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# Influence of plant spacing and fertility levels on growth, yield and economics of long duration pigeonpea (*Cajanus cajan* L. Millsp)

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## Abstract
The field experiment entitled "Influence of Plant spacing and Fertility Levels on Growth, Yield and Economics of Long Duration Pigeonpea (*Cajanus cajan L. Millsp*)" was conducted at OilSeed Research farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. The experimental field was levelled and well drained. The soil was clay loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus, high in available potassium and moderately alkaline in reaction. The environmental conditions prevailed during experimental period was favorable for normal growth and maturity of pigeonpea crop. The experiment was laid out in Factorial RBD with four spacing and three levels of fertilizer which comprises twelve treatment combinations. Each experimental unit was replicated three times. Experiment was conducted continuously two years in *kharif*2016 and 2017 with four spacing (60x30cm$^2$, 60x45 cm$^2$, 75x30cm$^2$ and 75x45cm$^2$) and three fertility levels (RDF 75%, RDF 100% and RDF 125%) as per treatments. Crop variety "AMAR" was sown on ridges.

Significant plant height, 100 grain weight, seed yield, stalk yield, net return and benefit cost ratio were recorded with plant spacings on the basis of two years pooled data, whenever, number of branches and pod plant$^{-1}$ were found non-significant. In case of fertility levelscrop produced significant number of branches, number of pods plant$^{-1}$, 100 grain weight, seed yield, stalk yield, net return and benefit cost ratio on pooled basis. The interaction effects of plant spacings and fertilizer levels were found significant with seed yield and straw yield and also given significant net monetary returns and benefit cost ratio. On the basis of two years mean data highest seed yield (2270 kg ha$^{-1}$), stalk yield (11470 kg ha$^{-1}$), net monetary return (Rs. 44095.00 ha$^{-1}$) and B:C ratio (2.24) were recorded, it may be due to higher number of plant population and application of high fertilizer dose (125% RDF).

**Keywords:** Seed yield, stalk yield, B:C ratio and pigeonpea

## Introduction
Pigeonpea (*Cajanus cajan* L. Millsp) is the second most important pulse crop in India after chickpea. It is occupying an area of 53.2 lakh hectare with a production of 47.8 lakh tonnes with an average productivity of 898 kg ha$^{-1}$ (Pigeonpea Coordinators Report 2017-18). India had a monopoly in pigeonpea production by accounting more than 80% of the world's total production. It is one of the protein rich legume crops of semi arid and sub tropical areas, and requires more attention in view of shortage of pulses to meet out the domestic requirement. The crop has the privilege to occupying the first place both in area and production among all the *kharif* pulses. Although pigeonpea ranks sixth in area and production in the world among other grain legumes; such as beans, peas and chickpeas, its uses are more diverse than others (Nene and Sheila 1990).

Generally, the local seed are cultivated by the farmers produces low grain yield and also susceptible to pests and diseases. The high yielding newly developed varieties will prove helpful in increasing the production and productivity in state. Among the released varieties by CSA University, the Cv. Amar was found promising and higher yielding particularly in central Uttar Pradesh for sole pigeonpea cultivation. It is not only high in yield but also having resistance to sterility mosaic. Unlike in cereals, varietal breakthrough in pulses has not yet been taken place. Therefore, the productivity has not been improved as desired. Choice of suitable plant geometry (plant spacing), optimum population, fertilizer dose etc. are the most important factors to enhance productivity of pigeon pea. The low yield of pigeonpea is mainly attributed to the inadequate and imbalanced nutrient application particularly with respect to nitrogen and phosphorus. Hence, the study was undertaken to investigate the effect of fertility levels and planting geometry to increase the production and productivity of pigeonpea.

## Materials and Methods
The present field experiment was conducted during kharif season of 2016 and 17 at Oil Seed

Research farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. To study the Influence of Plant spacing and Fertility Levels on Growth, Yield and Economics of Long Duration Pigeonpea (*Cajanus cajan* L. Millsp) under irrigated condition in view of study the response of late pigeonpea to different spacing and fertilizer levels.

The experimental field was well drained and levelled. The soil of the experimental plot was sandy loam, low in organic carbon (0.45%), 196 kg ha$^{-1}$ available N, medium in available $P_2O_5$ (25.20 kg ha$^{-1}$), and available $K_2O$ (175 kg ha$^{-1}$). The soil was moderately alkaline in reaction (pH 7.8).This was observed not favourable to make the nutrient availability, because pH range 6-7 seems to favour the availability of nutrients to the plants (Brady 1988). The experiment was laid out in Factorial RBD with three replications. The treatments were consisting of two different factors; spacing and fertility levels..Four spacing (Plant Population): S1 -60×30 cm$^2$, S2-60×45cm$^2$,S3 -75×30cm$^2$ and S4 -75×45cm$^2$, and three Fertilizer levels: F1- 75% RDF, F2 -100% RDF (20:50:20:20::N:P:K:S kg ha$^{-1}$) and F3 -125% RDF.

Seed yield of plants from each net plot were harvested and threshed, then seeds were cleaned by winnowing and weight of seed per plot was recorded in kg. Before threshing, weight of sun dried total biological yield from each plot was recorded. Dried leaves were also collected and weighed from each plot to add in biological yield.

## Results and Discussion

### Effect of spacing

In study the effect of spacing on growth and yield attributes. It is observed that plant spacing have non-significant effect on plant height, number of branches plant$^{-1}$and pods plant$^{-1}$ in both years. Whenever, 100 grain weight was resulted significant in 2$^{nd}$ year. Higher Significant plant height (212.50 cm) and 100 grain weight (10.79g) was recorded with spacing S1, which was 4.10%, 2.45% and 3.63%, and 5.28%, 3.42% and 4.07% higher over S2, S3 and S4 respectively.

The spacing of 60x30 cm$^2$ was gave significantly higher seed yield (2270.83 kg ha$^{-1}$) followed by 75x30 cm$^2$ (2117.83 kg ha$^{-1}$), 75x45 cm$^2$(2103.50 kg ha$^{-1}$) and by 60x45 cm$^2$ (2076.83 kg ha$^{-1}$), which was 6.73%, 7.36% and 8.54% higher than mentioned plant spacing, respectively. It might be due to sunlight, moisture and nutrients might be readily available to the plant which promotes to increase height. Parameswari et al. (2003) and Alse, U. N. (2017) also supported the above findings. In case of number of branches, number of pod/plant and seed index significantly recorded higher resulted higher reproductive growth. These results are in conformity with the results of Patel et al. (2008). Stalk yield was recorded higher in narrow plant spacing and decreased with the increase in plant spacing. This may be happened due to height of plants and higher plant population and there was compact vegetation and dry matter accumulation, it results higher stalk yield (11470.17 kg ha$^{-1}$). These results are in conformity with the results of Santiesteban et al., (2002).

The pooled data on net monetary return and benefit: cost ratio was revealed that the S1 gave higher net monetary returns (Rs. 44095.33 ha$^{-1}$) and high benefit: cost ratio (2.24). This monetary return was recorded 14.85%, 11.03% and 11.60% higher over spacing S1, S2 and S3 respectively. This may be due to high economic yield produced by the different range of spacing and a good response of plant growth and yield attributes. These results are in conformity with the results of Chhangani (2003).

### Effect of fertility levels

The data on growth and yield attributing parameters revealed that application of 75% RDF was produced lowest plant height (204.58 cm), branches plant$^{-1}$ (20.50), pods plant$^{-1}$ (170.21), and lowest 100 grain weight (10.09g), whenever fertility level 125% RDF was produced highest plant height (210 cm), branches plant$^{-1}$ (24.75), pods plant$^{-1}$ (177.79), and 100 grain weight (10.76g), which were 2.64%, 1.84%, 4.45 and 6.64% higher over 75% RDF application, respectively.

The data on mean seed yield (2241.75 kg ha$^{-1}$), stalk yield (11321.50 q ha$^{-1}$)was recorded significantly higher with fertility level (RDF 125%), It showed that the application of RDF 125% recorded highest seed yield and stalk yield, which was found 9.22% & 9.00% higher than application of RDF 75%, and 5.12% &5.11% than RDF 100%, respectively. This can be due to higher growth and yield contributing characters with higher level of fertilizer resulted higher seed and stalk yield. These similar results are conformity with results of Okeleye and Okelana (1997).

The data on net monetary returns (Rs 42699.17 ha-1) and benefit: cost ratio (2.17) were recorded significantly higher. This might be due to application of higher levels of fertilizer, which increased the availability of nutrient to the plants, resulted in high yield ultimately increase in gross monetary returns, net monetary returns and benefit: cost ratio. These results are in agreement with the findings of Magani and Kuchinda (2009).

### Effect of interaction

Interaction effect of plant spacing and fertility levels was found significant on the basis of two years mean. Highest seed yield (2516.50kg/ha-1), stalk yield (12709.50kg/ha-1), net monetary return (51954.67 Rs./ha$^{-1}$)and B:C ratio (2.43) were also influenced significantly in interactional effect of treatment S1 (60x30 cm$^2$) with F1 (RDF 125%).Table 3.

**Table 1:** Mean seed yield, straw yield, Net monetary returnsand Benefit:Cost (B:C) ratio as influenced by various treatments.

| Treatments | Seed yield (kg ha$^{-1}$) | | | Stalk yield (kg ha$^{-1}$) | | | Net returns(Rs ha$^{-1}$) | | | B:C ratio | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spacing (S)** | **2016** | **2017** | **Pooled** | **2016** | **2017** | **Pooled** | **2016** | **2017** | **Pooled** | **2016** | **2017** | **Pooled** |
| S1-60 x 30 cm2 | 2250.67 | 2291.00 | 2270.83 | 11370.00 | 11570.33 | 11470.17 | 43390.00 | 44800.33 | 44095.33 | 2.22 | 2.26 | 2.24 |
| S2-60 x 45 cm2 | 2062.00 | 2091.67 | 2076.83 | 10413.67 | 10563.67 | 10488.67 | 36773.67 | 37813.67 | 37543.89 | 2.04 | 2.06 | 2.05 |
| S3-75 x 30 cm2 | 2102.67 | 2133.00 | 2117.83 | 10619.00 | 10772.00 | 10695.50 | 38199.00 | 39262.00 | 39230.67 | 2.08 | 2.11 | 2.09 |
| S4-75 x 45 cm2 | 2088.33 | 2118.67 | 2103.50 | 10547.00 | 10699.67 | 10623.33 | 37697.00 | 38759.67 | 38978.55 | 2.06 | 2.09 | 2.08 |
| S. Em.± | 7.97 | 11.17 | 7.56 | 97.44 | 171.05 | 94.95 | 268.63 | 391.83 | 263.55 | 0.008 | 0.013 | 0.007 |
| C.D. at 5 % | 23.53 | 32.98 | 22.32 | 287.62 | 504.91 | 280.27 | 792.93 | 1156.61 | 777.91 | 0.022 | 0.033 | 0.021 |
| **Fertily levels(F)** | | | | | | | | | | | | |
| F1-RDF 75% | 2035.25 | 2069.75 | 2052.50 | 10278.75 | 10452.75 | 10365.75 | 36586.25 | 37795.25 | 37565.92 | 2.05 | 2.08 | 2.07 |
| F2-RDF 100% | 2117.00 | 2148.00 | 2132.50 | 10694.00 | 10848.00 | 10771.00 | 38704.00 | 39788.00 | 39621.25 | 2.09 | 2.12 | 2.11 |
| F3-RDF 125% | 2225.50 | 2258.00 | 2241.75 | 11239.50 | 11403.50 | 11321.50 | 41554.50 | 42893.50 | 42699.17 | 2.15 | 2.18 | 2.17 |
| S. Em.± | 6.90 | 9.68 | 6.55 | 84.38 | 148.13 | 82.23 | 232.64 | 339.33 | 228.24 | 0.007 | 0.010 | 0.006 |
| C.D. at 5 % | 20.38 | 28.56 | 19.34 | 249.08 | 437.26 | 242.72 | 686.70 | 1001.65 | 673.74 | 0.019 | 0.029 | 0.018 |

**Table 2:** Growth and yield parameters of long duration pigeon pea as influenced by plant spacing and fertility levels.

| Treatments | Plant height (cm) | | | No. of branche$^{-1}$ | | | No. of pod plant$^{-1}$ | | | 100 grain weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spacing (S) | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled | 2016 | 2017 | Pooled |
| S1 - 60 x 30 cm2 | 211.33 | 213.66 | 212.50 | 22.78 | 23.56 | 23.17 | 176.78 | 180.00 | 178.39 | 10.67 | 10.67 | 10.79 |
| S2 - 60 x 45 cm2 | 203.00 | 204.56 | 203.78 | 20.67 | 21.44 | 21.06 | 169.78 | 173.89 | 171.83 | 10.11 | 10.22 | 10.22 |
| S3 - 75 x 30 cm2 | 206.11 | 208.44 | 207.28 | 21.89 | 22.67 | 22.28 | 172.11 | 176.56 | 174.33 | 10.33 | 10.67 | 10.42 |
| S4 - 75 x 45 cm2 | 203.78 | 205.78 | 204.78 | 22.22 | 22.89 | 22.56 | 170.33 | 174.78 | 172.56 | 10.22 | 10.56 | 10.35 |
| S. Em.± | 2.83 | 3.24 | 2.058 | 0.72 | 0.99 | 0.720 | 3.11 | 3.78 | 1.930 | 0.14 | 0.07 | 0.041 |
| C.D. at 5 % | NS | NS | 6.075 | NS | NS | NS | NS | NS | N/A | NS | 0.21 | 0.122 |
| Fertilizer levels (F) | | | | | | | | | | | | |
| F1 – RDF 75% | 203.33 | 205.83 | 204.58 | 20.17 | 20.83 | 20.50 | 168.67 | 171.75 | 170.21 | 10.08 | 10.00 | 10.09 |
| F2 – RDF 100% | 205.75 | 207.58 | 206.67 | 21.67 | 22.33 | 22.00 | 172.67 | 177.00 | 174.83 | 10.25 | 10.67 | 10.49 |
| F3 – RDF 125% | 209.08 | 210.91 | 210.00 | 23.83 | 24.75 | 24.29 | 175.42 | 180.17 | 177.79 | 10.57 | 10.92 | 10.76 |
| S. Em.± | 2.45 | 2.81 | 1.782 | 0.62 | 0.86 | 0.623 | 2.69 | 3.27 | 1.671 | 0.12 | 0.07 | 0.036 |
| C.D. at 5 % | NS | NS | NS | NS | 2.54 | 1.840 | NS | NS | 4.933 | 0.36 | 0.41 | 0.106 |

**Table 3:** Interactional effect of seed yield, stalk yield, net monetary return and B:C ratio as influenced by plant spacing and fertility levels.

| Treatments interactions | | Seed yield (kg ha$^{-1}$) | Stalk yield (kg ha$^{-1}$) | Net returns (Rs ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|---|
| S1 (60x30cm$^2$) | F1-RDF 75% | 2109.50 | 10653.50 | 39188.67 | 2.12 |
| | F2-RDF 100% | 2186.50 | 11047.50 | 41142.67 | 2.16 |
| | F3-RDF 125% | 2516.50 | 12709.50 | 51954.67 | 2.43 |
| S2 (60x45 cm$^2$) | F1-RDF 75% | 2016.00 | 10181.50 | 35911.67 | 2.03 |
| | F2-RDF 100% | 2084.00 | 10525.00 | 37545.33 | 2.05 |
| | F3-RDF 125% | 2130.50 | 10759.50 | 38424.67 | 2.06 |
| S3 (75x30 cm$^2$) | F1-RDF 75% | 2049.50 | 10350.50 | 37085.67 | 2.06 |
| | F2-RDF 100% | 2141.00 | 10812.50 | 39542.67 | 2.11 |
| | F3-RDF 125% | 2163.00 | 10923.50 | 39563.67 | 2.09 |
| S4 (75x45 cm$^2$) | F1-RDF 75% | 2035.00 | 10277.50 | 36577.67 | 2.05 |
| | F2-RDF 100% | 2118.50 | 10771.00 | 38754.33 | 2.09 |
| | F3-RDF 125% | 2157.00 | 11321.50 | 39353.67 | 2.08 |
| S. Em.± | | 13.101 | 164.456 | 456.492 | 0.012 |
| C.D. at 5 % | | 38.671 | 485.445 | 1347.485 | 0.036 |

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