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## Original Research Article

# Influence of Chlorophyll Content and Leaf Area Index on Growth of Pigeonpea

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**Keywords**

Drip irrigation, Fertigation, Leaf area index and Chlorophyll

**A B S T R A C T**

The experiment was carried out during 2016-17 and 2017-18 to study the Influence of chlorophyll content and leaf area index on growth of pigeonpea with different fertigation levels, irrigation levels and colour plastic mulches at research field, College of Agricultural Engineering, Raichur. The leaf area index is an important source in manufacturing photoassimilates for determining dry matter accumulation and crop yield. An increase in LAI results in better utilization of solar energy. The values of leaf area index were found to be highest (2.41) in 100 per cent ET ($I_3$) and lowest was found (1.80) at 60 per cent ET ($I_1$). The results indicated that chlorophyll in the pigeonpea leaves was maximum (44.95) in 100 per cent RDF and minimum (40.51) was recorded as 75 per cent RDF.

## Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp] is an important food legume of the semi-arid tropics of Asia and Africa. It occupies a prime niche in sustainable farming systems of small and marginal rainfed farmers. It occupies a prominent place in Indian rainfed agriculture. It is an integral component in various agro ecologies of the country, it is inter cropped with the pulses, cereals, oilseeds and millets. More than 85 per cent of the world pigeonpea is produced and consumed in India. It is commonly known as redgram or arhar or tur or thogari.

The world acreage of pigeonpea is 4.86 M ha with an annual production of 4.1 M t. India is the largest producer and consumer of pigeonpea with an annual production of 3.29 M t in an area of 3.88 M ha with a productivity of 849 kg per ha. This is followed by Myanmar (0.60 M t), Malawi (0.16 M t) and Kenya (0.10 M t).

The green coloration of plant organs displaying chlorophyll is related to the amount of nutrients and water absorbed by the plant from the soil. Water that evaporates from the soil under the plastic film condenses on the lower surface of the film and falls back to the soil as droplets. So that soil moisture is preserved and consumed by the crop (Ashworth and Harrison, 1983). This process increases the concentration of carbon dioxide around the mulch film and improves photosynthesis. The greater chlorophyll content in leaves are important because photosynthetic activity and crop yield can increase with increased chlorophyll content of leaves.

## Materials and Methods

The experiment was carried out during 2016-17 and 2017-18 to study the Influence of chlorophyll content and leaf area index on growth of pigeonpea with different fertigation levels, irrigation levels and colour plastic mulches at research field, College of Agricultural Engineering, Raichur.

### Leaf area index (LAI)

The leaf area index (LAI) was measured with an AccuPAR 80 Ceptometer (Decagon Devices, Inc., Pullman, WA, USA) between 11:30 am and 3:30 pm.

The Ceptometer contains 80 individual quantum sensors on the probe and automatically calculates LAI based on PAR readings from the ground to the top of the crop canopy. The observations were recorded at different growth stages *viz*., at 90, 135 DAT and also at harvesting.

### Chlorophyll content of leaves

The chlorophyll content of green leaves of each of five tagged plants was recorded at different growth stages. For this estimation, Chlorophyll meter (Model, SPAD-502) was used and values obtained were expressed in percentage (%).

## Results and Discussion

### Leaf area index (LAI)

The results pertaining to leaf area index (LAI) affected by different fertigation levels, various drip irrigation levels and plastic colour mulches was studied in pigeonpea crop at various growth stages i.e. 90, 135 DAT and at harvest. The leaf area index of pigeonpea in all treatment data are presented in Table 1 and Figure 1. Leaf area index being an important tool to quantifying the photosynthesis accumulation in sink, resulted in increased growth of pigeonpea.

The leaf area index is an important source in manufacturing photo assimilates for determining dry matter accumulation and crop yield. An increase in LAI results in better utilization of solar energy. Thus, leading to higher dry matter accumulation through the process of photosynthesis. It is a positive index with direct influence on plant growth. Nitrogenous fertilizer was utilized more efficiently to develop leaves with optimum size (full leaf size) with more frequent availability of water. Nitrogen tremendously increasing leaf area expansion, number of palisade cells, chloroplast development and total protein contents in pigeonpea (Santosh Kumari, 2012). At the time of shooting, the treatment 100 per cent RDF recorded maximum leaf area index and lowest LAI was observed in 75 per cent RDF. Growth analysis is necessary to understand the plant growth in quantitative terms and to interpret crop yields under different environments (Kuttimani *et al*., 2013).

Leaf area index increased from emergence and reached its peak at crop maturity. However, leaf area index declined when crop reached senescence. The formation of abscisic acid in roots and its consequence translocation from root to shoot can cause reduced stomatal conductance and transpiration rate of leaves. The values of leaf area index were found to be highest in 100 per cent ET ($I_3$) and were closely followed 80 per cent ET ($I_2$). However, the limited water supply to pigeonpea at 60 per cent ET ($I_1$) affected the physiological development of the crop, the effect of which was highly pronounced during the maturity stage of the crop when the crop actually needed appreciable quantity of water for its water demand (Konyeha and Alatise, 2013).

**Table.1** Leaf area index of pigeonpea as influenced by fertilizer levels, irrigation levels and colour plastic mulching during 2016-17 and 2017-18

| Treatments | Leaf area index | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 90 DAT | | | 135 DAT | | | At Harvest | | |
| | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled | 2016-17 | 2017-18 | Pooled |
| **Fertilizer levels** | | | | | | | | | |
| $F_1$ | 1.75 | 1.72 | 1.73 | 1.81 | 1.78 | 1.80 | 1.78 | 1.74 | 1.76 |
| $F_2$ | 2.32 | 2.28 | 2.30 | 2.34 | 2.31 | 2.33 | 2.34 | 2.27 | 2.30 |
| S.Em± | 0.06 | 0.06 | 0.06 | 0.04 | 0.04 | 0.04 | 0.06 | 0.05 | 0.05 |
| C.D. at 5% | 0.38 | 0.38 | 0.38 | 0.27 | 0.26 | 0.27 | 0.36 | 0.27 | 0.31 |
| **Irrigation levels** | | | | | | | | | |
| $I_1$ | 1.80 | 1.76 | 1.78 | 1.83 | 1.80 | 1.82 | 1.84 | 1.76 | 1.80 |
| $I_2$ | 1.89 | 1.86 | 1.87 | 1.94 | 1.91 | 1.93 | 1.91 | 1.87 | 1.89 |
| $I_3$ | 2.41 | 2.38 | 2.39 | 2.46 | 2.43 | 2.45 | 2.43 | 2.39 | 2.41 |
| S.Em.± | 0.08 | 0.08 | 0.08 | 0.06 | 0.07 | 0.07 | 0.06 | 0.07 | 0.06 |
| C.D. at 5% | 0.26 | 0.26 | 0.26 | 0.21 | 0.21 | 0.21 | 0.20 | 0.22 | 0.20 |
| **Mulching** | | | | | | | | | |
| $M_1$ | 2.62 | 2.59 | 2.61 | 2.70 | 2.67 | 2.69 | 2.66 | 2.63 | 2.65 |
| $M_2$ | 2.23 | 2.20 | 2.21 | 2.29 | 2.26 | 2.27 | 2.26 | 2.22 | 2.24 |
| $M_3$ | 2.02 | 1.99 | 2.01 | 2.08 | 2.05 | 2.06 | 2.04 | 2.01 | 2.02 |
| $M_4$ | 1.25 | 1.21 | 1.23 | 1.24 | 1.22 | 1.23 | 1.27 | 1.18 | 1.22 |
| S.Em.± | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| C.D. at 5% | 0.28 | 0.29 | 0.29 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Interactions | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| CV (%) | 20.89 | 21.40 | 21.14 | 17.87 | 18.21 | 18.04 | 18.38 | 18.24 | 18.08 |
| General Mean | 2.03 | 2.00 | 2.01 | 2.08 | 2.05 | 2.06 | 2.06 | 2.01 | 2.03 |

**NS** – Non significant

**Main treatments: (F)**
$F_1$:75 per cent RDF
$F_2$: 100 per cent RDF

**Sub treatments: (I)**
$I_1$: Irrigation at 60 per cent ET
$I_2$: Irrigation at 80 per cent ET
$I_3$: Irrigation at 100 per cent ET

**Sub-Sub treatments: (M)**
$M_1$: White over black
$M_2$: Silver over black
$M_3$: Complete black
$M_4$: Control (without mulch)

**Table.2** Chlorophyll content of pigeonpea as influenced by fertilizer levels, irrigation levels and colour plastic mulching during 2016-17 and 2017-18

| **Treatments** | **Chlorophyll content** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **45 DAT** | | | **90 DAT** | | | **135 DAT** | | | **At harvest DAT** | | |
| | **2016-17** | **2017-18** | **Pooled** | **2016-17** | **2017-18** | **Pooled** | **2016-17** | **2017-18** | **Pooled** | **2016-17** | **2017-18** | **Pooled** |
| **Fertilizer levels** | | | | | | | | | | | | |
| $F_1$ | 50.03 | 42.38 | 46.21 | 57.57 | 51.64 | 54.61 | 59.41 | 53.27 | 56.34 | 44.31 | 40.22 | 42.26 |
| $F_2$ | 53.02 | 43.21 | 48.12 | 57.74 | 52.94 | 55.34 | 59.57 | 54.54 | 57.06 | 44.59 | 40.53 | 42.56 |
| S.Em± | 1.46 | 0.49 | 0.05 | 1.14 | 1.16 | 0.01 | 1.03 | 1.18 | 0.01 | 1.07 | 0.37 | 0.01 |
| C.D. at 5% | NS | NS | 0.15 | NS | NS | 0.03 | NS | NS | 0.03 | NS | NS | 0.03 |
| **Irrigation levels** | | | | | | | | | | | | |
| $I_1$ | 48.71 | 40.86 | 44.79 | 55.05 | 49.74 | 52.40 | 57.65 | 51.24 | 54.45 | 42.65 | 38.36 | 40.51 |
| $I_2$ | 51.32 | 42.25 | 46.79 | 56.81 | 52.22 | 54.51 | 58.81 | 53.72 | 56.26 | 43.81 | 39.75 | 41.78 |
| $I_3$ | 54.56 | 45.27 | 49.92 | 60.51 | 54.92 | 57.72 | 61.99 | 56.76 | 59.38 | 46.93 | 42.99 | 44.95 |
| S.Em.± | 0.82 | 0.83 | 0.91 | 1.15 | 1.19 | 1.01 | 0.99 | 1.31 | 1.12 | 1.00 | 1.10 | 0.85 |
| C.D. at 5% | 2.69 | 2.72 | 0.25 | 3.74 | 3.89 | 2.86 | 3.22 | 4.27 | 3.05 | 3.27 | 3.59 | 2.36 |
| **Mulching** | | | | | | | | | | | | |
| $M_1$ | 55.75 | 45.91 | 50.83 | 61.75 | 56.17 | 58.96 | 63.75 | 57.58 | 60.67 | 48.75 | 43.63 | 46.19 |
| $M_2$ | 51.34 | 44.17 | 47.76 | 59.12 | 53.92 | 56.52 | 61.25 | 55.51 | 58.38 | 46 | 41.68 | 43.84 |
| $M_3$ | 51.21 | 41.54 | 46.38 | 56.31 | 51.01 | 53.66 | 58.11 | 52.69 | 55.40 | 43.25 | 39.32 | 41.29 |
| $M_4$ | 47.82 | 39.56 | 43.68 | 53.45 | 48.06 | 50.76 | 54.83 | 49.84 | 52.34 | 39.81 | 36.82 | 38.32 |
| S.Em.± | 0.75 | 0.43 | 0.52 | 0.82 | 0.51 | 0.60 | 0.85 | 0.60 | 0.55 | 0.85 | 0.44 | 0.32 |
| C.D. at 5% | 2.12 | 1.23 | 1.45 | 2.33 | 1.45 | 1.82 | 2.41 | 1.72 | 1.61 | 2.43 | 1.25 | 0.96 |
| Interactions | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| CV (%) | 6.15 | 4.28 | 5.69 | 6.03 | 4.13 | 8.96 | 6.04 | 4.75 | 7.45 | 8.14 | 4.61 | 8.25 |
| General Mean | 51.53 | 42.79 | 47.16 | 57.66 | 52.29 | 54.98 | 59.48 | 53.92 | 56.69 | 44.45 | 40.37 | 42.41 |

**NS** – Non significant

**Main treatments: (F)**
$F_1$:75 per cent RDF
$F_2$: 100 per cent RDF

**Sub treatments: (I)**
$I_1$: Irrigation at 60 per cent ET
$I_2$: Irrigation at 80 per cent ET
$I_3$: Irrigation at 100 per cent ET

**Sub-Sub treatments: (M)**
$M_1$: White over black
$M_2$: Silver over black
$M_3$: Complete black
$M_4$: Control (without mulch)

**Fig.1** Effect of different fertigation levels, irrigation levels and color plastic mulches on leaf area index for pigeonpea during 2016-17 and 2017-18

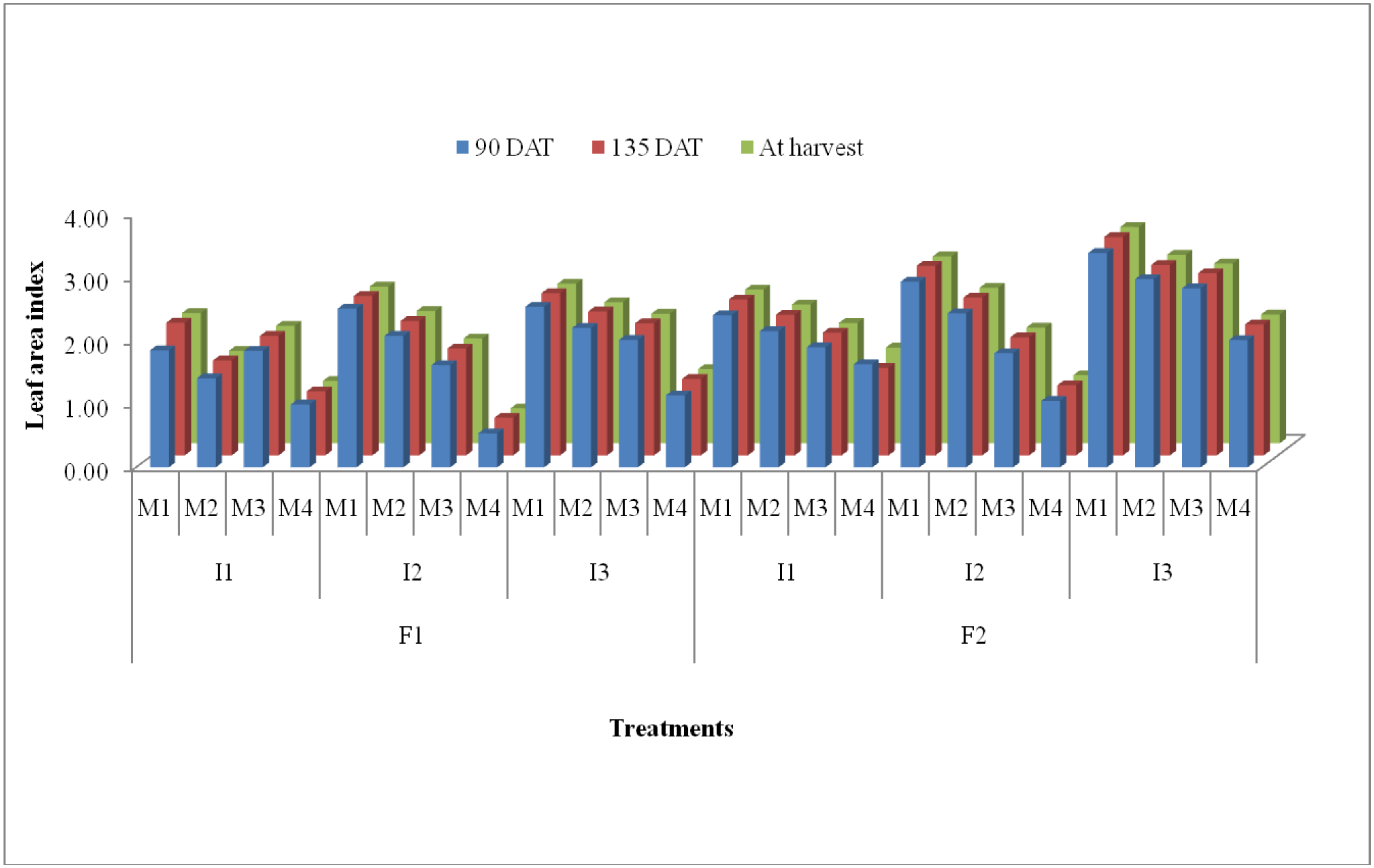
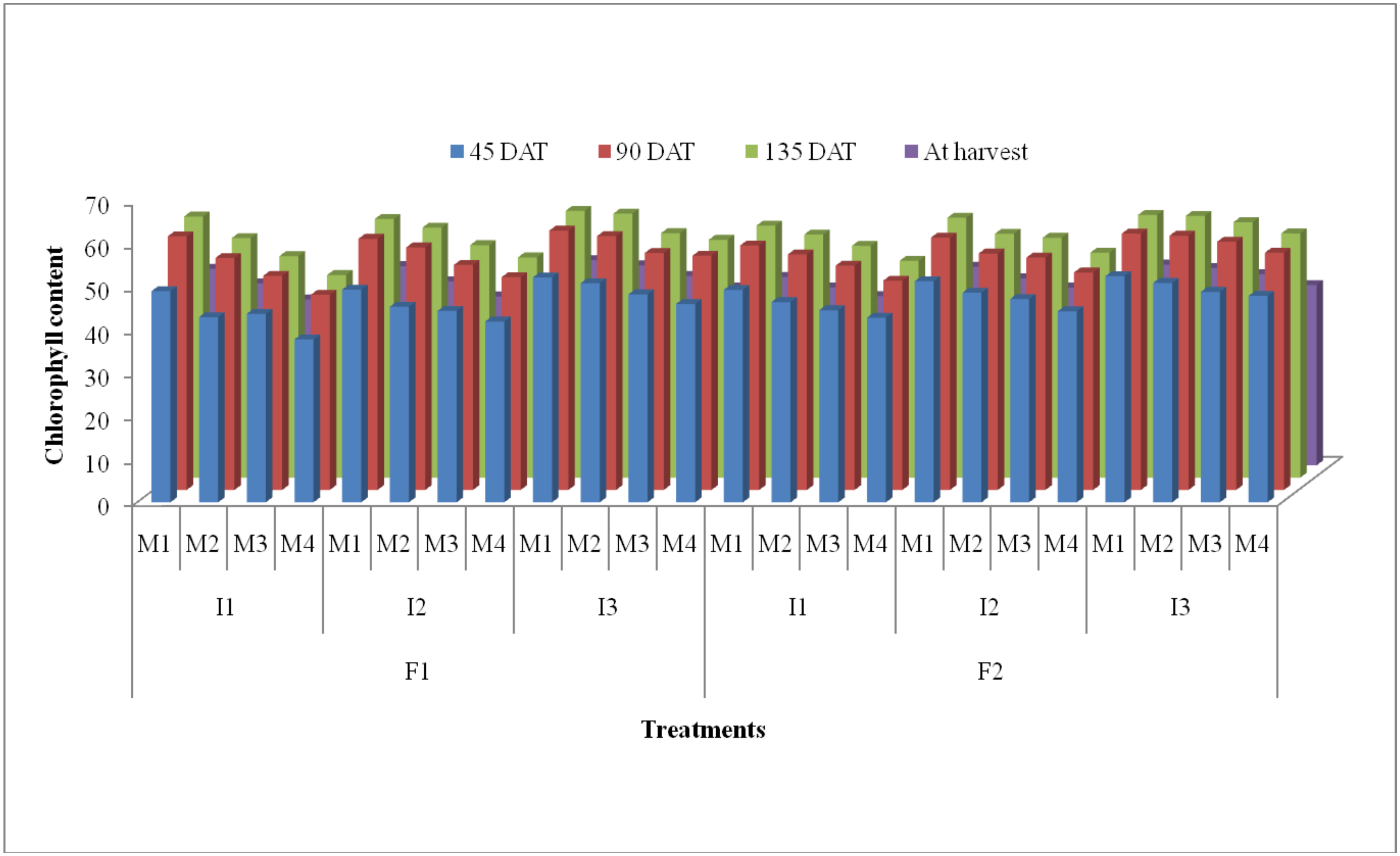


**Fig.2** Effect of different fertigation levels, irrigation levels and color plastic mulches on chlorophyll content for pigeonpea during 2016-17 and 2017-18



The reduction in LAI with lower irrigation levels might be due to reduced turgor pressure under moisture stress conditions which affected the leaf cell expansion. Similar observations were also made by Nguyen *et al.,* (2009). The Increased leaf area index could be attributed to the increased functional leaf area and delayed leaf senescence by production of phytohormones that enhanced cell division and elongation (Elankavi *et al.,* 2009).

Leaf area index recorded in afternoon hours was higher in mulched plot as compared to plot without mulch. The LAI was more in white plastic colour mulch followed by silver plastic colour mulch and black plastic colour mulch compared with without mulch treatment. The LAI increased from emergence and reached its peak at crop maturity.

Increase in leaf area might be attributed to change in plant microclimate by mulch which results in better vegetative growth of crop. Leaf area might have increased as soil temperatures raised to high due to effect of radiation transmission to the soil from different color mulches. These results are corroborated with Jimenez *et al.,* (2002), Jimnez *et al.,* (2011) and Mehan (2014).

## Chlorophyll content

The photosynthetic pigments are some of the most important internal factors, which in certain cases can limit the photosynthesis rate. The chlorophyll content of pigeonpea in all treatment data are presented in Table 2 and Figure 2. The chlorophyll in the leaves of pigeonpea significant effect on fertilization, irrigation and colour plastic mulch.

The results indicated that chlorophyll in the pigeonpea leaves was maximum in 100 per cent RDF and minimum was recorded as 75 per cent RDF. The chlorophyll is an essential component for photosynthesis occurs in chloroplasts a green pigments in all photosynthetic plant tissues, so more chlorophyll content in plants may be attributed to more uptake of nitrogen by the plants. Similar results were found by Malik *et al.,* (2011).

The results of this study indicated that nitrogen (N) and phosphorous (P) exhibited the most influence on the chlorophyll content of pigeonpea. Nitrogen is of vital important for plant growth due to being a part of amino acid, protein, enzymes and chlorophyll molecule.

Nitrogen is required by plants in comparatively larger amounts than other elements. The presence of N in excess promotes development of the above ground organs with abundant dark green (high chlorophyll) tissues of soft consistency and its contribution in increasing the grain yield. Such results clarified that N is essential for cell division and elongation as well as the root growth and dry matter content of pigeonpea (Saeid and Maryam, 2011).

Besides nitrogen, the results of this study also indicated that phosphorous (P) affect the chlorophyll content of pigeonpea. Phosphate is one of the most essential elements for plant growth after nitrogen. Phosphorous plays a significant role in several physiological and biochemical plant activities like photosynthesis, transformation of sugar to starch and transporting of the genetic traits (Mehrvarz *et al.,* 2008).

Phosphorous is important component which stimulates the photosynthesis and enters into the composition of rich energy compounds and strengthens roots of the plant. This leads finally to increase of the habit growth and chlorophyll content of the leaves. These results are in agreement with the findings of Jamal Ahmed Abbas (2009), Purwanto and Junaidah (2015).

From the present study it can be concluded that overall performance of pigeonpea crop was preeminent as compared to others. Mulching has significantly affect growth and yield of the pigeonpea crop and has important role in increase in leaf area index and chlorophyll content of the crop.

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