

# **EFFECT OF IRRIGATIONS AND PLANT SPACING ON GROWTH AND YIELD OF TRANSPLANTED PIGEONPEA**

**BY**

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B. Sc. (Agri.)

T 6065

**DISSERTATION**



*Submitted to the*

*Marathwada Agricultural University, Parbhani*

*in partial fulfillment of the requirement*

*for the award of the Degree of*

**MASTER OF SCIENCE**

(Agriculture)

IN

**AGRONOMY**

**DEPARTMENT OF AGRONOMY  
COLLEGE OF AGRICULTURE, PARBHANI  
MARATHWADA AGRICULTURAL UNIVERSITY  
PARBHANI - 431 402 (M.S.) INDIA**

**2010**

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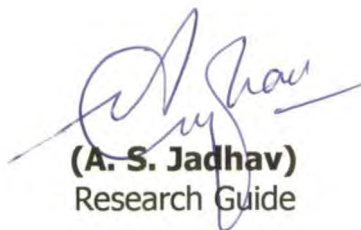
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## **CERTIFICATE-I**

This is to certify that the dissertation entitled "**EFFECT OF IRRIGATIONS AND PLANT SPACING ON GROWTH AND YIELD OF TRANSPLANTED PIGEONPEA**" submitted by **Mr. VIKAS KHAKA NARNALIKAR** to the Marathwada Agricultural University, Parbhani in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in the subject of **AGRONOMY** is record of original and bonafide research work carried out by him under my guidance and supervision. It is of sufficiently high standard to warrant its presentation for the award of the said degree.

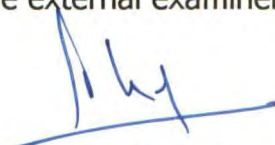
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This is to certify that the dissertation entitled "**EFFECT OF IRRIGATIONS AND PLANT SPACING ON GROWTH AND YIELD OF TRANSPLANTED PIGEONPEA**" Submitted by **Mr. VIKAS KHAKA NARNALIKAR** to the Marathwada Agricultural University, Parbhani in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in the subject of **AGRONOMY** has been approved by the student's advisory committee after viva-voce examination in collaboration with the external examiner.



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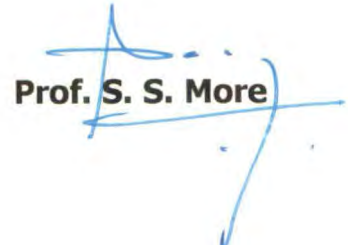
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## ACKNOWLEDGEMENT

*Words are the only available means expressing emotions in such formal acknowledgement as the formal and dead words cannot carry the fragrance of emotions with them.*

*I feel extremely honoured for the opportunity bestowed upon me to carry out research work under versatile guidance of my research guide Dr. A.S. Jadhav, Officer Incharge and Agronomist DWSRC, MAU, Parbhani, who in his unique way, provided me with constant encouragement and scholastic guidance. I am heartily thankful to him for his constant monitoring and rational criticism during preparation of this manuscript and above all his cordial treatment and affection which goes much beyond his formal obligation as the Chairman of my Advisory Committee.*

*Indeed, the words at my command are not adequate either in the form or spirit to convey the depth of gratitude to Dr. D.N. Gokhale, Head, Dept. of Agronomy, Prof. S.S. Solunke, Associate Professor, Dept. of Agronomy, Dr. H.K. Kausadikar, Assistant Professor, Dept. of Agril. Chemistry and Soil Science, Prof. S.S. More Assistant Professor, Dept. of Agril. Economics and Statistics; MAU, Parbhani, Members of my advisory committee for suggesting the need based research and showing keen interest in the topic by rendering intelligent suggestions to carry out the research work.*

*It is incumbent upon me to express my profound sense of gratitude to Dr. S.S. Kadam, Hon. Vice-Chancellor, MAU, Parbhani; Dr. P.R. Shivpuje, Associate Dean (P.G.), College of Agriculture, MAU, Parbhani and Dr. D.N. Gokhale Head, Dept. of Agronomy, MAU, Parbhani., who have been provided instrumental and assertive to the materialization of the research project.*

*My cordial thanks to Dr. U.N. Alse, Dr. U.M. Ghadge, Prof. L.S. Deshmukh, Prof. A.K. Gore, Dr. V.B. Awasarmal, Dr. C.B. Patil, Dr. G.M. Kote, Sawargaonkar Sir and other faculty members of Agronomy Department for their time to help and suggestions during conduct of this research.*

*Dr. A.S. Jadhav, Officers Incharge and Agronomist DWRC, MAU, Parbhani, may be regarded as the lighthouse for the ocean liners, whose guidance helped to navigate my ship of academic pursuit and I would like to mention my gratitude to them.*

*I am also thankful to Dr. C.G. Chandel, farm suptd. Mr. Bedre, Mr. Dawane and all farm labourers of Dept. of Agronomy, M.A.U. Parbhani for providing all the required facilities for completion of research work.*

*I have profound pleasure to record my sincere thanks to Sachin, Raj Dhanu, Santosh, Atul, Manoj, Amol, Nilesh, Prabhu, Rahul, Deepak, Ganesh, Vishal, Prajyot, Ganesh, Shridhar, Sandip, Prabhakar, Jitendra and others for their physical and moral support in successful completion of my research work.*

*No words are enough to record my heartiest gratitude and deep sentiments towards my father Shri. Khaka Narnalikar, mother Sau. Kusumbai Narnalikar, brother Vilas and Sister Vina for their moral support, spiritual inspiration and sharing the difficulties in building my educational career from better to best.*

*I am extremely thankful to either those who helped me directly or indirectly during the investigation.*

*Last but not the least, I appreciate with thanks the help given to me by all those whose names could not be specially mentioned.*

*Last but not least, my special thanks to Vivek Pawar and Balaji Sathe whose immense help made me possible to complete this manuscript.*



**( Narnalikar Vikas Khaka.)**

**Place : Parbhani**

**Date : 6 / 10 / 2010**

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## ABBREVIATIONS

%	=	Per cent
/	=	Per
@	=	At the rate
CD at 5 %	=	Critical difference
cm	=	centimetre
DAS	=	Days after sowing
cm <sup>2</sup>	=	centimetre square
DMP	=	Dry matter accumulation
<i>et al.</i>	=	and others
Fig.	=	Figure
g	=	Gram
GM	=	General mean
ha	=	Hectare
ha/hr	=	Hectare per hour
i.e.	=	That is
kg	=	Kilogram
LAI	=	Leaf area index
M	=	Meter
MW	=	Meteorological week
NS	=	Non significant
°C	=	Degree centigrade
PE	=	Pre emergence
SE±	=	Standard Error
Sq	=	Square
Viz.,	=	Namely
q/ha	=	Quintal per hectare
t/ha	=	tonne per hectare
1 Feddan	=	0.42ha
1 kintar	=	157.5kg



*INTRODUCTION*

## CHAPTER-I

# INTRODUCTION

Grain legumes are major sources of protein in vegetarian diet of the people in India. Pulses also have capability of returning a large amount of dry matter to the soil, help to maintain good physical condition and thereby productivity. Till recently, pulses were considered as a source of protein only, however, recent findings of “National Institute of Nutrition” conducted that pulses not supply 15 to 23% of proteins but also supply 20% calories of the dietary requirement. Thus pulses were valued both for proteins as well as calories requirement. (Anonymous, 1981)

Out of the pulses grown, in Indian pigeonpea and chickpea are the most important and occupying about 60% area and contributing 70% of total production of pulses.

Pigeonpea (*Cajanus cajan* (L.) Millsp) is cultivated in the semi-arid areas of tropics and subtropics. It is a native of Africa and the early traders have introduced the crop in India. The ability of pigeonpea to produce economics yields in soil characterized by moisture deficit makes it an important crop of dry land agriculture. Farmers grow it in various production systems as a mixed crop, intercrop, or a perennial crop using long established traditional practices.

Pigeonpea grains contain 23.3% protein, 35% minerals, 57.6% carbohydrates and provides 335 KCW energy/100g (Anonymous, 1999) since the primary objectives of pigeonpea cultivation has been to meet surplus of grains as such their was not much increase in production and productivity of pigeonpea.

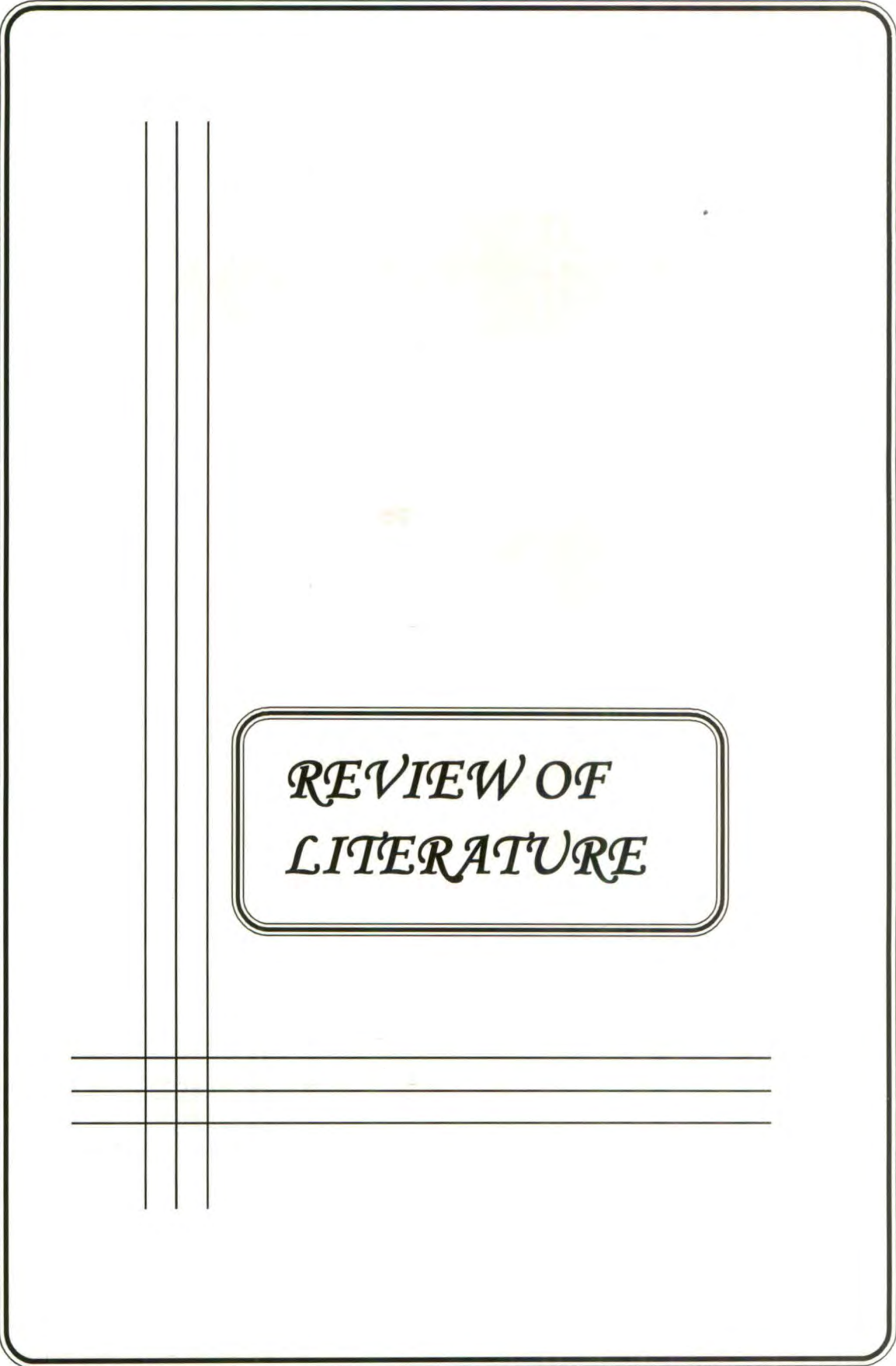
India has the world's largest hectarage 3.5 million ha. of pigeonpea and contributes about 90% of global production 2.4 million tonnes. The major pigeonpea growing states in India are Maharashtra, Madhya Pradesh, Uttar Pradesh, Karnataka and Gujrat. These states together contribute 86.1% of total growing area and 84.5% of total production (Asthana and Chaturvedi, 1999).

Maharashtra ranks first in both area and production of pigeonpea. In Marathwada pigeon pea is grown on an area of 0.46 million hectare. with production 0.37 million tones and productivity of Marathwada region is 818 kg. In Maharashtra, pigeonpea is grown on an area of 1.86 million hectare. With production of 0.85 million tones and productivity 760kg/ha. During the year 2009-2010 area under pigeonpea in India was 3.5 million ha with annual production 2.4 million tones, productivity of pigeonpea at national level 700 kg/ha and productivity at state level 760 kg/ha ([www.faostat.org](http://www.faostat.org)). This clearly indicates that, there is not much increase in yield and stagnated over a period of time with substantial fluctuations in spite of availability of number of disease resistant varieties. It seems the yield of these varieties has not been fully realized and stabilized. It is possible to enhance the productivity when grown as sole or in a cropping system by efficiently managing the crop agronomically.

The present investigation was undertaken to assess the effect of various agronomical practices in increasing and stabilizing the yield of BSMR-736, newly released disease resistant varieties of Marathwada Agricultural University for large scale cultivation in the state. The knowledge of row spacing and planting pattern of transplanted pigeonpea varieties will help to enhance the productivity and stabilize the yield of these varieties.

Therefore, the present investigation entitled “**Effect of irrigations and plant spacing on growth and yield of transplanted pigeonpea**” was under taken with the following objectives.

1. To study the yield performance of transplanted pigeonpea.
2. To study the responses of irrigation on transplanted pigeonpea.
3. To study the responses of plant spacing on transplanted pigeonpea.



*REVIEW OF  
LITERATURE*

## CHAPTER-II

### REVIEW OF LITERATURE

In the current chapter, efforts are being made to present the pertinent literature on research conducted on the various aspects of present investigation under following appropriate heads.

#### 2.1 Effect of plant spacing

##### 2.1.1 Effect of plant spacing on growth

Ahuja (1984) conducted a field experiment at Bichpuri, Agra (U.P.) and reported that number of branches per plant decreased with increase in plant density of pigeon pea.

Kapur *et al.* (1987) observed that the pigeonpea cultivars grown at 65,000 and 1,30,000 plants/ha did not show significant differences in days to flowering or maturity.

Puste (1988) reported that the pigeonpea grown at spacing of 30 and 40 cm between rows and 15 cm between plants gave greater leaf, stem, pod and dry matter yield/plant but lower leaf area index (2.17) and higher crop growth rate (0.53 g/plant/day) than either 40 x 10 cm or 20 x 15 cm between rows and plants, respectively.

Shankarlingappa and Hegde (1989) conducted an experiment at Nagamangala (Karnataka) and observed that the height of pigeonpea grown at 74000 plants/ha was significantly higher than 55555 plants/ha.

Singh and Kaira (1989) while studying in pigeonpea (T-21) noted that closer spacing recorded significantly more plant height

than wider spacings. The dry matter per plant was more under wider spacing than closer spacing.

### **2.1.2 Yield attributes**

Experimental results on short duration pigeonpea (T-21) showed that the number of pods/plant was higher with the plant population of 40,000 compared to 50,000 or 60,000 plants/ha (Singh *et al.*, 1971).

Alkinola and Whiteman (1975) studied different plant densities of pigeonpea observed that dry matter yields/plant decreased with increasing plant density. At higher density, number of pods/plant were also reduced.

Kapur *et al.* (1987) observed that pigeonpea grown at 65,000 and 1,30,000 plants/ha did not show only significant difference in 100 seed weight. However, number of pods/plant observed to be lower with decreasing plant density.

Tripathi and Chauhan (1990) reported that the yield attributes of pigeonpea increased with every decrease in the population because of reduced crop competition. Wider spacing of 40 x 15 cm encouraged more pods/plants, seed/pod and weight of 1000 seeds whereas, closer spacing of 20 x 15 cm with 333 thousand plants/ha recorded maximum seed yield compared to wider spacing of 40 x 15 cm with 167 thousand plants/ha due to higher plant population in closer spacing.

### 2.1.3 Yield

Thakur *et al.* (1985) reported that the pigeonpea crop grown at 50000, 80000 and 100000 plants/ha gave yields of 1.74, 1.58 and 1.60 t/ha, respectively.

Karsono and Sumarno (1987) Conducted a field trial at Muneng experiment station (East Jawa) and observed that the plant spacing of 30 x 10 cm gave the highest average yields to the tonne of 1.34 and 1.64 t/ha in the wet and dry season, respectively.

Singh and Prasad (1987) conducted an experiment at IARI, New Delhi and observed that, increasing density of pigeonpea from 10,0000 to 1,50,000 and 2,00,000 plants/ha decreased average seed yields of pigeonpea cultivars from 2.17 to 1.91 and 1.70 t/ha, respectively.

Patel *et al.* (1984) conducted an experiment in south Gujrat and observed that the pigeonpea cultivar gave higher seed yield with 90 cm row spacing than 50 or 120 cm.

Saraf andHegde (1984) Observed that the grain yield was positively and significantly correlated with plant height, branches per plant, pods per plant, test weight, LAI, AGR, NAR, CGR, and RGR, on the basis of these studies, it was suggested to incorporate larger canopy size and higher growth rate coupled with high pod number per plant for improvement in the productivity of pigeonpea.

Gondalia *et al.* (1988) conducted an experiment at Junagadh (Gujrat) on pigeonpea Cv. ICPL-87 grown in rows 30, 45 or 60 cm apart and reported the seed yields of 1.04, 1.08 and 1.06 t/ha,

respectively. An inter row spacing of 45 cm out yielded the rest by recording significantly the highest yield (1.08 t/ha).

Goyal *et al.* (1989) reported that the average seed yields of pigeonpea in rows spaced at 90 or 120 cm apart were similar and higher than with row spaced 150 cm apart higher seed yield was obtained with 10 cm plant spacing than 20 and 30 cm.

Sinha *et al.* (1989) observed that, the pigeonpea crop sown in rows 30, 50 or 70 cm apart, gave yield of 1.82, 1.52 and 1.32 t/ha, respectively.

Dubey and Upadhyaya (1991) conducted an experiment at Dindori and reported that, the row spacing of 30 and 45 cm gave significantly higher grain yield (10.6 and 11.9 q/ha, respectively) than that of 60 cm (9.5 q/ha). The wider row spacing of 60 cm drastically reduced the grain and stalk yield of pigeon pea.

Singh *et al.* (1991) conducted a trial at Pantnagar (U.P.) on pigeonpea varieties UPAS 120 and Pant A-3 under different inter and intra row spacings and found that seed yield was higher by UPAS 120 than Pant A-3. The yield was observed to be highest at 30 cm row spacing and 20 cm plant spacing.

Mohite *et al.* (1993) while studying the effects of inter and intra row spacing in variety ICPL-87 at Rahuri observed that, the inter row spacing of 30 cm gave significantly higher grain and stalk yields than 45 cm inter row spacing. Intra row spacing of 10 cm gave significantly higher grain and stalk yields than 15 and 20 cm intra row

spacing. Thus for ICPL-87 pigeonpea under Rahuri conditions in their opinion 30 x 10 cm spacing is desirable for optimum yields.

## **2.2 Effect of transplanting**

### **2.2.1 Effect of plant transplanting on growth**

Pan *et al.* (1989) reported that in field trials, seedlings of cotton cv. Yanmain 48 were (a) transplanted 30 days after sowing (b) given 1 per cent urea 30 days after sowing and transplanted 10 days after sowing and transplanted 10 days later compared with (a), all the later transplanting treatments increased plant height, number of true leaves and DW of seedlings, accelerated establishment after transplanting and improved quality (b) was most effective.

Li *et al.* (1990) in field trials in 1988-89 with cotton line 2122 and Cv. Sumain No. 1 sown and transplanted to wheat fields (after harvesting) at different dates and grown at different plant densities from 1600 to 6050 plants/mu, the relationship between rate of boll formation and number of flowering (before 31<sup>st</sup> July, 1-15 August, 16-31 August and 1-10 September). The rate of boll formation (bolls/mu per day) between 1 and 15 August was best correlated with the number of efficient bolls. Plant density affected the rate of boll formation. A plant density of 4600-4800 plants/mu gave the highest rate of boll formation and highest yield.

Hu *et al.* (1994) in 1991-93 studies were made of the adversity (stress) resistance of transplanted cotton pot diameter had a direct effect on seedling quality and adversity resistance than those in small spots from 8 to 12 days after sowing.

Abd-El-Hadi *et al.* (2000) reported that yield and yield components of directly sown (early or late) cotton seeds and transplanted cotton (Cv. Giza-80) plants, under 3 hill spacing (20, 25 and 30 cm) and K rates (0, 24 and 48 kg K<sub>2</sub>O/feddan) were compared in a field experiment conducted in Giza, Egypt, during 1995 on 1996. Plant height at harvest was significantly greater under direct late sowing compared with transplanting at 20 cm between hills. Node number of first fruiting branch was significantly higher for direct late sowing compared with transplanting cotton at 20 cm between hills. The number of total and open bolls per plant was lower under direct late sowing than all transplanting treatments.

### **2.2.2 Effect of transplanting on yield attributes**

Yasseen A-I-H (1993) studied in field experiments at Beheira, Egypt in 1991-92 cotton cv. Giza 70 was sown on 1 Apr. and 1 May directly to the field or sown in nurseries 1 April and transplanted on 1 May and given no foliar P, 1 application at bud stage, 1 application at pre-flowering or 2 applications (1 at bud stage + 1 at pre flowering). All yield components were highest when seedling were transplanted on 1 May except number of plants/feddan and seed index which were highest when sown on 1<sup>st</sup> May and 1<sup>st</sup> April respectively. Number of bolls/plant, number of open bolls/plant, weight of seed cotton/boll and per feddan and lint percentage were all highest with foliar application of P at bud stage + pre-flowering (1 Feddan = 0.42 ha).

Zhang-Jiaohal *et al.* (2001) a 2 year field experiment was conducted in Hubei, China to investigate the effect of early maturation and yield increase of transplanted cotton (*Gossuypium hirsutum* L.)

covered with plastic film (TCCPF) cotton Cv. E main No. 6 transplanted to field plots before 2-euphylla stage at 45,000 plants/ha and covered with plastic film (PF) on April 13, than the PF was taken off on June 20, with the transplanted cotton without PF covering as control. In 1999 the TCCPF had an average lint yield significantly higher than that of controls ( $P < 0.01$ ) and the average yield of lint harvested before October, 10 was 3.9 per cent higher. There were more early bolls, FU bolls and total bolls per plant. The TCCPF increased soil temperature, kept stability of soil moisture and decreased soil bulk density compared to control and the root system vigour at early growth stage was higher. In observations of Flower Bud Differentiation (FBD) in 1998. The TCCPF had a FBD intensity 3.2 per plant per day higher a FBD stage 3 days earlier or number of early bolls (before July, 15), 2.6 per plant more than that of control. The dry matter accumulation amount of TCCPF was higher and its percentage of dry matter distributed to reproduction organs (47.3%) was 3.1 higher.

### **2.2.3 Effect of transplanting on yield**

Kamel *et al.* (1991) reported that, methods for transplanting cotton Cv. Giza 75 seedlings were assessed at Moshtohor in 1987-88 seed cotton yield averaged 6.86 kintar/feddan with direct sowing and 3.56-8.86 kintar after transplanting. Yield was highest when cotton was sown in 18 x 10 cm plastic bags filled with clay soil and lowest with sowing in trays containing 5 x 5 x 7 cm pots all transplanting treatments were more expensive than direct sowing (1 Feddan = 0.42 ha, 1 kintar = 157.5 kg).

Abou-Zeid *et al.* (1995) studied in a field experiment in Egypt on 1990-92, cotton Cv. Giza 75 was sown on 31 March or 1 or 15 May or 30-d-old seedling raised in paper pots or over plastic sheeting were transplanted on 1<sup>st</sup> or 15<sup>th</sup> May or 45<sup>th</sup> d-old seedlings were transplanted on 15<sup>th</sup> May delaying sowing after 31<sup>st</sup> March decreased seed cotton yield, seed cotton yield was significantly decreased under transplanting compared with direct sowing on 31<sup>st</sup> March but 30-d-old seedling transplanted on 1<sup>st</sup> May gave higher yields than crops direct sown on the same date. Seed cotton yields from seedlings raised in paper pots or over plastic sheeting were similar. The lowest seed cotton yields were obtained from transplanting 30-d-old seedling on 15<sup>th</sup> May.

Kamel *et al.* (1994) in field trial in Egypt, 1992-93, 30-or 40-d-old cotton Cv. Giza 75 seedlings were transplanted on 31 March 10 or 20 April at densities of 43000, 51700 or 64600 plants/feddan cotton was also direct sown on the same 3 dates. Seed cotton yield was higher from direct sowing than from transplanting, yield at each transplanting date and plant density was higher from transplanting 30-d-old than 40-d-old seedlings yield was highest with the earliest transplanting date and lower from the lowest plant density than from the other 2 densities.

Radwan *et al.* (2000) field investigation were conducted during 3 successive cotton growing seasons (1993, 1994 and 1995) in Egypt, to evaluate the effect of transplanting and sowing on the population density of sap sucking insects (*Thrips tabaci*, *Aphids gossypii*, *Empoasca lybica*, *Jacobiasca lybica* and *Bemisia tabaci*) infesting cotton plants. Cotton plants that infestation levels but had the highest yield. Transplanted effect of sowing or transplanting date on pest population is also discussed.

## **2.3 Effect of irrigation**

### **2.3.1 Effect of irrigation on growth**

Keatinge *et al.* (1980) reported that vegetative growth, grain yields, pods, seeds and the length of growing season of pigeonpea were reduced by soil moisture stress.

Sinha *et al.* (1981) reported that irrigation applied at commencement of flowering increased the biomass in short, medium and long duration pigeonpea crop.

Bholomik *et al.* (1983) showed that highest yield caused by 2 irrigations at sowing and branching is associated with the manifestation of higher growth attributes like total dry matter accumulation, LAI, CGR and yield attributes like pods per plant, seeds/pod and 1000 seed weight of pigeonpea.

Wilson and Mulchow (1983) showed that *Glycine max* (cv. Buchananda and Durack) *Vigna mungo*, *Vigna radiata*, *Cajanus cajan* when grown on sandy loam soil and irrigated weekly or only during seedling establishment, drymatter yield and LAI were reduced under water stage from 49 to 62 percent and 38 to 51 percent respectively of values for irrigated crops.

### **2.3.2 Effect of irrigation on yield**

Chopra *et al.* (1979) observed that a single irrigation increased total biomass by 22-73 per cent, dry matter by 51 per cent and grain yield by 94-108 per cent of pigeonpea crop.

Sinha (1981) made evaluation of experiments conducted at Hyderabad and concluded that, irrigation applied to pigeonpea after commencement of flowering increased the biomass in short, medium and long duration cultivars.

Bhowmik *et al.* (1983) reported that, two irrigations at sowing and branching in combination with 50 kg P<sub>2</sub>O<sub>5</sub> per hectare produced maximum yields (26.7 q/ha) of pigeonpea (Cv. Hy-1).

Ikramullah and Rao (1983) concluded that, seed yields of pigeonpea grown on an alfisol in Andhra Pradesh were increased by increasing the number of irrigations from 2 to 4 and by increasing the density from 8 to 33 plants per m<sup>2</sup>.

Nilima and Malik (1983) found that, the yields of pigeonpea were highest when irrigated at vegetative stage, intermediate with one irrigation at the flowering stage or two irrigations at both the stages and lowest without irrigation.

Rao *et al.* (1983) conducted experiment on arhar and found that, when crop was sown in September, October, November on a deep vertisol, yields were increased by increasing the number of irrigations from 0 to 3, while the long duration Cv. NP (WR) -15 only gave significant response to one irrigation yields of both Cv. and their response to irrigation decreased with a delay in sowing.

Salih (1983) observed that, irrigation after every 12 days increased yields from 0.66 to 1.4 t/ha as compared with irrigation after every 24 days.

Lal and Gupta (1984) found that, irrigation at early vegetative phase increased yield by 14 per cent, 7 cm irrigation at branching increased yield by 26 per cent and 14 cm at this stage gave best increase (34 per cent) over control.

Bhan and Khan (1979) studied the effect of irrigation at critical growth stages on yields of four crops in Uttar Pradesh and concluded that in dry year of 1974, green gram, black gram, pigeonpea and groundnut gave highest seed yields with two irrigations applied at flower initiation and pod filling stage. When rainfall was adequate and well distributed green gram and black gram gave highest yields without irrigation but pigeonpea and groundnut required one irrigation at podfilling stage.

Results of the experiment conducted by Ramse and Surve (1984) revealed that, two irrigations to pigeonpea grown on medium black soil at critical growth stages i.e. 50 per cent flowering stage and pod filling stage gave 11 per cent more grain yield than no irrigation.

A field experiment conducted on pigeonpea at Hyderabad shown that, seed yield and yield components except seed weight were not significantly affected by irrigation treatments. However, when two irrigations were given at 75 and 105 days after sowing, maximum seed yield of 2133 and 2139 kg/ha recorded during 1978-79 and 1979-80, respectively. This showed that an increase of 19 and 14 per cent with irrigation over no irrigation (Reddy *et al.*, 1986).

Sondge and Rodge (1993) studied that in an field experiment during the winter season, pigeonpea cultivars BSMR-I and BSMR-II were irrigated at IW : CPE ratios of 0.3, 0.6 and 0.9 or not

irrigated (Rainfed). Seed yield increased quadratically with form 0.37 t/ha without irrigation to 1.28 t/ha with irrigation at 0.9 IW : CPE. BSMR-II produced greater yields than BSMR-I only with irrigation at 0.6 and 0.9 IW : CPE.



*MATERIAL AND  
METHODS*

## **CHAPTER-III**

### **MATERIAL AND METHOD**

The details of the materials used and methods adopted during the present investigation are described in this chapter.

#### **3.1 Experimental site:**

The experiment was conducted during kharif season of 2009-10 at Agricultural College Farm, Marathawada Agricultural University, Parbhani.

#### **3.2 Soil :**

The topography of plot was fairly leveled for the purpose of studying physico-chemical properties of soil, soil samples from 0-30 cm strata at random were taken all over the experimental areas before laying out the field.

Representative soil sample was analyzed for various physico-chemical properties viz, Mechanical analysis by International pipette method (piper 1966), available nitrogen by Alkaline permagnate method (Subbaiah and Asija 1965), organic carbon by Walkley and Black method (1934) available phosphorus by olsen method (Chopra and Kanwar, 1976), pH by glass electrode pH meter and electrical conductivity by conductivity bridge. The data presented in Table 1 revealed that the soil of the experimental plot was clayey in texture, low in nitrogen, medium, in phosphorus, rich in potassium and slightly alkaline in reaction.

**Table 1. Mechanical and chemical composition of composite soil sample of experimental field .**

<b>Particulars</b>	<b>Result</b>
<b>A. Mechanical Analysis</b>	
Coarse sand (%)	7.70
Fine sand (%)	11.58
Silt (%)	22.61
Clay (%)	55.60
Textural class (%)	Clayey
<b>B. chemical analysis.</b>	
Total nitrogen (%)	0.059
Available phosphorus (%)	0.0028
Available potassium (%)	0.041
Organic carbon (%)	0.632
Soil pH (%)	8.10
Electrical conductivity (%) (mm hos/cm <sup>3</sup> )	0.29

### **3.3 Cropping history**

The cropping history of the experimental plot for last three years is given in table 2.

**Table 2. Cropping history of experimental plot**

Year	Kharif	Rabi	Summer
2006-07	Soybean	Safflower	Fallow
2007-08	Jowar	Gram	Fallow
2008-09	Soybean	Safflower	Fallow
2009-10	Present Experimental	-	Fallow

It would be seen from table 2 that, residual effect of previous cropping pattern on soil fertility was almost uniform.

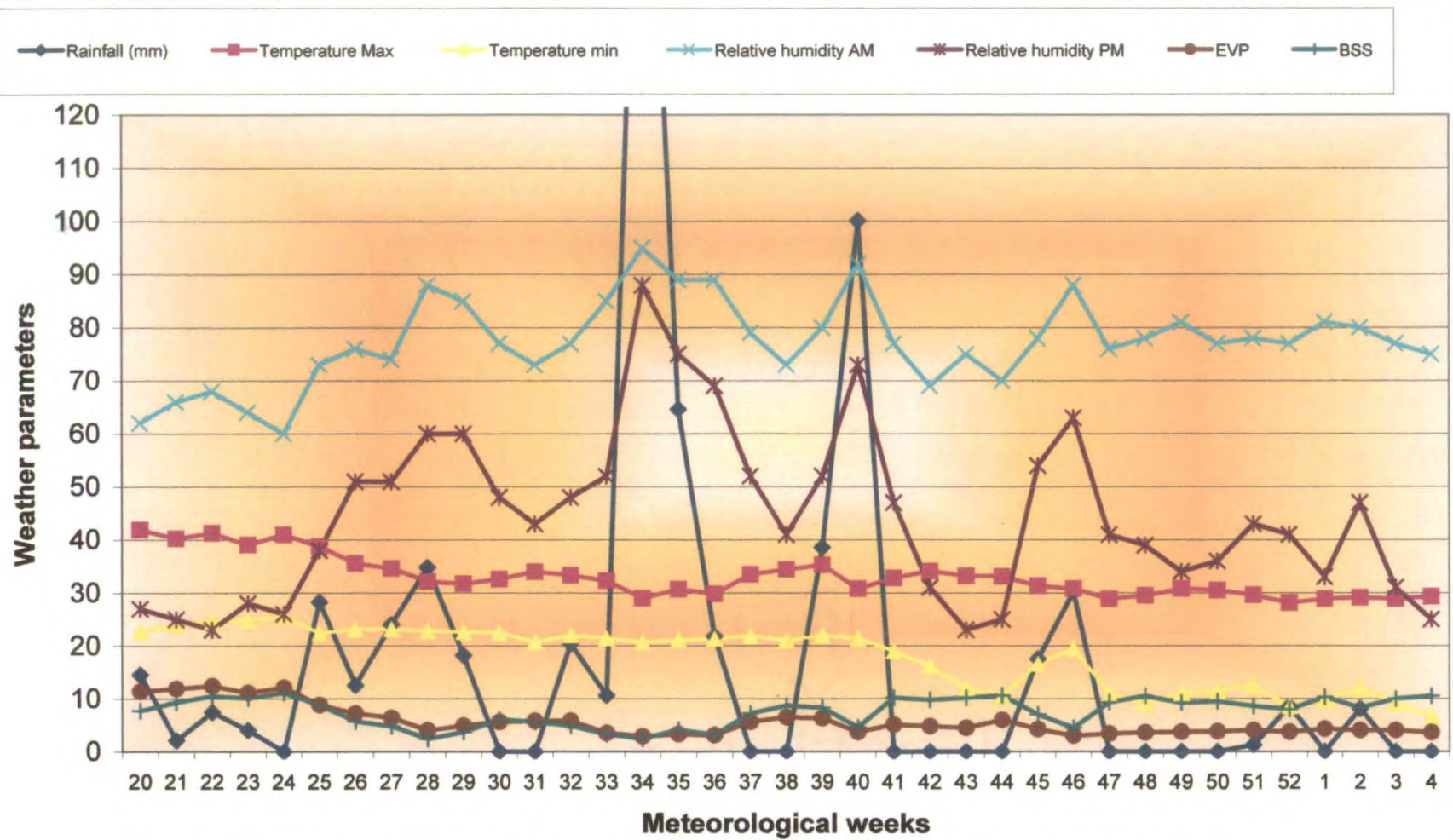
### **3.4 Climate and Weather:**

Parbhani is situated in sub tropical region at 408m above the mean sea level, 19<sup>0</sup>16', north latitude and 76<sup>0</sup>47' East longitude in Marathwada region of Maharashtra state. The mean annual precipitation approximates to 964mm and it is received mostly during June to September. The winter rains are uncertain and scanty. Most of the rainfall was received from south-west monsoon. The mean maximum temperature varies from 28.62<sup>0</sup>C in winter to about 40.9<sup>0</sup>C in summer, where as the mean minimum temperature varies from 12.10C to 24.90C during winter and summer respectively. Thus, climate of Parbhani is characterized with hot and dry summer and cold winter.

The weather data for the experimental period recorded at metrological observatory, Parbhani for the experimental period are given in Table 3.

**Table 3 Weekly weather data recorded during the period of investigation 2009 at Agro meteorological observatory, M.A.U. Parbhani.**

WK	Period	Rainfall (mm)	R.D.	Temperature °C		Humidity (%)		EVP	BSS (Hrs.)	W.V. (kmph)
				Max.	Min.	AM	PM			
20	14-20May	14.5	2	41.9	22.7	62	27	11.4	7.7	7.4
21	21-27May	2.1	0.0	40.3	24.0	66	25	11.9	9.3	8.5
22	28.03 June	7.4	1.0	41.3	24.6	68	23	12.4	10.5	8.9
23	01.10 June	4.0	1.0	39.1	24.8	64	28	11.1	10.1	10.4
24	11.17 June	0.0	0.0	41.0	25.6	60	26	12.1	11.1	9.2
25	18.24 June	28.3	1.0	38.8	22.4	73	38	8.8	8.8	7.3
26	25.01 July	12.5	1.0	35.6	23.1	76	51	7.2	5.7	6.6
27	02.08 July	24.0	1.0	34.6	23.2	74	51	6.4	4.8	7.0
28	09.15 July	34.8	4.0	32.2	22.8	88	60	4.0	2.4	6.5
29	16.22 July	18.2	2.0	31.7	22.6	85	60	4.9	3.7	8.2
30	23.29 July	0.0	0.0	32.6	22.5	77	48	5.6	6.1	8.7
31	30.05 Aug.	0.0	0.0	34.0	20.7	73	43	5.8	5.6	6.6
32	06.12 Aug.	20.4	1.0	33.3	22.0	77	48	5.8	4.9	6.5
33	13.19 Aug.	10.6	3.0	32.3	21.4	85	52	3.5	3.3	6.0
34	20.26 Aug.	207.7	6.0	29.0	20.7	95	88	2.9	2.4	4.4
35	27.02Sept.	64.6	2.0	30.7	21.1	89	75	3.3	4.1	5.6
36	03.09Sept.	21.8	3.0	29.8	21.3	89	69	3.1	3.2	6.6
37	10.16Sept.	0.0	0.0	33.5	21.9	79	52	5.6	7.2	3.7
38	17.23Sept.	0.0	0.0	34.4	21.0	73	41	6.5	8.7	3.5
39	24.30Sept.	38.6	2.0	35.3	22.0	80	52	6.3	8.3	5.4
40	01.07 Oct.	100.1	3.0	30.8	21.5	92	73	3.7	4.6	4.9
41	08.14 Oct.	0.0	0.0	32.8	19.0	77	47	5.1	10.2	3.0
42	15.21 Oct.	0.0	0.0	34.1	16.2	69	31	4.8	9.8	2.6



**Fig. 1 : Weekly weather data recorded during the course of investigation at meterological observatory, Department of Agricultural Meteorology M.A.U., Parbhani**

43	22.28 Oct.	0.0	0.0	33.2	12.0	75	23	4.5	10.2	3.0
44	29.04 Nov.	0.0	0.0	33.1	10.5	70	25	6.0	10.6	4.9
45	05.11 Nov.	17.5	2.0	31.3	16.6	78	54	4.2	7.0	6.0
46	12.18 Nov.	30.2	3.0	30.8	19.5	88	63	3.0	4.5	4.2
47	19.25 Nov.	0.0	0.0	28.9	10.9	76	41	3.4	9.3	2.9
48	26.02 Dec.	0.0	0.0	29.5	9.0	78	39	3.6	10.5	2.8
49	09.09 Dec.	0.0	0.0	30.8	11.0	81	34	3.7	9.2	2.4
50	10.16 Dec.	0.0	0.0	30.5	11.5	77	36	3.8	9.5	2.9
51	17.23 Dec.	1.3	0.0	29.6	12.5	78	43	4.0	8.6	4.4
52	24.31 Dec.	8.5	1.0	28.1	8.5	77	41	3.7	8.0	4.0
1	01.07 Jan.	0.0	0.0	28.9	9.8	81	33	4.3	10.3	3.5
2	08.14 Jan.	8.1	1.0	29.1	12.0	80	47	4.0	8.3	4.0
3	15.21 Jan.	0.0	0.0	28.9	9.1	77	31	4.0	10.0	3.5
4	22.28 Jan.	0.0	0.0	29.3	6.6	75	25	3.6	10.5	3.3

The total amount of rainfall recorded during the crop life period was 666.9 mm spread over 40 rainy days. The onset of south-west monsoon was noticed in 22<sup>nd</sup> MW. i.e 7.4 mm subsequently 4mm rains were received during 23<sup>rd</sup> MW followed by 38.3 mm in 25<sup>th</sup> MW. And 12.5 mm received 26 MW. Thus about 129.2 mm precipitation was received from 22<sup>nd</sup> to 29<sup>th</sup> MW which was sufficient to undertake Transplanting operations. Therefore Transplanting of pigeon pea was undertaken during third week of July i.e. on 16 July 2009. Frequent rains during subsequent period resulted in better plant establishment. In experimental field after that during July 2<sup>nd</sup> to October 1<sup>st</sup> about 504.8 mm rainfall was received in 27 rainy day which helps in better establishments of transplanted pigeon pea .

Thus, the total precipitation received during the crop growth period in 2009-10 was 666.9 mm in 40 rainy days which was slightly less than that of normal. The mean maximum temperature during week of transplanting is 31.7 °C and minimum is 22.6 °C in 29 MW. The mean maximum temperature during harvest week is 28.9 °C and minimum is 9.8 °C in 1<sup>st</sup> MW. The maximum and minimum temperature during crop life period is 35.3 °C and 8.5 °C. The mean relative humidity of morning and evening hours ranged between 76.80 % and 42.68 % during crop life period.

### **3.5 Experimental Details :**

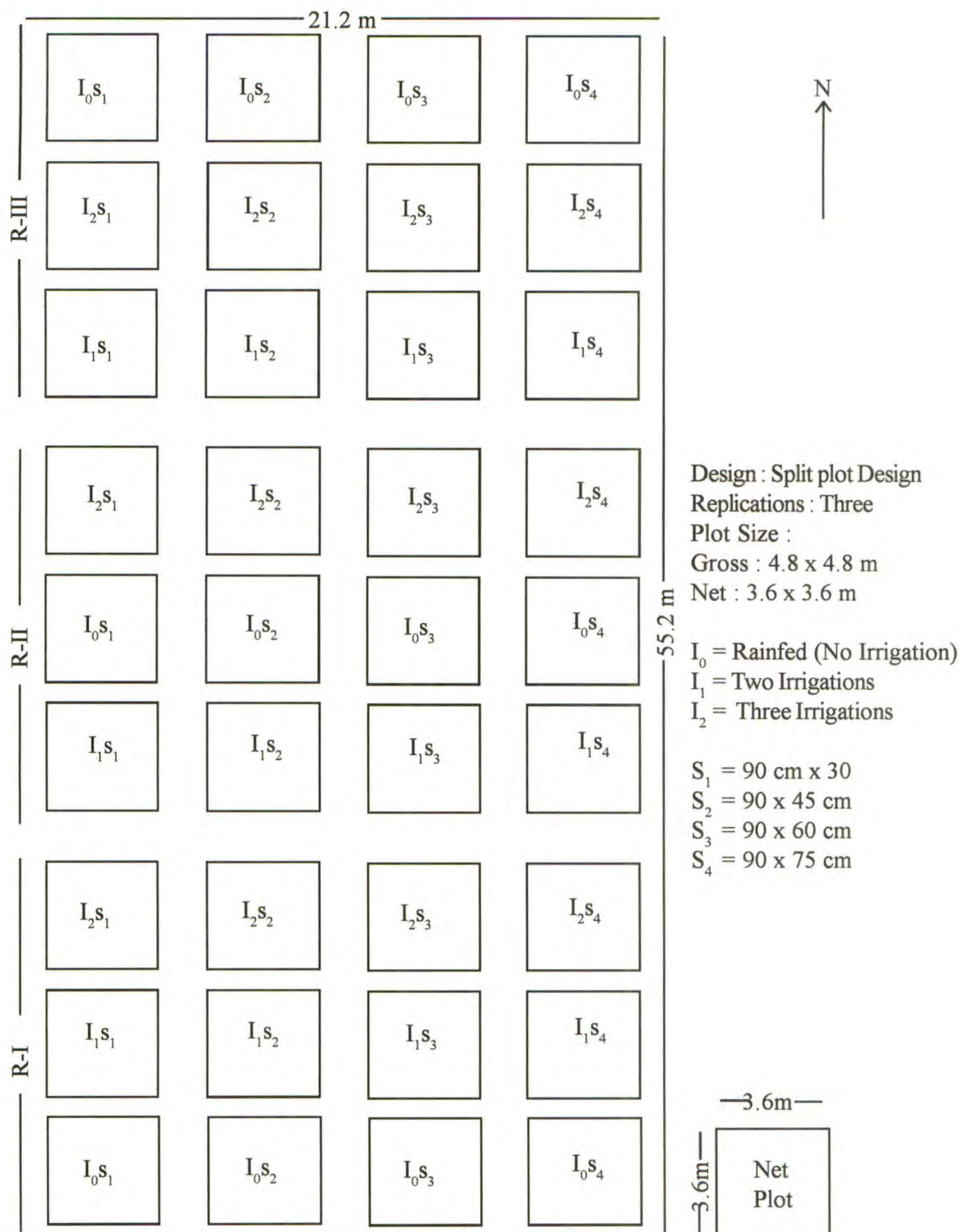
#### **3.5.1 Design and Treatments :**

The present experiment was laid out in split plot design and replicated thrice; the treatment consisted of three irrigation and four plant spacing.

##### **A) Main Plot Treatment (Irrigations)**

1. I<sub>0</sub> - Rainfed (No Irrigation)
2. I<sub>1</sub> - Two Irrigations. (Bud initiation stage and pod development stage).
3. I<sub>2</sub> - Three Irrigations. (Bud initiation stage, flowering stage and pod development stage).





**Fig 1 Plan of Layout**

## **B) Sub Plot (Spacing's)**

S <sub>1</sub>	-	90 cm x 30 cm
S <sub>2</sub>	-	90 cm x 45 cm
S <sub>3</sub>	-	90 cm x 60 cm
S <sub>4</sub>	-	90 cm x 75 cm

### **3.5.2 Layout :**

Plan of layout is depicted in Fig. 1 and actual layout of different treatments in fig. 2. The experimental field was laid out as pre plan after preparatory tillage. The gross plot size was 4.8 x 3.6m. The distance between two plot was 1 m and between two replication was 2 m/. The treatments were allotted to different plots randomly for each main plot and sub plot in a replication.

## **3.6 Details of cultural operations**

Details of cultural and other operations carried out during experimental period are given in table 4

### **3.6.1 Preparatory Tillage :-**

The land was ploughed with mould board plough and brought to fine tilth by subsequent two harrowings, stubbles of previous crop were collected and field was kept ready for transplanting in given layout.

### **3.6.2 Preparation of Seedlings :**

Seedlings was prepared in raised bed of size 3m x 2m x 0.15m. Length, breadth, and height. Six beds were

prepared and seeds were sown on date 15/06/09 on raised bed, one month seedlings were used for transplanting to main plot.

### **3.6.3. Fertilizer Applications :**

Recommended dose of fertilizer at the rate of 25 kg N and 50 kg P<sub>2</sub>O<sub>5</sub> per hectare was applied through D.A.P. and single super phosphate. Entire dose of Fertilizer was applied uniformly as a basal one.

### **3.6.4 Intercultural operation:**

Intercultivation three hand weedings and two hoeings were under taken to conserve the soil moisture and control weeds.

### **3.6.5 Plant protection**

The infestation of leaf folder was noted on the crop which was controlled by spraying of Chloropyriphos @25 ml/10 lit. of water at flowering stage, infestation of pod borers was noticed on the crop which was controlled by spraying of Quinolphos (25%) @ 25 ml/10 lit. of water.

### **3.6.6 Irrigation**

Irrigation was given by check basin method as per treatment details of Three irrigations i.e (at Bud initiation stage, flowering stage and pod development stage) and two Irrigations (at Bud initiation stage and pod development stage).



**Pigeon pea Seedlings**



**General view of experiment at 90 days**

**Plate 1. General view of pigeon pea seedlings and experimental plot**

### **3.6.7 Harvesting and Threshing :**

Before harvesting, the crop from net plots, observation plants were taken out from each net plot for recording post harvest observations per plant. The net plots were marked and the plants in border lines were harvested first, then the plant from net plots were harvested and sundried for a period of week.

The seed were separated by hand threshing and winnowing. The grain, stalk and biomass yields inclusive of tagged plants from each net plot were recorded separately.

### **3.6.7 Harvesting and Threshing :**

Before harvesting, the crop from net plots, observation plants were taken out from each net plot for recording post harvest observations per plant. The net plots were marked and the plants in border lines were harvested first, then the plant from net plots were harvested and sundried for a period of week.

The seed were separated by hand threshing and winnowing. The grain, stalk and biomass yields inclusive of tagged plants from each net plot were recorded separately.

**Table-4:- Schedule of cultural operations carried out in experimental plot.**

<b>Sr. No.</b>	<b>Operation</b>	<b>Frequency</b>	<b>Date of Operative</b>
A	Preparatory Tillage		
1	Ploughing	1	23/05/09
2	Harrowing	2	08/06/09
3	Cleaning	1	26/06/09
B	Sowing		
1	Sowing of Seed on Raised bed	1	15/06/09
2	Layout of field and fertilizer application	1	08/07/09
3	Transplanting	1	16/07/09
4	Gap filling	1	24/07/09
C	Intercultural Operations		
1	Hand weeding	3	07/08/09, 22/08/09, 10/09/09
2	Hoeing	2	06/08/09, 28/08/09
3	Fertilizer application	1	20/8/09
4	Irrigation Treatment	3	26/10/09, 14/11/09, 01/12/09
D	Plant Protection	2	25/08/09, 28/11/09
E	Harvesting	1	07/01/2010

**Table : 5:- Biometric Observations of Pigeon pea.**

<b>Sr. No.</b>	<b>Particulars</b>	<b>Frequency</b>	<b>DAS</b>	<b>Size of sample</b>
A	Pre harvest studies			
1	Initial plant stand	1	60 DAS	All plants in net plot
2	Height of plant (cm)	5	60,90,120,150 DAS and at harvest	Five random plant from each net plot
3	No. of functional leaves/plant	5	60,90,120,150 DAS and at harvest	Five random plants from each net plot
4	Leaf area/plant	5	60,90,120,150 DAS and at harvest	Five random plants from each net plot
5	Number of branches/plant	5	60,90,120,150 DAS and at harvest	Five random plants from each net plot
6	Total dry matter/plant	5	60,90,120,150 DAS and at harvest	Five random plants from each net plot
B	Post harvest study			
1	Final plant stand	1	At harvest	All plant in net plot
2	Number of pods/plant	1	At harvest	Five random plants from each net plot
3	Number of grains/pod	1	At harvest	Five random plants from each net plot
4	Weight of pods/plant (g)	1	At harvest	Five random plants from each net plot
5	Weight of grains/plant(g)	1	At harvest	Five random plants from each net plot
6	1000 grains weight (g)/ test weight	1	At harvest	1000 seeds weight from each net plot
7	Pod yield/ net plot (g)	1	At harvest	All plant in net plot
8	Grain yield/net plot (kg)	1	At harvest	All plant in net plot

9	Straw yield/net plot (kg)	1	At harvest	All plant in net plot
10	Biological yield/net plot (kg)	1	At harvest	All plant in net plot
11	Harvest index	1	At harvest	All plant in net plot

### **3.7 Collection of Data**

The data on important biometric observations were recorded on randomly selected five plants in each net plot with an interval of 30 days from 60 days after transplanting up to harvest. The details of biometric observations recorded are specified in Table – 5

#### **3.7.1 Initial plant stand and final plant stand :**

The number of initial plant stand from each net plot was recorded at 60 DAS and expressed as percentage to the theoretical population, similarly. The final plant stand from each net plot was recorded of harvest and expressed at percentage to the theoretical population

#### **3.7.2 Height of plant :**

The height of the main shoot of each plant was recorded from ground level to the base of apical bud with an interval of 30 days up to harvest.

### **3.7.3 Number of functional leaves per plant :**

Progressive number of functional leaves i.e. fully opened green leaves per plant, was counted on selected plants a 30 days interval and recorded up to harvest.

### **3.7.4 Leaf area per plant :**

The leaf area was calculated by using the plant uprooted for dry matter accumulation study from each net plot periodically. The leaves were separated and grouped into three grades viz., small, medium and big by visual observation. The grade wise leaves were counted and their frequency was recorded. The maximum length and breadth of two representative leaves from each grade was measured and the mean was worked out. The leaf area was calculated by using the formula for each grade.

$$A = L \times B \times K \times N$$

Where,

A – Leaf area in cm<sup>2</sup> under the particular group

B- Maximum average breadth of leaf in cm

K – Leaf area constant (0.7369, Muley, 1991)

N – Number of leaves under particular group

The leaf area of three grades was summed up and total leaf area in cm<sup>2</sup> per plant are given.

### **3.7.5 Number of primary branches per plant:**

Number of branches per plant was counted and recorded on selected plants from 60 DAS to harvest at 30 days interval.

### 3.7.6 Dry matter accumulation studies:

The selected plants, one each from net plot were uprooted carefully at every observation. The roots were removed and cleaned off the soil. These plants were cut and kept in paper bag labeled separately, air dried in the first instance and then oven dried at 70<sup>0</sup>C for 48 hours. Their final constant dry weights excluding roots were recorded.

### 3.8 Growth analysis:

#### 3.8.1 Absolute growth rate (AGR) :

Absolute growth rate is the total gain in height or weight of plant within a specific time interval. It is generally expressed as cm/day in case of plant height and g/day in case of dry matter production and is calculated by using the formula given by Richards (1960).

$$\text{AGR for plant height} = \frac{(H_2 - H_1)}{(t_2 - t_1)}$$

Where

H<sub>2</sub> and H<sub>1</sub> refer to plant height recorded at t<sub>2</sub> and t<sub>1</sub> time, respectively.

$$\text{AGR for dry matter} = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

Where,

W<sub>2</sub> and W<sub>1</sub> refer to plant dry matter recorded at t<sub>2</sub> and t<sub>1</sub> time respectively.

### 3.8.2 Relative growth rate (RGR) :

According to Blackman (1919), the increase in the drymatter of a plant in a process of continuous compound interest, where in the increment in any time interval adds to the capital for the subsequent growth. This rate of increment is called as relative growth rate (RGR) and it is expressed in g/g/day. This growth constant was worked 30 days interval by using the formula given by Fisher (1921).

$$\text{RGR} = \frac{(\log_e W_2 - \log_e W_1)}{(t_2 - t_1)}$$

Where,

$\log_e$  – Natural logarithm = 2.3026

$W_2$  and  $W_1$  are the total dry weight at  $t_2$  and  $t_1$  times, respectively.

### 3.8.3 Net assimilation rate (NAR) :

According to Gregori (1926), net assimilation rate is the rate of increase of dry weight per unit leaf area and it is expressed in g/g/cm<sup>2</sup>/day. This growth function was calculated by using formula.

$$\text{NAR} = \frac{(W_2 - W_1) \log_e A_2 - \log_e A_1}{(t_2 - t_1) (A_2 - A_1)}$$

Where,

$\log_e$  = Natural logarithm = 2.3026

$A_2$  and  $A_1$  refer to total leaf area per plant and  $W_2$  and  $W_1$  refers to dry weight recorded at time  $t_2$  and  $t_1$  respectively.

### 3.8.4 Leaf area index (LAI) :

Since, the crop yield is to be expressed per unit of ground area instead of per plant, the leaf area existing on unit ground area was proposed by Watson (1952) as an appropriate measured of crop growth. This measure is known as leaf area index (LAI). It is dimensionless ratio and calculated by formula:

$$\text{LAI} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Ground area per plant (cm}^2\text{)}}$$

### 3.9 Post harvest studies :

#### 3.9.1 Number of pods per plant at harvest:

The number of developed pods from five observation plant is counted and average per plant was worked out.

#### 3.9.2 Weight of pods per plant :

The dry weight of the pods separated from the five selected plants were recorded and the average weight (g) per plant was worked out.

#### 3.9.3 Number of grains per pod:

The number of grains per pod of the selected five plants was counted and the average number of grains was worked out.



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#### **3.9.4 Grain weight per plant**

Total weight of grains after threshing of five selected plants was recorded and it was divided by five to obtain mean grain yield per plant.

#### **3.9.5 Test weight :**

Weight of 1000 grains from the produce of each net plot was recorded in g as test weight separately for each treatment.

#### **3.9.6 Grain yield per plot :**

The plants from each net plot were harvested and kept for sun drying for one week. The pods were plucked, weighed and threshed with wooden hand thresher. Grains were cleaned after winnowing. The weight of clean grain per plot was recorded in kg which was converted to q/ha.

#### **3.9.7 Stalk yield per plot :**

The plants from each net plot were threshed and after threshing the weight of stalk was recorded as stalk weight / plot (kg) and was converted to stalk yield / ha.

#### **3.9.8 Bhoosa yield per plot :**

The bhoosa yield was computed by subtractive grain yield and stalk yield from the total weight of crop bundle, weighed before threshing.

### **3.8.9 Biological yield:**

The weight of the harvested and sundried plants in bundle from each net plot was recorded as biological yield per plot and then converted to biological yield per hectare.

### **3.10 Harvest Index:**

Harvest index indicates the yielding ability and efficiency of a crop to produce grain per unit of total biological yield. It was calculated by formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$



*EXPERIMENTAL  
FINDINGS*

## CHAPTER-IV

### EXPERIMENTAL FINDINGS.

The summarized data on the different aspects of present investigation with statistics and their interpretations are presented in this chapter.

#### **4.1. Initial plant stand and final plant stand: -**

Data on percent initial plant stand and final plant stand are presented in table 6. It is clear from the data presented in table 6 that plant population at initial stage and at harvest was not significantly influenced due to various treatments and their interactions. This indicates that the variations obtained in the different parameters under study are the real effects of treatments.

#### **4.2. Biometric Observations: -**

##### **4.2.1. Height of the plant: -**

Data on mean plant height (cm) recorded at different growth stages of the crop are presented in Table 7. The plant height was found to be increased progressively at every stages of crop growth till maturity. The rate of increase in plant height was as operatively slow during early period of growth up to (60 days), fast during 60 to 90 and

**Table 6:- Initial plant stand and final plant stand in (percent) as influenced by various treatments.**

<b>Treatments</b>	<b>Initial plant stand(%)</b>	<b>Final plant stand(%)</b>
Irrigations		
I <sub>0</sub>	93.25	90.12
I <sub>1</sub>	93.40	89.91
I <sub>2</sub>	93.45	89.89
SE ±	0.058	0.28
CD at 5%	NS	NS
Plant spacing		
S <sub>1</sub>	93.36	90.34
S <sub>2</sub>	92.44	88.42
S <sub>3</sub>	94.09	90.97
S <sub>4</sub>	93.59	90.17
SE ±	0.59	0.70
CD at 5%	NS	NS
Interactions		
IXS		
SE ±	1.03	1.21
CD at 5%	NS	NS
G.M.	93.37	89.97

**Table 7:- Mean plant height (cm) at various growth stages as influenced by various treatments.**

Treatment	Days after Sowing				
	60	90	120	150	At harvest
Irrigations					
I <sub>0</sub>	32.17	90.45	159.89	165.32	169.4
I <sub>1</sub>	31.22	94.60	164.83	176.65	213.71
I <sub>2</sub>	31.54	96.20	173.95	195.73	217.90
SE±	0.90	1.34	0.57	0.52	1.66
CD at 5%	NS	NS	1.72	1.54	4.95
Spacing					
S <sub>1</sub>	32.85	95.86	169.50	182.73	203.37
S <sub>2</sub>	32.33	95.13	167.27	180.27	201.84
S <sub>3</sub>	30.50	92.80	165.60	178.53	199
S <sub>4</sub>	30.90	91.20	162.50	175.40	197.13
SE±	0.59	1.04	1.25	1.27	2.45
CD 5%	1.75	3.09	3.73	3.78	7.27
Interaction					
IxS					
SE±	1.02	1.80	2.17	2.21	4.24
CD at 5%	NS	NS	NS	NS	NS
GM	31.64	93.75	166.22	179.23	200.34

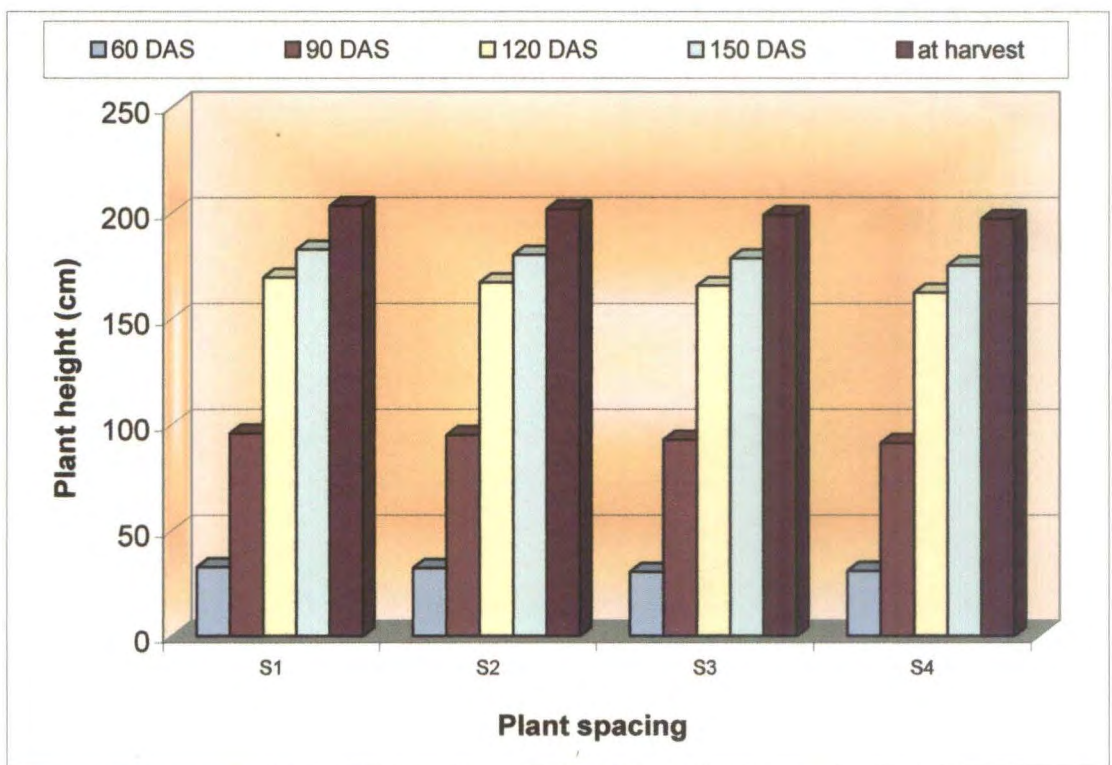
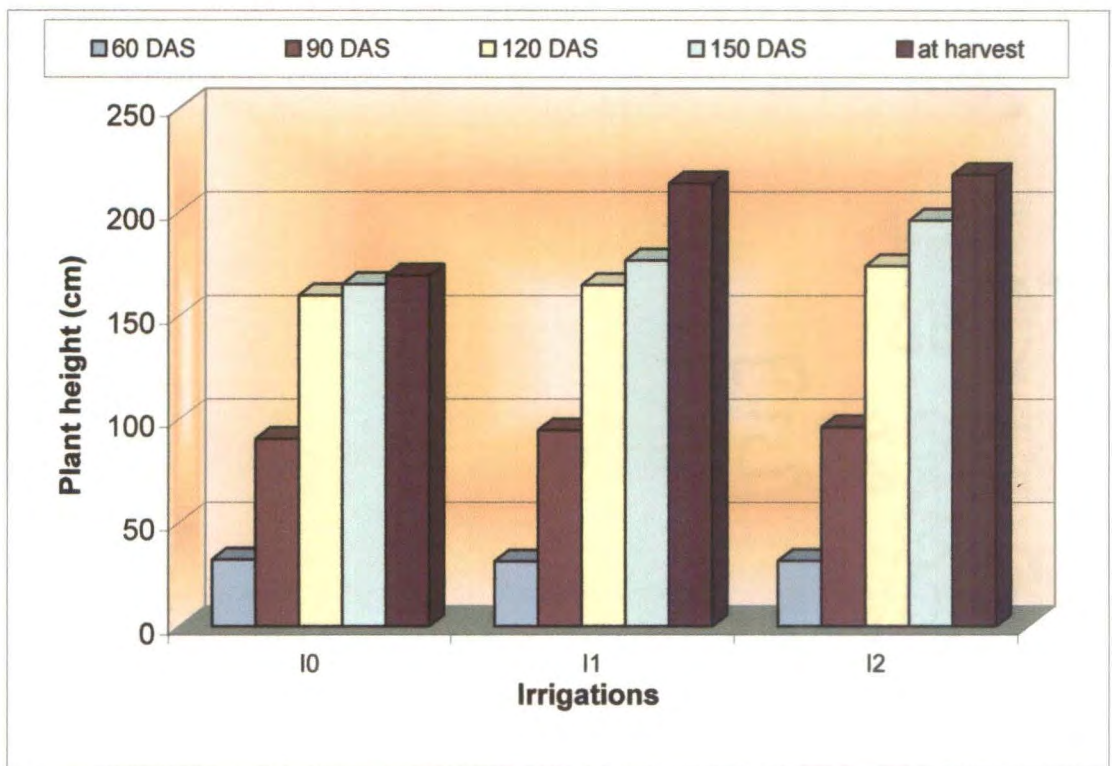


Fig. 3 : Mean plant height (cm) as influenced by different treatments

90 to 150 days and much faster between 90 to 120 DAS. It was almost constant after 150 days after transplanting.

**Irrigations: -**

The mean plant height was significantly influenced due to various irrigations at all stages of crop growth till harvesting. The height at 90 days recorded non significant. At these stages the no. of irrigations three and two, were at par with each other and found significantly superior over rainfed treatment.

**Plant spacing: -**

The mean plant height was significantly influenced due to various plant spacing at all stages of crop growth till harvesting. At these stages the plant spacing 30 cm and 45 cm were at par with each other and found significantly higher than 60 cm and 75 cm plant spacing.

**Interaction: -**

The interactions were found to be non significant.

**4.2.2 Number of functional leaves per plant: -**

Data on mean number of functional leaves per plant recorded at various growth stages are presented in table – 8. The mean number of leaves per plant increased slowly up to 60 DAS. Rapidly up to 120 DAS but decreased progressively these after till maturity due to leaf senescence.

**Table 8:- Mean number of functional leaves per plant at various growth stages as influenced by various treatments.**

Treatment	Days after transplanting				
	60	90	120	150	At harvest
Irrigations					
I <sub>0</sub>	10.25	235.98	291.4	176.95	83.9
I <sub>1</sub>	10.22	237.50	375.37	442.25	163.47
I <sub>2</sub>	9.85	256.75	393.18	534.02	232.77
SE±	0.10	2.37	1.87	2.75	3.20
CD at 5%	NS	7.05	5.55	8.18	9.49
Spacing					
S <sub>1</sub>	9.8	233.87	347.53	377.97	152.87
S <sub>2</sub>	10.06	240.43	353.27	377.47	156.70
S <sub>3</sub>	10.20	245.90	351.72	387.3	163.23
S <sub>4</sub>	10.36	253.43	360.73	394.90	167.4
SE±	0.29	4.42	3.01	3.97	3.97
CD at 5%	NS	13.12	8.95	11.79	11.79
Interaction					
IxS					
SE±	0.50	7.66	5.22	6.88	6.88
CD at 5%	NS	NS	NS	NS	NS
G.M.	10.10	243.41	353.31	384.41	160.05

**Irrigations: -**

The effect of irrigations on number of functional leaves were significant at all growth stages of the crop till maturity except 60 DAS it was non significant. At all the stages of crop growth, the irrigation treatments of three irrigation and two irrigations were found significantly superior over rainfed treatment in respect of functional leaves production.

**Plant spacing: -**

The effect of plant spacing's on number of functional leaves were significant at all stages except at 60 days after transplanting. At 90 and 120 days, 45 cm and 60 cm plant spacing were at par and recorded significantly higher functional leaves than 30 cm at other stages (90,120,150 days) 75 cm plant spacing was significantly superior over 30 cm, 45 cm and 60 cm plant spacing. Similarly 60 cm plant spacing was significantly superior over 30 cm plant spacing.

**Interaction: -**

The effect of interactions on number of functional leaves were non significant at all stages of crop growth. The relevant data at these stages are presented in table 8.

**Table 9:- Mean leaf area per plant (dm<sup>2</sup>) at various growth stages as influenced by various treatments.**

Treatment	Days after transplanting				
	60	90	120	150	At harvest
Irrigations					
I <sub>0</sub>	179.40	3930.4	3880.7	2123.2	502.9
I <sub>1</sub>	178.96	3955.8	5044.8	5218.1	980
I <sub>2</sub>	169.74	4276.4	5236.1	6300.9	1395.5
SE±	3.05	67.11	60.3	86.75	26.66
CD at 5%	NS	199.1	178.91	257.36	79.11
Spacing					
S <sub>1</sub>	171.52	3895.3	4528.2	4359.6	816.42
S <sub>2</sub>	176.19	4004.6	4604.6	4400.9	839.40
S <sub>3</sub>	178.53	4095.7	4743.2	4569.7	978.58
S <sub>4</sub>	177.90	4221.1	5006.1	4859.4	1203.6
SE±	2.03	69.67	87.67	90.82	45.3
CD at 5%	NS	206.68	260.1	269.43	134.57
Interaction					
IxS					
SE±	3.52	120.67	151.86	157.30	78.57
CD at 5%	10.44	NS	NS	NS	NS
G.M.	176.04	4054.2	4720.5	4547.4	959.49

### **4.2.3 Leaf Area per plant: -**

The data on leaf area per plant ( $\text{dm}^2$ ) as influenced by various treatments at different growth stages of the crop are presented in table 9. Mean leaf area per plant increased rapidly up to 120 days and there after decreased gradually due to leaf senescence. The rate of increase in leaf area per plant was observed to be much faster during 90 to 120 days after transplanting in rainfed treatment and 90 to 150 days after transplanting in irrigation treatment.

### **Irrigation: -**

Leaf area per plant was found to be significant due to effect of irrigations at all stages of growth except at 60 days after transplanting. At 150 days after transplanting of  $I_2$  (i.e. three irrigation) treatment produced maximum leaf area per plant ( $6300.9 \text{ cm}^2$ ) followed by  $I_1$  (i.e. Two irrigation) treatments ( $5218.1 \text{ cm}^2$ ). All these two irrigation treatment produced significantly more leaf area over  $I_0$  (i.e. rainfed) treatment. ( $2123.2 \text{ cm}^2$ )

### **Plant Spacing: -**

Mean leaf area per plant was significantly influenced by various plant spacing's during all the stages of crop growth except 60 DAS. Plant spacing of 75 cm put forth significantly highest leaf area over 60 cm, 45 cm and 30 cm plant spacing.

**Interaction: -**

The interaction effect of irrigation to plant spacing was found significant at 60 days only and other all interaction effects were found to be non significant with leaf area per plant.

**4.2.4 Number of Branches per plant: -**

Effect of different irrigations on mean number of branches per plant was found to be significant at all stages of growth except 60 days. It is revealed from the table 10 that number of branches produced by three irrigations ( $I_2$ ) at (i.e. Bud initiation stage, flowering stage and pod development stage) and two irrigations i.e ( $I_1$ ) at (Bud initiation stage and pod development stage) were at par with each other and produced significantly more number of branches per plant over rainfed ( $I_0$ ).

**Plant Spacing: -**

The number of branches per plant were influenced significantly by different plant spacing at all growth stages except 90 DAS, 60 cm and 45 cm plant spacing was at par and significantly superior over 30 cm. The 75 cm plant spacing was significantly superior over all the plant spacing.

**Interaction: -**

The effects of interactions on number of branches per plant were non significant at all growth stages.

**4.2.5 Mean Dry matter accumulation (g per plant): -**

The data on mean dry matter accumulation per plant at various stages of crop growth as influenced periodically by different treatments as shown is table. 11 The mean dry matter per plant at 60, 90, 120, 150 and at harvest was 2.59, 48.77, 112.51, 218.72 and 299.78 g/plant respectively. The total dry matter accumulation per plant increased from 2.59 g/plant at 60 days to 299.78 g/plant at harvest.

**Table 10:- Mean number of branches per plant at various growth stages as influenced by various treatments.**

Treatment	Days after transplanting				
	60	90	120	150	At harvest
Irrigations					
I <sub>0</sub>	3.1	13.4	14.97	17.85	19.20
I <sub>1</sub>	3.0	18.5	24.90	27.55	28.73
I <sub>2</sub>	3.15	19.75	25.70	28.50	30.10
SE±	0.049	0.37	0.76	0.44	1.35
CD at 5%	NS	1.10	2.2	1.30	4.01
Spacing					
S <sub>1</sub>	2.9	16.73	19.23	21.93	23.31
S <sub>2</sub>	3.1	17.06	21.70	24.26	25.73
S <sub>3</sub>	3.1	17.30	22.06	25.00	26.30
S <sub>4</sub>	3.2	17.80	24.43	27.33	28.70
SE±	0.04	0.80	1.18	1.16	0.91
CD at 5%	0.12	NS	3.52	3.45	2.70
Interaction					
IxS					
SE±	0.07	1.53	2.05	2.01	1.57
CD at 5%	NS	NS	NS	NS	NS
G.M.	3.10	17.22	21.85	24.63	26.01

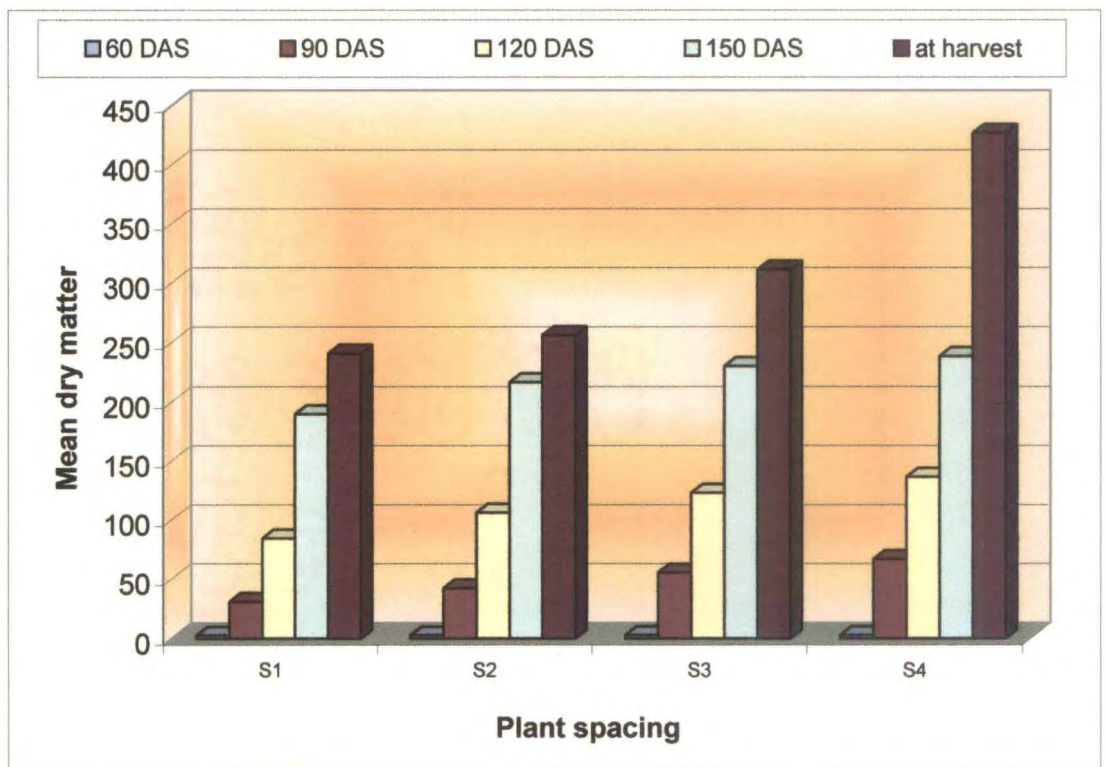
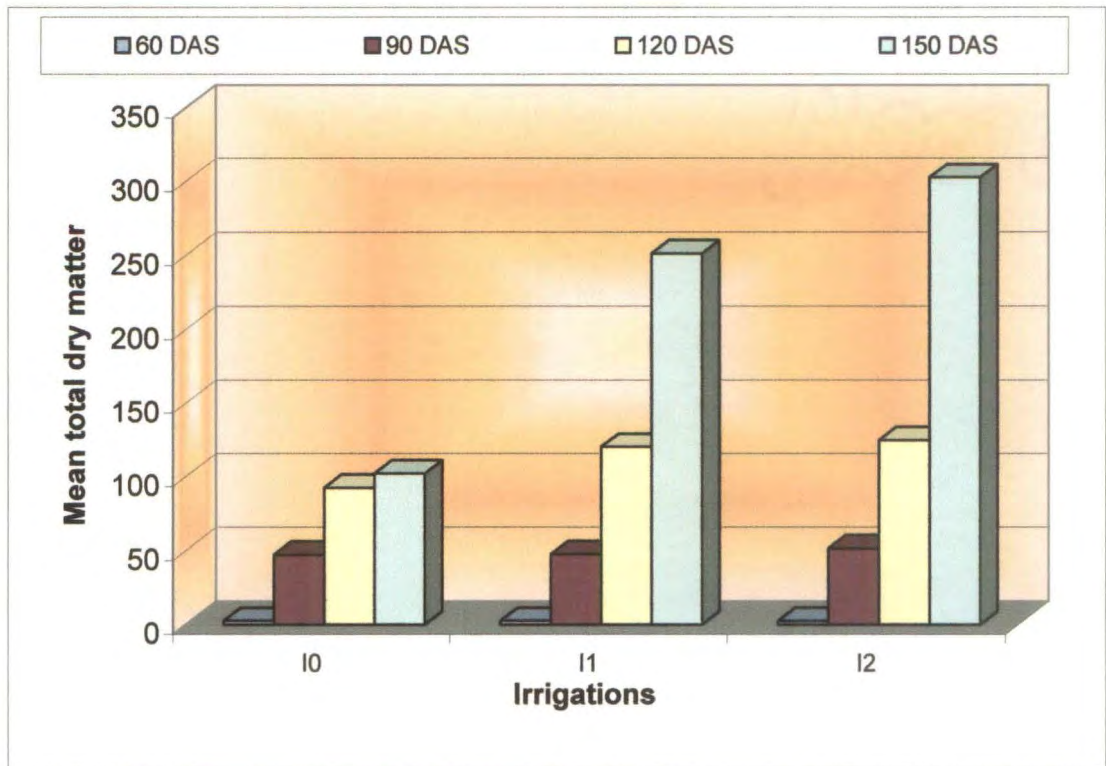


Fig. 4 : Mean dry matter weight (g plant<sup>-1</sup>) at various growth stages

**Irrigations: -**

The dry matter accumulation per plant was found to be significant due to irrigations at all stages except 60 and 90 days after transplanting maximum dry matter was observed with (I<sub>2</sub>) i.e Three irrigations (417.07 g/plant) and followed (I<sub>1</sub>) i.e Two irrigations (305 g/plant). These two treatments (I<sub>2</sub> and I<sub>1</sub>) accumulated significantly more dry matter over rainfed (I<sub>0</sub>) (177.28 g/plant).

**Plant Spacing: -**

The dry matter accumulation per plant was significantly influenced by various plant spacing's at all stages except at 60 days. At all growth stages 75 cm plant spacing accumulated significantly higher dry matter than 60 cm, 45 cm and 30cm.

**Interaction: -**

The effect of interaction between irrigations and plant spacing on dry matter production was found non significant at all stages of observation except at harvest.

**Table 11:- Mean dry matter weight (g) per plant at various growth stages as influenced by various treatments.**

Treatment	Days after transplanting				
	60	90	120	150	At harvest
Irrigations					
I <sub>0</sub>	2.63	47.27	92.50	102.25	177.28
I <sub>1</sub>	2.62	47.59	120.22	251.29	305.00
I <sub>2</sub>	2.53	51.44	124.81	302.62	417.07
SE±	0.026	0.95	2.89	3.62	3.95
CD at 5%	NS	NS	8.58	10.74	11.73
Spacing					
S <sub>1</sub>	2.52	30.86	84.33	189.77	240.57
S <sub>2</sub>	2.58	42.15	106.14	216.66	256.02
S <sub>3</sub>	2.62	55.27	123.07	230.07	311.30
S <sub>4</sub>	2.66	66.78	136.52	238.39	427.24
SE±	0.05	1.66	2.97	6.91	4.30
CD at 5%	NS	4.94	8.83	20.50	12.76
Interaction					
IxS					
SE±	0.10	2.88	5.16	11.97	4.066
CD at 5%	NS	NS	NS	NS	12.06
G.M.	2.59	48.77	102.51	218.72	299.78



**General view of experiment at flowering stage**



**General view of experiment at post flowering stage**

**Plate 2. General view of experiment at flowering and post flowering stage**

### **4.3. Growth analysis:-**

#### **4.3.1 Absolute Growth rate:- (plant height)**

Mean value of absolute growth rate (AGR) of height in cm/day obtained at various stages of crop growth are presented in table 12. Data presented in table -12 revealed that AGR for height was fast between 60-90 and 90-120 DAS, and steadily reduced there after till maturity.

#### **Irrigation : -**

In General. The higher values were observed in (I<sub>2</sub>) irrigations at all stages of crop growth, except (0-60 days). At 0-60 DAS (I<sub>0</sub>) irrigation i.e rainfed gives higher value than other treatment.

#### **Plant spacing : -**

In general higher value was observed in 30 cm plant spacing at all stages of plant growth, except. The 75 cm plant spacing gives higher value than other plant spacing.

#### **4.3.2 Absolute Growth rate (day matter) : -**

Mean values of AGR on dry matter (g/day) obtained at various growth stages are presented in table 13

Data in table 13 revealed that AGR for total dry matter was very slow during initial stage upto 60 days after transplanting and it was increased up to (120-150 Days) There after decline .

**Table 12:- Mean absolute growth rate (AGR) of height at various growth stages as influenced by various treatments (cm/day/plant).**

Treatment	Days after transplanting				
	0-60	60-90	90-120	120-150	150-at harvest
Irrigations					
I <sub>0</sub>	0.536	1.942	2.314	0.181	0.136
I <sub>1</sub>	0.520	2.112	2.341	0.694	1.235
I <sub>2</sub>	0.525	2.155	2.591	0.739	0.739
Plant Spacing					
S <sub>1</sub>	0.547	2.100	2.454	0.688	0.441
S <sub>2</sub>	0.538	2.093	2.404	0.719	0.433
S <sub>3</sub>	0.508	2.076	2.426	0.682	0.431
S <sub>4</sub>	0.515	2.01	2.376	0.724	0.430
G.M.	0.527	2.069	2.415	0.632	0.454

### **Irrigation : -**

It is revealed from the data that I<sub>2</sub> i.e (Three irrigations) found to be increase AGR during all the stages of growth period except (0-60 days). The highest AGR was recorded (5.927 g/day/plant) under I<sub>2</sub> irrigations treatments over rest of treatments. Minimum AGR was recorded in I<sub>0</sub> (rainfed) treatment at all growth stages except at harvest it was lowest of I<sub>1</sub> (1.790 g/day/plant).

### Plant Spacing : -

The plant spacing 75 cm recorded higher AGR on dry matter per plant at all growth stages of crop except, (90-120) days. At (90-120) days it was higher at 60 cm plant spacing (i.e. 2.126 g/plant).

**Table 13:- Mean absolute growth rate (AGR) of dry matter at various growth stages as influenced by various treatments (g/day/plant).**

Treatment	Days after transplanting				
	0-60	60-90	90-120	120-150	150-at harvest
Irrigations					
I <sub>0</sub>	0.087	1.488	1.507	0.325	2.501
I <sub>1</sub>	0.087	1.499	2.421	4.369	1.790
I <sub>2</sub>	0.084	1.630	2.445	5.927	3.815
Plant Spacing					
S <sub>1</sub>	0.084	1.478	2.115	3.481	1.086
S <sub>2</sub>	0.086	1.519	2.133	3.450	1.345
S <sub>3</sub>	0.087	1.555	2.126	3.566	3.041
S <sub>4</sub>	0.088	1.604	2.124	3.662	6.761
G.M.	0.086	1.539	2.124	3.540	2.873

### 4.3.3 Relative Growth rate :-

The mean values of RGR computed in g/g/day/plant from the data on total dry matter at various growth stages is shown in table 14.

The mean values of AGR during 0-60, 60-90, 90-120, 120-150, and 150 to harvest was 0.006896, 0.04246, 0.01204, 0.009062 and 0.004845 g/g/day/plant respectively.

Data presented in table 14 revealed that the RGR (g/g/day/plant) was increased right from 0-90 days and it was declined thereafter

### Irrigation: -

The RGR values were found higher in (I<sub>2</sub>) i.e Three irrigations at 60-90 days and 120-150 days it was 0.04362 and 0.01282 respectively. The RGR values of (I<sub>1</sub>) i.e Two irrigations at 90-120 days it was found significant than I<sub>2</sub> and I<sub>0</sub> irrigation. At 0-60 days RGR value of rainfed (I<sub>0</sub>) treatment was found significantly superior over I<sub>1</sub> and I<sub>2</sub> irrigations.

### Plant Spacing: -

The plant spacing of 75 cm was found beneficial in increasing the RGR at all stages except during 90-120 days. The plant spacing of 30 cm was found to be significantly higher in RGR at (90-120 days) as compared to 45 cm 60 cm and 75 cm plant spacing. The 75 cm plant spacing during 60-90 days produced higher RGR (i.e. 0.04269 g/g/day/plant) over other plant spacing of growth stages.

**Table 14:- Mean relative growth rate (RGR)-(g/g/day) per plant as influenced by various treatments.**

Treatment	Days after transplanting				
	0-60	60-90	90-120	120-150	150-at harvest
Irrigations					
I <sub>0</sub>	0.006982	0.04182	0.00972	0.00145	0.00796
I <sub>1</sub>	0.006971	0.04197	0.0134	0.01067	0.00280
I <sub>2</sub>	0.006718	0.04362	0.01283	0.01282	0.004646
Plant Spacing					
S <sub>1</sub>	0.006691	0.04231	0.01239	0.009602	0.001683
S <sub>2</sub>	0.006863	0.04236	0.01224	0.009464	0.002485
S <sub>3</sub>	0.006971	0.04247	0.01202	0.009640	0.005020
S <sub>4</sub>	0.007081	0.04269	0.01173	0.009737	0.009322
G.M.	0.006896	0.04246	0.01204	0.009062	0.004845

#### **4.3.4 Net assimilation rate:-**

Mean values of NAR computed from the data on total dry matter (g/plant) and leaf area (dm<sup>2</sup>)/plant) at various growth stages are presented in table 15

Data presented in table 15 revealed that NAR was fast during initial growth stage (0-60 days) and slow during 60-100 days and reducing thereafter.

#### **Irrigations: -**

The NAR values were found higher in Three irrigations over Two irrigations and rainfed at all stages of growth period except 90-120 days.

The NAR was found highest between 60-90 days which was 0.0005563 g/g/cm<sup>2</sup>/day/plant.

#### **Plant Spacing: -**

The plant spacing of 75 cm was found beneficial in increasing the NAR at all stages except at 90-120 days. The plant spacing of 30 cm was found to be significantly higher in NAR at (90-120 days) as compared to 45 cm, 60 cm 75 cm plant spacing's. The 60 cm plant spacing during (150- at harvest) was produce higher NAR to other plant spacing of growth stages.

**Table 15:- Mean net assimilation rate (NAR)-  
(g/g/cm<sup>2</sup>/day/plant) at various growth stages as influenced by  
various treatments.**

Treatment	Days after transplanting				
	0-60	60-90	90-120	120-150	150-at harvest
Irrigations					
I <sub>0</sub>	0.0005506	0.000531	0.0001668	0.0000484	0.000348
I <sub>1</sub>	0.0005496	0.0005336	0.0002348	0.00003698	0.0003068
I <sub>2</sub>	0.0005539	0.0005563	0.0002240	0.0004475	0.0005051
Plant Spacing					
S <sub>1</sub>	0.0005471	0.0005382	0.0002162	0.0003345	0.0001667
S <sub>2</sub>	0.0005481	0.0005382	0.0002133	0.0003269	0.0002570
S <sub>3</sub>	0.0005507	0.0005401	0.0002092	0.000333	0.0005667
S <sub>4</sub>	0.0005607	0.0005456	0.0002044	0.0003345	0.0001233
G.M.	0.0005515	0.0005404	0.0002098	0.0003135	0.0004833

#### 4.3.5 Leaf Area index: -

Data on mean values of leaf area index (LAI) at various growth stages are presented in table 16

It is evident from the data that LAI increased continuously from 60 days to 90 days and there after decreased gradually at increasing rate till harvest.

**Table 16:- Leaf area index (LAI) at various growth stages as influenced by various treatments.**

Treatment	Days after transplanting				
	0-60	60-90	90-120	120-150	150-at harvest
Irrigations					
I <sub>0</sub>	0.0379	0.831	0.8213	0.449	0.106
I <sub>1</sub>	0.0378	0.837	1.067	1.1043	0.2074
I <sub>2</sub>	0.0359	0.9050	1.1081	1.333	0.295
Plant Spacing					
S <sub>1</sub>	0.063	1.442	1.714	1.651	0.339
S <sub>2</sub>	0.043	0.988	1.161	1.111	0.231
S <sub>3</sub>	0.033	0.758	0.878	0.8462	0.1812
S <sub>4</sub>	0.0263	0.6253	0.7120	0.8628	0.1486
G.M.	0.0395	0.9123	1.0659	1.0510	0.2154

**Irrigation: -**

The higher LAI values were recorded in (I<sub>2</sub>) i.e three irrigation followed by (I<sub>1</sub>) i.e. two irrigations. At all growth stages except 0-60 days.

**Plant Spacing: -**

The higher LAI values were recorded in 30 cm plant spacing followed by 45 cm, 60 cm and 75 cm plant spacing at all the growth stages.

#### **4.4 Post harvest studies: -**

Data of post harvest studies namely number of pods per plant at harvest, weight of pods per plant, number of grains per pod, grain weight per plant and test weight are presented in table – 17.

##### **4.4.1 Number of pods per plant:-**

Data on mean number of pods per plant as influenced by various treatments are presented in table – 17.

#### **Irrigation: -**

The number of pods per plant was influenced significantly due to irrigations increase in irrigation resulted in significant increase in number of pods per plant. Thus the three irrigations i.e. (I<sup>st</sup> Bud initiation, II<sup>nd</sup>, flowering, III<sup>rd</sup> pod development stage) was found significantly superior over Two irrigations (at bud initiation and pod development stage) and rainfed. Similarly two irrigations was significantly superior over rain fed treatment in recording the number of pods per plant (Table- 17)

#### **Plant Spacing: -**

The number of pods per plant was influenced significantly due to various plants spacing increase in plant spacing resulted in significant increase in number of pods per plant. Thus the plant spacing of 75 cm was found significantly superior over 30 cm, 45 cm and 60 cm plant spacing.

Similarly 60 cm plant spacing was significantly superior over 30 cm and 45 cm plant spacing in recording the number of pods per plant. (Table – 17).

**Interactions: -**

Data presented in Table-17 indicated that the interaction was found to be non-significant to the number of pods per plant was significantly increased with increase in irrigation and plant spacings.

**4.4.2 Weight of pods per plant: -**

Data on pod weight per plant is presented in table 17 revealed that mean pod weight per plant was 172.50 g.

**Irrigation: -**

The weight of pods per plant increased significantly with increase in irrigations from rain fed to three irrigations.

**Plant Spacing: -**

The weight of pods per plant increased significantly with increase in plant spacing from 30 cm to 75 cm (i.e. 30 cm,45 cm, 60 cm and 75 cm)

**Interaction: -**

The data presented in Table-17 indicated that under all the irrigations treatments the pod weight was significantly increased with increased in plant spacing.

**4.4.3 Number of grains per pod:-**

The data presented in Table – 17 indicates that the mean number of grains per pod was 3.62.

**Irrigation: -**

The mean number of grains per pod was influenced significantly by number of irrigations under study.

**Plant Spacing: -**

The mean number of grains per pod was not influenced significantly by different plant spacing under study.

**Interaction: -**

The interaction was found to be non significant.

**4.4.4 Grain weight per plant: -**

Data in table 17 indicated that mean grain weight per plant was 109.85.

**Irrigations:-**

The weight of grains per plant increased significantly with every increase in irrigation from rainfed, two irrigations and three irrigations.

**Plant Spacing:-**

The weight of grains per plant increased significantly with increase in plant spacing from 30 cm, 45 cm, 60 cm, and 75 cm.

**Interaction: -**

The interactions effects were observed in respect of grain weight per plant found to be non significant.

**4.4.5 Test weight: -**

Data presented in Table 17 revealed that the mean test weight (1000 seed/weight) of pigeon pea was 104.39 g.

**Table -17:- Table mean no. of pods per plant at harvest, weight of pods per plant, number of grains per pod, grain weight per plant and seed weight as influenced by various treatments.**

	No. of pods/plant	Weight of pods/plant	No. of grain/pod	Grain weight/plant(g)	1000 seed weight (g)
<b>Irrigation</b>					
I <sub>0</sub>	227.60	115.26	3.55	72.83	102.56
I <sub>1</sub>	348.65	174.32	3.78	111.81	103.85
I <sub>2</sub>	455.83	227.92	3.54	144.91	106.75
SE ±	10.3	5.13	0.20	4.32	0.24
CD at 5%	30.65	15.23	NS	12.83	0.72
<b>Spacing</b>					
S <sub>1</sub>	138.63	69.43	3.62	44.36	104.4
S <sub>2</sub>	249.71	125.27	3.69	79.91	104.1
S <sub>3</sub>	363.95	182.48	3.76	117.41	104.4
S <sub>4</sub>	623.83	312.81	3.40	197.73	104.5
SE ±	13.20	5.06	0.22	5.68	0.32
CD at 5%	39.17	15.04	NS	16.85	NS
<b>Interactions</b>					
<b>I x S</b>					
SE ±	22.87	8.78	0.39	9.83	0.56
CD A+5%	NS.	NS	NS	NS	NS
Gm.	344.03	172.50	3.62	109.85	104.39

**Irrigation: -**

The test weight was significantly influenced by different irrigation treatment. The (I<sub>2</sub>) i.e Three irrigations treatment was significantly superior over two irrigation and rainfed. Similarly significant result was obtained in (I<sub>2</sub>) irrigation.

**Plant Spacing: -**

The test weight was non significantly influenced by different plant spacing.

**Interaction: -**

The interaction effects were observed in respect of test weight to be non significant.

**4.5 Yield: -**

Data on pod, grain, stalk, bhoosa, and biological yield (q/ha) and harvest index (percent) as influenced by various treatments are presented in table 18.

**4.5.1 Pod yield: -**

It is clear from table 18 that, pod yield per ha was significantly influenced by irrigations and plant spacing under study.

**Irrigation: -**

In Irrigations three irrigation i.e. (I<sup>st</sup> bud initiation, II<sup>nd</sup> flowering stage and III<sup>rd</sup> pod development stage) produced



**General view of experiment at pod development stage**



**General view of experiment at harvest**

**Plate 3. General view of experiment at pod development and harvest**

significantly higher pod yield than two irrigation at (bud initiation and pod development stage) and rainfed. The significantly lowest pod yield was obtained due to rain fed (no irrigation) treatment.

**Plant Spacing: -**

The plant spacing of 75 cm produced significantly higher pod yield than 60 cm, 45 cm, and 30 cm plant spacing. The significantly lowest pod yield was obtained due to 30 cm plant spacing.

**Interaction: -**

The interaction effects were found to be non significant in respect of pod yield. The 75 cm plant spacing produced more seed weight of 1000 seeds. The treatments of 30 cm, 45 cm and 60 cm plant spacings were at par with 75 cm plant spacing.

**4.5.2 Grain yield: -**

The data on grain yield (q/ha) presented in table 18 revealed that grain yield was influenced significantly by different Irrigations and plant spacing.

**Irrigations: -**

The three irrigations at bud initiation stage, flowering stage and pod development stage recorded significantly higher grain yield than the other two treatments of two irrigation and rainfed treatment. The significantly lowest grain yield was obtained due to (no irrigation) rainfed.

**Plant spacing: -**

The plant spacing of 75 cm recorded significantly higher grain yield than the narrow spacing 30 cm and 45 cm plant spacing.

**Interaction: -**

The interaction effects were found to be non significant in respect of grain yield.

**4.5.3 Stalk yield: -**

Data presented in table 18 revealed that stalk yield per hectare was influenced significantly due to different irrigations and plant spacing's.

**Irrigations:-**

In irrigation three irrigation i.e. (first bud initiation, second flowering stage and III<sup>rd</sup> at pod development stage) produced significantly higher stalk yield than two irrigation at (bud initiation and pod development stage) and rain fed (No irrigation) The significantly lowest stalk yield was obtained due to rain fed (no irrigation).

**Plant Spacing: -**

The plant spacing of 75 cm produced significantly higher stalk yield than 60 cm, 45 cm and 30 cm plant spacing. The significantly lowest stalk yield was obtained due to 30 cm plant spacing.

**Interaction:-**

The interaction effects were observed to be non significant.

**4.5.4 Bhoosa yield : -**

The data presented in table 18 revealed that bhoosa yield per hectare was influenced significantly due to irrigations and plant spacing treatment.

**Irrigation: -**

The three irrigations produced significantly higher bhoosa yield than two irrigations and rainfed treatment. The bhoosa yield was obtained significantly lowest of rainfed treatment.

**Plant Spacing: -**

The wider plant spacing of 60 cm and 45 cm plant spacing's were at par with each other and significantly higher than 30 cm plant spacing in respect of bhoosa yield per hectare.

**Interaction:-**

The interaction effects were observed to be non significant.

**4.5.5 Biological Yield:-**

The data on mean biological yield as influenced by various treatments are presented in table 18.

**Irrigation: -**

The biological yield as influenced significantly by no. of irrigations. Three irrigations at ( $I^{\text{st}}$  at bud initiation, second at flowering and third at pod development stage) produced significantly higher biological yield over Two irrigations and rainfed treatment. The ( $I_1$ ) i.e two irrigations was significantly superior over rainfed ( $I_0$ ) treatment in respect of biological yield per hectare.

**Plant Spacing: -**

The biological yield was influenced significantly by various plant spacing's. The plant spacing of 75 cm produced significantly higher biological yield over other treatments of 60 cm, 45 cm and 30 cm plant spacing.

**Interaction:-**

The interaction effects were found to be non significant.

#### **4.5.6 Harvest Index: -**

The data presented in table 18 indicated that mean harvest index was 26.13 percent.

It can be Seen from table 18 that, harvest index was not varied significantly in plant spacing but varied in irrigations treatment.

#### **Irrigation: -**

Harvest index of three irrigations was significantly superior over other two irrigation treatments i.e (Two irrigations and rainfed)

#### **Interactions:-**

The Interaction effect was obtained non significant.

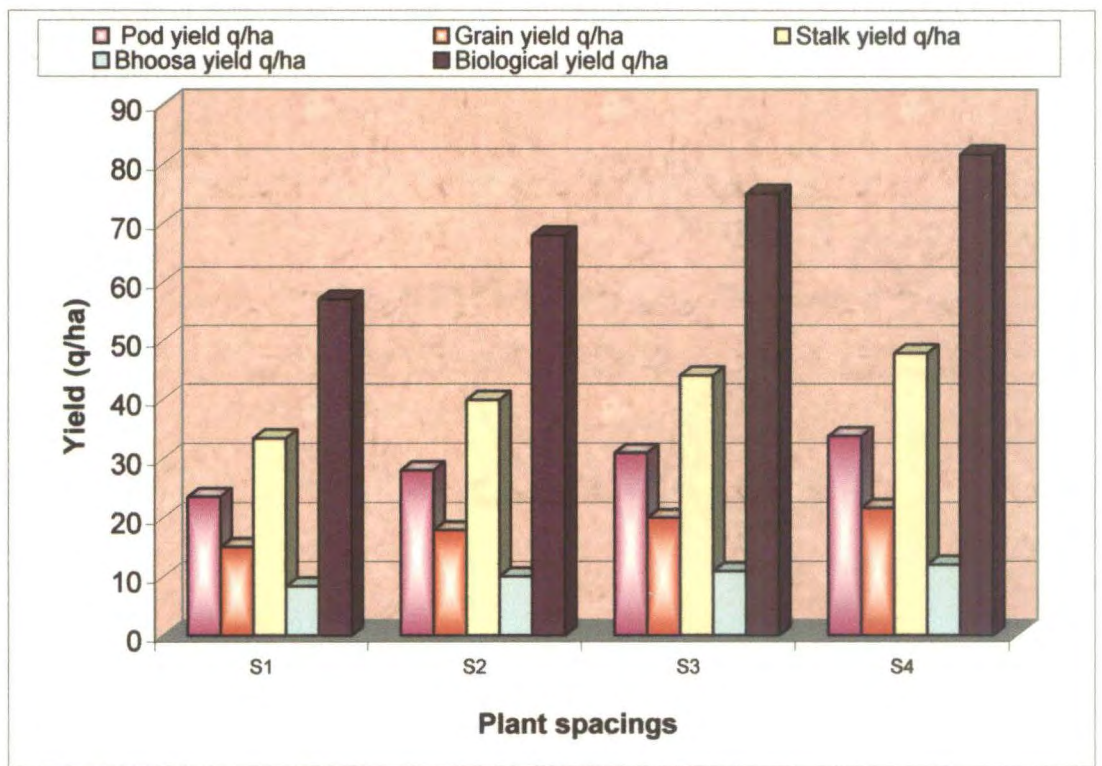
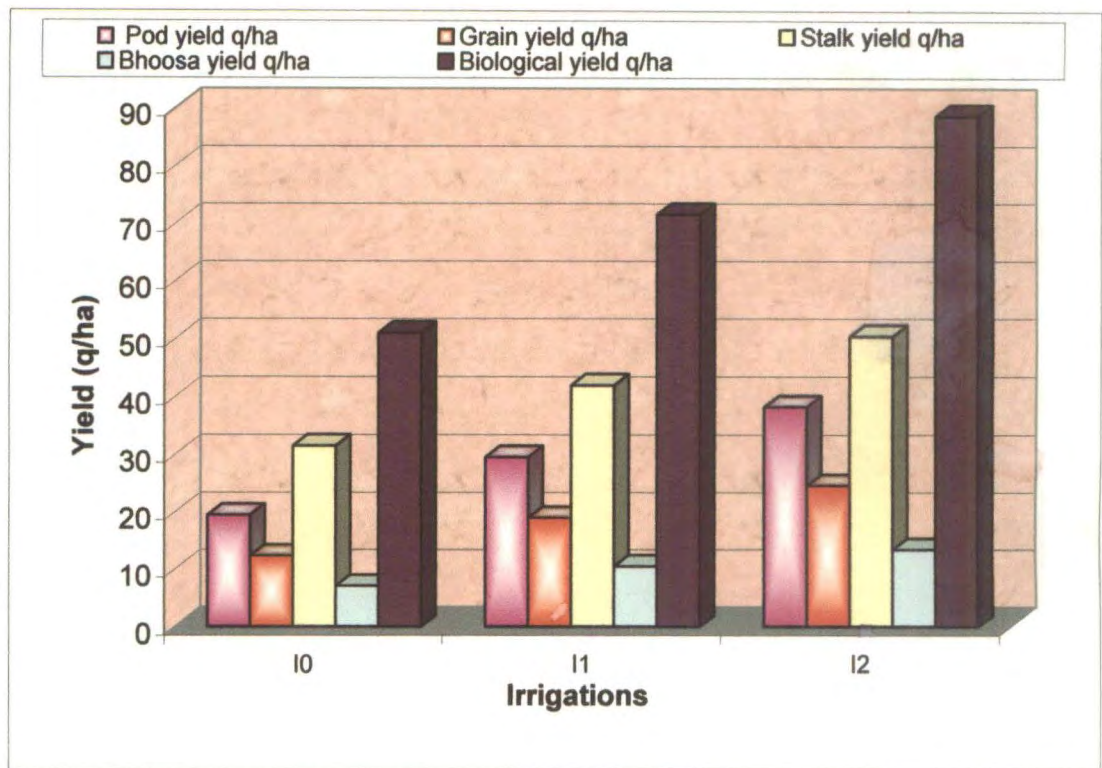


Fig. 5 : Pod, grain, stalk, bhoosa, biological yield as influenced by various treatments

**Table 18:- Pod, grain stalk, straw, biological yields and harvest index as influenced by various treatments.**

<b>Treatment</b>	<b>Pod yield/ (q/ha)</b>	<b>Grain yield/ (q/ha)</b>	<b>Stalk yield/ (q/ha)</b>	<b>Bhoosa/ yield/ (q/ha)</b>	<b>Biological yield (q/ha)</b>	<b>H.I %</b>
<b>Irrigation</b>						
I <sub>0</sub>	19.47	12.31	31.54	7.07	51.01	24.13
I <sub>1</sub>	29.56	18.95	41.97	10.50	71.54	26.48
I <sub>2</sub>	38.23	24.61	50.41	13.42	88.65	27.76
SE $\pm$	0.51	0.25	0.76	0.27	1.28	0.24
CD at 5%	1.54	0.74	2.27	0.80	3.81	0.71
<b>Spacing</b>						
S <sub>1</sub>	23.59	15.07	33.45	8.38	57.04	26.07
S <sub>2</sub>	28.02	17.88	39.89	10.03	67.92	26.06
S <sub>3</sub>	30.97	19.94	44.04	10.89	75.01	26.26
S <sub>4</sub>	33.78	21.61	47.84	12.02	81.63	26.12
SE $\pm$	0.81	0.49	1.17	0.32	1.98	0.094
CD at 5%	2.42	1.47	3.48	0.97	5.90	0.27
<b>Interaction</b>						
<b>I x S</b>						
SE $\pm$	1.41	0.86	2.03	0.56	3.44	0.16
CD at 5%	NS	NS	NS	NS	NS	NS
GM.	29.09	18.62	41.31	10.33	70.40	26.13



*DISCUSSION*

## CHAPTER-V

### DISCUSSION

The result of the present investigation are briefly discussed in this chapter.

#### **5.1 Soil and weather in relation to crop Growth :-**

The physio-chemical composition of soil revealed that the soil of the experimental plot was clayey in texture, low in total nitrogen, medium in available phosphorus and organic carbon, high in potassium and slightly alkaline in reaction.

The mean weekly weather data indicated that the total rainfall received during the experimental period was 666.9 mm in total 40 rainy days which was observed to be less than that of normal.

#### **5.2 Initial plant stand and final plant stand :-**

Data (Table 6) indicated that the mean Initial plant stand and final plant stand were non significantly influenced by given treatment under study.

#### **5.3 General Growth attributes :-**

The height of the plant was found to increase progressively at every stages of crop growth till maturity. The plant height increased comparatively slow up to 60 days. (Because we use 30 days old seedling for transplanting for the

establishment of seedling or settlement of transplanted seedlings in main plot, the initial height of plant, functional leaves, leaf area per plant, number of branches per plant, dry matter weight per plant at 60 days was found to be lower), Very fast during 60-120 days and relatively slow thereafter till maturity. All growth characters viz, plant height, branches, leaf area, number of leaves and dry matter production were favorably increased with irrigation at ( $I_2$ ) i.e. Three irrigation at bud initiation stage, flowering stage and pod development stage and ( $I_1$ ) i.e. Two irrigation at bud initiation stage and pod development stage. This indicate that these two irrigations ( $I_1$  and  $I_2$ ) have favored most of the characters as compared to rainfed ( $I_0$ ) these treatment might have provided best soil water - plant relationship to the crop throughout its growth period in general and critical growth stages in particular. Thus it might have enhanced absorption of nutrients and soil water in optimum conditions needed for better growth of crop Bhowmik *et al.*, (1983), Lal (1983) and Wilson and Mulchow (1983) reported the similar result.

The narrow plant spacing of 30 cm produced taller plant as compared to 45 cm, 60 cm and 75 cm plant spacing's after 90 days indicating the tendency of plant to grow tall when there were high plant densities.

Similar results were obtained by Shankarlingappa and Hegde (1989).

Mean number of functional leaves and leaf area per plant increased up to 150 days and peak rate was increased in leaf number and leaf area per plant was observed during 120-150 days after transplanting.

The leaf number and leaf area were not significantly influenced by different Irrigations at 60 days and at harvest probably due to slow crop growth rate during early stages and availability of more space to all the spacing's up to 60 days and at harvest it may be due to leaf senescence. At all other stages the maximum number of leaves and leaf area were observed at 75 cm plant spacing which may be due to availability of more area for the plant growth than other spacing's similar results were obtained by Puste (1988).

Mean number of leaves and leaf area per plant were found to improve with increase of plant spacing at all growth stages.

The interaction of irrigations and plant spacing's were found non significant except 60 days it was significant leaf area per plant.

The number of branches per plant were increased significantly with increase in spacing may be due to availability of greater space and reduced crop competition at wider spacing's. These findings are in confirmation with the results reported by Singh et. al., (1971) and Ahuja 1984).

The dry matter production per plant was significantly increased with increase of plant spacing's after 60 days. This may be attributed to availability of moisture, nutrient, sunlight and air from more unit area to the crop. This probably had resulted in higher assimilation of photosynthesis and dry matter production per plant.

The effect of interaction on dry matter production per plant was found significant at harvest.

Umate (1998) and Oza et. al.,(1996). Data on height and dry matter accumulation was further analyzed in terms of absolute growth rate (AGR). These studies indicate that active growth period was between 90 and 120 days after transplanting in pigeon pea. Irrigation at (I<sub>2</sub>) Three irrigations at (bud initiation, flowering and pod development stage and (I<sub>1</sub>) Two irrigations at bud initiation. and pod development stages had consistently give more AGR values both on height and dry matter as compared to rainfed (I<sub>0</sub>) treatment.

However relative growth rate (RGR) and (NAR) Net assimilation rate were not found consistent. Higher values of leaf area index (LAI) were noticed with (I<sub>2</sub>) Three irrigations and (I<sub>1</sub>)Two irrigations. Which has important bearing on yield. Higher LAI was noticed at 150 days after transplanting with (I<sub>2</sub>) Three irrigations. There after lower down due to senescence of leaves.

Saraf and Hegde (1984, Bhowmik et.al.,(1983) and Wilson and Mulchow (1983) also reported that LAI of pigeon pea was increased with application of irrigation to pigeon pea over rainfed.

The AGR values for plant height were increased up to 120 days which indicated that the vegetative growth phase was up to 120 days. There after, flowering stages started which might have resulted in decrease in AGR of plant height.

At most of the growth stages the AGR values for plant height increased with decrease of either row or plant spacing probably due to competition for sunlight with decreased spacing's.

But reverse trend was observed in AGR values for dry matter accumulation. This might be due to more dry matter production with increase of per plant area which resulted in less competition for nutrient, moisture and sunlight.

In case of RGR for dry matter it is observed that under different spacing's, the RGR values increased with increase in spacing's i.e. unit area per plant at most of growth stages which might have provided more sunlight, nutrient and moisture for more dry matter production.

The NAR values were influenced due to plant spacing after 120 days onwards. In this period the plant have started its reproductive stage. The photosynthetic activities mainly based on leaf area and sunlight availability. In wider spacing NAR values were more due to more leaf area per plant as well as more sunlight availability with less competition.

Higher LAI values were recorded with narrower spacing's. The LAI values depends on leaf area and land area per plant. The decrease in leaf area was not in proportion to decrease in land area in closer spacing's.

This might have resulted in increase of LAI values with decrease in spacing's. Similar findings were reported by Puste (1988).

#### **5.4 Yield attributes and yield : -**

The yield attributes viz. number of pods, pod weight, seed weight per plant and 1000 seed weight were influenced significantly with different irrigations. The combined effects of increase in number of pods, pod weight, 1000 seed weight which might have resulted in higher seed yield under irrigation treatments than rainfed treatment. At the attributing characters were recorded significantly superior under (I<sub>2</sub>) Three irrigations and (I<sub>1</sub>) Two irrigations over rainfed (I<sub>0</sub>). Higher moisture regimes in the soil probably provided favorable environment which stimulated the yield attributes viz. number of pods, pod

weight, 1000 seed weight and shelling percentage higher grain yield was the corollary of beneficial effects of irrigation on all yield contributing characters.

Similar results were reported by Bhan and Khan (1979), Chopra et.al (1974), Bhowmik et.al (1983) and Nilima and Malik (1983).

The pod weight and grain weight per plant were also significantly increased with increase of plant spacing from 30 cm to 75 cm. The similar effect of number of pods per plant might have resulted in pod weight per plant.

The bhoosa yield per plant was significantly increased with increase of plant spacing.

The harvest index and test weight were not significantly influenced by various treatments and there interactions. Kapur et.al, (1987) reported non significant influences of plant densities on test weight.

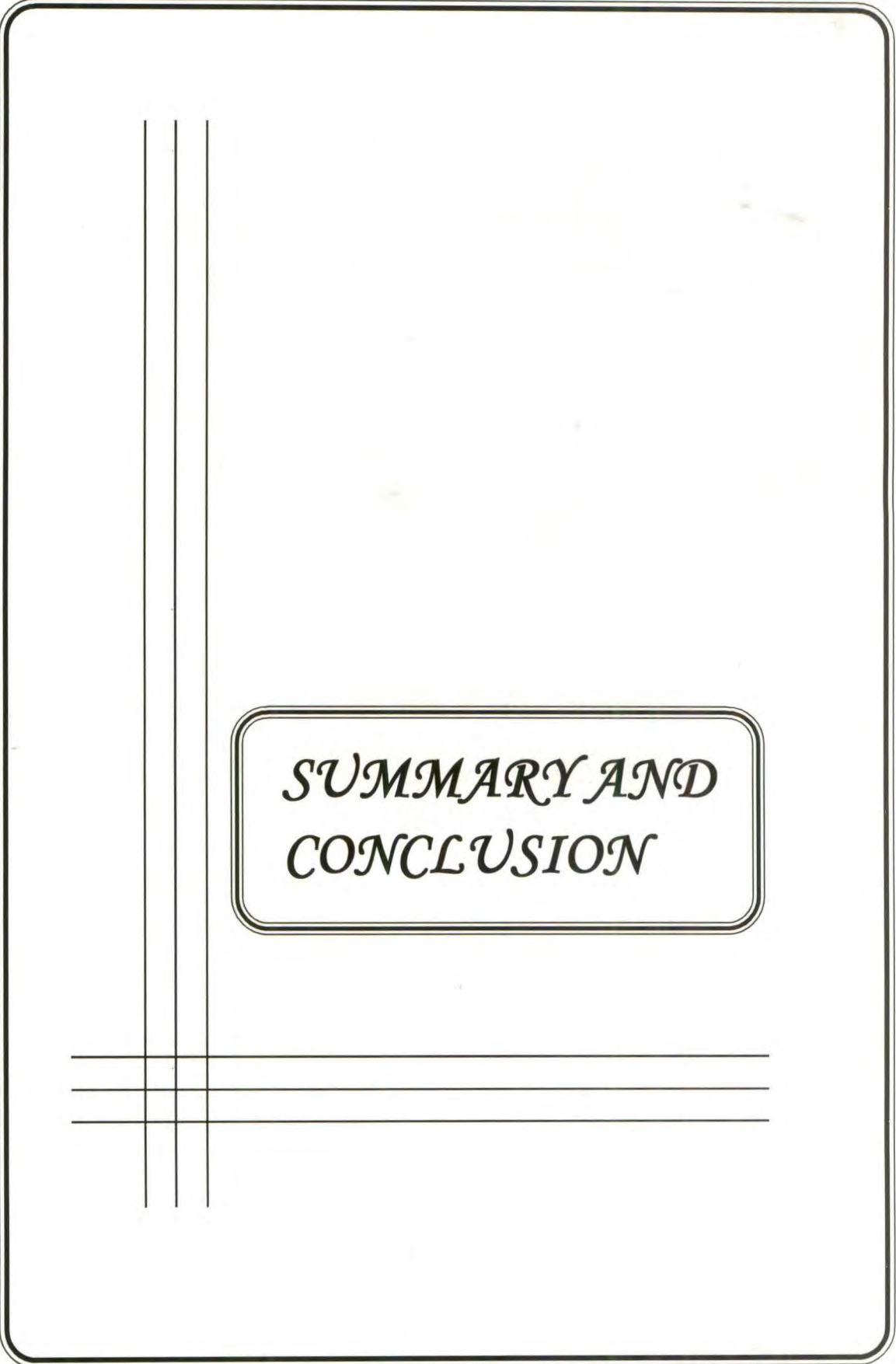
In general the beneficial effects of increase in plant spacing's were observed on growth and yield attributes viz. number of leaves, leaf area, number of branches, dry matter accumulation, number of pods, weight of pods and grains per plant. The increase in grain weight per plant with increase in spacing resulted owing to comparatively good growth of

individual plant because of the availability of more light, soil moisture, nutrients, microclimates etc. per plant. It produce more number of branches, leaf area and dry matter and finally the grain weight per plant.

The grain yield (q/ha) was significantly superior with 75 cm plant spacing than 60 cm, 45 cm and 30 cm plant spacing. As in 60 cm, 45 cm and 30 cm plant spacing plant population increased but yield per hectare was decreased. Where as, under 75 cm plant spacing, plant population was decreased but yield per plant was increased.

The interaction between Irrigation and plant spacing was obtained non significant.

Singh and Prasad (1987) reported the increase in yield with decrease in plant population, Mukharjee (1960), Singh et.al., (1984), Karsono and Sumarno (1987) and Goyal et.al., (1989) reported higher grain yields with decrease in row and plant spacing's.



*SUMMARY AND  
CONCLUSION*

## CHAPTER-VI

### SUMMARY AND CONCLUSION

A field experiment was conducted at college farm, Department of Agronomy, Marathwada Agricultural University, Parbhani during Kharif Season of 2009, to study the effect of irrigations and plant spacing's on growth and yield of transplanted pigeon pea.

The site of the experimental field was fairly leveled. The residual effect of previous crop was uniform. The soil in the experiment field was clayey in texture, low in total nitrogen medium in available phosphorus, rich in potassium and slightly alkaline in reaction. Weather data indicated that, the total precipitation received during experimental period was less than normal (666.9 mm).

The present experiment was laid out in split plot design with three replications. The treatments were three Irrigations ( $I_0$ ,  $I_1$ , and  $I_2$ ) (Rainfed, Two Irrigation, and Three irrigation) and four plant spacing. (30 cm, 45 cm, 60 cm and 75cm), row spacing was taken 90 cm as common.

Constituting Twelve Combinations. Three Irrigations as main plots and four plant spacing's as sub plot. Were allotted randomly within each replication.

The gross plot size was 4.8 x 4.8 m and net plot size was 3.6 m x 3.6 m. The seedlings were transplanted in main plot on 16 July 2009. With row spacing was taken 90 cm common and plant spacing's as per treatments. The recommended dose of fertilizer i.e. 25kg N. and 50 kg P<sub>2</sub> O<sub>5</sub> per hectare was applied as basal dose after transplanting.

Initial plant stand was recorded from each net plot on 60 days after transplanting. Biometric observations on various growth Characters viz. height of plant, number of functional leaves, number of branches and number of pods per plant were recorded periodically on five randomly selected plants from each net plot, similar studies on leaf area and dry matter accumulation were taken at various growth stages on only one representative plant from each net plot. Growth was analyzed by working out AGR (height and dry matter), RGR, NAR and LAI.

Post harvest studies were also under taken which include the pod weight, grain weight, number of grains per plant, harvest index and test weight. The plants from each net plot were harvested threshed and grains were cleaned. The grain, stalk and biomass obtained in each net plot inclusive of five labeled plants were weighed in kg and converted into q/ha.

The most important findings emerged from the present experiment are given below.

1. The percent initial plant stand and final plant stand were not influenced significantly due to different treatments indicating that the results obtained are the more effects of treatments.
2. The important growth attributes such as plant height, mean dry matter, leaf area and no. of branches per plant were favorably influenced by Irrigations, and found superior over rainfed ( $I_0$ ).
3. Growth functions namely absolute growth rate (AGR), relative growth rate (RGR) and leaf area index (LAI) were influenced by irrigations at all growth stages. Irrigation ( $I_2$ ) Three irrigation and ( $I_1$ ) Two irrigations recorded higher values of AGR and LAI than ( $I_0$ ) rainfed treatment.
4. Yield attributes such as number of pods, weight of pods, weight of seeds and 1000 seed weight were favorable influenced by irrigations.
5. Seed and Biological yield were significantly influenced by scheduling of irrigation over rainfed. Three irrigations gave highest seed and Biomass yield followed by Two irrigations.
6. The plant characteristics viz. height of plant, number of leaves, leaf area, number of branches, dry matter and number of

Pods per plant were significantly influenced by different treatments at most of the growth stages. These characters except plant height were improved with increase in plant spacing. The plant height was decreased with increase of spacing's.

7. It is clear from growth analysis study that the beneficial effect of increase in plant spacing were observed in increasing AGR (dry matter), RGR, NAR while AGR (plant height) LAI and CGR values decreased with increase in plant spacing at most of the growth stages.

8. Yield attributing characters viz., Number of pods, pod weight and grain weight per plant were improved significantly with increase of plant spacing's.

## CONCLUSION

On the bases of present investigation it may be inferred that :

The transplanted pigeon pea producing higher grain yield.

The Three irrigations treatment gives better yields than Two irrigations and rainfed treatments.

The plant spacing of 75 cm was found to be advantage in transplanted pigeon pea to obtain higher grain yield. (q/ha)



*LITERATURE  
CITED*

## LITERATURE CITED

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\* Originals are not seen

## THESIS ABSTRACT

- a) Title of the Thesis : “Effect of irrigations and plant spacing on growth and yield of transplanted pigeonpea”
- b) Name of student : Mr. Vikas Khaka Narnalikar
- c) Degree to be awarded : M.Sc. (Agriculture)
- d) Year of award of degree : 2010
- e) Major subject : Agronomy
- f) Total No. of pages in the thesis : 79
- g) Number of words in thesis abstract : 277
- h) Signature of the student :   
(Narnalikar V.K.)
- i) Name and address of Major Advisor :   
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## ABSTRACT

The field investigation entitled “Effect of irrigations and plant spacing on growth and yield of transplanted pigeonpea” was conducted during *Kharif* season of 2009 at the experimental farm, Department of Agronomy, College of Agriculture, Marathwada Agricultural University, Parbhani with an object to study the yield performance of transplanted pigeonpea, to study the response of irrigations and plant spacing on transplanted pigeonpea. The experiment was laid out in split plot design with three main plot treatments and four sub plot treatments. The treatments were  $I_0$  – Rainfed (No irrigation),  $I_1$  – Two irrigations (i.e. 1<sup>st</sup> at bud initiation stage and 2<sup>nd</sup> at pod development stage),  $I_2$  three irrigations (1<sup>st</sup> at bud initiation, 2<sup>nd</sup> at flowering stage and 3<sup>rd</sup> at pod development stage). Sub plot treatments were  $S_1$  – 90 x 30 cm,  $S_2$  – 90 x 45 cm,  $S_3$  – 90 x 60 cm,  $S_4$  – 90 x 75 cm plant spacing. Each treatment was repeated three times having gross and net plot size 4.8 x 4.8 m<sup>2</sup> and 3.6 x 3.6 m<sup>2</sup>, respectively. Variety used for experimental study was BSMR-736. Seed was sown on seed bed on 15<sup>th</sup> June, 2009 and seedlings were transplanted on 16<sup>th</sup> July, 2009.

From the result of the experiment it can be concluded that, growth factor *viz.* plant height (cm), number of functional leaves, leaf area per plant, number of branches and dry matter accumulation (g/plant) were significantly highest in treatment of  $I_2$  (i.e. three irrigations). Whereas, the yield contributing factors *viz.* number of pods per plant, weight of pods per plant, number of grains per pod, grain weight per plant were significantly highest in treatment  $I_2$  i.e. three irrigations and wider plant spacing of 75 cm ( $S_4$ ).