.57 | 102.78 | 113.43 | 3.3 | 7.2 | 9.6 |
| SEm ± | 2.33 | 3.49 | 4.15 | 0.52 | 0.47 | 0.48 |
| CD (0.05) | - | - | 12.16 | - | 1.37 | 1.42 |

**Table 1c:** Effect of V × S × N interaction on plant height and number of branches plant$^{-1}$.

| Treatments | Plant height (cm) | | | Number of branches plant$^{-1}$ | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| $v_1s_1n_1$ | 51.41 | 91.07 | 93.13 | 3.1 | 4.5 | 5.9 |
| $v_1s_1n_2$ | 51.43 | 94.42 | 94.02 | 3.0 | 4.8 | 5.9 |
| $v_1s_1n_3$ | 52.70 | 99.55 | 102.33 | 3.5 | 5.9 | 7.0 |
| $v_1s_2n_1$ | 50.47 | 94.47 | 96.77 | 3.4 | 6.9 | 7.8 |
| $v_1s_2n_2$ | 48.50 | 96.20 | 96.40 | 2.3 | 4.5 | 6.1 |
| $v_1s_2n_3$ | 45.83 | 88.27 | 93.92 | 2.5 | 6.1 | 7.9 |
| $v_2s_1n_1$ | 45.53 | 97.80 | 104.24 | 1.8 | 4.6 | 5.9 |
| $v_2s_1n_2$ | 48.30 | 104.43 | 118.57 | 3.4 | 6.9 | 8.5 |
| $v_2s_1n_3$ | 48.57 | 106.93 | 123.51 | 3.2 | 7.4 | 9.1 |
| $v_2s_2n_1$ | 46.29 | 106.93 | 125.93 | 3.7 | 9.3 | 11.7 |
| $v_2s_2n_2$ | 48.81 | 105.90 | 122.40 | 3.7 | 6.3 | 8.2 |
| $v_2s_2n_3$ | 49.30 | 117.30 | 132.93 | 4.1 | 8.2 | 11.3 |
| SEm ± | 3.29 | 4.94 | 5.86 | 0.74 | 0.66 | 0.68 |
| CD (0.05) | - | 14.48 | 17.19 | - | 1.94 | 2.00 |

The individual effects of the treatments on seed yield were significant (Table 2a, 2b and 2c). The individual effects revealed the highest seed yield in the variety APK 1 (997.78 kg ha$^{-1}$), closer spacing (1195.56 kg ha$^{-1}$) and at nutrient level of 40:80:40 kg NPK ha$^{-1}$ (1055.83 kg ha$^{-1}$). First order interactions $v_1s_1$, $v_1n_1$ and $s_1n_1$ recorded higher seed yields. Among the V × S × N interactions, $v_1s_1n_1$ interaction showed the highest seed yield (1360.00 kg ha$^{-1}$) and it was the lowest for $v_2s_2n_3$ (603.33 kg ha$^{-1}$).

Varietal differences recorded in yield is attributed to the genetic potential of the crop while the higher yields under closer spacing is due to the higher plant density. The increase

**Table 2a:** Effect of varieties, spacing and nutrient levels on yield attributes and yield.

| Treatments | Days to 50% flowering | Average pod weight (g) | Number of pods plant$^{-1}$ | 100-seed weight (g) | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|
| **Varieties (V)** | | | | | |
| $V_1$: APK 1 | 58.22 | 0.40 | 42.7 | 9.04 | 997.78 |
| $v_2$: Vamban (Rg)3 | 69.33 | 0.34 | 42.6 | 8.08 | 915.00 |
| SEm ± | 0.25 | 0.01 | 1.22 | 0.17 | 25.00 |
| CD (0.05) | 0.73 | 0.02 | - | 0.49 | 73.34 |
| **Spacing (S)** | | | | | |
| $s_1$: 40 cm × 20 cm | 63.61 | 0.38 | 39.3 | 8.46 | 1195.56 |
| $s_2$: 60 cm × 30 cm | 63.94 | 0.37 | 46.0 | 8.66 | 717.22 |
| SEm ± | 0.25 | 0.01 | 1.22 | 0.17 | 25.00 |
| CD (0.05) | - | - | 3.58 | - | 73.34 |
| **Nutrient levels (NPK) kg ha$^{-1}$** | | | | | |
| $n_1$: 40:80:40 | 64.25 | 0.38 | 44.8 | 8.68 | 1055.83 |
| $n_2$: 30:60:30 | 63.42 | 0.37 | 40.2 | 8.37 | 938.33 |
| $n_3$: 20:40:20 | 63.67 | 0.37 | 43.0 | 8.63 | 875.00 |
| SEm± | 0.30 | 0.01 | 1.49 | 0.20 | 30.62 |
| CD (0.05) | - | - | 4.38 | - | 89.82 |

**Table 2b:** Interaction effect of varieties, spacing and nutrient levels on yield attributes and yield.

| Treatments | Days to 50% flowering | Average pod weight (g) | Number of pods plant$^{-1}$ | 100-seed weight (g) | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|
| **V × S interaction** | | | | | |
| $v_1s_1$ | 58.22 | 0.40 | 38.1 | 8.86 | 1220.00 |
| $v_1s_2$ | 58.22 | 0.39 | 47.3 | 9.22 | 775.56 |
| $v_2s_1$ | 69.00 | 0.35 | 40.4 | 8.07 | 1171.11 |
| $v_2s_2$ | 69.67 | 0.34 | 44.7 | 8.10 | 658.89 |
| SEm± | 0.35 | 0.01 | 1.73 | 0.23 | 35.36 |
| CD (0.05) | - | 0.03 | 5.07 | 0.69 | 103.69 |
| **V × N interaction** | | | | | |
| $v_1n_1$ | 58.17 | 0.42 | 44.7 | 9.24 | 1073.33 |
| $v_1n_2$ | 58.33 | 0.38 | 42.2 | 8.62 | 1016.67 |
| $v_1n_3$ | 58.17 | 0.40 | 41.3 | 9.27 | 903.33 |
| $v_2n_1$ | 70.33 | 0.34 | 44.8 | 8.13 | 1038.33 |
| $v_2n_2$ | 68.50 | 0.35 | 38.2 | 8.13 | 860.00 |
| $v_2n_3$ | 69.17 | 0.34 | 44.7 | 7.99 | 846.67 |
| SEm ± | 0.43 | 0.01 | 2.12 | 0.29 | 43.30 |
| CD (0.05) | - | 0.04 | 6.21 | 0.84 | 127.01 |
| **S × N interaction** | | | | | |
| $s_1n_1$ | 64.17 | 0.38 | 43.2 | 8.37 | 1335.00 |
| $s_1n_2$ | 63.50 | 0.36 | 34.3 | 8.28 | 1183.33 |
| $s_1n_3$ | 63.17 | 0.39 | 40.3 | 8.74 | 1068.33 |
| $s_2n_1$ | 64.33 | 0.38 | 46.3 | 8.99 | 776.67 |
| $s_2n_2$ | 63.33 | 0.38 | 46.0 | 8.47 | 693.33 |
| $s_2n_3$ | 64.17 | 0.36 | 45.7 | 8.52 | 681.67 |
| SEm ± | 0.43 | 0.01 | 2.12 | 0.29 | 43.30 |
| CD (0.05) | - | - | 6.21 | - | 127.01 |

**Table 2c:** Effect of V × S × N interaction on yield attributes and yield.

| Treatments | Days to 50% flowering | Average pod weight (g) | Number of pods plant $^{-1}$ | 100-seed weight (g) | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|
| $v_1s_1n_1$ | 58.00 | 0.43 | 41.7 | 8.85 | 1360.00 |
| $v_1s_1n_2$ | 58.33 | 0.37 | 34.7 | 8.42 | 1250.00 |
| $v_1s_1n_3$ | 58.33 | 0.42 | 38.0 | 9.32 | 1050.00 |
| $v_1s_2n_1$ | 58.33 | 0.41 | 47.7 | 9.63 | 786.67 |
| $v_1s_2n_2$ | 58.33 | 0.39 | 49.7 | 8.82 | 783.33 |
| $v_1s_2n_3$ | 58.00 | 0.39 | 44.7 | 9.21 | 756.67 |
| $v_2s_1n_1$ | 70.33 | 0.33 | 44.7 | 7.90 | 1310.00 |
| $v_2s_1n_2$ | 68.67 | 0.35 | 34.0 | 8.14 | 1116.67 |
| $v_2s_1n_3$ | 68.00 | 0.36 | 42.7 | 8.15 | 1086.67 |
| $v_2s_2n_1$ | 70.33 | 0.34 | 45.0 | 8.36 | 766.67 |
| $v_2s_2n_2$ | 68.33 | 0.36 | 42.3 | 8.11 | 606.67 |
| $v_2s_2n_3$ | 70.33 | 0.32 | 46.7 | 7.83 | 603.33 |
| SEm ± | 0.61 | 0.02 | 2.99 | 0.41 | 61.24 |
| CD (0.05) | - | 0.05 | 8.77 | 1.19 | 179.61 |

in yield due to application of NPK in higher doses may be attributed to the balanced nutrition in adequate quantities and the cumulative effect of increase in number of pods per plant, average pod weight and 100 seed weight. The results corroborate the research findings of Sharma *et al.* (2010).

## CONCLUSION

Based on the results it can be concluded that the short duration red gram varieties APK 1 and Vamban (Rg) 3 are suited for cultivation in the southern laterites of Kerala. APK 1 is a short, lesser branching but early flowering, early maturing and higher yielding variety, compared to Vamban (Rg) 3 and hence can be recommended at a spacing of 40 cm × 20 cm with an NPK dose of 40: 80: 40 kg ha$^{-1}$ for cultivation.

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