Influence of mulch and drip irrigation on growth and yield of pigeonpea

ML Jadav, KP Mishra, Anjaney Pandey, US Mishra, A Duggal, SS Gautam and RK Khariya

Abstract

The field trials were conducted during the two consecutive kharif seasons 2016-17 and 2017-18 with three mulching and three irrigation levels viz. 60%, 80%, 100% CPE (cumulative pan evaporation) to determine the growth and yield attributes of pigeonpea (Cajanus cajan L.) in Vindhyan plateau of Madhya Pradesh. Mulching and irrigation levels significantly affected (P<0.05) the growth and yield attributes of pigeonpea. The maximum plant height was obtained in black plastic mulch (181.29 cm) and lowest in without mulch (161.99 cm) which has significantly difference of 11.91%. The significantly lowest height was registered in I1 (166.22 cm). Individual and interaction (MXI) effect was found significant at harvest in case of branching. Black plastic mulch registered maximum number of pods (119.34) which is 20.67% higher than without mulch (98.90). However, The number of pods per plant was significantly lowest with I1 (106.45) and highest with I3 (113.19) which is at par with I1 (111.97). Growth and yield attributes of pigeonpea gave better performance under plastic mulch than without mulch. Drip irrigation at 0.8% CPE results satisfactory than at upper and lower side.

Keywords: Pigeonpea, mulching, irrigation, vertisols, CPE, growth and yield

Introduction

Pigeonpea (Cajanus cajan (L) MillSp.) is a perennial member of the Fabaceae family and one of the major legume crop of the tropics and subtropics (Vanaja et al. 2010). Pulses are known as unique jewels of Indian farming. Pulses are an integral part of diets across the globe and have great potential to improve human health, conserve soils, protect the environment and contribute to global food security. The United Nations, declared 2016 as “International Year of Pulses”. India is the largest producer, consumer and importer of the pulses in the world. Pigeonpea is particularly rich in lysine, riboflavin, thiamine, niacin and iron (Manikandan and Sivasubramaniam, 2015). Pigeonpea plays an important role in food security, balanced diet and alleviation of poverty, since it is used in diverse ways as a source of food and fodder. Pigeonpea grown worldwide in an area of 4.23 m.ha., with a production and productivity of 4.68 MT and 751 kg/ha respectively. More than 85% area of pigeon pea is under rain fed condition (Sanjay et al., 2017). In India, it occupies an area of 3.71 m.ha. with a production and a productivity of 2.78 MT and 750 kg/ha respectively (GOI Report, 2015). Increased population resulted in reducing per capita availability of pulses to the masses. (Annual Report 2017-18, IIPR, Kanpur).

Lack of adequate water on a continuous basis is a serious obstacle to stable pigeonpea yields (Reddy and Virmani, 1980). Water stress affects the final yield due to the reduction in growth attributes i.e. plant height, number of pods, reduction in pod weight. Many researchers have reported that more than 50% of yield loss in pigeon-pea is due to drought (Roder et al. 1998; Sharma et al. 2012). The plant’s physiological processes get affected because of moisture stress in plant (Patel et al. 2001). Proper use of existing water resources by using suitable irrigation technologies to increase pigeonpea production per unit area is the need of the hour (Jeyjothi et al., 2017).

Mulching as a moisture conservation practice has been widely practiced as a mean of improving yields in water limited environment. It also favourably modifies the soil thermal regime, retards soil erosion and improves soil health. Apart from these the plastic mulching increases the soil temperature and moisture of upper layer of soil (Rao et al., 2018). Swathi et al. (2018) reported that the congenial environmental conditions determine the growth and flowering behaviour of pigeon pea.
There is still a scope in research to enhance productivity of the crop with the help of moisture conservation techniques. Drip and mulching are the most important resources and inputs, which have great influence on the productivity of pigeonpea (Solanki et al., 2019) [19]. Vision 2050 of IIPR (ICAR) also emphasized on resource conservation techniques in pulses viz., raised bed planting, drip irrigation and mulching to minimize water loss and enhance water productivity. Tiwari et al., (2012) [21] and Gireesh et al., (2019) [22] studied the yield gap, constraints and economics of pigeon pea production in Madhya Pradesh. Farmers are facing many constraints related with pigeonpea cultivation therefore proper resources management and scientific practices can increase the production and productivity of pigeonpea. Hence, the present work has been taken up to explore growth and yield attributes of pigeon pea through drip with mulching by providing congenial soil and water conditions near the plant root zone.

Materials and Methods
The study area is situated in central part of Madhya Pradesh which falls under agro-climatic zone of Vindhyan plateau. It situated at 23°16’48” N-latitude, 77°21’36” E-longitude. The field trials were conducted during the two consecutive kharif seasons 2016-17 and 2017-18 at farmer’s field of Sehore district of Madhya Pradesh. Area belongs to sub-tropical climate. The topography of the experimental site was uniform and leveled and the soil is vertisol.

TJT-501 pigeonpea variety was used for this experiment. Well treated bold seeds with Rhizobium culture and PSB were dibbed on ridge of RF at interval of 25 cm. Black plastic sheet of 25 micron and wheat straw @ 5 t/ha were used as mulch. It was laid out before establishment of the crop by cutting into pieces according to the treatment. Before spreading the plastic sheet on ridge, small circular holes were made with scissors at 25 cm apart. The sheet was spread above the lateral line. Afterwards all the sides of the mulch sheet were buried into the soil to a depth of 4-5 cm. Surface drip irrigation system was installed to irrigate pigeonpea for this field experiment. LDPE pipes of 16 mm diameter were used as lateral keeping lateral spacing 60 cm and inline dripper spacing 30 mm. Irrigation water was applied according to daily crop evapotranspiration of pigeonpea.

The experiment was laid out with combination of three mulching treatments were without mulch (M0), wheat straw mulch (M1) and black plastic mulch (M2) whereas three irrigation treatments were 60% CPE (I1), 80% CPE (I2) and 100% CPE (I3). In present study, a fixed irrigation interval of three days was adopted and amount of water applied was estimated based on previous days evapotranspiration. The irrigation was stopped 15 days before harvesting in all treatments. The observation on growth and yield attributes were recorded using standard procedures. The crop growth attributes i.e. plant height (cm), number of branches per plant and dry matter (g) accumulation were measured at 30, 60, 90, and 120 DAS and at harvest of pigeonpea. Yield attributes such as number of pods per plant, test weight (g), number of seeds per pod were observed very accurately at the time of harvest. The recorded data were statistically analyzed by using technique of analysis of variance for the split plot design given by Gomez and Gomez (1984) [5].

Results and Discussion
The result on the basis of pooled data showed that the crop growth and yield of pigeonpea were significantly affected by different mulching and irrigation treatments. Increase in mean plant height was rather slow up to 30 DAS, there after it increased linearly up to 120 DAS and after that it continued to increase until maturity at a diminishing rate (Table 1). The maximum plant height was obtained in black plastic mulch (181.29 cm) and lowest in without mulch (161.99 cm) which has significantly difference of 11.91%. The maximum plant height was recorded in I3 (176.10 cm) which is at par in I2 (174.16 cm). The significantly lowest height was registered in I1 (166.22 cm). The increased plant height might be due to better availability of moisture and nutrients near root zone during entire crop growth period which favoured the growth attributes. Almost similar trend was observed by Ghosh and Biswas (1984) [3] and Solanki et al. (2019) [19].

Data pertaining to number of branches per plant of pigeonpea was recorded and an average value was worked out for each treatment (Table 1). The significantly maximum number of branches registered under black plastic much (13.81) and minimum in without mulch (10.92). The irrigation treatment significantly affects the number of branches and maximum recorded in I2 (13.10) which is at par with I3 (11.64). The increased number of branches per plant might be due to better availability of moisture and nutrients during entire crop growth period which favoured the growth attributes. Also, drip irrigation treatment created better micro-climate as compared because of prolonged duration of watering. The above findings are in close conformity with the findings of Yadav et al. (2006) [23] and Savani et al. (2017) [6].

There was a gradual increment in dry matter accumulation with advancement in the age of the crop till harvest in all the treatments are presents in Table 1. It is obvious from data that the dry matter accumulation was significantly affected by the different treatments. Maximum and minimum value recorded under black plastic mulch (M2) followed by wheat straw mulch (M1) and without mulch (M0). The pooled data clearly indicate at harvest that the maximum average value under M2 is 118.03 g/plant whereas lowest value registered under M0 (106.65 g/plant). Rao et al. (2018) [12] also found the same trend. It is also revealed that the dry matter accumulation recorded with I1 (1.0 IW/CPE) throughout the crop life was statistically at par with I2. The dry matter accumulation per plant are 108.97 g/plant (I1), 114.21 g/plant (I2) and 113.83 g/plant (I3) registered at harvest. The dry matter accumulation variation found maximum due to mulching effect whereas lesser with discharge rate and irrigation treatments. Singh et al (2018) [18] and Jadhav et al. (2018) also found the same trend in dry matter accumulation. Different mulching treatments significantly affected the number of pods per plant (Table 2). The pooled data revealed that significantly maximum number of pods (119.34) registered under black plastic mulch (M2) whereas lowest value (98.90) in without mulch (M0). Ghose and Biswas (1984) [3] resulted that increase in pods due to increase in branches. The same result reported by Savani et al. (2017) [16]. Data on number of pods per plant was found significant due to effect of different irrigation levels. The pooled data revealed that lowest value recorded with I1 (106.45) and highest with I2 (113.19) which is at par with I3 (111.97) as shown in Table 4. These results are conformity with Jadhav et al. (2018) [16]. Different mulching treatments significantly influenced the test weight (Table 2). The pooled data indicate that significantly maximum value (10.24) registered under M2 which is at par...
with $M_1$ (10.11) whereas lowest value (9.16) recorded in $M_6$. The test weight variance due to different irrigation levels found significant. On the pooled data basis it is clear that lowest weight recorded with $I_1$ (9.61) and highest with $I_2$ (9.96) which is at par with $I_1$ (9.94). Effect of different mulching treatments on number of seeds per pod was found non-significant. The pooled data revealed that maximum number of seeds (3.35) registered under $M_2$ which is at par with $M_1$ (3.30) whereas lowest value (3.21) in $M_6$. Data on number of seeds per pod was found significant due to effect of different irrigation levels. The pooled data indicate that lowest value recorded with $I_1$ (3.21) and highest with $I_2$ (3.33) which is at par with $I_1$ (3.32). Savani et al. (2017) [16] and Jadhav et al. (2018) [6] reported same trend for yield parameters.

**Table 1**: Growth attributes of pigeonpea at different DAS and at harvest under different treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Height (cm)</th>
<th>No. of Branches</th>
<th>DMA (gms/plant)</th>
<th>Plant Height (cm)</th>
<th>No. of Branches</th>
<th>DMA (gms)</th>
<th>Plant Height (cm)</th>
<th>No. of Branches</th>
<th>DMA (gms)</th>
<th>Plant Height (cm)</th>
<th>No. of Branches</th>
<th>DMA (gms)</th>
<th>Plant Height (cm)</th>
<th>No. of Branches</th>
<th>DMA (gms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_1$</td>
<td>23.86</td>
<td>2.19</td>
<td>4.41</td>
<td>79.14</td>
<td>4.86</td>
<td>14.48</td>
<td>116.56</td>
<td>6.55</td>
<td>41.03</td>
<td>149.67</td>
<td>9.56</td>
<td>81.24</td>
<td>161.99</td>
<td>10.92</td>
<td>106.65</td>
</tr>
<tr>
<td>$M_2$</td>
<td>30.24</td>
<td>2.96</td>
<td>5.42</td>
<td>88.25</td>
<td>6.16</td>
<td>15.90</td>
<td>125.70</td>
<td>8.99</td>
<td>43.07</td>
<td>159.93</td>
<td>12.04</td>
<td>86.45</td>
<td>173.20</td>
<td>12.94</td>
<td>112.33</td>
</tr>
<tr>
<td>$M_3$</td>
<td>32.03</td>
<td>3.16</td>
<td>5.83</td>
<td>91.13</td>
<td>6.55</td>
<td>16.82</td>
<td>129.34</td>
<td>9.49</td>
<td>48.70</td>
<td>167.04</td>
<td>12.87</td>
<td>90.31</td>
<td>181.29</td>
<td>13.81</td>
<td>118.03</td>
</tr>
<tr>
<td>$I_1$</td>
<td>0.56</td>
<td>0.08</td>
<td>0.13</td>
<td>0.38</td>
<td>0.12</td>
<td>0.29</td>
<td>0.81</td>
<td>0.18</td>
<td>0.70</td>
<td>2.48</td>
<td>0.22</td>
<td>1.41</td>
<td>2.74</td>
<td>0.26</td>
<td>1.93</td>
</tr>
<tr>
<td>CD at 5%</td>
<td>1.56</td>
<td>0.21</td>
<td>1.06</td>
<td>0.55</td>
<td>0.81</td>
<td>0.81</td>
<td>2.24</td>
<td>0.50</td>
<td>0.94</td>
<td>6.87</td>
<td>0.62</td>
<td>3.90</td>
<td>7.61</td>
<td>0.71</td>
<td>5.36</td>
</tr>
</tbody>
</table>

DMA-Dry Matter Accumulation

**Table 2**: Yield attributes of pigeonpea at different DAS and at harvest under different treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pods per plant</th>
<th>100 seed weight (g)</th>
<th>Seeds per pod</th>
<th>Seed yield (q/ha)</th>
<th>Mulch (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_1$</td>
<td>98.90</td>
<td>9.16</td>
<td>3.21</td>
<td>11.83</td>
<td></td>
</tr>
<tr>
<td>$M_2$</td>
<td>113.36</td>
<td>10.11</td>
<td>3.30</td>
<td>16.51</td>
<td></td>
</tr>
<tr>
<td>$M_3$</td>
<td>119.34</td>
<td>10.24</td>
<td>3.35</td>
<td>17.31</td>
<td></td>
</tr>
<tr>
<td>$I_1$</td>
<td>1.79</td>
<td>0.21</td>
<td>0.06</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>CD at 5%</td>
<td>4.97</td>
<td>0.59</td>
<td>NS</td>
<td>0.58</td>
<td></td>
</tr>
</tbody>
</table>

Irrigation (I)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pods per plant</th>
<th>100 seed weight (g)</th>
<th>Seeds per pod</th>
<th>Seed yield (q/ha)</th>
<th>Mulch (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>106.45</td>
<td>9.61</td>
<td>3.21</td>
<td>14.07</td>
<td></td>
</tr>
<tr>
<td>$I_2$</td>
<td>113.19</td>
<td>9.96</td>
<td>3.33</td>
<td>16.01</td>
<td></td>
</tr>
<tr>
<td>$I_3$</td>
<td>111.97</td>
<td>9.94</td>
<td>3.32</td>
<td>15.77</td>
<td></td>
</tr>
<tr>
<td>CD at 5%</td>
<td>0.90</td>
<td>0.09</td>
<td>0.03</td>
<td>0.12</td>
<td></td>
</tr>
</tbody>
</table>

Irrigation (I)

**Conclusion**

On the basis of results obtained in present study, the drip irrigation as per crop evapotranspiration demand 80% CPE is giving best performance than lower (60%) and upper (100%) level. Black plastic mulch performs best and followed by wheat straw mulch and without mulch. It can be concluded that use of black plastic mulch at the 80% CPE (cumulative pan evaporation) with three days irrigation interval was found better in order to higher growth and yield attributes.

**References**


~ 377 ~