

**PRODUCTIVITY AND ECONOMICS OF PIGEONPEA  
BASED DIFFERENT INTERCROPPING SYSTEMS**

**THESIS**

*Submitted to the  
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola  
in partial fulfilment of the requirements  
for the Degree of*

**DOCTOR OF PHILOSOPHY  
IN  
AGRICULTURE  
(AGRONOMY)**


**BY  
MANISH PANDURANGRAO DESHPANDE**

**DEPARTMENT OF AGRONOMY,  
POST GRADUATE INSTITUTE,**

**Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,  
AKOLA ( M.S. ) INDIA**

## CERTIFICATE

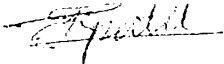
This is to certify that the thesis entitled "PRODUCTIVITY AND ECONOMICS OF PIGEONPEA BASED DIFFERENT INTERCROPPING SYSTEMS", submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Agriculture to Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, is a record of bonafide research work carried out by Mr. Manish Pandurangrao Deshpande under my guidance and supervision. The subject of the thesis has been approved by the student's advisory committee.



(D. G. Giri)  
Chairman,

Advisory Committee

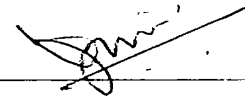
Countersigned



Associate Dean,  
Post Graduate Institute,  
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

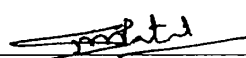
THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE INCLUDING  
EXTERNAL EXAMINER (after viva-voce)

Dr. D. G. Giri (Chairman)



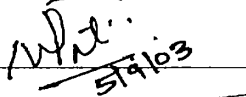
---

Dr. S. M. Patil (Member)



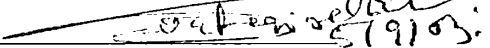
---

Dr. M. N. Patil (Member)




---

Dr. S. W. Jahagirdar (Member)



---

Shri. Abdul Hamid (Member)



---

Dr. M. Prabhakar (External Member)



---

## **Acknowledgement**

I feel great pleasure in taking this opportunity of expressing my deep sense of gratitude, indebtedness and appreciation to my major advisor Dr. D.G. Giri, Professor, Department of Agronomy and Chairman of the Advisory Committee for his scholastic and technical guidance, constructive criticism, valuable suggestions and constant encouragement during the entire course of this research investigation. His special interest in the appropriate presentation of the data and in the preparation of manuscript will be static forever in my heart.

I owe a deep sense of obligation to Dr. V.S. Shinde, Head, Department of Agronomy, Dr. P.D.K.V., Akola for his guidance during the course of this project.

I am highly obliged to Dr. V. D. Patil, Dean (Agriculture) and Director of Instructions and Dr. E.R. Patil, Associate Dean, Post Graduate Institute, Dr. P.D.K. V., Akola for providing necessary facilities to carryout the research work.

Thanks are due to the members of my advisory committee, Dr. S.M. Patil, Associate Professor, Department of Agronomy, Dr. M.N. Patil, Associate Professor, Department of Agricultural Chemistry and Soil Science, Shri. Abdul Hamid, Associate Professor, Department of Agronomy and Dr S.W. Jahagirdar, Assistant Professor, Department of Agricultural Economics and Statistics, Dr. P.D.K.V., Akola for their valuable suggestions and helpful comments throughout the course of investigation.

It also gives me great pleasure to mention my sincere thanks to Dr. K.J. Kubde, Assistant Professor (Agronomy), Dr. A.P. Karunakar, Assistant Professor (Agronomy), Dr. S.B. Sakhare, Assistant Professor (Agril. Botany) and Shri. H.B. Kale, Assistant Professor (Agronomy) for their cooperation.

Thanks are also extended to Shri. P.P. Kolhe, Assistant Professor, (Computer Science), Shri. B.Y. Mohodji, Shri.P.H. Sarap and Shri. Chavanji for their continuous help in statistical and chemical analysis and Shri. A.D. Pore for neat typing of manuscript.

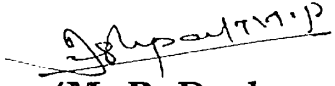
I express my sincere appreciation to my friends Gaju, Nitin, Sachin, Neeraj, Mangesh, Shrikant, Raj, Virendra, Dr. S.P. Lambe, Dr. B. A. Sonune,

Parikshit, Pankaj, Shri. P.C. Pagar, Sandip and Eshwar for their ever ready help throughout the course of research work.

I want to place my sincere thanks to my younger brother Santosh for his support in fulfilling this assignment.

Very few in their life get the opportunity of higher education. It will not be an exaggeration to say that this assignment may not have happened without this opportunity and blessings provided to me from my parents Dr. P.M. Deshpande and Sau. Chanda P. Deshpande. Hence I extend my honest thanks.

**Date : 27/05/2003**

  
**(M. P. Deshpande)**

## TABLE OF CONTENTS

---

CHAPTER	PARTICULAR	PAGE
I	INTRODUCTION	1-3
II	REVIEW OF LITERATURE	4-15
III	MATERIALS AND METHODS	16-34
IV	EXPERIMENTAL FINDINGS	35-77
V	DISCUSSION	78-91
VI	SUMMARY AND CONCLUSIONS	92-96
	LITERATURE CITED	97-102
	APPENDIX	
	VITA	
	THESIS ABSTRACT	

---

## LIST OF TABLES

---

TABLE	TITLE	PAGE
1	Area, production and productivity of vegetable crops in Maharashtra.	2
2	Physico-chemical properties of soil	16
3	Cropping history	17
4a	Monthly weather data for the year "2000-2001" recorded at Agril.Meteorological Obseervatory, Dr.P.D.K.V.,Akola	18
4b	Monthly weather data for the year "2001-2002" recorded at Agril. Meteorological Obseervatory, Dr.P.D.K.V.,Akola	19
5	Treatment details along with symbols used	20
6	Schedule of cultural observations	21
7	Quantity of fertilizers applied ( $\text{Kg ha}^{-1}$ ) to each crop in different treatments	24
8	Details of biometric observations recorded during 2000-2001 and 2001-2002	25
9	Emergence and final plant stand as influenced by different treatments during 2000-2001 and 2001-2002	36
10a	Plant height of pigeonpea as influenced by different treatments during 2000-2001	37
10b	Plant height of pigeonpea as influenced by different treatments during 2001-2002	38
11a	Number of branches plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001	39
11b	Number of branches plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2001-2002	40
12a	Number of functional leaves plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001	41

---

---

12b	Number of functional leaves plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2001-2002	41
13a	Leaf area plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001	43
13b	Leaf area plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2001-2002	43
14a	Total dry matter plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001	44
14b	Total dry matter plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2001-2002	45
15	Days to 50 per cent flowering and days to maturity of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	46
16a	Absolute growth rate (AGR) for height as influenced by different treatments (2000-2001)	47
16b	Absolute growth rate (AGR) for height as influenced by different treatments (2000-2001)	47
17a	Absolute growth rate (AGR) for total dry matter in pigeonpea as influenced by different treatments during 2000-2001	49
17b	Absolute growth rate (AGR) for total dry matter in pigeonpea as influenced by different treatments during 2001-2002	49
18a	Relative growth rate (RGR) in pigeonpea as influenced by different treatments during 2000-2001	50
18b	Relative growth rate (RGR) in pigeonpea as influenced by different treatments during 2001-2002	50
19a	Net assimilation rate in pigeonpea as influenced by different treatments (2000-2001)	51
19b	Net assimilation rate in pigeonpea as influenced by different treatments (2001-2002)	51
20a	Leaf area index in pigeonpea as influenced by different treatments (2001-2002)	53

---

---

20b	Leaf area index in pigeonpea as influenced by different treatments (2001-2002)	53
21	Yield attributing characters of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	55
22	Crop yield of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	57
23a	Height plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2000-2001)	59
23b	Height plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2001-2002)	60
24a	Number of branches plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2000-2001)	61
24b	Number of branches plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2001-2002)	62
25a	Number of leaves plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2000-2001)	63
25b	Number of leaves plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2001-2002)	64
26a	TDM plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2000-2001)	65
26b	TDM plant <sup>-1</sup> of different intercrops as influenced by base crop pigeonpea (2001-2002)	66
27	Yield attributing characters and yield of various intercrops as influenced by different treatments	67
28	Pigeonpea grain equivalent yield as influenced by different treatments during 2000-2001 and 2001-2002	68
29	Gross monetary returns, net monetary returns, benefit: cost ratio as influenced by different treatments during 2000-2001 and 2001-2002	70
30	LER, Aggressivity and RCC as influenced by different treatments during 2000-2001 and 2001-2002	72

---

---

31	Sustainable yield index and sustainable value index as influenced by different treatments	74
32	Weed dry matter as influenced by different treatments (2000- 2001 and 2001-2002	75
33	Soil fertility status for available nutrients after two years of experimentation	76
34	Correlation and path analysis	77

---

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>AFTER PAGE</b>
1	Monthly weather data during 2000-2001 and 2001-2002	18
2	Plan of layout	20
3	Mean plant height of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	36
4	Height of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002	36
5	Mean number of branches plant <sup>-1</sup> as influenced by different treatments during 2000-2001 and 2001-2002	39
6	Mean number of branches plant <sup>-1</sup> of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002	39
7	Mean number of leaves plant <sup>-1</sup> of pigeonpea at successive time intervals during 2000-2001 and 2001-2002	41
8	Mean number of leaves plant <sup>-1</sup> of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002	41
9	Leaf area plant <sup>-1</sup> of pigeonpea at successive growth stages during 2000-2001 and 2001-2002	43
10	Leaf area plant <sup>-1</sup> as influenced by different treatments during 2000-2001 and 2001-2002	43
11	Total dry matter plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	44
12	Total dry matter plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	44

---

13	Leaf area index plant <sup>-1</sup> of pigeonpea at successive time intervals during 2000-2001 and 2001-2002	53
14	Leaf area index plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	53
15	Number of pods plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	55
16	Number of grains plant <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	55
17	Grain yield ha <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002 and in pooled analysis	56
18	Husk yield ha <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	56
19	Straw yield ha <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	57
20	Biological yield ha <sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002	57
21	Pigeonpea grain equivalent yield as influenced by different treatments during 2000-2001 and 2001-2002 and in pooled analysis	68
22	Gross monetary returns as influenced by different treatments during 2000-2001, 2001-2002 and pooled analysis	69
23	Net monetary returns as influenced by different treatments during 2000-2001 and 2001-2002	69
24	Benefit: cost ratio as influenced by different treatments during 2000-2001, 2001-2002 and pooled analysis	71
25	Land equivalent ratio as influenced by different treatments during 2000-2001 and 2001-2002	72

---

---

26	Aggressivity as influenced by different treatments during 2000-2001 and 2001-2002	72
27	Relative crowding coefficient (RCC) as influenced by different treatments during 2000-2001 and 2001-2002	72
28	Sustainable yield index and sustainable value index as influenced by different treatments during 2000-2001 and 2001-2002	74
29	Weed dry matter as influenced by different treatments during 2000-2001 and 2001-2002	74
30	Available N status and its balance after two years of experiment as influenced by different treatments	76
31	Available P <sub>2</sub> O <sub>5</sub> status and its balance after two years of experiment as influenced by different treatments	76
32	Available K <sub>2</sub> O status and its balance after two years of experiment as influenced by different treatments	76

---

## LIST OF PHOTOGRAPHIC PLATES

---

<b>PLATES</b>	<b>TITLE</b>	<b>AFTER PAGE</b>
1	Treatment T <sub>1</sub> : Sole Pigeonpea	40
2	Treatment T <sub>2</sub> : Sole Blackgram	42
3	Treatment T <sub>8</sub> : Pigeonpea + Blackgram	42
4	Treatment T <sub>3</sub> : Sole Soybean	46
5	Treatment T <sub>9</sub> : Pigeonpea + Soybean	46
6	Treatment T <sub>4</sub> : Sole Cowpea	49
7	Treatment T <sub>10</sub> : Pigeonpea + Cowpea	49
8	Treatment T <sub>7</sub> : Sole Clusterbean	60
9	Treatment T <sub>13</sub> : Pigeonpea + Clusterbean	60

---

## ABBREVIATES AND ACRONYMS

AGR	- Absolute growth rate
BSH	- Bright sunshine hour
CD	- Critical difference
cm	- Centimeter
°C	- Degree Celsius
DAS	- Days after sowing
<i>et al.</i>	- et alia (and others)
g	- Gram
ha	- hectare
hr	- Hour
i. e.	- that is
Kg	- Kilo gram
Km	- Kilo meter
LAI	- Leaf area index
LER	- Land equivalent ratio
m	- Meter
mt	- million tonne
NAR	- Net assimilation rate
N. S.	- Nonsignificant
pH	- $[\log(\text{H}^+)]^{-1}$ concentration
RCC	- Relative crowding coefficient
RGR	- Relative growth rate
RH I	- Relative humidity during morning hours
RH II	- Relative humidity during afternoon hours
RF	- Rainfall
Rs	- Rupees
SE (m)±	- Standard error mean
SYI	- Sustainability yield index
SVI	- Sustainability value index
TDM	- Total dry matter
Tmax	- Maximum temperature
Tmin	- Minimum temperature
Viz.	- Videlicet (namely)
WS	- Wind speed
%	- Per cent
-1	- per



**A general view of experimental plot**

# *INTRODUCTION*

## CHAPTER I

### INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) is one of the most important pulse crops grown in India and *numerouno* among *kharif* pulses. Pigeonpea is grown world over mostly in tropical and subtropical countries for grains, fodder and fuel as sole crop, intercrop, mixed crop and in sequential cropping system. Among the major countries growing pigeonpea, India ranks first with about 90 per cent of world area and 85 per cent of production (Prasad, 2002).

In India, pigeonpea occupies an area of about 3.2 m ha with total production of 2.48 mt and with an average productivity of 775 Kg ha<sup>-1</sup> (FAO, 2002). Among different states, Maharashtra leads both in area and production. In Maharashtra, pigeonpea is grown under 1.96 m ha area with total production 0.66 m t with an average productivity of 602 Kg ha<sup>-1</sup>. (Anonymous, 2002).

The practice of intercropping in India is age old. Pigeonpea is widely acknowledged as an ideal base crop in an intercropping system because of its importance and high adaptability to a wide range of population densities and planting geometries. Because of its long duration nature, wide spacing and slow growth during early stage, many intercrops e.g. greengram, blackgram, soybean, cowpea, cereals, millets etc. have been successfully tried with pigeonpea for better efficiency, to increase productivity, net profit and to bring stability to cropping system under various agro-climatic conditions.

But in the event of main crop (pigeonpea) failure in an intercropping system due to biotic or abiotic stress, the above mentioned field crops can not compensate the economic losses incurred. To overcome such situation, short duration vegetable crops would be a better proposition as component crops in pigeonpea based intercropping systems. A number of vegetable crops, which are stress tolerant and short duration and high value, crops make them suitably fit in the cropping systems. Accommodating these crops in cropping systems would enhance the efforts to meet the ever rising demand of vegetable crops. These efforts would also enhance the income, generate rural employment and meet the nutritional requirement of the vast population.

Besides providing early, periodic and economic returns to farmers, intercropping of vegetables would also bring stability to the complex diverse risk prone agriculture.

Some short duration vegetable crops like cowpea (*Vigna sinensis* Savi.), clusterbean (*Cymopsis tetragonoloba* L.), bhindi (*Abelmoschus esculentus* L.) etc are stress tolerant and fetch higher value than field crops. Some workers have reported intercropping of cowpea and clusterbean in pigeonpea but these crops were raised for fodder purpose and very rarely for vegetable purpose. In case of clusterbean, it is grown on large scale only for industrial purpose. So far, there is no recognized region/area where these crops are purely grown for vegetable purpose. This may be due to lack of improved agro-techniques for increasing the yield of these vegetable crops. Still, farmers grow these crops for vegetable purpose according to their family needs. The commercial production of these vegetables is found in villages around urban areas. The production of these vegetables varies according to demands from urban areas.

In Maharashtra, the area and production of these vegetable crops, is quite negligible, (Table 1).

**Table 1: Area production and productivity of vegetable crops in Maharashtra.**

<b>Crop</b>	<b>Area (ha)</b>	<b>Production (t)</b>	<b>Productivity ( t ha<sup>-1</sup>)</b>
Cowpca	72368	15149	2.093
Bhindi	6893	40854	5.927
Clusterbean	4671	19735	4.225

Thus, there is great scope for increasing area and production of these vegetable crops by accommodating them in intercropping systems.

Among the vegetable crops, chilli (*Capsicum annum* L.) is an important vegetable cum spice crop of subtropics and tropics. India has the largest area of chilli in the world which shares nearly 47.11 per cent of world cultivation (Anonymous, 1992). In our country, the crop is grown on an area of about

9,15,200 hectares with an annual production of 10,18,000 tonnes of chilli during the year 1999-2000 (Peter and Nybe, 2002). Maharashtra is one of the major chilli producing states in India. In the year 2000-2001, the total area under this crop in the state was 1,07,624 hectares with an annual production of about 3,16,448 t of chilli (Anonymous, 2002). Taking into consideration the importance of chilli, this crop can also be considered for intercropping in pigeonpea.

With this background in mind, an experiment entitled “Productivity and economics of pigeonpea based different intercropping systems” was planned with following objectives,

- 1.To study the comparative performance of vegetable crops in intercropping with pigeonpea
- 2.To study the performance of sole crops and intercrops grown in pigeonpea as regards growth attributes, yield attributes and yield
- 3.To find out economic feasibility of different pigeonpea based intercropping systems under rainfed conditions

*REVIEW  
OF  
LITERATURE*

## **CHAPTER II**

### **REVIEW OF LITERATURE**

As mentioned earlier pigeonpea is the ideal base crop for cultivation under intercropping system. So far, various crops have been successfully tried as component crop in pigeonpea based intercropping system. There have been numerous studies on intercropping of short duration crops in pigeonpea like greengram, blackgram; medium duration crops like soybean, cowpea for fodder, clusterbean for seed/green manuring, cereals like sorghum, pearl millet, maize etc and cash crops like cotton. Studies on vegetable intercropping in pigeonpea were also found to be remunerative. Available information on various aspects of pigeonpea intercropping with crops included in present study alongwith some analogical studies is reviewed in this chapter.

#### **(I) Pigeonpea**

##### **2.1 Effect of different intercrops on growth of pigeonpea**

###### **2.1.1 Blackgram**

In one of the preliminary studies on intercropping of compatible crops with pigeonpea, conducted at IARI, New Delhi, Saraf *et al.* (1975) found that blackgram did not interfere with normal growth of pigeonpea as reflected by nonsignificant differences in plant height and number of branches per plant of pigeonpea grown under sole and intercropped situation.

The significant reductions in plant height; number of branches per plant, dry matter production of pigeonpea plant when grown in combination with blackgram were reported by Singh *et al.*, (1979) and Bishnoi *et al.*, (1987).

Tomar *et al.* (1984) tried different proportions of plant population in pigeonpea and blackgram intercropping system viz. 1:1, 1:2 and 2:2. When compared with sole pigeonpea, they did not find significant impact on plant height, number of primary and secondary branches per plant.

Sole pigeonpea recorded significantly higher plant height when compared with plant heights recorded in pigeonpea + blackgram (1:2) and pigeonpea + blackgram (1:3) treatment, (Venketeswarlu, 1986).

In an attempt to assess the productivity of pigeonpea based intercropping systems, Padhi *et al.* (1992) noticed that intercropping of pigeonpea + blackgram (2:3)

when compared with sole pigeonpea treatment significantly reduced the plant height and branches per plant and total dry matter.

A field experiment was conducted at Varanasi by Singh *et al.* (1993) to assess compatible intercrop plant population of blackgram with pigeonpea. It was reported that increasing the population of blackgram in pigeonpea from 50 to 100 per cent did not affect the plant height, dry matter per plant of pigeonpea. Similar trend of results was reported by Jadhav *et al.* (1996). While on the other hand sole cropped pigeonpea recorded significantly higher plant height, primary and secondary branches and number of leaves, leaf area per plant and leaf area index as compared to pigeonpea intercropped with greengram, (Pujari and Sheelavantar, 1998 and Pujari and Sheelavantar, 1999).

Srinivasulu, <sup>et al.</sup> (2000) found that plant height of pigeonpea was significantly increased due to blackgram intercropping, while the same intercropping did not affect dry matter and number of branches per plant at maturity during two years of experimentation.

### **2.1.2 Soybean**

Saraf *et al.* (1975) noticed that soybean, as an intercrop in pigeonpea did not influence the normal growth of pigeonpea. Soybean in intercropping system significantly reduced the plant height, number of branches per plant and dry matter production of pigeonpea as compared with the growth of pigeonpea in sole cropping (Singh *et al.*, 1979).

Several research workers tried different row proportions, different plant population pressures of soybean as an intercrop in pigeonpea. No significant reductions in plant height, number of branches per plant of pigeonpea were recorded by Tomar *et al.* (1984), Prasad and Srivastava (1991) and Jadhav *et al.* (1996).

A field experiment was conducted at Gulbarga (Karnataka) on Vertisols during *Kharif* season of 1992-93 to study the influence of cropping systems, intercrops and row proportions on plant height, branches, number of leaves, leaf area and leaf area index of pigeonpea. Sole cropped pigeonpea recorded significantly higher plant height, primary and secondary branches and number of leaves as compared to pigeonpea intercropped with soybean (Pujari and Sheelavantar, 1998). Sole cropped pigeonpea recorded significantly higher leaf area and leaf area index as compared to pigeonpea intercropped with soybean. The leaf area and leaf area index of pigeonpea were

significantly higher under 1:4 and 2:4 row proportions than under 2:1 row proportion of pigeonpea with soybean (Pujari and Sheelavantar, 1999).

### **2.1.3 Cowpea**

Very little information is available on effect of vegetable cowpea as an intercrop in pigeonpea. Generally, cowpea in intercropping system is grown either for seed purpose or as a fodder crop. This situation compelled author to present some relevant information pertaining to vegetable intercropping in pigeonpea and cowpea intercropped in other base crops.

When cowpea for seed purpose was grown as one of the intercrops in pigeonpea, it did not affect the plant height of pigeonpea in first year of experimentation but pigeonpea height was significantly reduced due to intercropping of cowpea for seed in second year of experimentation (Saraf *et al.*, 1975).

Intercropping of cowpea when raised for seed in pigeonpea significantly reduced the plant height, number of branches per plant and dry matter production of pigeonpea at harvest (Singh *et al.*, 1979).

Venketeswarlu (1986) tried two different row proportions viz., 1:2 and 1:3 in pigeonpea + cowpea intercropping system. He found similar plant height of pigeonpea in both proportions but he further noticed significant reduction in plant height in intercropped pigeonpea as compared to sole crop.

### **2.1.4 Bhindi (Okra)**

To evaluate the performance of rainfed pigeonpea based intercropping systems, a field experiment was conducted by Srinivasulu *et al.* (2000) during the rainy seasons of 1996 and 1997 at Varanasi. The results indicated no considerable variation between the sole cropped pigeonpea and pigeonpea + okra for the pigeonpea growth attributes like plant height and number of branches per plant. However, the dry matter of pigeonpea was markedly reduced when it was intercropped with okra.

### **2.1.5 Clusterbean**

Yadav *et al.* (1997) observed nonsignificant differences in plant height and number of branches per plant of pigeonpea between sole cropped pigeonpea and pigeonpea intercropped with clusterbean during the first year of experiment. But in second year, plant height and number of branches per plant of pigeonpea were significantly reduced due to intercropping of clusterbean as compared with sole cropped pigeonpea.

## **2.2 Effect of different intercrops on yield and yield attributes of pigeonpea**

### **2.2.1 Blackgram**

Saraf *et al.* (1975) reported higher yields in pigeonpea when intercropped with blackgram than sole cropped pigeonpea, though number of pods per plant remained nonsignificant for these two treatments. Intercropping of blackgram in pigeonpea also increased grain equivalent yield than sole cropping of pigeonpea.

Rafey *et al.* (1986) in their two years study reported that pigeonpea equivalent yield due to blackgram intercropping with pigeonpea significantly increased as compared with sole pigeonpea grain yields.

Singh and Singh (1981) inferred that blackgram was the most compatible crop in pigeonpea than bajra (pearlmillet) and sorghum. Intercropping of blackgram with pigeonpea had the least influence on the yield of pigeonpea.

Nonsignificant differences were observed for number of pods, weight of pods, weight of grains per plant, test weight and grain yield in sole cropped pigeonpea and intercropped pigeonpea with blackgram were observed by Bhadang (1983).

A study conducted to know the effect of intercropping on pigeonpea yield for consecutive 3 years (1985-88) showed the reduction in pigeonpea yield in general when intercropped with legumes, oilseeds and cereals (Patel and Parmar 1988). The yield reduction was highest with sorghum and lowest with sesame. However, when total production was considered, the pigeonpea + blackgram intercropping system recorded highest pigeonpea equivalent yield followed by pigeonpea + greengram and pigeonpea + sesame.

Tewari *et al.* (1989) recorded higher number of grains, grain weight per plant, test weight and yield of pigeonpea due to intercropping of blackgram with pigeonpea than sole cropped pigeonpea.

### **2.2.2 Soybean**

Prasad and Gautam (1987) tried pigeonpea and soybean under different planting patterns for two years. Pooled data showed that soybean, as an intercrop in both the planting pattern did not affect the grain yield of pigeonpea. Saraf *et al.* (1975) and Katare *et al.* (1983) also reported analogical results.

Pigeonpea grain yield decreased in intercropping with soybean by 17.57, 20.30 and 15.48 per cent in 1:1, 1:2 and paired row planting pattern respectively over sole planting pattern with 60 cm row spacing (Tomar *et al.*, 1987). They also found that

pigeonpea grain equivalent yields were significantly higher in both the intercropping systems than sole cropped pigeonpea. Results reported by Vyas *et al.* (1992), Nimje and Bhandarkar (1996) also confirmed the above research trend.

Soybean when intercropped with pigeonpea significantly reduced the grain yield of pigeonpea as compared to sole cropped pigeonpea while differences in grain equivalent yield remained nonsignificant. (Billore *et al.*, 1996).

### **2.2.3 Cowpea**

Cowpea when intercropped with pigeonpea did not influence the number of pods per plant, grain yield of pigeonpea and pigeonpea equivalent yield (Saraf *et al.*, 1975 and Khedekar and Nagre, 1980).

Three crop intercrop system involving pigeonpea + cowpea + groundnut reduced the grain yield of pigeonpea significantly as compared with yields obtained from sole cropped pigeonpea. However, this intercropping system recorded 74 per cent more pigeonpea grain equivalent yield over sole cropped pigeonpea yield, (Reddy and Reddy, 1980).

Singh and Singh (1995) tested combination of pigeonpea + cowpea for the two years of 1988 and 1989. In the second year of experimentation, rainfall received was 30 per cent less than the normal. The yield recovery in terms of pigeonpea grain equivalent yield was 12 and 50 per cent higher than sole cropped pigeonpea in the respective years of experimentation.

### **2.2.4 Chilli**

Arulnandhy (1991) proved that the fruit quality of erect fruit type chilli especially colour, can be upgraded by growing it as an intercrop with tall pigeonpea without any reduction in the yield of chilli.

### **2.2.5 Okra**

There were no considerable reductions in yields of pigeonpea due to okra intercropping (Behera *et al.*, 1999) but pigeonpea equivalent yield of the same treatment was significantly superior over sole pigeonpea yield during three years of experiments from 1994-96.

### **2.2.6 Clusterbean**

Intercropping of clusterbean in pigeonpea reduced the pigeonpea yield by 16 per cent while the same combination recorded 24 per cent higher pigeonpea grain equivalent yield over sole cropped pigeonpea (Behera *et al.* 1999).

## **2.3 Effect of different intercrops on yield and yield attributes of other crops**

### **2.3.1 Cowpea**

Padhi (2001) reported that when cowpea was intercropped with maize in different row proportions, 53 to 67 per cent yield increase with respect to maize equivalent yield was achieved over sole cropped maize.

### **2.3.2 Chilli**

To study the effect of intercrops on chilli under semi-arid conditions, Natarajan (1992) tried different vegetable intercrops in chilli. The intercrops except onion and coriander significantly reduced the yield of chilli. The sole cropped chilli recorded highest yield of 1.94 t ha<sup>-1</sup>, while chilli yield was lowest (1.30 t ha<sup>-1</sup>) under chilli + cowpea intercropping system.

### **2.3.3 Okra**

In view of lack of information on okra intercropping in rainy season, Singh (1993) tried different combinations of okra + frenchbean, okra + cowpea, okra + cauliflower, okra + brinjal and okra + tomato. Maximum reduction of 61 per cent was observed due to cowpea intercropping with okra. But the same treatment recorded maximum i.e. 53 per cent more okra equivalent yield than pure okra crop.

### **2.3.4 Clusterbean**

In case of maize, Padhi (2001) observed reduced number of grains per cob, maize grain yield and maize equivalent yield due to intercrop clusterbean, ultimately resulting in production efficiency of negative magnitude.

## **2.4 Effect of pigeonpea on yield and yield attributes of different intercrops**

### **2.4.1 Blackgram**

Venketeswarlu (1986) observed 26 and 15 per cent yield reduction in blackgram due to base crop of pigeonpea in 1:2 and 1:3 pigeonpea + blackgram intercropping system respectively. Rafey *et al.* (1986) and Padhi *et al.* (1992) also reported similar trend of results.

A beneficial association of blackgram and greengram with pigeonpea was reported by Tewari *et al.* (1989). But the effect of pigeonpea was visualized reverse on blackgram and greengram yield. Reduction in yield with these crops was to the tune of 7.52 and 9.79 per cent respectively. This decrease in yield was accompanied with decreasing number of grains per pod, grain weight per plant and test weight in blackgram and greengram.

Srinivasulu (2000) reported reduction in grain yield of intercropped blackgram due to base crop of pigeonpea to the tune of 47 per cent. By increasing the plant population from 50 to 100 per cent of intercropped blackgram in base crop pigeonpea, yield recovery of 50 to 75 per cent in intercropping was achieved as compared with sole blackgram yield (Singh *et al.*, 1993).

#### **2.4.2 Soybean**

Tomar *et al.* (1984) tested three different row proportions of 1:1, 1:2 and 2:2 in pigeonpea + soybean intercropping system. Soybean intercropped with pigeonpea in 1:2 row proportion recorded maximum yield (11.1 q/ha) over other combinations.

The significant reductions in number of branches, number of pods per plant in intercropped soybean due to pigeonpea as compared to sole blackgram was recorded by Prasad and Srivastava (1991). The difference in number of seeds per pod and test weight remained nonsignificant. Soybean grain yield was also affected considerably due to intercropping in pigeonpea. Danawale and Shinde (1996) reported similar results.

Prasad and Gautam (1987) observed 44-45 per cent reduction in soybean grain yield due to intercropping with pigeonpea. Protein content of soybean remained unaffected due to intercropping with pigeonpea while protein yield of soybean decreased relative to grain yield. Tomar *et al.* (1987) reported results on similar line.

Vyas *et al.* (1992) found almost similar reduction in soybean grain yield due to intercropping with base crop of pigeonpea in 1:1 and 2:2 row proportions.

#### **2.4.3 Cowpea**

On an average, 42 per cent yield reduction in cowpea was observed due to pigeonpea in three different pigeonpea based intercropping system (Reddy and Reddy, 1980)

Pigeonpea as a base crop reduced the seed yield of intercropped cowpea to the tune of 19 per cent (Venketeswarlu, 1986).

Padhi (2001) examined maize + cowpea intercropping system in three different row proportions of 1:1, 2:1 and 2:2. He observed reduction in cowpea yield due to maize crop to the extent of 70, 72 and 74 per cent respectively.

#### **2.4.4 Okra**

Srinivasulu *et al.* (2000) reported 37 per cent yield reduction in intercropped okra with base crop of pigeonpea.

#### **2.4.5 Clusterbean**

Yadav *et al.* (1997) showed that yield of intercropped clusterbean in pigeonpea could be considerably increased with application of recommended dose of fertilizer to intercropped clusterbean.

Sorghum as a base crop reduced the yield of intercropped clusterbean by 46 per cent for two years (Vishnumurthy and Vijayalakshmi, 1993).

Padhi (2001) stated that when clusterbean was introduced as intercrop in maize in 1:1 and 2:1 and 2:2 proportions, maize crop reduced the yields of clusterbean by 85, 87 and 84 per cent respectively.

### **2.5 Effect of intercropping systems on monetary returns**

#### **2.5.1 Pigeonpea + Blackgram**

There was a net loss of Rs. 313 ha<sup>-1</sup> when blackgram was intercropped with pigeonpea as compared with the net returns from sole pigeonpea as reported by Saraf *et al.* (1975).

Singh *et al.* (1979) reported maximum gross and net returns from pigeonpea + blackgram intercropping system as compared to other intercropping systems having pigeonpea as base crop and greengram, soybean, cowpea and finger millet as intercrops in different treatments. The pigeonpea + blackgram recovered 64 per cent higher net returns than sole cropped pigeonpea. Singh and Singh (1981), Tomar *et al.* (1984), Venketeswarlu (1986), Goyal *et al.* (1991), Padhi *et al.* (1992) and Kumar (1993) reported similar results with pigeonpea + blackgram intercropping system.

#### **2.5.2 Pigeonpea + Soybean**

Saraf *et al.* (1975) reported a net loss of Rs. 341 ha<sup>-1</sup> due to pigeonpea + soybean intercropping system when compared with net returns achieved from sole cropped pigeonpea.

About 17 per cent more net returns per hectare were obtained by Singh *et al.* (1979) due to pigeonpea + soybean intercropping than sole pigeonpea.

Maximum net returns (Rs. 4835 ha<sup>-1</sup>) were obtained from pigeonpea + soybean intercropping system in 1:2 row proportion than 1:1 or 2:2 row proportions of the same intercropping systems (Tomar *et al.*, 1984).

Prasad and Gautum (1987) concluded that pigeonpea + soybean in uniform row spacing of 60 cm recorded the highest gross as well as net returns and net returns per rupee invested.

Almost double increase in net returns in pigeonpea + soybean intercropping system than sole cropped pigeonpea was reported by Vyas *et al.* (1992).

Though intercropping combination of 1:1 and 1:2 in pigeonpea + soybean recorded higher net returns over sole cropped pigeonpea during their investigation, Nimje and Bhandarkar (1996) found pigeonpea + soybean intercropping in 1:3 row proportion was the most profitable combination.

Additional returns of Rs. 6183 ha<sup>-1</sup> were obtained when soybean was intercropped with pigeonpea (Yadav *et al.*, 1997).

### **2.5.3 Pigeonpea + cowpea**

Considering the economics of various crop mixtures tested by Saraf *et al.* (1975) it was seen that the net returns were maximum in pigeonpea + cowpea intercropping system. Venketeswarlu (1986) also found pigeonpea + cowpea as the most remunerative intercropping system than other intercropping systems tried.

About 16 per cent more net returns in pigeonpea + cowpea intercropping system than sole cowpea were achieved by Khedekar and Nagre (1980).

After investigating various pigeonpea based intercropping systems, Singh *et al.* (1979) concluded that though pigeonpea + cowpea combination required higher cost of cultivation than sole pigeonpea, the intercropping system recorded more net returns per hectare than sole pigeonpea cropping system.

Venketeswarlu (1986) observed that growing cowpea as an intercrop in pigeonpea received almost similar net returns (Rs. 2474 ha<sup>-1</sup>) as obtained in sole cropped pigeonpea (Rs. 2463 ha<sup>-1</sup>).

### **2.5.4 Chilli + Other Crops**

Natarajan (1992) found that chilli + okra was the best intercropping combination as the gross income from the intercropping systems was higher under normal and paired row planting.

Based on economics of chilli based intercropping system with two methods of planting, Arvazhi *et al.* (1997) concluded that chilli raised under paired row planting with aggregatum onion or blackgram or cepa onion as intercrop could be considered ideal to get high returns.

### **2.5.5 Pigeonpea + okra**

Singh (1993) reported the highest net returns under okra + cowpea intercropping system.

Okra + tomato intercropping system registered the highest net returns (Singh, 1995).

Higher returns of about Rs. 4200 ha<sup>-1</sup> were recorded in pigeonpea + okra intercropping than sole cropped pigeonpea as reported by Behra *et al.* (1999). They also observed that the same intercropping system gave the returns of Rs. 2.06 per rupee invested.

#### **2.5.6 Pigeonpea + clusterbean**

Additional returns of Rs. 2692 ha<sup>-1</sup> were obtained (Yadav *et al.* 1999) in pigeonpea + clusterbean intercropping system over sole pigeonpea.

About 81 per cent more net returns were reported by Behera *et al.* (1997) from pigeonpea + clusterbean intercropping system over sole pigeonpea.

### **2.6 Assessment of yield advantage in intercropping systems**

As it is not possible to assess yield advantages from any intercropping system by using only a single index, one has to evaluate the performance of an intercropping system by applying different indices so that advantages are validly assessed. There are different indices proposed by number of researchers. In his classical review, Willey (1979) has rightly evaluated different indices with illustrations. The information on different indices used in present investigation is reviewed under appropriate headings.

#### **2.6.1 Benefit: Cost ratio**

Benefit cost ratio is the ratio of gross returns to cost of cultivation, which can also be expressed as returns per rupee invested. This index provides an estimate of the benefit a farmer derives for the expenditure he incurs in adopting a particular cropping system. Any value above 2.0 is considered safe.

Prasad and Gautam (1987) reported maximum benefit cost ratio of 2.51 in pigeonpea + soybean in 60 cm uniform row spacing.

Tomar *et al.* (1987) found pigeonpea + soybean in 1:2 ratio more remunerative than 1:1 combination as the benefit cost ratio was found to be higher (3.23) in the 1:2 combination.

Intercropping blackgram in pigeonpea was found most remunerative than sesamum / greengram / sorghum intercropped with pigeonpea. The pigeonpea + blackgram intercropping system obtained highest benefit: cost ratio to the extent of 2.68 (Goyal *et al.*, 1991).

Behera, *et al.* (1999) evaluated the biological and economical feasibility of intercropping vegetable crops in rainfed pigeonpea. From their study, it was reported that growing vegetables like okra and clusterbean intercrops in pigeonpea could give higher benefit: cost ratio than rice or finger millet in pigeonpea.

### **2.6.2 Aggressivity**

McGeilchrist (1965) proposed this index. It assumes that mixtures form a replacement series and it gives a simple measure of how much the relative yield increase in species 'a' is greater than that for species 'b'.

An experiment was conducted by Billore *et al.* (1996) to determine the fertilizer need of pigeonpea and soybean under intercropping system. From their study, they concluded that negative sign of aggressivity values for soybean indicated the dominance of pigeonpea in the intercropping system while positive sign indicated just reverse i.e. dominance of intercrop over base crop. Higher values of aggressivity showed differences in competitive abilities and wider differences between actual and expected yield of both the crops. Willey (1979) and Holkar *et al.* (1991) also extended similar views.

### **2.6.3 Relative crowding coefficient**

De Wit (1960) proposed this index. It assumes that mixture treatment form a replacement series. Each species has its own coefficient, which gives a measure of whether that species has produced more, or less, yield than expected. To determine if there is a yield advantage of mixing, the product of the coefficients is formed.

The relative crowding coefficient (K), a product of crowding coefficient of soybean ( $K_a$ ) and pigeonpea ( $K_b$ ) was more than unity, indicating greater non-competitive interference than the competitive one (Holkar *et al.*, 1991). Similar trend of results was reported by Billore *et al.* (1996) for pigeonpea + soybean intercropping system.

### **2.6.4 Land Equivalent Ratio (LER)**

This index is generally accepted measure of assessing yield advantages from intercropping system. This index was proposed by Willey (1979). It is the measure of the relative land area under sole crops that is required to produce the yields achieved in intercropping. The LER value greater than unity indicates yield advantage.

Venketeswarlu (1986) tried different combinations of short duration legumes in pigeonpea. The pigeonpea + blackgram in 1:2 row proportion recorded highest land

equivalent ratio of 1.68 than pigeonpea + green gram and pigeonpea + cowpea in 1:2 and 1:3 row proportions. Tomar *et al.* (1987) reported similar results.

Sowing of 1 row of “Bragg” soybean between the lines of pigeonpea spaced at 60 cm gave the highest value of land equivalent ratio (1.65) as reported by Prasad and Srivastava (1991). The results were in agreement with the findings of Ahlavat *et al.* (1982) and Vyas *et al.* (1992).

While evaluating productivity of rainfed pigeonpea based different intercropping system, Padhi *et al.* (1992) concluded that pigeonpea + blackgram was most profitable intercropping system as compared to pigeonpea + greengram, pigeonpea + fingermillet and pigeonpea + groundnut. The pigeonpea + blackgram combination recorded highest land equivalent ratio of 1.43. Singh *et al.* (1993) also confirmed the above results.

Pigeonpea+okra intercropping was tested in three different row proportions by Srinivasulu *et al.* (2000). They recorded the highest land equivalent ratio in pigeonpea + okra intercropping system, when planted at 60 cm spacing.

#### **2.6.5 Sustainable yield index and sustainable value index**

Sustainable yield index denotes minimum guaranteed yield as a percentage to the maximum observed yield with high probability (Singh *et al.* 1990).

Pandey *et al.* (1992) concluded that pigeonpea + sorghum intercropping provided greater sustainable yield and economic stability at 30 kg N and 50 Kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> compared with sole pigeonpea and sole sorghum.

Kayande and Namaware (1995) reported that for Vidarbha region Hy. sorghum + pigeonpea (3:3), pigeonpea + greengram, pigeonpea + soybean (1:2) and cotton + green gram (1:1) were the sustainable intercropping systems.

*MATERIALS  
AND  
METHODS*

## CHAPTER III

### MATERIALS AND METHODS

The details of the materials used and methods adopted for conducting the present field investigation are described in this chapter under appropriate heads.

#### 3.1 Details of the experimental material

##### 3.1.1 Experimental site

The experiment was laid out in the field number 66 of the farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, (Maharashtra) during *kharif* seasons of 2000-2001 and 2001-2002.

##### 3.1.2 Soil

In order to know the physico-chemical properties of the experimental soil, the soil samples to the depth of 0-30 cm were randomly collected from the experimental field before sowing and analysed for physico-chemical properties. The results and methods adopted for analysis are presented in table 2.

**Table 2 : Physico-chemical properties of soil**

Sr. No.	Particulars	Results	Methods adopted
<b>A Mechanical analysis</b>			
1	Coarse sand (%)	4.95	
2	Fine sand (%)	19.80	Standard International Pipette method (Piper, 1966)
3	Silt (%)	25.70	
4	Clay (%)	49.55	
5	Textural class	Clayey	
<b>B. Chemical analysis</b>			
1	Total nitrogen (%)	0.04	Modified Kjeldahl's method (Piper, 1966)
2	Organic carbon (%)	0.36	Walkly and Black's Method (Jackson, 1967)
3	Available nitrogen Kg ha <sup>-1</sup>	194.48	Subbiah and Asija (1956)
4	Available P <sub>2</sub> O <sub>5</sub> Kg ha <sup>-1</sup>	19.70	Olsen's Method (Jackson, 1967)
5	Available K <sub>2</sub> O Kg ha <sup>-1</sup>	255.36	Flame Emission Spectrophotometer method (Jackson, 1967)
6	Soil pH	7.9	Glass Electrode pH meter (Jackson, 1967)

Perusal of data from table 2 indicates that the soil from experimental plot was clayey in texture; low in total nitrogen, organic carbon, available nitrogen (194.48 Kg ha<sup>-1</sup>) and phosphorous and marginally high in available potassium.

### 3.1.3 Cropping history of experimental plots

**Table 3 : Cropping history**

Year	Crop cultivated	
	Kharif	Rabi
1995-1996	Cotton	
1996-1997	Sunhemp	-
1997-1998	Cotton	-
1998-1999	Sorghum	-
1999-2000	Dhaincha	-
2000-2001	Present investigation	
2001-2002	Present investigation	

The cropping history of the experimental plot for last five years is presented in table 3. Plot No. 66 was leveled and had good drainage.

### 3.1.4 . Climatic conditions

Akola is situated at the latitude at 20<sup>o</sup>, 42' North and longitude of 77<sup>o</sup>, 02' East. The altitude of this place is 307.41 m above mean sea level. The climate of the place is semi-arid and is characterized by three distinct seasons, viz., hot and dry summer from March to May. Warm and rainy monsoon from June to October and mild winter from November to February. Rains are mostly received from South-West monsoon during June to October with mean annual precipitation of 824.8 mm, which is generally received in 41 rainy days. Winter rains are uncertain but have an average of 86.9 mm during October to January. The annual mean minimum temperature varies from 10.5 to 27.1<sup>o</sup>C, while the mean maximum temperature ranges from 28.2 to 42.6<sup>o</sup>C. The bright sunshine hour ranges from 4.1 to 10.0 per day and wind speed from 4.3 to 14.8 km/hr. The morning relative humidity ranges between 35 to 87 and evening humidity between 14 to 68 per cent respectively.

### 3.1.5a Weather conditions during 2000-2001

The data presented in table 4a (Fig. 1) revealed that the total rainfall received during crop season was 534.3 mm as against the normal (773.3 mm) which was deficient by 210.8 mm than the normal. The rains received during the month of June were insufficient to carry out the sowing of the crops.

Hence, the sowing was carried out late at the end of last week of June (30<sup>th</sup> June), when sufficient rains were received. In the month of August, rainfall received was 150.7 mm, which was lesser by 69.8 mm than the normal. During this month, crop suffered due to water stress resulting in stunted growth of experimental plot. In the month of September, total rainfall received was 55 mm, which was scanty by 48.2 mm than the normal. Rains were not received at all from October to December; therefore two life saving irrigations were applied to the crop during the months of October and December.

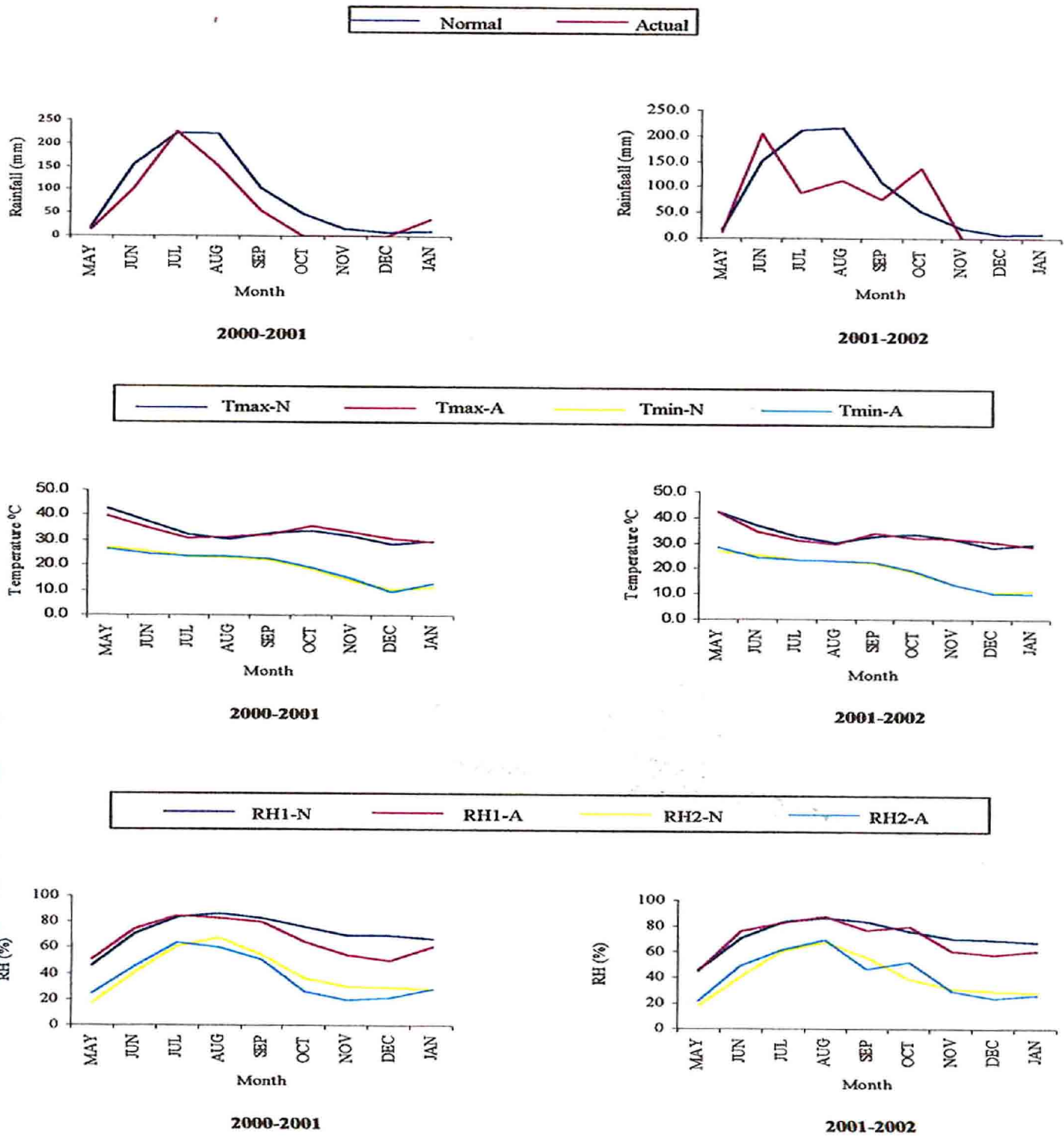
**Table 4a : Monthly weather data for the year "2000-2001" recorded at Agril.Meteorological Observatory, Dr.P.D.K.V.,Akola**  
(N- Normal A- actual)

MONTH	RF mm		Tmax °C		Tmin °C		BSH		WS km/hr		RHI %		RHII %	
	N	A	N	A	N	A	N	A	N	A	N	A	N	A
JAN 00	9.5	0.0	30.0	30.2	11.4	11.3	9.0	9.2	5.5	4.4	67	66	28	27
FEB	9.2	25.2	32.6	30.0	13.2	13.5	9.6	7.5	6.4	6.1	56	61	21	29
MAR	10.7	0.0	37.3	35.9	17.8	16.8	9.7	8.9	7.3	7.0	41	39	20	17
APR	3.6	0.5	41.2	42.4	23.2	24.0	10.1	9.4	9.1	9.2	35	34	14	12
MAY	17.9	13.4	42.6	39.9	27.1	26.3	10.0	9.2	14.4	13.5	46	51	17	25
JUN	155.2	102.3	37.2	34.7	25.6	24.4	7.2	5.6	15.0	14.2	71	75	41	45
JUL	224.3	226.3	32.5	30.9	23.7	23.3	4.7	3.7	12.0	11.5	84	85	61	64
AUG	220.5	150.7	30.3	31.6	22.9	23.7	4.1	5.1	11.6	10.8	87	83	68	60
SEP	103.2	55.0	32.7	32.5	22.1	22.5	6.9	6.4	8.0	7.0	83	80	55	51
OCT	47.3	0.0	33.9	35.7	18.5	18.9	8.5	8.4	4.7	3.5	76	65	37	26
NOV	14.7	0.0	31.7	33.4	13.9	14.5	8.8	8.6	4.9	3.9	70	55	30	20
DEC	8.6	0.0	28.2	31.0	10.5	9.5	9.0	8.7	4.8	2.8	70	50	29	22
JAN 01	9.5	38.2	30.0	29.4	11.4	12.8	9.0	7.0	5.5	4.7	67	61	28	28
<b>AVG</b>	<b>824.7</b>	<b>573.4</b>	<b>34.2</b>	<b>34.0</b>	<b>19.2</b>	<b>19.1</b>	<b>8.1</b>	<b>7.6</b>	<b>8.6</b>	<b>7.8</b>	<b>66</b>	<b>62</b>	<b>35</b>	<b>33</b>

Mean maximum and minimum temperatures were greater in the month of August and September than the normal coupled with water stress.

Bright sunshine hours were lower than the normal. The highest and lowest sunshine hours were 8.7 to 3.7 in December and July 2000 respectively. Wind speed in growing season was lesser than the normal. The highest wind speed was recorded in the month of June i.e. 14.2 km/hr.

Relative humidity was higher during the months of June and July than the normal. Relative humidity was highest in the month of August and lowest in the month of January. Morning relative humidity was higher than the relative humidity received in the evening.



**Fig. 1. Monthly weather data for the year 2000-2001 and 2001-2002**

Overall season was not favourable to the crop growth. Crop had passed through water stress twice in a growing period resulting in low growth rate of the crop and productivity. However, application of two life saving irrigations during 33<sup>rd</sup> and 43<sup>rd</sup> meteorological weeks helped for stabilizing the productivity of the crop.

**Table 4b : Monthly weather data for the year "2001-2002" recorded at Agricultural Meteorological Observatory, Dr.P.D.K.V.,Akola**

MONTH	RF mm		Tmax °C		Tmin °C		BSII		WS km h <sup>-1</sup>		RH %		RHII %	
	N	A	N	A	N	A	N	A	N	A	N	A	N	A
JAN 01	9.0	38.2	29.8	29.4	11.4	12.8	8.8	7.0	5.3	4.7	68	61	29	28
FEB	10.2	0.0	32.5	34.5	13.3	14.0	9.4	8.4	6.2	5.3	57	37	22	13
MAR	9.5	48.0	37.3	36.3	17.8	19.6	9.6	8.3	7.2	8.0	41	50	19	19
APR	3.1	13.1	41.2	39.9	23.2	22.3	10.0	8.4	9.0	7.4	35	51	14	22
MAY	16.6	12.8	42.5	42.3	27.0	28.2	9.9	9.0	14.2	14.7	46	45	18	22
JUN	150.5	204.5	37.2	34.5	25.6	24.6	7.2	4.8	14.9	14.7	71	76	41	50
JUL	212.2	89.2	32.5	31.1	23.7	23.7	4.5	2.4	11.9	10.9	84	83	61	62
AUG	215.7	112.4	30.4	29.8	23.0	22.9	4.1	2.9	11.4	10.2	87	88	68	70
SEP	111.1	76.4	32.5	34.0	22.2	22.5	6.6	6.2	7.9	6.3	84	77	57	47
OCT	52.3	136.6	33.7	32.2	18.6	19.2	8.4	6.4	4.8	3.8	76	80	39	52
NOV	20.0	0.0	31.6	31.7	14.1	13.8	8.7	8.5	4.7	3.4	70	61	31	30
DEC	8.4	0.0	28.3	30.8	10.6	10.5	8.8	8.6	4.6	3.0	70	58	30	24
JAN 02	9.0	0.0	29.8	29.0	11.4	10.2	8.8	8.3	5.3	4.4	68	61	29	27
FEB 02	10.2	1.8	32.5	33.0	13.3	15.9	9.4	7.7	6.2	5.2	57	55	22	25
AVG	818.6	731.2	34.1	33.9	19.2	19.5	8.0	6.7	8.5	7.7	66	64	36	37

### 3.1.5b Weather conditions during 2001-02

The data presented in table 4b (Fig. 1) indicated that the total rainfall received during the crop season was 617.3 mm, which was lesser by 142.7 mm than the normal (773.8 mm). The rains received during the month of June were sufficient to undertake sowing of the crop. Therefore the sowing was carried out at the end of first fortnight of June (15 June). In the month of July, the total rainfall received was 89.2 mm, which was lesser by 123 mm than the normal (212.2 mm). Similarly, the rains received during the month of August and September were 112.4 mm and 76.4 mm respectively, which were lesser by 103.3 mm and 34.7 mm respectively than the normal. During these months crop suffered due to water stress. Hence one protective irrigation during 37<sup>th</sup> and one light irrigation during 46<sup>th</sup> meteorological week to the crop were applied for stabilizing the productivity. During the month of October, the total rainfall

received was 136.6 mm, which was excess by 84.3 mm than the normal. Rains were not received at all from November to January.

Mean maximum and minimum temperatures were almost remained similar during the crop season.

Bright sunshine hours were less than the normal during the month of June to August. The highest sunshine hours were 8.6, recorded during the month of December. Wind velocity in the growing season was less than normal.

The relative humidity was highest during the month of August (88 per cent) and lowest during the month of December (24 per cent).

## 3.2 Experimental Details

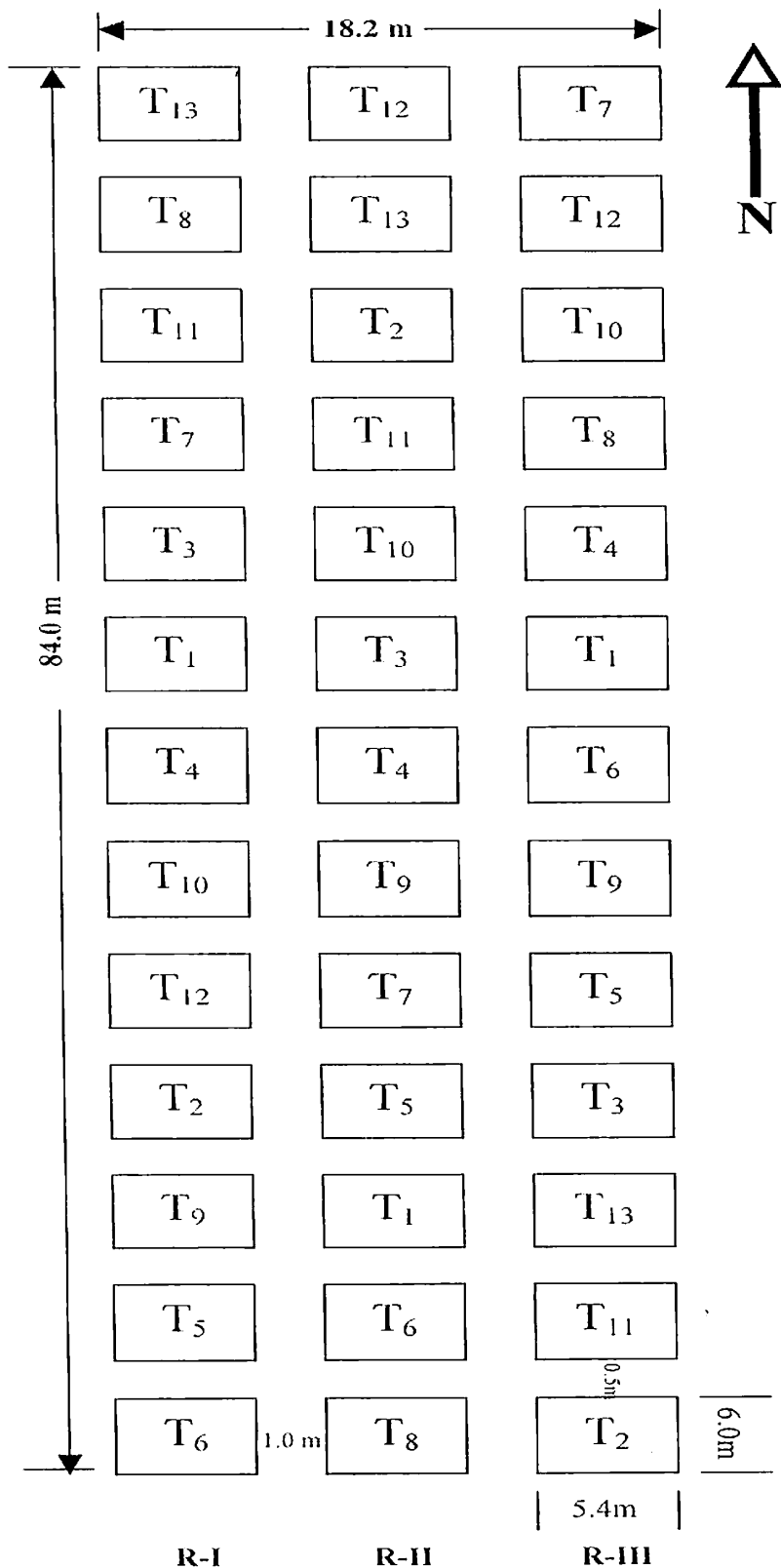
### 3.2.1 Experimental design and treatment details

The present investigation “Productivity and economics of pigeonpea based different intercropping systems” was laid out in randomized block design with three replications. The treatment details along with the symbols used are presented in table 5 and plan of layout is depicted in figure 2.

**Table 5 : Treatment details along with symbols used**

<b>Treatment name</b>	<b>Symbol</b>
Pigeonpea sole	T <sub>1</sub>
Blackgram sole	T <sub>2</sub>
Soybean sole	T <sub>3</sub>
Cowpea sole	T <sub>4</sub>
Chilli sole	T <sub>5</sub>
Bhindi (Okra) sole	T <sub>6</sub>
Clusterbean sole	T <sub>7</sub>
Pigeonpea + Blackgram	T <sub>8</sub>
Pigeonpea + Soybean	T <sub>9</sub>
Pigeonpea + Cowpea	T <sub>10</sub>
Pigeonpea + Chilli	T <sub>11</sub>
Pigeonpea + Bhindi	T <sub>12</sub>
Pigeonpea + Clusterbean	T <sub>13</sub>

Thirteen treatments were laid out in randomized block design (RBD) with three replications. The details of the experimental layout are given below.



**Treatment details**

Design : RBD  
 Number of Treatments : 13  
 Plot size : Gross : 6.0 m x 5.4 m  
 Net : 5.4m x 3.6m

**Treatments**

- T<sub>1</sub> – Pigeonpea sole
- T<sub>2</sub> – Blackgram sole
- T<sub>3</sub> – Soybean sole
- T<sub>4</sub> – Cowpea sole
- T<sub>5</sub> – Chilli sole
- T<sub>6</sub> – Bhindi sole
- T<sub>7</sub> – Clusterbean sole
- T<sub>8</sub> – Pigeonpea + Black gram (1:2)
- T<sub>9</sub> – Pigeonpea + Soybean (1:2)
- T<sub>10</sub> – Pigeonpea + Cowpea (1:2)
- T<sub>11</sub> – Pigeonpea + Chilli (1:2)
- T<sub>12</sub> – Pigeonpea + Bhindi (1:2)
- T<sub>13</sub> – Pigeonpea + Clusterbean (1:2)

Fig. 2. Plan of layout for the year 2000-2001 and 2001-2002

<b>1.Treatments</b>	: 13
<b>2.Replications</b>	: 3
<b>3.Total experimental plots</b>	: 39
<b>4.Gross plot size</b>	: 6.0 m x 5.4 m
<b>5.Net plot size</b>	: 5.4 m x 3.6 m
<b>6.Area of the net pot</b>	: 19.44 m <sup>2</sup>
<b>7.Distance between two replications</b>	: 1.0 m
<b>8.Distance between tow plots</b>	: 0.5 m

**9.Crop and varieties**

Pigeonpea	:	Asha (ICPL-87119)
Blackgram	:	TAU-1
Soybean	:	JS-335
Cowpea	:	Pusa komal
Chilli	:	Jayanti
Bhindi	:	Parbhani Kranti
Clusterbean	:	Pusa Navbahar

**10. Spacing:**

The distance between two rows was kept 60 cm while intra row distance varied according to crop species. For pigeonpea and other vegetable crops the plant to plant distance was 30 cm while for blackgram and soybean the distance between two plants was 5 cm.

**11. Seed rate (Kg ha<sup>-1</sup>)**

Pigeonpea	:	15.0
Blackgram	:	15.0
Soybean	:	75.0
Cowpea	:	20.0
Chilli	:	1.0
Bhindi	:	10.0
Clusterbean	:	8.0

In intercropping system each component crop was supplied with fertilizer dose with respect to their sown proportion.

### 3.2.2 Field Operations

The schedule of various cultural operations carried out during the period of experimentation is given in table 6.

**Table 6. Schedule of cultural observations**

Sr. No.	Field operations	2000-2001		2001-2002	
		Frequency	Date of operation	Frequency	Date of operation
1.	Ploughing	1	15.5.2000	1	21.5.2001
2.	Harrowing	2	30.5.2000,17.6.2002	2	30.5.2001, 10.6.2001
3.	Layout of experiment	1	28.6.2000	1	10.6.2001
4.	Sowing and transplanting	1	30.6.2000	1	15.6.2001
5.	Nursary planting of chilli	1	25.5.2000	1	25.5.2001
6.	Fertilizer application	1	30.6.2000	1	15.6.2001
7.	Weeding	2	30.7.2000, 30.8.2000	2	30.7.2001,30.8.2001
8.	Hoeing	2	15.7.2000, 15.8.2000	2	15.7.2001, 15.8.2001
9.	Protective irrigation	2	16.8.2000,25.10.2000	2	15.9.2001,15.11.2001
10.	Plucking of vegetables				
i.	Cowpea	7	20.8.2000,26.8.2000, 2.9.2000, 9.9.2000,14.9.2000, 20.9.2000 and 26.9.2000	5	6.8.2001,11.8.2001,16.8.2001, 31.8.2001,10.10.2001
ii.	Chilli	8	21.8.2000,26.8.2000,2.9.2000, 9.9.2000,19.9.2000,21.9.2000, 21.10.2000, 3.11.2000 and 14.11.2000	3	26.10.2001,2.11.2001,13.11.2001
iii.	Bhindi	9	20.8.2000,26.8.2000, 5.9.2000,9.9.2000,14.9.2000, 19.9.2000,25.9.2000,30.9.2000 and 21.10.2000	11	6.8.2001,11.8.2001,16.8.2001, 20.8.2001,24.8.2001,28.8.2001, 3.9.2001,10.9.2001,15.10.2001,21.10.2001 and 27.10.2001
iv.	Clusterbean	12	21.8.2000,26.8.2000,2.9.2000, 5.9.2000,9.9.2000,14.9.2000, 20.9.2000,26.9.2000,4.10.2000, 17.10.2000,17.10.2000,21.10.2000 and 3.11.2000	5	6.8.2001,11.8.2001,16.8.2001,24.8.2001, 3.9.2001,10.9.2001,15.10.2001, 21.10.2001 and 27.10.2001
11.	Harvesting				
i.	Pigeonpea	1	30.12.2000	1	13.1.2002
ii.	Blackgram	1	9.8.2000	1	31.8.2002
iii.	Soybean	1	4.9.2000	1	23.9.2002
iv.	Cowpea	1	6.9.2000	1	28.9.2002
v.	Chilli	1	30.12.2000	1	13.1.2002
vi.	Bhindi	1	28.10.2000	1	18.10.2001
vii.	Clusterbean	1	28.10.2000	1	16.2001
12.	Threshing				
i.	Pigeonpea	1	22.1.2001	1	19.1.2002
ii.	Blackgram	1	11.8.2000	1	2.9.2001
iii.	Soybean	1	6.9.2000	1	2.9.2001,25.9.2001

### **3.2.2.1 Preparation of land and layout of experiment**

The field was ploughed with tractor drawn plough and was brought to fine tilth by following disking and harrowing. The remains of previous crop were collected and field was leveled with the bullock drawn planker. The field was laid out as per plan of layout (fig. 2).

### **3.2.2.2 Sowing**

Certified seed for all crops under experimentation were used. The sowing was undertaken after receipt of sufficient rains. All the crops except blackgram and soybean were dibbled at intra row spacing of 30 cm. The seeds of blackgram and soybean were drilled. In each intercropping system, two rows of base crop pigeonpea were replaced by an intercrop maintaining 1:2 row proportion. This maintained 33 per cent plant population of base crop pigeonpea and 67 per cent crop stand of intercrop in each intercropping system. Chilli crop was transplanted 35 and 42 days after nursery planting in first and second year respectively.

### **3.2.2.3 Fertilizer application**

The recommended dose of fertilizer was applied to each crop in its sole crop stand. While in intercropping system the fertilizers were applied on their proportionate stand basis. For example, in every intercropping system, the base crop pigeonpea having 33 per cent plant population of its sole crop stand was supplied with 33 per cent of its recommended dose of fertilizers. On the other hand, other component crop in every intercropping system, having 67 per cent population stand of its sole crop stand was supplied with 67 per cent recommended dose of fertilizers. The fertilizers were mixed before sowing and *applied in bands to each crop in its sole and inter cropping system. The details of the fertilizers applied to each crop are presented in table 7.*

### **3.2.2.4 Interculture**

The crop was maintained in weed free conditions by two hand weedings and two hoeings.

### **3.2.2.5 Plant Protection**

There was negligible incidence of any major pest of base crop and other component crop. However, at the time of bud initiation, pigeonpea crop was dusted with 2 per cent dust of methyl parathion as a preventive measure of

**Table 7 : Quantity of fertilizers applied (Kg ha<sup>-1</sup>) to each crop in different treatment**

Treatments	Base Crop			Intercrop		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
T <sub>1</sub>	25.00	50.00	0	-	-	-
T <sub>2</sub>	25.00	70.00	0	-	-	-
T <sub>3</sub>	30.00	75.00	0	-	-	-
T <sub>4</sub>	25.00	50.00	0	-	-	-
T <sub>5</sub>	50.00	25.00	0	-	-	-
T <sub>6</sub>	50.00	50.00	0	-	-	-
T <sub>7</sub>	25.00	50.00	0	-	-	-
T <sub>8</sub>	8.25	16.50	0	16.75	33.50	0
T <sub>9</sub>	8.25	16.50	0	20.10	50.25	0
T <sub>10</sub>	8.25	16.50	0	16.75	33.50	0
T <sub>11</sub>	8.75	16.50	0	33.50	16.75	0
T <sub>12</sub>	25.75	16.50	0	33.50	33.50	0
T <sub>13</sub>	8.25	16.50	0	16.75	33.50	0

pigeonpea pod borer incidence. Similarly vegetable crops were sprayed with Malathion after every picking for controlling / preventing pod borer attack. There was no incidence of pest / diseases on blackgram and soybean during both the years of experimentation.

### 3.2.2.6 Irrigation

Two life saving irrigations were given during stress period to whole plot during both the years of experimentation.

### 3.2.2.7 Harvesting, drying and threshing

All the field crops viz., pigeonpea, blackgram and soybean were harvested at maturity according to their maturity signs. When more than two third of pods of pigeonpea turned brown, the plants were cut with sickle 5 to 7 cm above ground and kept in the field for sundrying. Then threshing was done by beating the pods by sticks. Most of the pods when turned black, blackgram was harvested by plucking the pods manually. The pods were allowed to dry and threshed. When the soybean plants reach maturity, the leaves turn yellow and

drop and pods dryout quickly. Drying and threshing was done similar to pigeonpea.

For vegetable crops, plucking of fruits was done periodically when these attained plucking stage. All the vegetable crops were plucked at different time interval.

### 3.2.3 Sampling technique and details of biometric observations

Growth observations were recorded on five labelled plants, selected randomly to represent the population in each net plot. In intercropping treatments five plants were selected from each component crop population in the net plot. The details of observations recorded during 2000-01 and 2001-02 are given in table 8 and the technique adopted is presented in the following paragraphs.

**Table 8 : Details of biometric observations recorded during 2000-2001 and 2001-2002**

	Particulars	Frequency	Days after sowing
<b>I</b>	<b>Pigeonpea</b>		
<b>A.</b>	<b>Growth studies</b>		
1	Plant Stand ( At emergence and harvest)	2	10,180
2	Height (cm)	12	15,30,45,60, 75, 90, 105, 120, 135, 150, 165 at harvest
3	Number of branches	12	-do-
4	Number of leaves	12	-do-
5	Leaf area (cm <sup>2</sup> )	12	-do-
6	Total dry matter (g)	12	-do-
	<b>Yield attributes and yield</b>		
1	Number of pods plant <sup>-1</sup>	1	After harvest
2	Number of grains plant <sup>-1</sup>	1	-do-
3	Grain yield plant <sup>-1</sup> (g)	1	-do-
4	100 seed weight (g)	1	-do-
5	Grain yield per net plot (Kg)	1	-do-
6	Straw yield per net plot (Kg)	1	-do-
<b>II</b>	<b>Blackgram</b>		
<b>A.</b>	<b>Growth Studies</b>		
1	Plant stand (At emergence and at harvest)	2	10
2	Plant height (cm)	5	15,30,45,00, at harvest
3	Number of branches	5	-do-
4	Number of leaves	5	-do-
5	Total dry matter (g)	5	-do-
<b>B.</b>	<b>Yield attributes and Yield</b>		
1	Number of pods plant <sup>-1</sup>	1	-do-

2	Number of grains plant <sup>-1</sup>	1	-do-
3	Grain yield plant <sup>-1</sup> (g)	1	-do-
4	Grain yield per net plot (Kg)	1	-do-
<b>III. Soybean</b>			
<b>A. Growth Studies</b>			
1	Plant stand (At emergence and at harvest)	2	10
2	Height (cm)	1	15,30, 45,60,75,90, 105
3	Number of branches		-do-
4	Number of leaves		-do-
5	Total dry matter (g)		-do-
<b>B. Yield attributes and yield</b>			
1	Number of pods plant <sup>-1</sup>	1	After harvest
2	Number of grains plant <sup>-1</sup>	1	-do-
3	Grain yield plant <sup>-1</sup> (g)	1	-do-
4	Grain yield per net plot (Kg)	1	-do-
<b>IV. Cowpea, Chilli, Bhindi, Clusterbean</b>			
<b>A. Growth studies</b>			
1	Plant stand (At emergence and at harvest)	2	10
2	Height (cm)		15,30,45,60,75,90, 105
3	Number of branches		-do-
4	Number of leaves		-do-
5	Total dry matter (g)		-do-
<b>B. Yield attributes and yield</b>			
1	Number of fruits plant <sup>-1</sup>		After each plucking
2	Fruit yield plant <sup>-1</sup> (Kg)		After harvest
3	Fruit yield per net plot (Kg)		After harvest

### 3.2.3.1 Pigeonpea, Blackgram and Soybean

#### (I) Growth studies

##### a) Plant stand

The plant population was recorded by actually counting the number of plants in the net plot after complete emergence and thinning as well as at harvest of the crop. For initial and final plant stands of blackgram and soybean per meter plant count was done by actually counting number of plants in one meter of three rows in net plot. The plant counts were converted in percentage for maintaining uniformity in sole and intercrop situation.

##### b) Plant height

The plant height (cm) of the field crops was measured in cm from ground level upto the terminal bud of the main shoot.

### **c) Number of branches**

The number of primary and secondary branches plant<sup>-1</sup> was collectively counted.

### **d) Number of leaves**

Mean number of fully opened, functional, trifoliolate leaves was computed plant<sup>-1</sup>.

### **e) Leaf area**

The mean leaf area plant<sup>-1</sup> (cm<sup>2</sup>) was measured using standard leaf area meter model.

### **f) Total dry matter**

Two plants selected randomly from each plot were cut at the base of the stem from ground level. The different plant parts were cut into pieces after recording number of leaves, branches. The pieces were filled into brown paper bags, properly labelled, air dried and then oven dried at 65°C for twenty four hours. The last constant weight (g) was recorded as total dry matter.

## **(II) Growth analysis**

Data on growth characters viz. plant height and dry matter accumulation plant<sup>-1</sup> were further analysed by working out growth functions viz. AGR and RGR which are the physiological determinants of the plant growth as affected by the treatments.

### **a) Absolute growth rate (AGR)**

AGR is the total gain in height or weight by a plant within a specific time interval. It is generally expressed as cm day<sup>-1</sup> in case of plant height and g day<sup>-1</sup> in case of dry matter accumulation plant<sup>-1</sup> and it is calculated by the following formula

$$\text{AGR (height) (cm day}^{-1}\text{)} = \frac{H_2 - H_1}{t_2 - t_1}$$

$$\text{AGR (dry matter)(g day}^{-1}\text{)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Were,  $H_2$  and  $H_1$  and  $W_2$  and  $W_1$  refer to the plant height and dry matter accumulation plant<sup>-1</sup> at times of  $t_2$  and  $t_1$ , respectively.

**b) Relative growth rate (RGR)**

According to Blackman (1919), the increase in dry matter of the plant is a process of continuous compound interest, wherein, the increment in any interval adds to the capital for subsequent growth. This rate of increment is known as RGR. The growth constant was worked out as per the formula given by Fisher (1921).

$$\text{RGR (g g}^{-1} \text{ day}^{-1}) = \frac{(\text{Log}_e W_2 - \text{Log}_e W_1)}{t_2 - t_1}$$

Where,  $W_1$  and  $W_2$  are the total dry weights of the plants at  $t_1$  and  $t_2$  times respectively.  $\text{Log}_e$  Natural logarithm (logarithm to the base of e).  $e = 2.3206$ .

**c) Net assimilation rate (NAR)**

It is increase in dry weight of plant per unit leaf area per unit time. NAR was calculated from the following equation.

$$\text{NAR (g cm}^{-2} \text{ day}^{-1}) = \frac{(W_2 - W_1) (\text{Log}_e L_2 - \text{Log}_e L_1)}{(t_2 - t_1) (L_2 - L_1)}$$

Where,  $L_1$  and  $L_2$  are total leaf area at times  $t_1$  and  $t_2$  respectively.  $W_1$  and  $W_2$  are totals dry weights at times  $t_1$  and  $t_2$  respectively.

**d) Leaf area index (LAI)**

Since the crop yield is assessed from per unit of ground area, instead of plant<sup>-1</sup>, the determination of leaf area per unit of ground area is a must. This measure is known as leaf area index. It was calculated from the data on leaf area plant<sup>-1</sup> at various stages of crop growth according to the formula proposed by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf area plant}^{-1} \text{ (cm}^2\text{)}}{\text{Ground area plant}^{-1} \text{ (cm}^2\text{)}}$$

### **(III) Developmental studies**

#### **a) Days to 50 per cent flowering**

The number of days required from sowing upto 50 per cent flowering was recorded from each plot.

#### **b) Days to maturity**

The number of days from sowing required for maturity was recorded from each plot.

### **(IV) Post harvest studies**

#### **a) Yield attributing characters**

##### **i) Number of pods plant<sup>-1</sup>**

The pods from the selected observation plants were plucked and their number was counted. The average number of pods plant<sup>-1</sup> was then worked out.

##### **ii) Number of grains plant<sup>-1</sup>**

The separated grains from pods of five plants were actually counted and average number of grains plant<sup>-1</sup> was worked out.

##### **iii) 100 seed weight**

100 grains of pigeonpea from produce of each net plot were actually counted and their weight (g) was recorded.

##### **iv) Grain yield plant<sup>-1</sup>**

The weight of separated grains from pods of five observation plants was recorded (g) and thus average grain yield plant<sup>-1</sup> was worked out.

#### **b) Yield**

##### **i) Grain yield per net plot**

After threshing of plants from net plot, grains were collected and weight of grains per net plot (Kg) was recorded. This yield obtained from net plot is converted into grain yield per hectare.

##### **ii) Straw or stover yield per net plot**

After threshing / plucking, the plants were collected from net plot and tied in bundles and allowed to dry in the field and their weight (Kg) was recorded after complete drying and this yield was converted into straw yield per hectare (t).

### **iii) Biological yield**

Biological yield (t) is the sum of grain yield and straw or stover yield. It is calculated as

Biological yield = Grain yield + straw or stover yield.

### **3.2.3.2 Cowpea, Chilli, Bhindi and Clusterbean**

#### **(I) Growth studies**

All the parameters of growth studies except leaf area mentioned under field crops were taken for vegetable crops.

#### **(II) Post harvest studies**

##### **a) Yield attributing characters**

###### **i) Number of fruits plant<sup>-1</sup>**

The fresh fruits from the selected observation plants were plucked and their number was counted. The average number of fruits plant<sup>-1</sup> was then worked out. The plucking was carried out periodically.

###### **ii) Weight of fruits plant<sup>-1</sup>**

After counting the number of fruits plant<sup>-1</sup>, the same were weighed (g) and average weight of fruits plant<sup>-1</sup> was worked out.

###### **iii) Fruit yield plant<sup>-1</sup>**

The sum of all the weights of fruits plant<sup>-1</sup> (g) recorded at successive plucking was made and recorded as yield plant<sup>-1</sup>.

##### **b) Yield**

###### **i) Fruit yield per net plot**

After plucking fruits from net plot at every plucking, the same were weighed (Kg). The sum of all such weights was worked out after last plucking and recorded as fruit yield per net plot (Kg). This yield was then converted into fruit yield per hectare (Kg).

### **3.2.4 Monetary returns**

The monetary returns (Rs) from different cropping systems were worked out on the basis of current prices of various farm produce.

#### **3.2.4.1 Gross monetary returns**

The total monetary value (Rs) of economic produce and byproducts obtained from the crops in the cropping system is calculated based on the current local market prices.

### 3.2.4.2 Net monetary returns

Net monetary returns (Rs) of each treatment are obtained by subtracting cost of cultivation of each treatment from respective gross returns.

### 3.2.4.3 Benefit cost ratio

It is the ratio of gross returns to the cost of cultivation (Appendix), which can also be expressed as returns per rupee invested.

### 3.2.5 Assessment of yield advantage

#### 3.2.5.1 Land equivalent ratio (LER)

The concept of LER is described in detail by Willey (1979). LER is defined as the relative land area under sole crops that is required to produce the yields achieved in intercropping. It is calculated as sum total of the ratios of yield of each component crop in an intercropping system to its corresponding yield when grown as a sole crop. Thus

$$\text{LER} = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where,

$Y_{ab}$  = Yield of species 'a' in association with species 'b',

$Y_{ba}$  = Yield of species 'b' in association with species 'a',

$Y_{aa}$  = Pure stand yield of species 'a',

$Y_{bb}$  = Pure stand yield of species 'b'.

#### 3.2.5.2 Aggressivity (A)

The index of aggressivity was proposed by Meceilchrist (1965). It assumes that mixtures form a replacement series and it gives a simple measure of how much the relative yield increase in species 'a' is greater than that for species 'b' in an intercropping system and can be expressed as  $A_{ab}$ .

$$A_{ab} = \frac{Y_{ab}}{Y_{aa} Z_{ab}} + \frac{Y_{ba}}{Y_{bb} Z_{ba}}$$

Where,

$Y_{ab}$  = Mixture yield of species 'a', in combination with 'b',

$Y_{ba}$  = Mixture yield of species 'b', in combination with 'a',

$Y_{aa}$  = Pure stand yield of species 'a',

$Y_{bb}$  = Pure stand yield of with species 'b',

$Z_{ab}$  = Sown proportion of species 'a' in mixture with 'b'

$Z_{ba}$  = Sown proportion of species 'b' in mixture with 'a'.

An aggressivity value of zero indicates that the component species are equally competitive. For any other situation, both species will have the same numerical value but the sign of the dominant species will be positive and that of the dominated negative, the greater the numerical value the bigger the difference in competitive abilities and the bigger the difference between 'actual' and 'expected' yield.

### 3.2.5.3 Relative crowding coefficient

This was proposed by de Wit (1960). It assumes that mixture treatments form a replacement series. Each species has its own coefficient (k) which gives a measure of whether that species has produced more, or less, yield than expected. It also measures the relative dominance of one component crop over the other in an intercropping system. For species 'a' in combination with 'b' it can be written as

$$K_{ab} = \frac{Y_{ab} \times Z_{ba}}{(Y_{aa} - Y_{ab}) \times Z_{ab}}$$

Where,

$Y_{ab}$  = Yield of species 'a' in association with 'b'

$Y_{aa}$  = Pure stand yield of species 'a'

$Z_{ab}$  = Sown proportion of species 'a' in association with species 'b'

$Z_{ba}$  = Sown proportion of species 'b' in association with species 'a'.

If a species has a coefficient less than, equal to, or greater than one, it means it has produced less yield, the same yield, or more yield than 'expected', respectively. The component crop with the higher coefficient is the dominant one. To determine if there is a yield advantage of mixing, the product of coefficients is formed. This is usually designated as K. If  $K > 1$  there is a yield advantage, if  $K=1$  there is no difference and if  $K < 1$  there is yield disadvantage.

### **3.2.6 Sustainability yield index (SYI) and sustainability value index (SVI)**

This index was suggested by Singh et al. (1990). The sustainability index denotes the minimum guaranteed yield as a percentage to the maximum observed yield with high probability. The index is expressed as

$$SYI = \frac{Y - \sigma}{Y_{\max}}$$

Where

Y = Estimated average yield of a practice over years,

$\sigma$  = Estimated standard deviation, and

$Y_{\max}$  = Observed maximum yield in the experiment.

For SVI, the monetary values of the economic produce were used instead of yield values.

### **3.2.7 Statistical analysis and interpretation of the data**

The statistical method of analysis of variance was used for analyzing the data. The data were statistically analysed by 'Analysis of variance method (Panse and Sukhatme, 1967) and the 'F' test of significance was used for testing the 'null hypothesis' in order to determine whether the observed treatment effects were real and discernible from chance effects. Whenever the results were found to be significant, critical difference (C.D.) was calculated for the comparison of treatment means. Suitable graphical representations and figures of relevant data were given at appropriate places.

#### **3.2.7.1 Pooled analysis**

The simple technique of analysis of variance may not be valid under two different seasonal conditions, if the error variance in the season are not of the same order and interaction (treatment x year) is also significantly different. Hence, pooled analysis of grain yield data of two years was carried out as per method described by Panse and Sukhatme (1967).

As the experiment for both the years was carried out on same site and with same randomization of treatments, the errors are dependent. In this case, technique of analysis of variance was followed by adding years as additional factor and the method of analysis similar to split plot design was followed.

### **3.2.7.2 Path\Coefficient Analysis**

The correlation coefficients between grain yield plant<sup>-1</sup> and certain growth and yield attributes were further partitioned into direct and indirect effects with the help of path coefficient analysis originally suggested by Wright (1921) and further outlined by Dewey and Lu (1959).

The nine characteristics viz., i.) height at 60 DAS, ii) leaves at 60 DAS, iii) leaves at 90 DAS, iv) leaf area at 60 DAS, v) TDM at 60 DAS, vi) TDM at 120 DAS, vii) number of pods plant<sup>-1</sup>, viii) number of grains plant<sup>-1</sup> and ix) grain yield plant<sup>-1</sup> were considered for path coefficient analysis.

*EXPERIMENTAL  
FINDINGS*

## **CHAPTER IV**

### **EXPERIMENTAL FINDINGS**

The important findings in the form of summarized data on growth and their attributes, statistical parameters and the critically interpreted results of the present investigation are presented in this chapter.

#### **4.1 Emergence count and final plant stand**

The data regarding the emergence count and final plant stand as affected by various treatments are presented in table 9. Perusal of data indicated that emergence count and final plant stand were higher (95.89, 92.76) during 2001-2002 as compared to the year 2000-2001(94.01, 90.94). There were no significant differences in emergence count and final plant stand due to different treatments during 2000-2001 and 2001-2002, suggesting the uniform and final stand and its persistence till maturity.

#### **(I) Pigeonpea**

#### **4.2 Preharvest studies**

The data on progression of growth and development of pigeonpea as influenced by different treatments of cropping systems during 2000-2001 and 2001-2002 recorded at periodical intervals in crop life period are presented under appropriate headings.

##### **4.2.1 Growth and development**

Growth of pigeonpea as influenced by different treatments in terms of plant height, number of branches, number of leaves, leaf area and total dry matter per plant were recorded at periodical intervals during both the years of experimentation.

##### **4.2.1.1 Plant height**

Height of the plant increased as the crop advanced in age attaining the mean height 194.30 cm and 246.21 cm at 180 DAS during 2000-2001 and 2001-2002 respectively, indicating that the vegetative growth of pigeonpea was more during 2001-2002 as compared to 2000-2001. The rapid increase in height was during 45 to 60 DAS. (Table 10a, 10b and Fig. 3,4).

**Table 9. Emergence and final plant stand as influenced by different treatments during 2000-2001 and 2001-2002**

Treatments	(per cent)			
	2000-2001		2001-2002	
	Emergence count	Final plant stand	Emergence count	Final plant stand
T <sub>1</sub> Pigeonpea sole	93.45	89.18	95.32	90.96
T <sub>2</sub> Blackgram sole	94.87	90.12	96.77	91.92
T <sub>3</sub> Soybean sole	94.84	91.68	96.74	93.51
T <sub>4</sub> Cowpea sole	95.77	91.42	97.69	93.25
T <sub>5</sub> Chilli sole	95.1	93.68	97.00	95.55
T <sub>6</sub> Bhindi sole	95.57	92.63	97.48	94.48
T <sub>7</sub> Clusterbean sole	94.83	91.88	96.73	93.72
T <sub>8</sub> Pigeonpea + Black gram	92.66	88.82	94.51	90.60
T <sub>9</sub> Pigeonpea + Soybean	93.76	90.88	95.64	92.70
T <sub>10</sub> Pigeonpea + Cowpea	93.64	91.69	95.51	93.52
T <sub>11</sub> Pigeonpea + Chilli	92.29	89.96	94.14	91.76
T <sub>12</sub> Pigeonpea + Bhindi	92.87	90.1	94.73	91.90
T <sub>13</sub> Pigeonpea + Clusterbean	92.51	90.19	94.36	91.99
SE (m) ±	2.02	1.71	2.06	1.74
C.D. (0.05)	N.S.	N.S.	N.S.	N.S.
<b>G.M.</b>	94.01	90.94	95.89	92.76

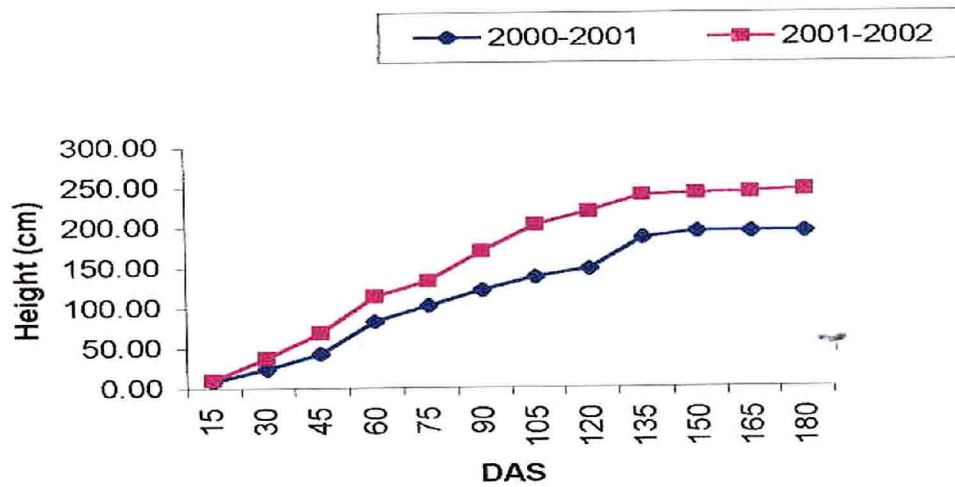


Fig. 3. Mean plant height of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

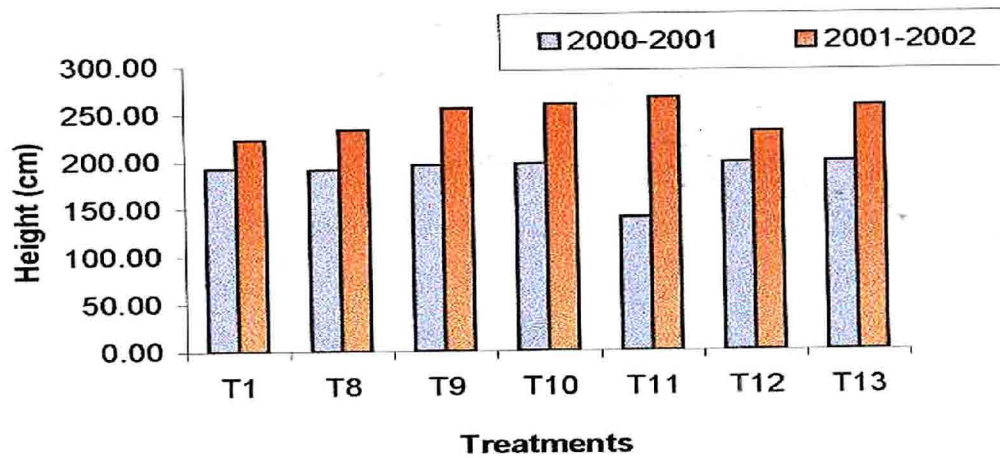


Fig. 4. Height of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002

**Table 10 a : Plant height of pigeonpea as influenced by different treatments during 2000-2001**

		<b>(cm)</b>											
<b>DAS</b>		<b>15</b>	<b>30</b>	<b>45</b>	<b>60</b>	<b>75</b>	<b>90</b>	<b>105</b>	<b>120</b>	<b>135</b>	<b>150</b>	<b>165</b>	<b>180</b>
<b>Treatments</b>													
T <sub>1</sub>	Pigeonpea Sole	8.31	25.71	48.25	89.69	103.16	123.48	148.57	151.38	185.11	192.06	192.09	192.09
T <sub>8</sub>	Pigeonpea +Black gram	8.19	25.70	43.14	81.74	106.30	124.09	139.78	149.14	183.14	190.88	191.34	191.34
T <sub>9</sub>	Pigeonpea + Soybean	8.72	21.83	43.60	79.84	107.16	119.99	134.72	145.36	188.36	195.45	195.38	195.38
T <sub>10</sub>	Pigeonpea + Cowpea	8.23	21.83	38.08	80.67	97.68	115.28	130.88	141.52	187.37	195.91	196.33	196.33
T <sub>11</sub>	Pigeonpea + Chilli	9.05	21.93	40.46	80.38	98.68	116.37	133.81	145.32	182.36	189.51	139.62	139.62
T <sub>12</sub>	Pigeonpea + Bhindi	8.40	22.69	40.87	82.49	107.18	125.19	141.17	155.63	190.16	196.72	197.36	197.36
T <sub>13</sub>	Pigeonpea + Clusterbean	8.23	23.85	41.69	82.72	97.76	119.33	135.23	141.41	1190.22	197.46	198.00	198.00
SE (m) ±		0.31	0.44	0.50	2.20	2.35	4.62	4.56	4.76	3.78	3.00	6.91	6.91
C.D. (0.05)		0.96	1.34	1.54	N.S.	7.25	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>G.M.</b>		<b>8.45</b>	<b>23.36</b>	<b>42.30</b>	<b>82.43</b>	<b>102.17</b>	<b>120.53</b>	<b>136.54</b>	<b>147.10</b>	<b>186.67</b>	<b>193.99</b>	<b>194.30</b>	<b>194.30</b>

### Effect of treatments

During 2000-2001, the height of the plant was influenced significantly due to different treatments only at 30, 45 and 75 DAS. At 30 DAS, treatment T<sub>1</sub> being par with T<sub>2</sub>, recorded greater plant height than other treatments. Treatments T<sub>11</sub>, T<sub>9</sub> and T<sub>10</sub> being par exhibited higher plant height over T<sub>12</sub> and T<sub>13</sub> treatments. However, treatment differences between T<sub>12</sub> and T<sub>13</sub> did not notice at significant level. At 45 DAS, T<sub>1</sub> showed significantly maximum plant height over other treatments. Treatment T<sub>8</sub> being par with T<sub>9</sub>, recorded greater plant height over other treatments. However, treatments T<sub>13</sub>, T<sub>12</sub> and T<sub>11</sub> were at par. AT 75 DAS, treatments T<sub>12</sub>, T<sub>9</sub>, T<sub>8</sub> and T<sub>1</sub> being par produced taller plants over other treatments. However, treatment T<sub>11</sub>, T<sub>13</sub> and T<sub>10</sub> were at par.

During 2001-2002, height of the plant was affected significantly by various treatments at 75,105,120,135,150,165 and 180 DAS. At 75 DAS,

**Table 10 b : Plant height of pigeonpea as influenced by different treatments during 2001-2002**

		(cm)											
DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	9.65	38.13	67.47	120.73	136.30	156.17	185.37	201.70	215.19	218.18	219.16	223.38
T <sub>8</sub>	Pigeonpea + Blackgram	9.61	35.40	71.70	108.97	128.47	172.17	200.83	216.83	225.17	230.36	230.97	233.17
T <sub>9</sub>	Pigeonpea + Soybean	10.05	39.40	76.10	115.00	147.33	177.50	206.57	222.90	246.29	248.28	250.00	255.05
T <sub>10</sub>	Pigeonpea + Cowpea	9.57	39.15	64.87	126.57	136.20	178.83	207.43	223.43	253.43	255.36	256.36	258.88
T <sub>11</sub>	Pigeonpea + Chilli	10.34	35.47	63.40	113.13	135.37	203.00	214.06	230.06	262.58	264.91	264.91	266.33
T <sub>12</sub>	Pigeonpea + Bhindi	9.73	18.33	65.53	103.03	115.87	116.50	192.91	208.11	223.23	226.04	227.44	230.35
T <sub>13</sub>	Pigeonpea + Clusterbean	9.56	37.97	68.20	105.30	124.80	187.67	211.91	228.24	250.27	252.11	253.19	256.31
SE (m) ±		0.56	3.32	4.24	13.01	2.35	9.81	5.78	5.80	4.46	4.31	4.56	4.63
C.D. (0.05)		N.S.	N.S.	N.S.	N.S.	7.23	N.S.	17.80	17.87	13.73	13.27	14.05	14.27
G.M.		9.79	37.25	68.18	113.25	132.33	170.26	202.73	218.86	239.59	242.18	243.14	246.21

treatment T<sub>9</sub> recorded significantly higher plant height over other treatments. Treatments T<sub>11</sub>, T<sub>10</sub> and T<sub>1</sub> being par showed higher plant height over T<sub>8</sub> and T<sub>13</sub> treatments. However, treatment difference between T<sub>8</sub> and T<sub>13</sub> was at par. At 105 and 120 DAS, treatments T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub> and T<sub>13</sub> being par, exhibited higher plant height over T<sub>1</sub> and T<sub>12</sub> treatments. However, treatment difference between T<sub>1</sub> and T<sub>12</sub> was not noticed. At 135, 150, 165 and 180 DAS, treatments T<sub>10</sub>, T<sub>11</sub> and T<sub>13</sub> being par recorded greater plant height over T<sub>1</sub>, T<sub>3</sub> and T<sub>12</sub> treatments. However, treatment differences amongst T<sub>1</sub>, T<sub>3</sub> and T<sub>12</sub> were not significant.

#### 4.2.1.2 Number of branches per plant

Mean number of branches per plant ranged from 2.14 to 34.25 during first year and 1.91 to 37.72 during second year of experimentation. (Tables 11a, 11b and Fig. 5, 6).

#### Effect of treatments

During 2000-2001, number of branches per plant was affected significantly due to different treatments only at 150, 165 and 180 DAS. AT 150

**Table 11a: Number of branches per plant of pigeonpea as influenced by different treatments during 2000-2001**

DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	—	2.00	7.13	9.07	20.90	22.18	24.96	28.36	33.00	33.18	33.21	33.03
T <sub>8</sub>	Pigeonpea + Blackgram	—	2.33	6.33	9.00	19.99	24.85	29.16	31.18	37.16	37.19	37.16	37.11
T <sub>9</sub>	Pigeonpea + Soybean	—	2.00	6.33	8.47	19.27	23.96	27.32	31.25	35.06	35.76	25.76	35.76
T <sub>10</sub>	Pigeonpea + Cowpea	—	2.33	5.80	8.07	18.40	22.56	27.11	31.03	35.00	35.48	32.28	32.28
T <sub>11</sub>	Pigeonpea + Chilli	—	2.00	6.80	8.80	18.27	22.23	27.83	30.92	32.89	32.11	32.62	32.63
T <sub>12</sub>	Pigeonpea + Bhindi	—	2.33	6.33	9.20	18.43	23.59	26.16	30.89	30.00	30.02	30.51	30.54
T <sub>13</sub>	Pigeonpea + Clusterbean	—	2.00	6.47	8.40	17.53	22.88	26.42	31.01	34.12	34.58	34.29	34.67
SE (m) ±		—	0.28	0.49	0.83	1.00	1.18	1.22	1.22	1.23	0.82	5.81	5.79
C.D. (0.05)		—	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	2.51	17.90	17.84
G.M.		—	2.14	6.46	8.81	18.97	23.11	26.97	30.67	34.25	33.78	33.69	33.72

DAS, treatments T<sub>8</sub>, T<sub>9</sub> and T<sub>10</sub> being par resulted in production of higher number of branches per plant over other treatments. Treatments T<sub>1</sub>, T<sub>11</sub> and T<sub>13</sub> being par showed greater number of branches than T<sub>12</sub>. At 165 DAS, treatment T<sub>8</sub> recorded more number of branches over other treatments. Treatments T<sub>1</sub>, T<sub>11</sub> and T<sub>13</sub> being par, produced more number of branches per plant over T<sub>9</sub>, T<sub>10</sub> and T<sub>12</sub> treatments. However, treatment difference between T<sub>10</sub> and T<sub>12</sub> was not significant. AT 180 DAS, treatments T<sub>8</sub> and T<sub>9</sub> being par, exhibited more number of branches over other treatments. Treatments T<sub>1</sub> and T<sub>13</sub> being par, showed significant impact in recording maximum number of branches per plant over T<sub>10</sub>, T<sub>11</sub> and T<sub>12</sub> treatments. However, treatment difference between T<sub>10</sub> and T<sub>11</sub> was not significant.

During 2001-2002, number of branches per plant was influenced significantly only at 105, 120, 135, 150 and 165 DAS. At 105, 120, 135 and 150 DAS, the highest number of branches per plant was registered with treatment T<sub>11</sub> over other treatments. The treatment differences amongst other



**Plate 1 : Treatment T<sub>1</sub> (Sole Pigeonpea)**

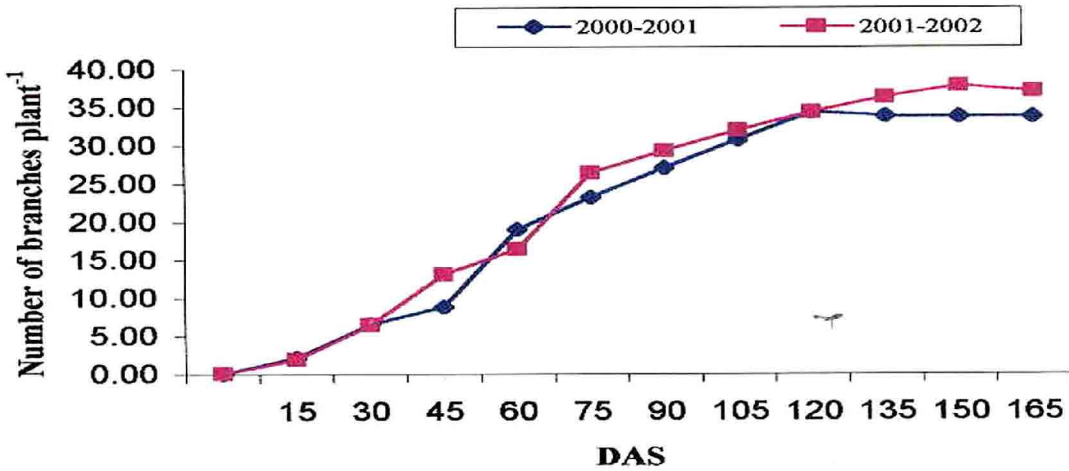


Fig. 5. Mean number of branches plant<sup>-1</sup> as influenced at successive time intervals during 2000-2001 and 2001-2002

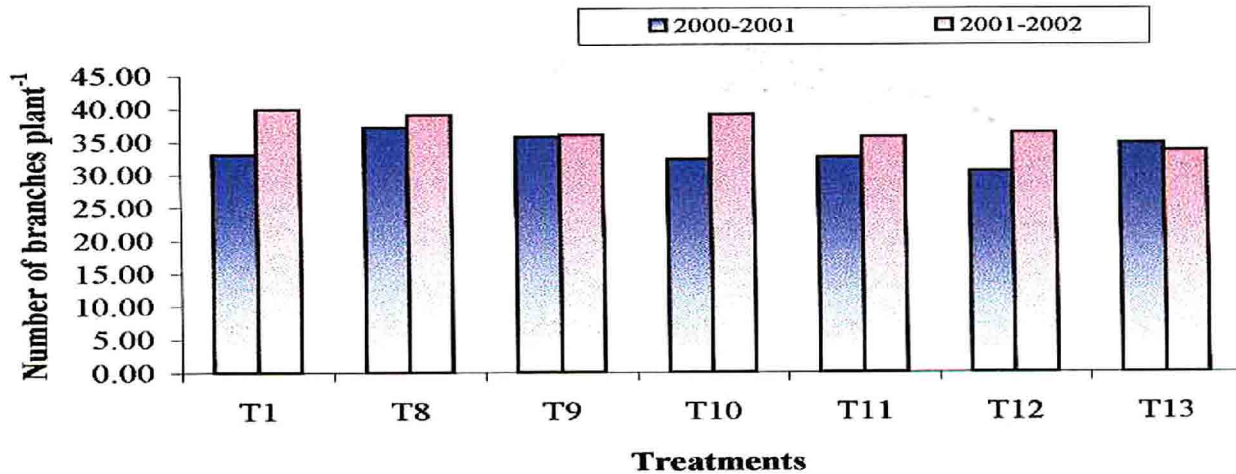
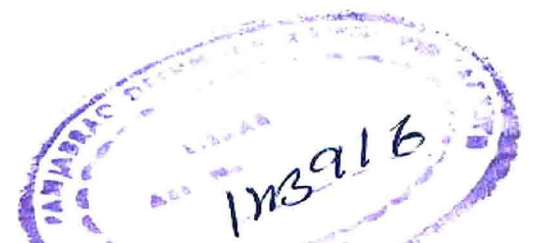


Fig. 6. Mean number of branches plant<sup>-1</sup> of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002



**Table 11b: Number of branches per plant of pigeonpea as influenced by different treatments during 2001-2002**

DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole		2.93	6.60	15.20	18.73	23.34	27.48	30.77	35.18	37.62	39.00	39.92
T <sub>8</sub>	Pigeonpea + Blackgram		1.67	6.40	12.72	15.66	24.83	27.12	29.16	32.29	35.29	38.93	39.06
T <sub>9</sub>	Pigeonpea + Soybean		1.67	7.60	13.01	16.22	26.34	29.19	33.01	34.88	35.04	35.19	35.98
T <sub>10</sub>	Pigeonpea + Cowpea		2.00	5.13	11.21	14.31	22.34	26.38	30.46	33.39	36.09	38.12	39.07
T <sub>11</sub>	Pigeonpea + Chilli		2.00	6.40	13.50	16.70	35.67	38.04	40.52	41.18	42.78	43.00	35.74
T <sub>12</sub>	Pigeonpea + Bhindi		1.67	7.00	11.42	14.81	24.17	27.13	29.09	31.67	34.15	35.99	36.25
T <sub>13</sub>	Pigeonpea + clusterbean		2.00	5.27	13.63	17.00	26.00	28.31	30.08	31.48	32.00	32.89	33.58
SE (m) $\pm$			0.41	0.92	0.91	1.24	2.51	1.90	2.05	1.58	1.26	1.57	3.51
C.D. (0.05)			N.S.	N.S.	N.S.	N.S.	N.S.	5.87	6.32	4.86	3.89	4.83	N.S.
G.M			1.91	6.43	13.00	16.28	26.34	29.16	31.87	34.30	36.19	37.72	36.94

treatments were not at the level of significance. AT 165 DAS, treatments T<sub>1</sub>, T<sub>8</sub> and T<sub>11</sub> being par, produced greater number of branches per plant over other treatments. Treatments T<sub>9</sub>, T<sub>10</sub> and T<sub>12</sub> being par, recorded higher number of branches than treatment T<sub>13</sub>. However, treatment differences amongst T<sub>9</sub>, T<sub>10</sub> and T<sub>12</sub> were not evident.

#### 4.2.1.3 Number of functional leaves per plant

The mean maximum number of functional leaves per plant (297.69) was noticed at 135 DAS during first year of experimentation. The corresponding figure during second year of experimentation was 342.43 at 165 DAS (Tables 12a, 12b and Fig.7, 8).

#### Effect of treatments

During 2000-2001, number of functional leaves per plant was significantly affected due to different treatments at 60, 90, 105, 120, 135, 150, 165 and 180 DAS. At 60 DAS, maximum number of leaves per plant was noticed with treatments T<sub>1</sub> and T<sub>12</sub> over other treatments. At other stages, treatment T<sub>1</sub> recorded significantly greater number of leaves per plant over

**Table 12a: Number of functional leaves per plant of pigeonpea as influenced by different treatments during 2000-2001**

DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	3.47	8.20	17.47	57.93	108.33	175.27	247.36	285.29	311.36	298.36	275.56	250.28
T <sub>8</sub>	Pigeonpea + Black gram	3.73	8.07	14.37	40.60	92.41	150.16	210.31	231.16	255.57	238.18	217.11	194.83
T <sub>9</sub>	Pigeonpea + Soybean	3.53	8.60	15.47	35.03	94.12	152.43	217.78	260.41	294.16	274.41	249.43	234.15
T <sub>10</sub>	Pigeonpea + Cowpea	3.60	7.87	17.40	34.00	88.46	141.63	206.11	281.18	310.12	300.36	275.48	259.20
T <sub>11</sub>	Pigeonpea + Chilli	3.40	7.97	18.20	38.40	98.67	148.37	211.21	257.54	279.42	262.88	241.43	216.15
T <sub>12</sub>	Pigeonpea + Bhindi	3.33	7.77	17.57	48.67	100.34	166.51	231.59	294.11	330.11	312.33	291.68	269.40
T <sub>13</sub>	Pigeonpea + Clusterbean	3.33	7.33	18.93	39.13	102.26	158.17	225.13	272.49	302.77	291.91	266.86	247.58
SE (m) ±		0.17	0.68	1.58	3.39	11.48	4.99	4.71	3.59	7.48	7.12	4.12	5.81
C.D. (0.05)		N.S.	N.S.	N.S.	10.45	N.S.	15.36	14.50	11.05	23.08	21.94	12.71	17.90
G.M.		3.48	7.97	17.06	41.97	97.80	156.08	221.36	268.88	297.64	282.63	259.65	238.80

**Table 12b: Number of functional leaves per plant of pigeonpea as influenced by different treatments during 2001-2002**

DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	12.64	23.46	31.53	82.16	114.01	170.29	189.78	240.51	272.04	302.33	340.37	280.80
T <sub>8</sub>	Pigeonpea + Black gram	11.39	24.67	27.93	80.12	106.22	162.14	183.42	228.34	261.41	290.18	325.59	271.66
T <sub>9</sub>	Pigeonpea + Soybean	12.94	26.07	30.47	83.43	113.80	176.38	195.24	234.79	270.40	303.41	352.18	290.78
T <sub>10</sub>	Pigeonpea + Cowpea	10.96	22.60	31.33	72.36	102.59	157.33	177.41	221.13	252.73	291.36	347.93	282.61
T <sub>11</sub>	Pigeonpea + Chilli	13.04	25.00	30.20	80.12	112.69	171.68	197.19	250.1	281.23	320.57	379.58	309.12
T <sub>12</sub>	Pigeonpea + Bhindi	12.90	21.73	33.20	78.04	104.26	161.03	178.22	213.27	250.36	291.38	319.58	268.39
T <sub>13</sub>	Pigeonpea + Clusterbean	11.89	23.27	32.40	91.02	107.17	167.16	183.68	219.92	252.18	295.34	331.81	289.97
SE (m) ±		1.11	2.25	2.52	9.64	3.42	4.73	5.36	6.14	8.34	7.11	8.47	8.71
C.D. (0.05)		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	18.92	N.S.	N.S.	26.11	N.S.
G.M.		3.48	23.84	31.01	79.61	108.68	166.57	186.42	229.72	262.91	299.22	342.43	284.76

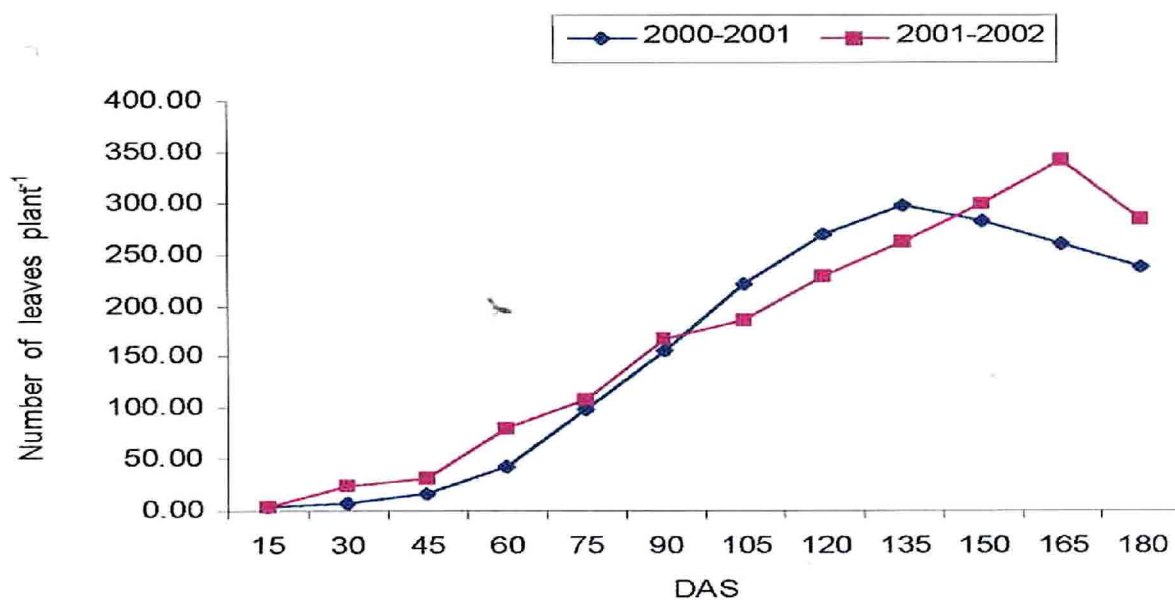


Fig. 7. Mean number of leaves plant<sup>-1</sup> of pigeonpea at successive time intervals during 2000-2001 and 2001-2002

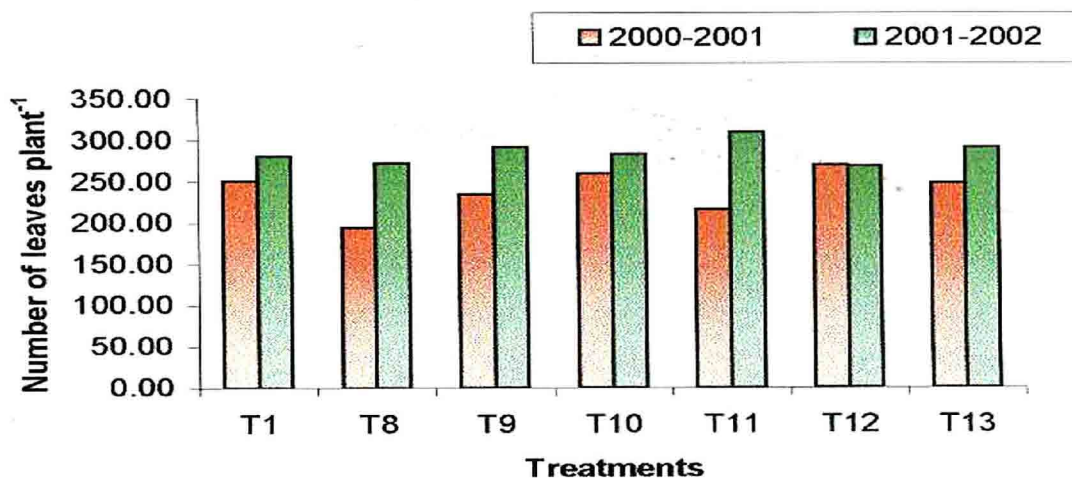


Fig. 8. Mean number of leaves plant<sup>-1</sup> of pigeonpea as influenced by different treatments at 180 DAS during 2000-2001 and 2001-2002

other treatments. However, it was at par with treatment T<sub>12</sub> at all stages except at 150 DAS. The lowest number of leaves was recorded with the treatment T<sub>8</sub> from 120 days onwards.

During 2001-2002, number of functional leaves per plant was affected significantly at 120 and 165 DAS only. At 120 DAS, treatments T<sub>1</sub>, T<sub>9</sub> and T<sub>11</sub> being par, exhibited greater number of leaves than other treatments. However, treatment differences as regards number of functional leaves were not evident with other treatments. At 165 DAS, the highest number of functional leaves per plant was recorded with the treatment T<sub>11</sub> over other treatments. Treatments T<sub>1</sub>, T<sub>9</sub> and T<sub>10</sub> being par, registered greater number of leaves per plant over T<sub>8</sub>, T<sub>12</sub> and T<sub>13</sub>. However, treatment differences amongst T<sub>8</sub>, T<sub>12</sub> and T<sub>13</sub> were not evident.

#### **4.2.1.4 Leaf area per plant**

The mean leaf area per plant increased progressively up to 135 DAS during first year and 165 DAS during second year of experimentation. The corresponding figures for its maximum were 2883.25 cm<sup>2</sup> and 4251.87 cm<sup>2</sup> per plant (Tables 13a, 13b and Fig. 9, 10).

#### **Effect of treatments**

During 2000-2001, leaf area per plant was affected significantly due to different treatments at 60, 90, 105, 120, 135, 150, 165 and 180 DAS. At 60 DAS, treatments T<sub>1</sub> and T<sub>12</sub> being par, showed larger leaf area per plant over other treatments. However, other treatments viz., T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>13</sub> were at par. At 90 and 105 DAS, treatments T<sub>12</sub>, T<sub>1</sub> and T<sub>13</sub> being par, recorded maximum leaf area per plant over other treatments. Other treatments viz., T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub> were at par. AT 120, 135, 150, 165 and 180 DAS the highest leaf area was recorded with treatment T<sub>12</sub>. However, the lowest leaf area was registered with treatment T<sub>8</sub>. Remaining treatments showed inconsistency in exhibiting the leaf area per plant (Fig. 10).

During 2001-2002, significantly higher leaf area per plant was noticed due to different treatments at 120 and 165 DAS only. At 120 DAS, the highest leaf area was recorded by the treatments T<sub>11</sub>, T<sub>1</sub> and T<sub>9</sub> as compared to other treatments. Other treatments viz., T<sub>8</sub>, T<sub>10</sub>, T<sub>12</sub>, T<sub>13</sub> were at par. At 165 DAS, treatment T<sub>11</sub> recorded significantly maximum leaf area over other treatments.



**Plate 2 : Treatment T<sub>2</sub> (Sole Blackgram)**



**Plate 3 : Treatment T<sub>3</sub> (Pigeonpea + Blackgram)**

**Table 13a: Leaf area per plant of pigeonpea as influenced by different treatments during 2000-2001**

		(cm <sup>2</sup> )											
DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	33.16	78.36	167.08	544.15	1036.22	1676.52	2366.09	2728.91	2978.28	2853.93	2635.81	1845.1
T <sub>8</sub>	Pigeonpea +Black gram	34.18	73.74	131.53	371.71	846.05	1374.77	1925.46	2116.35	2339.83	2180.62	1987.75	1391.4
T <sub>9</sub>	Pigeonpea + Soybean	33.23	80.88	145.46	329.98	885.17	1433.56	204.16	2449.08	2766.55	2580.75	2345.85	1642.1
T <sub>10</sub>	Pigeonpea + Cowpea	34.10	74.51	164.82	322.06	837.91	1341.55	1952.32	2663.40	2937.53	2845.08	2609.41	1826.6
T <sub>11</sub>	Pigeonpea + Chilli	33.10	77.56	177.18	373.84	960.84	1444.43	2056.19	2507.4	2720.24	2559.21	2350.42	1645.3
T <sub>12</sub>	Pigeonpea + Bhindi	32.92	79.03	178.16	495.23	681.86	1694.41	2356.86	2992.86	3359.20	3178.27	2968.10	2077.7
T <sub>13</sub>	Pigeonpea + Clusterbean	32.92	78.70	192.67	398.22	1040.60	1609.54	2290.92	2772.86	3080.99	2970.48	2715.60	1900.9
SE (m) ±		1.63	6.45	15.53	33.48	115.88	47.51	44.69	34.51	72.50	69.31	39.66	27.762
C.D. (0.05)		5.01	N.S.	N.S.	103.17	N.S.	146.44	137.72	106.35	223.40	213.60	122.21	85.547
G.M.		33.65	77.48	165.36	406.38	898.34	1510.68	2142.29	2604.38	2883.25	2738.33	2516.13	1761.3

**Table 13b: Leaf area per plant of pigeonpea as influenced by different treatments during 2001-2002**

		(cm <sup>2</sup> )											
DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	118.71	198.63	322.84	516.10	882.36	1336.29	1684.18	2729.16	3416.28	4018.52	4226.24	3529.87
T <sub>8</sub>	Pigeonpea +Black gram	110.16	175.96	339.49	503.29	846.80	1272.23	1627.74	2591.06	3282.79	3857.02	4042.72	3414.97
T <sub>9</sub>	Pigeonpea + Soybean	119.00	191.18	358.76	524.08	909.86	1380.08	1732.63	2664.25	3395.68	4032.88	4372.80	3655.33
T <sub>10</sub>	Pigeonpea + Cowpea	109.52	197.37	311.01	454.54	817.87	1234.59	1574.40	2509.25	3173.78	3872.71	4320.11	3552.62
T <sub>11</sub>	Pigeonpea + Chilli	124.16	190.25	344.03	503.29	898.38	1347.20	1749.94	2838	3531.69	4260.96	4713.10	3885.87
T <sub>12</sub>	Pigeonpea + Bhindi	119.16	209.15	299.03	490.22	831.81	1263.63	1581.59	2420.06	3144.02	3872.97	3968.10	3373.87
T <sub>13</sub>	Pigeonpea + Clusterbean	111.10	204.11	320.23	508.94	854.38	1311.17	1630.05	2496.52	3166.88	3925.61	4119.95	3645.14
SE (m) ±		10.47	20.24	22.54	61.59	26.88	37.07	47.53	69.58	104.78	94.55	105.20	109.43
C.D. (0.05)		N.S.	N.S.	N.S.	189.79	N.S.	N.S.	N.S.	214.73	N.S.	N.S.	324.18	N.S.
G.M.		115.89	195.24	327.91	500.06	863.07	1306.46	1654.36	2606.81	3301.87	3977.24	4251.87	3579.66

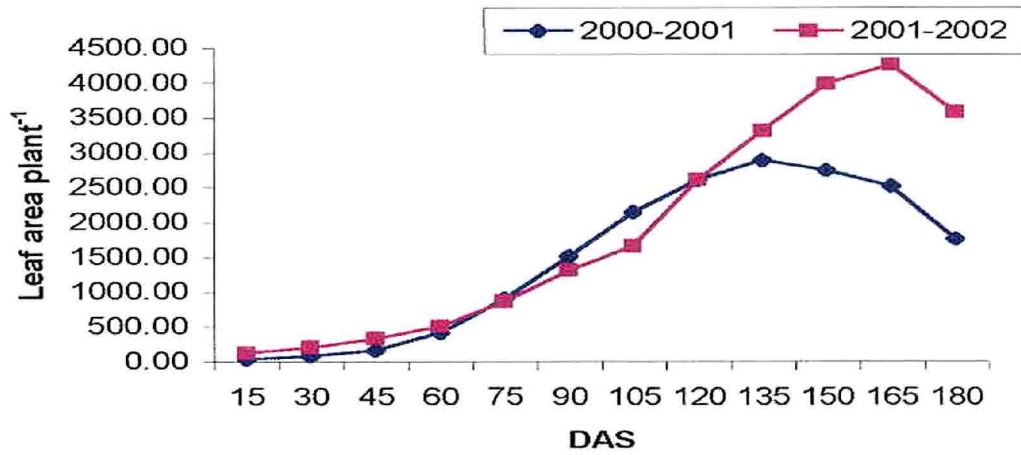


Fig. 9. Leaf area plant<sup>-1</sup> (cm<sup>2</sup>) of pigeonpea at successive growth stages during 2000-2001 and 2001-2002

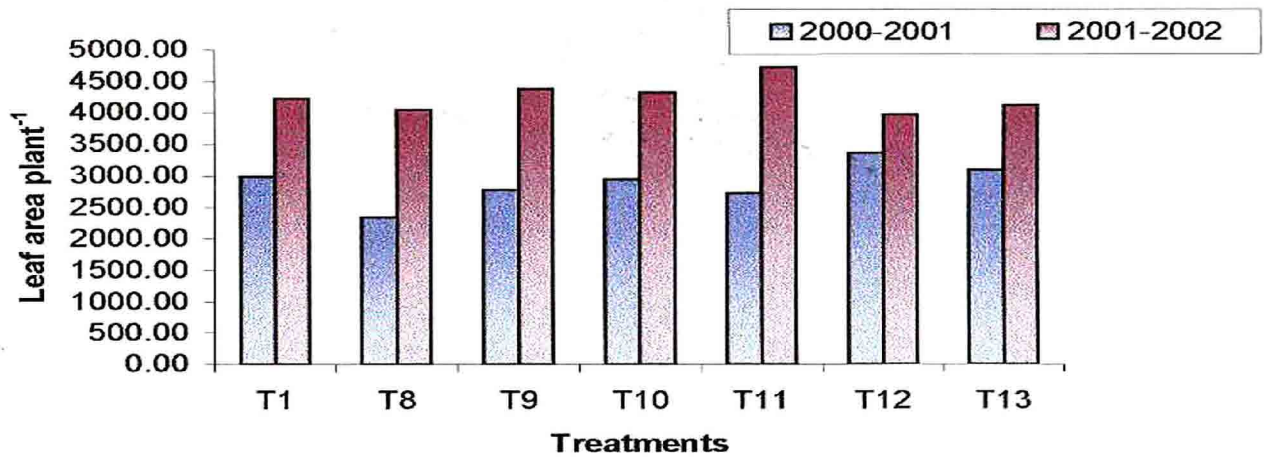


Fig. 10. Leaf area plant<sup>-1</sup> (cm<sup>2</sup>) as influenced by different treatments during 2000-2001 and 2001-2002

Treatments T<sub>1</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>13</sub> being par, recorded greater leaf area per plant over T<sub>8</sub> and T<sub>12</sub>.

#### 4.2.1.5 Total dry matter per plant

Total dry matter accumulation increased progressively and reached to its maximum at 150 DAS (174.02 g plant<sup>-1</sup>) during 2000-2001 and at 165 DAS (220.79 g plant<sup>-1</sup>) during 2001-2002 (Tables 14a, 14b and Fig. 11, 12).

**Table 14a: Total dry matter of pigeonpea as influenced by different treatments during 2000-2001**

		(g)											
DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	12.43	17.80	32.18	51.36	85.24	102.89	135.86	148.27	159.86	175.96	172.37	170.31
T <sub>8</sub>	Pigeonpea +Blackgram	11.68	17.83	30.29	50.18	82.46	102.64	129.36	142.72	161.12	179.12	170.66	162.18
T <sub>9</sub>	Pigeonpea + Soybean	12.03	18.17	30.04	52.18	84.00	100.86	141.92	151.36	165.82	178.37	169.17	164.49
T <sub>10</sub>	Pigeonpea + Cowpea	12.39	16.27	25.66	42.86	72.36	93.37	127.18	141.59	151.48	171.55	164.34	160.27
T <sub>11</sub>	Pigeonpea + Chilli	11.81	17.93	31.16	45.36	79.12	98.12	131.31	147.16	154.86	170.07	167.36	160.60
T <sub>12</sub>	Pigeonpea + Bhindi	11.83	16.63	29.88	49.74	77.07	101.76	138.37	150.91	160.91	172.86	162.42	159.13
T <sub>13</sub>	Pigeonpea + Clusterbean	12.18	16.97	30.10	50.50	79.33	97.97	131.16	147.49	159.37	170.24	165.74	160.76
SE (m) ±		0.31	0.56	2.89	5.36	4.98	5.29	5.77	6.28	4.87	4.91	4.13	5.65
C.D. (0.05)		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
<b>G.M.</b>		<b>12.05</b>	<b>17.37</b>	<b>29.90</b>	<b>48.91</b>	<b>79.94</b>	<b>99.66</b>	<b>133.69</b>	<b>147.07</b>	<b>159.06</b>	<b>174.02</b>	<b>167.44</b>	<b>162.63</b>

#### Effect of treatments

During 2000-2001, data recorded on total dry matter accumulation per plant at all the dates of observation were not affected significantly due to different treatments.

During 2001-2002, total dry matter accumulation per plant was influenced significantly due to different treatments at 60, 135, and 165 DAS only. AT 60 DAS, treatments T<sub>1</sub> and T<sub>13</sub> being par, produced higher total dry matter per plant over other treatments. Treatments T<sub>8</sub>, T<sub>9</sub> and T<sub>11</sub> being par, recorded greater dry matter production than treatments T<sub>10</sub> and T<sub>12</sub>. However,

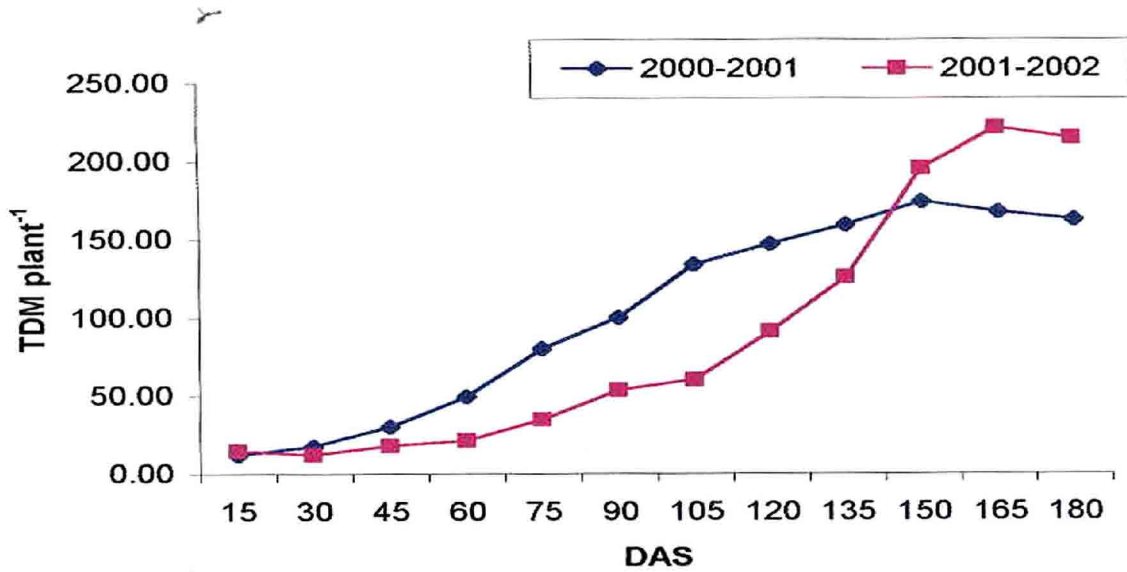


Fig. 11. Total dry matter plant<sup>-1</sup> (g) of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

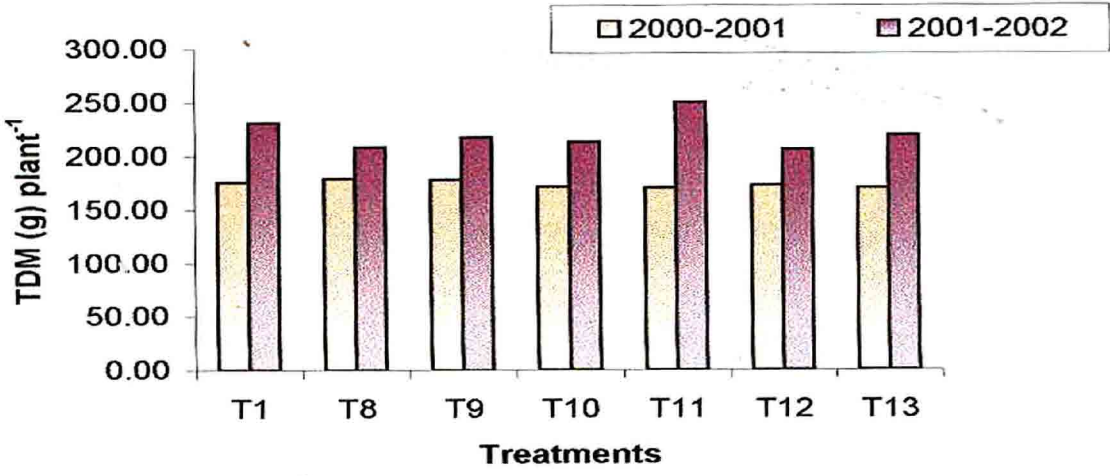


Fig. 12. Total dry matter plant<sup>-1</sup> (g) of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

**Table 14b: Total dry matter of pigeonpea as influenced by different treatments during 2001-2002**

		(g)											
DAS		15	30	45	60	75	90	105	120	135	150	165	180
Treatments													
T <sub>1</sub>	Pigeonpea Sole	14.18	16.43	18.07	23.41	37.81	55.43	66.67	98.52	131.68	204.27	230.68	227.92
T <sub>8</sub>	Pigeonpea +Blackgram	14.27	15.68	17.20	20.09	33.11	49.52	56.51	88.47	122.02	188.35	208.34	197.99
T <sub>9</sub>	Pigeonpea + Soybean	15.18	16.03	18.41	21.49	35.69	51.00	59.83	90.86	127.14	194.51	217.29	211.28
T <sub>10</sub>	Pigeonpea + Cowpea	14.29	16.39	16.51	18.23	32.00	47.49	56.16	81.37	117.05	190.45	213.57	208.28
T <sub>11</sub>	Pigeonpea + Chilli	14.88	15.81	18.00	21.57	34.96	52.67	61.97	101.48	136.54	211.33	249.88	239.79
T <sub>12</sub>	Pigeonpea + Bhindi	14.33	15.83	15.58	18.79	31.63	48.97	57.48	85.84	118.22	181.76	206.22	202.04
T <sub>13</sub>	Pigeonpea + Clusterbean	14.49	16.18	19.07	22.35	36.04	53.52	61.16	90.15	128.44	196.69	219.52	212.92
SE (m) ±		0.40	0.31	0.84	0.86	2.27	2.27	3.11	2.90	3.97	4.27	5.37	7.35
C.D. (0.05)		N.S.	N.S.	N.S.	2.63	N.S.	N.S.	N.S.	N.S.	12.24	N.S.	16.56	22.40
G.M.		14.52	12.05	17.55	20.85	34.32	53.28	59.83	90.95	125.57	195.34	220.79	214.32

treatment difference between T<sub>10</sub> and T<sub>12</sub> was not evident. At 135 DAS, treatments T<sub>11</sub>, T<sub>1</sub>, T<sub>13</sub> and T<sub>9</sub> being par, resulted in accumulation of higher total dry matter over T<sub>8</sub>, T<sub>10</sub> and T<sub>12</sub> treatments. However, treatment differences were not evident amongst T<sub>8</sub>, T<sub>10</sub> and T<sub>12</sub> treatments. At 165 DAS, the highest total dry matter production was registered with the treatment T<sub>11</sub>. The treatments T<sub>9</sub>, T<sub>10</sub> and T<sub>13</sub> being par produced higher total dry matter production than treatments T<sub>8</sub> and T<sub>10</sub>. However, treatment difference between T<sub>8</sub> and T<sub>10</sub> was not significant.

#### 4.2.1.6 Days to 50 per cent flowering and days to maturity

During 2000-2001, pigeonpea crop recorded early 50 per cent flowering (110.43) and maturity (176.71) as compared to 50 % flowering (127.62) and maturity (207.46) during 2001-2002 (Table 15).

#### Effect of treatments

During both the years of investigation, days to 50 per cent flowering and days to maturity were not affected significantly due to different treatments.

**Table 15: Days to 50 per cent flowering and days to maturity of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002**

Treatments	Days to 50 % flowering		Days to maturity	
	2000-2001	2001-2002	2000-2001	2001-2002
T <sub>1</sub> Pigeonpea Sole	111.33	128.33	178.33	208.33
T <sub>8</sub> Pigeonpea +Black gram	109.00	129.00	177.67	207.33
T <sub>9</sub> Pigeonpea + Soybean	110.67	127.67	176.67	207.33
T <sub>10</sub> Pigeonpea + Cowpea	109.67	125.67	177.33	206.67
T <sub>11</sub> Pigeonpea + Chilli	111.00	129.00	175.33	209.67
T <sub>12</sub> Pigeonpea + Bhindi	112.33	126.33	176.00	207.67
T <sub>13</sub> Pigeonpea + Clusterbean	109.00	127.33	175.67	207.33
SE (m) ±	2.53	1.74	2.25	2.15
C.D. (0.05)	N.S.	N.S.	N.S.	N.S.
<b>G.M.</b>	<b>110.43</b>	<b>127.62</b>	<b>176.71</b>	<b>207.76</b>

### 4.3 Growth analysis

#### 4.3.1 Absolute growth rate (AGR) for height

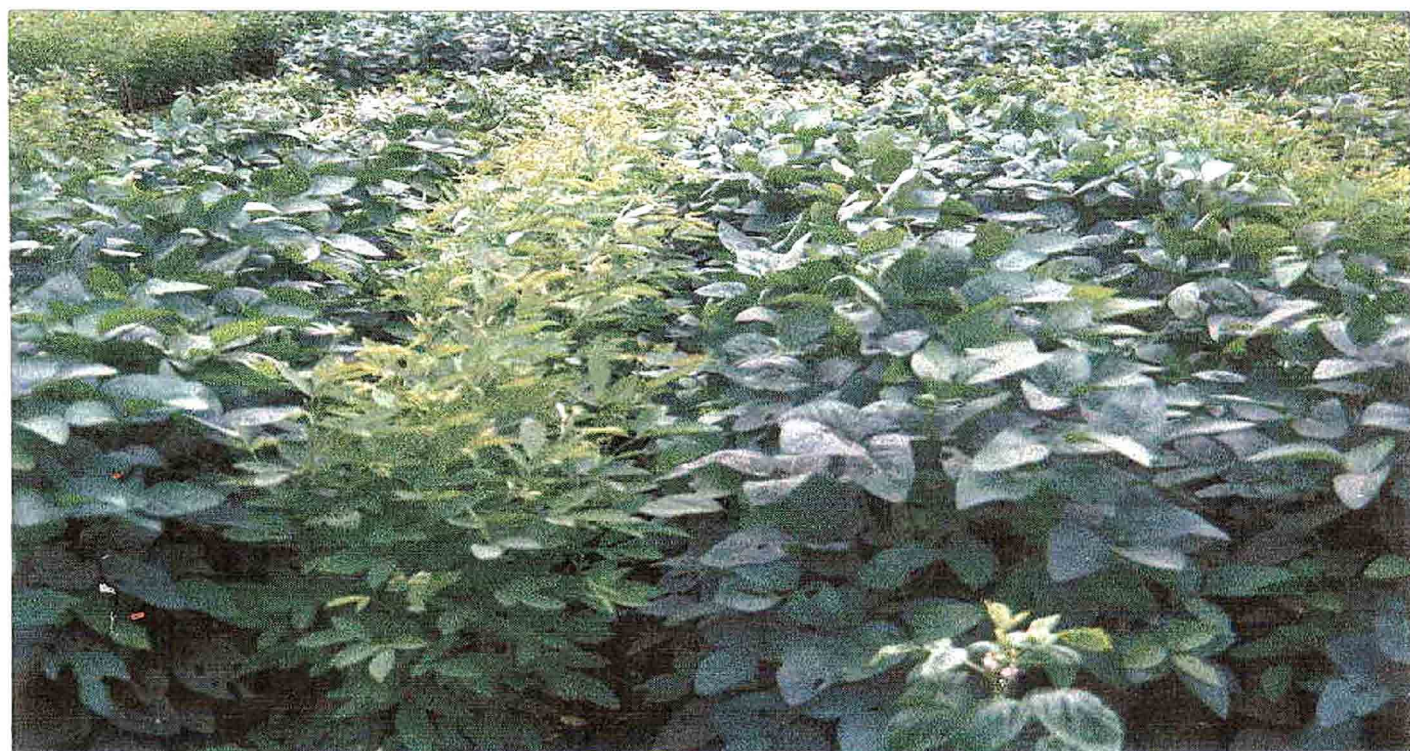
Data on absolute growth rate for height as affected by different treatments are presented in table 16a and 16b AGR for height increased up to 60 and 90 DAS during 2000-2001 and 2001-2002 respectively and reduced at subsequent growth stages. The mean maximum AGR of 2.681 and 3.000 cm day<sup>-1</sup> plant<sup>-1</sup> was recorded between 46-60 and 76-90 DAS during 2000-2001 and 2001-2002 respectively.

#### Effect of treatments

During 2000-2001, AGR for height was affected at the level of significance only between 16-30 and 31-45 DAS. In between 16-30 DAS, treatment T<sub>8</sub> being par with T<sub>1</sub>, exhibited highest value AGR for height which was significantly greater over other treatments. Treatment T<sub>13</sub> being par with treatment T<sub>12</sub>, showed greater value of AGR over T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>. However,



**Plate 4 : Treatment T<sub>3</sub> (Sole Soybean)**



**Plate 5 : Treatment T<sub>9</sub> (Pigeonpea + Soybean)**

**Table 16a: Absolute growth rate (AGR) for height as influenced by different treatments (2000-2001)**

		(cm day <sup>-1</sup> )										
Treatments		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165
T <sub>1</sub>	Pigeonpea Sole	0.5542	1.1598	1.5047	2.7604	0.8982	1.3547	1.1393	0.7207	2.2487	0.4633	0.0093
T <sub>8</sub>	Pigeonpea +Black gram	0.5462	1.1611	1.1684	2.5824	1.4482	1.3618	1.0238	0.6507	2.2533	0.5293	0.0307
T <sub>9</sub>	Pigeonpea + Soybean	0.5813	0.8584	1.4676	2.4153	1.8193	0.8573	0.9820	0.7093	2.8667	0.4727	0.0287
T <sub>10</sub>	Pigeonpea + cowpea	0.5489	0.8573	1.1324	2.8391	1.1340	1.3958	0.8178	0.7093	3.0833	0.5249	0.0458
T <sub>11</sub>	Pigeonpea + Chilli	0.6036	0.8291	1.2649	2.6609	1.2204	1.1791	1.1627	0.7673	2.4693	0.4767	0.0073
T <sub>12</sub>	Pigeonpea + Bhindi	0.5600	0.9864	1.1784	2.7742	1.6462	1.2007	1.0609	0.9684	2.3020	0.4373	0.0427
T <sub>13</sub>	Pigeonpea + Clusterbean	0.5484	1.0238	1.2073	2.7349	1.0029	1.4380	1.0600	0.3924	3.2738	0.4602	0.0582
S.E.(m) ±		0.0208	0.0349	0.0493	0.1292	0.2162	0.3126	0.3629	0.1351	0.3434	0.1021	0.5514
C.D. 5%		N.S.	0.1075	0.1522	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>		<b>0.5632</b>	<b>0.9823</b>	<b>1.2748</b>	<b>2.6810</b>	<b>1.3099</b>	<b>1.2553</b>	<b>1.0352</b>	<b>0.7026</b>	<b>2.6424</b>	<b>0.4806</b>	<b>0.0318</b>

**Table 16b: Absolute growth rate (AGR) for height as influenced by different treatments (2000-2001)**

		(cm day <sup>-1</sup> )										
Time interval		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165
Treatments												
T <sub>1</sub>	Pigeonpea Sole	0.6431	1.8991	1.9556	3.5511	0.9711	1.3913	1.9464	1.0889	0.8993	0.1998	0.0653
T <sub>8</sub>	Pigeonpea +Black gram	0.6404	1.7196	2.4200	2.4844	1.3000	2.9136	1.9109	1.0667	0.7556	0.1467	0.0400
T <sub>9</sub>	Pigeonpea + Soybean	0.6702	1.9564	2.4467	2.5933	2.1556	2.0111	1.9378	1.0889	1.5593	0.1318	0.1156
T <sub>10</sub>	Pigeonpea + Cowpea	0.6378	2.0000	1.6867	4.1133	0.6422	2.8080	1.9409	1.0667	2.0000	0.1289	0.0667
T <sub>11</sub>	Pigeonpea + Chilli	0.6893	1.6751	1.8622	1.0933	3.7044	4.5089	0.7371	1.0667	2.1682	0.1547	0.0000
T <sub>12</sub>	Pigeonpea + Bhindi	0.6489	1.9067	1.8133	2.4978	1.0578	3.1756	1.7609	1.0667	0.9547	0.1867	0.0933
T <sub>13</sub>	Pigeonpea + Clusterbean	0.6373	1.8938	2.0156	2.4733	1.3000	4.1913	1.6160	1.0889	1.4700	0.1204	0.0733
S.E.(m) ±		0.0373	0.2489	0.2791	0.9158	0.7850	0.6344	0.9312	0.2918	0.3749	0.0313	0.0461
C.D. 5%		N.S.	N.S.	N.S.	N.S.	N.S.	1.9550	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>		<b>0.6524</b>	<b>1.8644</b>	<b>2.0286</b>	<b>2.6867</b>	<b>1.5902</b>	<b>3.0000</b>	<b>1.6929</b>	<b>1.0762</b>	<b>1.4010</b>	<b>0.1527</b>	<b>0.0649</b>

treatment differences amongst T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub> were not evident. In between 31-45 DAS, treatment T<sub>1</sub> being par with T<sub>9</sub>, recorded maximum value of AGR for height over other treatments (T<sub>8</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>12</sub> and T<sub>13</sub>).

During 2001-2002, treatment T<sub>11</sub> being par with T<sub>3</sub> resulted in increased values of AGR over other treatments. Treatments T<sub>12</sub>, T<sub>8</sub> and T<sub>10</sub> being par recorded higher value of AGR over T<sub>9</sub> and T<sub>1</sub>. However, treatment difference between T<sub>9</sub> and T<sub>1</sub> was not noticed.

#### **4.3.2 Absolute growth rate (AGR) for total dry matter**

Negative trend of AGR was noticed in between 151-165 and 166-180 DAS during 2000-2001 and between 166-180 DAS only during 2001-2002. The highest mean value of AGR for total dry matter was observed in between 91-105 and 136-150 DAS during 2000-2001 and 2001-2002 respectively (Table 17a, 17b).

#### **Effect of treatments**

During 2000-2001, no significant impact of different treatments was marked on absolute growth rate for total dry matter.

During 2001-2002, absolute growth rate for total dry matter was significantly affected due to different treatments between 46-60 DAS only. At this stage, treatment T<sub>1</sub> was found significantly superior in expressing higher value for absolute growth rate of total dry matter. The second best position was recorded by treatment T<sub>11</sub>, which was superior over other treatments. Treatments T<sub>9</sub> and T<sub>12</sub> were observed at par.

#### **4.3.3 Relative growth rate (RGR)**

In general, maximum values of RGR were noticed at initial stage of crop (0-15 DAS) during both the years of experimentation. The negative trend was marked as regards RGR in between 151-165 and 166-180 DAS during first year of experimentation and between 166-180 DAS during second year of experimentation (Table 18a, 18b).

#### **Effect of treatments**

Relative growth rate was not affected significantly due to different treatments at any of the stages of crop growth during both the years of study.

**Table17a: Absolute growth rate (AGR) for total dry matter in pigeonpea as influenced by different treatments during 2000-2001 (g day<sup>-1</sup>)**

Treatments	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180
T <sub>1</sub> Pigeonpea Sole	0.828	0.358	0.959	1.279	2.259	1.177	2.198	0.827	0.773	1.073	-0.239	-0.137
T <sub>8</sub> Pigeonpea +Black gram	0.779	0.410	0.830	1.335	2.143	1.345	1.781	0.891	1.227	1.200	-0.564	-0.565
T <sub>9</sub> Pigeonpea + Soybean	0.802	0.402	0.798	1.476	2.121	1.124	2.737	0.629	0.964	0.837	-0.613	-0.312
T <sub>10</sub> Pigeonpea + Cowpea	0.826	0.258	0.626	1.149	1.964	1.401	2.254	0.961	0.659	1.338	-0.481	-0.272
T <sub>11</sub> Pigeonpea + Chilli	0.787	0.408	0.882	0.947	2.240	1.278	2.213	1.057	0.513	1.014	-0.181	-0.406
T <sub>12</sub> Pigeonpea + Bhindi	0.789	0.320	0.883	1.324	1.820	1.648	2.441	0.836	0.667	0.797	-0.696	-0.219
T <sub>13</sub> Pigeonpea + Clusterbean	0.812	0.319	0.876	1.360	1.922	1.243	2.259	1.042	0.792	0.723	-0.299	-0.332
S.E.(m) ±	0.021	0.036	0.794	0.502	0.394	0.560	0.583	0.500	0.432	0.382	0.400	0.529
C.D. 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>	<b>0.803</b>	<b>0.354</b>	<b>0.836</b>	<b>1.267</b>	<b>2.067</b>	<b>1.316</b>	<b>2.269</b>	<b>0.892</b>	<b>0.799</b>	<b>0.997</b>	<b>-0.439</b>	<b>-0.321</b>

**Table17a: Absolute growth rate (AGR) for total dry matter in pigeonpea as influenced by different treatments during 2001-2002 (g day<sup>-1</sup>)**

Time interval	0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180
Treatment												
T <sub>1</sub> Pigeonpea Sole	0.177	0.010	0.006	0.017	0.031	0.029	0.008	0.027	0.019	0.029	0.008	-0.006
T <sub>8</sub> Pigeonpea +Black gram	0.177	0.006	0.006	0.010	0.033	0.027	0.009	0.030	0.021	0.029	0.007	-0.003
T <sub>9</sub> Pigeonpea + Soybean	0.181	0.004	0.009	0.010	0.034	0.027	0.007	0.028	0.022	0.028	0.007	-0.005
T <sub>10</sub> Pigeonpea + cowpea	0.177	0.009	0.000	0.007	0.037	0.029	0.008	0.025	0.024	0.032	0.008	-0.005
T <sub>11</sub> Pigeonpea + chilli	0.180	0.004	0.009	0.012	0.032	0.033	0.006	0.033	0.020	0.029	0.011	-0.006
T <sub>12</sub> Pigeonpea + Bhindi	0.177	0.007	-0.001	0.012	0.033	0.033	0.008	0.027	0.022	0.029	0.008	-0.005
T <sub>13</sub> Pigeonpea + clusterbean	0.178	0.007	0.011	0.011	0.032	0.026	0.009	0.026	0.024	0.028	0.007	-0.006
S.E.(m) ±	0.002	0.002	0.003	0.002	0.006	0.005	0.004	0.004	0.003	0.003	0.003	0.004
C.D. 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>	<b>0.1783</b>	<b>0.0067</b>	<b>0.0057</b>	<b>0.0114</b>	<b>0.0332</b>	<b>0.0293</b>	<b>0.0079</b>	<b>0.0279</b>	<b>0.0218</b>	<b>0.0294</b>	<b>0.0080</b>	<b>-0.005</b>



**Plate 6 : Treatment T<sub>4</sub> (Sole Cowpea)**



**Plate 7 : Treatment T<sub>10</sub> (Pigeonpea + Cowpea)**

**Table 18a: Relative growth rate (RGR) for total dry matter in pigeonpea as influenced by different treatments during 2000-2001**

		<b>(g g<sup>-1</sup> day<sup>-1</sup>)</b>											
<b>Time Interval</b>		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180
<b>Treatments</b>													
T <sub>1</sub>	Pigeonpea Sole	0.168	0.024	0.039	0.031	0.034	0.013	0.018	0.006	0.005	0.006	-0.001	-0.001
T <sub>8</sub>	Pigeonpea +Black gram	0.164	0.028	0.035	0.033	0.033	0.015	0.015	0.007	0.008	0.007	-0.003	-0.004
T <sub>9</sub>	Pigeonpea + Soybean	0.166	0.027	0.033	0.037	0.032	0.012	0.023	0.004	0.006	0.005	-0.004	-0.002
T <sub>10</sub>	Pigeonpea + Cowpea	0.168	0.018	0.030	0.035	0.035	0.017	0.020	0.007	0.005	0.008	-0.003	-0.002
T <sub>11</sub>	Pigeonpea + Chilli	0.164	0.028	0.037	0.025	0.037	0.014	0.020	0.008	0.003	0.006	-0.001	-0.002
T <sub>12</sub>	Pigeonpea + Bhindi	0.165	0.023	0.037	0.034	0.031	0.018	0.021	0.006	0.004	0.005	-0.004	-0.001
T <sub>13</sub>	Pigeonpea + Clusterbean	0.167	0.022	0.038	0.034	0.030	0.014	0.020	0.007	0.005	0.004	-0.002	-0.002
S.E.(m) ±		0.002	0.002	0.007	0.012	0.007	0.006	0.005	0.004	0.003	0.002	0.002	0.002
C.D. 5%		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>		<b>0.166</b>	<b>0.024</b>	<b>0.036</b>	<b>0.033</b>	<b>0.033</b>	<b>0.015</b>	<b>0.020</b>	<b>0.006</b>	<b>0.005</b>	<b>0.006</b>	<b>-0.003</b>	<b>-0.002</b>

**Table 18b: Relative growth rate (RGR) for total dry matter in pigeonpea as influenced by different treatments during 2001-2002**

		<b>(g g<sup>-1</sup> day<sup>-1</sup>)</b>											
<b>Time interval</b>		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180
<b>Treatments</b>													
T <sub>1</sub>	Pigeonpea Sole	0.945	0.150	0.110	0.356	0.960	1.362	0.495	2.190	2.211	4.839	1.761	-1.295
T <sub>8</sub>	Pigeonpea +Blackgram	0.951	0.094	0.102	0.192	0.868	1.086	0.474	2.131	2.237	4.422	1.332	-0.545
T <sub>9</sub>	Pigeonpea + Soybean	1.012	0.057	0.158	0.206	0.947	1.237	0.373	2.069	2.419	4.491	1.519	-1.132
T <sub>10</sub>	Pigeonpea + cowpea	0.953	0.140	0.008	0.114	0.918	1.168	0.443	1.681	2.379	4.893	1.541	-1.094
T <sub>11</sub>	Pigeonpea + Chilli	0.992	0.062	0.146	0.238	0.893	1.485	0.316	2.634	2.337	4.986	2.570	-1.634
T <sub>12</sub>	Pigeonpea + Bhindi	0.955	0.100	-0.017	0.214	0.789	1.332	0.458	1.889	2.160	4.236	1.631	-1.099
T <sub>13</sub>	Pigeonpea + Clusterbean	0.966	0.113	0.193	0.218	0.913	1.177	0.498	1.933	2.553	4.550	1.522	-1.153
S.E.(m) ±		0.003	0.344	0.005	0.004	0.171	0.215	0.208	0.327	0.333	0.519	0.756	0.869
C.D. 5%		N.S.	N.S.	N.S.	0.012	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>		<b>0.968</b>	<b>0.102</b>	<b>0.100</b>	<b>0.220</b>	<b>0.898</b>	<b>1.264</b>	<b>0.437</b>	<b>2.075</b>	<b>2.328</b>	<b>4.631</b>	<b>1.697</b>	<b>-1.136</b>

**Table 19a: Net assimilation rate in pigeonpea as influenced by different treatments (2000-2001)**

		<b>(g cm<sup>-2</sup> day<sup>-1</sup>)</b>											
<b>Time interval</b>		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	165-180
<b>Treatments</b>													
T <sub>1</sub>	Pigeonpea Sole	0.0343	0.0025	0.0038	0.0032	0.0033	0.0011	0.0015	0.0004	0.0003	0.0003	0.0000	0.0000
T <sub>8</sub>	Pigeonpea +Black gram	0.0337	0.0030	0.0035	0.0076	0.0066	0.0013	0.0012	0.0004	0.0004	0.0003	-0.0001	-0.0002
T <sub>9</sub>	Pigeonpea + Soybean	0.0324	0.0026	0.0030	0.0033	0.0031	0.0010	0.0018	0.0003	0.0003	0.0002	-0.0001	-0.0001
T <sub>10</sub>	Pigeonpea + Cowpea	0.0357	0.0018	0.0025	0.0033	0.0033	0.0014	0.0016	0.0005	0.0002	0.0004	-0.0001	-0.0001
T <sub>11</sub>	Pigeonpea + Chilli	0.0306	0.0026	0.0034	0.0023	0.0033	0.0012	0.0014	0.0005	0.0002	0.0003	0.0000	-0.0001
T <sub>12</sub>	Pigeonpea + Bhindi	0.0318	0.0020	0.0035	0.0032	0.0030	0.0016	0.0017	0.0004	0.0002	0.0002	-0.0002	-0.0001
T <sub>13</sub>	Pigeonpea + Clusterbean	0.0355	0.0021	0.0034	0.0033	0.0030	0.0012	0.0015	0.0005	0.0003	0.0002	-0.0001	-0.0001
S.E.(m) ±		0.0026	0.0003	0.0008	0.0018	0.0009	0.0005	0.0005	0.0002	0.0001	0.0001	0.0001	0.0001
C.D. 5%		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
<b>MEAN</b>		<b>0.0334</b>	<b>0.0024</b>	<b>0.0033</b>	<b>0.0037</b>	<b>0.0037</b>	<b>0.0012</b>	<b>0.0015</b>	<b>0.0004</b>	<b>0.0003</b>	<b>0.0003</b>	<b>-0.0001</b>	<b>-0.0001</b>

**Table 19a: Net assimilation rate in pigeonpea as influenced by different treatments (2001-2002)**

		<b>(g cm<sup>-2</sup> day<sup>-1</sup>)</b>											
<b>Time interval</b>		0-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	150-165	
<b>Treatments</b>													
T <sub>1</sub>	Pigeonpea Sole	0.0998	0.0029	0.0009	0.0011	0.0013	0.0010	0.0002	0.0009	0.0008	0.0017	0.0006	
T <sub>8</sub>	Pigeonpea +Black gram	0.0983	0.0020	0.0011	0.0008	0.0015	0.0010	0.0003	0.0011	0.0010	0.0020	0.0006	
T <sub>9</sub>	Pigeonpea + Soybean	0.1070	0.0011	0.0014	0.0009	0.0017	0.0011	0.0002	0.0009	0.0009	0.0017	0.0006	
T <sub>10</sub>	Pigeonpea + cowpea	0.0994	0.0027	0.0001	0.0005	0.0017	0.0011	0.0003	0.0007	0.0009	0.0017	0.0006	
T <sub>11</sub>	Pigeonpea + chilli	0.1050	0.0012	0.0012	0.0009	0.0014	0.0013	0.0002	0.0012	0.0009	0.0019	0.0010	
T <sub>12</sub>	Pigeonpea + Bhindi	0.0992	0.0020	-0.0002	0.0007	0.0017	0.0013	0.0002	0.0007	0.0007	0.0013	0.0005	
T <sub>13</sub>	Pigeonpea + clusterbean	0.1009	0.0023	0.0017	0.0008	0.0014	0.0009	0.0003	0.0008	0.0009	0.0015	0.0005	
S.E.(m) ±		0.004	0.0007	0.0005	0.0001	0.0004	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	
C.D. 5%		N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
<b>MEAN</b>		<b>0.1014</b>	<b>0.0020</b>	<b>0.0009</b>	<b>0.0008</b>	<b>0.0015</b>	<b>0.0011</b>	<b>0.0002</b>	<b>0.0009</b>	<b>0.0009</b>	<b>0.0017</b>	<b>0.0007</b>	

#### **4.3.4 Net assimilation rate (NAR)**

Negative trend of NAR was found in between 151-165 and 166-180 DAS during 2000-2001 only. In general, the higher values of NAR were registered in between 0-15 DAS during 2000-2001 and 2001-2002 (Table 19a, 19b).

##### **Effect of treatments**

Treatment differences as regards NAR were not found significant during both the years of investigation.

#### **4.3.5 Leaf area index (LAI)**

The mean LAI increased progressively up to 165 DAS during first year of the study and up to 150 DAS during second year of study and decreased later on (Table 20a, 20b and figures 13, 14).

##### **Effect of treatments**

During 2000-2001, LAI was influenced significantly due to different treatments only at 60, 120 and 165 DAS. At 60 DAS, treatment T<sub>1</sub> being par with all other treatments, showed maximum LAI than treatment T<sub>8</sub>. At 120 DAS, treatments T<sub>11</sub>, T<sub>1</sub> and T<sub>9</sub> being par, recorded significantly greater values of LAI over treatments T<sub>8</sub>, T<sub>10</sub>, T<sub>13</sub> and T<sub>12</sub>. Treatment differences amongst T<sub>8</sub>, T<sub>10</sub>, T<sub>13</sub> and T<sub>12</sub> were not evident. At 165 DAS, treatment T<sub>11</sub> expressed higher value of LAI over all other treatments. Treatments T<sub>9</sub> and T<sub>10</sub> being par, showed greater values of LAI over treatments T<sub>1</sub>, T<sub>13</sub>, T<sub>8</sub> and T<sub>12</sub>. Treatment differences amongst T<sub>1</sub>, T<sub>13</sub>, T<sub>8</sub> and T<sub>12</sub> were not significant.

During 2001-2002, LAI was significantly affected due to different treatments at 60, 90, 105, 120, 135, 150, 165 and 180 DAS. At 60 DAS, treatments T<sub>1</sub> and T<sub>12</sub> being par showed higher values of LAI over other treatments (T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub> and T<sub>13</sub>). However, differences among these treatments (T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub>, T<sub>11</sub> and T<sub>13</sub>) were not significant. At 90 and 105 DAS, treatments T<sub>1</sub>, T<sub>12</sub>, and T<sub>13</sub> being par, recorded higher LAI over other treatments (T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>). However, treatment differences amongst T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub> were not found at the level of significance. At 120 DAS, treatment T<sub>12</sub> showed higher value of LAI over all other treatments. Treatments T<sub>13</sub> and T<sub>1</sub> being par showed higher values of LAI over other treatments. However, treatment difference between T<sub>11</sub> and T<sub>10</sub> was not significant. Treatments T<sub>11</sub> and T<sub>9</sub> being par, recorded higher LAI than treatment T<sub>8</sub>. At 135 DAS, treatments T<sub>12</sub> and T<sub>13</sub>

**Table 20a: Leaf area index in pigeonpea as influenced by different treatments (2001-2002)**

		DAS											
Treatments		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>1</sub>	Pigeonpea Sole	0.0660	0.1104	0.1794	0.2867	0.4902	0.7424	0.9357	1.5162	1.8979	2.2325	2.3479	1.9610
T <sub>8</sub>	Pigeonpea +Black gram	0.0612	0.0978	0.1886	0.0434	0.4704	0.7068	0.9043	1.4395	1.8238	2.1428	2.2460	1.8972
T <sub>9</sub>	Pigeonpea + Soybean	0.0661	0.1062	0.1993	0.2912	0.5055	0.7667	0.9626	1.4801	1.8865	2.2405	2.4294	2.0307
T <sub>10</sub>	Pigeonpea + Cowpea	0.0606	0.1097	0.1728	0.2525	0.4544	0.6859	0.8747	1.3940	1.7632	2.1515	2.4001	1.9737
T <sub>11</sub>	Pigeonpea + Chilli	0.0690	0.1057	0.1911	0.2796	0.4991	0.7484	0.9722	1.5767	1.9621	2.3672	2.6184	2.1588
T <sub>12</sub>	Pigeonpea + Bhindi	0.0662	0.1162	0.1661	0.2723	0.4621	0.7020	0.8787	1.3445	1.7467	2.1517	2.2045	1.8744
T <sub>13</sub>	Pigeonpea + Clusterbean	0.0617	0.1134	0.1779	0.2827	0.4747	0.7284	0.9056	1.3866	1.7594	2.1809	2.2889	2.0251
S.E.(m) ±		0.0051	0.0112	0.0125	0.0342	0.0149	0.0206	0.0264	0.0386	0.0583	0.0525	0.0584	0.0608
C.D. 5%		N.S.	N.S.	N.S.	0.1054	N.S.	N.S.	N.S.	0.1189	N.S.	N.S.	0.18	N.S.
<b>Mean</b>		<b>0.0644</b>	<b>0.1085</b>	<b>0.1822</b>	<b>0.2441</b>	<b>0.4795</b>	<b>0.7258</b>	<b>0.9191</b>	<b>1.4482</b>	<b>1.8342</b>	<b>2.2096</b>	<b>2.3622</b>	<b>1.9887</b>

**Table 20b: Leaf area index in pigeonpea as influenced by different treatments (2001-2002)**

		DAS											
Treatments		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>1</sub>	Pigeonpea Sole	0.0184	0.0436	0.0928	0.3079	0.5757	0.9314	1.3145	1.5161	1.6546	1.5855	1.4643	0.9014
T <sub>8</sub>	Pigeonpea +Black gram	0.0190	0.0407	0.0731	0.2065	0.4700	0.7638	1.0697	1.1758	1.2999	1.2115	1.1043	0.7383
T <sub>9</sub>	Pigeonpea + Soybean	0.0185	0.0449	0.0808	0.1830	0.4918	0.7964	1.1379	1.3606	1.5370	1.4337	1.3032	0.7509
T <sub>10</sub>	Pigeonpea + cowpea	0.0189	0.0414	0.0916	0.1789	0.4655	0.7453	1.0846	1.4797	1.6320	1.5806	1.4497	0.7111
T <sub>11</sub>	Pigeonpea + Chilli	0.0184	0.0431	0.0984	0.2077	0.5337	0.8025	1.1423	1.3929	1.5112	1.4218	1.3058	0.7589
T <sub>12</sub>	Pigeonpea + Bhindi	0.0188	0.0439	0.0993	0.2751	0.3788	0.9413	1.3094	1.6627	1.8662	1.7657	1.6489	0.9119
T <sub>13</sub>	Pigeonpea + Clusterbean	0.0188	0.0437	0.1070	0.2212	0.5781	0.8942	1.2727	1.5405	1.7117	1.6503	1.5087	0.8642
S.E.(m) ±		0.0008	0.0036	0.0087	0.0986	0.0643	0.0263	0.0249	0.0191	0.0402	0.0385	0.0221	0.0249
C.D. 5%		N.S.	N.S.	N.S.	0.0572	N.S.	0.0812	0.0766	0.0591	0.1240	0.1186	0.0680	0.0769
<b>Mean</b>		<b>0.0187</b>	<b>0.0430</b>	<b>0.0919</b>	<b>0.2258</b>	<b>0.4991</b>	<b>0.8393</b>	<b>1.1902</b>	<b>1.4469</b>	<b>1.6018</b>	<b>1.5213</b>	<b>1.3979</b>	<b>0.8052</b>

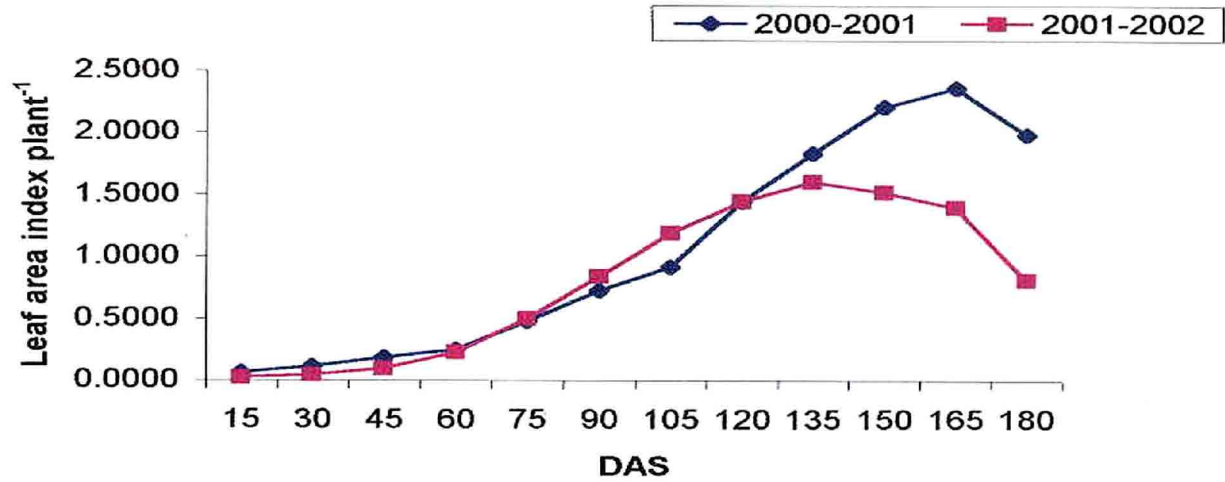


Fig. 13. Leaf area index plant<sup>-1</sup> of pigeonpea at successive time intervals during 2000-2001 and 2001-2002

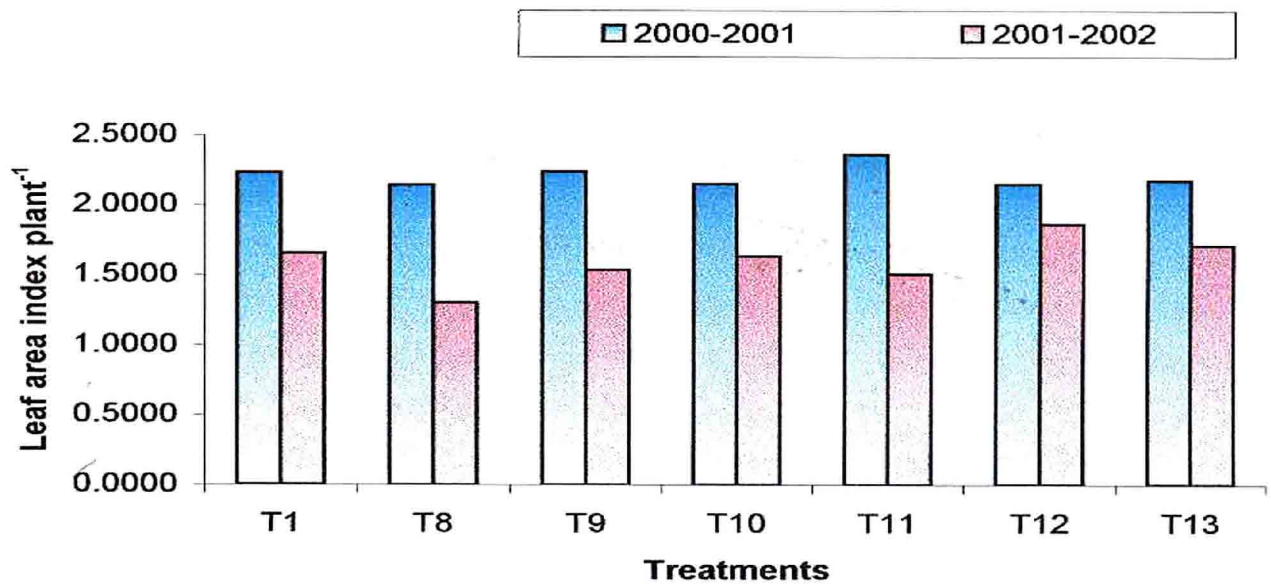


Fig. 14. Leaf area index plant<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

being par recorded higher values of LAI over other treatments. Treatment T<sub>1</sub> recorded greater value LAI over treatments T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>. However, treatment differences among T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub> were not seen at the level of significance. At 150 DAS, more or less similar trend was noticed as regards LAI. At 165 DAS, treatment T<sub>12</sub> showed higher value of LAI over other treatments. Treatment differences amongst T<sub>1</sub>, T<sub>10</sub> and T<sub>13</sub> were not significant. Treatments T<sub>11</sub> and T<sub>9</sub> being par, showed higher values of LAI than T<sub>8</sub>. The lowest values of LAI were noticed from 105 to 165 DAS. At 180 DAS, treatments T<sub>12</sub>, T<sub>1</sub> and T<sub>13</sub> being par recorded higher values of LAI over other treatments (T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>). However, the differences amongst these treatments (T<sub>8</sub>, T<sub>9</sub>, T<sub>10</sub> and T<sub>11</sub>) were not found significant.

#### **4.4 Post harvest studies**

##### **4.4.1 Yield attributes**

Data in respect of number of pods per plant, number of grains per plant, 100 seed weight and grain yield per plant as affected by different treatments are shown in table 21 and depicted in figures 15 and 16.

###### **4.4.1.1 Number of pods per plant**

The mean number of pods per plant was more during 2000-2001 (345.14) as compared to 2001-2002 (300.47).

##### **Effect of treatments**

During 2000-2001, there was no significant impact of different intercrops on number of pods per plant in pigeonpea. However, intercropping of different crops helped in significantly increasing the number of pods per plant in pigeonpea than sole cropped pigeonpea (T<sub>1</sub>).

During 2001-2002, intercropping of soybean (T<sub>9</sub>) being par with T<sub>8</sub> and T<sub>10</sub>, showed significantly higher number of pods in pigeonpea over other treatments. Intercropping of chilli, bhindi and clusterbean being equally effective recorded more number of pods per plant in pigeonpea than its sole cropping (T<sub>1</sub>).

###### **4.4.1.2 Number of grains per plant**

Number of grains per plant was greater during 2000-2001 (1210.05) as compared to the succeeding year (1053.05) (Table 21).

**Table 21: Yield attributing characters of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002**

Treatments	No. of Pods plant <sup>-1</sup>			No. of grains plant <sup>-1</sup>			Test weight (g)			Grain yield plant <sup>-1</sup> (g)		
	2000-01	2001-02	Pooled	2000-01	2001-02	Pooled	2000-01	2001-02	Pooled	2000-01	2001-02	Pooled
T <sub>1</sub> Pigeonpea Sole	183	171.33	177.67	641.67	606	623.83	10.27	10.29	10.28	65.67	62.33	64
T <sub>8</sub> Pigeonpea + Black gram	367.67	325.66	355.83	1285.3	1139.7	1212.5	10.15	10.1	10.12	130	118	124
T <sub>9</sub> Pigeonpea + Soybean	333.33	368.33	340.67	1164.3	1289	1226.7	10.28	10.75	10.51	119.67	139	129.33
T <sub>10</sub> Pigeonpea + Cowpea	407	333.33	371.17	1425.3	1166.7	1296	10.22	10.25	10.24	145	120.33	132.67
T <sub>11</sub> Pigeonpea + Chilli	391.67	314.67	360.67	1375.7	1101.3	1238.5	10.17	10.71	10.44	139.67	118	128.83
T <sub>12</sub> Pigeonpea + Bhindi	363.67	313	340.67	1284	1096	1190	10.53	10.58	10.56	135	116	125.5
T <sub>13</sub> Pigeonpea + Clusterbean	369.67	277	326.17	1294	972.67	1133.4	10.18	10.56	10.37	132	102.67	117.33
SE (m) ±	30.42	17.04	15.05	107.94	85.99	58.55	0.18	0.57	0.13	9.88	10.73	5.75
C.D. (0.05)	93.45	52.52	46.39	332.63	121.6	180.42	N.S.	N.S.	N.S.	30.43	33.05	12.53
GM <sup>†</sup>	345.14	300.47	324.69	1210.05	1053.05	1131.55	10.26	10.46	10.36	123.86	110.90	117.38

### Effect of treatments

During 2000-2001, intercropping treatments did not influence the character of number of grains per plant in pigeonpea. However, all the treatments of intercropping recorded more number of grains per plant in pigeonpea than its sole crop (T<sub>1</sub>).

During 2001-2002, the highest number of grains per plant was recorded in treatment T<sub>9</sub>, which was significantly greater over all other treatments. Intercropping of blackgram (T<sub>8</sub>), cowpea (T<sub>10</sub>), chilli (T<sub>11</sub>) and bhindi (T<sub>12</sub>) being par, showed more number of grains per plant in pigeonpea over treatments T<sub>13</sub> and T<sub>9</sub>. Intercropping of clusterbean (T<sub>13</sub>) also recorded greater number of grains per plant in pigeonpea than its sole crop (T<sub>1</sub>).

#### 4.4.1.3 100 seed weight

Mean 100 seed weight of pigeonpea was greater (10.46) during 2001-2002 than 2000-2001 (10.26) (Table 21).

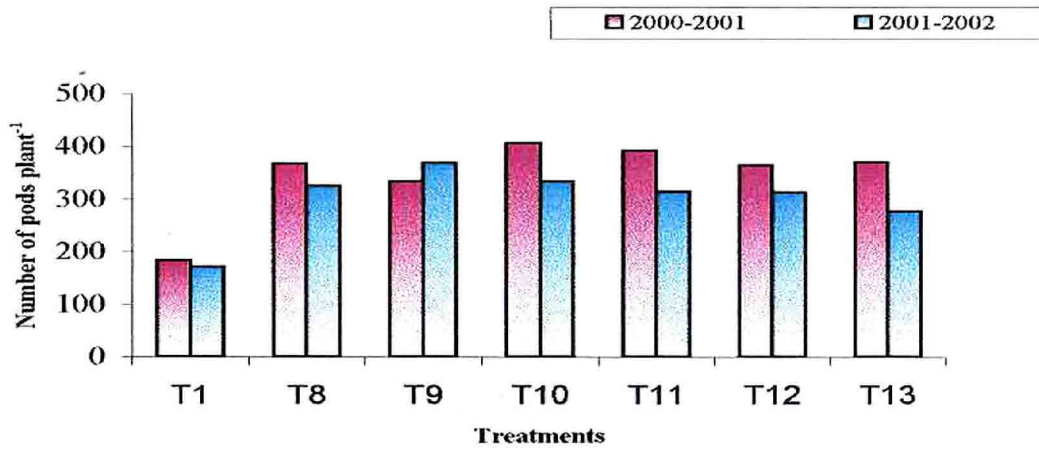


Fig.15. Number of pods plant<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

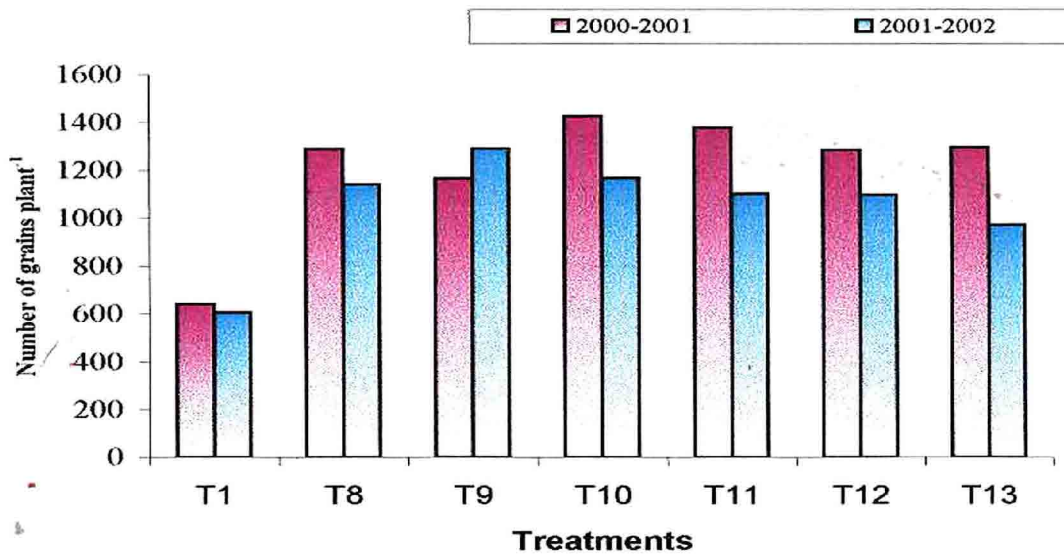


Fig.16. Number of grains plant<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

## **Effect of treatments**

100 seed weight of pigeonpea did not affect significantly due to different treatments during both the years of experimentation.

### **4.4.1.4 Grain yield per plant**

Mean grain yield per plant (Table 21) was greater during 2000-2001 (123.86) as compared to 2001-2002(110.90).

## **Effect of treatments**

During both the years of experimentation, use of different intercrops did not affect the grain yield per plant in pigeonpea. However, there was significant reduction in grain yield per plant of pigeonpea in its sole cropping.

## **4.5 Yield**

### **4.5.1 Grain yield**

During 2000-2001, the mean grain yield of pigeonpea (Table 22 and figure 17) was greater (2386 Kg ha<sup>-1</sup>) than 2001-2002 (1646 Kg ha<sup>-1</sup>)

## **Effect of treatments**

During first year of study and in pooled analysis, significant increase in the yield of pigeonpea was noticed with the treatment of sole pigeonpea (T<sub>1</sub>). However, intercropping of different crops in pigeonpea did not mark grain yield of pigeonpea at the level of significance. Similar trend of results was noticed during second year of experimentation. However, intercropping of blackgram (T<sub>8</sub>), soybean (T<sub>9</sub>), cowpea (T<sub>10</sub>), chilli (T<sub>11</sub>) and bhindi (T<sub>12</sub>) showed their superiority on intercropping of clusterbean (T<sub>13</sub>) in recording highest grain yield of pigeonpea.

### **4.5.2 Husk Yield**

~~During 2001-2002, the mean husk yield of pigeonpea (Table 22 and figure 18) was greater (2712 Kg ha<sup>-1</sup>) than 2000-2001 (1742 Kg ha<sup>-1</sup>).~~

## **Effect of treatments**

During 2000-2001, significantly highest husk yield per hectare was recorded with pigeonpea sole cropping (T<sub>1</sub>) over other treatments. However, no significant difference was noticed in recording husk yield of pigeonpea due to different intercrops attempted with pigeonpea.

During 2001-2002, no significant impact of different treatments was noticed on husk yield of pigeonpea.

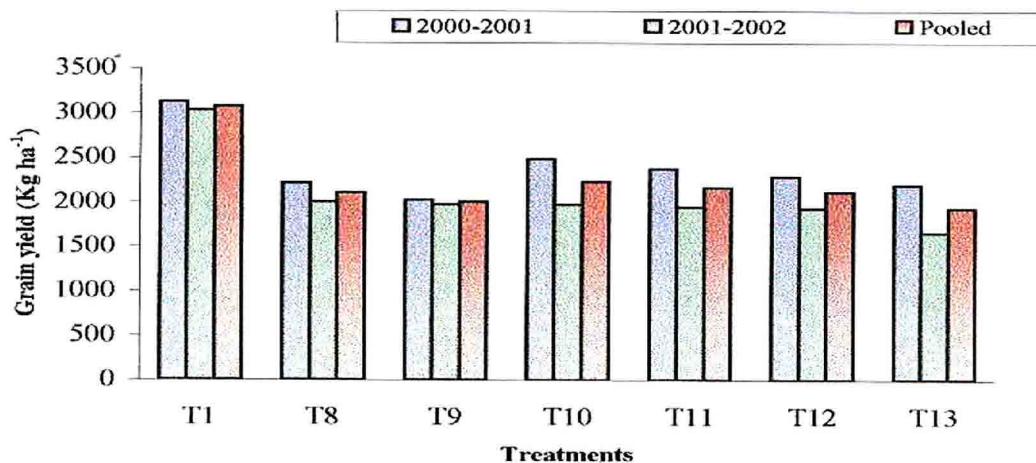


Fig. 17. Grain yield ha<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002 and in pooled analysis

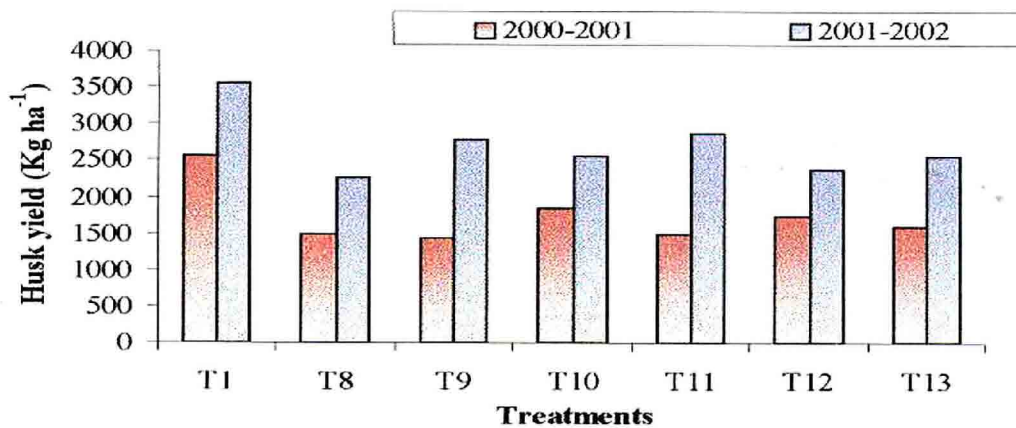


Fig. 18. Husk yield ha<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

**Table 22: Crop yield of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002**

Treatments	Grain yield (Kg ha <sup>-1</sup> )			Husk yield (Kg ha <sup>-1</sup> )		Straw yield (Kg ha <sup>-1</sup> )		Biological yield (Kg ha <sup>-1</sup> )		Harvest Index	
	2000-2001	2001-2002	Pooled	2000-2001	2001-2002	2000-2001	2001-2002	2000-2001	2001-2002	2000-2001	2001-2002
T <sub>1</sub> Pigeonpea Sole	3121	27	3074	2572	3550	5401	11831	11094	18407	28.07	16.52
T <sub>8</sub> Pigeonpea +Blackgram	2213	2001	2106	1492	2263	3189	7644	6893	11929	32.78	16.35
T <sub>9</sub> Pigeonpea + Soybean	2027	1975	2001	1440	2778	2983	7767	6450	12521	31.30	16.44
T <sub>10</sub> Pigeonpea + Cowpea	2485	1973	2229	1852	2572	3498	7202	7828	11746	31.72	17.31
T <sub>11</sub> Pigeonpea + Chilli	2374	1947	2162	1492	2881	3240	8591	7107	13421	33.47	14.45
T <sub>12</sub> Pigeonpea + Bhindi	2287	1934	2110	1749	2366	3549	6019	7585	11406	30.27	17.06
T <sub>13</sub> Pigeonpea + Clusterbean	2196	1662	1929	1595	2572	3344	7304	6967	11601	31.54	14.00
SE (m) ±	2.25	1.06	1.12	1.65	3.75	2.88	4.77	5.98	8.55	1.55	0.84
C.D. (0.05)	N.S.	3.27	3.46	5.09	N.S.	8.88	14.71	18.43	26.35	N.S.	N.S.
GM	2386.14	1645.57	2230.14	1741.71	2711.71	3600.57	8051.14	7703.43	13004.43	31.31	16.02

#### 4.5.3 Straw yield

During 2001-2002, the mean straw yield of pigeonpea (Table 22 and figure 19) was greater (8051 Kg ha<sup>-1</sup>) than 2000-2001 (3601 Kg ha<sup>-1</sup>).

#### Effect of treatments

During 2000-2001, pigeonpea sole cropping (T<sub>1</sub>) resulted in production of higher straw yield per hectare over other intercropping systems. There was no significant impact of different intercropping treatments on straw yield of pigeonpea. More or less similar results were observed during 2001-2002.

#### 4.5.4 Biological yield

During 2001-2002, the mean biological yield of pigeonpea (Table 22 and figure 20) was greater (10304 Kg ha<sup>-1</sup>) than 2000-2002 (7703 Kg ha<sup>-1</sup>).

#### Effect of treatments

During both the years of study, significantly highest biological yield of pigeonpea was observed with sole cropping of pigeonpea (T<sub>1</sub>). However, use of

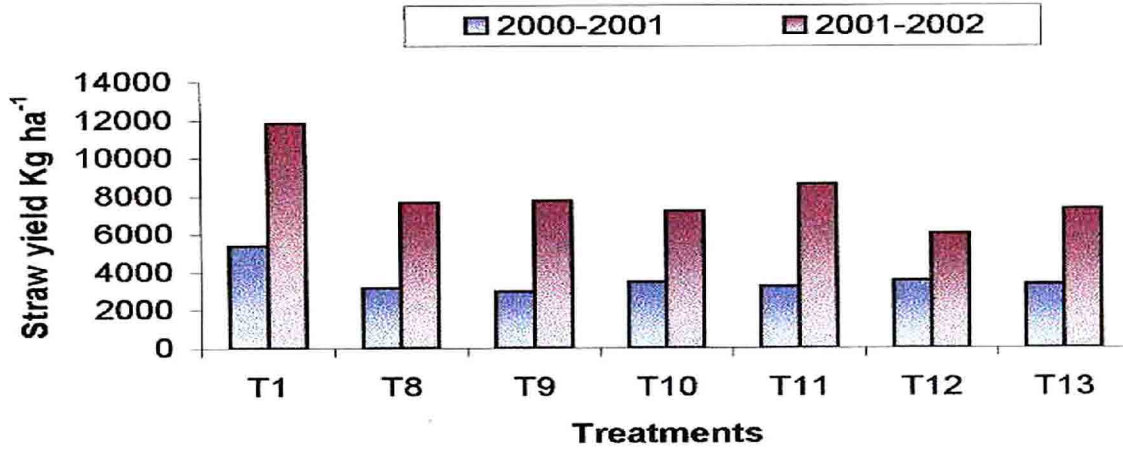


Fig. 19. Straw yield ha<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

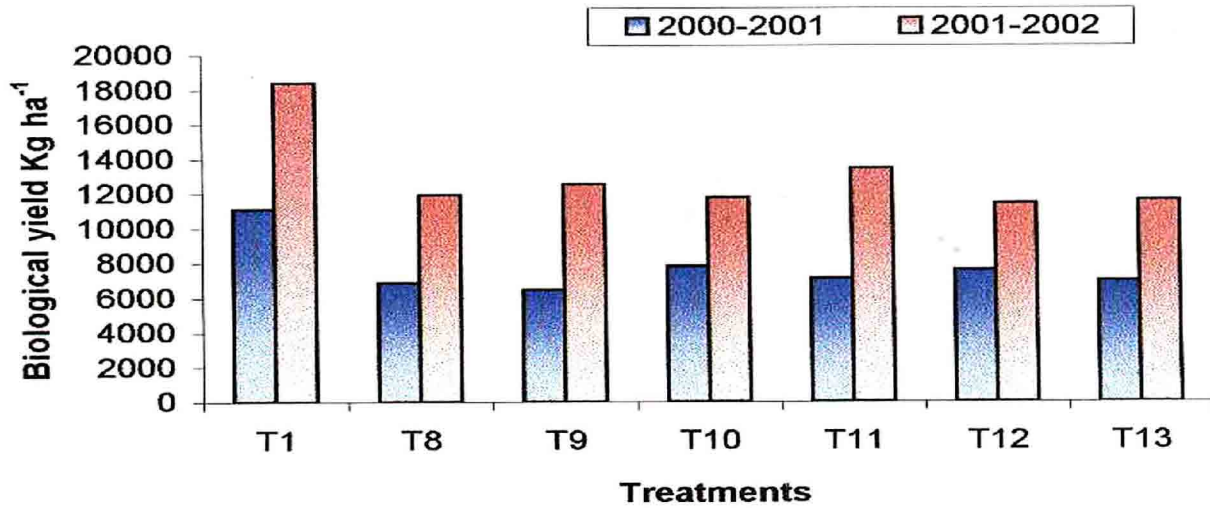


Fig. 20. Biological yield ha<sup>-1</sup> of pigeonpea as influenced by different treatments during 2000-2001 and 2001-2002

different intercrops with pigeonpea did not register any significant increase in the yield of pigeonpea.

#### **4.5.5 Harvest index**

During 2000-2001, the mean harvest index of pigeonpea (Table 22) was greater (31.31%) in compared to 2001-2002 (16.02%).

#### **Effect of treatments**

The values of harvest indices were not affected significantly due to different treatments in both the years of investigation.

#### **(II) Intercrops (Blackgram, Soybean, Cowpea, Chilli, Bhindi and Clusterbean)**

### **4.6 Preharvest studies**

#### **4.6.1 Growth**

Growth performance of different intercrops in comparison to sole crops as affected by different treatments during both years is shown in tables 23a, 23b, 24a, 24b, 25a, 25b, and 26a, 26b.

#### **Effect of treatments**

Growth performance of intercrops viz., blackgram, soybean, cowpea, chilli, bhindi and clusterbean for height, number of branches per plant, number of leaves of plant and total dry matter production per plant was greater with sole crops as compared to there performance in association with pigeonpea during both the years of study.

### **4.7 Post harvest studies**

#### **4.7.1 Yield attributes and yield**

Yield attributes of intercrops as affected by different treatments during both the years of study are presented in table 27. In general, yield attributes and yield in soybean and chilli were comparatively towards higher side during first year as compared to the second year of study. However, reverse was the trend in blackgram, cowpea, bhindi and clusterbean.

**Table 23a: Height per plant of different intercrops as influenced by base crop pigeonpea (2000-2001)**

		(cm)											
Treatments		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole	8.23	13.26	33.17	47.01	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	8.00	14.10	34.02	46.88	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>8.12</b>	<b>13.68</b>	<b>33.60</b>	<b>46.95</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	12.93	26.18	71.86	81.16	91.31	93.12	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	12.88	25.89	66.82	81.04	90.27	92.67	---	---	---	---	---	---
	<b>Mean</b>	<b>12.91</b>	<b>26.04</b>	<b>69.34</b>	<b>81.10</b>	<b>90.79</b>	<b>92.90</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	8.21	14.36	33.52	43.87	49.36	58.11	60.77	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	7.11	14.02	33.47	40.37	47.74	55.22	59.26	---	---	---	---	---
	<b>Mean</b>	<b>7.66</b>	<b>14.19</b>	<b>33.50</b>	<b>42.12</b>	<b>48.55</b>	<b>56.67</b>	<b>60.02</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	24.64	29.24	39.64	47.33	53.34	54.08	55.16	55.08	44.64	59.64	61.11	64.09
T <sub>11</sub>	Pigeonpea + Chilli	22.17	27.24	38.61	40.72	45.83	47.78	52.04	53.69	43.67	54.36	57.31	58.23
	<b>Mean</b>	<b>23.41</b>	<b>28.24</b>	<b>39.13</b>	<b>44.03</b>	<b>49.59</b>	<b>50.93</b>	<b>53.60</b>	<b>54.39</b>	<b>44.16</b>	<b>57.00</b>	<b>59.21</b>	<b>61.16</b>
T <sub>6</sub>	Bhindi sole	6.24	14.26	43.76	57.44	61.82	72.14	73.29	74.55	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	6.11	12.41	41.80	51.08	58.91	66.41	70.03	72.08	---	---	---	---
	<b>Mean</b>	<b>6.18</b>	<b>13.34</b>	<b>42.78</b>	<b>54.26</b>	<b>60.37</b>	<b>69.28</b>	<b>71.66</b>	<b>73.32</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole	3.50	19.56	37.42	63.81	81.12	91.40	99.13	103.91	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean	3.25	18.06	32.66	64.22	80.87	91.57	96.21	100.18	---	---	---	---
	<b>Mean</b>	<b>3.38</b>	<b>18.81</b>	<b>35.04</b>	<b>64.02</b>	<b>81.00</b>	<b>91.49</b>	<b>97.67</b>	<b>102.05</b>	---	---	---	---

**Table 23b : Height per plant of different intercrops as influenced by base crop pigeonpea (2001-2002)**

Treatments		(cm)											
		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole	7.27	14.67	34.07	43.13	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	7.30	15.23	30.87	41.83	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>7.29</b>	<b>14.95</b>	<b>32.47</b>	<b>42.48</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	10.63	23.70	64.90	70.77	85.03	89.43	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	10.50	25.93	64.53	68.50	81.13	88.70	---	---	---	---	---	---
	<b>Mean</b>	<b>10.57</b>	<b>24.82</b>	<b>64.72</b>	<b>69.64</b>	<b>83.08</b>	<b>89.07</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	7.19	15.70	35.23	47.13	52.80	61.67	62.11	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	6.94	13.93	30.40	42.67	48.83	59.11	59.78	---	---	---	---	---
	<b>Mean</b>	<b>7.07</b>	<b>14.82</b>	<b>32.82</b>	<b>44.90</b>	<b>50.82</b>	<b>60.39</b>	<b>60.95</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	23.61	31.38	35.41	39.14	41.27	42.04	42.86	44.64	45.38	47.22	47.89	47.89
T <sub>11</sub>	Pigeonpea + Chilli	22.46	33.03	34.18	37.27	39.65	41.11	42.09	43.67	44.29	45.98	46.14	46.14
	<b>Mean</b>	<b>23.04</b>	<b>32.21</b>	<b>34.80</b>	<b>38.21</b>	<b>40.46</b>	<b>41.58</b>	<b>42.48</b>	<b>44.16</b>	<b>44.84</b>	<b>46.60</b>	<b>47.02</b>	<b>47.02</b>
T <sub>6</sub>	Bhindi sole	10.11	25.87	78.22	123.03	147.43	177.15	177.15	177.15	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	10.27	25.23	65.53	115.73	138.43	156.92	156.92	156.92	---	---	---	---
	<b>Mean</b>	<b>10.19</b>	<b>25.55</b>	<b>71.88</b>	<b>119.38</b>	<b>142.93</b>	<b>167.04</b>	<b>167.04</b>	<b>167.04</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole	10.08	23.53	45.80	68.97	75.78	82.44	94.11	94.44	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean	9.35	26.40	50.70	60.73	68.00	81.33	92.33	92.78	---	---	---	---
	<b>Mean</b>	<b>9.72</b>	<b>24.97</b>	<b>48.25</b>	<b>64.85</b>	<b>71.89</b>	<b>81.89</b>	<b>93.22</b>	<b>93.61</b>	---	---	---	---



**Plate 8 : Treatment T<sub>7</sub> (Sole Clusterbean)**



**Plate 9 : Treatment T<sub>13</sub> (Pigeonpea + Clusterbean)**

**Table 24a: Number of branches per plant of different intercrops as influenced by base crop pigeonpea (2000-2001)**

Treatments		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole		1.42	3.95	6.11	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram		1.38	3.82	6.29	---	---	---	---	---	---	---	---
	<b>Mean</b>		<b>1.40</b>	<b>3.89</b>	<b>6.20</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole		1.21	2.27	2.97	3.88	3.97	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean		1.29	2.21	3	3.79	4.02	---	---	---	---	---	---
	<b>Mean</b>		<b>1.25</b>	<b>2.24</b>	<b>2.99</b>	<b>3.84</b>	<b>4.00</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	1.09	3.29	4.21	5.67	7.09	7.13	7.13	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	1.16	3.35	4.16	5.49	7.16	7.21	7.21	---	---	---	---	---
	<b>Mean</b>	<b>1.13</b>	<b>3.32</b>	<b>4.19</b>	<b>5.58</b>	<b>7.13</b>	<b>7.17</b>	<b>7.17</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole		1.13	3.87	6.83	8.28	8.79	9.36	11.47	12.64	13.33	13.6	13.6
T <sub>11</sub>	Pigeonpea + Chilli		1.61	3.91	7.04	8.52	9.1	9.54	11.29	12.87	14.04	14.81	14.81
	<b>Mean</b>		<b>1.37</b>	<b>3.89</b>	<b>6.94</b>	<b>8.40</b>	<b>8.95</b>	<b>9.45</b>	<b>11.38</b>	<b>12.76</b>	<b>13.69</b>	<b>14.21</b>	<b>14.21</b>
T <sub>6</sub>	Bhindi sole		1.02	1.61	1.66	1.66	2.1	2.1	2.1	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi		1.07	1.54	1.64	1.85	2.24	2.24	2.24	---	---	---	---
	<b>Mean</b>		<b>1.05</b>	<b>1.58</b>	<b>1.65</b>	<b>1.76</b>	<b>2.17</b>	<b>2.17</b>	<b>2.17</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole		1.47	3.59	5.27	6.49	6.65	7.09	7.09	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean		1.59	4.21	5.88	7.04	7.35	7.42	7.42	---	---	---	---
	<b>Mean</b>		<b>1.53</b>	<b>3.90</b>	<b>5.58</b>	<b>6.77</b>	<b>7.00</b>	<b>7.26</b>	<b>7.26</b>	---	---	---	---

**Table 24b: Number of branches per plant of different intercrops as influenced by base crop pigeonpea (2001-2002)**

Treatments		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole		1.86	4.68	6.51	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram		1.4	4.57	6.59	---	---	---	---	---	---	---	---
	<b>Mean</b>		<b>1.63</b>	<b>4.63</b>	<b>6.55</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole		1.63	2.48	3.14	4.81	4.31	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean		1.49	2.43	3.02	4.15	4.15	---	---	---	---	---	---
	<b>Mean</b>		<b>1.56</b>	<b>2.46</b>	<b>3.08</b>	<b>4.48</b>	<b>4.23</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	1.41	3.67	4.36	5.86	7.57	7.64	7.64	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	1.37	3.67	4.17	5.69	7.48	7.51	7.51	---	---	---	---	---
	<b>Mean</b>	<b>1.39</b>	<b>3.67</b>	<b>4.27</b>	<b>5.78</b>	<b>7.53</b>	<b>7.58</b>	<b>7.58</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole		0.89	1.57	2.67	4.1	5.06	5.27	6.04	6.48	6.57	6.57	6.57
T <sub>11</sub>	Pigeonpea + Chilli		1.01	1.74	2.91	4.28	5.15	5.51	6.24	6.51	6.64	6.64	6.64
	<b>Mean</b>		<b>0.95</b>	<b>1.66</b>	<b>2.79</b>	<b>4.19</b>	<b>5.11</b>	<b>5.39</b>	<b>6.14</b>	<b>6.50</b>	<b>6.61</b>	<b>6.61</b>	<b>6.61</b>
T <sub>6</sub>	Bhindi sole		1.11	1.19	1.19	1.89	2.11	2.11	2.11	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi		1.37	1.51	1.51	1.97	2.31	2.31	2.31	---	---	---	---
	<b>Mean</b>		<b>1.24</b>	<b>1.35</b>	<b>1.35</b>	<b>1.93</b>	<b>2.21</b>	<b>2.21</b>	<b>2.21</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole		1.68	4.04	5.52	6.1	8.04	8.14	8.14	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean		1.73	4.18	2.39	6.42	7.97	8.02	8.02	---	---	---	---
	<b>Mean</b>		<b>1.71</b>	<b>4.11</b>	<b>3.96</b>	<b>6.26</b>	<b>8.01</b>	<b>8.08</b>	<b>8.08</b>	---	---	---	---

**Table 25a : Number of leaves per plant of different intercrops as influenced by base crop pigeonpea (2000-2001)**

Treatments		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole	2.24	2.8	7.7	9.53	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	1.56	2.52	7.73	9.55	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>1.90</b>	<b>2.66</b>	<b>7.72</b>	<b>9.54</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	1.53	2.4	2.53	5.51	6.98	8.48	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	1.56	2.67	2.81	5.76	7.12	8.36	---	---	---	---	---	---
	<b>Mean</b>	<b>1.55</b>	<b>2.54</b>	<b>2.67</b>	<b>5.64</b>	<b>7.05</b>	<b>8.42</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	2.47	6.2	9.6	11.31	13.44	11.09	7.82	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	2.07	6.56	9.07	12.42	13.95	11.82	8.11	---	---	---	---	---
	<b>Mean</b>	<b>104.74</b>	<b>6.38</b>	<b>9.34</b>	<b>11.87</b>	<b>13.70</b>	<b>11.46</b>	<b>7.97</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	10.26	36	68.08	97.52	147.2	201.6	265.5	308.4	381.2	422.2	485.1	479.3
T <sub>11</sub>	Pigeonpea + Chilli	8.8	19.8	43.2	92.17	135.7	197.3	251.7	295.2	372.4	415.9	477	471
	<b>Mean</b>	<b>9.53</b>	<b>27.90</b>	<b>55.64</b>	<b>94.85</b>	<b>141.47</b>	<b>199.42</b>	<b>258.57</b>	<b>301.76</b>	<b>376.79</b>	<b>419.03</b>	<b>481.05</b>	<b>475.15</b>
T <sub>6</sub>	Bhindi sole	4.6	6.6	9.6	15.17	19.96	21.64	22.17	21.19	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	3.33	5.6	7	13.41	17.32	19.91	21.08	20.51	---	---	---	---
	<b>Mean</b>	<b>3.97</b>	<b>6.10</b>	<b>8.30</b>	<b>14.29</b>	<b>18.64</b>	<b>20.78</b>	<b>21.63</b>	<b>20.85</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole	3.73	9.6	30	35.18	51.29	67.87	71.25	70.17	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean	4.07	6.9	22.6	28.39	45.59	61.13	68.27	65.32	---	---	---	---
	<b>Mean</b>	<b>3.90</b>	<b>8.25</b>	<b>26.30</b>	<b>31.79</b>	<b>48.44</b>	<b>64.50</b>	<b>69.76</b>	<b>67.75</b>	---	---	---	---

**Table 25b : Number of leaves per plant of different intercrops as influenced by base crop pigeonpea (2001-2002)**

Treatments	DAS												
	15	30	45	60	75	90	105	120	135	150	165	180	
T <sub>2</sub>	Blackgram sole	1.8	5.4	9.73	3.8	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	1.63	4.89	8	7.47	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>1.72</b>	<b>5.15</b>	<b>8.87</b>	<b>5.64</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	1.86	4.45	9.11	12.91	13.86	11.58	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	1.94	4.51	9.89	13.78	14.21	12.12	---	---	---	---	---	---
	<b>Mean</b>	<b>1.90</b>	<b>4.48</b>	<b>9.50</b>	<b>13.35</b>	<b>14.04</b>	<b>11.85</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	2.42	7.81	10.67	14.88	16.09	10.29	8.31	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	2.51	7.24	10.27	14.22	15.96	11.36	8.82	---	---	---	---	---
	<b>Mean</b>	<b>2.47</b>	<b>7.53</b>	<b>10.47</b>	<b>14.55</b>	<b>16.03</b>	<b>10.83</b>	<b>8.57</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	8.22	22.31	48.07	67.12	107.6	188.7	224.4	298.4	353.7	359.4	351.1	345.2
T <sub>11</sub>	Pigeonpea + Chilli	7.51	18.41	39.93	54.28	90.87	169.7	208.4	357.9	301.1	322.3	330.6	327.1
	<b>Mean</b>	<b>7.87</b>	<b>20.36</b>	<b>44.00</b>	<b>60.70</b>	<b>99.23</b>	<b>179.20</b>	<b>216.40</b>	<b>328.11</b>	<b>327.39</b>	<b>340.84</b>	<b>340.83</b>	<b>336.15</b>
T <sub>6</sub>	Bhindi sole	3.88	7	11.13	18.6	25.52	30.38	28.18	27.39	27.11	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	3.53	6.4	11.87	21.2	27.16	31.19	29.56	27.74	27.53	---	---	---
	<b>Mean</b>	<b>3.71</b>	<b>6.70</b>	<b>11.50</b>	<b>19.90</b>	<b>26.34</b>	<b>30.79</b>	<b>28.87</b>	<b>27.57</b>	<b>27.32</b>	---	---	---
T <sub>7</sub>	Clusterbean sole	5.16	13.26	34.08	42.78	63.33	72.17	74.43	70.07	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean	4.97	12.47	32.12	39.09	56.84	67.04	70	69.71	---	---	---	---
	<b>Mean</b>	<b>5.07</b>	<b>12.87</b>	<b>33.10</b>	<b>40.94</b>	<b>60.09</b>	<b>69.61</b>	<b>72.22</b>	<b>69.89</b>	---	---	---	---

**Table 26a : TDM per plant of different intercrops as influenced by base crop pigeonpea (2000-2001)**

Treatments		(g)											
		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole	2.14	3.87	6.16	7.14	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	2.19	3.71	6.06	7.11	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>2.17</b>	<b>3.79</b>	<b>6.11</b>	<b>7.13</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	2.09	2.65	5.37	9.89	14.57	15.09	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	2.16	2.57	5.29	9.53	13.97	14.91	---	---	---	---	---	---
	<b>Mean</b>	<b>2.13</b>	<b>2.61</b>	<b>5.33</b>	<b>9.71</b>	<b>14.27</b>	<b>15.00</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	3.27	5.52	9.76	11.89	16.88	19.26	15.41	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + Cowpea	3.21	5.38	9.51	11.04	15.12	18.48	16.31	---	---	---	---	---
	<b>Mean</b>	<b>3.24</b>	<b>5.45</b>	<b>9.64</b>	<b>11.47</b>	<b>16.00</b>	<b>18.87</b>	<b>15.86</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	3.47	12.18	23.03	32.98	49.79	68.18	89.78	104.29	128.93	142.78	164.06	162.10
T <sub>11</sub>	Pigeonpea + Chilli	2.98	6.70	14.61	31.17	45.90	66.72	85.11	99.42	125.93	140.65	161.32	159.30
	<b>Mean</b>	<b>3.23</b>	<b>9.44</b>	<b>18.82</b>	<b>32.08</b>	<b>47.85</b>	<b>67.45</b>	<b>87.45</b>	<b>101.86</b>	<b>127.43</b>	<b>141.72</b>	<b>162.69</b>	<b>160.70</b>
T <sub>6</sub>	Bhindi sole	3.18	5.47	9.18	16.31	21.58	29.77	32.49	27.81	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	3.21	5.33	8.81	14.63	18.22	25.86	27.34	21.93	---	---	---	---
	<b>Mean</b>	<b>3.20</b>	<b>5.40</b>	<b>9.00</b>	<b>15.47</b>	<b>19.90</b>	<b>27.82</b>	<b>29.92</b>	<b>24.87</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole	3.11	4.18	9.51	16.48	21.41	30.52	41.57	37.42	---	---	---	---
T <sub>13</sub>	Pigeonpea + Clusterbean	3.27	4.21	9.47	17.19	21.02	28.82	37.61	36.36	---	---	---	---
	<b>Mean</b>	<b>3.19</b>	<b>4.20</b>	<b>9.49</b>	<b>16.84</b>	<b>21.22</b>	<b>29.67</b>	<b>39.59</b>	<b>36.89</b>	---	---	---	---

**Table 26b : TDM per plant of different intercrops as influenced by base crop pigeonpea (2001-2002)**

Treatments		(g)											
		DAS											
		15	30	45	60	75	90	105	120	135	150	165	180
T <sub>2</sub>	Blackgram sole	2.27	4.01	6.89	7.78	---	---	---	---	---	---	---	---
T <sub>8</sub>	Pigeonpea + Blackgram	2.11	3.91	6.45	7.51	---	---	---	---	---	---	---	---
	<b>Mean</b>	<b>2.19</b>	<b>3.96</b>	<b>6.67</b>	<b>7.65</b>	---	---	---	---	---	---	---	---
T <sub>3</sub>	Soybean sole	2.71	3.18	6.24	10.01	16.22	14.21	---	---	---	---	---	---
T <sub>9</sub>	Pigeonpea + Soybean	2.67	3.11	6.10	9.92	15.59	13.13	---	---	---	---	---	---
	<b>Mean</b>	<b>2.69</b>	<b>3.15</b>	<b>6.17</b>	<b>9.97</b>	<b>15.91</b>	<b>13.67'</b>	---	---	---	---	---	---
T <sub>4</sub>	Cowpea sole	3.91	6.14	10.69	13.36	20.22	18.49	16.51	---	---	---	---	---
T <sub>10</sub>	Pigeonpea + cowpea	3.97	3.29	10.48	13.31	19.09	17.95	16.04	---	---	---	---	---
	<b>Mean</b>	<b>3.94</b>	<b>4.72</b>	<b>10.59</b>	<b>13.34</b>	<b>19.66</b>	<b>18.22</b>	<b>16.28</b>	---	---	---	---	---
T <sub>5</sub>	Chilli sole	2.78	7.55	16.26	22.70	36.35	63.81	75.81	100.90	119.61	121.54	118.75	116.74
T <sub>11</sub>	Pigeonpea + chilli	2.59	6.23	13.51	18.36	30.73	57.40	70.47	87.21	101.84	109.01	111.79	110.64
	<b>Mean</b>	<b>2.69</b>	<b>6.89</b>	<b>14.89</b>	<b>20.53</b>	<b>33.54</b>	<b>60.61</b>	<b>73.14</b>	<b>94.06</b>	<b>110.73</b>	<b>115.28</b>	<b>115.27</b>	<b>113.69</b>
T <sub>6</sub>	Bhindi sole	3.81	6.27	11.41	18.72	24.61	31.55	35.58	30.29	---	---	---	---
T <sub>12</sub>	Pigeonpea + Bhindi	3.91	6.31	11.98	16.91	22.37	30.32	32.23	24.88	---	---	---	---
	<b>Mean</b>	<b>3.86</b>	<b>6.29</b>	<b>11.70</b>	<b>17.82</b>	<b>23.49</b>	<b>30.94</b>	<b>33.91</b>	<b>27.59</b>	---	---	---	---
T <sub>7</sub>	Clusterbean sole	3.87	5.11	9.74	19.01	24.22	33.31	47.38	39.13	---	---	---	---
T <sub>13</sub>	Pigeonpea + clusterbean	3.61	4.99	9.27	16.36	21.51	30.26	44.24	31.89	---	---	---	---
	<b>Mean</b>	<b>3.74</b>	<b>5.05</b>	<b>9.51</b>	<b>17.69</b>	<b>22.87</b>	<b>31.79</b>	<b>45.81</b>	<b>35.51</b>	---	---	---	---

## Effect of treatments

In general, the performance of intercrops as regards yield attributes and yield was found better under sole cropping as compared to their performance in association with pigeonpea.

**Table 27 : Yield attributing characters and yield of various intercrops as influenced by different treatments**

Treatment		No. of pods or fruits plant-1		Grain or fruit weight plant-1 (g)		Yield Kg ha-1	
		2000-2001	2001-2002	2000-2001	2001-2002	2000-2001	2001-2002
T2	Blackgram sole	19.02	33.67	7.14	7.38	653	1209
T8	Pigeonpea + Blackgram	17.1	26	7.1	7.58	525	834
	<b>Mean</b>	<b>18.06</b>	<b>29.835</b>	<b>7.12</b>	<b>7.48</b>	<b>589</b>	<b>1021.5</b>
T3	Sybean Sole	60.33	55.67	14.74	15.63	2457	2522
T9	Pigeonpea + Soybean	45.27	42.67	16.52	13.05	1835	1383
	<b>Mean</b>	<b>52.8</b>	<b>49.17</b>	<b>15.63</b>	<b>14.34</b>	<b>2146</b>	<b>1952.5</b>
T4	Cowpea sole	36	53.8	69.12	202.33	3806	5768
T10	Pigeonpea + cowpea	46.76	50.77	67.07	182	2419	2627
	<b>Mean</b>	<b>41.38</b>	<b>52.285</b>	<b>68.095</b>	<b>192.165</b>	<b>3112.5</b>	<b>4197.5</b>
T5	Chilli sole	209.15	22.33	136.52	22.67	7521	803
T11	Pigeonpea + chilli	392.98	13.07	72.54	11.7	2676	89
	<b>Mean</b>	<b>301.065</b>	<b>17.7</b>	<b>104.53</b>	<b>17.185</b>	<b>5098.5</b>	<b>446</b>
T6	Bhindi sole	5.96	20.03	42.09	275.67	2293	7712
T12	Pigeonpea + Bhindi	3.78	17.47	34.48	237	1263	5836
	<b>Mean</b>	<b>4.87</b>	<b>18.75</b>	<b>38.285</b>	<b>237</b>	<b>1778</b>	<b>6774</b>
T7	Clusterbean sole	48.81	79.6	67.22	153.33	3691	6019
T13	Pigeonpea + clusterbean	25.87	67	49.44	135	1831	4743
	<b>Mean</b>	<b>37.34</b>	<b>73.3</b>	<b>58.33</b>	<b>144.165</b>	<b>2761</b>	<b>5381</b>

#### 4.8 Pigeonpea grain equivalent yield

Data in respect of pigeonpea grain equivalent yield, as influenced by different treatments during both the years of study are presented in table 28 and depicted in figure 21.

##### Effect of treatments

During 2000-2001, treatment T<sub>5</sub> being par with treatments T<sub>11</sub> and T<sub>10</sub>, recorded significantly higher pigeonpea grain equivalent yield over other treatments. Treatments T<sub>9</sub>, T<sub>13</sub>, T<sub>1</sub> and T<sub>12</sub> being par, showed significantly higher pigeonpea grain equivalent yields over other treatments (T<sub>4</sub>, T<sub>7</sub>, T<sub>3</sub>, T<sub>6</sub> and T<sub>2</sub>). Treatment T<sub>4</sub> being par with T<sub>7</sub>, documented greater pigeonpea grain equivalent yield over T<sub>3</sub>, T<sub>6</sub> and T<sub>2</sub>. However, differences amongst T<sub>3</sub>, T<sub>6</sub> and T<sub>2</sub> treatments were not significant.

**Table 28: Pigeonpea grain equivalent yield as influenced by different treatments during 2000-2001 and 2001-2002**

Treatment	Grain equivalent yield (Kg ha <sup>-1</sup> )		
	2000-2001	2001-2002	Pooled
T <sub>1</sub> Pigeonpea sole	3121	3027	3094
T <sub>2</sub> Blackgram sole	846	1567	1206
T <sub>3</sub> Soybean sole	1662	1699	1681
T <sub>4</sub> Cowpea sole	2100	3183	2641
T <sub>5</sub> Chilli sole	4150	443	2297
T <sub>6</sub> Bhindi sole	1265	4263	2763
T <sub>7</sub> Clusterbean sole	2036	3321	2679
T <sub>8</sub> Pigeonpea +Black gram	2893	3083	2988
T <sub>9</sub> Pigeonpea + Soybean	3263	2275	2769
T <sub>10</sub> Pigeonpea + Cowpea	3820	3472	3621
T <sub>11</sub> Pigeonpea + Chilli	3850	1963	2907
T <sub>12</sub> Pigeonpea + Bhindi	2983	5154	4069
T <sub>13</sub> Pigeonpea +Clusterbean	3206	4287	3747
SE (m) ±	263	258	167
C.D. (0.05)	739	725	404
<b>GM</b>	<b>2707</b>	<b>2903</b>	<b>2805</b>

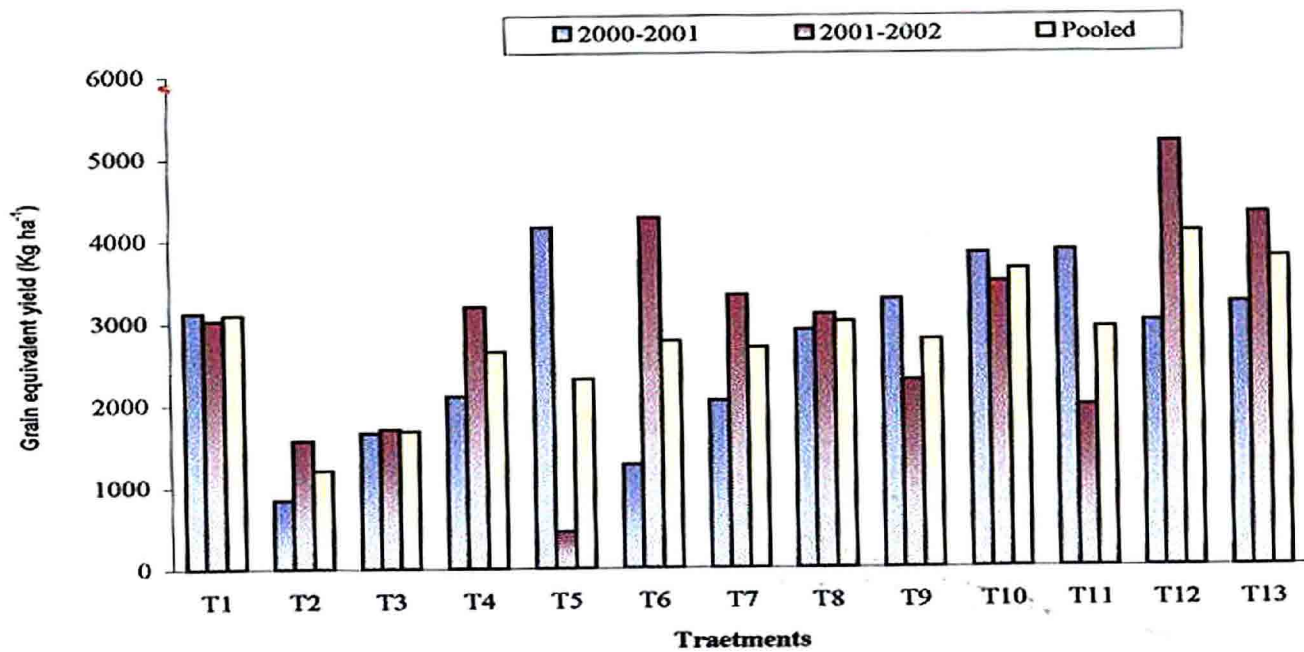


Fig. 21. Pigeonpea grain equivalent yield (Kg ha<sup>-1</sup>) as influenced by different treatments during 2000-2001, 2001-2002 and in pooled analysis

During 2001-2002, treatment T<sub>12</sub> resulted in obtaining higher pigeonpea grain equivalent yield over other treatments. Treatments T<sub>13</sub> and T<sub>6</sub> being par, showed higher pigeonpea grain equivalent yield over other treatments. However, treatment differences amongst T<sub>10</sub>, T<sub>7</sub>, T<sub>4</sub>, T<sub>8</sub>, T<sub>1</sub>, T<sub>9</sub>, T<sub>11</sub>, T<sub>3</sub>, T<sub>2</sub>, T<sub>5</sub> were not significant. In pooled analysis, treatments T<sub>12</sub> and T<sub>13</sub> being par, showed significantly higher pigeonpea grain equivalent yield over other treatments. However, treatment difference between T<sub>13</sub> and T<sub>10</sub> was not significant. Treatments T<sub>1</sub>, T<sub>8</sub>, T<sub>11</sub>, T<sub>9</sub> and T<sub>6</sub> being par, recorded significantly greater pigeonpea grain equivalent yields over T<sub>7</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>3</sub> and T<sub>2</sub>. However, treatment differences amongst T<sub>7</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>3</sub> and T<sub>2</sub> were not evident.

#### **4.9 Economics of treatments**

##### **4.9.1 Gross monetary returns**

Data as regards gross monetary returns per hectare as influenced by different treatments during both the years of study and in pooled analysis are shown in table 29 and figure 22.

##### **Effect of treatments**

During 2000-2001, treatments T<sub>5</sub>, T<sub>10</sub>, T<sub>11</sub>, T<sub>9</sub>, T<sub>1</sub> and T<sub>13</sub> being par registered significantly higher gross monetary returns over other treatments. However, treatment differences among T<sub>11</sub>, T<sub>9</sub>, T<sub>1</sub>, T<sub>13</sub>, T<sub>12</sub> and T<sub>8</sub> were not significant. Treatments T<sub>7</sub>, T<sub>4</sub> and T<sub>3</sub> being par, recorded significantly higher gross monetary returns per hectare over the treatments T<sub>6</sub> and T<sub>2</sub> treatments. However, treatment difference between T<sub>2</sub> and T<sub>6</sub> did not reach to the level of significance.

During 2001-2002, treatment T<sub>12</sub> documented significantly higher gross monetary returns over other treatments. However, treatment differences between T<sub>13</sub>, T<sub>6</sub> and T<sub>9</sub>, T<sub>11</sub> were not significant. Treatments T<sub>6</sub>, T<sub>10</sub>, T<sub>1</sub> and T<sub>8</sub> being par, exhibited higher gross monetary returns over other treatments. However, treatment differences among T<sub>8</sub>, T<sub>7</sub> and T<sub>4</sub> and T<sub>9</sub> were not significant. The lowest gross monetary returns were recorded with treatment T<sub>5</sub>. In pooled analysis, treatments T<sub>12</sub>, T<sub>13</sub> and T<sub>10</sub> being par resulted in recording significantly greater gross monetary returns over other treatments. Treatment differences between T<sub>1</sub> and T<sub>8</sub>, amongst T<sub>11</sub>, T<sub>9</sub> and T<sub>6</sub> being par registered higher gross monetary returns over T<sub>7</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>3</sub> and T<sub>2</sub>. However, treatment

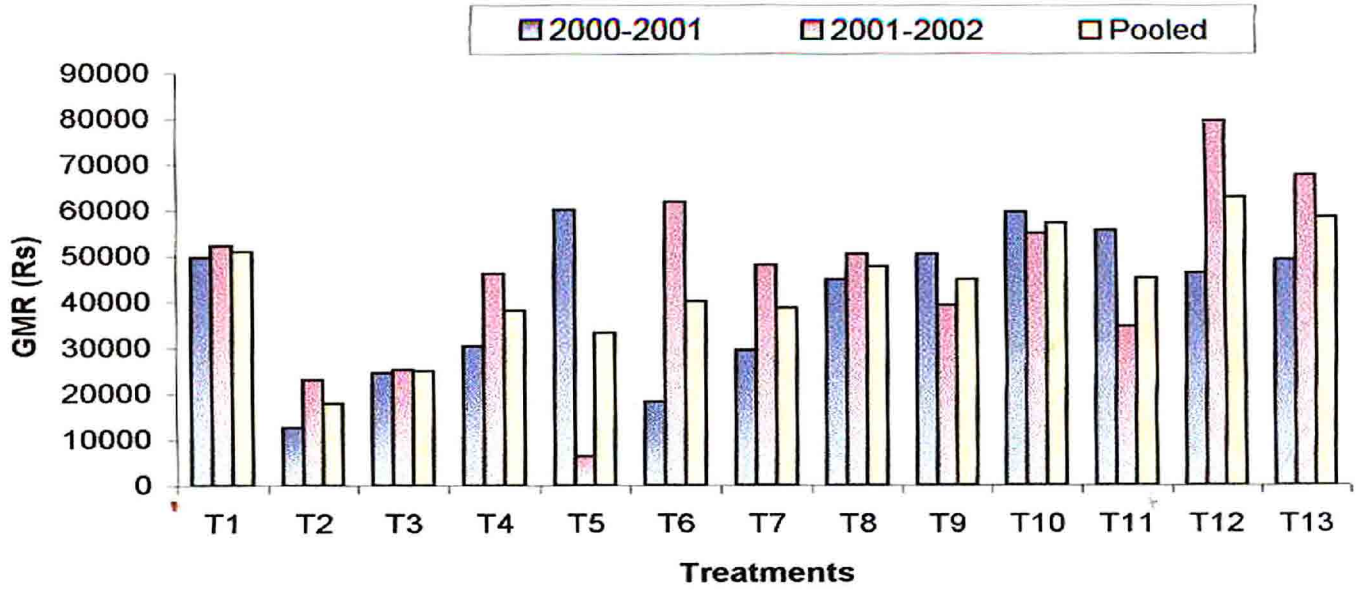


Fig. 22. Gross monetary returns ha<sup>-1</sup> as influenced by different treatments during 2000-2001, 2001-2002 and pooled analysis

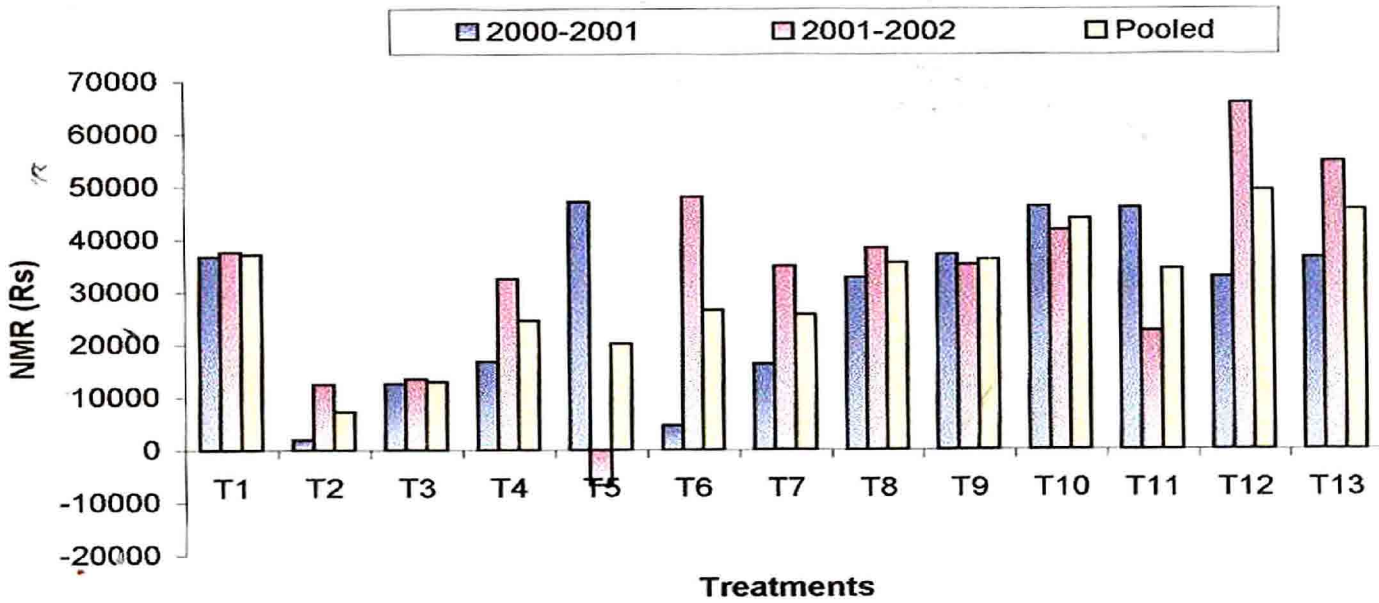


Fig.23. Net monetary returns ha<sup>-1</sup> as influenced by different treatments during 2000-2001 and 2001-2002

differences amongst T<sub>6</sub>, T<sub>7</sub>, T<sub>9</sub> and T<sub>5</sub> were not significant. The lowest gross monetary returns were observed with treatments T<sub>5</sub> and T<sub>2</sub>.

**Table 29: Gross monetary returns, net monetary returns, benefit: cost ratio as influenced by different treatments during 2000-2001 and 2001-2002**

Treatment	Gross Returns (Rs)			Net Returns (Rs)			Benefit : Cost Ratio		
	2000-2001	2001-2002	Pooled	2000-2001	2001-2002	Pooled	2000-2001	2001-2002	Pooled
T <sub>1</sub> Pigeonpea Sole	49755.4	52281.52	51018.61	36612.15	39138.57	37875.36	2.79	2.98	2.88
T <sub>2</sub> Blackgram sole	12637.23	23122.53	17879.88	1953.58	12439.28	7196.63	0.18	1.16	0.67
T <sub>3</sub> Soybean sole	24618.2	25372.47	24995.34	12665.82	13420.09	13042.95	1.06	1.12	1.09
T <sub>4</sub> Cowpea sole	30445.17	46148.67	38296.92	16741.92	32445.42	24593.67	1.22	2.37	1.8
T <sub>5</sub> Chilli sole	60175	6423.5	33299.25	47036.58	-6714.93	20160.82	3.58	0.51	2.05
T <sub>6</sub> Bhindi sole	18347.33	61813.5	40080.42	4695.68	48161.86	26428.77	0.34	3.53	1.94
T <sub>7</sub> Clusterbean sole	29526.84	48154.5	38842.67	16253.58	34881.25	25567.42	1.23	2.63	1.93
T <sub>8</sub> Pigeonpea +Black gram	44838.94	50451.37	47645.15	32684.01	38296.45	35490.23	2.69	3.15	2.92
T <sub>9</sub> Pigeonpea + Soybean	50456.27	39268.23	44862.26	37268.59	26080.56	31674.57	2.83	1.98	2.4
T <sub>10</sub> Pigeonpea + cowpea	59582.37	55020.23	57301.3	46127.45	41565.32	43846.38	3.43	3.09	3.26
T <sub>11</sub> Pigeonpea + chilli	55673.07	34780.13	45206.6	43048.02	22195.09	32621.55	3.42	1.76	2.59
T <sub>12</sub> Pigeonpea + Bhindi	46257.3	79403.53	62830.42	32636.78	65783.02	49209.9	2.4	4.83	3.61
T <sub>13</sub> Pigeonpea + clusterbean	49275.11	67632	58453.55	36353.52	34710.42	45531.97	2.81	4.23	3.52
SE (m) ±	3831.21	3671.95	2368.26	3831.15	3871.95	2368.89	0.29	0.3	0.18
C.D. (0.05)	11183.07	11301.97	6899.41	11182.88	11301.97	6899.48	0.84	0.87	0.52
G.M.	40891.4	45374.78	43131.72	28005.98	65294.79	30249.25	2.152308	2.564615	2.358462

#### 4.9.2 Net monetary returns

Data in respect of net monetary returns as influenced by different treatments during both the years of investigation are presented in table 29 and in figure 23.

## **Effect of treatments**

During 2000-2001, treatments T<sub>5</sub>, T<sub>10</sub> and T<sub>11</sub> being par, registered significantly higher net monetary returns over other treatments. Treatments T<sub>9</sub>, T<sub>1</sub>, T<sub>13</sub>, T<sub>8</sub> and T<sub>12</sub> being par, documented higher net monetary returns over other treatments. However, treatment differences between T<sub>4</sub> and T<sub>7</sub> and amongst T<sub>3</sub>, T<sub>6</sub> and T<sub>2</sub> were not evident. The lowest net monetary returns were recorded with the treatment T<sub>2</sub>.

During 2001-2002, treatment T<sub>12</sub> recorded significantly higher net monetary returns over other treatments. The second best position was recorded by treatment T<sub>6</sub>, which was at par with T<sub>10</sub>. Treatments T<sub>10</sub>, T<sub>1</sub>, T<sub>8</sub>, T<sub>7</sub> and T<sub>13</sub> being par, resulted in higher amount of net returns over other treatments (T<sub>4</sub>, T<sub>9</sub>, T<sub>11</sub>, T<sub>3</sub>, T<sub>2</sub> and T<sub>5</sub>). However, treatment differences amongst T<sub>4</sub>, T<sub>9</sub>, T<sub>11</sub> and T<sub>3</sub>, T<sub>2</sub> and T<sub>5</sub> were not significant. The lowest monetary returns were observed with the treatment T<sub>5</sub>.

In pooled analysis, significantly higher net monetary returns were recorded with the treatment T<sub>12</sub>, which was at par with T<sub>13</sub>. Treatment T<sub>10</sub> being par with T<sub>1</sub>, showed higher net monetary returns over other treatments. Treatment differences amongst T<sub>1</sub>, T<sub>8</sub>, T<sub>11</sub>, T<sub>9</sub> and T<sub>6</sub>, T<sub>7</sub>, T<sub>4</sub>, T<sub>5</sub> and between T<sub>3</sub> and T<sub>2</sub> were not evident. Lowest performance as regards net monetary returns was observed with treatment T<sub>2</sub>.

### **4.9.3 Benefit : Cost ratio**

B:C ratio as influenced by different treatments during both the years of study and in pooled analysis are presented in table 29 as depicted in figure 24.

During 2000-2001, treatments T<sub>5</sub>, T<sub>10</sub> and T<sub>11</sub> being par, resulted in higher B:C ratios, which were significantly greater over other treatments. Treatments T<sub>9</sub>, T<sub>13</sub>, T<sub>11</sub> and T<sub>8</sub> being par, recorded significantly greater values of B:C ratios over other treatments. However, treatment differences amongst T<sub>7</sub>, T<sub>9</sub> and T<sub>3</sub> and between T<sub>6</sub> and T<sub>2</sub> were not significant. The lowest B:C ratio was noted with the treatment T<sub>2</sub>.

During 2001-2002, treatment T<sub>12</sub> being par with T<sub>13</sub>, documented highest B:C ratio over other treatments. The second best position was observed with treatment T<sub>13</sub>. However, the lowest B : C ratio was documented with treatment T<sub>5</sub>.

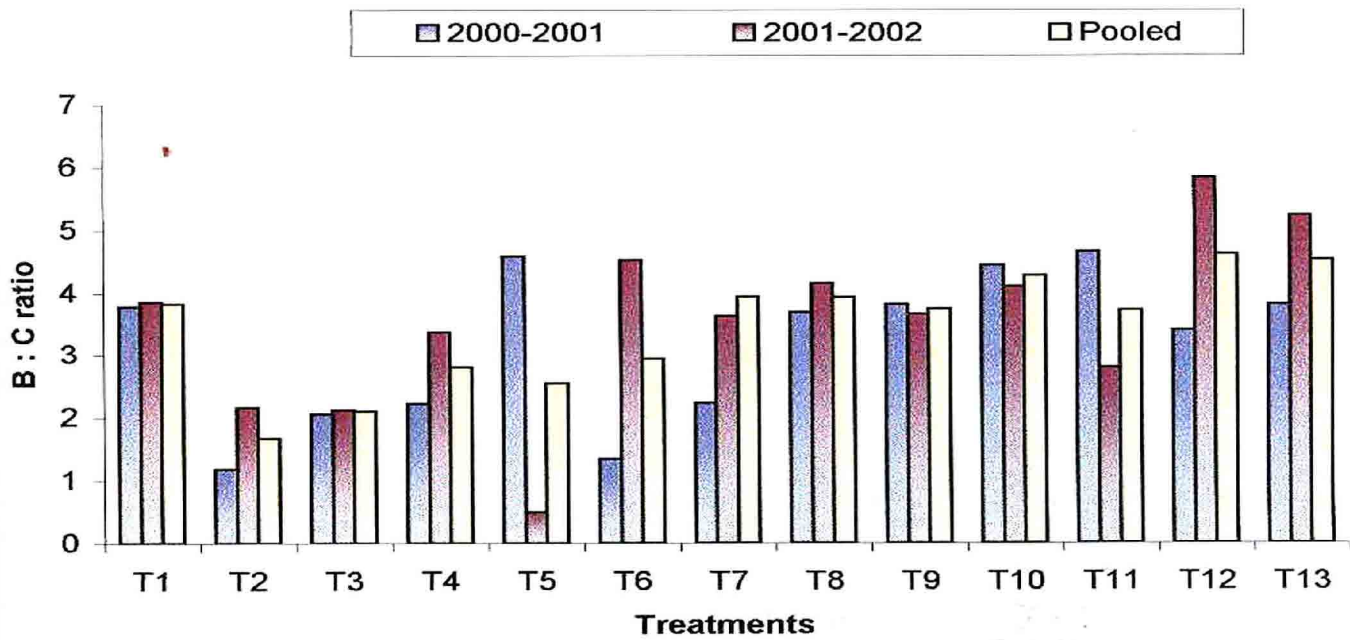


Fig. 24. Benefit : cost ratio as influenced by different treatments during 2000-2001 , 2001-2002 and pooled analysis

In pooled analysis similar was the trend of the results.

#### 4.10 Evaluation of intercropping treatments

Data recorded on land equivalent ratio, aggressivity and relative crowding coefficient as influenced by different treatments during both the years of experimentation are presented in table 30 and depicted in figures 25, 26, 27.

##### 4.10.1 Land Equivalent Ratio (LER)

The mean maximum LER was greater during first year (1.35) than second year (1.19).

##### Effects of treatments

The values of LER were not affected due to treatments during 2000-2001. However, during 2001-2002, treatment T<sub>12</sub> being par with T<sub>8</sub>, T<sub>13</sub>, T<sub>9</sub> and T<sub>10</sub>, recorded higher LER which was significantly superior over the treatment T<sub>11</sub>.

**Table 30: LER, Aggressivity and RCC as influenced by different treatments during 2000-2001 and 2001-2002**

Treatment	Land equivalent ratio (LER)	Aggressivity (A)			Relative Crowding Coefficient (RCC) K=Kab X Kba					
		2000-2001	2001-2002	Mean	2000-2001	2001-2002	Mean			
T <sub>8</sub>	Pigeonpea + Black gram	1.52	1.35	1.44	-0.30	-0.24	-0.27	1.39	0.69	1.04
T <sub>9</sub>	Pigeonpea + Soybean	1.43	1.20	1.32	-0.29	-0.15	-0.22	0.56	0.11	0.34
T <sub>10</sub>	Pigeonpea + Cowpea	1.50	1.11	1.31	-0.15	-0.09	-0.12	0.60	0.08	0.34
T <sub>11</sub>	Pigeonpea + Chilli	1.12	0.72	0.92	-0.04	0.16	0.06	0.13	0.01	0.07
T <sub>12</sub>	Pigeonpea + Bhindi	1.28	1.40	1.34	-0.11	-0.31	-0.21	1.08	0.43	0.76
T <sub>13</sub>	Pigeonpea + Clusterbean	1.24	1.35	1.30	-0.12	-0.36	-0.24	0.25	0.04	0.15
SE (m) ±		0.07	0.11		0.07	0.07		0.47	0.31	
C.D. (0.05)		N.S	0.36		N.S	0.22		N.S	N.S	
<b>GM</b>		<b>1.35</b>	<b>1.19</b>		<b>-0.17</b>	<b>-0.18</b>		<b>0.67</b>	<b>0.23</b>	

##### 4.10.2 Aggressivity (A)

Mean aggressivity was greater during first year of experimentation (-0.17) than second year (-0.18).

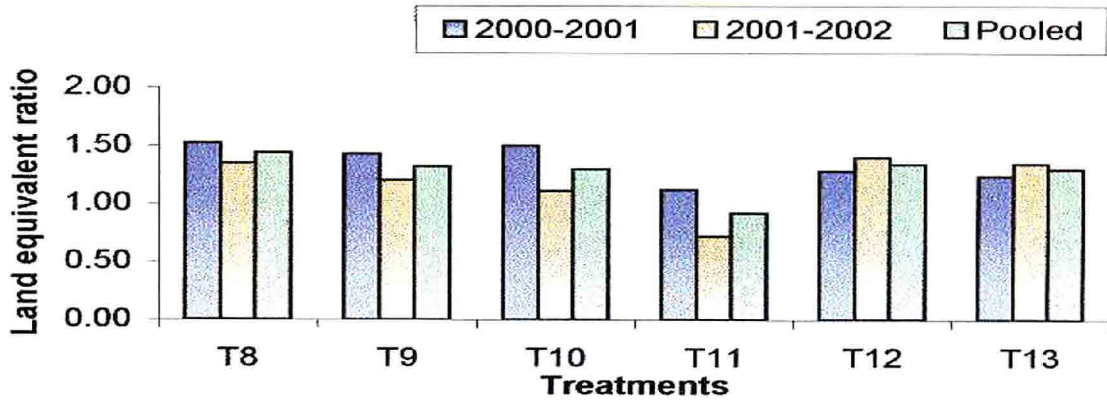


Fig. 25. Land equivalent ratio as influenced by different treatments during 2000-2001 and 2001-2002

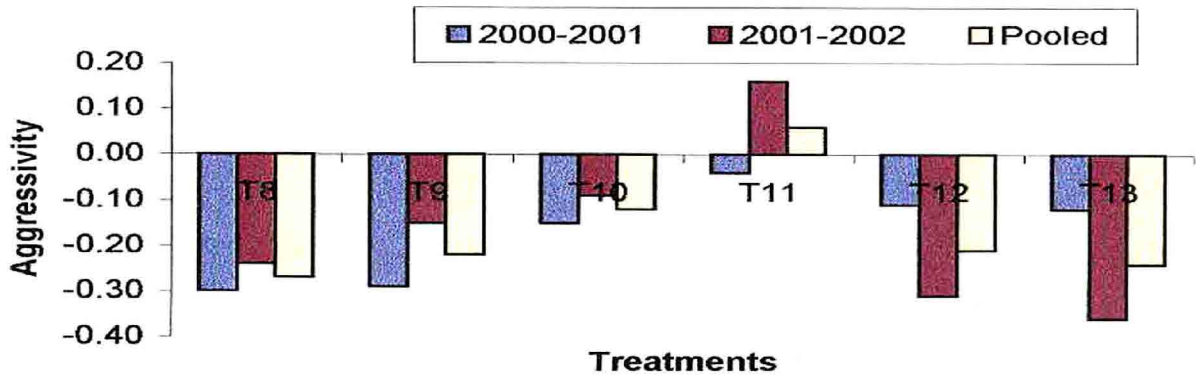


Fig. 26. Aggressivity as influenced by different treatments during 2000-2001 and 2001-2002

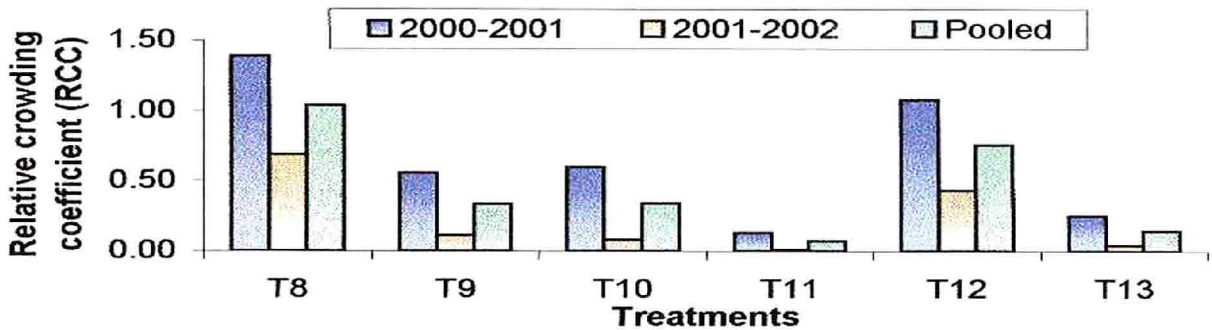


Fig.27. Relative crowding coefficient (RCC) as influenced by different treatments during 2000-2001 and 2001-2002

### **Effect of treatments**

During 2000-2001, there was no significant impact on aggressivity due to different treatments.

However, during 2001-2002, the highest value of aggressivity was recorded with treatment T<sub>11</sub>.

### **4.10.3 Relative crowding coefficient (RCC)**

The mean value of RCC was lesser during second year (0.23) of experimentation than first year (0.67).

### **Effect of treatments**

RCC ( $K=K_{ab} \times K_{ba}$ ) was not affected significantly due to any of the treatments tried under study during both the years of experimentation.

### **4.10.4 Sustainable yield Index (SYI) and sustainable value index (SVI)**

There was a significant impact of different treatments on both sustainable yield index and sustainable value index (Table 31 and figure 28).

### **Effect of treatments**

Treatment T<sub>8</sub> being par with treatments T<sub>1</sub>, T<sub>9</sub> and T<sub>3</sub> recorded significantly highest SYI over remaining treatments. Treatment T<sub>6</sub> and T<sub>5</sub> being par documented significantly lowest values of SYI. Other treatments recorded intermediate positions regarding SYI.

Treatment T<sub>9</sub> being par with treatments T<sub>8</sub>, T<sub>10</sub>, T<sub>1</sub>, T<sub>3</sub> and T<sub>13</sub> registered significantly highest SVI over rest of the treatments. Treatment T<sub>13</sub> being par with treatment T<sub>12</sub> recorded significantly lowest magnitude of SVI, which was negative. Other treatments documented intermediate positions regarding SVI.

### **Weed dry matter study**

Data on weed dry matter as affected by different treatments in both the years of investigation are shown in table 32 and depicted in figure 29. In general, weed dry matter was more during first year of study as compared to second year of study.

### **Effect of treatments**

During 2000-2001, treatments T<sub>6</sub>, T<sub>7</sub>, T<sub>13</sub> being par recorded significantly higher dry matter production m<sup>-2</sup> of weeds over other treatments. Treatments T<sub>5</sub>, T<sub>1</sub>, T<sub>12</sub> and T<sub>11</sub> being par, resulted in production of higher dry matter of weeds, which were significantly greater over T<sub>8</sub>, T<sub>9</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>3</sub> and T<sub>10</sub>. The

**Table 31 : Sustainable yield index and sustainable value index as influenced by different treatments**

Treatments		Sustainable Yield Index (SYI)	Sustainable Value Index (SVI)
T <sub>1</sub>	Pigeonpea Sole	0.87 (62.06)	0.79 (53.19)
T <sub>2</sub>	Blackgram sole	0.54 (32.74)	0.16 (9.07)
T <sub>3</sub>	Soybean sole	0.82 (57.38)	0.69 (45.84)
T <sub>4</sub>	Cowpea sole	0.67 (42.66)	0.54 (32.80)
T <sub>5</sub>	Chilli sole	0.13 (7.65)	- 0.15 (- 8.59)
T <sub>6</sub>	Bhindi sole	0.29 (17.14)	0.09 (5.18)
T <sub>7</sub>	Clusterbean sole	0.62 (39.16)	0.48 (29.38)
T <sub>8</sub>	Pigeonpea + black gram	0.88 (64.14)	0.85 (61.60)
T <sub>9</sub>	Pigeonpea + Soybean	0.85 (60.17)	0.87 (62.61)
T <sub>10</sub>	Pigeonpea + Cowpea	0.79 (52.36)	0.79 (51.96)
T <sub>11</sub>	Pigeonpea + Chilli	0.39 (23.29)	0.48 (29.01)
T <sub>12</sub>	Pigeonpea + bhindi	0.46 (27.37)	0.50 (29.87)
T <sub>13</sub>	Pigeonpea + Clusterbean	0.68 (47.06)	0.67 (44.59)
SE (m) ±		0.06	0.08
C.D. (0.05)		0.19	0.24
<b>GM</b>		<b>0.61</b>	<b>0.54</b>

(Figures in parentheses are arcsine transformations)

lowest amount of dry matter production of weed was recorded with treatments T<sub>10</sub>, T<sub>3</sub> and T<sub>4</sub>.

During 2001-2002, treatment T<sub>5</sub> produced higher dry matter of weeds, which was significantly superior over other treatments. Treatments T<sub>11</sub>, T<sub>7</sub> and T<sub>6</sub> being par, showed greater amount of dry matter of weeds over other

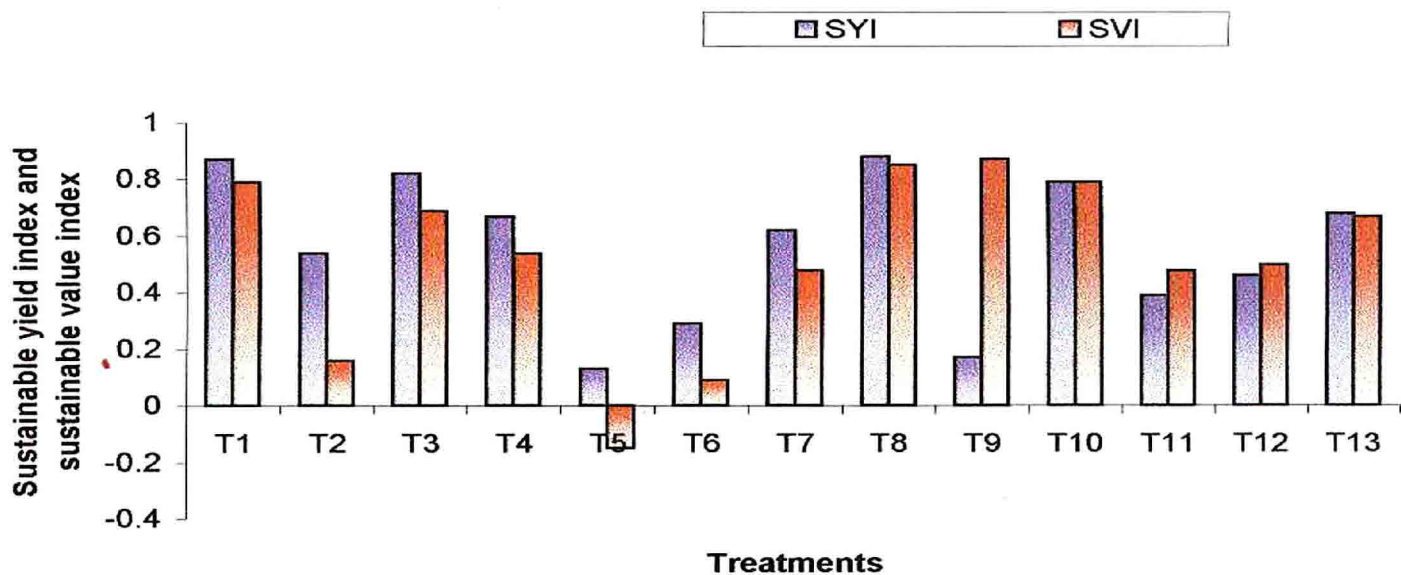


Fig. 28. Sustainable yield index and sustainable value index as influenced by different treatments during 2000-2001 and 2001-2002

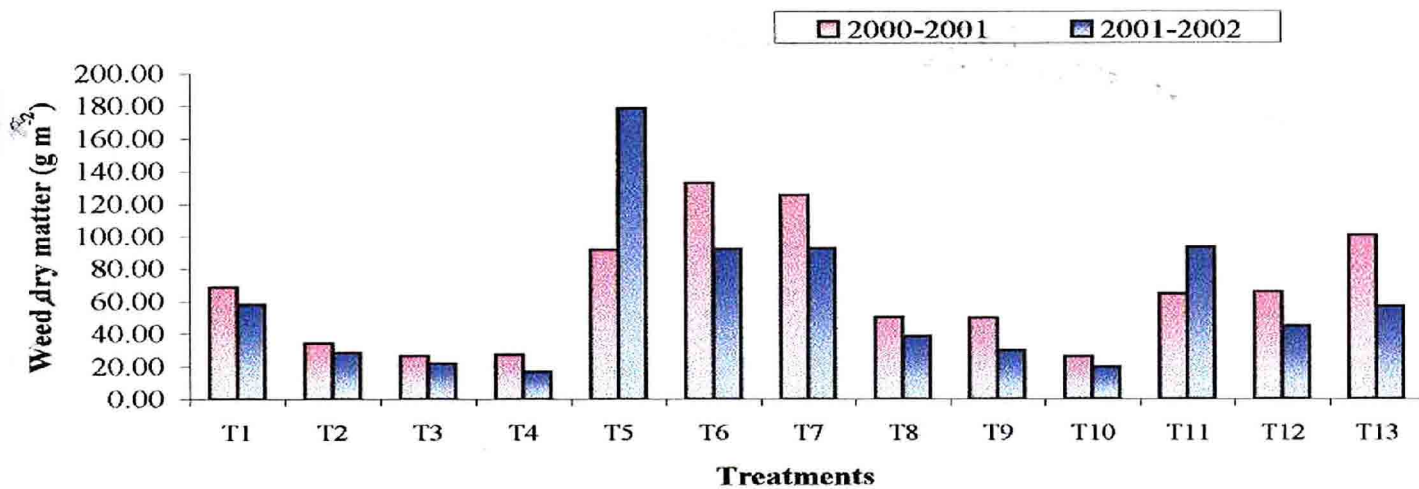


Fig. 29. Weed dry matter ( $\text{g m}^{-2}$ ) as influenced by different treatments during 2000-2001 and 2001-2002

treatments. Treatments T<sub>4</sub>, T<sub>10</sub> and T<sub>3</sub> recorded remarkably lower values of dry matter production of weeds.

**Table 32: Weed dry matter as influenced by different treatments (2000-2001 and 2001-2002)**

		(g m <sup>-2</sup> )		
Treatment		Weed dry weight		
		2000-2001	2001-2002	Mean
T <sub>1</sub>	Pigeonpea Sole	68.90	57.88	63.39
T <sub>2</sub>	Blackgram sole	34.07	28.23	31.15
T <sub>3</sub>	Soybean sole	26.31	21.84	24.08
T <sub>4</sub>	Cowpea sole	27.27	16.55	21.91
T <sub>5</sub>	Chilli sole	91.82	178.74	135.28
T <sub>6</sub>	Bhindi sole	132.86	92.41	112.64
T <sub>7</sub>	Clusterbean sole	125.44	92.60	109.02
T <sub>8</sub>	Pigeonpea +Black gram	50.10	38.45	44.28
T <sub>9</sub>	Pigeonpea + Soybean	49.64	29.80	39.72
T <sub>10</sub>	Pigeonpea + Cowpea	26.24	19.40	22.82
T <sub>11</sub>	Pigeonpea + chilli	64.51	93.40	78.96
T <sub>12</sub>	Pigeonpea + Bhindi	65.92	44.60	55.26
T <sub>13</sub>	Pigeonpea + Clusterbean	100.71	56.80	78.76
SE (m) ±		12.20	11.40	
C.D. (0.05)		35.62	33.27	
<b>G.M.</b>		<b>66.45</b>	<b>59.28</b>	

### Soil fertility status

The data on fertility status of experimental plot in terms of available nutrients at the end of two years of experimentation as influenced by different treatments is presented in the table 33 and figures 30, 31 and 32.

**Table 33 : Soil fertility status for available nutrients after two years of experimentation**

Treatments		(Kg ha <sup>-1</sup> )					
		Avail N		Avail P <sub>2</sub> O <sub>5</sub>		Avail K <sub>2</sub> O	
		Final status	Balance	Final status	Balance	Final status	Balance
T <sub>1</sub>	Pigeonpea Sole	226.94	32.46	9.64	-10.06	284.42	28.74
T <sub>2</sub>	Blackgram sole	208.95	14.47	19.21	-0.49	302.41	46.73
T <sub>3</sub>	Soybean sole	231.75	37.27	17.75	-1.95	279.61	23.93
T <sub>4</sub>	Cowpea sole	222.79	28.31	18.39	-1.31	288.57	32.89
T <sub>5</sub>	Chilli sole	204.74	10.26	10.38	-9.32	306.62	50.94
T <sub>6</sub>	Bhindi sole	187.63	-6.85	19.16	-0.54	323.73	68.05
T <sub>7</sub>	Clusterbean sole	217.75	23.27	11.78	-7.92	293.61	37.93
T <sub>8</sub>	Pigeonpea + Black gram	224.28	29.8	7.05	-12.65	287.08	31.4
T <sub>9</sub>	Pigeonpea + Soybean	216.29	21.81	10.01	-9.69	295.07	39.39
T <sub>10</sub>	Pigeonpea + cowpea	230.17	35.69	8.62	-11.08	281.19	25.51
T <sub>11</sub>	Pigeonpea + chilli	209.17	14.69	9.55	-10.15	301.48	45.8
T <sub>12</sub>	Pigeonpea + Bhindi	202.88	8.4	9.08	-10.62	308.38	52.7
T <sub>13</sub>	Pigeonpea + clusterbean	223.88	29.4	9.36	-10.34	287.48	31.8
<b>Initial</b>		<b>194.48</b>		<b>19.7</b>		<b>255.68</b>	

The highest nutrient balance of available nitrogen in the soil was recorded with the treatment of T<sub>3</sub> followed by treatments T<sub>10</sub> and T<sub>1</sub>. The lowest nutrient balance of available nitrogen was observed with the treatments T<sub>6</sub>, T<sub>12</sub> and T<sub>5</sub>. Other treatments recorded intermediate positions.

In general, all the treatments recorded negative balance of available phosphorus in the soil after two years of investigations. All the intercropping treatments recorded higher negative balance than their respective sole crops.

The highest nutrient balance of available potassium in the soil was recorded with the treatment T<sub>6</sub> followed by T<sub>5</sub> and T<sub>12</sub>, while the lowest nutrient balance of available potassium was recorded with the treatments of T<sub>3</sub>, T<sub>10</sub> and T<sub>1</sub>.

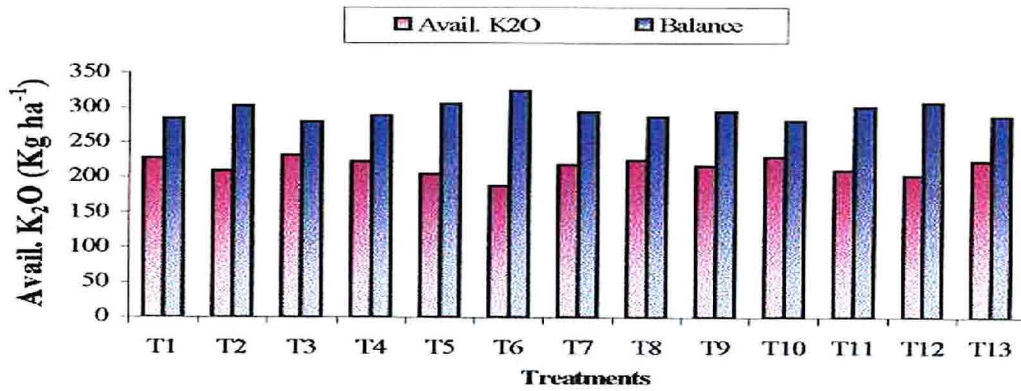


Fig. 30. Available N status ( $\text{Kg ha}^{-1}$ ) and its balance after two years of experiment as influenced by different treatments

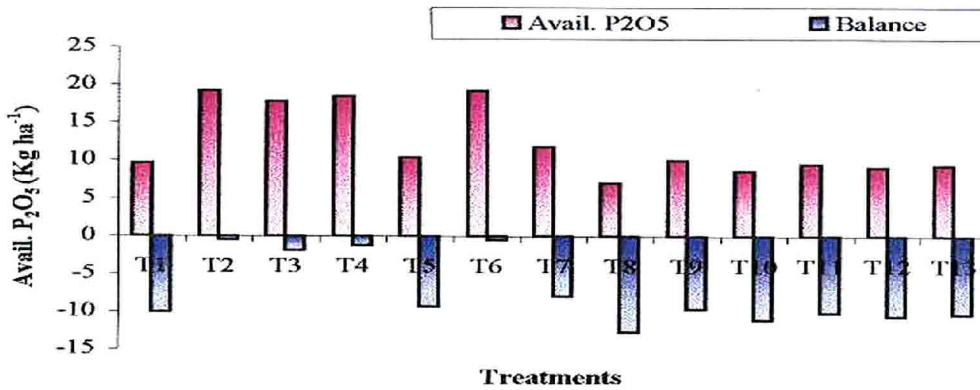


Fig. 31. Available  $\text{P}_2\text{O}_5$  ( $\text{Kg ha}^{-1}$ ) status and its balance after two years of experiment as influenced by different treatments

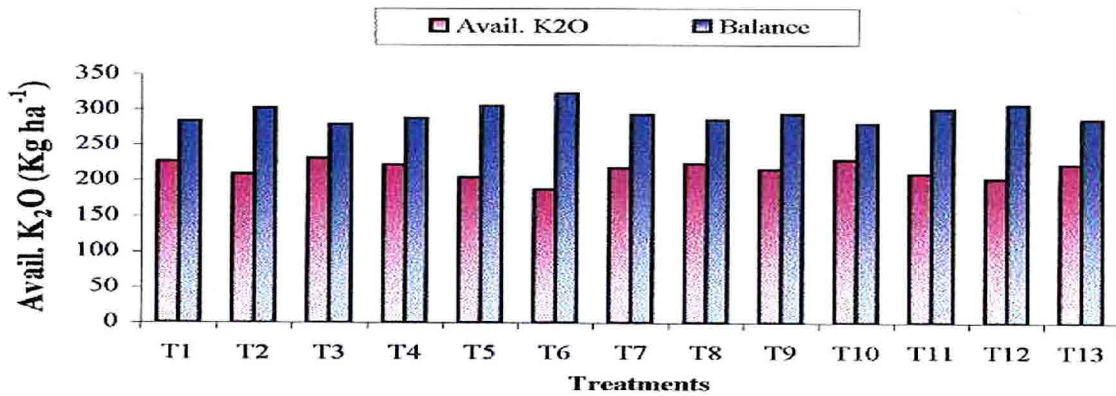


Fig. 32. Available  $\text{K}_2\text{O}$  ( $\text{Kg ha}^{-1}$ ) status and its balance after two years of experiment as influenced by different treatments

## Correlation and path analysis studies

Table 34 revealed the direct and indirect effects of various growth and yield attributing characters on grain yield plant<sup>-1</sup> in sole pigeonpea pooled over two years. Direct effect of leaves at 90 DAS, leaf area at 60 DAS, TDM at 60 DAS on grain yield were negative with high magnitude. For height at 60 DAS, leaves at 60 DAS and TDM at 120 DAS the direct effects were positive. Maximum indirect effects on grain yield plant<sup>-1</sup> for all above mentioned characters via number of pods plant<sup>-1</sup> were positive. The direct effect of number of pods plant<sup>-1</sup> was negative and its total indirect effect was positive with higher magnitude than direct effect. The direct effect of number of grains plant<sup>-1</sup> was positive and highest among all characters while the indirect effect was negative with lower magnitude. The residual effect was 0.35.

**Table 34 : Correlation and path analysis**

Character	Direct effect	Total indirect effect	Maximum indirect Effect	Phenotypic correlation
Height 60 DAS	0.024	-0.144	0.216	-0.121
Leaves 60 DAS	0.376	-0.628	0.435	-0.251
Leaves 90 DAS	-0.153	-0.205	0.952	<b>-0.357*</b>
Leaf area 60 DAS	-0.501	0.117	0.676	<b>-0.385*</b>
TDM 60 DAS	-0.234	0.043	0.084	-0.191
TDM 120 DAS	0.187	-0.238	0.259	-0.051
No. Of pods plant <sup>-1</sup>	-1.526	2.177	1.989	<b>0.652**</b>
No. grains plant <sup>-1</sup>	2.029	-1.31	0.231	<b>0.719**</b>

R = 0.304 (5 %) and 0.393 (1%) and Residual =0.35

The correlation studies expressed negative correlation for height 60 at DAS, leaves at 60 DAS, leaves at 90 DAS, leaf area at 60 DAS, TDM at 60 DAS and TDM at 120 DAS with grain yield plant<sup>-1</sup>. Only leaves at 90 DAS and leaf area 60 DAS were negatively significant both at 5% and 1%. However, number of pods plant<sup>-1</sup> and number of grains plant<sup>-1</sup> were positively correlated and highly significant with grain yield plant<sup>-1</sup>.

# *DISCUSSION*

## **CHAPTER V**

### **DISCUSSION**

The results of the investigation reported in the previous chapter are discussed in the present chapter under appropriate headings.

#### **5.1 Soil**

Perusal of data from table 1 indicated that the soil from experimental plot was clayey in texture; low in total nitrogen, organic carbon, and available nitrogen and phosphorous and marginally high in available potassium. The soil reaction was slightly alkaline.

#### **5.2 Cropping history of the experimental site**

The history of last five years revealed that the single cropping was followed during each year with cropping intensity of 100 per cent. As the crop of dhaincha was grown during 1999-2000, the fertility of the experimental plot was observed at higher level.

#### **5.4 Crop growth and development**

Crop growth is a dynamic process and is affected by continuous interactions occurring between environment and physiological processes of plant.

##### **5.4.1 General growth of pigeonpea**

The growth of pigeonpea crop in general could be realised if series of physiological processes involved are seen critically at various growth stages. The growth and yield attributes recorded at various growth stages showed that pigeonpea crop could be divided into three growth phases viz., 1) Early phase i.e. first 60 days, 2) Grand growth phase i.e. 60-105 days and 3) Reproductive phase i.e. 105 days to maturity.

The early growth phase started from emergence to 60 days in which growth was slow in respect of plant height, leaf area and total dry mater per plant. At this stage, crop attained height of 82.43 cm (42.42 per cent), leaf area of 406.38 cm<sup>2</sup> (14.10 per cent) and 48.91 g (28.11 per cent) total dry matter production per plant during 2000-2001. The corresponding figures for the second year were 113.25 cm (46 per cent), 500.06 cm<sup>2</sup> (11.76 per cent) and 20.85 g (9.44 per cent) respectively. The grand growth phase occurred during

60 to 105 DAS. By the end of this phase, the plant attained the height of 136.54 cm (70.27 per cent), 26.97 branches (79.98 per cent), leaf area of 2142.29 cm<sup>2</sup> (74.30 per cent) and total dry matter of 133.69 g per plant (76.83 per cent). The corresponding figures for the year 2001-2002 were 202.73 cm (82.34 per cent), 29.16 (78.94 per cent), 1654.36 cm<sup>2</sup> (61.31 per cent) and 90.95 g (41.19 per cent) respectively.

At the end of grand growth stage, flowering started. Flowering initiated around 105 DAS, attained 50 per cent flowering at 110.43 DAS during 2000-2001 and at 127.62 DAS during 2001-2002 (Table ). During this phase plant attained the maximum value in respect of height of plant, number of branches, number of leaves, leaf area and total dry matter production per plant during both the years of study.

In brief, 70 to 100 per cent of the maximum values of plant characters i.e. plant height; number of branches and total dry matter were attained up to 165 DAS. After 165 DAS, the plant characters, particularly leaf area and total dry matter production per plant decreased due to leaf senescence towards crop maturity. The pod development was subsequently increased from 165 DAS. The crop matured at 176.71 DAS during 2000-2001 and at 207.70 DAS during 2001-2002.

#### **5.4.2 General growth of different intercrops**

Growth of different intercrops was observed and described in different phases.

##### **5.4.2.1 Blackgram**

The life cycle of blackgram (var. TAU-1) can be divided into different growth stages viz., i) early growth phase, ii) grand growth phase and iii) reproductive growth phase. Early growth phase started from sowing to 30 DAS where growth of crop was slow in respect of plant height, number of leaves and total dry matter. However, satisfactory growth was noticed in these characters up to 60 DAS. This stage can be classified as grand growth stage.

The crop, after completion of early phase attained plant height of 13.68 cm (29.14 per cent), 1.21 branches (22.58 per cent), 2.66 leaves (19.92 per cent) and 3.79 g of total dry matter (30.49 per cent) per plant during 2000-2001. The corresponding figures for 2001-2002 were 14.95 cm (35.19 per cent),

4.63 (24.89 per cent), 3.16 (13.39 per cent) and 3.96 g (51.77 per cent) respectively. At the end of grand growth i.e. after 45 DAS, the crop attained plant height of 33.60 cm (71.57 per cent), 3.89 branches (62.74 per cent), 7.72 leaves (80.92 per cent) and 6.11 g of total dry matter (85.69 per cent) per plant during 2000-2001. The corresponding figures for 2001-2002 were 32.47 cm (76.44 per cent), 4.63 (70.69 per cent), 8.87 (100 per cent) and 6.67 g (87.19 per cent) respectively.

Flowering initiated on 38 DAS and 42 DAS during 2000-2001 and 2001-2002 respectively. Pod formation was noticed 45 DAS and rapid pod development occurred at 60 DAS. During 2000-2001, 2-3 days variation was noticed in each growth phase of the crop which ultimately resulted in delaying of maturity of the crop as compared to previous year. The crop matured at 68 DAS and 76 DAS during first and second year of study respectively.

#### **5.4.2.2 Soybean**

The growth of soybean (var. JS-335) can be divided into three growth phase viz. 1) early phase i.e. 0-30 DAS, 2) grand growth i.e. 30-60 DAS and 3) reproductive phase i.e. 60 days onward upto maturity.

During 2000-2001 after completion of early phase the soybean crop attained height of 26.04 cm (28.03 per cent) , 1.25 branches (31.25 per cent) , 2.54 leaves (24.45 per cent) and 2.61 g of total dry matter (14.20 per cent) per plant. The corresponding figures for the year 2001-2002 were 24.82 cm (27.87 per cent), 1.56 (34.82 per cent), 4.48 (331.91 per cent) and 3.15 g (19.80 per cent) respectively. At the end of grand growth phase, during first year the crop attained plant height of 81.10 cm (87.30 per cent), 2.99 branches (74.75 per cent), 5.64 leaves (67.85 per cent) and 9.71 g of total dry matter (64.73 per cent) per plant. During second year, the corresponding figures were 69.84 cm (78.19 per cent), 3.08 (68.75 per cent), 13.35 (95.09 per cent) and 13.36 g (62.66 per cent) respectively.

Flowering initiated at 36 and 38 DAS respectively during first and second year. The corresponding figures for crop maturity were 96 and 105 DAS.

Pod formation occurred during 60-75 DAS and rapid pod development occurred during 75-90 DAS during 2000-2001. Similar trend of results was

observed with little variation of 2-3 days in each growth phase during 2001-2002.

#### **5.4.2.3 Cowpea**

Cowpea (var. Pusa Komal) is a rapid growing crop and its growth is categorized in three growth phases similar to soybean crop.

At the end of early phase i.e. 30 DAS, the crop attained plant height of 14.19 cm (23.64 per cent), 3.32 branches (46.30 per cent), 6.38 leaves (16.57 per cent) and 5.45 g of total dry matter (28.94 per cent) per plant during 2000-2001. The corresponding figures for the year 2001-2002 were 14.82 cm (24.32 per cent), 3.67 (76.25 per cent), 7.53 (90.77 per cent) and 4.72 g (67.85 per cent) respectively. Initiation of flowering was at 42 and 45 DAS during respective years of study. The crop was harvested after 97 and 105 DAS respectively during two years of study when the last plucking was completed.

#### **5.4.2.4 Chilli**

During both the years of study, chilli crop (var. Jayanti) showed continuous and almost uniform growth regarding plant height, number of branches, number of leaves and total dry matter per plant. Therefore, can be differentiated into 0-30 DAS as early growth phase, 30-60 DAS as grand growth phase, 60-90 DAS as flowering, 90-120 fruit development and 120 DAS up to harvesting as maturity phase. But the crop achieved its maximum values for different growth parameters up to 150 DAP.

Flowering initiated 47 and 52 DAT during 2002-2001 and 2001-2002 respectively. The chilli crop performed better during 2000-2001 as compared to 2001-2002.

#### **5.4.2.5 Bhindi**

Similar to cowpea, differentiation of growth of bhindi crop (var. Parbhani Kranti) was done in three different growth phases viz. 1) early growth phase i.e. first 30 days, 2) grand growth phase i.e. 30-60 DAS and 3) reproductive phase i.e. 60 DAS up to maturity.

At the end of early phase, bhindi crop has attained plant height of 13.84 cm (18.19 per cent), 1.05 branches (48.39 per cent), 6.10 leaves (28.20 per cent) and 5.40 g of total dry matter (10.61 per cent) per plant during 2000-2001. During 2001-2002, the corresponding figures were 25.55 cm (26.68 per

cent), 1.35 (56.11 per cent), 6.70 (17.82 per cent) and 6.29 g (18.55 per cent) respectively.

During first year of experimentation, at the end of grand growth phase, the crop has attained plant height of 54.26 cm (74.00 per cent), 165 branches (76.04 per cent), 14.29 leaves (86.18 per cent) and 15.47 g of total dry matter (66.51 per cent) per plant. The corresponding figures for second year were 119.38 cm (71.47 per cent), 1.35 (87.33 per cent), 19.90 (91.24 per cent) and 17.82 g (69.27 per cent) respectively.

Flowering initiated during grand growth phase at 42 and 46 DAS during first and second year of study.

#### **5.4.2.6 Clusterbean**

The growth of clusterbean crop (var. Pusa Navbahar) can be divided into three growth phases viz. 1) early growth phase i.e. first 30 days, 2) grand growth phase i.e. 30-75 DAS and 3) reproductive phase i.e. 75 DAS to maturity.

At the end of early phase, the clusterbean crop attained plant height of 18.81 cm (18.43 per cent), 1.53 branches (22.60 per cent), 8.25 leaves (11.83 per cent) and 4.20 g of total dry matter (10.61 per cent) per plant during first year. During second year, the corresponding figures were 24.97 cm (28.68 per cent) 1.71 (21.16 per cent), 12.67 (17.82 per cent) and 5.05 g (11.02 per cent) respectively.

During 2000-2001, at the end of grand growth phase, the crop attained 81.00 cm (79.37 per cent) plant height, 6.77 (76.86 per cent) branches 48.44 (69.44 per cent) leaves, 21.22 g (83.20 per cent) and 22.87 g (49.92 per cent) respectively.

Flowering initiated at 41 and 45 DAS during 2002-2001 and 2001-2002 respectively.

In brief, the growth performance of different intercrops regarding all the growth parameters was better during second year of study as compared to first year of study except chilli. The growth performance of chilli crop was better during first year as compared to second year. Reverse was the trend for bhindi crop. This was due to favourable season prevailed for chilli and bhindi crops during first and second year respectively.

## **5.5 Effect of treatments**

Emergence count and final plant stand did not show any significant impact due to different treatments in both the years of investigation (Table). This provided reliability in testing of treatment effects.

### **5.5.1 Pigeonpea**

#### **5.5.1.1 Growth performance**

During 2000-2001, significantly higher values of growth parameters viz. height at 165 DAS with pigeonpea + clusterbean, number of branches and total dry matter per plant at 150 DAS with pigeonpea + blackgram, leaves and leaf area per plant at 135 DAS with pigeonpea + bhindi were registered. Increase in these growth parameters of pigeonpea might be attributed to non-competitive behaviour of clusterbean, blackgram and bhindi when grown in association with pigeonpea. Similar results of enhancement in growth parameters of pigeonpea were reported by Srinivasulu *et al.*, (2000), Singh *et al.*, (1993), Patel and Parmar (1988) Saraf *et al.*, (1975). However, significantly lowest values for these parameters like height at 165 DAS, number of leaves and leaf area per plant at 135 DAS with pigeonpea + blackgram, number branches per plant at 150 DAS with pigeonpea + bhindi and total dry matter per plant at 150 DAS with pigeonpea + chilli were documented. Lower values of these parameters in pigeonpea might be attributed to high competitive nature due to quick growing habit of intercrops like blackgram, bhindi and chilli. Similar findings were also reported by Venkateswarlu (1986), Behera *et al.*, (1996), Padhi *et al.*, (1992), Dubey *et al.*, (1991), Singh *et al.*, (1979).

During 2001-2002, significantly higher values of growth parameters viz. height at 180 DAS, number of branches, number of leaves, leaf area and total dry matter per plant at 165 DAS with pigeonpea + chilli were registered. Non-competitive performance of the chilli crop with pigeonpea resulted in enhancement of these growth parameters. These results are in conformity with Behera *et al.*, (1996). However, significantly lowest plant height at 180 DAS with sole pigeonpea, number of branches per plant at 165 DAS with pigeonpea + clusterbean, number of leaves, leaf area and total dry matter per plant with pigeonpea + bhindi were recorded. Reduction in plant height of sole pigeonpea might be due to the competition of more plant population per unit area.

Findings, analogical to present investigation were reported by Patil *et al.*, (1997) and Puste and Jana (1996). Intercropped pigeonpea proved most competent in sharing the environmental resources resulting in enhanced growth parameters of pigeonpea like number of branches, number of leaves, leaf area and total dry matter per plant.

During 2001-2002, at 165 DAS, significantly maximum total dry matter production per plant was observed under the treatment of pigeonpea + chilli, while significantly lowest values were recorded under the treatment pigeonpea + bhindi. Chilli crop suffered heavily due to unfavourable season and pigeonpea dominated intercropped chilli, which shared greater part of growth resources viz. light, nutrients, moisture, etc. This ultimately resulted in production of maximum total dry matter per plant by pigeonpea in pigeonpea + chilli intercropping system. In contrast to chilli, intercropped bhindi in association with pigeonpea proved most competent with pigeonpea in sharing environmental resources, which finally resulted in minimum dry matter production per plant by pigeonpea + bhindi intercropping system. Behera *et al.*, (1996) also indicated non-competitive behaviour of intercrops due to unfavourable season.

#### **5.5.1.2 Yield attributing characters and yield**

During 2000-2001 significantly maximum values for number of pods, number of grains and grain yield per plant were recorded under the treatment of pigeonpea + cowpea while significantly lowest values for the same yield attributes were observed under the treatment of sole pigeonpea crop (Table ). This might be due to the fact that cowpea during first year of investigation did not interfere with the normal growth of pigeonpea. Analogical results to this context were reported by Saraf *et al.*, (1975). On the other hand, pigeonpea in sole cropping might have experienced interplant competition due to higher plant density as compared to intercropping system particularly after the harvest of intercropped cowpea. These results are in line with the work reported by Puste and Jana (1996).

During 2001-2002, the treatment of pigeonpea + soybean recorded significantly maximum values for number of pods, number of grains and grain yield per plant while significantly lowest values for these yield attributes were

registered under the treatment of sole pigeonpea. Non interference of soybean crop in normal growth of pigeonpea might have attributed to document the yield attributes in pigeonpea towards higher side (Saraf *et al.*, 1975). The situation was coupled with harvesting of intercropped soybean after which pigeonpea in the intercropping system was automatically put on wider spacing that reduced interplant competition for nutrients, water, air and light and ultimately resulted in recording higher yield attributes.

During 2000-2001, significantly maximum grain yield was recorded under the treatment of sole pigeonpea while lowest grain yield was registered under the treatment of pigeonpea + soybean. Although, the lowest yield attributing characters were documented under the treatment of sole pigeonpea, this treatment had maximum plant density (100 per cent) amongst all the treatments, other treatments having only 33 per cent of sole pigeonpea plant population. Thus, it could be inferred that population density of sole cropping of pigeonpea compensated the lower yield attributing characters to register maximum grain yield. These results are in conformity with the findings reported by Patil *et al.*, (1997). During 2001-2002, significantly maximum grain yield was recorded under the treatment of sole pigeonpea where as lowest grain yield was recorded by pigeonpea in association with clusterbean. The results might be attributed to the higher plant population in sole pigeonpea, which compensated the lower yield attributes in the same treatment. Significantly lowest grain yield of pigeonpea under the treatment of pigeonpea + clusterbean may be attributed to lowest grain yield per plant of pigeonpea under the same treatment. These results are in conformity with findings reported by Giri and De (1978).

Significantly maximum husk yield was recorded under the treatment of sole pigeonpea during both the years of experimentation. Significantly lowest husk yields were documented under the treatments of pigeonpea + blackgram and pigeonpea + soybean during 2000-2001 and 2001-2002 respectively. The decrease in husk yield per hectare of pigeonpea under the treatments of pigeonpea + blackgram and pigeonpea + soybean might have attributed to comparatively lesser area of the base crop in intercropping than sole cropped pigeonpea.

Significantly highest straw yield was achieved under the treatment of sole pigeonpea during both the years of study. The treatment pigeonpea + soybean recorded significantly lowest straw yield of pigeonpea during 2000-2001 while it was lowest in pigeonpea + bhindi intercropping treatment during 2001-2002.

Biological yield was significantly influenced by different treatments during both the years of experimentation. Effect of treatments on biological yield in pigeonpea was similar to results observed for straw yield. Maximum biological yield obtained under sole pigeonpea might be attributed to maximum grain, husk and straw yield during both the years of investigation. During 2000-2001 and 2001-2002, lowest values for biological yield were registered under the treatments of pigeonpea + soybean and pigeonpea + bhindi respectively. The findings may be justified by the fact that straw yield contributed greater share in biological yield and straw yields recorded under these two treatments during respective years were significantly lowest.

Harvest index was not influenced significantly by different treatments during both the years. But harvest index was greater during first year of experimentation as compared to second year. This might be due to less biological yield obtained by pigeonpea during first year as compared to second year.

Maximum harvest index was recorded under the treatment of pigeonpea + chilli during 2000-2001 while pigeonpea + cowpea documented maximum harvest index during second year. The results might be attributed to the greater contribution of economic yield in biological yield as witnessed under these two treatments during respective years as compared to other treatments.

## **5.5.2 Intercrops (Blackgram, Soybean, Cowpea, Chilli, Bhindi and Clusterbean)**

### **5.5.2.1 Growth performance**

Growth performance as regards height, number of branches, number of leaves and total dry matter accumulation per plant of all the intercrops except chilli and bhindi was satisfactory in sole and intercropping systems during both the years of study. Growth performance of chilli was satisfactory during 2000-2001 while the performance of chilli was not satisfactory both as sole and

intercrop during 2001-2002. Reverse was the trend regarding growth performance of bhindi where it was satisfactory during 2001-2002 but it was not satisfactory in sole and intercropping system during 2000-2001. This might be due to favourable and unfavourable seasons for chilli crop during 2000-2001 and 2001-2002 respectively. While bhindi experienced unfavourable season during 2000-2001 and performed better as season was favourable during 2001-2002.

#### **5.5.2.2 Yield attributes and yield**

Blackgram recorded greater number of pods and yield per plant during second year of experimentation as compared to first year. This situation led in registering greater yield per hectare during second year of investigation as compared to first year. These results might be attributed to more favourable season for blackgram, prevailed during 2001-2002 as compared to 2000-2001.

In contrast, the season during 2000-2001 was more conducive for soybean growth compared to 2001-2002, which was reflected in recording greater yield attributes and yield per hectare during 2000-2001 as compared to 2001-2002.

Cowpea and clusterbean also registered similar trend of the results as observed under blackgram crop.

Chilli crop performed well during first year of experimentation both in sole and intercropping systems but the growth was poor during second year of experimentation due to unfavourable season. In second year of experimentation, unfavourable season was coupled with shading effect of pigeonpea on chilli under the treatment of pigeonpea + chilli, which ultimately resulted in poor performance of intercropped chilli. Such adverse effect of taller component on shorter one in an intercropping system was reported by Palaniappan (1985).

#### **5.5.3 Grain equivalent yield**

During 2000-2001, sole chilli recorded significantly maximum pigeonpea grain equivalent yield as the favorable season prevailed for chilli crop during 2000-2001 and crop fetched better market value. Blackgram, on the other hand, due to comparatively lower inherent yield potential resulted in recording significantly lowest pigeonpea equivalent yield. Similar observations

were recorded by Behera *et al.* (1996). Among different intercropping systems, pigeonpea + chilli recorded maximum pigeonpea grain equivalent yield. Better value and higher production of chilli crop compensated the pigeonpea losses incurred due to lower population. The higher production of intercropped chilli also gave additional yield and enhanced production of the intercropping system, (Srinivasulu *et al.*, 2000)

During 2001-2002, bhindi crop performed better in terms of growth and yield parameters, which ultimately resulted in high production of bhindi crop. Comparatively higher production of bhindi crop among different intercrops resulted in recording significantly maximum pigeonpea grain equivalent yield in sole bhindi and pigeonpea + bhindi intercropping systems (Behera *et al.*, 1996). Poor performance of chilli crop during second year resulted in documenting lowest pigeonpea grain equivalent yield in sole chilli as well as Pigeonpea + Chilli intercropping systems. In general, all the intercropping systems involving vegetables achieved higher grain equivalent yield than sole pigeonpea. This is because of better utilization of resources in intercropping systems than sole crop stand (Prasad and Srivastava, 1991).

#### **5.5.4 Gross monetary returns, net monetary returns and benefit: Cost ratio**

During 2000-2001, significantly highest values of gross monetary returns, net monetary returns and benefit cost ratio with sole chilli were recorded (Table 29). Better growth performance of chilli crop was the reason for obtaining highest values of these economic parameters under sole chilli crop. Behera *et al.*, (1996) also reported better monetary returns and benefit: cost ratio with vegetables. However, lowest values of gross monetary returns, net monetary returns and benefit: cost ratio were registered under the treatment of sole blackgram. The reduction in these economic parameters under sole blackgram might be due to lower productivity of the blackgram crop. Reduction in monetary returns due to low productivity of field crop as compared to vegetables was reported by Behera *et al.*, (1996).

During 2001-2002, significantly highest values of gross and net monetary returns and benefit: cost ratio were documented with the treatment of pigeonpea + bhindi. Increase in the economic parameters under pigeonpea +

bhindi might be due to favourable season for bhindi which resulted in higher production and pigeonpea registered more than expected yield in association with bhindi crop. Work done by Behera *et al.*, (1999) also indicated profitability of growing bhindi in association with pigeonpea. However sole chilli registered significantly lowest gross and net monetary returns and benefit: cost ratio. Poor performance of chili crop due to unfavourable season might be the reason for recording lowest values of these economic parameters, (Behera *et al.*, 1996).

#### **5.5.5 Land equivalent ratio, aggressivity and relative crowding coefficient**

Land equivalent ratio and aggressivity during 2000-2001 and relative crowding coefficient during both the years of study were not influenced significantly due to different treatments (Table 30).

During 2001-2002, significantly maximum land equivalent ratio with the treatment pigeonpea + bhindi was recorded. This might be due to early growth and fruiting in bhindi and shedding before pigeonpea canopy closed in, (Behera *et al.*, 1996). Significantly lowest land equivalent ratio was registered with pigeonpea + chilli. This reduction in land equivalent ratio might be ascribed to unsatisfactory performance of chilli crop in intercropping system due to unfavourable season (Behera *et al.*, 1996) coupled with shading effect of taller component viz., pigeonpea on shorter chilli, (Palaniappan, 1985).

Significantly highest value of aggressivity was documented under the treatment of pigeonpea + chilli during 2001-2002 suggesting dominance of pigeonpea over component chilli crop in intercropping system similar dominance of pigeonpea on soybean in pigeonpea +soybean was reported by Billore *et al.* (1996). On the other hand significantly lowest value of aggressivity was registered with pigeonpea + cowpea which was negative. The negative sign suggested dominance of cowpea over pigeonpea in pigeonpea + cowpea intercropping system. This might be due to the difference between actual and expected yield of pigeonpea in intercropping system. Similar dominance of soybean on pigeonpea was reported by Billore *et al.*, (1996).

#### **5.5.6 Sustainable yield index and sustainable value index**

SYI denotes the minimum guaranteed yield as percentage to the maximum observed yield with high probability. Both SYI and SVI were

significantly affected by different treatments, (Table 31). After two years of experiment, the treatment pigeonpea + blackgram intercropping was found to be most sustainable (0.88) cropping system and its SVI was also significantly superior (0.85). Among different vegetable intercropping treatments, pigeonpea + cowpea (SYI=0.79, SVI=0.79) and pigeonpea + clusterbean (SYI=0.68, SVI=0.67) were found most sustainable. The results might be due to better performance of these crops for two successive years.

#### **5.5.7 Weed dry matter**

During both the years of study, the weed dry matter was significantly affected due to different treatments, (Table 32) . During both the years, the treatment pigeonpea + cowpea suppressed significantly maximum weeds among all the treatments followed by sole cowpea. Low weed growth under cowpea was due to its smothering nature owing to fast growth and good canopy structure (Ali, 1988), and Shetty and Rao (1977). Shetty and Rao (1977) also postulated that besides canopy structure, the residual effect of cowpea seemed to have detrimental effect on subsequent germination of weed seeds later in the season.

#### **5.5.8 Correlation and path analysis studies**

It can be observed from correlation and path analysis studies (Table 34) that, indirect effect of height at 60 DAS, leaves at 60 DAS, leaves at 90 DAS, leaf area at 60 DAS, TDM 60 at DAS and TDM at 120 DAS via number of pods plant<sup>-1</sup> was maximum among all characters. Leaves at 90 DAS and leaf area at 60 DAS were negatively correlated and significant with grain yield plant<sup>-1</sup>. While for leaves at 90 DAS, direct and total indirect effects on grain yield plant<sup>-1</sup> were negative; the direct effect for leaf area at 60 DAS was negative with higher magnitude than positive total indirect effect.

Though the direct effect of number of pods plant<sup>-1</sup> was negative, the positively significant correlation with grain yield plant<sup>-1</sup> could be attributed to nullification of this negative effect by the higher magnitude of positive total indirect effect. For number of grains plant<sup>-1</sup>, the highly significant positive correlation with grain yield plant<sup>-1</sup> was due to internal cancellation of negative total indirect effect by the higher magnitude of positive direct effect.

**Future line of work**

1. Intercropping of vegetables with pigeonpea was found remunerative therefore the study of different vegetables as intercrops with different field crops needs to be tested.
2. Studies on different row proportions and plant densities are required to be made with field crops and vegetables in intercropping systems.
3. Possibilities of trying management strategies in different field crops + vegetables intercropping systems are required to be explored.
4. Impact of different intercroppings on pest, diseases and weed infestation is required to be studied.

*SUMMARY  
AND  
CONCLUSION*

## **CHAPTER – VI**

### **SUMMARY AND CONCLUSION**

The results of the present investigation are summarized in this chapter.

An agronomic investigation entitled “Productivity and economics of pigeonpea based different intercropping system” was conducted in *kharif* season of 2000-2001 and 2001-2002 at farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, and Akola.

The soil of the experimental plot was almost uniform in fertility status before conducting the experiment.

#### **6.1 Weather**

The total rainfall received was 534.3 mm during the year 2000-2001 and 657.3 mm during 2000-2001 respectively. The mean maximum temperature ranged from 29.4 to 42.4°C in 2000-2001 and 29.0 to 42.3 °C in 2001-2002 and mean minimum temperature from 9.5 to 26.3 °C during 2000-2001 and 10.2 to 28.2 during 2001-2002.

During 2000-2001, the average relative humidity was 62 per cent during morning hours while it was 33 per cent during afternoon hours. The corresponding figures for the year 2001-2002 were 64 and 37 per cent respectively.

The average sunshine hours recorded was 7.6 and 6.7 in a day during 2000-2001 and 2001-2002 respectively.

The experiment was laid out in randomized block design with 13 treatments consisting of seven sole cropping treatments and 6 intercropping treatments, replicated thrice. The layout consisted of 39 plots. The gross and net plot sizes were 6.0m x 5.4 m and 5.4 x 3.6m respectively.

Important findings obtained from present investigation are summarized below.

#### **6.2 Emergence and final plant stand**

Emergence count and final plant stand did not show any significant impact due to different treatments in both the years of investigation (Table 9). This provided reliability in testing of treatment effects.

## **(I) Pigeonpea**

### **6.3 Growth and growth attributes**

#### **Effect of treatments**

During 2000-2001, significantly higher values of growth parameters viz. height at 165 DAS with pigeonpea + clusterbean, number of branches and total dry matter per plant at 150 DAS with pigeonpea + blackgram, leaves and leaf area per plant at 135 DAS with pigeonpea + bhindi were registered. During 2001-2002, significantly higher values of growth parameters viz. height at 180 DAS, number of branches, number of leaves, leaf area and total dry matter per plant at 165 DAS with pigeonpea + chilli were registered (Tables 10a and 10b).

### **6.4 Yield and yield attributes**

Significantly maximum values for number of pods, number of grains and grain yield per plant were recorded under the treatment of pigeonpea + cowpea and pigeonpea + soybean during 2000-2001 and 2001-2002 respectively while, significantly lowest values for the same yield attributes were observed under the treatment of sole pigeonpea crop during both the years of experimentation (Table 21).

Significantly maximum grain yield was recorded under the treatment of sole pigeonpea during both years of investigation while, lowest grain yield was registered under the treatment of pigeonpea + soybean during 2000-2001 and with pigeonpea + clusterbean during 2001-2002 (Table 22).

Significantly maximum husk yield was recorded under the treatment of sole pigeonpea during both the years of experimentation. Significantly lowest husk yields were documented under the treatments of pigeonpea + blackgram and pigeonpea + soybean during 2000-2001 and 2001-2002 respectively (Table 22).

Significantly maximum straw yield was achieved under the treatment of sole pigeonpea during both the years of study. The treatment pigeonpea + soybean recorded significantly lowest straw yield of pigeonpea during 2000-2001 while it was lowest in pigeonpea + bhindi intercropping treatment during 2001-2002 (Table 22).

Effect of treatments on biological yield in pigeonpea was similar to the results observed for straw yield during both the years of investigation. There

was no significant impact on harvest index due to different treatments during both the years (Table 22).

## **(II) Intercrops (Blackgram, Soybean, Cowpea, Chilli, Bhindi and Clusterbean)**

### **6.5 Growth**

#### **Effect of treatments**

Growth performance as regards height, number of branches, number of leaves and total dry matter accumulation per plant of all the intercrops except chilli and bhindi was satisfactory in sole and intercropping systems during both the years of study (Tables 23 a and b, 24 a and b, 25 a and b and 26 a and b).

### **6.6 Yield and attributes**

Blackgram recorded greater number of pods and yield per plant during second year of experimentation as compared to first year. In contrast, the season during 2000-2001 was more conducive for soybean growth as compared to 2001-2002, which was reflected in recording greater yield attributes and yield per hectare during 2000-2001 as compared to 2001-2002. Cowpea and clusterbean also registered similar trend of the results as observed under blackgram crop (Table 27).

Chilli crop performed better during first year of experimentation both in sole and intercropping systems but the growth was poor during second year of experimentation (Table 27).

### **6.7 Pigeonpea grain equivalent yield**

During 2000-2001, sole chilli recorded significantly maximum pigeonpea grain equivalent yield (Table 28). On the other hand, blackgram recorded significantly lowest pigeonpea equivalent yield. Among different intercropping systems, pigeonpea + chilli recorded maximum pigeonpea grain equivalent yield. During 2001-2002, significantly maximum pigeonpea grain equivalent yield was recorded with the treatments sole bhindi and pigeonpea + bhindi intercropping systems. The lowest pigeonpea grain equivalent yield was documented in sole chilli as well as pigeonpea + chilli intercropping systems. In general, all the intercropping systems involving vegetables achieved higher grain equivalent yield than sole pigeonpea.

## **6.8 Monetary returns**

During 2000-2001, significantly highest values of gross monetary returns, net monetary returns and benefit cost ratio with sole chilli were recorded (Table 29). However, lowest values of gross monetary returns, net monetary returns and benefit: cost ratio were registered under the treatment of sole blackgram. During 2001-2002, significantly highest values of gross and net monetary returns and benefit: cost ratio were documented with the treatment of pigeonpea + bhindi. However sole chilli registered significantly lowest gross and net monetary returns and benefit: cost ratio.

## **6.9 Assessment of yield advantage**

During 2001-2002, significantly maximum land equivalent ratio with the treatment pigeonpea + bhindi was recorded. Significantly lowest land equivalent ratio was registered with pigeonpea + chilli. Significantly highest value of aggressivity was documented under the treatment of pigeonpea + chilli during 2001-2002 while, significantly lowest value of aggressivity was registered with pigeonpea + cowpea (Table 30).

## **6.10 Sustainable yield index and sustainable value index**

The treatment pigeonpea + blackgram intercropping was found to be most sustainable cropping system which recorded significantly highest values of sustainable yield index and sustainable value index. Among different vegetable intercropping treatments, pigeonpea + cowpea and pigeonpea + clusterbean were found most sustainable (Table 31).

## **6.11 Weed studies**

During both the years, the treatment pigeonpea + cowpea suppressed significantly maximum weeds among all the treatments followed by sole cowpea (Table 32).

## **Conclusions**

On the basis of pooled analysis of two years data, the following conclusions can be drawn,

1. Overall evaluation of different intercropping systems, pigeonpea + cowpea intercropping system was found to be better.
2. On the basis of pigeonpea grain equivalent yield, pigeonpea + bhindi, pigeonpea + clusterbean and pigeonpea + cowpea seemed to be useful.

3. On the basis of monetary returns, pigeonpea + bhindi, pigeonpea + clusterbean and pigeonpea + cowpea found to be remunerative.
4. On the basis of land equivalent ratio, pigeonpea + blackgram, pigeonpea + soybean, pigeonpea + bhindi, pigeonpea + cowpea and pigeonpea + clusterbean intercropping systems were found effective.
5. On the basis of sustainability, pigeonpea + blackgram, pigeonpea + soybean and pigeonpea + cowpea intercropping systems proved to be sustainable.

### **Recommendations**

As the research project was conducted for two years, recommendations of intercropping on the basis of pooled results can be given as under,

Pigeonpea + cowpea and pigeonpea + clusterbean be adopted in Vidarbha conditions.

*LITERATURE  
CITED*

## LITERATURE CITED

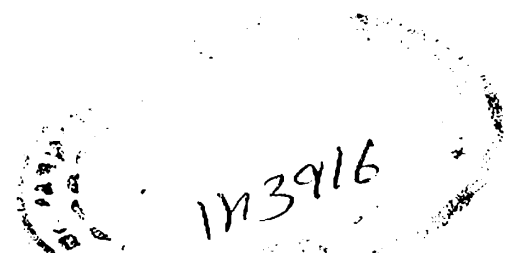
- Ahlawat, I.P.S., A. Singh and N.K. Motha (1982). Studies on weed control in solid and mixed stands of pigeonpea and soybean. *Indian J. Agron.* **27**(2): 191-193
- Ali Masood, R.K. Pandey and C.R. Rawat (1982). Studies on intercropping and weed management in pigeonpea under dryland conditions *Madras Agric. J.* **69** (7): 474-478.
- Anonymous (1992). Statistics on area, production and productivity in Chilli, general information system terminal of National informatics center. Dial up service, NAARM, Hyderabad.
- Anonymous (2002). District wise area, production and productivity of field crops. *Govt. of Maharashtra website [http://agri.mah.nic.in/statistics/agricultural\\_statistics/](http://agri.mah.nic.in/statistics/agricultural_statistics/).*
- Aravazhi, E., S. Natarajan and S. Thamburaj (1997). Economics of intercropping in chilli. *South Indian Horti.* **45** (3 & 4): 193-194.
- Arulnandhy, V. (1991). Improvement of fruit quality in chilli under chilli / pigeonpea intercropping *IPN* **13**: 15
- Behera, B., D.D. Mishra, G.S. Singh, P.K. Mohapatra, A. Alim and P.C. Senapati (1996). Prospects of vegetable crops in pigeonpea based intercropping systems in rainfed lateritic soils of Orissa. *Indian. J. Dryland Agric. Res. and Dev.* **11** (2): 65-68.
- Behera, B., G.S. Singh and P.C. Senapati (1999). Biological and economical feasibility of intercropping vegetable crops in rainfed pigeonpea in eastern ghats. *Indian. J. Soil. Cons.* **27** (3): 207-210.
- Bhadang, M.M. (1983). Intercropping studies of greengram, blackgram and groundnut in pigeonpea (*Cajanus cajan*). M.Sc. thesis (unpub.)
- Billore, S.D., K. Singh, Mridula Bargale and R.K. Joshi (1996). Fertilizer management in pigeonpea and soybean intercropping system under rainfed conditions. *Indian J. Pulses Res.* **9** (2): 120-129.
- Bishnoi, K.C., Balbir Singh and Ajit Singh (1987). Studies on compatibility of greengram and blackgram cultivars in pigeonpea based intercropping systems. *Indian J. Agron.* **32** (2): 127-129.
- Blackman, V.M. (1919) The compound interest law and plant growth. *Ann. Bot.* (London) **33**: 353-360.

- Danawale, N.J. and S.H. Shinde (1996). Crop row ratio in pigeonpea-soybean intercropping system. *J. Maharashtra agric. Univ.*, **21**(3): 479-480.
- \*Dewey, D.R. and K.H. Lu (1959). A correlation and path coefficient analysis of components of crested wheat grass dried production. *Agron. J.* **51** (9): 515-518.
- \*De Wit, C.T. (1960). On competition, *Verlag landbouwkundige onderzoek.* **66**(8): 1-82
- Dubey, O.P., D.C. Garg, J.P. Dixit and K.P. Tiwari. (1991). Intercropping in short duration pigeonpea. *Indian J. Agron.* **36** (2): 253-254
- FAO (2002). FAO website. [http://www.fao.org/statistical database/agriculture/ primary crops.](http://www.fao.org/statistical/database/agriculture/primary_crops)
- \*Fisher, R.A. (1921). Some remarks on the methods formulated in recent articles on the quantitative analysis of plant growth. *Ann. Appld. Biol.*, **7**:367-372. (C.F. Plant Physiology, V.A.: 3-17. Edited by F.C. Steward, 1969) Academic Press, New York.
- Goyal, S.N., N.L. Patel, N.M. Patel and R.P.S. Ahlawat (1991). Intercropping studies in pigeonpea under rainfed conditions. *Indian J. Agron.* **36** (1): 49-51.
- Giri, Gajendra and Rajat De. (1978). Intercropping of pigeonpea with other grain legumes under semiarid rainfed conditions. *Indian J. Agric. Sci.* **48**(11): 659-665
- Holkar, S., J.G. Jagtap, S.D. Billore and V.K. Mishra (1991). Evaluation of soybean (*Glycine max*) and pigeonpea (*Cajanus cajan*) genotypes grown in intercropping system *Indian J. Agric. Sci.* **61** (2): 93-96.
- Jackson, M.I. (1967) Soil chemical analysis. Prentice Hall, India Pvt. Ltd., New Delhi.
- Jadhav, A.S., O.P.S. Verma, M.U. Yadav and A.A. Shaikh (1996). Response of pearl millet hybrids to nitrogen in intercropping systems. *J. MAU.* **21**(3): 412-415
- Kayande, K.S. and P.L. Namaware (1995). Sustainable cropping systems for Vidarbha region under rainfed conditions. *PKV Res. J.* **19** (1): 8-10.
- Katare, R.A., V.M. Bhale and K.S. Mulgir (1983). Pigeonpea/ pearl millet intercrop pays more. *IPN* **2**: 30-31
- Khedekar, P.K. and K.T. Nagre (1980). Studies on the companion cropping of arhar (*Cajanus cajan*) with legumes and oil seed crops. *PKV Res. J.* **4** (1): 22-23

- Kumar, V. (1993). Fertilizer management in pigeonpea (*Cajanus cajan*) and blackgram (*Phaseolus mungo*) intercropping system under rainfed conditions. *Indian J. Agron.* **38** (4): 628-630.
- Lawand, B.T., S.G. Rajput and V.K. Patil (1990). Effect of planting methods on growth and yield of clusterbean under rainfed conditions. *PKV Res. J.* **14** (1): 78-79.
- \*McGilchrist, C.A. (1965). Analysis of competition experiments. *Biometrics.* **21**: 975-985
- Natarajan, S. (1992). Effect of intercrops on chilli (*Capsicum annum* L.) under semidry condition. *South Indian Horticulture* **40** (5): 273-276.
- Nimje, P.M. and D.M. Bhandarkar (1996). Effect of pigeonpea (*Cajanus cajan*) + soybean (*Glycine max*) intercropping and phosphorus fertilization on nitrogen requirement of wheat (*Triticum aestivum*). *Indian J. Agric. Sci.* **66** (6): 321-327.
- Padhi, A.K. (2001). Effect of vegetable intercropping on productivity, economics and energetics of maize (*Zea mays*) *Indian J. Agron.* **46** (2): 204-210.
- Padhi, A.K., B.K. Sadhoo and K.C. Das (1992). Productivity of rainfed pigeonpea (*Cajanus cajan*) based intercropping systems. *Indian J. Agric. Sci.* **62** (9): 594-598.
- Palanippan, S. P.(1985). Cropping systems in the tropics-Principles and Management. Willey Eastern Ltd., New Delhi and Tamilnadu Agricultural University, Coimbatore.
- Pandey, R.C., R.P. Singh, P.P. Sharma, R.P. Pandey, Ajay Pandey and V.D. Dwivedi. (1992). Effect of N and P fertilizers on sustainability of pigeonpea and sorghum systems in sole and intercropping. *IPN* **15**: 11-15
- Panse, V.G. and P.V. Sukhatme (1967). Statistical methods for agricultural workers, ICAR, New Delhi.
- Patel, N.R., and M. T. Parmar (1988). Studies on intercropping of compatible crops with pigeonpea under rainfed conditions. *Indian J. Agron.* **33**(3): 253-256
- Patil, J.R., M.M. Dhanoji, B.T. Pujari and D.M. Mannur (1997). Response of pigeonpea to varying plant population. *Karnataka J. Agric. Sci.* **10** (1): 10-12

- Peter, K.V. and E.V. Nybe (2002): Dominating global markets. The Hindu survey of India Agriculture 2002 published by S. Rangarajan at National Press, Chennai: 87-100.
- \*Piper, C.S. (1966). Soil and plant analysis. Hans Publishers, Bombay. 135-136
- Prasad, K. and R.C. Gautam (1987). Grain yield, protein yield and economics of pigeonpea and soybean as influenced by planting patterns and weed control methods under different cropping systems *Ann. Agric. Res.* **8** (1): 13-17.
- Prasad, K. and V.C. Srivastava (1991). Pigeonpea (*Cajanus cajan*) and soybean (*Glycine max*) intercropping systems under rainfed situation. *Indian J. Agri. Sci.* **61** (4) : 243-246.
- Prasad Rajendra (2002). Text Book of Field Crop Production (Edtd). ICAR, New Delhi.
- Pujari, B.T. and M.N. Sheelavantar (1998). Influence of intercrops and row proportions on pigeonpea growth. *Karnataka J. Agric. Sci.* **11** (4): 889-896.
- Pujari, B.T. and M.N. Sheelavantar (1999). Influence of cropping systems, intercrops and row proportions on leaf area and leaf area index in pigeonpea. *Karnataka J. Agric. Sci.* **12** (1-4 combined): 1-5.
- Puste, A. M. and P. K. Jana (1996). Response of pigeonpea cultivars to spacing. *Indian Agric.* **40**(1): 53-56
- Rafey, A., S.N. Pasupalak and U.K. Verma (1986). Optimum time of sowing greengram and blackgram as intercrops of pigeonpea in the rainfed uplands of Bihar. *Indian J. Agric. Sci.* **56** (2): 92-96.
- Reddy, A.R. and M.R. Reddy (1980). Relative efficiency of a multi intercrop system in pigeonpea under rainfed conditions. *Indian. J. Agron.* **25** (3): 508-510.
- Saraf, C.S., A. Singh and I.P.S. Ahlawat (1975). Studies on intercropping of compatible crops with pigeonpea. *Indian J. Agron.* **20** (2): 127-130.
- Shetty, S.V.R. and M.R. Rao (1977). Weed management studies in pigeonpea based intercropping. *Proceedings of the 6<sup>th</sup> Asian Pacific Weed science Conference, Jakarta, Indonesia, 11-17 July 1977.*
- Singh R.P., S.K. Das, U.M. Bhaskara, Narayana Reddy and V.Rao (1990). Towards sustainable dryland agricultural practices. Hyderabad, Andhra Pradesh, India: Central Research Institute for Dryland Agriculture. 106

- Singh Dharam and R.K. Singh (1995). Effect of levels and placement of phosphorous on moisture use in pigeonpea based intercropping systems under dryland conditions. *Ann. Agric. Res.* **16** (3): 289-291.
- Singh Kalyan and Mahatim Singh (1981). Intercropping of urd with arhar. *Indian farming.* **30** (11): 11-12.
- Singh Mahatim, Kalyan Singh, R.K. Singh and B.S. Sumitra (1979). Effect of intercrops on the growth and yield of pigeonpea *Indian J. Agric. Sci.* **49** (2): 100-104.
- Singh, R.A., A.K. Singh and U.N. Singh (1993). Compatible intercrop population pressure with pigeonpea. *Indian J. Dryland Agric. Res. Dev.* **8** (1): 71-73.
- Singh, R.V. (1993). Production potential and economics of vegetable intercropped with rainfed okra. *Indian. J. Horti.* **50** (1): 73-76.
- Singh, R.V. (1995). Influence of N.P. fertilization on performance and production economics of rainfed okra intercropped with tomato. *Indian J. Horti.* **52** (1): 64-69.
- Srinivasulu, K., R.P. Singh and K. Madhavi (2000). Performance of rainfed pigeonpea (*Cajanus cajan*) based intercropping system under varying planting patterns. *Crop Res.* **20** (1): 56-61.
- Subbaih, B.V. and G.L. Asija (1956). A rapid procedure for determination of available nitrogen in soil. *Current Sci.* **25** : 256-260.
- Tewari, A.N., K.K. Singh and K.S. Rathi (1989). Note on compatibility of component crops involving pigeonpea based cropping system. *Indian J. Agron.* **34** (4): 496-498.
- Tomar, R.S.S., M.S. Upadhyaya and R.A. Sharma (1987). Effect of planting patterns in pigeonpea + soybean intercropping system. *Indian J. Agron.* **32** (4): 322-325.
- Tomar, S.S., R.K. Sharma and K.N. Namdeo (1984). Relative efficiency of multi intercrop system in pigeonpea under rainfed condition. *Indian J. Agron.* **29** (4): 475-479.
- Venkateswarlu, S. (1986). Intercropping pigeonpea with short duration pulses in semi arid Alfisols. *Indian J. Dryland Agric. Res. & Dev.* **1**: 48-55.
- Vishnumurthy, T. and K. Vijayalakshmi. (1993). Intercropping sorghum with clusterbean or greengram in Alfisols of Andhra Pradesh. *Indian J. Dryland Agric. Res. and Dev.* **8**(1): 54-56.



- Vyas, M.D., R.A. Khan and J.S. Raghu (1992). Economics of intercropping and mixed cropping of soybean with pigeonpea. *Indian J. Pulses Res.* **5** (1): 114-116.
- Watson, D. J. (1952). The physiological basis of variation in yield. *Advan. Agron.* **4**: 101-105.
- Willey, R.W. (1979). Intercropping – Its importance and research needs. Part-I. Competition and yield advantages. *Field Crop Abstracts.* **32** (1): 1-10.
- \*Wright, S. (1921). Correlation and causation. *J. Agric. Res.* **20**: 557-558.
- Yadav, R.P., R.K. Sharma and U.K. Srivastava (1997). Fertility management in pigeonpea (*Cajanus cajan*) based intercropping system under rainfed conditions. *Indian. J. Agron.* **42** (1): 46-49.

\* Originals not seen.

# *APPENDIX*

Appendix I - Cost of cultivation

(Rs ha<sup>-1</sup>)

Sr. No.	Particulars	T <sub>1</sub> Pigeonpea Sole	T <sub>2</sub> Blackgram sole	T <sub>3</sub> Soybean sole	T <sub>4</sub> Cowpea sole	T <sub>5</sub> Chilli sole	T <sub>6</sub> Bhindi sole	T <sub>7</sub> Clusterbean sole	T <sub>8</sub> Pigeonpea + Black gram	T <sub>9</sub> Pigeonpea + Soybean	T <sub>10</sub> Pigeonpea + cowpea	T <sub>11</sub> Pigeonpea + chilli	T <sub>12</sub> Pigeonpea + Bhindi	T <sub>13</sub> Pigeonpea + clusterbean
1	land preparation	3120	3120	3120	3120	3120	3120	3120	3120	3120	3120	3120	3120	3120
2	Seed	600	450	1500	1400	300	1000	800	500	1200	1133.33	400	866.67	733.33
3	Sowing (labour)	370	370	370	370	370	370	370	370	370	370	370	370	370
4	Fertilizers (Urea + MP+SSP)	1159.25	1159.25	1658.38	1159.25	954.43	1407.65	1159.25	1159.25	1492.01	1159.25	1022.71	1324.85	1159.25
5	Fertilizers application cost	74	74	74	74	74	74	74	74	74	74	74	74	74
6	Inter-cultivation													
	Hoeings(2)+weedings(2)*	1140	770	770	770	1140	770	770	770	770	770	770	770	770
7	Crop protection													
i.	Rs 200/spraying	-	-	-	1000	1000	1100	800	-	-	666.67	666.67	733.33	533.33
ii.	Rs 250/follidol dusting	500	500	500	-	-	-	-	166.67	166.67	166.67	166.67	166.67	166.67
8	Protective irrigation	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
9	Watching	4440	2500	2220	4440	4440	4440	4440	4440	4440	4440	4440	4440	4440
10	Harvesting	370	370	370	370	740	370	740	370	370	370	370	370	370
11	Threshing	370	370	370	-	-	-	-	185	185	185	185	185	185
	Total cost	13143.25	10683.25	11952.38	13703.25	13138.43	13651.65	13273.25	12154.92	13187.68	13454.92	12585.05	13620.52	12921.58

Current prices (Rs 100 Kg<sup>-1</sup>) of agricultural produce prevailed during 2001-2002 :

Pigeonpea: 1450

Blackgram : 1879

Soybean : 977

Coepea, Chilli , Bhindi, Clusterbean : 800

Pigeonpea stalk : 80

Blackgram straw : 100

*VITA*

## **VITA**

**Mr. Manish Pandurangrao Deshpande** was born on 12<sup>th</sup> Aug. 1976 at Parbhani (M.S.) India. He completed his S. S. C. from Shri. S.B. Highschool Aurangabad with 79.85 per cent and H. S. C. from Shri. Dayanand Science College, Latur with 70.65 per cent. He sought admission in College of Agriculture, Parbhani under Marathwada Agriculture University and passed B.Sc. (Agri.) and secured CGPA 8.24 / 10 during 1997. He was scholarship holder at graduate level. He did his post graduation from Department of Agronomy, MAU, Parbhani and obtained M.Sc. (Agri.) degree in 1999 with CGPA 8.43 / 10.

He admitted in the Department of Agronomy for Doctoral Degree in 1999 and secured CGPA of 8.73 in 10.0 point scale.

*THESIS  
ABSTRACT*

# THESIS ABSTRACT

Title of the thesis : **“PRODUCTIVITY AND ECONOMICS OF  
PIGEONPEA BASED DIFFERENT  
INTERCROPPING SYSTEMS”**

Full name of the student : **DESHPANDE MANISH PANDURANGRAO**

Name and address of Major advisory : Dr. D.G. Giri, Professor, Department of Agronomy, Dr.PDKV, and Akola. .

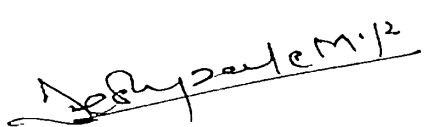
Degree to be awarded : Ph.D. (Agri.)


Year of award of degree : 2003

Major subject : Agronomy

Total number of pages in thesis : 102

Number of words in the abstract : 250

Signature of student : 

Signature, name and address of forwarding authority :   
(Dr. V.S. Shinde)  
Head, Deptt. of Agronomy,  
Dr. PDKV, Akola

---

## ABSTRACT

An agronomic investigation entitled “ Productivity and economics of pigeonpea based different intercropping systems” was conducted in *kharif* seasons of 2000-2001 and 2001-2002 at the farm of Department of Agronomy, Dr. PDKV, and Akola. The experiment was laid out in randomized block design

