“PERFORMANCE OF SOYBEAN VARIETIES IN INTERCROPPING WITH PIGEONPEA UNDER RAINFED CONDITION”

THESIS

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By

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CERTIFICATE-I

This is to certify that the thesis entitled, ***"Performance of soybean varieties in intercropping with pigeonpea under rainfed condition"*** *submitted in partial fulfillment of the requirement for the degree of* ***MASTER OF SCIENCE*** *in* ***AGRICULTURE*** *of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by* ***Mr. Rakesh Chouhan*** *under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.*

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigation has been duly acknowledged by him.

(Dr. B.M. Maurya)
Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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Member	*(Dr. D.P. Dubey)*	*…….*
Member	*(Shri O.P. Dhurve)*	*……..*
Member	*(Shri Ashish Upadhyay)*	*……..*

CERTIFICATE-II

This is to certify that the thesis entitled ***"Performance of soybean varieties in intercropping with pigeonpea under rainfed condition"*** *submitted by* ***Mr. Rakesh Chouhan*** *to Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE*** *in* ***AGRICULTURE*** *in the* ***Department of Agronomy,*** *College of Agriculture, Rewa (M.P.) has after evaluation been approved by the Student's Advisory Committee after an oral examination of the same.*

(Dr. B.M. Maurya)
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Director of Instructions		*…….*

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LIST OF TABLES

intercropping with pigeonpea.

4.6 Average yield contributing characters of different soybean verities as influenced by intercropping with pigeonpea.

4.7 Average biomass, grain yield an harvest index of different soybean verities as influenced by intercropping with pigeonpea.

4.8 Average plant population of pigeonpea as influenced by intercropping with soybean variety.

4.9 Average shoot height of pigeonpea as different stages of growth as influenced by intercropping with soybean.

4.10 Average number of trifolic leaves/plant of pigeonpea at different stages of growth as influenced by intercropping with soybean.

4.11 Average number of root nodules/plant, days taken to 50% flowering and maturity of pigeonpea.

4.12 Average growth character of pigeonpea as influenced by intercropping with soybean.

4.13 Average yield contributing characters of pigeonpea as influenced by intercropping with soybean.

4.14 Average biomass and grain yield (q/ha), harvest index and LER of pigeonpea as influenced by intercropping with soybean.

4.15 Average pigeonpea equivalent yield (q/ha), GMR, NMR, B:C ratio, LER and economic LER

LIST OF FIGURES

12. Average grain yield/plant (g) of pigeonpea under different treatments.

13. Average biomass and seed yield of pigeonpea is influenced by sole and intercropping with soybean varieties.

14. Average LER of pigeonpea under sole and intercropping with soybean varieties.

15. Average pigeonpea equivalent yield (q/ha) as influenced by different treatment.

16. Average gross monetary return and net monetary return (Rs/ha) of sole and intercropping pigeonpea with different soybean varieties.

17. Land equivalent ratio (LER) of sole and intercropped pigeonpea with different soybean varieties.

18. Average benefit:cost ratio (B:C ratio) of sole and intercropped pigeonpea with different soybean varieties.

CONTENTS

CHAPTER-I

INTRODCTION

India is major pulse growing country in the world that occupied an area of 22.434 million hectares with the annual production of 15 million tonnes. The average yield of pulse crops is 668 kg/ha which is very low (Anonymous 2004). Although pulses are richest and cheapest source of protein in Indian vegetarian diets, the per capita availability of pulse per day in our country is going to decrease day by day due to uncontrolled population flood which had declined from 60.7 g in 1951 to 35 g/day in 2002 (Anonymous 2004). Apart from above, pulse crops have a mechanism to fix atmospheric nitrogen in root nodules not only to meet their own nitrogen requirement but also to ameliorate soil fertility.

Among various pulse crops pigeonpea (*Cajanus cajan* (L.) millsp) is one of the most important *kharif* pulse in India, which is cultivated over 3.61 million hectares with the production of 2.7 million tonnes. The average yield of pigeonpea is 754 kg/ha. This crop plays an important role in Indian vegetarian daily diet, which contains 20-25 per cent protein. The state of Madhya Pradesh is being eminently suited for cultivation of pigeonpea, which is cultivated over 3.25 lakh hectares with the production of 2.18 lakh tonnes. The average yield of pigeonpea in the state is 666 kg/ha which is very low (Anonymous 2008).

Soybean (*Glycine max* (L.) merill.) has gained popularity in recent years as it contains 20-25 per cent oil and protein 36-42 per cent with well balanced amino acid makeup especially glycogen, tryptophane and lysine. It also contains vitamins Iron, Copper and other essential elements required for the proper growth of human body. Its oil is richest source of lecithin, plant sterol and unsaturated fatty acids which reduces the cholesterol in blood. Soybean grains have protein two times more than meat, three times more

than eggs and eleven times more than milk. It contains low carbohydrate, hence, recommended for daily diets to diabetic patients. It is used in preparation of paints, varnishes, lubricants, biscuits. milk powder, soymilk and some medicines. Being a leguminous crop it is successfully used in crop rotation, intercropping, mixed cropping and amelioration of soil fertility by fixing atmospheric nitrogen and adding organic matter to the soil. Its cake is a valuable cattle feed and concentrated organic manures. In Madhya Pradesh soybean crop is cultivated over an area of 5.24 million hectares with the annual production of 5.20 million tonnes. The average yield of soybean is 1036 kg/ha (Anonymous, 2008). Presently, about 78 per cent acreage and production of soybean is concentrated in the state of Madhya Pradesh.

In intercropping, the component crops are usually sown in parallel lines. As early as 1949, Aiyer highlighted the advantages of intercropping in India. Willey (1979) made critical analysis of the advantages accrued from the system. This has opened new avenue for undertaking field experiment to investigate the efficacy of the system for productive utilization of available resources.

Thus, a challenging target in agricultural production has to be achieved with a proper management. Since there is hardly any scope to bring additional land area under cultivation, newer approaches to extend their cultivation under different cropping situations become imperative therefore there is a need to evolve suitable genotypes and production technology for various synergetic and intercropping system.

The perception value of intercropping has changed radically over the year. Experimental findings suggest that intercropping can provide substantial yield advantages compared to sole cropping. These advantages may especially important because they are achieved not by means of costly inputs but by the simple expedient of growing crop together (Willey 1979).

Intercropping of pigeonpea and soybean has become popular in soybean growing tract of Madhya Pradesh. As early as in 1976, Saxena and Yadav, evaluated the optimum row proportion of soybean cultivars in intercropping with pigeonpea at Pantnagar. At later, few more experiments were conducted in different parts of the country on intercropping of soybean with pigeonpea (Ahlawat *et al.* 1982, Prasad *et al.* 1985, Tomar *et al.* 1987, Thakre *et al.* 1988, Dubey *et al.* 1991, Billore *et al.* 1991, Jain *et al.* 1991, Jadhao *et al.* 1992, Sodhya and Thakur, 1992, Nimje, 1995, Nimje, 1996 and Nimje and Bhandarkar 1996, Maurya, 1997, Maurya, 1999 and Maurya and Rathi 2001).

In replacement series of intercropping particular row number of one crop is replaced by suitable number of row (s) by another crop (Willey, 1979). In these two crops research workers have considered both component crops as main and intercrop. In replacement system of intercropping of soybean with pigeonpea, most of the research workers have replaced the row (s) of soybean by pigeonpea (Ahlawat *et al.* 1982, Prasad *et al.* 1985, Billore *et al.* 1991, Jadhao *et al.* 1992, Sodhya and Thakur, 1992 and Shraf *et al.* 1993, Maurya 1997, Maurya 1999, Maurya and Rathi 2001).

Intercropping of soybean and pigeonpea in 4:2 rows system has been found most suitable for intercropping (Maurya 20001, Maurya and Rathi 2000 and Anonymous 2008). But soybean varieties have not been evaluated against the teletoxic effect of pigeonpea in intercropping.

Most of the research workers have reported that pigeonpea crop has more teletoxic effect on soybean in intercropping, The yield reduction varies from 10% to 33% in additive (Prasad and Shrivastava 1991) and 3% to 28% in replacement series (Holkar *et al* 1991).

Keeping above facts in view present experiment entitled “performance of different soybean varieties in intercropping with pigeonpea under rainfed condition” has been taken with the following objectives.

Objective of Investigation

1. To find out suitable soybean variety for intercropping with pigeonepea.
2. To find out the effect of soybean varieties on growth and development of pigeonpea in intercropping.
3. To find out the economics of different treatments.

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CHAPTER-II

REVIEW OF LITERATURE

The main purpose of the present field study was to evaluate the soybean varieties suitable for intercropping with pigeonpea. The past work has been critically examined in view of the objectives of the present study and the same has been presented here under the following heads.

Intercropping of soybeans with pigeon pea

In intercropping, the component crops are usually sown in parallel lines whereas in mixed cropping, the arrangement of two crops is irregular. Aiyer (1949), for the first time in India, highlighted the advantages to intercropping. Willey (1979) made critical analysis of the advantages accrued from the system. This has opened new avenue for undertaking field studies to find out the efficacy of the system.

Accordingly field studies were taken to evaluate the soybean varieties suitable for intercropping under rainfed conditions of Madhya Pradesh.

Intercropping of pigeonpea and soybean in additive series

The intercropping of 1 line of soybean in between 2 rows of pigeonpea (1:1) was recommended in performance to its sole cropping by Saxena and Yadav (1976), Ahlawat *et al.* (1982), Prasad *et al.* (1985), Tomar *et al.* (1987), Prasad and Shrivastava (1991 a and 1991 b), Tomar *et al.* (1990), Shanthaveerabhadraiah *et al.* (1991), Dubey *et al.* (1991), Jain *et al.* (1991) Jadhao *et al.* (1992), Singh and Singh (1994), Nimje (1995) and Nimje (1996).

Sarkar *et al.* (1995) obtained a LER 1.146 when 2 rows of soybean was intercropped in between 2 rows of pigeonpea.

The intercropping of 2 lines of soybean in between 2 paired rows of pigeonpea was studied and recommended by Ahlawat *et al.* (1982), Prasad *et al.* (1985) Tomar *et al.* (1987), Prasad and Shrivastava (1991 a and 1991), Shanthaveerabhadraiah *et al. (*1991*).* Jain *et al. (*1991*)* and Sodhya and Thakur (1992).

The intercropping of 2 row of soybean in between 2 paired rows of pigeonpea in additive series was found better than the intercropping on 1 row of soybean in between 2 row of pigeonpea (1:1) in the studies of Ahlawat *et al.* (1982), Prasad *et al.* (1985), Prasad and Shrivastava (1991) and Sodhya and Thakur (1992).

The intercropping of 1 row of soybean in between 2 rows of pigeonpea (1:1) was found better than paired row pigeonpea and 2 rows of intercropped soybean (2:2) reported by Prasad and Shrivastava (1991), Shanthaveerabhadraiah *et al. (1991)* and Singh *et al.* (1991).

Singh *et al.* (1991) reported that intercropping of 1 row of soybean in between 2 rows of pigeonpea (1:1) and 2 rows of soybean in between 2 paired rows of pigeonpea (2:2) in additive series was found unsuitable for intercropping as it reduced the LER varied from 0.759 to 0.937.

Maurya (1997) reported that replacement system (4:2) of intercropping proved better than additive system. When soybean (4 rows) and pigeonpea (2 rows) were grown in association. The LER was 1.28 and economic LER was 1.73 in replacement system. Similar finding were also reported by Maurya (1999) and Maurya and Rathi (2000).

Kumar *et al. (2003)* from Hissar reported that intercropping of pigeonpea and green gram (2:1) gave higher pigeonpea equivalent yield and LER as compared to sole cropping when 1 row of green gram was planted in between two rows of pigeonpea.

Shrivastava *et al.* (2004) from Raipur reported that the highest seed yield of pigeonpea (1190 kg/ha) was recorded under sole pigeonpea. Which

also gave highest net return (Rs 20017/ha) and benefit cost ratio (6.29) than intercropping with urd. The next best performing treatment was pigeonpea paired row Intercropped with Urd bean, which gave pigeonpea equivalent yield (1141 kg/ha), net return (Rs. 18845/ha) benefit cost ratio (4.73) and LER (1.45).

Kumar and Rana, (2007) from IARI New Delhi reported that planting of one row of green gram in between paired row (30/70) of pigeonpea proved superior to the sole pigeonpea in terms of pigeonpea equivalent yield and economics.

Intercropping of soybean and pigeonpea in replacement series

Intercropping of 4 rows of soybean followed by 2 rows of pigeonpea (4:2) in replacement series was recommended as compared to its sole cropping by Tomar *et al.* (1987), Thakre *et al.* (1988), Holkar *et al.* (1991), Billore *et al.* (1991), Billore and Upadhyay (1992), Billore *et al.* (1993), Shraf *et al.* (1993), Maurya (1997) and Maurya (1999).

Intercropping of soybean + pigeonpea in 2:1 (every third row of soybean was replaced by one row of pigeonpea) was found better than its sole cropping as reported by Tomar *et al.* (1987), Tomar *et al.* (1990), Jadhao *et al.* (1992) Sodhya and Thakur (1992), Nimje (1995), Nimje (1996) and Nimje and Bhandarkar (1996).

Intercropping of 3 rows of soybean followed by 1 row of pigeonpea (3:1) was found better than (2:1) system of intercropping in replacement series by Nimje (1995), Nimje (1996) and Nimje and Bhandarkar (1996).

Jadhao *et al.* (1992) reported that intercropping of 2 rows of soybean followed by 1 row of pigeonpea *yielded* a LER 1.55 and was better than intercropping of 3 rows of soybean followed by one row of pigeon pea (3:1) which had a LER of 1.51.

Tomar *et al.* (1987) found that soybean + pigeonpea intercropping in row ratio of 2:1 (every) third row of soybean was replace by one row of pigeonpea) and 4:2 (when fifth and sixth row of soybean was replaced by two rows of pigeonpea) were equal in LER 1.39 and 1.40. Verma (2001) from Uttar Pradesh reported that intercropping of soybean and pigeonpea gave the highest net return (Rs. 19465/ha) in replacement series of intercropping and also resulted in significantly higher pigeonpea equivalent yield than additive series.

Lakhena (2008). From Rewa reported that of intercropping of soybean and pigeonpea in additive 2:1 and 3:2 and in replacement 4:2 proved better than sole cropping of both component crops. Out of the two intercropping additive system was better than replacement system. Soybean and pigeonpea showed adverse effect on each other particularly in additive series. The extent of which was more in soybean than pigeonpea the yield of soybean was reduced by 56% in 2:1 additive system, 25% in 3:2 additive and 22% in 4:2 replacement system of Intercropping as compared its plant population. The adverse effect of soybean on pigeonpea was 2% in 3:2 and 6% in 2:1 additive system. The synergistic effect of soybean on pigeonpea was also observed in 4:2 replacement system by 18% as compared to its plant population. The similar findings where also reported by Anonymous (2008).

Effect of pigeonpea on soybean in additive system of intercropping

In intercropping association, the effect of component crop on each other is a common phenomenon which is attributed to competition for growth resources with and without allelopathy.

In the present case teletoxic effect of pigeonpea on soybean has been reported by Saxena and Yadav (1976) and Ahlawat *et al.* (1982) but the reasons for this effect are still to be searched out. One of the common observation is the relative growth and yield of pigeonpea which has shown

varying degree of effect on soybean. In case of increase in the growth and yield of pigeonpea, it has shown adverse effect on growth and yield of pigeonpea which has shown varying degree of effect on soybean and *vice-versa.*

Maurya and Rathi (2000) from Kanpur reported that grain yield of soybean due to association of pigeonpea was reduced by 54.96% in additive and 45.1% in replacement system of intercropping. A remarkable reduction was noted in harvest index of soybean which was 23.75% in replacement and 19.6% in additive system in comparison to 29.24% in sole cropping. Soybean growth was poor due to association of pigeonpea in additive series.

Effect of soybean on pigeonpea in additive series of intercropping

Adverse effect of soybean on pigeonpea in additive system of intercropping (1:1) was reported @ 8-13 per cent by Saxena and Yadav (1976), @ 17.6 per cent by Tomar *et al.* (1987), @ 6.25 per cent by Prasad and shrivastava (1991), @ 9.1 per cent by Shanthaveerabhadraiah *et al. (1991), @ 13-29* per cent by Singh *et al. (1991) @ 14.8 per cent by* Jain *et al.* (1991), @ 7 per cent by Singh and Singh (1994), @ 14 per cent by Nimje (1995) and @ 16 per cent by Nimje (1996).

The adverse effect of soybean on pigeonpea (when 2 rows of soybean was intercropped in between paired rows of pigeonpea) was reported by several workers. The extent of yield reduction of pigeonpea was @ 4-15.3 per cent by Prasad and Shrivastava (1991 a), @ 23 per cent by Shanthaveerabhadraiah *et al. (*1991*),* @ 17.19 per cent by Jain *et al.* (1991) and @ 17-33 per cent by Singh *et al.* (1991) as compared with its sole cropping. However, the maximum extent of yield reduction (34%) was reported by Sarkar *et al. (1995)* when two rows of soybean were intercropped in between two rows of pigeonpea.

Grain yield of pigeonpea was unaffected due to intercropping of 1 row of soybean in between two rows of pigeonpea in the studies of Ahlawat *et al.* (1982), Prasad *et al.* (1985), Prasad and Shrivastava (1991) and Dubey *et al.* (1991).

The yield of pigeonpea was increased by 5.3 percent (Prasad and Shrivastava, 1991) and by 38.5 percent (Sodhya and Thakur, 1992) in additive series of intercropping (when 2 rows of soybean were intercropped in between paired row of pigeonpea).

Maurya (2000) reported that yield of pigeonpea by association of soybean was 17.5% less than sole pigeonpea. Harvest index of pigeonpea was increased in replacement series (17.66%) than sole pigeonpea (16.7%). Yield contributing characters were superior in replacement system than sole pigeonpea due to intercropping of soybean.

Effect of pigeonpea on soybean in replacement series

Nimje (1995) and Nimje (1996) reported that grain yield of soybean decreased by 17.3 to 18 per cent in intercropping when every third row of soybean was replaced by one row of pigeonpea.

The extent of reduction in the grain yield of soybean in intercropping with pigeonpea when every fourth row of soybean was replaced by one row of pigeonpea was estimated by different workers which varied from a minimum of 7 per cent by Jadhao *et al.* (1992), 22.3 per cent by Nimje (1995) and 33 per cent by Nimje (1996). While it was only 9 per cent in 4:2 row system (Tomar *et al. 1987).*

Sodhya and Thakur (1992) found that grain yield of soybean was increased by 34 per cent in intercropping when every third row of soybean was replaced by one row of pigeonpea. However, Tomar *et al. (1987) and* Jadhao *et al.* (1992) found no effect in intercropping 2:1 row system.

Holkar *et al.* (1991) reported that grain yield of soybean was increased by 3-28 per cent due to intercropping of pigeonpea when every fifth and sixth row of soybean was replaced by 2 rows of pigeonpea. Similarly, Billore *et al.* (1993) also reported positive effect of pigeonpea on grain yield of soybean by 7.3 to 10 per cent.

Lakhena (2008) reported that land equivalent ratio was maximum (0.5) under Intercropped soybean in 3:2 additive system followed by 0. 44 under 4:2 replacement and 2:1 additive system as compared to its sole cropping. The rate of reduction in grain yield as compared to its plant population was 56% in 2:1 additive system, 22% in 4:2 replacement system and 25% in 3:2 additive system. Pigeonpea crop had more teletoxic affect on soybean. In 2:1 additive system of intercropping followed by 3:2 additive system of intercropping while it was least under 4:2 replacement system of intercropping. The similar findings were also reported by Anonymous (2008).

Effect of soybean on pigeonpea in replacement series

Sodhya and Thakur (1992) reported that grain yield of pigeonpea was reduced by 24.5 per cent due to intercropping of soybean when every third row of soybean was replaced by one row of pigeonpea. Similarly, 6 per cent yield reduction in pigeonpea due to intercropping of soybean was reported by Nimje (1996) in the same row system.

Positive effect of soybean on pigeonpea in replacement system

Effect of soybean on pigeonpea has been studied by Tomar *et al.* (1987). Holkar *et al.* (1991) and Billiore *et al.* (1993) in 4:2 row system while it was studied by Jabhao *et al.* (1992), Nimje (1995,1996) in 3:1 row ratio in 2:1 row system, the effect of soybean on pigeonpea has been reported by Tomar *et al.* (1987), Jadhao *et al.* (1992) and Nimje (1995).

Tomar *et al.* (1987) reported that yield of pigeonpea with intercropping of soybean in 4:2 was increased by 18 per cent when fifth and sixth rows of soybean was replaced by pigeonpea while in the studies of Holkar *et al.* (1991) and Billore *et al.* (1993) the pigeonpea yield remained unaffected in the intercropping of soybean and pigeonpea in 4:2 system.

Jadhao *et al.* (1992) estimated an increase of 15 per cent in grain yield of pigeonpea in 3:1 row ratio while Nimje (1995) obtained an increase of 35 per cent in grain yield of pigeonpea.

In 2:1 system Tomar *et al.* (1987), Jadhao *et al.* (1992) and Nimje (1995) reported almost similar advantage in the grain yield of pigeonpea which was about 13 per cent.

Lakhena (2008) reported that the yield attributing character of pigeonpea was affected significantly due to intercropping in additive and replacement system. The biomass per plant, productive branches per plant, number of pods per plant, pod weight per plant, number of grains per plant, numbers of grains per pod and grain yield per plant of pigeonpea were significantly higher in intercropped pigeonpea 4:2 replacement system followed by 3:2 additive system. All above characters were lower under 2:1 additive system of intercropping.

Effect of component crops on each other in replacement and additive series

The effect of component crops on each other was studied in additive and replacement series by Tomar *et al.* (1987), Jadhao *et al.* (1992), Nimje (1995) and Nimje (1996).

Tomar *et al.* (1987) compared the replacement series of intercropping of soybean with pigeonpea in 2:1 and 4:2 with additive series (1:1). The intercropping of soybean and pigeonpea in both replacement series (2:1and

4:2) proved better than additive series (1:1) as the LER in the two system (1:40 nd1.39) was much higher than LER in additive series.

In replacement series the grain yield of soybean was reduced by 9 per cent but the grain yield of pigeonpea was increased by 18 per cent. In additive series, the results were vice-versa, where soybean yield was increased by 6.78 percent, while the grain yield of pigeonpea was reduced by 17.6 per cent.

Jadhao *et al.* (1992) compared the intercropping of soybean with pigeonpea in 2:1 replacement series with 1:1 additive series. They also established the superiority of 2:1 system over 1:1sysrem.

In 2:1 system the grain yield of soybean was almost equal to proportion of its rows while the grain yield of pigeonpea was found to be increased by 22 per cent. In additive series, grain yield of soybean was increased by 3 per cent while the grain of pigeonpea was reduced by 23 per cent.

In the studies by Nimje (1995), a reduction of 17.3 per cent was estimated in the grain yield of soybean with 12.9 per cent increase in the grain yield of pigeonpea in 2:1 system. However, this system proved to be better than additive series (1:1) in which the grain yield of soybean with pigeonpea was found to be reduced @10 per cent and 14.5 per cent respectively.

Further studies were made by Nimje (1996) in which intercropping of soybean with pigeonpea in (3:1) system was compared with additive system (1:1). The intercropping of soybean and pigeonpea in 3:1 row system proved better than additive system. The grain yield of soybean was reduced by 33 per cent while an increase of 26 per cent was calculated in the grain yield of pigeonpea. But in additive series soybean yield was increased by 3 per cent with a reduction of 16 per cent in grain yield of pigeonpea in additive series.

Evaluation of soybean varieties for intercropping

Study on evaluation of soybean varieties suitable for intercropping with pigeonpea was first time made by Yadav and Saxena (1976) at Pantnagar from where they reported that soybean variety J-3 give more yield than Clark-63. The soybean variety J-3 was early maturing than Clark-63. Thereafter few more experiments were conducted to evaluate the soybean varieties suitable for intercropping with pigeonpea, which have been summariesed here.

Singh *et al.* (1991) reported that soybean cultivars PK-262 and JS 74-24-2 gave more yield in inter cropping than soybean cultivars PK-627

Holker *et al.* (1991) from Indore, reported that the early maturing soybean variety JS 71-05 gave maximum yield (14.81 q/ha) which was 40% higher than late maturing variety P-416.

Nimje (1995) from Bhopal, reported that soybean variety Punjab – 1 which was early maturing performed well in intercropping with pigeonpea in 3:1 and 2:1 system of intercropping.

Lakhena (2008) from Rewa, reported that early maturing variety JS 93-05 was better for intercropping with pigeonpea as it gave higher soybean equivalent yield, gross profit, net profit and B:C ratio as compared to soybean variety JS-335. The soybean variety JS 93-05 gave 15% higher grain yield than soybean variety JS-335. All yield contributing character were found superior with pigeonpea than soybean variety JS-335.

On the basis of above cited work it is concluded that early maturity and short growing habits were most desirable character of soybean for intercropping with pigeonpea.

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CHAPTER–III

MATERIALS AND METHODS

The field studies entitled **"Performance of soybean varieties in intercropping with pigeonpea under rainfed conditions"** was carried out during *Kharif* season of 2008–2009 under the edaphic and climatic conditions of Rewa (M.P.). The materials used and method employed during the course of investigation are given in details in this chapter.

3.1 Experimental Site

The experiment was conducted at research farm of J.N.K.V.V. under All India Coordinated research project on Dry land Agriculture, Kuthulia, Rewa(M.P.). The topography of the field was uniform with a gentle slope East to West direction. The said experiment was the part of a research programme launched under "All India Coordinated research project on Dry land agriculture" of ICAR at main centre Rewa (M.P.)

3.2 Soil

The soil texture of experimental field was silty clay loam having a good drainage. To determine the physical, chemical and physico - chemical characteristics of the soil, soil samples were taken randomly from several places to get a composite sample from 0 to 15 cm depth with the help of soil auger before sowing.

Table 3.1. Physico-Chemical properties of soil of experimental field.

Properties	Constituents	Composition	Method used	Remark
Physical	Sand % Silt % Clay %	25.21 39.04 35.75	International Pipette method (Jackson, 1962)	Silty Clay Loam
Chemical 1.	pH	7.15	pH meter (Piper, 1950)	Normal
2.	Electrical Conductivity dsm^{-1}	0.18	Solubridge method (Black, 1965)	Normal
3.	Organic corbon %	0.5	Walkey and Black method (1934)	Medium
4.	Available nitrogen kg/ha	240.80	Alkaline permagnate method (Subbiah and Asija, 1956)	Low
5.	Available phosphorus kg/ha	14.3	Olsen's method (Olsen *et al.,* 1954)	Medium
6.	Available potassium (kg/ha)	179.2	Flame photometer (Chappman and Pratt. 1961)	Medium

It is evident from Table 3.1 that soil was neutral in reaction, low in available nitrogen and medium in available phosphorus and potassium.

Table 3.2. Cropping history of the experimental field.

S.No.	Year	*Kharif* season	Rabi season
1	2002-03	Urd	Fallow
2	2003-04	Urd	Fallow
3	2004-05	Soybean+ Arhar + Barbati	Fallow
4	2005-06	Urd	Gram
5	2006-07	Urd	Lentil
6	2007-08	Soybean	Lentil
7	2008-09	Present experiment	–

3.3 Climate and weather conditions

3.3.1 Climate and season

Rewa is located in North Eastern part of Madhya Pradesh at $24^0$30' North latitude, $81^0$15' East longitude and 365.7 meters above mean sea level. It has sub tropical climate with hot and dry summer and cold winters which are the main features of the region. The minimum and maximum temperature occasionally reaches 12.65^0C and 39.92^0C in the month of January and May, respectively. The average annual rainfall of the tract is 1050 mm.

3.3.2 Rainfall during the cropping season

The total rainfall throughout the cropping season was 709.6 mm received in 42 rainy days. The maximum and minimum temperature recorded during the cropping season was 40.8^0C and 3.7^0C in the month of June and December, respectively.

3.3.3 Weather conditions

The weekly values of important weather parameters prevailed during experimental season were recorded at the meteorological observatory of the Kuthulia Farm, Rewa (M.P.). The data has been given in Table 3.3 and depicted in Fig. 1

Table 3.3 meteorological data during crop season(weekly).

SMW	Date	Rainfall in mm	Temperature		Humidity		Wind speed	Sun shine	No. of rainy day
			Max.	Min.	Max.	Min.			
23	4 – 10	10.2	40.0	25.0	82	53	2.3	6.3	1
24	11-17	7.3	32.8	26.2	84	69	2.5	4.9	1
25	18-24	39.8	29.2	25.0	91	81	3.5	1.7	2
26	25-1 July	72.4	32.4	24.7	90	72	1.5	3.2	3
27	2 – 8	119.6	29.9	23.8	91	59	2.6	0.4	5
28	9-15	22.2	31.6	24.8	87	61	2.9	3.8	2
29	16-22	84.6	32.4	25.1	90	60	2.00	4.1	3
30	23-29	82.0	31.3	25.6	86	57	1.2	4.7	5
31	30-05 August	8.2	32.6	26.8	84	59	2.3	8.5	2
32	6-12	34.2	32.57	25.57	85.28	60.85	1.45	7.82	3
33	13-19	105.2	30.6	25.0	87.8	61.85	1.75	3.81	2
34	20-26	19.0	31.5	25.2	82.8	57.7	0.84	5.85	1
35	27-2 Sept.	5.7	32.8	25.2	86.4	57.5	1.42	7.3	1
36	3-9	2.4	33.7	24.5	84.8	60	13.8	8.8	2
37	10-16	19.6	34.5	23.7	84.7	59.7	1.44	6.5	2
38	17-23	15.8	27.2	23.8	90.4	73.2	2.6	4.27	1
39	24-30 Sept.	4.4	32.14	22.5	88.7	60.7	1.44	7.4	0
40	1-7 October	00.00	33.7	23.5	36	47	1.1	8.8	0
41	8-14	00.00	34.5	20.0	87	51	0.6	8.7	0
42	15-21	00.00	33.1	16.7	83	60	0.4	7.4	0
43	22-28	00.00	31.8	14.7	81	66	0.5	7.1	0
44	29-4 Nov.	00.00	32.1	13.4	79	62	0.5	7.2	0
45	5-11	00.00	30.9	10.9	80	65	0.7	8.9	0
46	12-18	00.00	29.5	13.3	80	61	1.1	7.1	0
47	19-25 Nov.	20.00	25.9	12.5	84	60	0.5	5.4	1
48	26-2 Dec.	00.00	26.6	9.0	79	57	0.2	7.3	0
49	3-9	00.00	26.8	8.7	85	61	0.7	8.8	0
50	10-16	00.00	27.0	8.8	83	60	0.5	8.2	0
51	17-23	00.00	27.9	9.7	81	59	0.2	6.9	0
52	24-31 Dec.	18.70	28.0	5.7	97	75	0.2	8.9	2
1	1-7 January	00.00	24.4	6.81	77.85	55.7	0.25	6.14	0
2	8-14	18.3	23.11	12.28	75	59.14	0.87	2.94	3
3	15-21	00.00	25.5	7.5	83.2	59.85	0.32	6.27	0
4	22-28 January	00.00	26.9	7.98	79.2	53.7	0.64	7.14	0
Total		**709.6**							**42**

Experimental details

The experimental details are given below and the plan of layout is depicted in Fig. 2

Location	:	J.N.K.V.V., (RARS) Kuthulia Farm All India Coordinated research project on Dryland Agriculture, College of Agriculture, Rewa (M.P.)
Design of experiment	:	RBD
Replication	:	3
Number of treatments	:	8
Total number of plots	:	24

Gross plot size and number of rows

	Plot size (Sq metre)	Soybean	Pigeonpea	Percent row
Sole pigeonpea	3.6×3.00m	6	-	100%
4:2	3.6×3.00 m	8	4	66% + 66%

Distance between replication	:	1 m.	
Distance between plot to plot	:	1 m.	
Spacing between rows	:	Sole Pigeonpea at 60 cm. apart Soybean + Pigeonpea in 4:2 at 30 cm. row apart	
Date of sowing	:	30/6/08	
Crop Variety	:		
(1) Soybean	:	(1) JS 93 - 05	(2) JS - 335
		(3) JS 95 – 60	(4) JS 76 - 205
		(5) Surabhi	(6) NRC - 37
		(7) JS 97 - 52	
(2) Pigeonpea		Asha (ICPAL 87119)	
Seed rate			
Soybean	:	100 kg/ha on per row basis	
Pigeonpea	:	20 kg/ha in sole and 13 kg/ha in intercropping on of	

per row basis.

Fertilizer dose :

Soybean : N - 20 kg, $P_2 0_5$ - 60kg, $K_2 0$ - 20 kg/ha

Pigeonpea : N - 20 kg, $P_2 0_5$- 60kg, $K_2 0$ - 20 kg/ha

On the basis of per row.

Agronomic package of practices

As per programme because it was approved on – going experiment of AICRP on Dryland Agriculture.

3.4 Treatments Combination

The details of treatments and symbols used are given below

Treatments

T_1 - Sole pigeon Asha 60 cm rows apart

T_2 - Soybean JS 93-05 + Pigeonpea (4:2 rows) 30 cm apart

T_3 - Soybean JS-335 + Pigeonpea (4:2 rows) 30 cm apart

T_4 - Soybean JS 95-60 + Pigeonpea (4:2 rows) 30 cm apart

T_5 - Soybean JS 76-205 + Pigeonpea (4:2 rows) 30 cm apart

T_6 - Soybean Surabhi + Pigeonpea (4:2 rows) 30 cm apart

T_7 - Soybean NRC-37 + Pigeonpea (4:2 rows) 30 cm apart

T_8 - Soybean JS 97-52 + Pigeonpea (4:2 rows) 30 cm apart

3.5 Characteristics of crop varieties

1. **Soybean variety (JS 93-05)**

Growth habit of the plant is semi determinate with 50-60 cm. plant height, 3 to 4 branches and flower colour is violet. Seed is yellow in colour hilum colour is black seed shape is spherical and medium in size with test weight of 10 to 12 g per 100 seed. It is resistant to shattering and also resistant to major insect pest. It contains 18 to

19% oil and 41-42% protein in seed. Flowering takes place in 38 to 39 days while it matures in 90-95 days. Its yield potential is 20-25 q/ha.

2. **Soybean variety (JS-335)**

This variety was released in the year 1994 for M.P. state by J.N.K.V.V. It has been developed by crossing of JS 78-77 (Kalitur × PS 73-32)×JS 71-05. It is semi determinate in growth habit with 55-60 cm in plant height and 2-3 branches per plant. Flower colour is violet. Seed colour is yellow spherical in shape and medium in size with black hilum. Its test weight (100 seed) is 11-12 g. It is resistant to pod shattering, bacterial pustule, bacterial blight, alternaria blight and tolerant to green mosaic virus disease and stem fly. Its seed contains 17-18% oil and 37-38% protein. This variety matures in 95-100 days and flowering takes place in 40-42 days after sowing. Its yield potential is 25-30 q/ha.

3. **JS 95 – 60:** It is the earliest maturing variety (82-87 Days) develop from J.N.K.V.V. Its pod contains 4 seeds. It is most suitable for shallow soil in low rainfall areas. This variety have good germination capacity and tolerant to high temperature, stem fly, girdle beetle and root rot disease. Its yield potential is 18 to 20 q/ha.

4. **JS 76–205:** This variety matures in 104 days and its seed coat colour is black, flower colour is violet, yield potential varies from 16 to 22q/ha

5. **NRC–37:** It is medium duration maturing variety (100 to 105 days) develop from national research centre on soybean Indore. This variety has good germination capacity resistance to pod shattering and major insect and diseases. Its yield potential varies from 20 to 30 q/ha. Plant height varies from 90 to 100 cm. Seed coat colour is yellow with medium grain size.

6. **JS 97–52:** This variety has been recently released from J.N.K.V.V. Jabalpur. This variety matures in 98 to 102 days having medium plant height 60 to 80 cm. This variety contains 40% protein and 20% oil.

The average test weight is 9 to 10 gm per 100 seed. This variety has prolong germination capacity. This variety resistance to yellow vein mosaic, root rot, bacterial spot and cercospora diseases. This verity can also be grown in water logged areas. This variety has yield potential of 25 to 30 q/ha.

7. **Characteristics of pigeonpea variety Asha (ICPL 87119)**

This variety matures in 190 to 195 days. Plant height is medium, erect with dense branching. Stem colour is green. Pods are spotted by red strips. Grain size is medium and round in shape. It is resistant to wilt and sterility mosaic virus disease. Yield potential varies from 20-25 q/ha.

3.6 Cultural operation

The cultural operation were carried out as and when required. The details are given in Table 3.4

Table 3.4 schedule of pre-sowing and post-sowing operations.

S.No.	Operations		Date
1	Land preparation		29/6/08
2	Layout of experiment		29/6/08
3	Sowing		30/6/08
4	Thinning		14/7/08
5	Interculture–weeding		20/7/08
6	Interculture-II		14/8/08
7	Plant protection (Two)	For soybean For pigeonpea	30/8/08 25/11/08
8	Harvesting	Soybean, JS 95-60, Surabhi, JS-335, JS 76-205, JS 93-05, NRC-37, JS 97-52, JS-335, Pigeonpea(Asha)	26/9/08 3/10/08 17/10/08 27/01/09
9	Threshing	Soybean Pigeonpea	26/10/08 23/02/09

3.6.1 Field preparation

Two ploughing were done by tractor drawn cultivator followed by planking Drainage channels were prepared for proper drainage of excess water during rains to avoid water logging.

3.6.2 Fertilizer application

Total quantity of fertilizer was applied as basal dose on per row basis for both component crops. Fertilizer dose was kept 20 kg N, 60 kg P_2O_5 and 20 kg K_2O/ha for both crops and it was placed in rows before sowing.

3.6.3 Seed rate and seed treatment

To obtain the optimum plant population, seed rate of soybean was kept 100 kg/ha and pigeonpea was kept 20 kg/ha on per row basis. Before sowing seed was treated with Thirum @ 3 g/kg seed of both crops followed by seed inoculation by *Rhizobium* culture @ 10 g/kg of seed.

3.7.4 Method of sowing

The experimental sowing was done on 30th June 2008 maintaining the row to row spacing of 60 cm in pigeonpea pure crop and in intercropping row spacing was kept 30 cm apart in 4:2. The seed and fertilizer were drilled in rows directly. The seed was sown in rows by manual labour and was covered immediately.

3.8 Post sowing operations

3.8.1 Plant population (Thinning)

One thinning was done at 15 DAS in every plot to maintain the optimum plant population and to provide proper crop geometry.

3.8.2 Interculture

Two hand weeding was done at 20 DAS and 45 DAS to remove the weeds from the plots.

3.8.3 Plant protection

One spraying of Endosulphan @ 2 ml/litre was done in soybean to control insect while pigeonpea crop was protected by spraying of Monocrotophos 2 ml/litre at pre flowering stage.

3.8.4 Sampling technique

For this purpose, five plants of soybean and pigeonpea were selected randomly and tagged. All the pre and post-harvest observations were recorded on said selected plants and mean value was worked out accordingly.

3.8.5 Harvesting

The soybean crop was harvested after assessing the maturity i.e. when 90 percent pods turned brown, plants became yellow and leaves started shedding. Soybean variety JS 95-60 was harvested on 26th September 2008 while soybean variety JS 93-05, Surabhi, JS 76-205 were harvested on 3rd October. JS-335, NRC-37, JS 97-52 on 17th October 08. The harvesting was done by cutting the shoot biomass with the help of sickle. Net plot was harvested after removing the border plant from all the side. Pigeonpea crop was harvested when 90% pods were turned dark brown. The border rows and plants from all the sides were removed first, then net plot harvesting was done as per treatment on 27/02/09.

3.8.6 Weighing of total biological yield

Harvested produce of net plot was allowed for sun drying for a week in case of soybean and 20 days in case of pigeonpea. Total produce was weighed with the help of spring balance before threshing.

3.8.7 Threshing and Winnowing

Threshing of the produce was done by beating it with the help of wooden sticks on threshing floor. It was made plot wise. Winnowing

operations was also done in the same manner with the help of hand winnower under natural wind prevailing at that time.

3.8.8 Record of produce

Just after winnowing clean grains were weighed in kilograms with the help of balance and dry sticks of pigeonpea and soybean with the help of spring balance. Straw yield of soybean was estimated after subtracting the grain yield from total biomass. Straw yield in pigeonpea was estimated after subtracting the grain yield + sticks yield from total biomass. Thereafter these products were converted into quintal per hectare by multiplying the following factor in both crops.

Treatments	**Multiplying factor**
Sole pigeonpea	16.66
Soybean + Pigeonpea (4:2) (Replacement)	22.22

To find out the effect of soybean on pigeonpea and effect of pigeonpea on soybean in intercropping, different growth and yield contributing characters have been recorded and are given here.

3.8.9 Sampling techniques

For this purpose, five plants of pigeonpea and five plants of soybean were selected randomly and tagged.

3.9 Details of experimental studies

(A) Pre harvest studies

3.9.1 Plant stand

Number of plants per net plot was counted after thinning at 20 DAS. Final plant population was recorded at harvest to see the mortality percentage. Finally it was converted in to number of plants per square meter.

3.9.2 Plant height

It was measured in centimeters from the ground up to the base of the growing tips of main shoots on sampled plants after thinning at 25, 50 and 75 DAS and at harvest stage in soybean and 30, 60, 90 120, 150 and 180 DAS and at harvest stage in pigeonpea.

3.9.3 Number of nodules per plant

The number of root nodules was counted at 60 DAS in both the crops by digging the roots of sampled plants.

3.9.4 Leaf Area Index

The leaf area index was recorded at 60 DAS in soybean and 90 DAS in pigeonpea with the help of following formula as proposed by Watson 1947.

$$\text{LAI} = \frac{\textbf{Total leaf area of the crop}}{\textbf{Ground area occupied by the crop}}$$

$$\text{LAI(Soybean)} = \frac{L \times W \times 0.64 + 2 \times L \times W \times 704 \times \text{Number of leaves/ plant} \times \text{Number of plants /m}^2}{100 \times 100}$$

L = Length of leaves

W = Width of leaves

Value of K for terminal leaf = 0.64

Value of K for lateral leaf =0.704

As reported by Puttoswamy *et al.* (1978)

For pigeanpea k value for terminal leaf were worked out by plotting the four leaves on graph paper from each cropping system and actual leaf area was determined and their length and width were measured to

find out false leaf area and k value was worked out on the basis of above and mean value was taken

$$K = \frac{\text{Actual leaf area (sq cm)}}{\text{False leaf area (sq cm)}}$$

Determination of K for pigeonpea leaf area under various cropping systems.

Terminal leaf			**Lateral leaf**		
Actual leaf area sq. mm	False leaf area sq. mm.	K	Actual leaf area	False leaf area	*K*
1474.5	2190.30	0.67	1054.60	1525.6	0.69

3.9.5 Days taken to 50 per cent flowering

It is number of days in which 50 per cent of the plants flowered for this purpose, a complete row of both the component crops was selected and number of flowered plants was counted in every alternate days.

3.9.6 Days taken to maturity

It is the number of days in which plants attained maturity. Maturity of soybean crop was assessed when 90 percent pods turned brown, plants became yellow and leaves started shedding. While maturity of pigeonpea was assessed when 95 percent pods turned dark drown.

(B) Post harvest studies

After harvesting of the crop, yield attributes on sampled plants, yields and harvest index were recorded in both the crops. The details of these observations are given under.

3.9.1 Pods per plant

Number of pods per plant was counted on the sampled plants and average values were obtained by dividing the total number of pods with the number of plants used in both the component crops.

3.9.2 Pod weight per plant

The pods of both the component crops were separated from the sampled plants and were weighted in grams. The average weight of pod per plant was calculated by dividing it with number of sampled plants.

3.9.3 Grains per pod and per plant

Out of total pods per plant, number of grains separated out was counted in both the components. Later total number of grains were divided by total number of pods to find out the number of grains per pod.

3.9.4 Length of the pod

Length of ten pods which were selected randomly in both the component crops was measured in centimeter and mean value was calculated.

3.9.5 Test – weight

100 grains in soybean, as well as in pigeonpea were counted from the grains obtained from main shoots and weighed with the help of physical balance to find out the test weight.

3.9.6 Grain yield per plant

Grains obtained from sampled plants were weighted on pan balance in g/ plant and average grain yield/plant was calculated.

3.9.7 Height of first pod bearing node, number of nodes per plant and pod bearing nodes

In soybean, height of first pod bearing node was measured in centimeter from ground surface on sampled plants. The total number of nodes on main stem was counted and average value was worked out. The pod bearing nodes was counted on main stem of sampled plants.

3.9.8 Pods per bearing node

In soybean total number of pods per plant was divided by total number of pod bearing nodes per plant.

3.9.9 Harvest index

The grain recovery was calculated with the help of following formula which was suggested by Nichiporovitch (1960)

$$\text{Harvest index \%} = \frac{\text{Grain yield q/ha}}{\text{Total biological yield q/ha}} \times 100$$

3.9.10 Pigeonpea equivalent yield

The Pigeonpea grain yield equivalent was calculated with the help of following formula

$$\text{Pigeonpea equivalent yield (q/ha)} = \frac{\text{Pigeonpea grain yield (q/ha) x rate of pigeonpea(Rs/q)} + \text{Soybean yield (q/ha) x rate of soybean grain (Rs/q)}}{\text{Rate of Pigeonpea grain (Rs/q)}}$$

Land equivalent ratio (LER)

Land equivalent ratio (LER) is the relative land under sole crops that is required to produce the yields achieved in intercropping. LER was computed from equivalent yield pigeonpea from following formula

$$LER = \sum_{i=1}^{M} \frac{Y_i}{Y_{ij}}$$

Skeleton of ANOVA table for soybean data

Sources of variation	D. F.	SS	MS	F_{cal}	F_{table} 5%	1%
Replication	2				3.88	6.93
Treatment	6				3.00	4.82
Error	12					
Total	20					

$$SEM \pm = \sqrt{\frac{MSE}{r}}$$

$$SED = \sqrt{2} \times SEM$$

CD at 5% = SED × t at 5% for 12 df

SED × 2.179

Skeleton of ANOVA table for pigeonpea data and pigeonpea equivalent yield.

Sources of variation	D. F.	SS	MS	F_{cal}	F_{table} 5%	1%
Replication	2				3.74	6.51
Treatment	7				2.75	4.30
Error	14					
Total	23					

$$SEM \pm = \sqrt{\frac{MSE}{}}$$

$$SED = \sqrt{\frac{2}{r=3}} \times SEM$$

$$CD \text{ at } 5\% = SED \times t \text{ at } 5\% \text{ for } 14 \text{ df}$$

$$= SED \times 2.145$$

3.13 Economic of the treatments

The cost of soybean and pigeonpea production for all the treatment combination was worked out on the basis of input cost and market price of produce. The average was calculated for different treatments. Net income per hectare was calculated by deducting the cost of cultivation per hactare from price of produce. The benefit; cost ratio was calculated by dividing the gross income of the treatment by the total expenditure for the treatment.

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CHAPTER – IV

RESULTS

The present experiment entitled "**Performance of soybean varieties in intercropping with pigeonpea under rainfed condition"** was carried out at Dry land research farm, College of Agriculture JNKVV Rewa, during *Kharif* season of 2008-09. The observation and different characters viz. vegetative growth, yield attributes, yield and economical grain yield of soybean and pigeonpea were recorded at specified period. The treatments consisted of sole pigeonpea and intercropping of four rows of soybean followed by two rows of pigeonpea (4:2). The soybean varieties for intercropping with pigeonpea were JS 93-05 (check), JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52. All the above varieties of soybean were intercropped with pigeonpea (Asha) in 4:2 row systems at 30 cm apart. The analysis of variance "ANOVA" tables are given in Appendices. The findings of investigation are given in this chapter in tabular form and illustrated through bar diagram and histogram where ever felt necessary under following heads.

1) Effect of pigeonpea on soybean varieties in intercropping.

2) Effect of soybean varieties on pigeonpea in intercropping.

3) Evaluation of different soybean varieties in intercropping.

1) **Effect of pigeonpea on soybean varieties in intercropping**

The soybean varieties JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52 were intercropped with pigeonpea variety Asha in 4:2 system of intercropping. The soybean variety JS 93-05 was taken as local check and all the varieties were compared in respect to plant population growth attributes, yield contributing characters and the yield. The main findings have been presented here under following heads.

A) **Pre-harvest study of soybean**

4.1) **Plant Population**

The data pertaining to plant population of soybean at 20 DAS and at harvest stage of soybean have been given in Table 4.1 and depicted through Fig.3. The statistical analysis of soybean plant population per row length of plot have been given in Appendix 1 and finally plant population were converted in per m^2 at both the stages.

Table 4.1. Average plant population of soybean as influenced by intercropping with pigeonpea.

Treatments		Plant population / row length of plot		Plant population / M^2		Mortality (%)
		Initial 20 DAS	Final at harvest	20 DAS	At harvest	
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	36.00	31.33	26.66	23.20	12.97
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	34.66	31.33	25.67	23.20	9.62
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	35.33	32.00	26.17	23.70	9.43
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	34.33	31.66	25.42	23.45	7.74
T_6	Saybean (Surabhi) + Pigeonpea (Asha) in 4:2	36.66	33.33	27.15	24.68	9.09
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	36.33	29.33	26.91	21.72	19.28
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	36.00	29.00	26.66	21.48	19.42
SEm ±		1.15	0.70	-	-	
CD at 5%		NS	2.13	-	-	

After perusal of the data it is evident that the initial plant population per row length of gross plot was varied from 34.33 to 36.66 plants/row length of plot. At harvest stage of soybean reduction in plant population were observed which varied from 7.74% to 19.42% due to teletoxic effect of pigeonpea and was lowest under soybean variety JS 76-205 (7.74%) preceded by 9.09% under soybean variety Surabhi and 9.43% under soybean variety JS 95-60. The reduction in plant population was maximum in medium duration soybean varieties NRC-37 and JS 97-52 which was higher than 19%.

4.2) **Plant height**

The data pertaining to plant height of soybean measured at 25, 50 and 75 DAS and at harvest stage of soybean intercropped in 4:2 with pigeonpea have been given in Table 4.2 and depicted in Fig. 4. The statistical analysis have been given in Appendix -2.

Table 4.2 Average plant height of different soybean varieties as influenced by intercropping with pigeonpea.

Treatments		Plant Height (cm)			
		25 DAS	**50 DAS**	**75 DAS**	**At harvest**
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	28.40	47.07	49.80	50.60
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	31.00	51.07	52.33	52.40
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	34.40	44.60	44.73	44.80
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	28.80	49.07	50.26	50.30
T_6	Saybean (Surabhi) + Pigeonpea (Asha) in 4:2	31.67	55.20	55.80	55.84
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	31.20	73.07	73.10	73.12
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	29.27	71.00	72.07	72.13
SEm ±		0.80	0.73	0.72	0.60
C D at 5%		2.02	2.25	2.24	1.83

It is evident from the results that plant height of soybean at different stages under different soybean varieties were differed significantly. The rate of growth was maximum up to 50 days stage. Thereafter, it was constant. Soybean variety JS 95-60 was dwarf in growth habit (44.53 cm) while soybean varieties NRC – 37 and JS 97-52 were taller in growth habit. The rate of increase 0.89 cm / day up to 50 days stages under soybean variety JS-95-60 and 1.47 cm / day under soybean variety NRC-37 and JS 97-52.

4.3) Number of trifolic leaves at different stages

The average number of trifolic leaves / plant of soybean at different stages of growth i.e 25, 50 and 75 DAS have been given in Table 4.3 and depicted through Fig.5. The statistical analysis have been given in Appendix 3.

Table 4.3 Average number of trifolic leaves and leaf area index of different soybean varieties as influenced by intercropping with pigeonpea

Treatments		Number of trifolic leaves/plant			
		25 DAS	50 DAS	75 DAS	LAI at 50 DAS
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	8.60	15.33	12.13	2.48
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	9.26	15.86	13.00	2.78
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	10.93	14.60	8.26	2.61
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	8.20	15.00	10.53	2.75
T_6	Saybean (Surabhi) + Pigeonpea (Asha) in 4:2	8.60	17.46	11.53	2.66
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	8.46	17.60	14.86	2.63
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	8.86	18.26	15.40	2.71
SEm ±		0.33	0.20	0.68	0.11
C D at 5%		1.02	0.61	2.09	0.25

After perusal of the data it is evident that number of trifolic leaves / plant of soybean differed significantly under different varieties. It was maximum in NRC-37 and JS 97-52 and were at par to Surabhi variety of soybean at 50 days stage. The rate of increase in number of trifolic leaves/ plant were maximum up to 50 days stage thereafter, it was declining.

4.4) Leaf Area Index

Data pertaining to leaf area index of different varieties of soybean under intercropping with pigeonpea have been given in Table 4.3 and statistical analysis is presented in Appendix 4.

After perusal of the results it is clear that leaf area index of soybean varied from 2.48 to 2.78. It was maximum under soybean variety JS- 335 followed by soybean variety JS 76-205 in intercropping with pigeonpea in 4:2 row systems.

4.5) Number of nodules/plant:-

Data pertaining to number of nodules/plant at 60 DAS stage of different varieties of soybean has been given in Table 4.4. The statistical analysis is given in Appendix -5.

Table 4.4 Average number of nodules/plant, days taken to 50% flowering and maturity of soybean varieties as influenced by intercropping with pigeonpea

Treatments		Number of nodules/plant at 60 DAS	50% flowering in days	Maturity in days
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	34.33	40.00	88.33
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	77.83	40.00	99.33
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	33.00	35.33	77.33
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	63.33	39.33	90.33
T_6	Saybean (Surabhi) + Pigeonpea (Asha) in 4:2	50.16	38.66	90.00
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	67.83	46.66	104.66
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	41.33	47.33	105.33
SEm ±		1.11	0.42	0.73
C D at 5%		3.43	1.29	2.25

It is evident from data that number of nodules per plant differed significantly by intercropping with pigeonpea under different soybean varieties. It was maximum (77.83) under soybean variety JS-335 followed by soybean variety NRC-37 and JS 76-205. It was lowest (33/plant) under soybean variety JS 95-60.

4.6) Days taken to 50% flowering

The data pertaining to days taken to 50% flowering under different varieties of soybean as influenced by intercropping with pigeonpea has been given in Table 4.4 and statistical analysis has been shown in Appendix-6. It is clear from the results that soybean variety JS 95-60 gave early flowering as compared to other varieties. The maximum number of days (47.33) was taken for 50% flowering by soybean variety JS 97-52.

4.7) Days taken to maturity of soybean

Data pertaining to days taken to maturity of different varieties of soybean under the influence of intercropping with pigeonpea has been given in table 4.4 and statistical analysis is shown in Appendix-7. It is evident from result that earliest maturity of soybean was observed under JS 95-60 followed by JS 93-05, Surabhi and JS 76-205. The maturity of soybean was delayed under soybean varieties JS 97-52 and NRC-37.

4.8) Biomass/ Plant

Air dry biomass per plant of soybean at harvest stage under different varieties of soybean as influenced by Intercropping with pigeonpea has been given in Table 4.5 and statistical analysis is represented in Appendix-8

Table- 4.5 Average dry weight (g/plant), branches, number of nodes, pod bearing nodes and pod length of different soybean varieties as influenced by inter copping with pigeonpea.

Treatments		Biomass per plant (g)	Branches per plant	Height of first pod bearing nodes (cm)	Number of nodes / plant	Number pod bearing nodes/ plant	Number of pods / bearing nodes	pod length (cm)
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	20.73	3.20	8.12	11.26	7.46	4.27	4.13
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	19.22	2.26	9.80	12.46	7.40	4.92	3.30
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	30.25	2.80	7.90	9.86	7.60	5.81	3.90
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	28.54	2.60	10.90	11.53	6.07	4.10	3.97
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	28.76	3.13	8.90	11.80	8.40	5.61	3.97
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	30.00	1.53	12.50	14.40	6.53	4.86	2.70
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	25.86	1.86	11.90	13.26	6.80	5.79	2.77
SEm ±		0.91	0.39	0.27	0.49	0.50	0.30	0.10
CD at 5%		2.82	1.21	0.86	1.50	1.54	0.94	0.30

It is clear from results that maximum biomass per plant of soybean (30.25 g/ plant) was recorded in soybean variety JS 95-60 followed by NRC-37 (30 g/plant). The biomass per plant was lowest under soybean variety JS – 335 and JS 93-05.

4.9) Number of branches per plant

Branches per plant were counted at harvest of soybean which have been given in Table 4.5 and statistical analysis is given in Appendix -9.

It is clear from the result that JS 93-05 which was taken as Local check gave maximum number of branches (3.2/plant) followed by soybean variety Surabhi (3.13 branches /plant). The number of branches per plant were found lowest under soybean variety NRC-37 (1.53/plant) preceded by soybean variety JS 97- 52.

4.10) Height of pod bearing nodes

Height of first pod bearing node on main shoot was measured at harvest stage of soybean which has been given in Table 4.5 and statistical analysis is given in Appendix -10.

It is clear from the results that height of first pod bearing node was started from lower nodes in soybean varieties JS 95-60, JS 93-05 and Surabhi. The first pod bearing nodes was started from higher nodes in soybean varieties NRC-37 and JS 97 – 52.

4.11) Number of nodes per plant

The number of nodes per plant on main shoot of soybean was counted at harvest stage of soybean which has been given in Table 4.5 and statistical analysis is given in Appendix-11.

It is evident from the data that number of nodes per plant were higher under soybean variety NRC-37, JS 97-52 and JS–335 while it was lowest under soybean variety JS 95-60.

4.12) Number of pod bearing node per plant

The data pertaining to number of pod bearing nodes per plant at harvest of soybean has been given in Table 4.5 and statistical analysis is shown in Appendix–12.

After perusal of the results it is evident that maximum number of pod bearing nodes per plant was observed under soybean variety Surabhi followed by JS 95 – 60 and JS 93 – 05.

4.13) Number of pods per bearing node

Data on number of pods per bearing node has been given in Table 4.5 and statistical analysis is given in Appendix- 13.

Results make it clear that soybean variety JS 95- 60 gave maximum number of pods per bearing node (5.81) followed by JS 97 – 52 and Surabhi varieties of soybean while it was lowest in soybean variety JS 76- 205.

4.14) Pod length

Pod length of soybean measured at harvest stage of soybean has been given on Table 4.5 and statistical analysis has been given in Appendix- 14.

It is clear from the results that pod length was maximum under soybean variety JS 93-05 followed by JS 76 – 205 and Surabhi pod length was shorter under soybean variety NRC- 37 and JS 97 – 52.

4.15) Pod yield per plant

Data on pod yield per plant was taken at harvest stage of soybean and the same has been given in Table 4.6 and depicted in Fig 6. The statistical analysis is given in Appendix – 15.

Table 4.6 Average yield contributing characters of different soybean varieties as influenced by intercropping with pigeonpea.

Treatments		Pod weight/ plant(g)	Number of pods/plant	Number of seeds/ pod	Number of seeds/plant	Seed yield per plant (g)	Test weight (100-seeds)
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	12.45 (0.00%)	31.85 (0.00%)	3.30	105.10	8.30 (0.00%)	7.99 (0.00%)
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	11.53	36.47 (114.50%)	2.60	94.66	7.69 (92.65%)	8.19 (2.50)
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	22.48 (180.56%)	44.15 (138.61%)	3.07	135.54	14.99 (176.35%)	11.11 (39.04%)
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	10.56	24.88	3.13	77.89	7.04 (84.81%)	9.15 (14.51%)
T_6	Saybean (Surabhi) + Pigeonpea (Asha) in 4:2	19.30 (155.02%)	47.12 (147.94%)	3.27	154.08	12.87 (155.06%)	8.38 (4.88%)
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	10.11	31.73	2.33	73.93	6.74 (81.44%)	9.24 (15.64%)
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	9.70	39.37 (123.61%)	2.40	94.48	6.47 (77.95%)	6.98 (-12.64%)
SEm ±		0.48	0.65	0.14	0.64	0.20	0.40
CD at 5%		1.50	2.00	0.30	1.96	0.63	0.87

* Figures in parentheses are percent over local check

After perusal of results it is clear that soybean variety JS 95-60 gave 80.56% higher pod yield then soybean variety JS 93-05. Similarly, soybean variety Surabhi gave 55.02% higher pod yield per plant than soybean variety JS 93-05. All other varieties of soybean gave inferior pod yield per plant than soybean variety JS 93-05 in intercropping with pigeonpea.

4.16) Number of pods per plant

Data pertaining to number of pods per plant of different varieties of soybean as influenced by intercropping with pigeonpea has been given in Table 4.6 and statistical analysis is presented in Appendix-16.

It is clear from the results that number of pods per plant was reduced under soybean variety NRC-37 @ 37% and 21.88% under soybean variety JS 76-205 as compared to local check JS 93-05. The number of pods per plant was increased @ 14.5% in soybean variety JS-335, @ 23.61% in JS 97-52, @ 38.61% in JS 95-60 and @ 47.94% in Surabhi variety of soybean as compared to local check JS 93-05.

4.17 Number of seed per pod

Data on number of seed per pod of soybean varieties under the influence of intercropping with pigeonpea has been given in Table 4.6 and statistical analysis is shown in Appendix-17.

Its clear from the result that number of seeds per pod was maximum in local check variety of soybean JS 93-05 followed by Surabhi and JS 95-60. All other varieties were found inferior in respect to number of seeds per pod as compared to soybean variety JS 93-05.

4.18) Number of seeds per plant

Number of seeds per plant was counted at harvest stage of soybean and the same has been given in Table 4.6. The statistical analysis is presented in Appedix-18. It is evident from the data that maximum number of seeds per plant were noted under soybean variety Surabhi (154.08/plant) followed by soybean variety JS 95-60 (135.54/plant). The rate of increase

was 46.6% in Surabhi and 28.96% in soybean variety JS 95-60 over local check variety JS 93-05.

4.19) Seed yield per plant

The seed yield per plant under different varieties of soybean as Influenced by intercropping with pigeonpea has been presented in Table 4.6 and depicted in Fig.6. The statistical analysis is given in Appendix-19.

After perusal of the result it is evident that seed yield per plant was found to increase by 55.06% under Surabhi and 76.35% under JS 95-60 varieties of soybean as compared to local check variety JS 93-05. Grain yield per plant was found to decrease by 7.35% in soybean variety JS-335, 15.91% in soybean variety JS 76-205, 18.56% in NRC-37 and 22.05% in JS 97-52 varieties of soybean as compared to local check JS-93-05.

4.20) Test weight

The weight of 100-seeds of different varieties of soybean were weighed on electronic balance and the same is given in Table 4.6. The statistical analysis is shown in Appendix – 20. After perusal of the results it is clear that test weight varied from 6.98 gram/100 seed in JS 97-52 to 11.11g/100 seed in JS 95-60. The highest test weight 11.11 g was obtained in soybean variety JS 95-60 followed by 9.24 g in NRC-37 and 9.15 g JS 76-205 under the influence of intercropping with pigeonpea. The soybean varieties JS-335, Surabhi, JS 76-205, NRC- 37 and JS 95-60 gave higher test weight @ 2.5% to 39.04% over local check JS 93-05.

4.21) Biomass yield

Biomass yield of different soybean varieties under the influence of intercropping with pigeonpea has been given in Table 4.7 and depicted in Fig.-7. The statistical analysis has been given in Appendix-21.

Table 4.7 Average biomass, grain yield and harvest index of different soybean varieties as influenced by intercropping with pigeonpea.

Treatment		Biomass yield per plot (kg)	Grain yield per plot (kg)	Biomass yield (q/ha)	Grain yield (q/ha)	Harvest index (%)
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	1.20	0.500	26.66 (0.00)	11.10 (0.00)	41.59
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	1.60	0.500	35.55 (133.34%)	11.10 (100%)	31.06
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	2.10	0.67	46.66 (175.01%)	15.03 (135.40%)	32.38
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	1.90	0.60	42.21 (158.32%)	13.32 (120%)	31.63
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	2.00	0.67	44.43 (166.65%)	15.03 (135.40%)	34.67
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	1.76	0.30	39.25 (147.22%)	6.66 (60%)	17.15
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	1.60	0.46	35.55 (133.34)	10.36 (93.33)	29.16
SEm±		0.12	0.03	2.86	0.77	2.88
CD at 5%		0.39	0.10	8.80	2.36	8.85

* Figures in parentheses are percent over JS 95-05 (Local check)

After perusal of the results it is clear that all the soybean varieties gave significantly higher biomass/ha as compared to local check variety JS 93-05. The rate of increase varied from 33.34% to 75.0% under different varieties and maximum biomass (46.66 q/ha) was observed in JS 95-60 followed by Surabhi variety of soybean (44.43q/ha).

4.22) Grain yield

The grain yield data of different soybean varieties has been given in Table 4.7 and shown in Fig. 7. The statistical analysis is given in Appendix-22.

It is evident from the result that soybean variety NRC-37 gave lowest grain yield (6.66 q/ha) preceded by JS 97-52 (10.36 q/ha) the soybean variety JS-335 gave equal yield in intercropping as compared to local check variety JS 93-05. The soybean variety Surabhi and JS 95-60 gave 35.4% higher yield than local check variety JS 93-05 in intercropping with pigeonpea.

4.23) Harvest index

Date pertaining to harvest index of different soybean varieties has been given in Table 4.7 and depicted in Fig. 8. The statistical analysis has been shown in Appendix-23.

It is clear from the result that soybean variety JS 93-05 (Local check) gave highest harvest index (41.59%) which was at par to soybean variety Surabhi and JS 95-60. The lowest harvest index 17.15% was obtained in soybean variety NRC-37 due to intercropping with pigeonpea.

B) Effect of soybean on pigeonpea in intercropping

4.24 Plant population

Data pertaining to plant population of pigeonpea under the influence of intercropping with soybean per row length of gross plot and per square meter at 20 DAS after sowing and at harvest stage of pigeonpea have been given in Table 4.8 and depicted in Fig. 9. The statistical analysis for per row length is shown in Appendix-24.

Table 4.8 Average plant population of pigeonpea as influenced by intercropping with different soybean varieties.

Treatment		Plant population/ row length of plot		Plant population /M^2		Mortality %	Percent plant population at 20DAS
		Initial at 20DAS	Final at harvest	20DAS	At Harvest		
T_1	Sole pigeonpea (Asha)	16.33	15.44	9.07	8.58	5.40	100
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	15.33	12.66	5.67	4.68	17.41	62.51
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	16.00	12.33	5.92	4.56	22.93	65.27
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	16.33	13.33	6.04	4.93	18.37	66.59
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	15.66	12.66	5.80	4.68	19.15	63.94
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	16.00	13.66	5.92	5.05	14.62	65.27
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	15.00	11.28	5.55	4.18	24.68	61.19
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	15.66	12.33	5.80	4.56	21.26	63.94
SEm ±		0.50	0.84				
CD at 5%		NS	2.57				

After perusal of results it is clear that initial plant population of pigeonpea after thinning at 20 days stages on the basis of per row of gross plot were not differed significantly in intercropping and sole cropping of pigeonpea. The pigeonpea plants per unit area were 100% in sole pigeonpea ands 61% to 66.59% in intercropping with different varieties of soybean. The mortality of pigeonpea plants was higher in intercropping (14.62% to 24.68%) with different soybean varieties while it was only 5.4% in sole pigeonpea.

The plant population of soybean at harvest stages was found to reduce 5.4% to 24.68% and differed significantly by intercropping with different varieties of soybean. The higher mortality of pigeonpea plants were observed in intercropping with soybean variety NRC-37 followed by JS 97-52 and JS-335.

4.25 Shoot height

The shoot height of pigeonpea was measured at 30, 60, 90, 120, 150 and 180 days after showing and at harvest stage which have been presented in Table 4.9 and shown through Fig.10. The statistical analysis are given in Appendix-25.

It is evident from the data that shoot height of pigeonpea was increased by 52.66. cm in between 30-60 days after sowing (@1.75 cm per day), 50.27cm in between 60-90 days after sowing (@1.67 cm per day) and 35.67 cm in between 90-120 days after sowing (@1.19 cm per day) in Sole pigeonpea. The height of pigeonpea was affected significantly due to intercropping with different varieties of soybean. Finally the plant height of pigeonpea was maximum in sole cropping and significantly reduce in intercropping with different varieties of soybean in 4:2 rows system.

Table 4.9 Average shoot height of pigeonpea at different stages of growth as influenced by intercropping with soybean.

Treatment		Plant height (cm)					
		30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150DAS**	**180 DAS and at harvest**
T_1	Sole pigeonpea (Asha)	34.6	87.26	137.53	173.20	177.13	177.53
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	36.33	81.13	123.86	152.60	155.67	156.33
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	37.53	89.06	131.33	158.86	161.07	161.33
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	38.53	80.93	121.33	151.06	155.60	155.80
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	33.33	81.33	119.40	150.40	153.13	154.06
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	35.26	80.00	121.66	146.06	153.80	153.80
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	34.93	79.53	123.66	145.73	148.00	148.86
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	33.40	77.66	123.60	147.80	154.00	154.80
SEm ±		0.49	0.95	0.71	1.00	1.03	1.15
CD at 5 %		1.49	2.90	2.15	3.03	3.10	3.48

4.26. Number of trifolic leaves per plant

The number of trifolic leaves per plant of pigeonpea were counted at 30, 60, 90, 120, 150 and 180 days after sowing in sole and intercropped pigeonpea with different varieties of soybean are given in Table 4.10. The statistical analysis is given in Appendix-26.

Table 4.10 Average number of trifolic leaves/plant of pigeonpea at different stages of growth as influenced by intercropping with soybean.

Treatment		Number of trifolic leaves per plant						Leaf area index at 120 DAS
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS and at harvest	
T_1	Sole pigeonpea (Asha)	12.13	70.86	204.00	236.86	232	214	3.71
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	12.86	54.13	141.46	164.40	163.07	156.73	2.76 74.39
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	12.86	55.86	142.80	175.00	174.93	161.60	2.6
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	11.93	48.46	117.93	159.86	166.73	170.20	2.65
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	10.26	33.20	109.06	145.13	184.67	155.40	2.73
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	10.73	34.80	103.80	132.53	140.33	134.46	2.68
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	11.20	33.20	97.40	148.13	146.60	142.40	2.81 75.75
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	12.46	44.66	117.60	156.40	153.20	145.06	2.53 68.19
SEm ±		0.26	0.79	0.59	0.67	1.02	1.31	0.17
CD at 5 %		0.80	2.40	1.80	2.05	3.09	3.99	0.52

After perusal of the results it is evident that number of trifolic leaves per plant of pigeonpea was significantly higher is sole pigeonpea at 30, 60, 90, 120, 150 and 180 days after sowing which were significantly higher over intercropping with different varieties of soybean.

4.27 Leaf area index

The leaf area index of pigeonpea at 120 DAS was calculated which has been given in Table 4.10. The statistical analysis is presented in Appendix 27.

It is clear from the results that leaf area index of pigeonpea was maximum 3.71 in sole pigeonpea and varied from 2.53-2.81 in intercropping with different varieties of soybean which were equal 68.19-75.75% sole pigeonpea.

4.28 Number of nodules per plant

The average number of root nodules per plant of pigeonpea was counted at 90 DAS which is given in Table 4.11 and statistical analysis has been presented in Appendix-28.

It is evident from the results that number of nodules per plant of pigeonpea were not differed significantly in sole and in intercropping with soybean. It was minimum in intercropping with soybean variety JS 97-52 (7.33) and was maximum in intercropping with soybean variety JS-335. But the difference was non-significant.

4.29 50 per cent flowering

Average number of days taken to 50 per cent flowering of pigeonpea was recorded which has been presented in Table 4.11. The statistical analysis is given in Appendix-29.

Table 4.11 Average number of root nodules/plant, days taken to 50% flowering and maturity of pigeonpea.

Treatment		Number of nodules/plant at 90 DAS	Days taken to 50% flowering (Days)	Days taken to maturing (days)
T_1	Sole pigeonpea (Asha)	9.60	124.66	180.00
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	8.16	124.66	181.33
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	9.66	127.00	181.66
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	8.33	127.33	182.33
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	7.83	126.66	182.33
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	8.66	125.66	181.00
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	8.16	126.33	179.66
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	7.33	125.00	180.33
SEm ±		1.05	0.79	0.98
CD at 5 %		NS	NS	NS

It is clear from the result that 50 per cent flowering of pigeonpea was not differed significantly in sole cropping as well as in intercropping with soybean. The 50 per cent flowering of pigeonpea was delayed in intercropping by 1-3 days under different soybean varieties as compared to sole cropping.

4.30 Maturity

Average number of days taken to maturity of pigeonpea in sole cropping as well as intercropping with different soybean varieties have been given in Table 4.11 and statistical analysis is given in Appendix-30.

After perusal of the result it is clear that maturity of pigeonpea was not affected significantly in sole cropping and in intercropping with different varieties of soybean. The maturity of pigeonpea was varied from 179.66 days-182.33 days. But the different was non significant.

4.31 Biomass per plant

Air dry biomass of pigeonpea was recorded at harvest stage which has been given in Table 4.12 and statistical analysis is given in Appendix-31.

It is evident from the data that biomass per plant of pigeonpea was maximum in sole cropping (161.65 g/plant) followed by 156.65 g in intercropping with soybean variety JS 76-205. Biomass per plant of pigeonpea was reduce significantly due to intercropping with soybean and lowest biomass 116.22 g/plant was obtained in intercropping with soybean variety NRC - 37 followed by JS - 335.

Table 4.12- Average growth characters of pigeonpea as influenced by intercropping with soybean.

Treatment		Biomass/ plant (g)	Number of productive branches / plant	Productive Branches %	Unproductive branches / plant	unproductive branches %	Total branches
T_1	Sole pigeonpea (Asha)	161.65	13.77	82.35	2.95	17.65	16.72
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	130.56	12.44	67.49	5.99	32.51	18.43
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	119.33	10.33	65.05	5.55	34.95	15.88
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	139.32	10.33	80.20	2.55	19.80	12.88
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	156.65	10.88	81.68	2.44	18.32	13.32
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	125.26	12.44	82.98	2.55	17.02	14.19
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	116.22	10.33	64.60	5.66	35.40	15.99
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	129.80	11.33	71.34	4.55	28.66	15.88
SEm ±		1.15	0.43		0.45		1.03
CD at 5 %		3.51	1.33		1.37		3.13

4.32 Branches per plant

The average number of productive, unproductive and total branches per plant of pigeonpea have been given in Table 4.12 and depicted in Fig. 11. The statistical analysis is given in Appendix-32.

After perusal of the results it is of clear that number of productive branches per plant were higher (13.77/plant) in sole pigeonpea followed by intercropped pigeonpea with soybean variety JS 93-05 and Surabhi. The unproductive branches per plant of pigeonpea was lower in sole pigeonpea, intercropped pigeonpea with soybean variety JS 95-60, JS 76-205 and Surabhi. The total branches per plant of pigeonpea was higher in intercropped pigeonpea with soybean variety JS 93-05 (18.43) followed by sole pigeonpea (16.72).

4.33 Number of pods per plant

The data on number of pods per plant of pigeonpea was recorded at harvest stage of pigeonpea and the same is given in Table 4.13. The statistical analysis is given in Appendix-33.

It is clear from the results that number of pods per plant was significantly higher in intercropped pigeonpea with soybean variety JS-335 followed by sole pigeonpea and were at par. The lowest number of pods per plant of pigeonpea (75.37) was observed in intercropped pigeonpea with soybean variety NRC-37 and followed by JS 97-52.

Table 4.13 Average yield contributing characters of pigeonpea as influenced by intercropping with soybean

Treatment		Number of pods per plant	Pod length (cm)	Pod weight per plant (g)	Number of grain per plant	Number of seeds/ pod	Grain yield per plant (g)	Test weight (g)
T_1	Sole pigeonpea (Asha)	87.68	3.42	34.19	324.22	3.20	32.33	9.48
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	81.76	3.40	32.37	344.44	3.06	32.64	9.49
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	88.12	3.40	36.30	280.44	3.20	25.06	8.95
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	83.40	3.82	35.52	375.77	3.13	34.83	9.29
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	84.50	3.47	35.99	325.44	3.00	31.33	9.64
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	82.89	3.44	32.49	351.10	3.13	32.57	9.28
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	75.37	3.32	28.79	265.88	2.93	25.57	9.65
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	79.23	3.99	34.54	295.33	3.13	(20.90) 25.96 (19.7)	8.80
SEm ±		1.39	0.21	0.19	3.73	0.23	1.76	0.31
CD at 5 %		4.23	NS	0.58	11.34	NS	5.35	NS

4.34 Pod length

The data on pod length of pigeonpea was recorded at harvest stage of soybean which is given in Table 4.13 and statistical analysis is given in Appendix-34. It is clear from the results that pod length of pigeonpea was not affected significantly in sole cropping and in intercropping with different varieties of soybean.

4.35 Pod weight

The data recorded on pod weight per plant of pigeonpea in sole and in intercropping is given in Table 4.13 and statistical analysis is shown in Appendix-35. After perusal of the results it is clear that the pod yield per plant of pigeonpea was significantly higher in intercropped soybean variety JS-335 which was at par to intercropping of soybean variety JS 95-60 and JS 76-205 and also in sole pigeonpea.

4.36 Number of grains per plant and per pod

The number of grains per plant and per pod of pigeonpea under sole and intercropping have been given in Table 4.13. The statistical analysis are given in Appendix-36 and 37. It is evident from the data that number of seeds per pod of pigeonpea was not affected significantly in sole and in intercropping with different soybean varieties. The number of grains per plant of pigeonpea was found significant. The maximum number of grain per plant of pigeonpea was observed in intercropping with soybean variety JS 95-60 followed by intercropping with soybean variety Surabhi. The lowest number of grains per plant of pigeonpea was observed in intercropping with soybean varieties NRC-37, JS-335 and JS 97-52.

4.37 Grain yield per plant

The data on grain yield per plant of pigeonpea is given in Table 4.13 and depicted in Fig. 12. The statistical analysis is given in Appendix-38. It is evident that grain yield per plant of pigeonpea was significantly higher in intercropping with soybean variety JS 95-60 which was at par to intercropping

with soybean variety Surabhi and JS 93-05 and also in sole pigeonpea. The grain yield per plant was reduced by 19.7 -20.9 per cent in intercropping by medium duration variety of soybean (NRC 37 and JS 97-52).

4.38 Test weight

The data on 100 seed weight (test weight) of pigeonpea is given in Table 4.13 and statistical analysis is shown in Appendix-39. It is clear from the results that test weight of pigeonpea was not affected significantly in sole and intercropping with different soybean varieties, which varied from 8.8-9.64 g/100 seed.

4.39 Biomass yield

Data pertaining to biomass yield of pigeonpea is given in Table 4.14 and depicted in Fig.13. The statistical analysis is given in Appendix-40.

It is clear from the results that biomass of pigeonpea was highest (82.74 q/ha.) in sole pigeonpea. The biomass of pigeonpea was lower in intercropping with all varieties of soybean and varied from 19.99 q/ha – 42.95 q/ha. The reduction in biomass as compared to plant population was observed by 18% - 42% in intercropping with different soybean varieties. It was found lowest (19.99 q/ha) in intercropping with soybean variety NRC-37 and was maximum in intercropping with soybean variety JS 76-205.

4.40. Grain yield

Data pertaining to grain yield of pigeonpea in sole cropping and intercropping is presented in Table 4.14 and depicted in Fig.13. The statistical analysis is given in Appendix-41.

After perusal of the results it is clear that pigeonpea yield was maximum (16.6 q/ha) in sole cropping and it was varied from 4.53-10.28 q/ha in intercropping with different varieties of soybean. The pigeonpea yield was reduced by 5% -39% due to intercropping with different soybean varieties as compare to its initial plant population per unit area.

Table 4.14. Average biomass and grain yield (q/ha), harvest index and LER of pigeonpea as in influenced by intercropping with soybean.

Treatment		Biomass yield/plot (Kg)	Grain yield / plot (kg)	Biomass (q/ha)	Grain yield (q/ha)	Harvest index %	LER
T_1	Sole pigeonpea (Asha)	4.96	0.997	82.74 (0.00) 1.00	16.60 (0.00)	20.06	1.00
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	1.800	0.346	40.19 0.48	7.68	25.60	0.46
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	1.83	0.463	36.29 0.43	10.28	21.25	0.61
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	1.96	0.392	34.81 0.42	8.72	25.17	0.52
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	2.15	0.388	42.95 0.51	8.61	20.07	0.51
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	2.24	0.426	35.73 0.43	9.47	26.56	0.57
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	1.20	0.204	19.99 0.24	4.53	22.71	0.27
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	1.66	0.299	32.58 0.39	6.64	20.46	0.40
SEm ±		0.24	0.018	0.86	0.67	0.99	
CD at 5 %		0.74	0.026	2.62	2.04	3.00	

4.41. Harvest index

The harvest index of pigeonpea was calculated for find out the economical yield to total biomass yield and the same is given in Table 4.14. The statistical analysis is given the Appendix-42. It is evident from the result that the harvest index of pigeonpea was varied from 20.06% in sole pigeonpea to 26.56% in intercropping with soybean variety Surabhi. The harvest index was at par in intercropping with soybean variety JS 93-05 and JS 95-60 as compared to intercropping of pigeonpea and soybean variety Surabhi.

4.42. Land equivalent ration

Data on land equivalent ratio of pigeonpea is given in Table 4.14 and depicted in Fig.14. It is clear from the results that LER of pigeonpea varied from 0.27 to 0.61 in intercropping with different varieties of soybean. It was maximum in intercropping with soybean varieties JS-335 followed by Surabhi, JS 95-60 and JS 76-205. The LER was lowest in intercropping of pigeonpea and soybean variety NRC-37(0.27).

3. Evaluation of different soybean varieties for intercropping with pigeonpea

For evaluation of different soybean varieties in intercropping with pigeonpea. The pigeonpea equivalent yield, cost of cultivation, gross monetary return, net monetary return, B:C ratio and land equivalent ratio were calculated and the same have been presented here.

4.43. Pigeonpea equivalent yield

Pigeonpea equivalent yield under sole and intercropping with different soybean varieties is given in Table 4.15 and depicted in Fig. 15. The statistical analysis is given in Appendix-43.

Table 4.15 Average pigeonpea equivalent yield (q/ha), GMR, NMR, B:C ratio, LER and economic LER of different cropping system.

Treatment		Pigeonpea equivalent yield (q/ha)	GMR (Rs./ha)	NMR (Rs./ha)	B:C	LER	Economic LER
T_1	Sole pigeonpea (Asha)	16.60 (0.00%)	43147	31906	3.83	1.00	1.00
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	16.01 (94.447%)	41089	24216	2.43	0.96	0.73
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	18.61 (112.04%)	46869	29696	2.75	1.12	0.93
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	19.99 (120.42%)	50869	33996	3.01	1.20	1.06
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	18.60 112.04	47802	30929	2.83	1.12	0.96
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	20.74 124.93%	52556	35683	3.11	1.24	1.11
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	9.52 57.40%	25263	8390	1.49	0.57	0.26
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	14.41 86.80%	37141	20268	2.20	0.86	0.63
SEm ±		0.80	-	-	-	-	-
CD at 5 %		2.45	-	-	-	-	-

After Perusal of the results it is clear that pigeonpea equivalent yield differed significantly in sole and in intercropping with different soybean varieties. The intercropping of pigeonpea with soybean variety Surabhi gave maximum pigeonpea equivalent yield (20.74 q/ha) followed by JS 95-60, JS-

335 and JS 76-205.The rate of increase in pigeonpea equivalent yield varied from 12.04% (JS-335) to 24.93% (Surabhi) in intercropping as compared to sole cropping of pigeonpea. The pigeonpea equivalent yield in intercropping was decreased by 5.56% (JS 93-05) to 42.6% (NRC-37) as compared to sole pigeonpea.

4.44 Gross monetary return

The data on gross monetary return of sole pigeonpea and intercropping with different soybean varieties is given in Table 4.15 and depicted in Fig.16. The details of cost of cultivation, cast of inputs is given in Appendix 44, 45 and 46. It is clear from the data that the gross monetary return was maximum Rs. 52556/ha in intercropping of soybean variety Surabhi with pigeonpea in 4.2 row system followed by Rs. 50869/ha in JS 95-60.The gross monetary return Rs. 25263/ha was lowest and were found under soybean variety NRC-37 in intercropping with pigeonpea.

4.45 Net monetary return

Data on net monetary return of sole and intercropping of pigeonpea with different soybean varieties is given in Table 4.15 and depicted in Fig. 16. It is clear from the data that intercropping of pigeonpea with soybean variety Surabhi and JS 95-60 gave higher net monetary return over sole pigeonpea at the rate of 11 and 6% over sole pigeonpea. While the net monetary return was found to decrease by 7% in intercropping with soybean variety JS-335 and 74% in intercropping with soybean variety NRC-37 as compared to sole pigeonpea.

4.46 Land Equivalent Ratio (LER)

Data on land equivalent ratio of soybean and pigeonpea intercropping is given in Table 4.15 and shown in Fig. 17. Intercropping of pigeonpea with soybean varieties JS-335, JS 76-205, JS 95-60 and Surabhi were found effective as value of LER was more than 1. The maximum LER 1.24 was obtained by intercropping of pigeonpea with soybean variety Surabhi followed

by LER 1.2 in JS 95-60 and LER 1.12 in JS-335 and JS 76-205. These varieties of soybean were found effective for intercropping with pigeonpea in 4:2 rows system. The soybean variety NRC-37, JS 97-52 and JS 93-05 were not found suitable for intercropping with pigeonpea as the value of LER was found less than 1.

4.47 Economic LER

The data pertaining to economic LER of soybean and pigeonpea intercropping is given in Table 4.15. The intercropping of pigeonpea with soybean varieties Surabhi and JS 95-60 were found most suitable and economical in intercropping than sole cropping of pigeonpea as gave value of economic LER more than 1. Rest of the soybean varieties in intercropping with pigeonpea gave economic LER less than 1 and were unsuitable for intercropping with medium duration pigeonpea variety Asha in 4:2 row system.

4.48 Benefit cost ratio

The benefit cost ratio was calculated and is given in Table 4.15 and depicted in Fig. 18. It is clear from the results that B:C ratio 3.83 was maximum in sole pigeonpea followed by 3.11 in intercropping with soybean variety Surabhi and JS 95-60 (3.01). The benefit cost ratio 1.49 was lowest in intercropping of pigeonpea with soybean variety NRC-37.

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CHAPTER – V

DISCUSSION

The present field study entitled **"Performance of soybean varieties in intercropping with pigeonpea under rainfed conditions"** was taken at JNKVV farm Kuthulia, under All India coordinated research project on Dry land Agriculture in *kharif* 2008-09. The soil of the experimental field was silty clay loam in texture with netural in reaction (ph 7.15), medium in organic carbon, phosphorus, potassium and low in available nitrogen with good drainage. The total rainfall 709.6 mm was received in 42 rainy days. Pigeonpea in sole and in intercropping (2:4) were taken with soybean varieties JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52. The pigeonpea variety was Asha (ICPL 87119).

The results have been presented in chapter-IV. The scientific basis of results achieved and supported by the findings of other scientist is the subject matter of this chapter.

5.1 Growth and yield of soybean in association of pigeonpea

Soybean varieties JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52 were taken in intercropping with pigeonpea variety. Asha in 4:2 system in which 66% rows of soybean and pigeonpea were kept.

Initial plant population per row length basis was uniform under different soybean varieties. The mortality of plants in different soybean varieties varied from 7.74 to 19.28%. It was lower under soybean variety JS 76-205, Surabhi, JS 95-60 and JS-335 were maximum in soybean varieties JS 97-52 and NRC-37 (Table 5.1).

The various observations on growth parameter like shoot height, branches per plant and height of pod bearing node from higher nodes were significantly affected in soybean varieties NRC-37 and JS 97-52 which

showed etiolated growth. This might be due to teletoxic effect of pigeonpea on soybean. The flowering and maturity of soybean in NRC-37 and JS 97-52 delayed as compared to other soybean varieties by which pigeonpea exerted more teletoxic effect on soybean (Table 5.2). Similar findings were also reported by Prasad and Shrivastava (1991), Singh *et al*. (1991) and Nimje (1995). The various observation on yield attributing character like branches per plant, number of pod bearing nodes per plant, pod weight per plant, number of seeds per plant, test weight and seed yield per plant were reduced significantly in NRC-37 and JS 97-52 finally grain yield was affected significantly (Table 5.4). The reduction in grain and biomass yield of soybean varieties JS 97-52 and NRC-37 in association of pigeonpea is explained on the basis of combined effect of reduction in final plant population and poor development of pods and grain. The adverse effect of pigeonpea on growth, yield attributes and yield of medium duration soybean varieties have also been reported by a number of research worker (Saxena and Yadav 1976, Ahlawat *et al*. 1982, Singh *et al*. 1991, Prasad and Shrivastava, 1991, Jadhao *et al*. 1992, Nimje 1995 and Nimje 1996).

The mortality of soybean plant were lower in JS 76-205, Surabhi, JS 95-60 and JS-335 in intercropping with pigeonpea in 4:2 system. The plant height was dwarf. The maturity and 50% flowering was earlier in soybean varieties Surabhi, JS 95-60, JS 76-205, JS-335 and JS 93-05 by which pigeonpea exerted less teletoxic effect on above soybean varieties. The branches per Plant, number of pod bearing nodes per plant, number of nodes per bearing node, number of pods per plant, number of seeds per plant and seed yield per plant were superior as compared to soybean varieties NRC-37 and JS 97-52 by which the soybean varieties Surabhi, JS 95-60, JS 76-205, JS-335 and JS 93-05 gave higher yield (Table 5.3 and 5.4). It is due to dwarf plant type, early flowering and maturity of soybean having lesser duration of association with pigeonpea by which teletoxic effect of pigeonpea was less on above varieties. Therefore these varieties were found most suitable for

intercropping. Similar finding were also reported by Singh *et al*. (1991), Holker *et al*. (1991), Nimje (1995) and Lakhena (2008).

5.2 Effect of soybean varieties on pigeonpea

Soybean and pigeonpea was grown in 4:2 system of intercropping and was compared with sole cropping of pigeonpea. Initial plant population of pigeonpea per row length basis was uniform at 20 DAS while it was reduced at harvest stage of pigeonpea. The mortality of pigeonpea plants was 5.4% in sole cropping and varied from 14.62% to 24.68% in intercropping with different soybean varieties (Table 5.5). Among different intercropping the mortality of pigeonpea plant were higher in association of soybean varieties NRC-37, JS 97-52 and JS-335. The unproductive branches of pigeonpea were higher due to association of soybean varieties JS 93-05, NRC-37, JS-335 and JS 97-52 showed etiolated growth of pigeonpea due to teletoxic effect of soybean. The adverse effect of soybean on pigeonpea plant was more under association of medium duration soybean varieties and was less under early maturing varieties. In early maturing varieties pigeonpea crops recovered after harvest of soybean while pigeonpea growth was not recovered due to association of soybean varieties like NRC-37 and JS 97-52 which was due to reduction in productive branches, number of seed per plant, grains per plant, grain yield per plant and finally grain and biomass yield of pigeonpea (Table 5.7). The adverse effect of medium duration soybean varieties in intercropping on pigeonpea was reported by a number of research worker @ 8-13 per cent by Saxena and Yadav (1976), @ 17.6 Per cent by Tomar *et al*. (1987), @ 6.25 per cent by Prasad and Shrivastava (1991), @ 9.1 per cent by Shanthaveerabhadraiah *et al.* (1991), @ 13-29 per cent by Singh *et al.* (1991), @ 14.81 per cent by Jain *et al.* (1991), @ 7 per cent by Singh and Singh (1994), @ 14 per cent by Nimje (1995) and @ 16 per cent by Nimje (1996).

The teletoxic effect of soybean varieties on pigeonpea yield varied from 4.08 per cent in JS 335 to 38.72 per cent in soybean variety NRC-37 in

intercropping (Table 5.8). Medium maturing soybean varieties had more teletoxic effect than early maturing varieties (JS 95-60, JS-335 and Surabhi). This is because of the fact that after harvest of soybean varieties (JS 93-60, Surabh and JS 76-205). Pigeonpea crop recovered faster while in association with medium duration soybean varieties (NRC-37 and JS 97-52) exerted more teletoxic effect for longer period in association with pigeonpea. These findings are inconformity with the findings of Singh *et al*. (1991), Holker *et al*. (1991), Nimje (1995) and Lakhena (2008).

5.3 Evaluation of different intercropping systems

Pigeonpea crop was grown in sole cropping and in intercropping with soybean varieties (JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52) in 2:4. For evaluation of different system pigeonpea equivalent yield, gross monetary return, net monetary return, benefit cost ratio and LER on the basis of pigeonpea equivalent yield were calculated. Intercropping of soybean and pigeonpea in 4:2 system with soybean varieties JS 95-06, Surabhi and JS 76-205 gave 12 per cent to 24.93 per cent higher pigeonpea equivalent yield as compared to sole pigeonpea (Table 5.9). It may be due to less teletoxic association of each component crops on each other due to dwarf plant types and early maturity of soybean, which exerted less competition in intercropping. The similar finding were also reported by Tomar *et al*. (1987), Holker *et al.* (1991), Billore *et al*. (1993), Maurya (1997), Maurya and Rathi (2000) and Lakhena (2008).

The NMR was higher under intercropping of soybean and pigeonpea with soybean variety Surabhi followed by JS 95-60 which also gave B:C ratio more than 3. The economic LER was 1.11 and 1.06 in intercropping with soybean varieties Surabhi and JS 95-60 with pigeonpea (Table 5.9). It is because of fact that these varieties were having dwarf plant type and early maturity of soybean by which pigeonpea exerted less teletoxic effect on soybean. Similarly due to early maturity of soybean pigeonpea crop

recovered after harvest of soybean in association by which grain yield both component crop was increased. Therefore, intercropping of soybean varieties Surabhi and JS 95-60 and pigeonpea variety Asha gave more yield. The similar finding were also reported by Tomer *et al*. (1987), Thakre *et al*. (1988), Holker *et al* (1991), Billore *et al*. (1991), Billore and Upadhyay (1992), Billore *et al*. (1993), Sharf *et al*. (1993), Maurya (1997) and Maurya (1999) in 4:2 system in intercropping.

Table.5.1 Plant Population /M^2 and plant height (cm) of soybean in association of pigeonpea.

Treatments		Plant population /M^2		Plant height (cm)			
		20 DAS	Final at harvest	25 DAS	50 DAS	75 DAS	At harvest
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	26.66	23.20	28.40	47.07	49.80	50.60
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	25.67	23.20	31.00	51.07	52.33	52.40
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	26.17	23.70	34.40	44.60	44.73	44.80
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	25.42	23.45	28.80	49.07	50.26	50.30
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	27.15	24.68	31.67	55.20	55.80	55.84
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	26.91	21.72	31.20	73.07	73.10	73.12
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	26.66	21.48	29.27	71.00	72.07	72.13
SEM ±		1.15	0.70	0.80	0.73	0.72	0.60
C.D. at 5%		NS	2.135	2.02	2.25	2.24	1.83

Table 5.2 Growth and development of soybean in association of pigeonpea.

Treatments		Number of Leaves/plant			Leaf area Index	Number of Nodules/plant At 60 DAS	50% Flowering days	Maturity in days	Biomass per plant (g)
		25 DAS	50 DAS	75 DAS					
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	8.60	15.33	12.13	2.48	34.33	40.00	88.33	20.73
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	9.26	15.86	13.00	2.78	77.83	40.00	99.33	19.22
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	10.93	14.60	8.26	2.61	33.00	35.33	77.33	30.25
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	8.20	15.00	10.53	2.75	63.33	39.33	90.33	28.54
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	8.60	17.46	11.53	2.66	50.16	38.66	90.00	28.76
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	8.46	17.60	14.86	2.63	67.83	46.66	104.66	30.00
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	8.86	18.26	15.40	2.71	41.33	47.33	105.33	25.86
SEM ±		0.33	0.20	0.68	0.115	1.11	0.42	0.73	0.91
C.D. at 5%		1.02	0.61	2.09	0.25	3.43	1.29	2.25	2.82

Table 5.3 Different characters of soybean in association of pigeonpea.

Treatments		Branches per plant	Height of pod bearing nodes (cm)	Number of nodes per plant	Number of pod bearing node/plant	Number of pods per bearing nodes	Pod length (cm)	Pod weight per plant (g)	Number of pods/ plant	Number of seeds per pod
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	3.20	8.12	11.26	7.46	4.27	4.13	12.45	31.85	3.30
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	2.26	9.80	12.46	7.40	4.92	3.30	11.53	36.47	2.60
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	2.80	7.90	9.86	7.60	5.81	3.90	22.48	44.15	3.07
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	2.60	10.90	11.53	6.07	4.10	3.97	10.56	24.93	3.13
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	3.13	8.90	11.80	8.40	5.61	3.97	19.30	47.12	3.27
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	1.53	12.5	14.40	6.53	4.86	2.70	10.11	31.73	2.33
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	1.86	11.90	13.26	6.80	5.79	2.77	9.70	39.37	2.40
SEM ±		0.39	0.27	0.49	0.50	0.30	0.10	0.48	0.65	0.14
C.D. at 5%		1.21	0.86	1.50	1.54	0.94	0.30	1.50	2.00	0.30

Table 5.4 Yield and yield attributes of soybean in association of pigeonpea

Treatments		Number of seed per plant	Seed yield per plant (g)	Test weight (100 seeds) (g)	Biomass yield per plot (kg)	Grain yield per plot (kg)	Biomass yield (q/ha)	Grain yield (q/ha)	Harvest index (%)
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	105.10	8.30	7.99	1.20	0.500	26.66	11.10	41.59
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	94.66	7.69	8.19	1.60	0.500	35.55	11.10	31.06
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	137.54	14.99	11.11	2.10	0.67	46.66	15.03	32.38
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	77.89	7.04	9.15	1.90	0.60	42.21	13.32	31.63
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	154.08	12.87	8.38	2.00	0.67	44.43	15.03	34.67
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	73.93	6.74	9.24	1.76	0.30	39.25	6.66	17.15
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	94.48	6.47	6.98	1.60	0.46	35.55	10.36	29.16
SEM ±		0.64	0.20	0.40	0.12	0.03	2.86	0.77	2.88
C.D. at 5%		1.96	0.63	0.87	0.39	0.10	8.80	2.36	8.85

Table 5.5 Plant population and plant height of pigeonpea in sole and in intercropping with soybean

Treatment		Plant population /m^2			Plant height/plant (cm)					
		Initial 20 DAS	Final At harvest	Mortality %	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
T_1	Sole pigeonpea	9.07	8.58	5.40	34.60	87.26	137.53	173.20	177.13	177.53
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	5.67	4.68	17.41	36.33	81.13	123.86	152.60	155.67	156.33
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	5.92	4.56	22.93	37.53	89.06	131.33	158.86	161.07	161.33
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	6.04	4.93	18.37	38.53	80.93	121.33	151.06	155.60	155.80
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	5.80	4.68	19.15	33.33	81.33	119.40	150.40	153.13	154.06
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	5.92	5.05	14.62	35.26	80.00	121.66	146.06	153.80	153.80
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	5.55	4.18	24.68	34.93	79.53	123.66	145.73	148.00	148.86
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	5.80	4.56	21.26	33.40	77.66	123.60	147.80	154.00	154.80
SEM ±		-	-	–	0.49	0.95	0.71	1.00	1.03	1.15
C D at 5%		-	-	–	1.49	2.90	2.15	3.03	3.14	3.48

Table 5.6 Average growth characters of pigeonpea in association of soybean verities.

Treatment		Number of leaver/plant						Leaf area index	Number of nodules per plant at 90 DAS	50% Flowering Days	Maturity Y in days	Biomass per plant (g)
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS					
T_1	Sole pigeonpea	12.13	70.86	204.00	236.86	232.00	214.00	3.71	9.60	124.66	180.00	161.65
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	12.86	54.13	141.46	164.40	163.07	156.73	2.76	8.16	124.66	181.33	130.56
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	12.86	55.86	142.80	175.00	174.93	161.60	2.66	9.66	127.00	181.66	119.33
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	11.93	48.46	117.93	159.86	166.73	170.20	2.65	8.33	127.33	182.33	139.32
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	10.26	33.20	109.06	145.13	184.67	155.40	2.73	7.83	126.66	182.33	156.65
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	10.73	34.80	103.80	132.53	140.33	134.46	2.68	8.66	125.66	181.00	125.26
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	11.20	33.20	97.40	148.13	146.60	142.40	2.81	8.16	126.33	179.66	116.22
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	12.46	44.66	117.60	156.40	153.20	145.06	2.53	7.33	125.00	180.33	129.80
SEM ±		0.26	0.79	0.59	0.67	1.02	1.31	0.17	1.05	0.79	0.98	1.15
C D at 5%		0.80	2.40	1.80	2.05	3.09	3.99	0.52	NS	NS	NS	3.51

Table 5.7 Average yield and yield attributing characters of pigeonpea in association of soybean variety.

Treatment		Number of Productive branches/ plant	Number of Un productive branches /plant	Total branches /plant	Number of pods/ plant	Pod length /plant (cm)	Pod weight/ plant (g)	Number of grains /plant	Number of seeds / pod	Grain yield/plant (g)	Test weight (g)
T_1	Sole pigeonpea	13.77	2.95	16.72	87.68	3.42	34.19	324.22	3.20	32.33	9.48
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	12.44	5.99	18.43	81.76	3.40	32.37	344.44	3.06	32.64	9.49
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	10.33	5.55	15.88	88.12	3.40	36.30	280.44	3.20	25.06	8.95
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	10.33	2.55	12.88	83.40	3.82	35.52	375.77	3.13	34.83	9.29
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	10.88	2.44	13.32	84.50	3.47	35.99	325.44	3.00	31.33	9.64
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	12.44	2.55	14.99	82.89	3.44	32.49	351.10	3.13	32.57	9.28
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	10.33	5.66	15.99	75.37	3.32	28.79	265.88	2.93	25.57	9.65
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	11.33	4.55	15.88	79.23	3.99	34.54	295.33	3.13	25.96	8.80
SEM ±		0.43	0.45	1.03		1.39	0.21	0.19	3.73	0.23	1.76
C D at 5%		1.33	1.37	3.13		4.23	NS	0.58	11.34	NS	5.35

Table 5.8 yield and LER of pigeonpea in association of soybean varieties.

Treatment		Biomass yield / plot (kg)	Grain yield /plot (kg)	Biomass (q/ha)	Grain yield (q/ha)	Harvest index %	LER	% Reduction
T_1	Sole Pigeonpea	4.96	0.997	82.74	16.60	20.06	1.00	-
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	1.800	0.346	40.19	1.69	25.60	0.46	16
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	1.83	0.463	36.29	10.29	21.25	0.61	4
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	1.96	0.392	34.81	8.72	25.17	0.52	14
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	2.15	0.388	42.95	8.61	20.07	0.51	12
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	2.24	0.426	35.73	9.47	26.56	0.57	8
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	1.20	0.204	19.99	4.53	22.71	0.27	34
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	1.66	0.299	32.58	6.64	20.46	0.40	23
SEM ±		0.31	0.24	0.86	0.67	0.99	-	-
C D at 5%		NS	0.74	2.62	2.04	3.00	-	-

Table 5.9 Average pigeonpea equivalent yield (q/ha), GMR, NMR, B:C ratio, LER and economic LER of different cropping system.

Treatment		Pigeonpea equivalent yield (q/ha)	GMR (Rs./ha)	NMR (Rs./ha)	B:C	LER	Economic LER
T_1	Sole pigeonpea (Asha)	16.60 (0.00%)	43147	31906	3.83	1.00	1.00
T_2	Soybean (JS 93-05) (Check) +Pigeonpea (Asha) in 4:2	16.01 (94.447%)	41089	24216	2.43	0.96	0.73
T_3	Soybean (JS- 335) +Pigeonpea (Asha) in 4:2	18.61 (112.04%)	46869	29696	2.75	1.12	0.93
T_4	Soybean (JS 95-60) +Pigeonpea (Asha) in 4:2	19.99 (120.42%)	50869	33996	3.01	1.20	1.06
T_5	Soybean (JS 76-205) +Pigeonpea (Asha) in 4:2	18.60 112.04	47802	30929	2.83	1.12	0.96
T_6	Soybean (Surabhi) + Pigeonpea (Asha) in 4:2	20.74 124.93%	52556	35683	3.11	1.24	1.11
T_7	Soybean (NRC-37) +Pigeonpea (Asha) in 4:2	9.52 57.40%	25263	8390	1.49	0.57	0.26
T_8	Soybean (JS 97-52) +Pigeonpea (Asha) in 4:2	14.41 86.80%	37141	20268	2.20	0.86	0.63
SEm ±		0.80	-	-	-	-	-
CD at 5 %		2.45	-	-	-	-	-

CHAPTER –VI

SUMMARY, CONCLUSION AND SUGGESTION FOR FURTHER WORK

The present experiment entitled **"Performance of soybean varieties in intercropping with pigeonpea under rain fed conditions"** was taken under All India coordinated research project on Dry land Kuthulia farm of JNKVV. College of Agriculture, Rewa during *Kharif* season of 2008-09 in which two cropping system (sole pigeonpea and intercropping of with soybean varieties JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52 in 2:4 system) were tried. The pigeonpea variety Asha (ICPL-87119) was taken as test variety in sole and in intercropping with different soybean varieties. The experiment was taken in randomized block design three replication with the following objectives.

1) To find out suitable soybean variety for intercropping with pigeonpea.
2) To find out the effect of soybean varieties on growth and development of pigeonpea in intercropping.
3) To find out economics of different measurement.

The sowing of soybean and pigeonpea in sole and in intercropping was done on 30th June 2008 manually with uniform application of 20 kg. N, 60 kg. P_2O_5 and 20 kg k_2O/ha on the basis of per row in both components crop. The seed rate of soybean was kept 100 kg/ha and for pigeonpea was 20 kg/ha on per row basis. Four rows of different soybean varieties (JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52) were intercropped after

two rows of pigeonpea (Asha) and was compared with sole cropping of pigeonpea which were planted at 60 cm row apart.

Weed control was done manually at 25 and 45 days after sowing. Insect pest of soybean and pigeonpea crop was controlled by two spraying of Endosulphan @ 1 lit/ha.

The soil of experimental field was neutral in reaction (pH-7.15), EC-0.18 dsm^{-1}, medium in organic carbon (0.52%), available phosphorus (14.3 kg/ha) and available potash (179.2 kg/ha) and low in available nitrogen (240.8 kg/ha). The soil was silty clay loam in texture. The total rain fall received during the crop season was 709.6 mm. distributed in 42 rainy days. All other recommended package of practices under rain fed condition were adopted. The soybean crop was harvested 26-9-08 to 17-10-08 while pigeonpea crop was harvested on 27 January 2009. The silent finding on the present experiment are summarized here under-

1) Effect of pigeonpea on soybean.

2) Effect of soybean varieties on pigeonpea in intercropping.

3) Evaluation of different intercropping.

1) <u>Effect of pigeonpea on soybean variety in intercropping</u>

Four rows of soybean followed by two rows of pigeonpea (4:2) was planted in intercropping with medium duration variety Asha and was compared with local check variety of soybean JS 93-05. The other soybean varieties for intercropping with pigeonpea were JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52.

A) Pre harvest

Plant population

The plant population of per row of soybean at 20 days after sowing was equal in all the intercropping system. The row proportion of soybean was

kept 66 per-cent in intercropping with pigeonpea under all the varieties of soybean. The mortality of soybean plants were lowest in intercropping with pigeonpea under soybean variety JS 76-205 (7.74). The mortality of soybean plant were maximum in soybean variety NRC-37 and JS 97-52 in intercropping with pigeonpea.

Plant height

Taller plants of soybean in intercropping with pigeonpea was observed in JS 97-52 and NRC-37. Soybean plant height was less in intercropping with pigeonpea under soybean variety JS 95-60, JS 93-05, JS 76-205 and Surabhi.

Number of nodules/plant

Number of nodules per plant under different soybean variety in intercropping with pigeonpea was maximum in JS-335 followed by NRC-37 and JS 76-205.

Days taken to 50% flowering and maturity

Earlier 50% flowering and maturity of soybean in intercropping with pigeonpea was observed in soybean varieties JS 95-60 followed by JS 93-05, Surabhi and JS 76-205. The maturity and 50% flowering was delayed in intercropping with pigeonpea under soybean varieties NRC-37 and JS 97-52.

B) Post harvest

Yield contributing characters

Number of branches per plant of soybean were significantly higher in JS 93-05 followed by Surabhi, JS 95-60 and JS 76-205 in intercropping with pigeonpea. Number of branches per plant were lower in soybean variety NRC-37 and JS 97-52 in intercropping with pigeonpea.

Height of first pod bearing node was started from lower node in JS 95-60, Surabhi, JS 93-05 and JS-335 varieties of soybean in intercropping with pigeonpea.

Number of pods per plant and pod bearing nodes per plant were higher in soybean variety Surabhi, JS 95-60 and JS 93-05 in intercropping with pigeonpea. Pod and seed yield per plant of soybean was significantly higher in soybean variety JS 95-60 and Surabhi which was 55 to 80.56% higher than local check variety JS 93-05.

The similar trend were observed in seed yield per plant, number of seeds per plant and number of pods per plant in intercropping with pigeonpea.

Test weight

Hundred seed weight (Test weight) of different soybean varieties varied from 6.98 g. to 11.11 g. The test weight was maximum under soybean variety JS 95-60 followed by JS 97-52 which was 15.64% to 39.04% higher than local check variety JS 93-05 in intercropping with pigeonpea.

Biomass yield

The maximum biomass yield of soybean 46.66 q/ha was observed under JS 95-60 followed by 44.43 q/ha in Surabhi and 42.21 q/ha in JS 76-205 in intercropping with pigeonpea. The biomass yield per hectare was increased by 75% in JS 95-60, 66% in Surabhi, 58.32% in JS 76-205, in intercropping with pigeonpea as compare to local check variety JS 93-05.

Grain yield

The grain yield of soybean was maximum 15.03 q/ha in Surabhi and JS 95-60 followed by 13.32 q/ha in JS 76-205 variety of soybean in intercropping with pigeonpea. Soybean variety NRC-37 and JS 97-52 gave lower yield by 40% in NRC-37 and JS 97-52 as compared to local check variety JS 93-05 in intercropping with pigeonpea.

Harvest index

Harvest index of soybean variety JS 93-05 was maximum (41.59%) followed by Surabhi (34.67%) and JS 95-60 (32.38%). The lower harvest index of soybean was obtained in NRC-37 variety of soybean (17.15%) and JS 97-52 (29.16%).

2) <u>Effect of soybean varieties on pigeonpea in intercropping</u>

Pigeonpea crop was grown in sole and in intercropping system (4:2 replacement) with different soybean variety JS 93-05, JS-335, JS 95-60, JS 76-205, Surabhi, NRC-37 and JS 97-52.

A) Pre harvest studies

Plant population

The initial plant population per row length in intercropping and sole cropping of pigeonpea was equal and at par. The plant population of pigeonpea differed significantly at harvest stage due to mortality of pigeonpea which varied from 5.4 to 24.68%. The mortality of pigeonpea plant varied from 5.4% in sole cropping to 24.68% in intercropping with soybean variety NRC-37. The mortality of pigeonpea plant were higher in intercropping in medium duration soybean variety NRC-37 and JS 97-52 followed by JS-335 varieties of soybean. The initial row proportion was 100% in sole cropping and 61 to 67% in intercropping with different soybean varieties which was equal to desired plant population.

Growth characters

The plant height, number of trifolic leaves and leaf area index of pigeonpea, plant were significantly higher in sole cropping while it was lower in intercropping with soybean variety NRC-37 and JS 97-52 at all the stages of growth.

Days taken to 50% Flowering and maturity

Days taken to 50% flowering and maturity of pigeonpea was not affected significantly in sole cropping and in intercropping with different soybean varieties in 4:2 system.

Number of nodules per plant

The number of nodules per plant of pigeonpea was counted at 90 DAS and was not found significant. A though number of nodules per plant were higher in sole pigeonpea and in intercropping with soybean variety JS- 335.

Post- harvest

Branches per plant

Productive and total branches per plant were significantly higher in sole pigeonpea followed by intercropping with soybean varieties Surabhi and JS 95-60. The unproductive branches of pigeonpea was higher in intercropping with soybean varieties NRC-37, JS-335, JS 93-05 and JS 97-52 which varied from 28.66% to 35.4%

Yield contributing characters

The number of pods per plant of pigeonpea was maximum in intercropping with soybean variety JS-335 which was at par to sole pigeonpea and intercropping of pigeonpea with soybean varieties JS 76-205 and JS 95-60. Pod length of pigeonpea in intercropping and in sole cropping was not affected significantly. The pod weight per plant of pigeonpea was maximum 36.3gm/plant in intercropping with soybean variety JS-335 followed by JS 76-205 and JS 95-60 which was at par to sole pigeonpea. The number of grains per plant of pigeonpea The was significantly higher in intercropping with soybean variety JS 95-60 followed by Surabhi. Number of seeds per pod of pigeonpea was not affected significantly. Similarly, test weight of pigeonpea was not affected significantly in sole cropping and also in intercropping with different soybean varieties. The grain yield per plant of

soybean 34.3 gm per plant was maximum in intercropping with soybean variety JS 95-60 which was at par to sole pigeonpea and intercroped pigeonpea with soybean varieties Surabhi. JS 93-05 and JS 76-205.

Biomass yield

The biomass yield of pigeonpea was maximum (82.74 q/ha) in sole cropping followed by intercropping of soybean varieties JS 76-205 and JS 93-05 which was 51% and 48% of sole pigeonpea.

Grain yield

The grain yield of pigeonpea 16.6 q/ha was maximum in sole cropping and varied from 4.53 to 10.28 q/ha in intercropping with different soybean varieties.

Harvest Index

The harvest index of pigeonpea was maximum in intercropping with soybean variety Surabhi (26.56%) followed by JS 93-05 (25.6%) and JS 95-60 (25.17%). The harvest index value of pigpeonpea was lowest in sole cropping followed by intercropping with soybean variety JS 76-205 and JS 97-52 which were found at par.

Land equivalent ratio

The LER of pigeonpea in intercropping with different soybean varieties varied from 0.27 to 0.61 and was maximum in intercropping with soybean variety JS-335 (0.61) followed by Surabhi (0.57). The teletoxic effect of soybean varieties on pigeonpea varied from 5% to 39%. The teletoxic effect of soybean variety NRC-37 was maximum (39%) followed by JS 97-52 (26%) as compared to its initial plant population (66%). The teletoxic effect of soybean varieties JS-335 and Surabhi varied from 5 to 9% which were found most effective for intercropping with pigeonpea.

3. **Evaluation of different soybean varieties for intercropping with pigeonpea**

Pigeonpea equivalent yield

The pigeonpea equivalent yield was maximum 20.74 q/ha in intercropping with soybean variety Surabhi followed by 19.99 q/ha in JS 95-60 and 18.6 q/ha in JS-335 and JS 76-205. These soybean varieties gave 12% to 24.93% higher pigeonpea equivalent yield as compared to sole pigeonpea.

Gross and Net Return

The gross profit Rs. 52556/ha was maximum in intercropping of pigeonpea with soybean variety Surabhi followed by JS 95-60 and JS 76-205

The net monetary return Rs. 35683/ha was maximum in intercropping of pigeonpea and soybean variety Surabhi followed by JS 95-60. These soybean varieties in intercropping with pigeonpea gave 6 to 11% higher net return as compared to sole pigeonpea.

Land Equivalent Ratio

The land equivalent ratio was maximum in pigeonpea intercropping with soybean variety Surabhi (1.24) followed by JS 95-60 (1.20) and JS-335 and JS 76-205 (1.12). Rest of the soybean varieties in intercropping with pigeonpea gave a LER less than 1 and were found unsuitable for intercropping.

Benefit Cost Ratio

The benefit cost ratio 3.83 was maximum in sole pigeonpea followed by 3.11 in intercropping with soybean variety Surabhi and 3.01 in soybean variety JS 95-60.

Conclusion :-

1. Soybean and pigeonpea in intercropping showed adverse effect on each other. The teletoxic effect of pigeonpea was more on soybean variety NRC-37 and JS-97 52.The teletoxic effect of soybean varieties NRC-37 and JS-97-52 was more on pigeonpea in intercropping.

2. The soybean varieties Surabhi, JS-95-60 JS-335 and JS 76-205 were found most suitable for intercropping with pigeonpea as gave LER more than 1. The soybean varieties JS-93-05, NRC-37, JS 97-52 were found unsuitable for intercropping with pigeonpea as these were given LER less than 1 on the basis of pigeonpea equivalent yield.

3. Benefit cost ratio was maximum in intercropping of pigeonpea was with soybean varieties Surabhi and JS-95-60. These were found most suitable and economical for intercropping with pigeonpea as it gave economic LER more than 1.

Suggestion for farther work

1. The experiment must be repeated in same location to draw a sound conclusion.
2. Teletoxic effect of pigeonpea on soybean in intercropping must be evaluated by including the recent released soybean varieties.

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APPENDICES

APPENDIX – I

ANOVA Table for average plant population of soybean in per row of plot.

Source of variance	D.F.	M.S. at stage initial	M.S. at final stage	F_{table} at 5%
Replication	2	4.61	0.145	3.88
Treatment	6	11.41	10.19*	3.00
Error	12	4.00	1.47	
Total	20	–	–	

Appendix - II

ANOVA table for average plant height of soybean at different stages of growth.

Source of variance	D.F.	Mean sum of square				F_{table} at 5%
		25DAS	50DAS	75 DAS	At harvest	
Replication	2	0.30	5.32	3.43		3.88
Treatment	6	12.95*	360.91*	249*	3.16	3.00
Error	12	1.92	1.61	1.59	196.99*	
Total	20	–	–	–	1.09	
					–	

Appendix – III

ANOVA table for average number of leaves/plant of soybean at different stages of growth.

Source of variance	D.F.	Mean sum of square			F_{table} at 5%
		25DAS	50DAS	75DAS	
Replication	2	0.765	2.25	2.015	3.88
Treatment	6	2.80*	6.31*	18.33*	3.00
Error	12	0.335	0.61	1.40	
Total	20	–	–	–	

* Significant at 5% level.

** Significant at 1% level

Appendix - IV

ANOVA table for average leaf area index (LAI) of soybean at 60 DAS.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.08	0.04	2	3.88
Treatment	6	0.18	0.03	1.50	3.00
Error	12	0.28	0.02		
Total	20	0.54	–	–	

Appendix - V

ANOVA table for mean number of root nodules per plant in soybean at 60 DAS.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	8.67	4.335	1.90	3.88
Treatment	6	5503.96	917.32	404.10	3.00
Error	12	27.33	2.27		
Total	20	5539.96	–	–	

Appendix – VI

ANOVA table for average number of days taken to 50% flowering of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	2.96	1.48	2.79	3.88
Treatment	6	343.62	57.27	108.05*	3.00
Error	12	6.38	0.53		
Total	20	352.96	_		

* Significant at 5% level.

** Significant at 1% level

Appendix – VII

ANOVA table for average number of days taken to maturity of soybean

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.09	0.04	0.03	3.88
Treatment	6	1135.90	189.31	118.32*	3.00
Error	12	19.24	1.60		
Total	20	1155.24	–		

Appendix - VIII

ANOVA table for average soybean biomass per plant (g) at harvest

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	2.45	1.22	0.57	3.88
Treatment	6	106.66	17.77	8.34*	3.00
Error	12	25.57	2.13		
Total	20	134.68	–		

Appendix - IX

ANOVA table for average number of branches per plant of soybean at harvest.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.70	0.35	0.74	3.88
Treatment	6	7.14	1.19	2.53	3.00
Error	12	5.73	0.47		
Total	20	13.57	–		

* Significant at 5% level.
** Significant at 1% level.

Appendix - X

ANOVA table for average height of first pod bearing node of soybean (cm).

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.072	0.036	0.15	3.88
Treatment	6	59.59	9.93	42.44*	3.00
Error	12	2.81	0.23		
Total	20	62.47	–		

Appendix – XI

ANOVA table for average number of nodes per plant of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	2.41	1.20	1.66	3.88
Treatment	6	38.63	6.43	8.89*	3.00
Error	12	8.69	0.72		
Total	20	49.73	–		

Appendix – XII

ANOVA table for average number of pod bearing nodes per plant of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	1.18	0.59	0.75	3.88
Treatment	6	14.52	2.42	3.10*	3.00
Error	12	9.36	0.78		
Total	20	25.06	–		

* Significant at 5% level.

** Significant at 1% level

Appendix - XIII

ANOVA table for average number of pods per bearing node of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.89	0.44	1.58	3.88
Treatment	6	9.84	1.64	5.85*	3.00
Error	12	3.40	0.28		
Total	20	14.13	–		

Appendix – XIV

ANOVA table for average pod length of soybean (cm).

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.11	0.055	1.83	3.88
Treatment	6	6.62	1.10	36.77*	3.00
Error	12	0.40	0.03		
Total	20	7.13	–		

Appendix – XV

ANOVA table for average pod weight per plant of soybean (g).

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.64	0.32	0.44	3.88
Treatment	6	97.70	16.28	22.61*	3.00
Error	12	8.74	0.72		
Total	20	107.08	–		

* Significant at 5% level.
** Significant at 1% level.

Appendix - XVI

ANOVA table for average number of pods per plant of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.66	0.33	0.25	3.88
Treatment	6	1103.65	183.94	142.59*	3.00
Error	12	15.50	1.29		
Total	20	1119.81	–		

Appendix – XVII

ANOVA table for average number of seeds per pod of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.18	0.09	1.50	3.88
Treatment	6	3.18	0.53	8.83*	3.00
Error	12	0.76	0.06		
Total	20	4.12	–		

Appendix - XVIII

ANOVA table for average number of grains per plant of soybean.

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.93	0.46	0.37	3.88
Treatment	6	2283.04	380.50	309.35*	3.00
Error	12	14.78	1.23		
Total	20	2298.75	–		

* Significant at 5% level.
** Significant at 1% level

Appendix - XVIII

ANOVA table for average grain yield per plant of soybean (g).

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.45	0.22	1.80	3.88
Treatment	6	14.36	2.39	18.99*	3.00
Error	12	1.52	0.12		
Total	20	16.33	–		

Appendix - XX

ANOVA table for average test weight of soybean (g) (100 seeds)

Source of variance	D.F.	S.S.	M.S.	F_{cal}	F_{table} at 5%
Replication	2	0.69	0.34	1.34	3.88
Treatment	6	96.51	16.085	62.83*	3.00
Error	12	3.08	0.25		
Total	20	100.28	–		

Appendix - XXI

ANOVA table for average biomass yield of soybean (q/ha)

Source of variance	D.F.	S.S.	M.S.	F_{cat}	F_{table} at 5%
Replication	2	24.46	12.23	0.49	3.88
Treatment	6	821.03	136.83	5.56*	3.00
Error	12	294.84	24.57		
Total	20	1140.33	–		

* Significant at 5% level.
** Significant at 1% level.

Appendix – XXII

ANOVA table for average grain yield of soybean (q/ha)

Source of variance	D.F.	S.S.	M.S.	F_{cat}	F_{table} at 5%
Replication	2	3.17	1.58	0.87	3.88
Treatment	6	252.51	42.08	23.18*	3.00
Error	12	21.78	1.81		
Total	20	277.46	–		

Appendix - XXIII

ANOVA table for average harvest index of soybean (%).

Source of variance	D.F.	S.S.	M.S.	F_{cat}	F_{table} at 5%
Replication	2	5.82	2.91	0.116	3.88
Treatment	6	1188.01	198.00	7.94*	3.00
Error	12	299.04	24.92		
Total	20	1492.87	–		

Appendix - XXIV

Mean sum of square for average plant population of pigeonpea in per row length of net plot.

Source of variation	D F	M S Initial	M S Final	F_{Table} at 5 %
Replication	2	1.29	1.17	3.74
Treatment	7	0.66 (NS)	1.31 (NS)	2.72
Error	14	0.76	2.16	
Total	23	-	-	

Significant at 5% level

Significant at 1% level

Appendix - XXV

Mean sum of square for average plant height of pigeonpea at different stages of growth.

Source of variation	D.F.	MS at 30 DAS	MS at 60 DAS	MS at 90 DAS	MS at 120 DAS	MS at 150 DAS	MS at 180 DAS	F_{Table} at 5%
Replication	2	1.22	0.27	2.10	1.66	8.835	4.91	3.74
Treatment	7	10.42*	46.61*	110.32*	248.85*	231.19*	226.51*	2.77
Error	14	0.728	2.74	1.52	3.01	3.23	3.97	
Total	23	–	–	–	–	–	–	

Appendix -XXVI

Mean sum of square for average number of trifolic leave plant at different stages of growth.

Source of variation	D.F.	MS at 30 DAS	MS at 60 DAS	MS at 90 DAS	MS at 120 DAS	MS at 150 DAS	MS at 180 DAS	F_{Table} at 5%
Replication	2	0.52	3.00	1.20	1.22	12.16	5.12	3.74
Treatment	7	2.87*	529.86*	3537.29*	3042.16*	2507.91*	1815.07*	2.77
Error	14	0.21	1.88	1.06	1.37	3.13	5.20	
Total	23	–	–	–	–	–	–	

Appendix - XXVII

ANOVA Table for average leaf area index (LAI) per plant in pigeonpea at 120 DAS.

Source of Variation	**D.F.**	**S.S.**	**M.S.**	**F_{cal}**	F_{Table} at 5%
Replication	2	0.14	0.07	0.77	3.74
Treatment	7	2.90	0.41	4.60*	2.77
Error	14	0.3	0.02		
Total	23	3.92			

* Significant at 5% level.

** Significant at 1% level

Appendix - XXVIII

ANOVA Table for average number of root nodules / plant in pigeonpea at 90 DAS.

Source of Variation	D.F.	S.S.	M.S.	F_{cal}	F_{Table} at 5%
Replication	2	0.87	0.43	0.31	3.74
Treatment	7	13.94	1.99	1.46	2.77
Error	14	19.04	1.36		
Total	23	33.85			

Appendix - XXIX

ANOVA Table for average number of days taken to 50% flowering of pigeonpea.

Source of Variation	D F	S S	M S	F_{cal}	F_{Table} at 5%
Replication	2	11.59	5.79	3.08	3.74
Treatment	7	23.84	3.40	1.81	2.77
Error	14	26.41	1.88		
Total	23	61.84			

Appendix - XXX

ANOVA Table for average number of days taken to maturity of pigeonpea (in days).

Source of Variance	D F	S S	M S	F_{cal}	F_{Table} at 5%
Replication	2	3.09	1.54	0.52	3.74
Treatment	7	21.84	3.12	1.06	2.77
Error	14	40.91	2.92		
Total	23	65.84			

* Significant at 5% level.
** Significant at 1% level

Appendix - XXXI

Mean sum of square for average number dry matter per plant (g) of pigeonpera at harvest.

Source of Variation	D F	S S	M S	F_{cal}	F_{Table} at 5%
Replication	2	13.87	6.93	1.72	3.74
Treatment	7	4180.74	597.24	148.56*	2.77
Error	14	56.33	4.02		
Total	23	4250.94			

Appendix- XXXII

ANOVA Table for average productive, unproductive and total branches / plant of pigeonpea at harvest.

Source of Variance	D F	M S	M S	M S at harvest	F_{Table} at 5%
Replication	2	0.2	0.84	2.79	3.74
Treatment	7	3.67	6.53*	22.11*	2.77
Error	14	1.59	0.38	3.21	
Total	23	-	-	-	

Appendix- XXXIII

ANOVA Table for number of pods per plant of pigeonpea.

Source of Variation	D F	S S	M S	F_{cal}	F_{Table} at 5%
Replication	2	10.30	5.15	0.88	3.74
Treatment	7	372.98	53.28	9.12*	2.77
Error	14	81.81	5.84		
Total	23	465.09			

* Significant at 5% level.
** Significant at 1% level

Appendix- XXXIV

ANOVA Table for average pod length (cm).

Source of Variation	**D F**	**S S**	**M S**	**F_{cal}**	F_{Table} at 5%
Replication	2	0.32	0.76	0.72	3.74
Treatment	7	1.17	0.16	0.75	2.77
Error	14	2.04	0.14		
Total	23	4.62	-	-	-

Appendix - XXXV

ANOVA Table for average pod weight per plant (g).

Source of Variation	**DF**	**SS**	**M S**	**F_{cal}**	**F_{Table} at 5%**
Replication	2	0.011	0.0025	0.045	3.74
Treatment	7	10.21	0.17	3.54	2.77
Error	14	0.679	0.048		
Total	23	1.90	-		

Appendix- XXXVI

ANOVA Table for average number of grains per plant of pigeonpea

Source of Variation	**DF**	**SS**	**M S**	**F_{cal}**	**F_{Table} at 5%**
Replication	2	4.70	2.35	0.056	3.74
Treatment	7	29471.98	4210.28	100.42*	2.77
Error	14	586.95	41.92		
Total	23	30063.63	-		

* Significant at 5% level.

** Significant at 1% level

Appendix- XXXVII

ANOVA Table for average number of grains per pod of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	0.57	0.28	1.78	3.74
Treatment	7	0.18	0.025	0.16	2.77
Error	14	2.29	0.16		
Total	23	3.04	-		

Appendix- XXXVIII

ANOVA Table for average grain yield per plant (g) of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	3.31	1.65	0.17	3.74
Treatment	7	2563.31	366.18	39.12*	2.77
Error	14	131.15	9.36		
Total	23	2697.77	-		

Appendix- XXXIX

ANOVA Table for average test weight (100 seeds) of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	0.75	0.37	0.65	3.74
Treatment	7	3.16	0.45	0.78	2.77
Error	14	4.31	0.57		
Total	23	11.91	-		

* Significant at 5% level.

** Significant at 1% level

Appendix- XXXX

ANOVA Table for average bio mass yield (q/ha) of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	5.79	2.89	1.28	3.74
Treatment	7	7212.17	1030.31	457.91*	2.77
Error	14	31.52	2.25		
Total	23	7249.48	-		

Appendix- XXXXI

ANOVA Table for average grain yield (q/ha) of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	7.52	3.76	2.74	3.74
Treatment	7	261.33	37.33	27.25*	2.77
Error	14	19.18	1.37		
Total	23	288.03	-		

Appendix- XXXXII

ANOVA Table for average harvest index (%)of pigeonpea.

Source of Variation	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	19.84	9.92	3.31	3.74
Treatment	7	346.49	49.49	16.55*	2.77
Error	14	55.18	2.99		
Total	23	421.51	-		

* Significant at 5% level.

** Significant at 1% level

Appendix- XXXXIII

ANOVA Table for average for pigeonpea equivalent yield.

Source of Variance	DF	SS	M S	F_{cal}	F_{Table} at 5%
Replication	2	1.40	0.7	0.35	3.74
Treatment	7	274.31	39.18	19.99*	2.77
Error	14	27.56	1.96		
Total	23	303.27	-		

* Significant at 5% level.
** Significant at 1% level

Appendix -XXXXIV

Cost of different input

1. Cost of ploughing Rs. 500/ha.
2. Cost of Planking Rs. 500/ha.
3. Cost of sowing Rs. 500/ha.
4. Cost of Rhizobium culture - Rs 10 per packet
5. Cost of Thirum (100 g.) – Rs. 20
6. Cost of Soybean seed/kg – Rs. 20
7. Cost of Pigeonpea seed/kg – Rs. 30
8. Cost of fertilizer
   a. Nitrogen/kg @ Rs. 12/kg
   b. Phosphorus (P_2O_5) @ Rs. 18/kg.
   c. Potash (K_2O)/ kg @ Rs. 13/ kg
9. Cost of labour wages/ days Rs. 106
10. Cost of Endosulphan @ Rs. 225/ litter
11. Hire of sprayer/ day Rs. 20
12. Rental value Rs. 1000/ha/ year
13. Interest @ 10% anum

Appendix - XXXXV

Cost of produce.

1. Sale rate of soybean grains at market rate Rs. 18/kg
2. Sale rate of pigeonpea grain Rs. 24/kg
3. Sale rate of soybean Rs. 50/q
4. Sale rate of Straw and sticks of pigeonpea Rs. 50/q

Appendix -XXXXVI

Details of cost of cultivation (Rs/ha)

Treatments		Ploughing and Planking	Seed cost	Fertilizer cost	Rhizobium + Thirum	Sowing	P P	Weeding	Harvesting	Threshing	Winowing	Interest	Total
T_1	Sole pigeonpea (Asha)	1500	600	1580	100	500	914	3180	1060	1060	212	535	11241
T_2	Soybean (JS 93-05) (Check)+ pigeonpea (Asha)	1500	400 + 1320 = 1720	2085	132	500	1206	3180	700+2120 = 2820	700+1590 = 2290	636	803	16873
T_3	Soybean (JS-335)+ Pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873
T_4	Soybean (JS 95-60)+ pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873
T_5	Soybean (JS 76-205) + pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873
T_6	Soybean (Surabhi) + pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873
T_7	Soybean (NRC-37)+ Pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873
T_8	Soybean (JS 97-52) + pigeonpea (Asha)	1500	1720	2085	132	500	1206	3180	2820	2290	636	803	16873

VITA

The author was born on 04.08.1982 at village Dabri, Post Maltar, Distt. Khargone (M.P.). He passed his High School Certificate Examination from Govt. HSSC School, Singune and Higher Secondary School Certificate Examination from Govt. HSSC, Khargone (M.P.) during the year 2000 and 2002, respectively.

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Fig 1 Weekly mean temperature ^{0}C, rainfall (mm), number of rainy days and relative humidity (%) during crop season

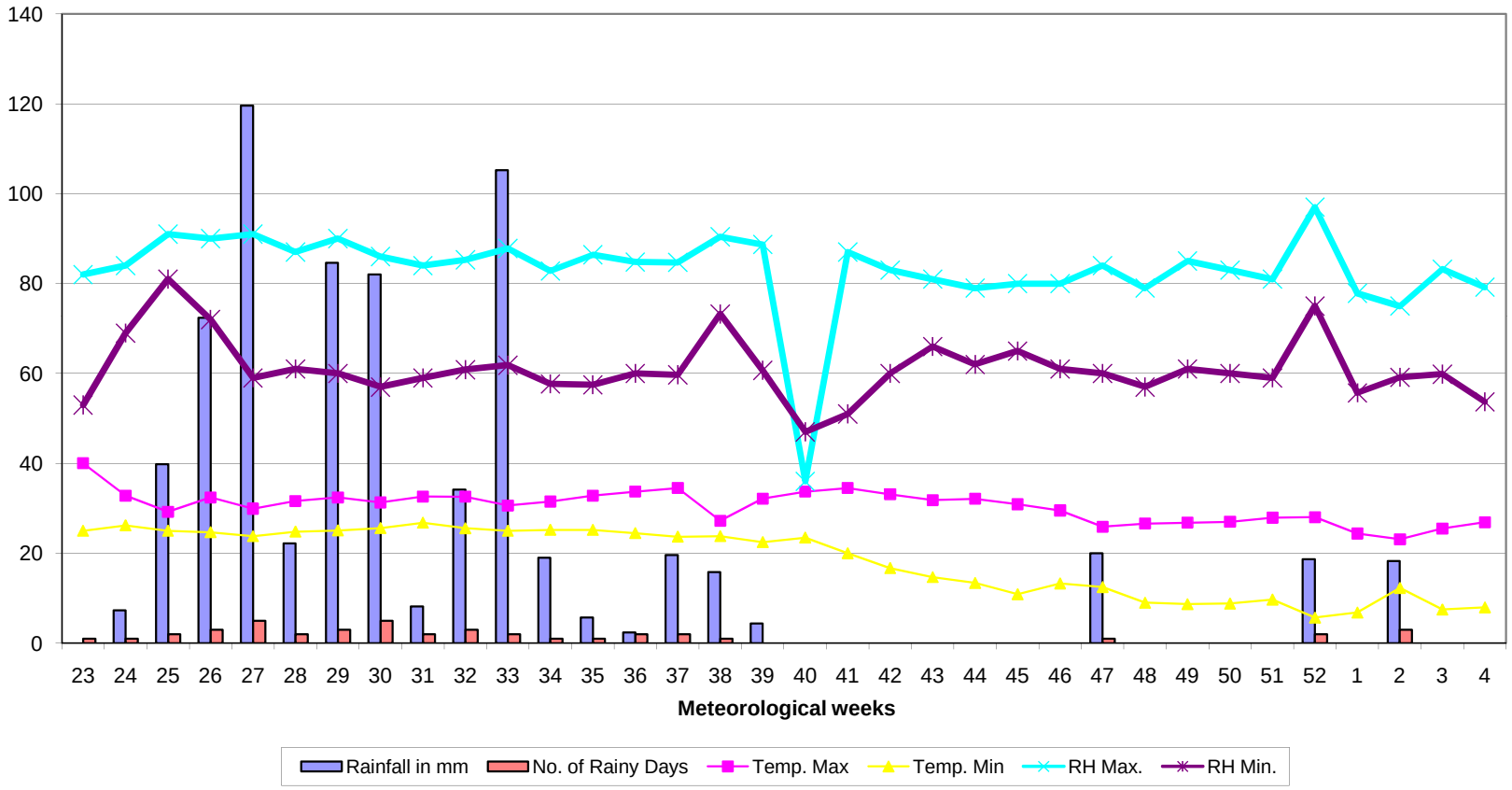


Fig. 3 Average number of soybean plants/m^2 at 20 DAS and at harvest under different treatments

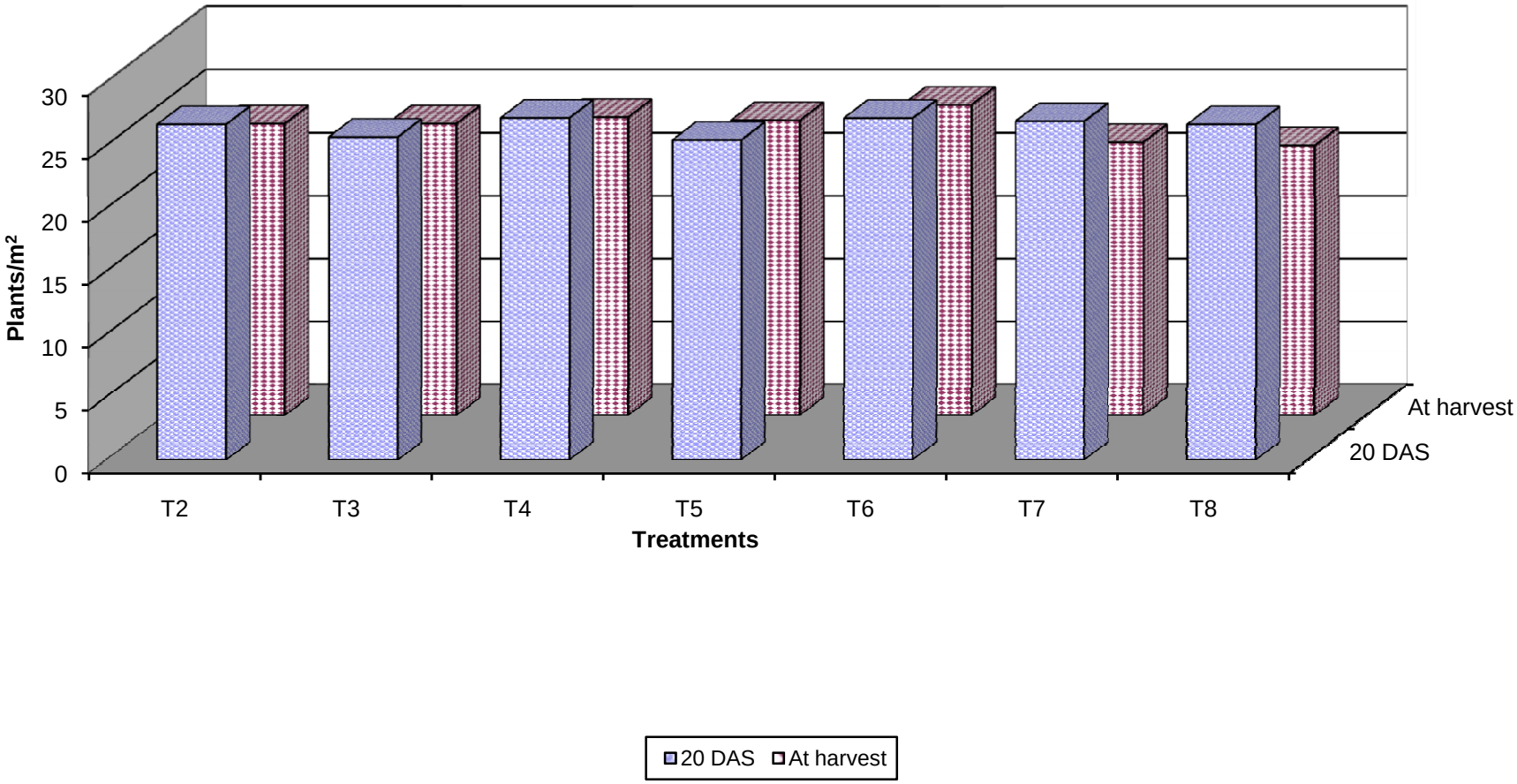


Fig 4 Average plant height (cm) of soybean varieties as influenced by intercropping with pigeonpea

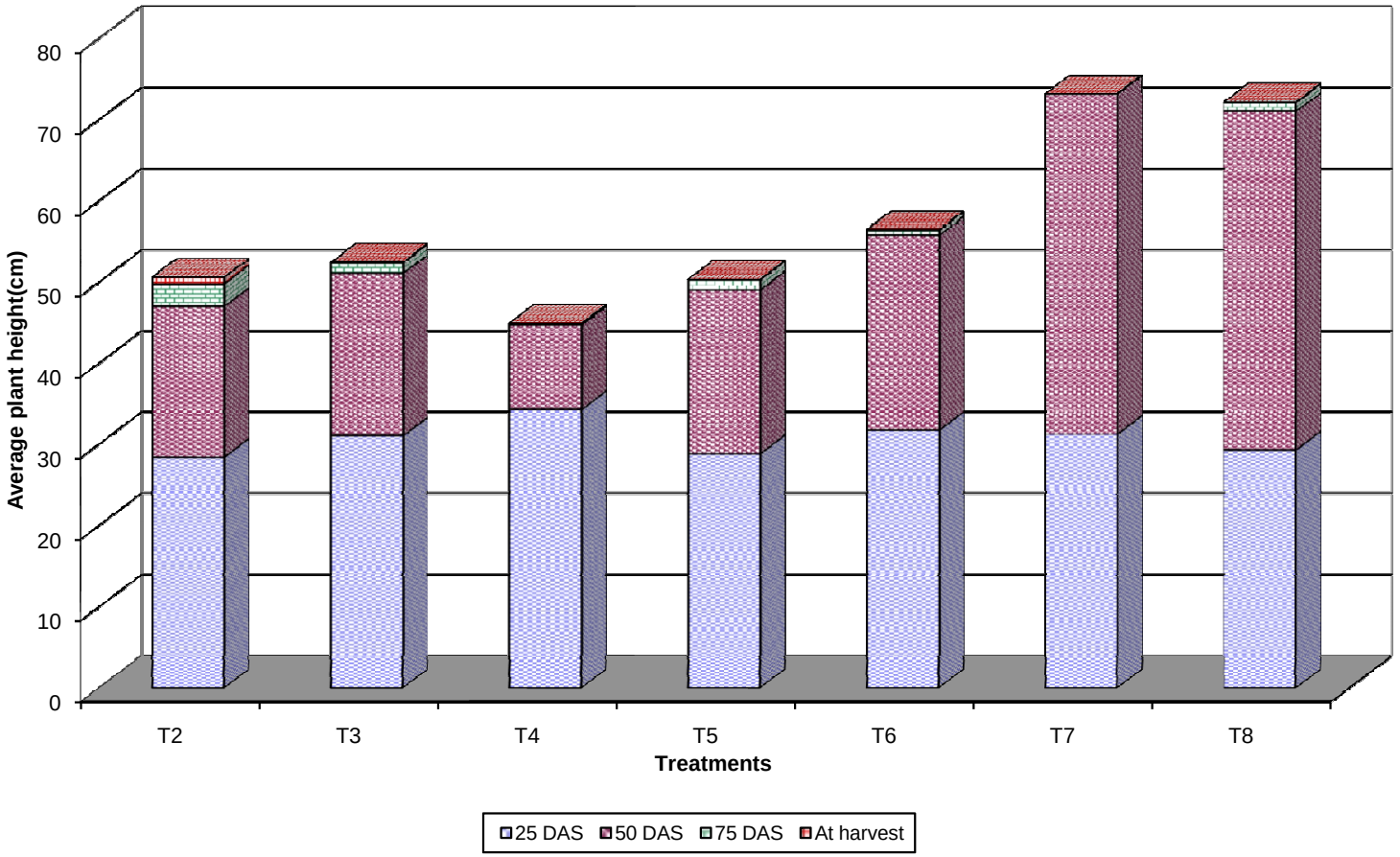


Fig.5 Average number of trifolic leaves per plant of different soybean varieties at different stages of growth as influenced by intercropping with pigeonpea

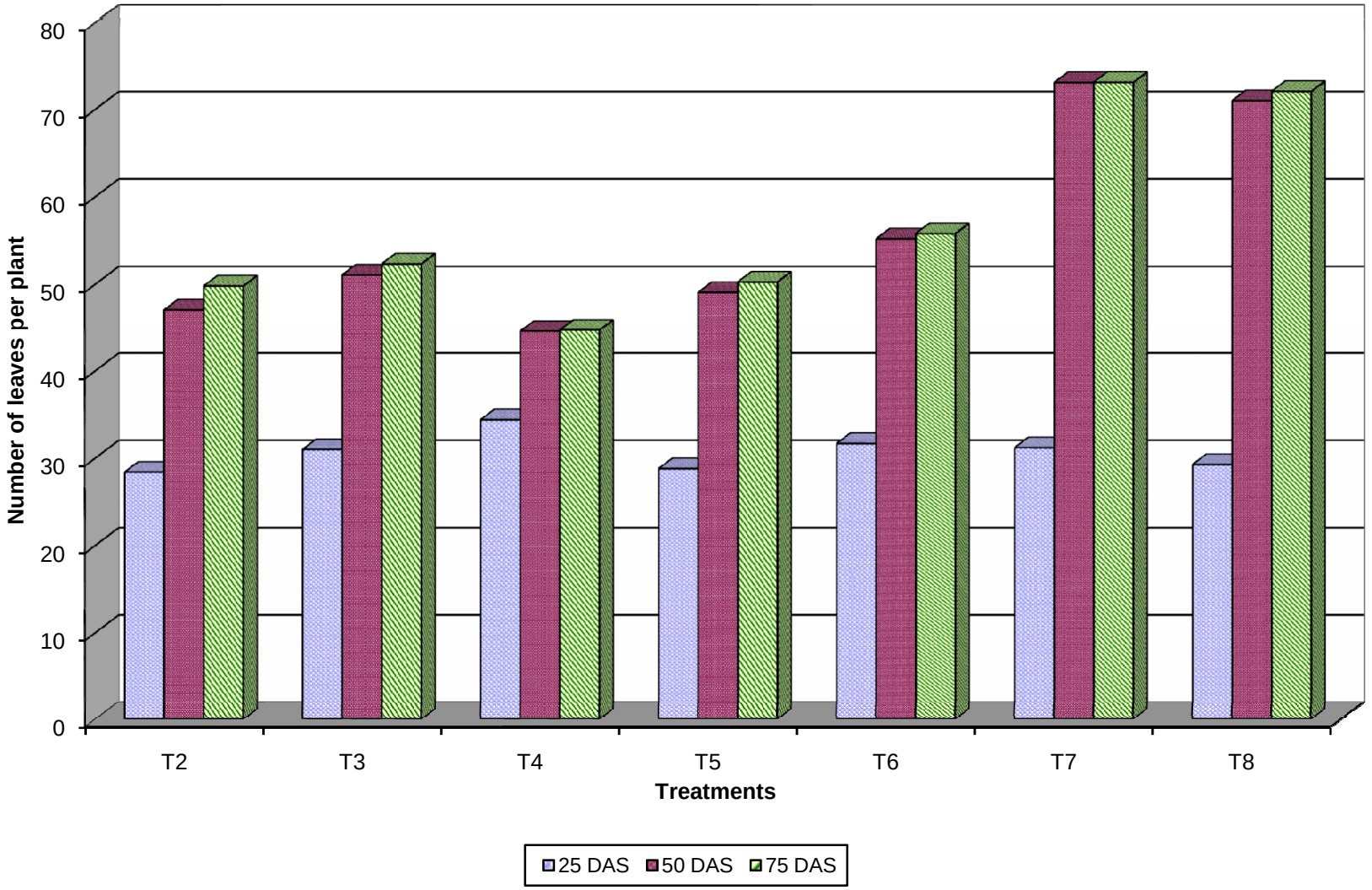


Fig.6 Average pod and seed yield per plant of soybean varieties under intercropping with pigeonpea(g)

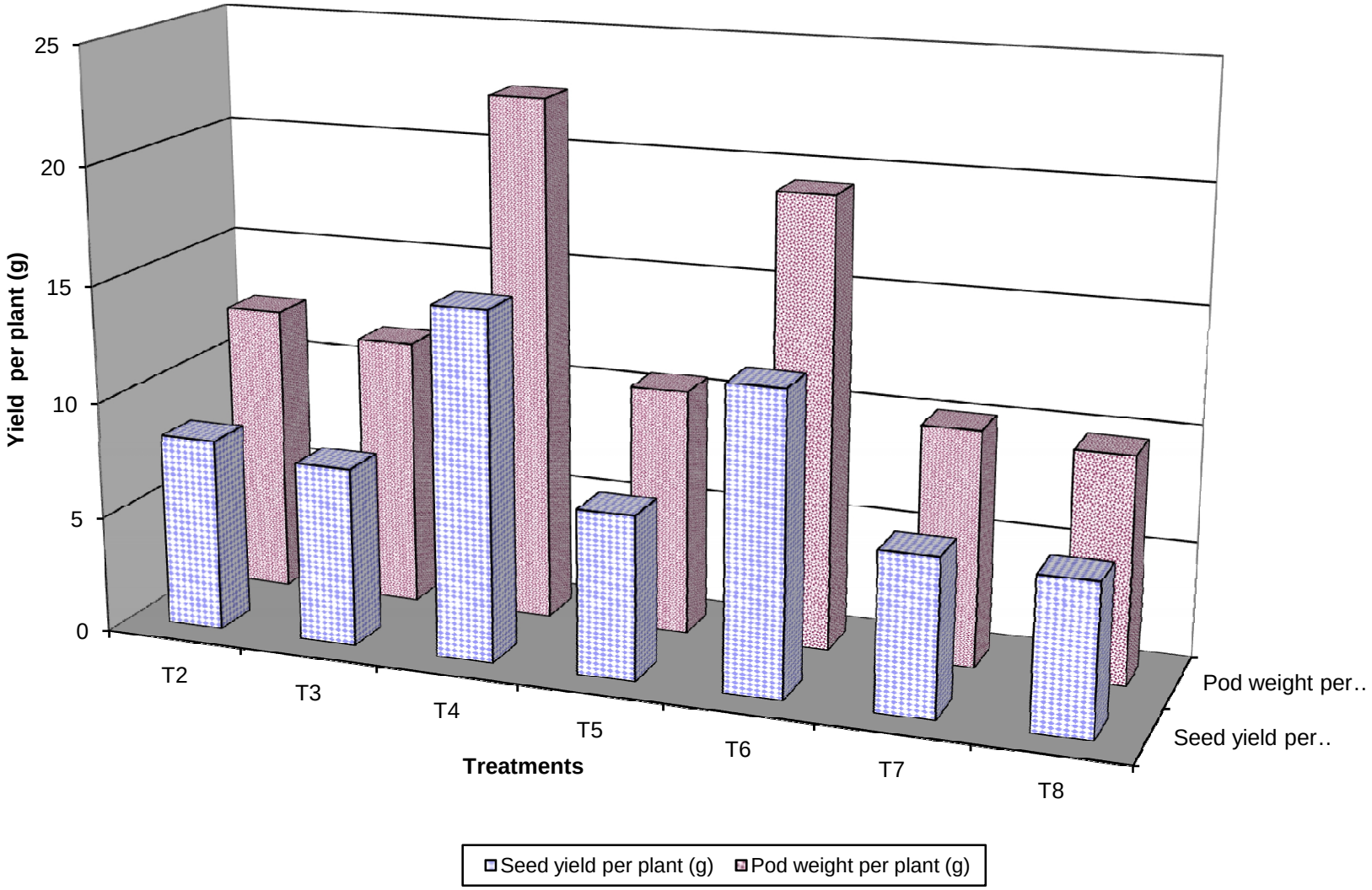


Fig. 7 Average crop shoot biomass and seed yield of different soybean varieties as influneced by intercropping with pigeonpea(q/ha)

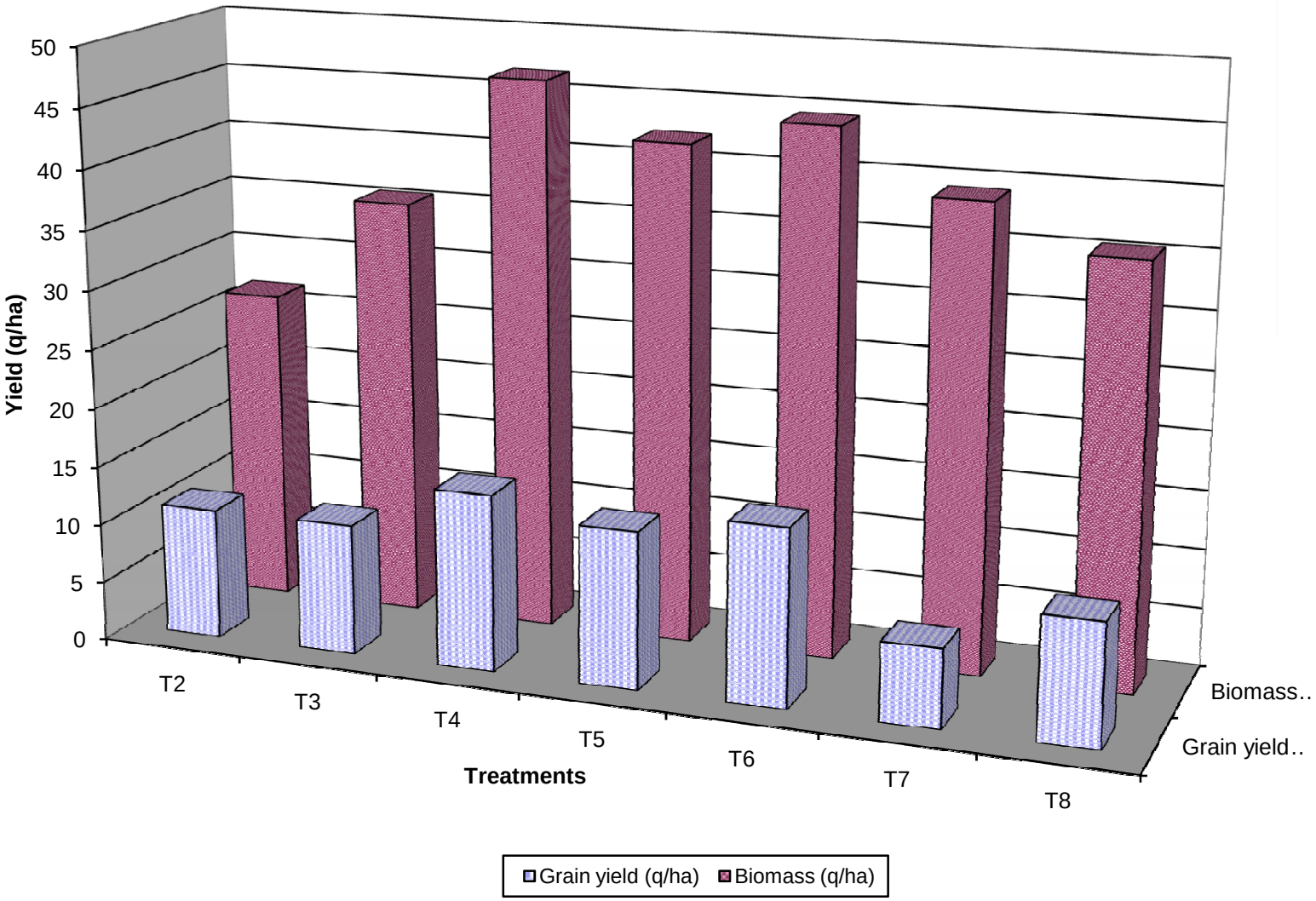


Fig.8 Average harvest index (%) of soybean varieties as influenced by intercropping of pigeonpea

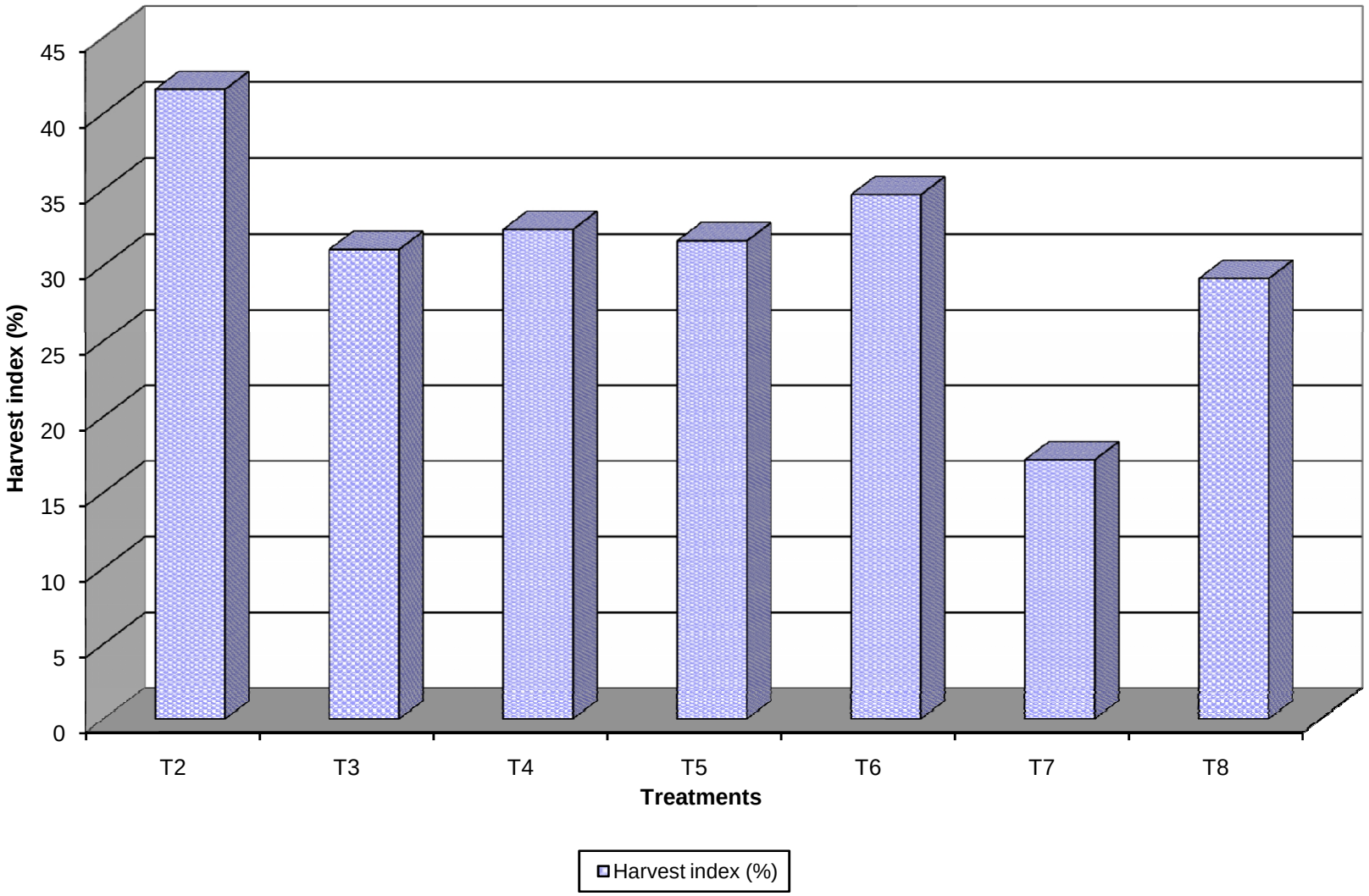


Fig. 9 Average number of pigeonpea plants/m^2 at 20 DAS and harvest stage under different treatments

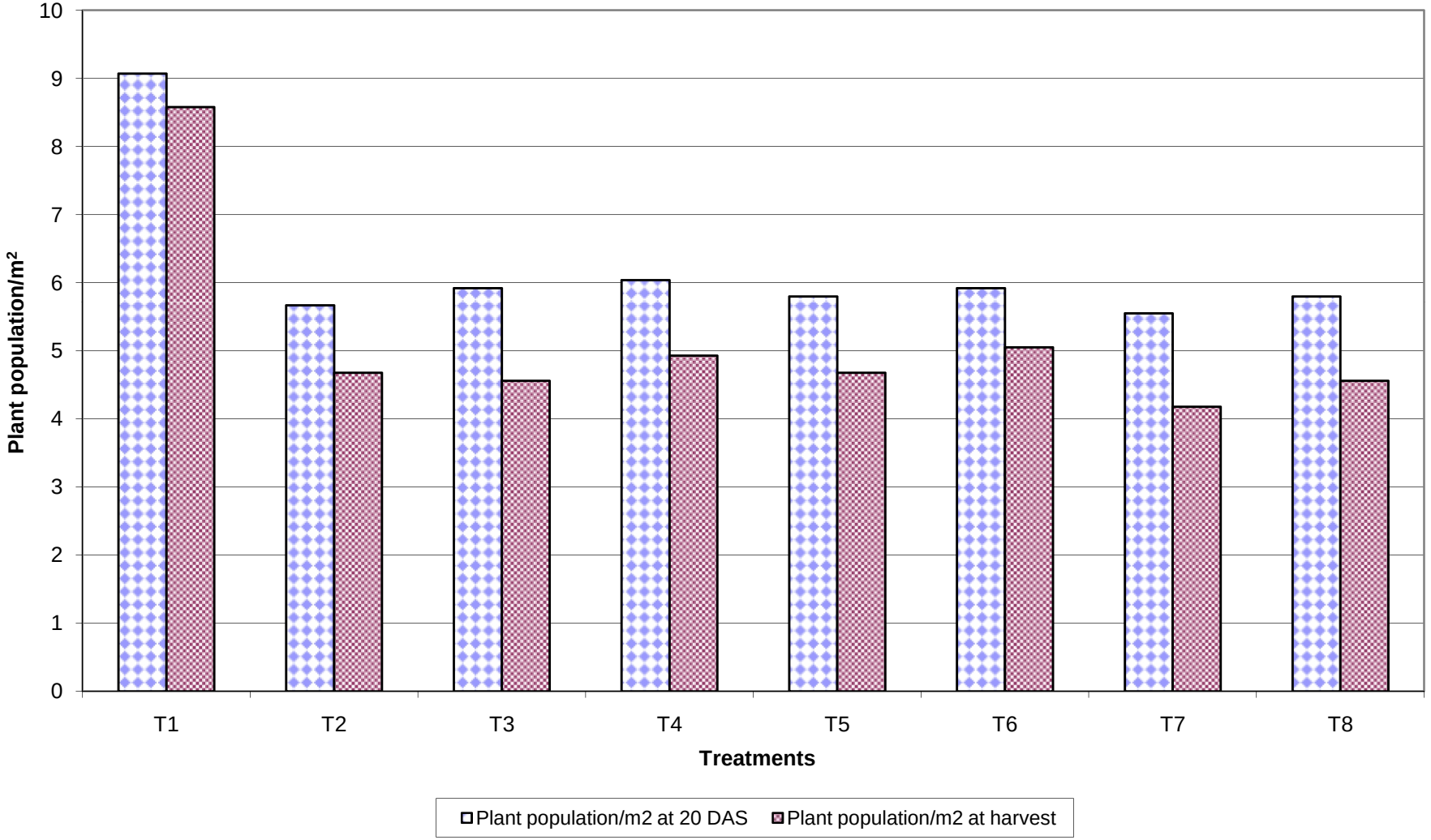


Fig.10 Average plant height(cm) of pigeonpea at different stages of growth as influenced by different treatments

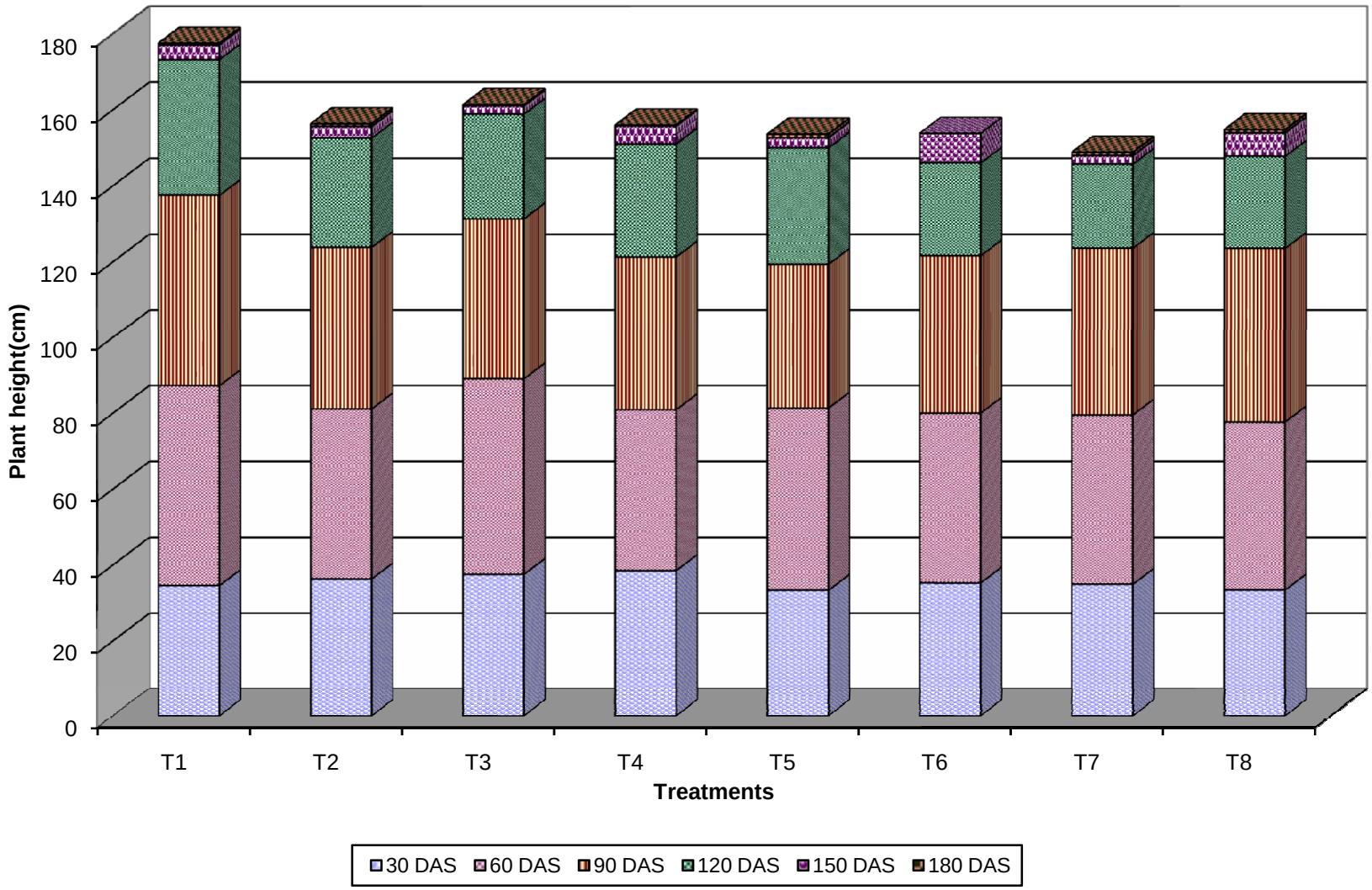


Fig.11 Average number of productive, unproductive and total branches per plant of pigeonpea as influenced by different treatments

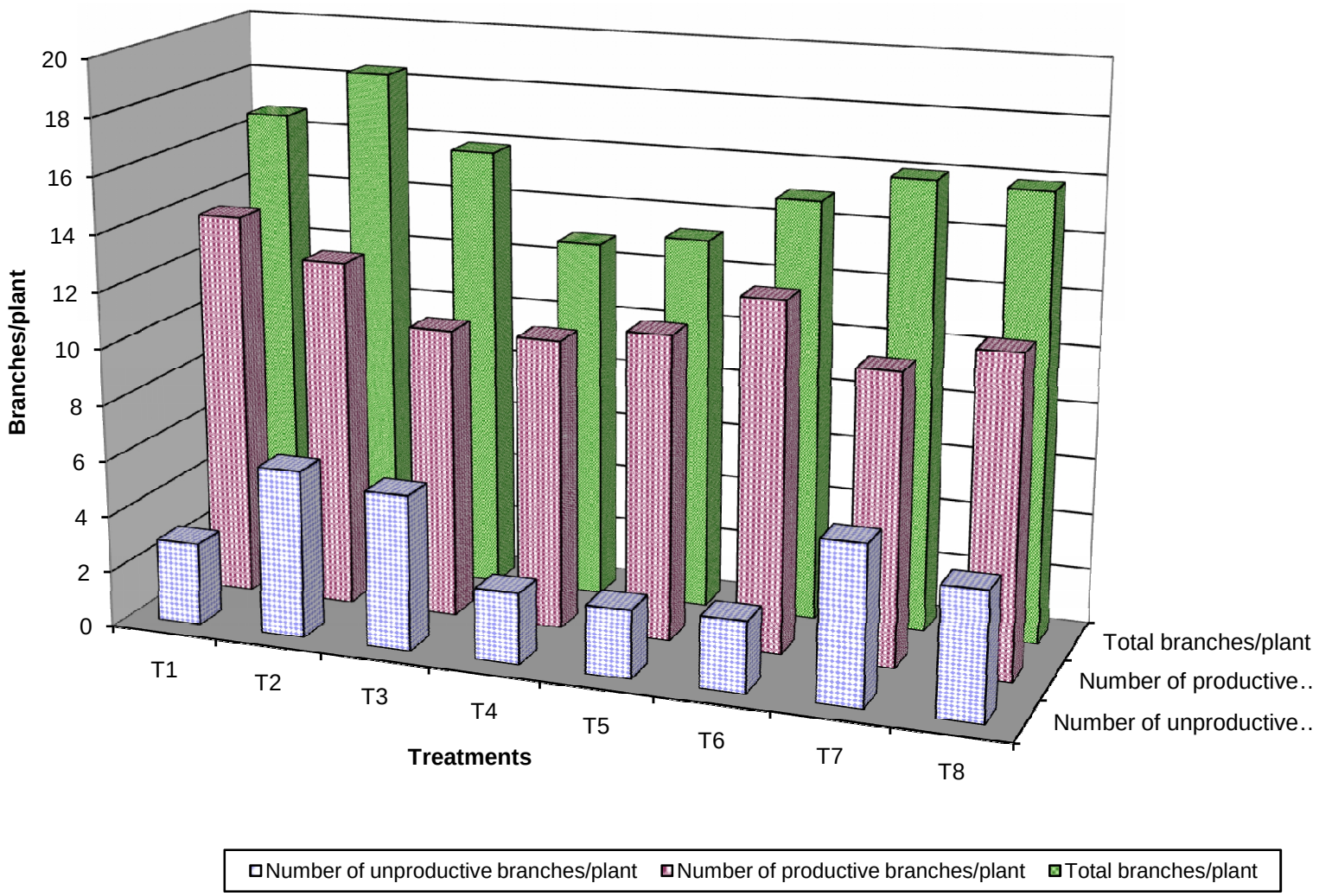


Fig.12 Average grain yield/plant (g) of pigeonpea under different treatments

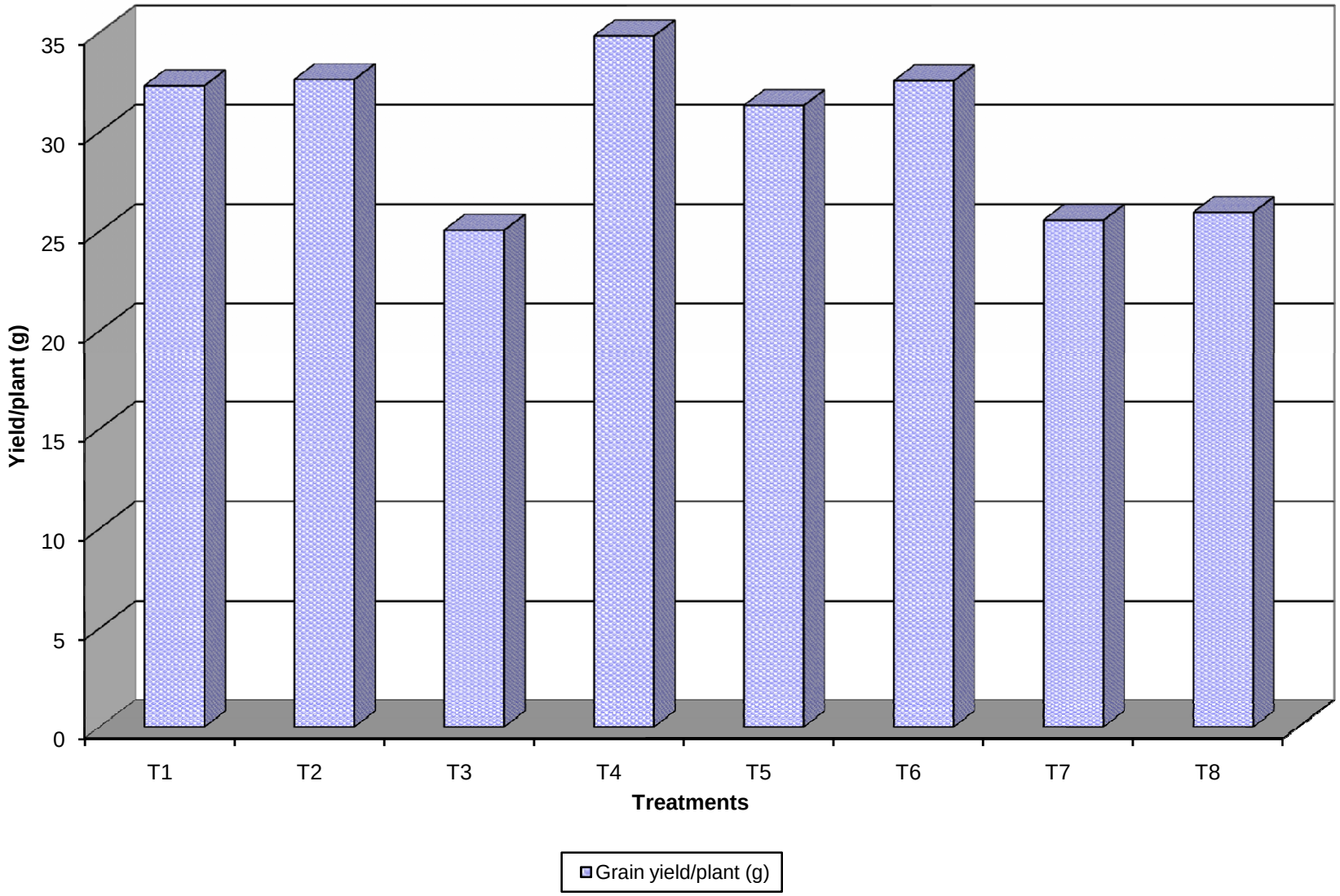


Fig.13 Average biomass and seed yield of pigeonpea as influenced by sole and intercropping with soybean varieties

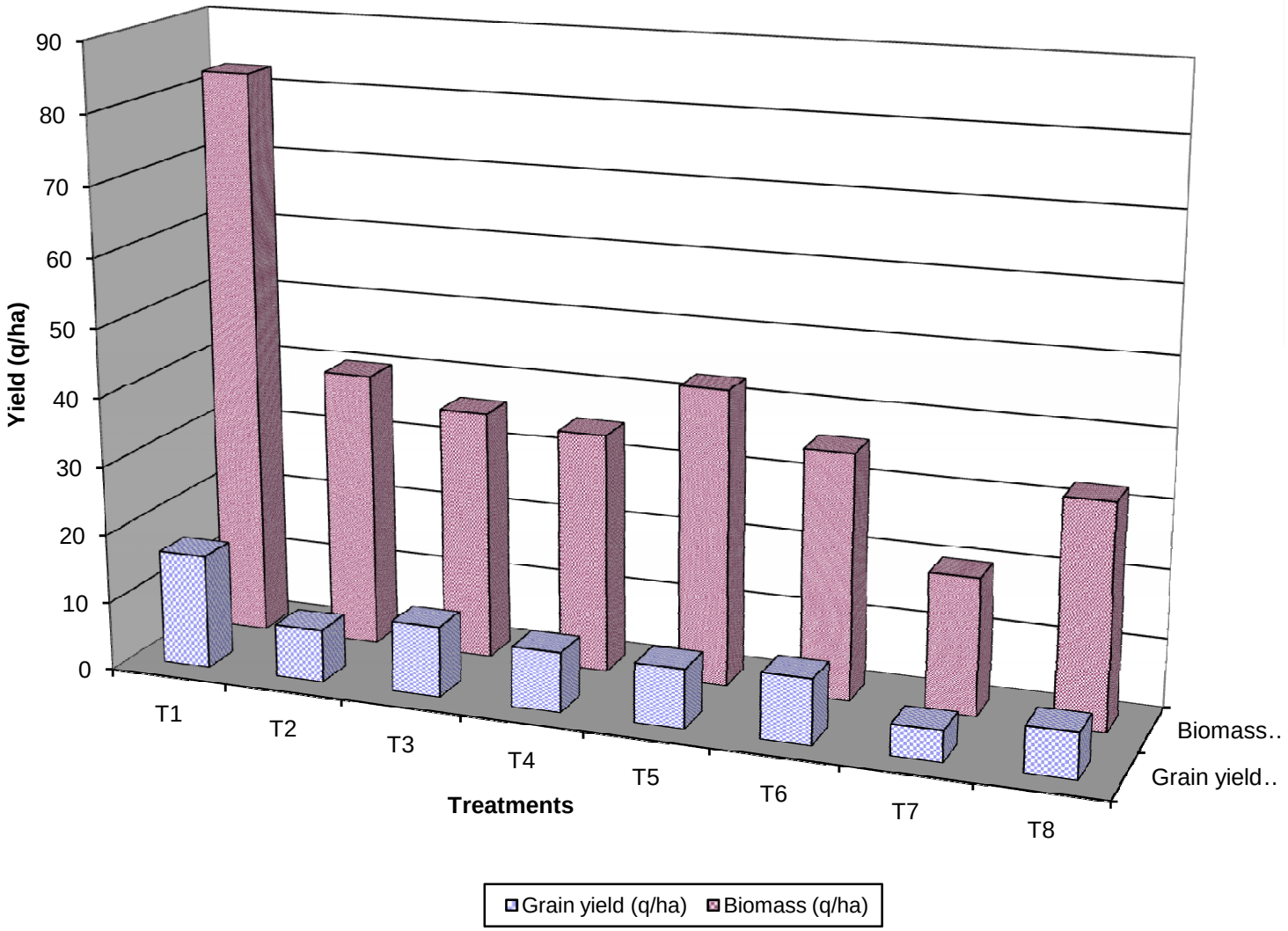


Fig. 14 Average LER of pigeonpea under sole and intercropping with soybean varieties

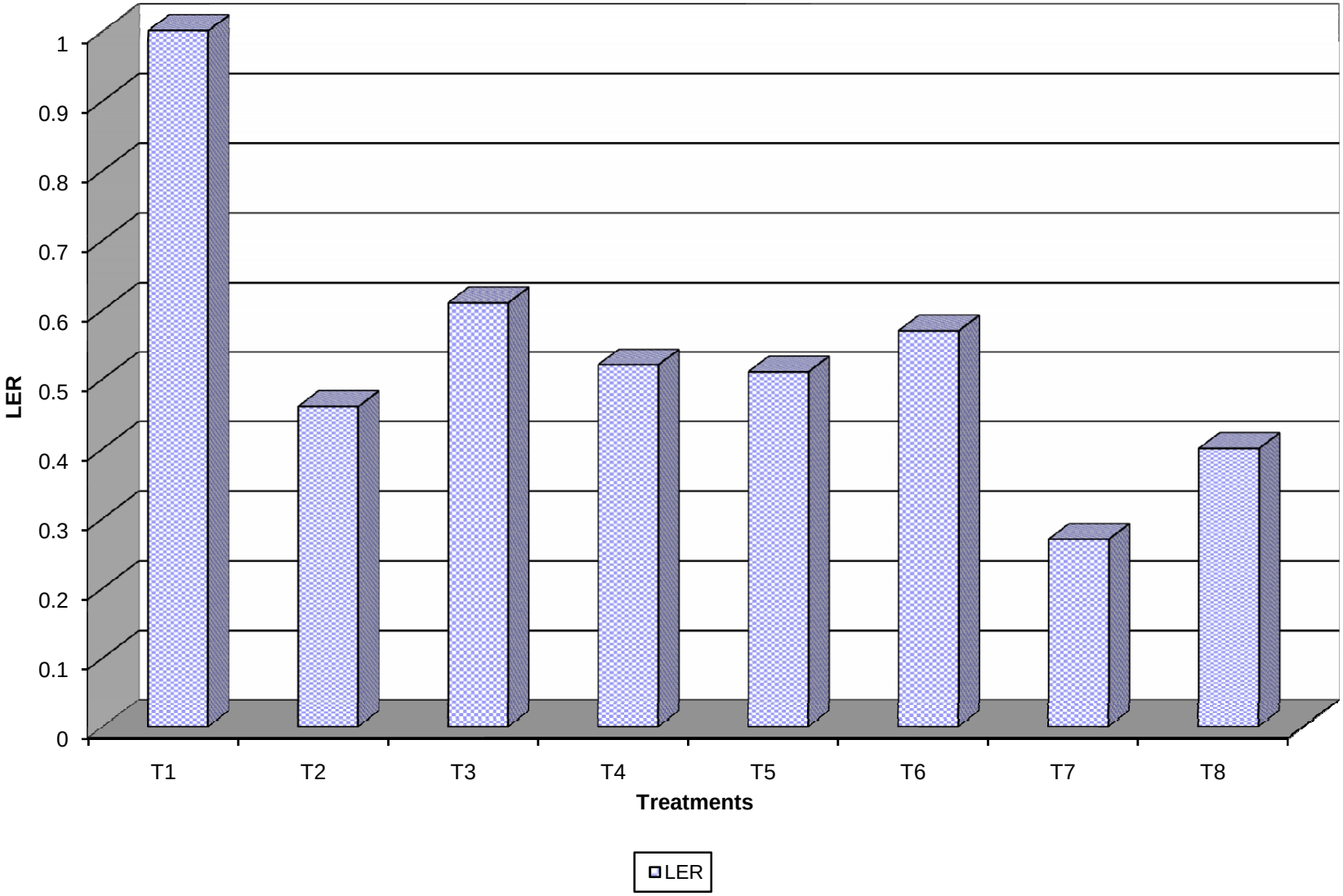


Fig.15 Average pigeonpea equivalent yield (q/ha) as influenced by different treatments

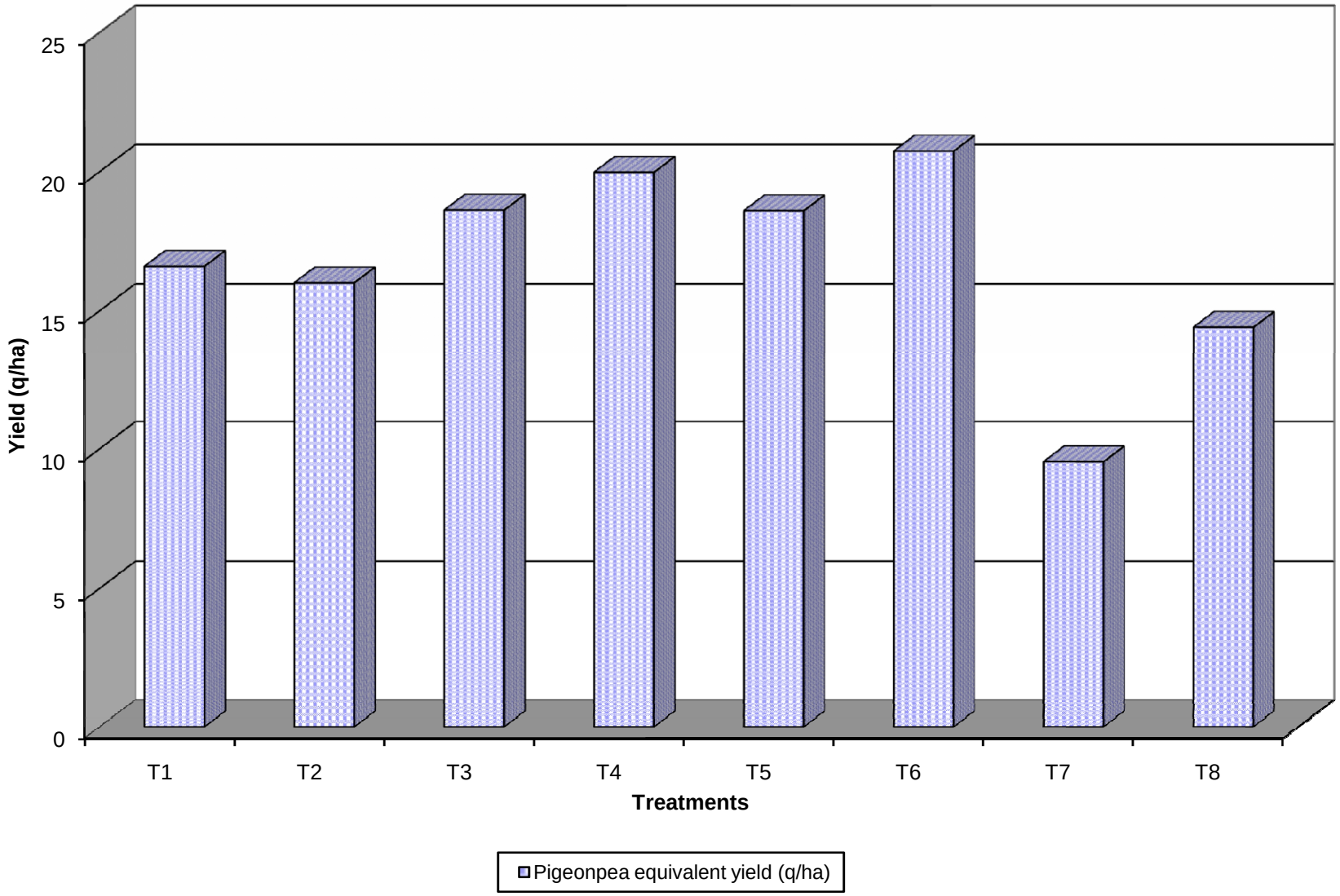


Fig.16 Average gross monetary return and net monetary return (Rs/ha) of sole and intercropped pigeonpea with different soybean varieties

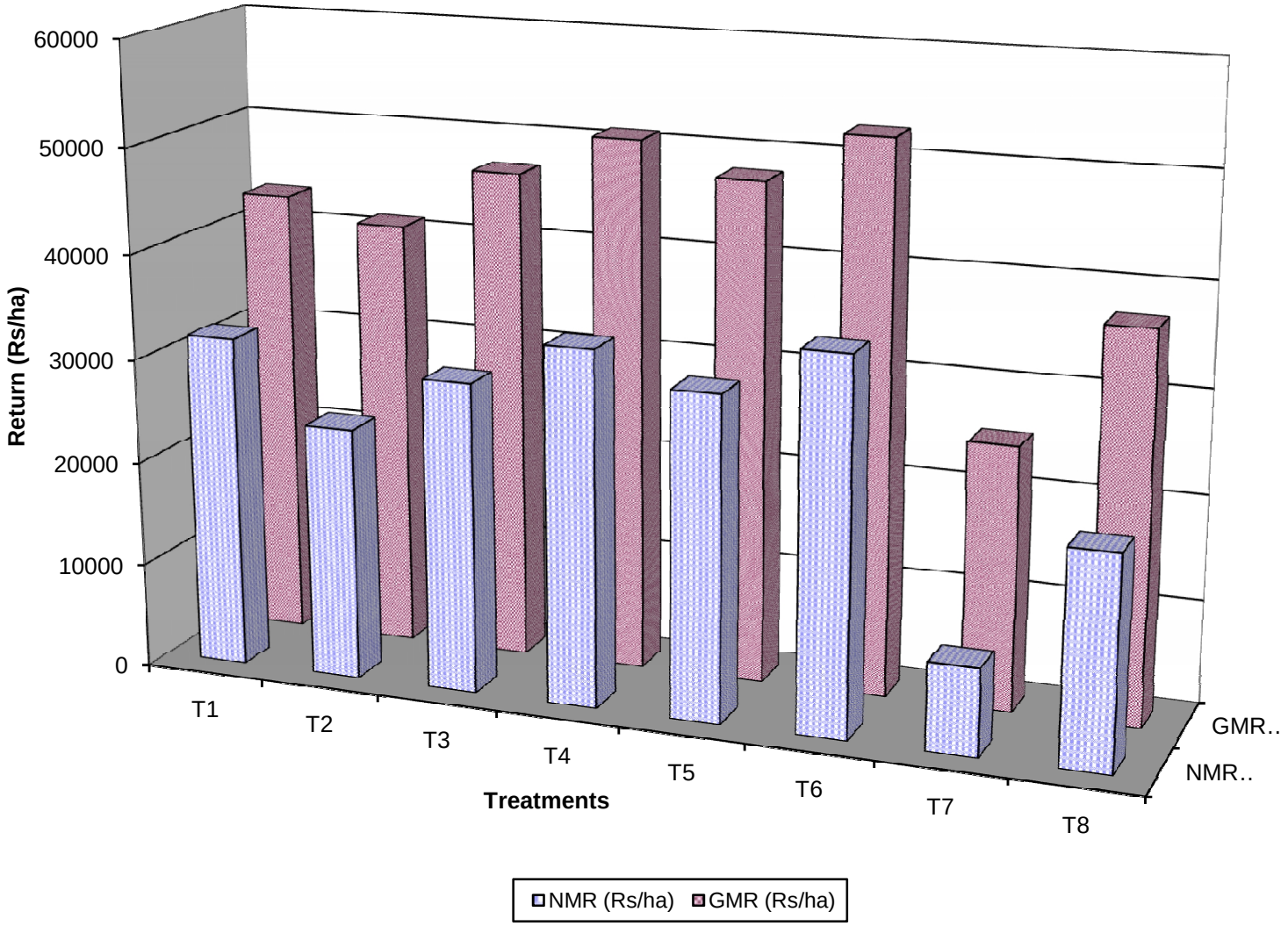


Fig.17 Land equivalent ratio (LER) of sole and intercropped pigeonpea with different soybean varieties

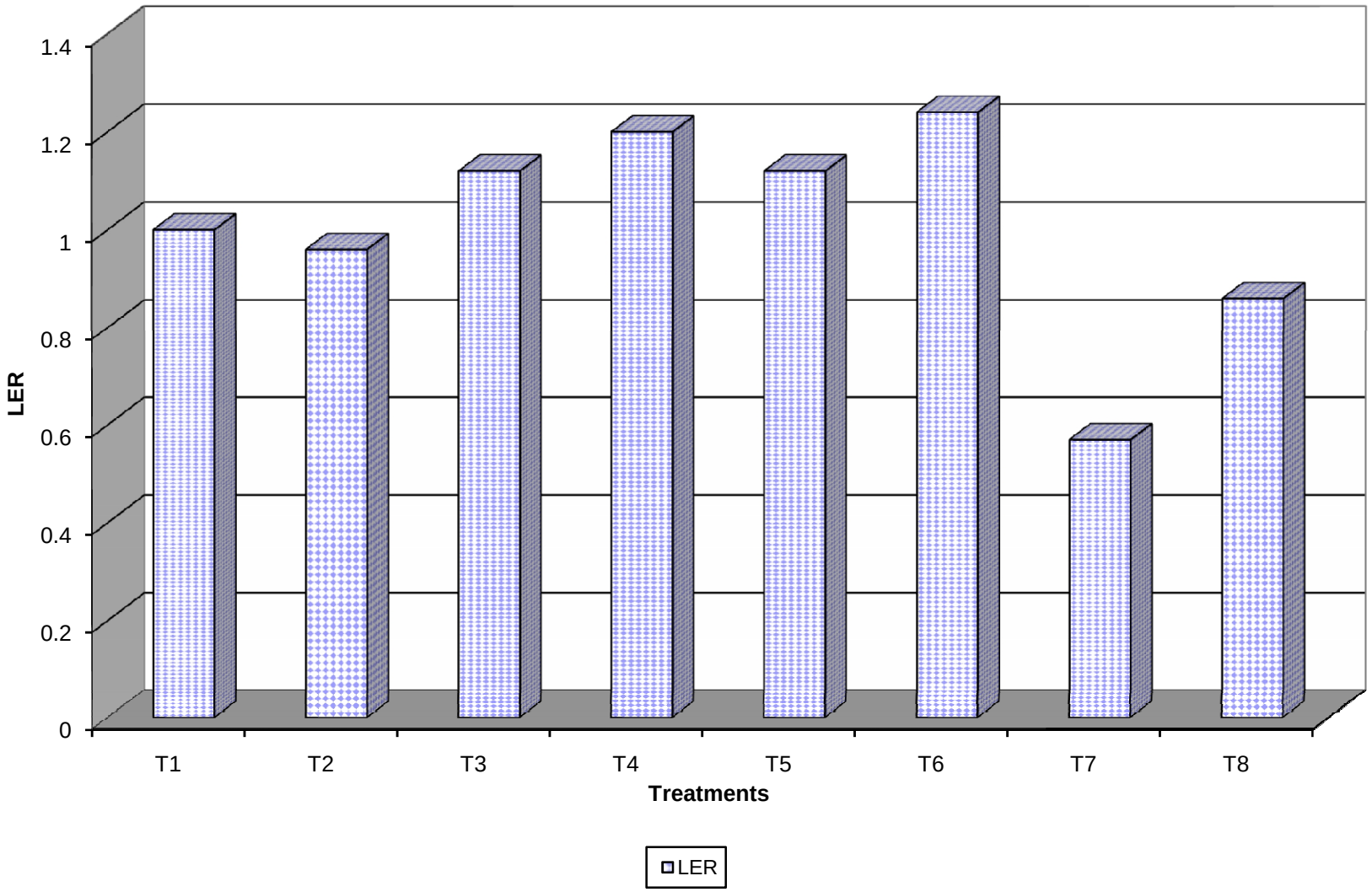
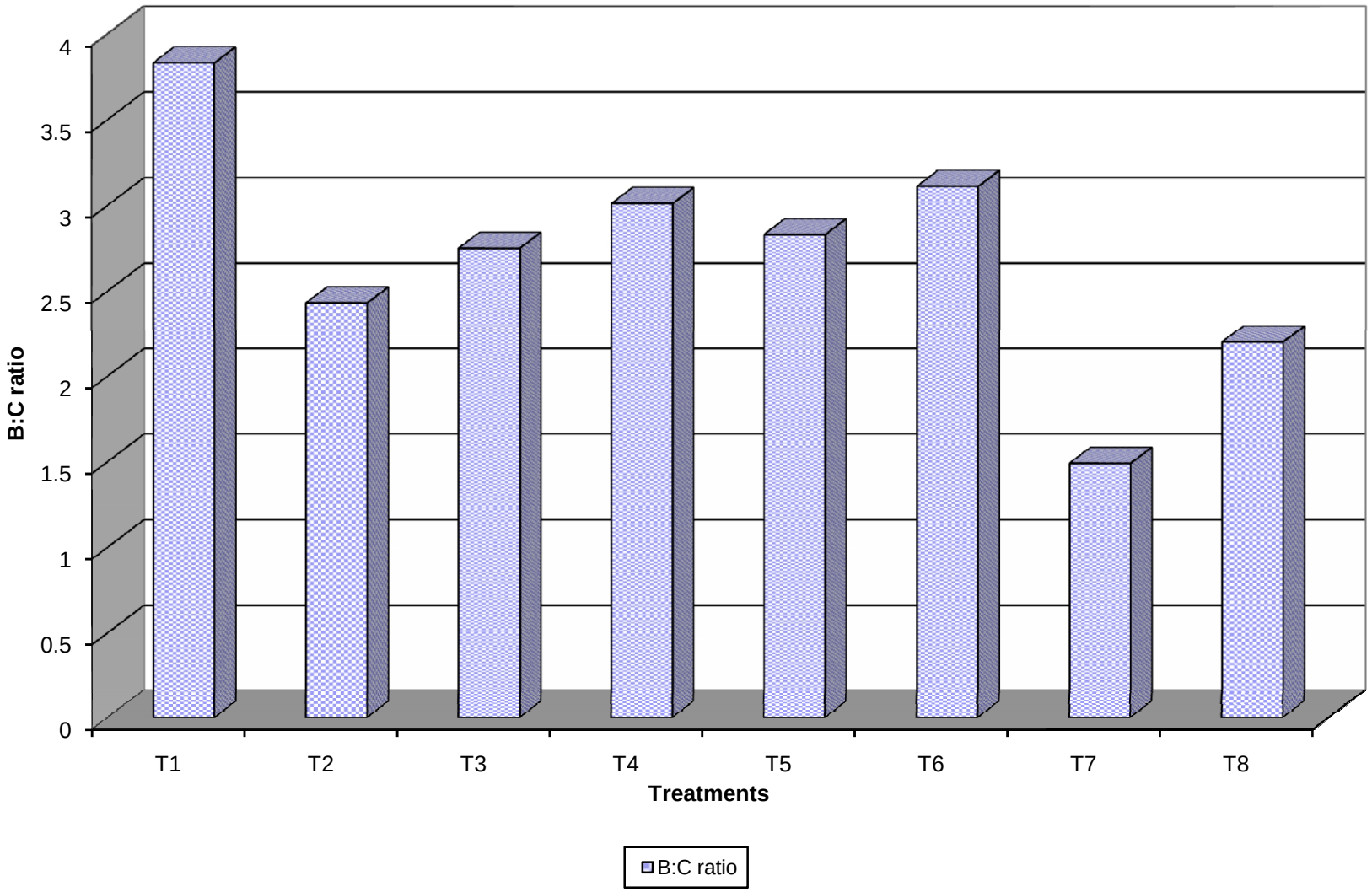


Fig.18 Averge benefit:cost ratio (B:C ratio) of sole and intercropped pigeonpea with different soybean varieties



Smw	Rainfall in mm	Temperature		Humidity		Wind speed	Sun shine	No. of rainy day
		Max.	Min.	Max.	Min.			
a23	10.2	40	25	82	53	2.3	6.3	1
24	7.3	32.8	26.2	84	69	2.5	4.9	1
25	39.8	29.2	25	91	81	3.5	1.7	2
26	72.4	32.4	24.7	90	72	1.5	3.2	3
27	119.6	29.9	23.8	91	59	2.6	0.4	5
28	22.2	31.6	24.8	87	61	2.9	3.8	2
29	84.6	32.4	25.1	90	60	2	4.1	3
30	82	31.3	25.6	86	57	1.2	4.7	5
31	8.2	32.6	26.8	84	59	2.3	8.5	2
32	34.2	32.57	25.57	85.28	60.85	1.45	7.82	3
33	105.2	30.6	25	87.8	61.85	1.75	3.81	2
34	19	31.5	25.2	82.8	57.7	0.84	5.85	1
35	5.7	32.8	25.2	86.4	57.5	1.42	7.3	1
36	2.4	33.7	24.5	84.8	60	13.8	8.8	2
37	19.6	34.5	23.7	84.7	59.7	1.44	6.5	2
38	15.8	27.2	23.8	90.4	73.2	2.6	4.27	1
39	4.4	32.14	22.5	88.7	60.7	1.44	7.4	0
40	0	33.7	23.5	36	47	1.1	8.8	0
41	0	34.5	20	87	51	0.6	8.7	0
42	0	33.1	16.7	83	60	0.4	7.4	0
43	0	31.8	14.7	81	66	0.5	7.1	0
44	0	32.1	13.4	79	62	0.5	7.2	0
45	0	30.9	10.9	80	65	0.7	8.9	0
46	0	29.5	13.3	80	61	1.1	7.1	0
47	20	25.9	12.5	84	60	0.5	5.4	1
48	0	26.6	9	79	57	0.2	7.3	0
49	0	26.8	8.7	85	61	0.7	8.8	0
50	0	27	8.8	83	60	0.5	8.2	0
51	0	27.9	9.7	81	59	0.2	6.9	0
52	18.7	28	5.7	97	75	0.2	8.9	2
1	0	24.4	6.81	77.85	55.7	0.25	6.14	0
2	18.3	23.11	12.28	75	59.14	0.87	2.94	3
3	0	25.5	7.5	83.2	59.85	0.32	6.27	0
4	0	26.9	7.98	79.2	53.7	0.64	7.14	0
Total	**709.6**							**42**

	Rainfall in mm	Temp. Max	Temp. Min	Himu. Max	Himu. Min	Wind Spee	Sun Shine	No. of Rain
a23		40	25	82	53	2.3	6.3	1
24	7.3	32.8	26.2	84	69	2.5	4.9	1
25	39.8	29.2	25	91	81	3.5	1.7	2
26	72.4	32.4	24.7	90	72	1.5	3.2	3
27	119.6	29.9	23.8	91	59	2.6	0.4	5
28	22.2	31.6	24.8	87	61	2.9	3.8	2
29	84.6	32.4	25.1	90	60	2	4.1	3
30	82	31.3	25.6	86	57	1.2	4.7	5
31	8.2	32.6	26.8	84	59	2.3	8.5	2
32	34.2	32.57	25.57	85.28	60.85	1.45	7.82	3
33	105.2	30.6	25	87.8	61.85	1.75	3.81	2
34	19	31.5	25.2	82.8	57.7	0.84	5.85	1

35	5.7	32.8	25.2	86.4	57.5	1.42	7.3	1
36	2.4	33.7	24.5	84.8	60	13.8	8.8	2
37	19.6	34.5	23.7	84.7	59.7	1.44	6.5	2
38	15.8	27.2	23.8	90.4	73.2	2.6	4.27	1
39	4.4	32.14	22.5	88.7	60.7	1.44	7.4	0
40	0	33.7	23.5	36	47	1.1	8.8	0
41	0	34.5	20	87	51	0.6	8.7	0
42	0	33.1	16.7	83	60	0.4	7.4	0
43	0	31.8	14.7	81	66	0.5	7.1	0
44	0	32.1	13.4	79	62	0.5	7.2	0
45	0	30.9	10.9	80	65	0.7	8.9	0
46	0	29.5	13.3	80	61	1.1	7.1	0
47	20	25.9	12.5	84	60	0.5	5.4	1
48	0	26.6	9	79	57	0.2	7.3	0
49	0	26.8	8.7	85	61	0.7	8.8	0
50	0	27	8.8	83	60	0.5	8.2	0
51	0	27.9	9.7	81	59	0.2	6.9	0
52	18.7	28	5.7	97	75	0.2	8.9	2
1	0	24.4	6.81	77.85	55.7	0.25	6.14	0
2	18.3	23.11	12.28	75	59.14	0.87	2.94	3
3	0	25.5	7.5	83.2	59.85	0.32	6.27	0
4	0	26.9	7.98	79.2	53.7	0.64	7.14	0

	20 DAS	At harvest
T_2	26.66	23.2
T_3	25.67	23.2
T_4	26.17	23.7
T_5	25.42	23.45
T_6	27.15	24.68
T_7	26.91	21.72
T_8	26.66	21.48

	25 DAS	50 DAS	75 DAS	At harvest
T2	28.4	18.67	2.73	0.8
T3	31	20.07	1.26	0.07
T4	34.4	10.33	0.13	0.07
T5	28.8	20.27	1.19	0.04
T6	31.67	24.13	0.6	0.04
T7	31.2	41.87	0.03	0.02
T8	29.27	41.73	1.07	0.06

t	20 DAS	At harvest
T2	26.66	23.2
T3	25.67	23.2
T4	27.17	23.7
T5	25.42	23.45
T6	27.15	24.68
T7	26.91	21.72
T8	26.66	21.48

	25 DAS	50 DAS	75 DAS
T2	28.4	47.07	49.8
T3	31	51.07	52.33
T4	34.4	44.6	44.73
T5	28.8	49.07	50.26
T6	31.67	55.2	55.8
T7	31.2	73.07	73.1
T8	29.27	71	72.07

t	Seed yield	Pod weight per plant (g)
T2	8.3	12.45
T3	7.69	11.53
T4	14.99	22.48
T5	7.04	10.56
T6	12.87	19.3
T7	6.74	10.11
T8	6.47	9.7

t	Grain yield	Biomass (q/ha)
T2	11.1	26.66
T3	11.1	35.55
T4	15.03	46.66
T5	13.32	42.21
T6	15.03	44.43
T7	6.66	39.25
T8	10.36	35.55

t	Harvest index (%)
T2	41.59
T3	31.06
T4	32.38
T5	31.63
T6	34.67
T7	17.15
T8	29.16

	Plant popu	Plant population/m2 at harvest
T1	9.07	8.58
T2	5.67	4.68
T3	5.92	4.56
T4	6.04	4.93
T5	5.8	4.68
T6	5.92	5.05
T7	5.55	4.18
T8	5.8	4.56

	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
T1	34.6	52.66	50.27	35.67	3.93	0.4
T2	36.33	44.8	42.73	28.74	3.07	0.66
T3	37.53	51.53	42.27	27.53	2.21	0.26
T4	38.53	42.4	40.4	29.73	4.74	0.2
T5	33.33	48	38.07	30.6	2.73	0.93
T6	35.26	44.74	41.66	24.4	7.74	0
T7	34.93	44.6	44.13	22.07	2.27	0.86
T8	33.4	44.26	45.94	24.2	6.2	0.8

	Number of	Number of	Total branches/plant
T1	2.95	13.77	16.72
T2	5.99	12.44	18.43
T3	5.55	10.33	15.88
T4	2.55	10.33	12.88
T5	2.44	10.88	13.32
T6	2.55	12.44	14.99
T7	5.66	10.33	15.99
T8	4.55	11.33	15.88

	Grain yield/plant (g)
T1	32.33
T2	32.64
T3	25.06
T4	34.83
T5	31.33
T6	32.57
T7	25.57
T8	25.96

	Grain yield	Biomass (q/ha)
T1	16.6	82.74
T2	7.68	40.19
T3	10.28	36.29
T4	8.72	34.81
T5	8.61	42.95
T6	9.47	35.73
T7	4.53	19.99
T8	6.64	32.58

	LER
T1	1
T2	0.46

T3	0.61
T4	0.52
T5	0.51
T6	0.57
T7	0.27
T8	0.4

	Pigeonpea equivalent yield (q/ha)
T1	16.6
T2	16.01
T3	18.62
T4	19.98
T5	18.6
T6	20.74
T7	9.53
T8	14.41

	NMR (Rs/h	GMR (Rs/ha)
T1	31906	43147
T2	24216	41089
T3	29696	46869
T4	33996	50869
T5	30929	47802
T6	35683	52556
T7	8390	25263
T8	20268	37141

	LER
T1	1
T2	0.96
T3	1.12
T4	1.2
T5	1.12
T6	1.24
T7	0.57
T8	0.86

	B:C ratio
T1	3.83
T2	2.43
T3	2.75
T4	3.01
T5	2.83
T6	3.11
T7	1.49
T8	2.2

T1
T2
T3
T4
T5

T6
T7
T8

	Rainfall in mm	Temp. Max	Temp. Min	RH Max.	RH Min.	No. of Rainy Days
23	40	25	82	53	1	
24	7.3	32.8	26.2	84	69	1
25	39.8	29.2	25	91	81	2
26	72.4	32.4	24.7	90	72	3
27	119.6	29.9	23.8	91	59	5
28	22.2	31.6	24.8	87	61	2
29	84.6	32.4	25.1	90	60	3
30	82	31.3	25.6	86	57	5
31	8.2	32.6	26.8	84	59	2
32	34.2	32.57	25.57	85.28	60.85	3
33	105.2	30.6	25	87.8	61.85	2
34	19	31.5	25.2	82.8	57.7	1

35	5.7	32.8	25.2	86.4	57.5	1
36	2.4	33.7	24.5	84.8	60	2
37	19.6	34.5	23.7	84.7	59.7	2
38	15.8	27.2	23.8	90.4	73.2	1
39	4.4	32.14	22.5	88.7	60.7	0
40	0	33.7	23.5	36	47	0
41	0	34.5	20	87	51	0
42	0	33.1	16.7	83	60	0
43	0	31.8	14.7	81	66	0
44	0	32.1	13.4	79	62	0
45	0	30.9	10.9	80	65	0
46	0	29.5	13.3	80	61	0
47	20	25.9	12.5	84	60	1
48	0	26.6	9	79	57	0
49	0	26.8	8.7	85	61	0
50	0	27	8.8	83	60	0
51	0	27.9	9.7	81	59	0
52	18.7	28	5.7	97	75	2
1	0	24.4	6.81	77.85	55.7	0
2	18.3	23.11	12.28	75	59.14	3
3	0	25.5	7.5	83.2	59.85	0
4	0	26.9	7.98	79.2	53.7	0