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Field Evaluation of Different Land Configuration Techniques for Pigeonpea (*Cajanus cajan* L.)

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A B S T R A C T

The present investigation was conducted during *Kharif* season of year 2017 at farmers field of Raipur district of Chhattisgarh Plains to find out effect of different land configuration techniques for pigeonpea cultivation on growth, yield and yield attributes on pigeonpea crop. All treatment had significant effect on growth, yield and yield attributing characters like plant height, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 100 seed weight, seed yield, straw yield and harvest index. T_1 –ridge and furrow method with 90 x 20 cm spacing resulted in higher plant height (182.98 cm), number of branches plant^{-1} (17.97), number of pods plant^{-1} (147.67), number of seeds pod^{-1} (3.55), 100 seed weight (10.24 g), seed yield (16.91 q ha^{-1}), straw yield (44.31 q ha^{-1}) and harvest index (27.62 per cent), respectively and was found superior over rest of the treatments, which was followed by T_2 – flat bed method of spacing 90 x 20 cm and T_3 – flat bed method of spacing 60 x 20 cm. The minimum value of all above growth, yield and yield attributing characters was associated with crop sowing with broadcast method.

Introduction

India is major pulse growing country. The pulses are integral part of cropping system all over the country. Pulses are considered as lifeblood of agriculture because they occupy a unique position in every known system of farming as a main, catch, cover, green manure, intercrop, relay and mixed crop. It finds an important place in the farming systems adopted by small and marginal farmers in a large number of developing countries as it restores the soil fertility by fixing atmospheric nitrogen. Thus pulses play a vital role in providing protein rich food to human beings and in sustaining both soil health and crop production on long-term basis. India has the distinction of being the largest producer of pulses in the world, accounting for 37 per cent of the area and 27 per cent of the world's production. Further, 90 per cent of the total global pigeonpea, 65 per cent of chickpea and 37 per cent of lentil area falls in India with corresponding production of 93, 68 and 32 per cent of the global production, respectively (Lal *et al.,* 1996).

Even though India has largest area under cultivation of pulses, productivity is far lower than that of developed countries like China. United Nations organization (UNO) has also declared 2016 as International Year of Pulses to increase the overall productivity of pulses around the globe.

Pigeon pea, commonly known as redgram or tur or arhar [*Cajanus cajan* (L.) Millsp.], is the second most important pulse crop after chickpea in India. It is one of the important legume crops of tropics and subtropics and cultivated since prehistoric times and grown throughout the tropical and subtropical regions of the world between 300 N and 350 S latitudes. However, major area under pigeonpea in India is lying between 140S and 280 N latitudes (Anonymous, 2011). 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 100 g (Anonymous, 1981). Pigeon pea 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 up to 200 kg N ha^{-1} (Anonymous, 2010), 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.

Since the primary objective of pigeonpea has been to meet domestic requirement for food and fuel with limited surplus of grains, as such there was not much increase in production and productivity of pigeonpea. In India, the area under pigeonpea during 2016-17 was 5338 thousand hectares with production of 4873 thousand tonnes and average productivity of 913 kg ha^{-1} (Anonymous, 2017a). Generally, Pigeonpea is grown in almost all states of India, but it is cultivated extensively in Bihar, Uttar Pradesh, Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka, West Bengal, Gujarat and Chhattisgarh.

The total geographical area of Chhattisgarh is 13.8 m ha of which 5.9 m ha area is under gross cultivation. Pigeonpea occupies 66.20 thousand ha with production of 39.6 thousand tones. The average productivity of Pigeonpea in Chhattisgarh is 598 kg ha^{-1} (Anonymous, 2017 b).

Chhattisgarh, from last few years is facing severe problem of drought due to vagaries of monsoon like late onset, early withdrawal, prolonged dry spell between two rains etc. As a result of this, crop failure due to lack of water availability has become a common phenomenon. Under limited water conditions, it is very important to conserve available moisture in soil that plant should be provided at critical growth stages. Lack of moisture at these stages is one of the major reasons that limits growth and yield of crops. Hence, in this context efficient utilization of rain water play an important role. This can be achieved by means of various land configuration practices. Ridges and furrow, BBF are some of the methods for conserving soil moisture for getting higher yield. This system is widely practiced by the farmers, where cultivation of crops in the wider rows is done and these rows are set permanently over long period in the dryland areas for higher crop productivity. These practices reduces runoff thereby store more soil moisture. Water logging condition hampers nodulation, enhance Phytopthora blight and root incidence often leading to complete crop failure in heavy rainfall areas. To avoid this problem modified land configuration such as ridge and furrows has been advocated (Desai *et al.,* 2000). This method is effective on black cotton soils. Infiltration rate is increased considerably by reducing the runoff and soil loss. The soil will be able to provide the moisture throughout the growth stages of the crops and also improve the soil physico-chemical and biological properties. In view of above facts, the present investigation was conducted during *Kharif* season of year 2017 at farmers field of Raipur district of Chhattisgarh Plains to find out effect of different land configuration techniques for pigeonpea cultivation on growth, yield and yield attributes on pigeonpea crop.

Materials and Methods

The present study was conducted during *Kharif* season of year 2017 at farmers' field of Bemta village of Tilda block at Raipur district. This experiment was laid out in Randomized Block Design with six number of replications. The soil of the farmers' field was sandy loam in texture, neutral in reaction and had low nitrogen and medium phosphorus and potassium contents. Treatment consisting of ridge and furrow method (90 x 20 cm), flat bed method (90 x 20 cm), flat bed method (60 x 20 cm) was tested during experimentation against broadcasting as control plot. Medium duration variety "Asha" was grown as a test crop. The duration of variety is 160-190 days with production potential of 16-18 q ha^{-1} and is a wilt resistant variety. The crop was sown as per treatments mentioned above, after onset of monsoon using a certified seed with seed rate of 20 kg ha^{-1}. To prevent the crop from soil and seed borne diseases, the seeds were treated with rhizobium, PSB and fungicides. The crop was fertilized with 20, 60 and 30 kg N, P_2O_5 and K_2O ha^{-1}, 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 four 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 four randomly selected one square meter place and then average was 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 for 100 seeds was taken from the seeds produce, counted and its weight was recorded. Seed yield of a square meter from four randomly selected place of each plot was noted down, after threshing, winnowing and drying and calculated in q 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 q 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.

$$\text{Harvest Index (HI) \%} = \frac{\text{Economical yield (q ha}^{-1}\text{)}}{\text{Biological Yield (q ha}^{-1}\text{)}} \times 100$$

Biological yield = seed yield + straw yield

Results 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, staw yield and harvest index during the year of experimentation (Table 1 and 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 Treatment T_1 - Ridge and furrow method (90 x 20 cm) produced longer plants of 182.98 cm during experimentation and was found significantly superior over other land configuration practices, followed by T_2 – flat bed method of spacing 90 x 20 cm (175.38 cm) and T_3 – flat bed method of spacing 60 x 20 cm (173.03 cm) during experiment, respectively and both T_2 and T_3 was found at par results with each other. Pandey *et al.,* (2014) also reported almost similar results, indicating that higher values of growth attributes of pigeonpea was found with raised bed as compare to flat bed. The results also fall in line with the findings of Indapuganti *et al.,* (2007), Kalokhe (2010), Sathe (2015) and Kumar *et al.,* (2012). The shortest plant height was obtained under broadcasting method (155.36 cm).

Effect on number of branches plant^{-1}

The data on number of branches plant^{-1} under various land configuration treatments was presented in Table 1. Results reveal that all the treatments differ statistically significant from each other. However, the highest number of branches plant^{-1} (17.97) was found with crops sown with ridge and furrow (90 x 20 cm) method and was found superior over any other treatments, followed by T_2 – flat bed method with spacing 90 x 20 cm (16.26) and T_3 – flat bed method with spacing 60 x 20 cm (14.60) during experiment year, respectively. The lowest number of branches plant^{-1} was obtained with crop sown with broadcasting (12.75).

These results confirm the findings of Kalokhe (2010) in which he conducted an experiment to study the effect of land configurations, biofertilizers and reported that growth parameters viz., plant height, number of leaves, leaf area, number of branches and total dry matter production was significantly higher in ridges furrow as compared to flat bed planting.

This report was supported by Pandey *et al.,* (2014), Kantwa *et al.,* (2006), Indapuganti *et al.,* (2007), Kumar *et al.,* (2012). Sathe (2015) also reported that significantly higher plant height, more number of functional leaves, more leaf area, number of branches and dry matter production in ridges 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} (147.67) was recorded in crops sown with ridge and furrow (90 x 20 cm) method and was found superior over any other treatments, followed by T_2 – flat bed method with spacing 90 x 20 cm (130.35) and T_3 – flat bed method with spacing 60 x 20 cm (118.86). The lowest number of pods plant^{-1} was obtained with T_4 – broadcasting (92.35). Pandey *et al.,* (2014) also reported similar results in which they stated that significantly higher yield attributes like number of pods plant^{-1} and seed yield of pigeonpea was found superior with raised bed as compare to flat bed.

The results are in confirmation with Kantwa *et al.,* (2005), in which they conducted the experiment on effect of land configuration on performance of pigeonpea and reported that BBF improved the yield attributes (pods/plant and seeds/pod) of pigeonpea over flat planting Kantwa *et al.,* (2006), Indapuganti *et al.,* (2007) also finds similar results.

Effect on number of seeds pod^{-1}

Various land configuration practices has a significant effect on number of seeds pod^{-1} of pigeonpea (Table 1). Highest number of filled seeds pod^{-1} (3.55) was recorded with crop sown in ridge and furrow (90 x 20 cm) method and was found statistically superior over any other land configuration practices. However, this treatment was found statistically at par results with crop sown with T_2 – flat bed method with spacing 90 x 20 cm (3.43), followed by T_3 – flat bed method with spacing 60 x 20 cm (3.21). The lowest number of seeds pod^{-1} was obtained with pigeonpea sowing with broadcast (3.0).

The result are in confirmation with Kantwa *et al.,* (2005) reported that BBF improved the yield attributes (pods/plant and seeds/pod) of pigeonpea over flat planting.

Effect on 100 seed weight (g)

In regard with effect of different land configuration techniques for pigeonpea cultivation on 100 seed weight, heavier seeds (10.24 g) was associated with crop sown in ridge and furrow (90 x 20 cm) method and was found significantly superior over any other treatments and was presented in Table 1. However, this treatment was found statistically at par results with crop sown in T_2 – flat bed method with spacing of 90 x 20 cm (10.08 g), which was followed by treatment T_3 – flat bed method with spacing 60 x 20 cm (9.28 g). The lighter seed was obtained with pigeonpea sowing with broadcast (9.03 g).

Kumar *et al.,* (2012) from Indian Agricultural Research Institute, New Delhi also found that, there is a significant improvement in yield attributes and yield components under BBF and Paired row planting over uniform row planting. Pandey *et al.,* (2014) also find similar results and reported that significantly higher values of yield attributes and seed yield of pigeonpea was found with raised bed as compare to flat bed.

Effect on Seed yield (q ha^{-1})

Effect of different land configuration techniques for pigeonpea cultivation on seed yield was presented in Table 2. The results showed that all treatments differ significantly from each other. Treatment T_1 – Ridge and furrow method (90 x 20 cm) recorded statistically significant highest seed yield (16.91 q ha^{-1}), and was found superior over rest other treatment techniques.

T_2 – flat bed method with spacing of 90 x 20 cm recorded seed yield of 14.15 q ha^{-1}, and was followed by treatment T_3 – flat bed method with spacing 60 x 20 cm (12.74 q ha^{-1}). On the other hand, the minimum seed yield was recorded under control plot (6.95 q ha^{-1}). Same trends were also found by Pandey *et al.,* (2014) and Kumar *et al.,* (2012). The results was also confirms the findings of Desai *et al.,* (2000) in which they noted the beneficial effect of land configuration on pigeonpea crop in vertisols and results revealed that significant effect of different land configuration on seed yield of pigeonpea. Mishra *et al.,* (2009) and Ram *et al.,* (2011) also reported that the adoption of raised bed system resulted higher seed yield than ridge plus furrow and flat bed systems.

Table.1 Effect of different land configuration techniques on pigeonpea growth and yield attributes

Treatments	Plant Height (cm)	Number of Branches Plant^{-1}	Number of Pods Plant^{-1}	Number of Seeds Pod^{-1}	100 Seed Weight (g)
T_1 – Ridge and Furrow method (90 x 20 cm)	182.98	17.97	147.67	3.55	10.24
T_2 – Flat bed method (90 x 20 cm)	175.38	16.26	130.35	3.43	10.08
T_3 – Flat bed method (60 x 20 cm)	173.03	14.60	118.86	3.21	9.28
T_4 – Broadcasting	155.36	12.75	92.35	3.0	9.03
SEm±	**1.39**	**0.51**	**2.87**	**0.04**	**0.60**
CD (P=0.05)	**4.19**	**1.52**	**8.66**	**0.13**	**0.18**

Table.2 Effect of different land configuration techniques on pigeonpea seed yield, straw yield and harvest index

Treatments	Seed Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvest Index (%)
T_1 – Ridge and Furrow method (90 x 20 cm)	16.91	44.31	61.22	27.62
T_2 – Flat bed method (90 x 20 cm)	14.15	39.88	54.03	26.18
T_3 – Flat bed method (60 x 20 cm)	12.74	38.46	51.20	24.88
T_4 – Broadcasting	6.95	31.42	38.37	18.11
SEm±	**0.32**	**1.15**	**0.55**	**-**
CD (P=0.05)	**0.95**	**3.46**	**1.67**	**-**

Mankar and Nawlakhe (2013) from Nagpur also concluded that opening of furrow in every row recorded maximum and significantly higher pigeonpea yield over opening furrow after every 2 and 3 rows and 27.3% more yield over flat bed.

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.

The final build up of yield is cumulative function of yield components.

Higher seed yield under these treatments was due to the highest branches plant^{-1}, pods plant^{-1}, seeds pod^{-1} and seed 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 high yield.

Effect on straw yield (q ha^{-1})

As far as straw yield of pigeonpea under different land configuration techniques was concerned, highest straw yield (44.31 q ha^{-1}) was associated with treatment T_1 – Ridge and furrow method (90 x 20 cm) and was found statistically superior over rest other treatments, followed by T_2 – flat bed method with spacing 90 x 20 cm (39.88 q ha^{-1}) and T_3 – flat bed method with spacing 60 x 20 cm (38.46 q ha^{-1}). However, T_2 and T_3 were found statistically at par with each other.

The lowest straw yield was recorded with control plot (31.42 q ha^{-1}). Kantwa *et al.,* (2006), Kalokhe (2010) and Sathe (2015) also find similar results.

Effect on harvest index (%)

Harvest index reflects the proportion of assimilate distribution between economical and total biomass. Under different land configuration techniques for pigeonpea cultivation, maximum harvest index was recorded with crop sown with ridge and furrow method (27.62 per cent) followed by T_2 – flat bed method with spacing 90 x 20 cm (26.18 per cent) and T_3 – flat bed method with spacing 60 x 20 cm (24.88 per cent), whereas minimum harvest index were registered under control plot T_4 – broadcasting (18.11 per cent).

On basis of ongoing experiment, it was concluded that sowing of pigeonpea in ridge and furrow method with spacing of 90 x 20 cm found to be effective and achieve higher seed yield, staw yield and yield attributing characteristics like plant height, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 100 seed weight and harvest index than any other techniques.

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