Performance of Pigeonpea (Cajanus cajan L.) sown on different land configuration techniques

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Abstract
The field experiment carried out during Kharif season of 2018 and 2019 at College of Agriculture, Gwalior to evaluate the performance of pigeonpea under different land configurations. The trials involved three land configurations i.e., Flat bed (C1), Ridge and furrow (C2) and Opening of furrow after two row (C3) with 3 replications. The study revealed that among different land configurations, ridge and furrow method gave significantly higher values of all growth attributes viz., plant height (cm) and number of branches plant\(^{-1}\); yield attributes viz., number of pods plant\(^{-1}\), number of seed pod\(^{-1}\) and test weight and seed yield (kg/ha). Harvest index (%) over rest of the other treatments, respectively. Hence, it was conducted that treatment Ridge and furrow (C2) was economically feasible as compared to other methods of sowing of pigeonpea.

Keywords: Pigeonpea, land configuration, ridge and furrow, yield

Introduction
India is the world’s largest producer and consumer of a wide variety of pulses which is dominated by tropical and sub-tropical crops such as chickpea, red gram (pigeon pea), black gram, green gram (mung bean) and lentil and so on, high in protein, fiber, vitamins and also supplies of high quality carbohydrate, minerals and vitamins. The carbohydrates provided by pulses are released slowly as compared to cereals and so a high value for maintaining optimal blood sugar levels and restoring energy over a long period of time after the meals. Pulses in general are one of most sustainable crop utilizing just 359 liter of water to produce one kg of pulses, as compared with 1,802 for soybeans and 3,071 for groundnut. They also contribute to soil quality by fixing nitrogen in the soil. In India, the area under total pulses during 2017-18 was 29.36 million hectares with production of 24.51 million tones and average productivity of 835 kg ha\(^{-1}\) (Anonymous, 2017-18)\(^{[1]}\). Pulses are the rich source of protein and energy but largely cultivated under energy starved conditions, mostly on marginal and sub marginal land and more than three-fourth of the area under pulses is still rainfed resulting in poor crop productivity.

Among pulses, Pigeonpea (Cajanus cajan (L.) Millsp.) is cultivated in the semi-arid areas of topics and subtropics. It is commonly known as red gram or tur or arhar predominantly grown during Kharif. It provides protein rich food, firewood and income for resource poor small farmers. The crop owes its popularity to the fact that being a leguminous plant; it is capable of fixing atmospheric nitrogen and thereby restores nitrogen content in the soil. Its deep root system helps in extracting nutrients and moisture from deeper soil layers thus making it suitable for rainfed condition. Pigeon pea is a long duration pulse crop mainly being cultivated in poor soils under rainfed condition and the crop has capacity to thrive well under low input and adverse condition (Kumar and Paslawar 2017)\(^{[10]}\). Among the pulses it is extensively used as an important source of protein in human diet. Pigeonpea grain contains 23.3 per cent protein, 3.5 per cent minerals, and 57.6 per cent carbohydrates and provides 335 cal energy per 100g (Anonymous, 1981)\(^{[1]}\). Pigeonpea has multiple uses, besides its consumption in the form of dry split dhal the tender green seeds are used as vegetables and the stem and roots as fuel wood. In addition, it is also used for forage purpose and improves soil health through its deep strong rooting system, leaf drop at maturity and addition of nitrogen by symbiotic activities during the crop growth. Pigeonpea being an important nitrogen fixing crop can fix atmospheric N upto 200 kg N ha\(^{-1}\) (Anonymous, 2010)\(^{[2]}\). Hence, pigeonpea is often called as “Biological plough”. Extensive ground cover by pigeonpea prevents soil erosion by wind and water, encourages infiltration of rain water and smothers the weeds.

Pigeonpea is the fifth prominent legume crop in the world and ranked second after chickpea in India in terms of area and production. The major pigeonpea growing states in India are Maharashtra, Madhya Pradesh, Karnataka, Gujrat and Andhra Pradesh.
In India, the area under pigeonpea during 2017-18 was 4.46 million hectares with production of 4.18 million tones and average productivity of 937 kg ha⁻¹. In Madhya Pradesh the area was 6.47 lakh hectares with production of 8.39 lakh tones (Anonymous, 2017-18) [3]. In recent years, uncertainties in rain water availability, the swings in the onset, continuity and withdrawal pattern of monsoon has made crop production more risky in rainfed areas (Singh, 2000) [14]. Under these circumstances efficient rain water management practices acts as insurance for crops during abnormal rainfall situation. For getting a sustainable crop production system under rainfed condition, the conservation of rain water and its efficient recycling are imperative. The rain water can be conserved either in situ or ex-situ in natural or manmade structures for supplemental irrigation. In-situ rain water conservation can be carried out either through tillage or land surface management (Singh and Singh, 2015). Among the various land surface management practices ridges and furrow, broad bed furrow, tied ridges and furrow are very promising in controlling surface runoff, reducing the soil loss through erosion and increasing infiltration. On this backdrop there is need to evolve an appropriate agro-technology for successful cultivation of pigeonpea that result in efficient rain water conservation through various land configuration techniques. Keeping the above fact in view the present investigation on the effect of different land configuration techniques on growth, yield and yield attributes on pigeonpea crop.

**Materials and Methods**

The field experiment was conducted during Kharif 2018 and 2019 at the College of Agriculture, Gwalior (M.P.). The soil of the experimental field was sandy clay loam. Soil of the experimental field was rich in potash content but low in organic carbon, available nitrogen and medium in available phosphorus contents. It is slightly alkaline in reaction and had moderate cation exchange capacity. The experiment was conducted in Split plot design with three number of replications. Treatment consisting of Flat bed, Ridge and Furrow, Opening of furrow after two row. Pigeonpea variety “ICPL 88039” was sown on 1st August 2018 and 1st August 2019 at spacing of 45cm x 15cm using seed rate of 20kg/ha and fertilized with 20:50:20 NPK kg/ha, respectively as basal dose. The harvesting was done manually with the help of sickle, when the crop attained full maturity. The produce of a square meter from five randomly selected place of each plot was tied into bundle and allowed to sun drying in respective plots. The harvested bundles were weighed with the help of balance and transported to threshing floor. Threshing of produce of each plot was done separately by beating with wooden sticks; the seeds were then cleaned manually and weighed.

The plant height was measured from ground level upto growing tip of plant at harvest from five randomly selected one square meter place and then average worked out. The number of branches plant⁻¹, number of pods plant⁻¹, number of seeds pod⁻¹ were counted at harvest from one square meter randomly selected spot and the mean number were computed. A random sample of 1000 seeds was taken from the seed produce, counted and its weight was recorded. Seed yield of a square meter of each plot was noted down, after threshing, winnowing and drying and calculated in kg ha⁻¹. Straw yield was obtained by deducting the seed yield from the weight of total dry produce (biological yield) of respective plot and calculated in kg ha⁻¹. The figure of biological yield was calculated by summing seed yield and straw yield. Finally it was converted on hectare basis.

**Harvest Index** is the ratio of economic yield to the total biological yield. Harvest index reflects the proportion of assimilate distribution between economical and total biomass. It is computed by the following formula.

\[
\text{Harvest index (HI)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100
\]

**Result and Discussion**

Different land configuration practices for pigeonpea cultivation had significant effect on plant height, number of branches plant⁻¹, number of pods plant⁻¹, number of seeds pod⁻¹, test weight(g), seed yield, straw yield and harvest index during the year of experimentation (Table 1 & 2).

**Effect on plant height (cm)**

Among different land configuration practices for pigeonpea cultivation have significant effect on length of plants and were presented in Table(1). Cultivation of pigeonpea with ridge and furrow treatment method produced tallest plants (169.76 &165.46 cm) which was at par with the treatment opening of furrow after two rows (166.50 &164.65 cm) was found significantly superior over flat bed (156.35 &154.96 cm) respectively, during both the years. This might be due to favorable seed bed, aeration, more conservation of water in ridge and furrow and initial vigorous growth resulted in more plant height of the crop. These results are confirm the findings of Indapuganti et al., (2007) [4], Kalokhe (2010) [7], Sathe (2015) [13] and Kumar et al., (2012) [8].

**Effect of number of branches plant⁻¹**

The data on number of branches plant⁻¹ under various land configuration treatments was presented in Table (1). Results revealed that all the treatments differ statistically significant from each other. However, the highest number of branches plant⁻¹ (15.33 &15.16) was found with crop sown with ridge and furrow method which was statistically at par with the treatment opening of furrow after two rows (14.96 &14.41) and was found significantly superior over flat bed (12.70 &12.82) respectively, during both the years. This might be due to the more plant height and vegetative growth of the plants grown on ridge and furrow. Moreover, the space available for side rows on ridge and furrow was more than that of flat bed system. Similar results were obtained by Kalokhe (2010) [7], Kumar et al., (2012) [8], Pandey et al., (2014) [11]. Sathe (2015) [13] also reported that significantly higher plant height, more number of branches and dry matter production in ridge and furrow as compared to Flat bed planting.

**Effect on number of pods plant⁻¹**

As far as data on number of pods plant⁻¹ is concerned, all the treatments regarding land configuration practices of pigeonpea cultivation differ significantly with each other and was presented in Table(1). Results revealed that highest number of pods plant⁻¹ (94.39 & 89.33) was recorded in crop sown with ridge and furrow method which were at par with the treatment opening of furrow after two rows (89.67 & 85.33) and was found superior over flat bed method (84.94 & 73.17) respectively, during both the years. Increase in number of pods plant⁻¹ due to proper growth of crop, which might have resulted in greater translocation of food material to the reproductive part, which also reflected towards superiority in yield attributing characters. Pandey et al.,(2014) [11] also
reported similar results in which they stated that significantly higher yield attributes like number of pods plant\(^{-1}\) and seed yield of pigeon pea was found superior with raised bed as compare to flat bed.

The results are in confirmation with Kantwa et al., (2005)\(^9\), in which they conducted the experiment on effect of land configuration on performance of pigeon pea and reported that Broad bed furrow improved the yield attributes (pods\(^{-1}\) and seed\(^{-1}\)) of pigeon pea over flat planting.

**Effect on number of seeds pod\(^{-1}\)**
Various land configuration practices has a significant effect on number of seeds pod\(^{-1}\) of pigeon pea was presented in Table (1). Highest number of filled seed pod\(^{-1}\) (3.92 & 3.87) was recorded with crop sown in ridge and furrow method which was at par with the treatment opening of furrow after two rows (3.70 &3.78) and was found statistically superior over flat bed (3.37 &3.33). The higher growth attributes followed by more synthesis and translocation of food material to the source might have resulted in more number of seed per pods. The effect of land configurations on yield attributes are in line with the reports of Kantwa et al., (2005)\(^9\) reported that Broad bed furrow improved the yield attributes (pods/plant and seed/pod) of pigeon pea over flat planting.

**Effect on test weight (g)**
In regard with effect of different land configuration techniques for pigeon pea cultivation on test weight, heavier seeds (102.89 & 100.83 g) was recorded with crop sown in ridge and furrow method which was at par with the treatment opening of furrow after two rows (102.83 & 97.78 g) and was found significantly superior over flat bed (97.44 & 92.17 g ) and was presented in Table (1). The overall better growth, development with the support of conserved soil moisture might have reflected in higher test weight plant\(^{-1}\).

Kumar et al., (2012)\(^8\) from Indian Agricultural Research Institute, New Delhi also found that, there is a significant improvement in yield attributes and yield component under BBF and paired row planting over uniform row planting. Pandey et al., (2014)\(^11\) also find similar results and reported that significantly higher values of yield attributes and seed yield of pigeon pea was

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Number of branches plant(^{-1})</th>
<th>Number of pods plant(^{-1})</th>
<th>Number of grains pod(^{-1})</th>
<th>Test weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1- Flat bed</td>
<td>156.35 &amp; 154.96</td>
<td>12.70 &amp; 12.82</td>
<td>84.94 &amp; 73.17</td>
<td>3.37 &amp; 3.33</td>
<td>97.44 &amp; 92.17</td>
</tr>
<tr>
<td>C2- Ridge and furrow</td>
<td>169.76 &amp; 165.46</td>
<td>15.33 &amp; 15.16</td>
<td>94.39 &amp; 89.33</td>
<td>3.92 &amp; 3.87</td>
<td>102.89 &amp; 100.83</td>
</tr>
<tr>
<td>C3- Opening of furrow after two rows</td>
<td>166.50 &amp; 164.65</td>
<td>14.96 &amp; 14.41</td>
<td>89.67 &amp; 85.33</td>
<td>3.70 &amp; 3.78</td>
<td>102.83 &amp; 97.78</td>
</tr>
<tr>
<td>S.E.(m)(\pm)</td>
<td>2.065 &amp; 1.906</td>
<td>0.345 &amp; 0.275</td>
<td>1.714 &amp; 1.767</td>
<td>0.088 &amp; 0.085</td>
<td>1.157 &amp; 1.418</td>
</tr>
<tr>
<td>C.D.(P&lt;0.05)</td>
<td>8.108 &amp; 7.483</td>
<td>1.353 &amp; 1.079</td>
<td>6.729 &amp; 6.938</td>
<td>0.344 &amp; 0.333</td>
<td>4.544 &amp; 5.566</td>
</tr>
</tbody>
</table>

**Effect on Seed yield and straw yield (kg ha\(^{-1}\))**
Effect of different land configuration techniques for pigeon pea cultivation on seed and straw yield was presented in Table (2). The results showed that all treatments differ significantly from each other. Ridge and furrow method recorded statistically significant highest seed yield (1774.07 & 1661.42 kg ha\(^{-1}\)) and straw yield (5473.15 &5304.63 kg ha\(^{-1}\)) which was at par with the treatment opening of furrow after two rows and was found superior over flat bed method. This might be due to more favoured overall growth and yield attributing characters due to favourable seed bed, better aeration, scope for more space benefit of more conserved moisture in furrows and its support at critical growth stages like pod initiation and development. This result correlate with the work of Jaypaul (1996)\(^3\), Jain et al., (2000)\(^6\) and Raut et al., (2000)*\(^12\)*.

The capacity of plants to produce seed yield depends not only on the size of photosynthetic systems, it’s efficiently and length of time for which it is active but also on translocation of dry matter into economic sink. Higher seed yield under these treatments was due to the highest branches plant\(^{-1}\), pods plant\(^{-1}\), seed pod\(^{-1}\), and test weight resulted in higher dry matter production, high growth in terms of LAI, which resulted in higher production of photosynthesis, which acts as a source and greater translocation of food materials to the reproductive parts resulted in superiority of yield attributing characters and ultimately highest yield.

**Effect on Harvest Index (%)**
Harvest index reflects the proportion of assimilate distribution between economical and biological. Under different land configurations technique for cultivation of pigeon pea, maximum harvest index (24.42 & 23.83%) was recorded with crop sown with ridge and furrow method which was at par with the treatment opening of furrow after two rows (23.87 & 23.45%) over treatment of flat bed (23.15 &23.23%).

Based on two year study it could be concluded that sowing of pigeon pea in ridge and furrow found to be effective and achieve higher seed yield, straw yield and yield attributing characteristics like plant height, number of branches plant\(^{-1}\), number of pods plant\(^{-1}\), number of seeds pod\(^{-1}\), test weight and harvest index than any other techniques.

**Conclusion**
It was concluded from the study that crop planted on ridge and furrow method with proper production technology gives good yield as well as economically feasible as compared to other methods of sowing of pigeon pea.
References