STUDIES ON CROP GEOMETRY OF CERTAIN SHORT DURATION PIGEONPEA [Cajanus cajan (L.) Millsp.] CULTIVARS

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STUDIES ON CROP GEOMETRY OF CERTAIN SHORT DURATION PIGEONPEA [*Cajanus cajan* (L.) Millsp.] CULTIVARS

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ABSTRACT

An experiment was conducted at the College Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand on loamy sand soil (**Goradu**) during *Kharif* season of 1990-91. Twelve treatment combinations comprising of four different pigeonpea cultivars (ANDT-1, ANDT-2, BDN-2 and T-15-15), three levels of crop geometries (60 x 30 cm, 75 x 30 cm and 90 x 30 cm) were tried in split plot design with four replications.

A common dose at the rate of 25 kg N and 50 kg P_2O_5 per hectare through urea and diammonium phosphate were applied in furrows before sowing to supply nitrogen and phosphorus.

The results revealed that the differences in seed yield were not siginficant due to different cultivars, however, the cultivar ANDT-2 gave numerically higher seed yield (691.81 kg/ha) than rest of the cultivars. Whereas, the stalk yield was significantly influenced by different

cultivars. The cultivar T-15-15 produced significantly the highest stalk yield (3946.02 kg/ha) over rest of the cultivars. Dry fodder yield did not differed significantly among different cultivars.

The differences in morphological parameters and other yield attributes viz., plant height, number of branches per plant, days to first flower, days to maturity, number of pods per plant, number of seeds per pod, 100 seed weight and harvest index were significant due to different pigeonpea cultivars. The cultivar ANDT-2 showed earliest maturity among all the cultivars. While, the highest protein content of grains was recorded by the cultivar T-15-15. The seed yield per plant was not differ significantly among different cultivars.

The differences in seed, stalk and dry fodder yields were significant due to different crop geometries. The narrow crop geometry of 60 x 30 cm produced significantly higher seed, stalk and dry fodder yields of 659.80, 2403.51 and 911.06 kg/ha, respectively.

Increasing crop geometry from 60 x 30 cm to 90 x 30 cm was resulted in progressive improvement in number of branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant, 100-seed weight and protein content of grains; while the plant height was decline with increased crop geometry. The maturity of pigeonpea cultivars was enhanced with reduced crop geometry. However, days to first flower and harvest index were not significantly influenced by different crop geometries.

The trend in respect of net realization and cost benefit ratio was favourable with the cultivar ANDT-2 and crop geometry of 60 x 30 cm.

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CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON CROP GEOMETRY OF CERTAIN SHORT DURATION PIGEONPEA [Cajanus cajan (L.) Millsp.] CULTIVARS"** submitted by **Shri Natwarlal Rughnathbhai Patel** in partial fulfilment of the requirements for the degree of **Master of Science (Agriculture)** in **AGRONOMY** of the Gujarat Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

PLACE : ANAND

Date: October 7,1991.

(T. G. MEISHERI)
Major Advisor

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INTRODUCTION

I INTRODUCTION

Pulses are edible legumes and are a necessity in the rural economy of India, because they form an important constituent of human diet and cattle feeds in the country. People consume a good deal of pulse seeds in one or the other form of dietary preparation, preferably 'dal' at least once in a day in their menu. Some of the legume seeds as such, and dried leaves, tender stems, seed-coats and 'chuni' (broken pieces of seeds obtained in the process of grinding) that form bye products of pulses are fed to cattle. Besides providing an essential portion of the food of human being and cattle, leguminous plants play an important role either in maintaining or improving fertility of the soil, and are recognised as restores of soil fertility by virtue of their natural ability to fix atmospheric nitrogen in the soil through nodules that develop on their roots.

Apart from these functions, pulse crops are also valuable in soil and water conservation programme on account of their rapid growth which provides quick and thick vegetative cover to the soil and are therefore well suited for controlling soil erosion in areas with heavy rainfall and having erodable soils.

It is by virtue of Nature's gift that environmental conditions especially climate and soils have been favourable for successful growth of a great variety of pulses from the Himalayas to the southern most end of the Indian peninsula. About one-seventh of the cultivated area of the country is annually sown with pulse crops. The pulses that are commonly grown in various parts of the country are gram, pigeonpea, blackgram, greengram, lentil-masur, horse gram, peas, lang and kidneybeans, of these pigeonpea and gram occupy about 50 per cent of the total area. Moreover, 60 per cent of the total production of all the pulses is that of pigeonpea and gram in the country. Thus, pigeonpea and gram having been grown almost in the state of India are considered very important pulse crops in Indian Agriculture.

An equally important feature regarding pulses is that they fit well in crop rotations and crop mixtures. Because of their relatively low water requirement, pulses are the backbone of India's dryland farming contributing almost 75 per cent of the total cropped area in the country (Swaminathan, 1989).

Among the Kharif pulses, pigeonpea [Cajanus cajan (L.) Millsp.] is the second most important pulse crop of the world. It belongs to the order leguminosae, sub-order papilionaceae and tribe phaseoleae, commonly designated as redgram, arhar, tur and cajan in the different parts of India.

There prevails some controversy about the origin of pigeonpea plant. However, according to P. de Sorney

(1916), the botanical name '*Cajanus cajan*' now used for pigeonpea has been derived from the word 'Catjany' which is of Indian origin. Therefore, pigeonpea is believed to have its origin in India.

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is largely grown in tropical and sub-tropical regions of the world. It is at present largely cultivated in India, Pakistan, west Indies, Nigeria, Burma and Viet-nam. In India, total production and area of pigeonpea during 1986-87 were 2.31 million tonnes and 3.23 million hectares, respectively, having productivity of 715.0 kg/ha (Anon., 1988).

In India, cultivation of pigeonpea is mainly confined to Maharastra, Uttar Pradesh, Karnataka, Madhya Pradesh, Andhra Pradesh and Gujarat. Gujarat State ranks sixth with respect to area and fifth in production in the country. During the year 1986-87, area and production of pigeonpea in the State was 3.18 lakh hectares and 1.46 lakh tonnes, respectively, having productivity of 459.1 kg/ha (Anon., 1988). In Gujarat, pigeonpea is mainly grown in Broach, Baroda, Surat, Panchmahals, Kaira and Bulsar districts.

Pigeonpea has very wide adaptability of climate and soil. The soils on which it is grown are vary with the main crops with which it is raised in mixture. Pigeonpea is grown successfully with sorghum in loamy and medium black soils with pearlmillet in sandy loam and drilled

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paddy in the <u>Basar</u> soil. Though it is successfully adopted on variety of soils, it grows very luxuriantly and gives comparatively high outturn per hectare on sandy loam soil.

Pigeonpea grains are rich in protein (22-23 per cent). It provides balanced diet with cereals for human as well as for animals too, especially in developing countries where protein deficiency is predominantly noticed. Greenpods are used as vegetables in the certain part of the country especially in the state of Gujarat. Residues obtained from the pigeonpea crop after threshing give palatable and nutritious fodder for cattle. Dry stalk are used as fuel in rural areas as well as for variety or purposes such as roofing, walling sides of cart and basket making too, (Lal, 1976).

Over and above, the food values of 'tur' grain, it is a good rotational crop. It possesses tap root-system which enter deep into the soil, hence it thrives best in the rainfed areas. Being a drought tolerant, is an ideal crop for mixed and intercropping with other crops in dry farming regions. Pegionpea crop is capable of ameliorating the poor soil fertility conditions encountered in arid regions and thus helps in nitrogen economy. The copious leaf shedding adds considerable amount of organic matter to the soil. The results of work carried out at Pusa

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(Anon., 1970) have revealed that a crop of pigeonpea add organic matter equivalent to about 15 tonnes of cowdung per hectare.

The crop, with such a high value in Agriculture and of vast importance to human beings has not been cared for exploiting its yielding potentialities as compared to cereals and other cash crops. No wonder, the crop finds an enviable place in the cropping pattern of most of the areas in the country.

It is almost an established fact that the evaluation of suitable high yielding cultivars play a vital role for profitable production of pigeonpea. Most of the cultivars now, under cultivation are of medium-long duration and occupy the land for about 6 to 8 months which often damaged by pod borer and frost etc. Therefore, they have little role to play in intensive agriculture (Singh, 1981). As against this, the short duration cultivars can respond to better management and can be fitted well in the newly developing multiple cropping system (Singh, 1981).

Of the several agronomical factors, crop geometry also play a vital role in augmenting potentially maximum production of pigeonpea crop. Plants grown in close proximity to one other will compete with each other for any environmental resources which is available in limited amounts. Thus, it becomes necessary to maintain optimum plant population per unit area for minimizing keen

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competition between plants for any environmental resources. The optimum plant density can be achieved by sowing plants at widely different patterns of arrangement. Crop geometry is one of them which is the ratio of distance between the plants within the row to the distance between the rows. The effect of crop geometry on yield depends upon the plasticity of the individual plant. In general, as crop geometry increases by increasing row width, yield per unit area declines. Therefore, establishment of an appropriate crop geometry for maintaining the optimum plant population per unit area is the mass pre-requisite to obtain maximum yield of pigeonpea.

Pigeonpea is the main pulse crop of middle Gujarat occupying 33.9 per cent of the total cropped area of the state. At present, T-15-15 and BDN-2 are the two recommended cultivars of the state which took medium-long duration for maturity. Thus, it is not feasible to take second crop in <u>rabi</u> season. Increasing facilities have opened the avenues for multiple cropping in this potentially productive region. Very little informations are available regarding suitable cultivars of pigeonpea and their crop geometry for the regions where this crop has taken on large scale with its vital importance. Therefore, newly evolved, newly introduced and promising

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strains of the pigeonpeas are need to be compared with appropriate crop geometry for the middle Gujarat conditions.

In view of the facts and due consideration as stated in the foregoing paragraphs, it was, therefore, thought worth while to study the crop geometry of certain short duration pigeonpea cultivars, during Kharif 1990 at the College Agronomy Farm, of the B. A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand for achieving the following specific objectives:

1. To find out suitable short duration pigeonpea cultivar for middle Gujarat conditions.
2. To find out appropriate crop geometry for short-duration pigeonpea cultivars.
3. To know the interaction effect of cultivars and crop geometry on the growth and yield of pigeonpea.
4. To assess the economics of using different pigeonpea cultivars and crop geometry.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

Pulses have an unique position in Indian agriculture because protein is the important constitute of Indian vegetarian diet. The gap between the availability and the requirement of pulses is not only large but is increasing over the years.

The only practical means of solving the protein malnutrition problem in the country is to increase the production of pulse crops. There are two ways of increasing production of any crop i.e. by increasing its area and the area under pulse crops by replacing the principal crops like wheat, pearlmillet, maize, sorghum, rice, cotton and sugarcane is very limited. The per hectare yield of pulses particularly pigeonpea can be increased only by the adoption of new pulse production strategy.

Crop production being a complex phenomenon is controlled by a large humber of endogenous and exogenous factors. Of the agronomic factors known to augment pigeonpea yield, selection of suitable cultivars and appropriate crop geometry are of vital importance for harvesting potential production of pigeonpea.

Attempts are, therefore, made here to present a brief review of the recent research work carried out in India and abroad on pigeonpea crop are summarised in the following heads.

2.1 Effect of different pigeonpea cultivars

2.2 Effect of crop geometry

2.3 Interaction effect of cultivars and crop geometry.

2.1 EFFECT OF DIFFERENT PIGEONPEA CULTIVARS

Realising the facts and importance of pulses in Indian Agriculture and in human dietary system, in 1967 ICAR, New Delhi started All India Co-ordinated Research Project for crop improvement by evolving short duration and high yielding cultivars of pulse crops. The local cultivars of pigeonpea are late maturing, occupying the land for longer period and often facing the moisture stress at maturity.

To overcome these, one should select a cultivar which is of short duration and high yielding and has a great value under sequential cropping system.

2.1.1 Effect of different pigeonpea cultivars on seed yield

Manjhi et al. (1973) conducted field investigation on sandy loam soil at I.A.R.I., New Delhi during *kharif* seasons of 1969 and 1970, comprising three cultivars of pigeonpea (T-21, AS-10 and Sharda) with three planting dates and nutrient applications. From the results, they reported that the cultivar Sharda yielded (20.7 q/ha) significantly higher than AS-10 and T-21. However, cultivars T-21 and AS-10 remained at par.

A field trial was conducted at I.A.R.I., New Delhi during 1972 and 1973 on sandy loam soil to study the comparative performance of pigeonpea cultivars (T-21, Pusa ageti and Sharda) to different row spacings. From the results of the trial, Ahlawat *et al.* (1975) reported that the cultivar did not show significant differences in grain yield in the year 1972 but the cultivar T-21 recorded significantly higher yield than Pusa ageti and Sharda in the year 1973. However, Pusa ageti and Sharda were remained at par.

Veeraswamy *et al.* (1975) conducted field investigation at Plant Breeding Research Station, Coimbtore under rainfed condition during 1973 as well as under irrigated condition in 1974. They reported that under rainfed condition the variety CO-2 had registered consistantly higher grain yield (825 kg/ha) with an increase of 16 per cent over a standard strain CO-1. While under irrgiated condition gave 23 per cent higher grain yield over CO-1.

Lenka and Satpathy (1976) while conducting an experiment at Bhubaneshwar on sandy loam soil during *Kharif* season of 1973 and 1974 to study the response of arhar varieties (S_5, T-21 and R-60) to nutrient application. They reported that the variety R-60 gave higher seed yield (13 q/ha) than that of S_5 (9.8 q/ha) and T-21 (9.5 q/ha).

Raj et al. (1977) tested sixteen cultivars of pigeonpea under A.I.C.R.P. for Dryland Agriculture, Kovilpatti during rabi season of 1971-74 under black soil condition. It was revealed that the varieties Khargone-2, R-60 and S-8 gave significantly higher yield than local.

An experiment was conducted at ICRISAT, Patancheru on vertisol during Rabi season of 1975-76 involving six pigeonpea cultivars of different maturity group viz., early (T-21 and Pusa ageti), medium (C-11 and ICP-1) and late [NP (WR)-15 and ICP-7065]. From the results of this trial, Narayanan and Sheldrake (1979) reported that the highest grain yield was obtained from the medium duration cultivars C-11 and ICP-1, while the lowest seed yield was obtained from early duration cultivars.

An experiment conducted at Gujarat Agricultural University, Sardar Krushinagar during Kharif 1979 comprising medium and long duration pigeonpea cultivars (T-21, JA-3 and T-15-15). Results revealed that the seed yield was not altered significantly due to different cultivars (Anon., 1980).

Dhingra et al. (1980) conducted an experiment at Punjab Agricultural University, Ludhiana during Kharif 1979 on loamy sand soil comprising two pigeonpea genotypes (T-21 and AL-15) and four spacing regimes (25, 37.5, 50 and 75 cm). It was revealed that the seed yield among the cultivars of pigeonpea was non-significant.

Faroda and Singh (1980) conducted an experiment at Hissar during *kharif* season of 1975, 1976 and 1977 on sandy loam soil to study the performance of short duration cultivars of pigeonpea (Prabhat, UPAS-120, T-21 and Pant A-2). They observed that the cultivar UPAS-120 recorded significantly the highest grain yield of 18.92 q/ha, while the lowest grain yield was recorded in Pant.A-2.

Roysharma *et al*. (1980) conducted a varietal trial at Dholi, Bihar during 1977-78 and 1978-79. They concluded that the late cultivars (Bahar and Basant) gave higher grain yield as compared with medium cultivars (S8, BS-I and BR-183) and early cultivars (UPAS-120, Prabhat, Pant.A-4 and Pant.A-2).

A state varietal trial consisting 18 entries of midlate maturity conducted at S.K.Nagar, Junagadh and Anand locations during *Kharif* 1981. Results revealed that at S.K.Nagar, T-15-15 gave the highest grain yield (2056 kg/ha). Whereas, at Junagadh and Anand it was at par with BDN-2 (Anon., 1981-82).

From the results of field experiment conducted at Plant Breeding Department, H.A.U., Hissar, Malik *et al*. (1981) observed that the variety H. 77-216 gave significantly higher seed yield of 2.09 t/ha as compared to UPAS-120 (1.59 t/ha) and Prabhat (1.31 t/ha).

An investigation was conducted at I.A.R.I., New Delhi on sandy loam soils under dry land condition comprising three pigeonpea cultivars (Pusa ageti, P.4785 and Prabhat) in relation to plant density and 'P' fertilizer by Ahlawat and Saraf (1981). They reported that the cultivar Pusa ageti gave higher grain yield than Prabhat, however it remain at par with P-4785.

Chauhan and Singh (1981) conducted an experiment at R. B. S. College, Bichpuri, Agra during Kharif 1973-74, involving three pigeonpea cultivars (Pusa ageti, T-21 and Sharda). It was observed that the cultivar Pusa ageti produced maximum grain yield in the tune of 11.24 q/ha and 5.5 and 13.6 per cent higher yield over T-21 and Sharda, respectively.

A varietal trials were conducted at Agriculture College Farm, Dapoli during Kharif 1975-77 comprising nine promising varieties of pigeonpea. From the results, Bhosale et al. (1982) reported that the variety BS-1 gave significantly more grain yield than Hy-1, UPAS-120, Pusa ageti, Sharda and Prabhat but remained at par with A-2, T-21 and Pant.A-9.

A State varietal trial conducted at Navsari during rabi season of 1983-84 indicated that the yield differences among seven arhar entries were not significant. Numerically BDN-2 (1239 kg/ha) recorded the highest yield followed by AGS-522 (1193 kg/ha) and AGS-521 (1165 kg/ha) giving 35.4, 30.4 and 27.3 per cent higher yield over T-15-15, respectively (Anon., 1983-84).

A field experiment was conducted at R. B. S. College Research Farm, Bichpuri during Kharif 1978 and 1979 involving three cultivars of pigeonpea viz., Prabhat, Pant.A-I and Pant.A-3. From the investigation, Ahuja (1984) concluded that the cultivar Pant.A-3 produced significantly higher grain yield than Pant.A-I and Prabhat.

Patel *et al*. (1984) conducted an experiment at N. M. College of Agriculture, College Agronomy Farm, Navsari (Gujarat) during Kharif, 1980 to study the response of pigeonpea cultivars (T-15-15, B-12 and Pusa ageti) to varying row spacing (60, 90 and 120 cm) and fertilizer. The results revealed that the cultivar T-15-15 performed significantly better than B-12 and Pusa ageti with respect to grain yield (11.9 q/ha).

A field experiment was conducted at N. A. R. P., G. A. U, Bharuch during 1983-84 with three promising pigeonpea cultivars (T-15-15, Bhadbhoot and BDN-2) revealed that significantly the highest grain yield was recorded by T-15-15 (1283 kg/ha) followed by BDN-2 and Bhadbhoot (Anon., 1985).

A field experiment was conducted at N. A. R. P., *G. A. U.*, Bharuch during 1983-84 find out suitable dates of sowing along with optimum population density for four promising varieties of pigeonpea viz., T-15-15, Bhadbhoot, Nylon and BDN-2 indicated that the variety Bhadbhoot produced the highest grain yield (1072 kg/ha) over rest of the varieties, whereas, BDN-2 recorded the lowest grain yield in the tune of 682 kg/ha (Anon., 1985a).

A field experiment was conducted at N. A. R. P., Arnej (Bhal) on fifteen promising varieties of pigeonpea under rainfed condition during 1982-85. From the results, it was revealed that the differences were not significant among varieties in 1984-85, however, the variety BDN-2 gave maximum grain yield (777.8 kg/ha). Whereas in pooled analysis, the variety T-15-15 gave significantly the highest average grain yield (481.5 kg/ha) over rest of the varieties (Anon., 1985b).

A State varietal trial conducted at Navsari to evaluate sixteen promising strains of arhar revealed that the highest grain yield (3811 kg/ha) was recorded by T-15-15 which was followed by C-11 (3769 kg/ha) and BDN-1 (3728 kg/ha) registered 3.4, 2.3 and 1.1 per cent higher yield over BDN-2 (Anon., 1985-86).

An experiment was conducted at N. A. R. P., G. A. U., Bharuch during 1985-86 to evaluate the performance of dite pigeonpea types under rainfed conditions. Results indicated that none of the varieties were found to give higher yield than check BDN-2 (1715 kg/ha) (Anon., 1986).

Bisnoi and Phogat (1986) conducted an experiment at H. A. U., Hissar during Kharif 1979, comprising two

Arhar varieties (UPAS-120 and Prabhat). From the results, they found that the variety UPAS-120 was significantly better than Prabhat in producing highest grain yield (16.65 q/ha).

Singh *et al*. (1986) conducted an experiment during *Kharif* 1983-84 at Regional Research Station, Ambikapur (M.P.) to study the response of pigeonpea varieties to phosphorus fertilizer. From the results, they concluded that the variety JA-3 produced the highest grain yield (23.16 q/ha) followed T-21 (19.72 q/ha) and local cultivar (16.63 q/ha).

Yadahalli and Reddy (1987) conducted an experiment to study the performance of short duration pigeonpea genotypes during summer 1985 at Hebbal, Bangalore on a clay loam soil. They concluded that there was no significant difference in seed yield among two genotypes (DL-82 and ICPL-8332).

From the results of the trial conducted with two pigeonpea varieties at I. C. A. R. Research Farm, Jharnapani during 1982-83 under rainfed condition, Dwivedi and Patel (1988) reported that the variety Bahar recorded significantly higher grain yield of 20.09 q/ha and 22.50 q/ha during 1982 and 1983, respectively than the variety T-21.

Govil *et al*. (1988) from the field study with four pigeonpea cultivars (Pusa-84, Pusa-78, Pusa ageti and

DL-78-1) at I. A. R. I., New Delhi, reported that the cultivar Pusa-84 was found significantly superior in respect of seed yield.

Puste and Jana (1988) conducted an experiment at Kalyani (W.B.) during winter 1980-81 and 1982-83 with two pigeonpea varieties [5(124) and Bahar]. They observed that the grain yield was not significantly differed due to varieties. They further reported that the variety Bahar recorded 6.8 and 6.2 per cent higher seed yield than 5(124) during 1980-81 and 1982-83, respectively.

Bhat *et al*. (1989) conducted an experiment at Dharwad (Karnataka) during *Rabi* season invloving five cultivars of pigeonpea (Hy-3C, C-11, PT-221, TS-136-1 and CO-3). From the study, they found that the cultivar TS-136-1 produced significantly the highest grain yield (10.82 q/ha). However, cultivars C-11 and Hy-3C were remained at par.

Patra (1989) conducted field investigation on vertisol at Regional Research Station, Keonjhar, Orissa to study the response of early pigeonpea cultivars (ICPL-292, ICPL-288 and Local) to fertilizer during *Kharif* 1987. He reported that the cultivars did not differ significantly in respect of grain yield.

An early pigeonpea cultivars tested at different locations in Gujarat State during *Kharif* 1990-91 revealed that the differences in grain yield was significant due to different genotypes of pigeonpea. The variety ANDT-2 gave significantly higher grain yield over Pusa ageti in the tune of 1750, 1208, 897 and 2201 kg/ha at Sardar Krushinagar (Dantiwada), Junagadh, Navsari and Vadodara, respectively in the State of Gujarat (Anon., 1991a).

The foregoing review on effect of different pigeonpea cultivars on seed yield has clearly indicated that the different pigeonpea genotypes had more or less influenced the grain yield. Further, on the basis of recent scientific advancement, it can be concluded that the early and short duration cultivars of pigeonpea yielded less as compared to medium and late maturing cultivars of pigeonpea.

2.1.2 Effect of different pigeonpea cultivars on stalk yield

Lenka and Satpathy (1976) while working at Bhubaneswar reported that the variety R.60 gave higher straw yield (57.8 q/ha) than that of S-5 and T-21.

Narayanan and Sheldrake (1979) reported from the trial conducted on vertisol at ICRISAT, Patancheru that the highest shoot dry weight was recorded in late maturing cultivars [ICP-7065 and NP (WR)-15].

Dhingra et al. (1980) conducted an experiment on loam sand soil during Kharif 1979 involving two pigeonpea genotypes (T-21 and AL-15) They concluded that the dry matter yield was significantly differed among cultivars. Cultivar T-21 recorded more dry matter than that of AL-15.

Ahlawat and Saraf (1981) conducted an experiment at I. A. R. I., New Delhi on sandy loam soil under dryland condition with three pigeonpea cultivars viz., Pusa ageti, P-4785 and Prabhat. From the trial, they concluded that the highest stalk yield was recorded in Pusa ageti than that of P-4785 and Prabhat.

Chauhan and Singh (1981) reported that under Agra conditions, cultivars T-21 significantly recorded higher straw yield followed by Sharda, while lowest straw yield was recorded with Pusa ageti cultivar of pigeonpea.

From the results of the trial conducted with three pigeonpea cultivars viz., Prabhat, Pant.A-1 and Pant.A-3 at R. B. S. College Research Farm, Bichpuri, Agra, Ahuja (1984) reported that the variety Pant.A-3 produced significantly higher stalk and straw yield than Pant.A-1 and Prabhat.

Patel et al. (1984) while conducting an experiment at College Agronomy Farm, Navsari (Gujarat) found that the variety T-15-15 performed significantly better than B-12 and Pusa ageti cultivar of pigeonpea with respect to stalk yield (56.3 q/ha).

Bisnoi and Phogat (1986) while studying the comparative performance of different pigeonpea cultivars during Kharif 1979, reported that the variety UPAS-120 was significantly better than Prabhat in respect to dry weight/plant (104.43 g).

Patra (1989) conducted field study on vertisol at Regional Research Station, Keonjhar, Orissa to study the response of early pigeonpea cultivars viz., ICPL-292, ICPL-288 and local to fetilizer during Kharif 1987, reported that the cultivar ICPL-292 recorded significantly higher stalk yield than ICPL-288 and local.

2.1.3 Effect of different pigeonpea cultivars on growth and yield attributes

Manjhi et al. (1973) carried out an experiment at I. A. R. I., New Delhi on sandy clay loam soil during Kharif season of 1969 and 1970, involving three varieties (T-21, AS-10 and Sharda). From the results, they reported that the variety Sharda produced significantly more seed weight and number of pods per plant as compared to T-21 and AS-10.

While conducting an experiment at I. A. R. I., New Delhi to study the comparative performance of pigeonpea varieties (T-21, Pusa ageti and Sharda) to various row spacings, Ahlawat et al. (1975) observed that the varieties T-21 and Pusa ageti were at par and significantly superior to Sharda with respect to plant height and pods per plant; however, Pusa ageti produced more branches than T-21 and Sharda. They also observed that the highest seed weight was recorded with the cultivar Sharda followed by Pusa ageti and T-21.

Veeraswamy et al. (1975) reported that the pigeonpea cultivar CO-2 was matured earlier by 20 days and recorded higher seed weight than that of standard strain CO-1.

An investigation carried out by Lenka and Satpathy (1976) to study the response of arhar varieties (S_5, T-21 and R_{60} to nutrient application during Kharif 1973 and 1974, on sandy loam soil at Bhubaneswar. From the results, revealed that the variety R_{60} produced higher number of branches and pods per plant than the cultivars T-21 and S_5. They also reported that the varieties S_5, T-21 and R_{60} matured in 162, 171 and 197 days, respectively.

Narayanan and Sheldrake (1979) observed that harvest index was lowered in late cultivars as compared to medium cultivars.

Dhingra et al. (1980) conducted field investigation at P. A. U. Ludhiana during Kharif 1979 on loam sand soil, comprising two pigeonpea genotypes (T-21 and AL-15) and four spacing regions (25, 37.5, 50 and 75 cm). From the results, they reported that the cultivar T-21 recorded more branches per plant than AL-15. They also observed that the cultivar T-21 was comparatively long duration than cv. AL-15 took on an average 100, 107 and 149 days to flower initiation, flower completion and maturity, respectively as compared with 83, 93 and 129 days, respectively in AL-15.

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From the results of an experiment conducted at Hissar to study the performance of short duration cultivars (Prabhat, Upas-120, T-21 and Pant.A-2), Faroda and Singh (1980) observed that the cultivar T-21 was recorded the highest plant height, while the lowest plant height was observed with the cultivar Prabhat.

From the results of varietal trial conducted at Dholi, Bihar during 1977-78 and 1978-79, Roysharma et al. (1980) observed that the cultivar Basant took less days to flower initiation (115 days) as compared to Bahar (122 days) among late cultivars, while among the medium cultivars, BR-183 took less days to flower initiation as compared to cultivars S_8 and BS.I.

At Hissar, Malik et al. (1981) observed that the variety H.77-266 flowered later than Prabhat and earlier than Upas-120.

While conducting varietal trials at Agricultural College Farm, Dapoli during Kharif 1975-77 on nine promising varieties of redgram, Bhosale et al. (1982) observed that the variety Pant.A-9 matured earlier than all other promising varieties of red gram. BS-1, T-21, Pant.A-2 and Pant.A-9 matured in 165, 165, 157 and 130 days, respectively.

While conducting an experiment on pigeonpea varieties viz., Prabhat, Pant.A-1 and Pant.A-3 at

R. B. S. College Research Farm, Bichpuri during Kharif 1978 and 1979, Ahuja (1984) reported that the variety Pant.A-1 attained maximum plant height followed by Prabhat and Pant.A-3. Whereas the variety Pant.A-3 produced higher number of branches and pods per plant than Prabhat, but remained at par with Pant.A-I. He, further noticed that cultivars Pant.A-3 and Pant.A-1 exhibited higher harvest index than Prabhat.

While studying the response of arhar varieties (T-15-15, B-12 and Pusa ageti) to varying row spacings and fertilizer at College Farm, Navsari (Gujarat) during Kharif 1980, Patel et al. (1984) observed that the variety T-15-15 performed significantly better than B-12 and Pusa ageti with respect to number of branches/plant, pods/plant, grains/pod and 1000 grain weight.

Bisnoi and Phogat (1986) carried out an experiment at H. A. U., Hissar during Kharif 1979, comprising two arhar varieties (Upas-120 and Prabhat). From the results of an experiment, they found that the variety Upas-120 was significantly better in producing more pods and higher test weight.

While studying the response of pigeonpea varieties to phosphorus fertilization at Regional Research Station, Ambikapur (M.P.), Singh et al. (1986) reported that the variety JA-3 had higher number of pods/plant, seeds/pod and higher seed weight.

Yadahalli and Reddy (1987) carried out an experiment to study the performance of short duration pigeonpea genotypes during summer 1985 at Hebbal, Bangalore on clay loam soil. From the results, they observed that the genotype DL-82 had higher number of pods per plant and 100 seed mass than ICPL 8332, while higher harvest index and seeds per pod was observed in ICPL 8332.

While working at I. C. A. R., Research Farm, Jharnapani with two red gram varieties under rainfed condition, Dwivedi and Patel (1988) reported that the variety Bahar recorded higher value of branches per plant, pods per plant, seeds per pod and 1000-seed weight than the variety T-21.

Govil et al. (1988) carried out an experiment at I. A. R. I., New Delhi during Kharif season with four pigeonpea cultivars (Pusa 84, Pusa 78, Pusa ageti and DL 78-1). From the results, they observed that the cultivar Pusa-84 was significantly superior with respect to pods per plant, branches per plant, seeds per pod, plant height and harvest index over all other cultivars. They further reported that the cultivars Pusa ageti and Pusa-84 was matured later than the cultivars Pusa-78 and DL-78-1.

While working with two pigeonpea varieties [5(124) and Bahar] at Kalyani (W.B.), Puste and Jana (1988) observed that Bahar variety recorded significantly higher number of pods and heavier seeds than 5(124), but produced less number of seeds per pod than the variety 5(124).

Bhat et al. (1989) conducted an experiment at Dharwad during Rabi season with five pigeonpea genotypes (Hy-3C, C-11, PT-221, TS-136-1 and CO.3). From the results, they observed that the genotype TS-136-1 gave significantly higher grain yield per plant than all other genotypes.

Patra (1989) while working with early pigeonpea cultivars (ICPL-292, ICPL-288 and KAS-1) at Regional Research Station, Keonjhar, Orissa reported that cultivars did not differ with respect to plant height and number of pods per plant, however, the cultivar KAS-1 had significantly higher grain number per pod but lower 100 seed mass than all other cultivars.

2.1.4 Effect of different pigeonpea cultivars on protein content of grains

Veeraswamy et al. (1975) conducted a critical yield trial at Plant Breeding Research Station, Coimbtore under rainfed condition during 1973. They reported that the variety CO-2 had recorded the higher protein content of 19.3 per cent which was about 1.9 per cent higher than that of CO-1.

While working at I. A. R. I., New Delhi with three pigeonpea cultivars viz., Pusa ageti, P.4785 and

Prabhat on a sandy loam soil under dry land condition, Ahlawat and Saraf (1981) reported that crude protein was not significantly differed due to varieties.

2.2. EFFECT OF CROP GEOMETRY

Crop geometry plays an important role in maintaining adequate plant population. Establishment of an appropriate crop geometry for maintaining the optimum plant population per unit area is the mass pre-requisite to obtained maximum yield for any field crops. Moreover, crop geometry provides space for easy interculturing, weeding and application of fertilizer in the field. An appropriate crop geometry also renders scope for a better growth and development of crop which ultimately reflects in higher crop production.

Attempts are therefore, made here to present brief summary of review pertaining to the effect of crop geometry on pigeonpea.

2.2.1 Effect of crop geometry on seed yield

Hammerton (1971) conducted an experiment at Augustine, West Indies, involving plant densities in the range from 47900 to 43000 plants/ha (0.21 - 2.32 m^2/ plant). From the results, he noticed that increase in area/plant decreased pod yield per hectare from 8.0 t/ha at the closest spacing (0.21 m^2/plant).

While conducting an experiment on pigeonpea cv. T-21 at Jabalpur during <u>kharif</u> 1969 with three plant population (40,000, 50,000 and 60,000 plants/ha) and two row spacings (75 and 100 cm), Singh _et al_. (1971) reported that significantly the highest grain yield (1214 kg/ha) was obtained at maximum plant population (60,000 plants/ha). They also reported that row spacing had no influence on grain yield of pigeonpea.

A study was under taken on pigeonpea cv. SA-1 by Veeraswamy _et al_. (1972) at Coimbtore during monsoon season of 1966-69 with different treatments (90 x 20 cm, 90 x 30 cm, 90 x 40 cm, 120 x 20 cm, 120 x 30 cm, 120 x 40 cm, 150 x 20 cm, 150 x 30 cm spacings and broadcast method). From the results, they observed that the spacing of 90 x 30 cm had given the highest grain yield of 1032 kg/ha as against 630 kg/ha was obtained from the broadcast sowing.

Field investigation conducted by Manjhi _et al_. (1973) at I. A. R. I., New Delhi on sandy loam soil during the _Kharif_ season of 1969 and 1970 revealed that a row spacing of 50 cm gave significantly higher grain yield than that of 75 cm row spacing, Similar results was further reported by Ahlawat _et al_. (1975).

While working at Agricultural Research Station, Meeruth (U.P.), Rathi _et al_. (1974) reported that 50 cm inter-row spacing gave significantly the highest grain yield (23.3 q/ha) over rest of the inter-row spacings (i.e. 75 and 100 cm).

Akinola and Whiteman (1975) conducted an experiment at Red land bay, Nigeria during 1972 comprising different spacings from 1.219 m x 1.129 m to 0.305 m x 0.152 m. From the results, they showed that the maximum seed yield (2774 kg/ha) was obtained at a spacing o 0.914 m x 0.610 m (17,940 plants/ha) differed significantly from the yield of 2560 kg/ha produced at the lowest density.

From the result of an experiment conducted on clay loam soil at Lawrence field, Jamaica with two pigeon pea cultivars [cv, 17 (BE)] and cv. 20 (GI 27/4a), sown at the spacings viz., 90 x 90 cm and 45 x 45 cm, Hammerton (1976) reported that closer spacing (45 x 45 cm) gave higher seed yield than that of wider spacing (90 x 90 cm).

Yadahalli et al. (1976) while working on pigeonpea cv. Hyd-3C indicated that increased plant density from 50,000 to 75,000 plants/ha ellevated seed yield from 1.88 to 2.08 t/ha in new cajan cv. Hyd-3C.

In an experiment on early maturity cv. T-21 on sandy loam soil during 1971-73 with three inter-row spacings viz., 50, 75 and 100 cm, Rathi and Tripathi (1978) observed that inter-row spacing of 75 cm gave the maximum grain yield over 50 cm and 100 cm inter-row spacings.

While conducting an experiment on pigeonpea cv. Sharda at Varansi, Singh et al. (1978) reported that the highest grain yield of pigeonpea was recorded under closer spacing of 50 cm to wider row spacing of 75 cm. The similar results were further reported by Sandhu *et al*. (1981) at P. A. U., Ludhiana.

From the results of an experiment conducted on cultivators field, Devarayapuram districts of Tamil Nadu on red loam soil during 1974-75, Subramanian *et al*. (1978) showed that the plant spacing of 30 cm and 20 cm were produced significantly higher grain yield of 801 and 794 kg/ha, respectively as against only 710 kg/ha grain yield obtained from wider plant spacing (40 cm).

An experiment conducted at P. A. U., Ludhiana by Dhingra *et al*. (1980) during *Kharif* 1979 on a loam sand soil with pigeonpea cvs. (T-21 and AL-15) sown at four row spacings viz., 25, 37.5, 50 and 75 cm. From the results, they reported that significantly the highest seed yield (1425 kg/ha) was obtained under the closest row spacing of 25 cm over wider row spacings.

While conducting an expeirment at H. A. U., Hissar during 1975-77 on sandy loam soil with four spacings viz., 25, 37.5 50 and 62.5 cm, Faroda and Singh (1980) noticed that significantly higher grain yield was obtained from row spacing of 37.5 cm than that of wider row spacings (50 and 62.5 cm). They also showed that narrow row spacing of 25 cm was significantly better in respect of grain yield as compared to wider spacing (62.5 cm).

An experiment conducted at Pantnagar on short duration pigeonpea cv. T-21 by Singh and Kalra (1980) indicated that significantly the highest grain yield was obtained when crop was sown at 10 x 60 cm spacing, where as the lowest grain yield was recorded under the wider spacing (30 x 60 cm).

Ahlawat and Saraf (1981) carried out an experiment at I. A. R. I., New Delhi on sandy loam soil, comprising pigeonpea varieties (Pusa ageti, P.4785 and Prabhat) and three plant densities viz., 50×10^3, 100×10^3 and 150×10^3 plants/ha. The results revealed that medium and high plant densities out yielded the low density with respect to grain yield.

While studying the response of pigeonpea varieties (Pusa ageti, Sharda and T-21) to varying row spacings (40, 60 and 80 cm) at R. B. S. College Research Farm, Bichpuri on sandy loam soil during Kharif 1973 and 1974, Chauhan and Singh (1981) found that the row spacing of 60 cm gave significantly higher grain yield over 40 and 80 cm spacings.

Masood Ali (1981) conducted an experiment at dryland project, I. G. F. R. I., Jhansi on red loamy soil during Kharif 1977. From the results, concluded that wider row spacing of 60 cm was found significantly better than narrow spacing (45 cm) with respect to grain yield.

While studying the effect of different spacings (0.9 x 0.4, 0.6 x 0.4 and 0.6 x 0.2 m) on the growth and grain yield of dwarf pigeonpea cv. cita-1 under Ibadan condition, Nigeria in 1980, Toyo (1982) found that significantly the highest grain yield was obtained at the highest plant population density.

An experiment carried out by Ikramullah and Rao (1983) with pigeonpea cv. C_{11} on Alfisol during 1979 and 1980, comprising six plant spacings viz., 30 x 10, 45 x 10, 30 x 20, 60 x 10, 45 x 20 and 60 x 20 cm. From the results, they reported that the seed yield was consistently increased with decreased in plant spacing. The highest seed yield was obtained at the 30 x 10 cm spacing over rest of the spacings.

Patel (1983) conducted an experiment at College Agronomy Farm, G. A. U., Anand on sandy loam soil during *Kharif* 1981, with pigeonpea cv. T-15-15 grown at three different spacings viz., 150 x 30, 150 x 60 and 150 x 90 cm. He observed that an intra-row spacing of 30 cm gave significantly the highest grain yield over 60 and 90 cm intra-row spacings.

Field investigation carried out by Wallis *et al*. (1983) at University of Queensland Research Farm, Red land Bay, consisting four row spacings viz., 20 x 10 cm, 30 x 10 cm, 40 x 10 cm and 60 x 10 cm. From the results, they observed that grain yield per hectare was increased with decreased row spacing. They noticed that the highest grain yield (3800 kg/ha) was obtained at the closest row spacing (20 x 10 cm) over rest of the spacings.

During the study on response of pigeonpea cultivars (B-12, T-15-15 and Pusa ageti) to varying row spacings (60, 90 and 120 cm) at College Agronomy Farm, G. A. U., Navsari during *Kharif* 1980, Patel *et al*. (1984) noted that the row spacing of 90 cm gave significantly the highest grain yield (12.0 q/ha) as compared to 120 and 60 cm row spacings.

While conducting an experiment at Rajendranagar during *rabi* 1978-79 and 1979-80on vertisols, Reddy *et al*. (1984) found that significantly the highest seed yield was recorded at 3.33 lakh plants/ha (30 x 10 cm), while the lowest seed yield was obtained at 0.83 lakh plants/ha (60 x 20 cm).

From the results of an experiment conducted to study the effect of row spacings (25 x 20 and 37.5 x 13.3 cm) on growth and yield of pigeonpea varieties (Bahar, Laxmi and T-21) at Ranchi, Shrivastava (1984) showed that significantly higher grain yield was obtained under the row spacing of 25 x 20 cm than that of 37.5 x 13.3 cm row spacing.

Field investigation conducted by Sing *et al*. (1984) at I. A. R. I., New Delhi during 1978 and 1979 on sandy loam soil indicated that plant geometry of 75 x 20 cm gave better grain yield than 50 x 30 cm..

Ahlawat _et al_. (1985) carried out an experiment at I. A. R. I., New Delhi on calcareous sandy loam soil with three levels of plant densities viz., 50×10^3 (100 x 20 cm), 66.7×10^3 (75 x 20 cm) and 100×10^3 (50 x 20 cm). From the results, they reported that seed yield of pigeonpea increased with decreased in plant density, however, the difference between 66.7×10^3 and 50×10^3 plants/ha were not marked.

An experiment conducted at Tissuchi (U.P.) during 1982-84 on pigeonpea cv. Bahar, sown on ridges spaced at 45, 60, 75 and 90 cm apart. From the results, Tripathi (1986) observed that the spacings did not differed significantly with respect to grain yield, however, the highest seed yield was obtained with 45 cm row spacing.

Singh and Prasad (1987) conducted an experiment at I. A. R. I., New Delhi during _Kharif_ 1984 on sandy loam soil, comprising three plant densities (100×10^3, 150×10^3 and 200×10^3 plants/ha). They reported that grain yield was decreased significantly as plant density increased from 100×10^3 to 200×10^3 plants/ha.

While studying the yield potential of two short duration pigeonpea genotypes (DL-82 and ICPL-8332) under four spacings (30 x 5, 30 x 10, 45 x 5 and 45 x 10 cm) at Hebbal, Bangalore, Yadahalli and Reddy (1987) reported that singficantly the highest seed yield was obtained at closer spacings of 30 x 5 and 45 x 5 cm.

Gondalia et al. (1988) while conducting an experiment at Pulse Research Farm, G. A. U., Junagadh during Kharif 1985-86 reported that inter row spacings of 45 cm recorded significantly the highest grain yield (10.8 q/ha) over rest of the row spacings (30 and 60 cm).

Goyal et al. (1989) carried out an experiment at N. A. R. P. Research Station, G. A. U., Bharuch during kharif 1981-82 to 1984-85 to study the response of pigeonpea cultivar (T-15-15, Bhadbhoot and BDN-2) to varying row spacings (90, 120 and 150 cm). From the results, they noticed that the inter-row spacings of 90 cm and 120 cm produced significantly higher grain yield per hectare over 150 cm inter row spacing, however, there was reduction in grain yield when the row spacing was increased beyond 90 cm.

Singh and Kalra (1989) carried out an experiment at Meerut, during Kharif 1976 and 1977 on pigeonpea cv. T-21 sown at three plant spacings (10, 20 and 30 cm) in row 60 cm apart. They reported that closer spaced crop (60 x 10 cm) had maximum grain productivity per day (18.74 kg/ha) followed by 60 x 20 cm and 60 x 30 cm spacings. They also observed same trend with respect to grain yield per hectare.

From the result of an experiment conducted on clayey soil of the College Agronomy Farm, G. A. U., Navsari during Kharif 1989-90, Sarvaiya (1990) showed that inter row spacing of 90 cm gave significantly higher seed yield (13.9q/ha) than 60 cm and 120 cm inter-row spacings.

From the above cited review, it is observed that closer spaced pigeonpea gave higher seed yield per hectare as compared to wider spaced pigeonpea, however, there was some controversial results with respect to seed yield per hectare among the cited references.

2.2.2 Effect of crop geometry on stalk yield

Akinola and Whiteman (1975) conducted an experiment at Red land bay, Nigeria involving different spacing from 1.219 m x 1.129 m to 0.305 m x 0.152 m. From the results, they reported that the highest dry matter yield (22950 kg/ha) was produced at 0.305 m x 0.305 m spacing (107.639 plants/ha).

While conducting an experiment at Sao mannuel on dark red latosol with three row spacings viz., 0.5, 1.0 and 1.5 m apart, Marchi et al. (1981) noticed that crop sown with 0.5 m row spacing produced the highest dry matter (5.94 t DM/ha), while the lowest was obtained with 1.5 m spacing (3.82 t DM/ha).

An experiment conducted by Rowden et al. (1981) at the University of Queensland Research Farm, Red land bay with four plant densities (2 x 10^5, 3 x 10^5, 5 x 10^5

and 1×10^6 plants/ha). They observed that the highest dry matter yield (8200 kg/ha) was recorded at the plant density of 1×10^6 plants/ha, as against lowest dry matter (4200 kg/ha) obtained with the plant density (2×10^5 plants/ha).

From the results of an experiment conducted at College Agronomy Farm,G. A. U., Anand during Kharif 1981, Patel (1983) observed that an intra row spacing of 30 cm produced higher stalk yield than that of 60 and 90 cm intra-row spacings.

During the study on response of pigeonpea cultivars (B-12, T-15-15 and Pusa ageti) to row spacings (60, 90 and 120 cm) at College Agronomy Farm, G. A. U., Navsari during Kharif 1980, Patel et al. (1984) reported that the stalk yield obtained due to 60 and 90 cm row spacings were on par and significantly higher than wider row spacing (120 cm).

At Tissuchi (U.P.), Tripathi (1986) reported that the spacing of 45 cm produced significantly higher stalk yield followed by 60, 75 and 90 cm cow spacing.

Singh and Prasad (1987) while conducting an experiment at I. A. R. I., New Delhi, on sandy loam soil during Kharif 1984 showed that the stalk yield was increased with the plant density increased from 100×10^3 to 200×10^3 plants/ha.

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While working at Pulse Research Farm, G. A. U., Junagadh, Gondalia *et al.* (1988) reported that an inter-row spacing of 45 cm gave significantly the highest stalk yield (26.4 q/ha) over rest of the row spacings (30 cm and 60 cm).

Sarvaiya (1990) conducted an experiment on clayey soil of the College Agronomy Farm, G. A. U., Navsari during *Kharif* season of 1989-90. He reported that an inter row spacing of 90 cm gave significantly the highest stalk yield (53.2 q/ha) over other two row spacings (60 cm and 120 cm).

2.2.3 Effect of crop geometry on growth and yield attributes of pigeonpea

Hammerton (1971) while conducting an experiment on two dwarf pigeonpea cultivars, reported that the plant height at flowering and harvesting was increased as the plant density increased from 4300 to 47900 plants/ha.

Singh *et al.* (1971) conducted an experiment on pigeonpea cv. T-21 at Jabalpur, involving three plant populations (40,000, 50,000 and 60,000 plants/ha) and two row spacings (50 and 75 cm). They observed that significantly the highest number of branches (17.4) and pods per plant (169.6) were produced with the plant population of 40,000 plants/ha as compared to 60,000 plants/ha, whereas, the plant height was unaffected by row spacing and plant population.

Manjhi *et al*. (1973) conducted an experiment at I. A. R. I., New Delhi involving two row spacings (50 cm and 75 cm). From the results, they revealed that pods per plant and 1000 grain weight were not affected significantly dye to inter-row spacing.

Ahlawat *et al*. (1975) carreid out an experiment at I. A. R. I., New Delhi with two inter-row spacings (50 and 75 cm). They observed that significantly higher number of branches and pods per plant were obtained under row spacing of 75 cm than 50 cm row spacing, while the plant height and test weight were not affected by different row spacings.

While working at Redland bay, Nigeria, Akinola and Whiteman (1975) showed that at the widest row spacing (1.219 m x 1.129 m), pod ripening occurred 12 days later than at the closest spacing (0.305 m x 0.152 m).

Hammerton (1976) observed that wider spacing (90 x 90 cm) produced more number of pods plant as compared to narrow spacing (45 x 45 cm).

Narayanan and Sheldrake (1979) while working at ICRISAT, Pantancheru (A.P.) reported that greater harvest index was obtained at lower population densities (12.5 and 25 plants/m^2).

Dhingra *et al*. (1980) conducted field investigation at P. A. U., Ludhiana with pigeonpea cvs. (T-21 and AL-15) sown at four row spacings viz., 25, 37.5, 50 and 75 cm.

From the results they concluded that the highest seed weight, branches and pods per plant were recorded with 75 cm row spacing as compared to rest of the row spacings. However, row spacing failed to influence the number of days to flower initiation and maturity in both cultivars.

Faroda and Singh (1980) observed that 62.5 cm and 50 cm row spacings were produced significantly higher number of pods per plant than that of narrow row spacings (25 cm and 37.5 cm).

While working at Pantnagar (U.P.), Singh and Kalra (1980) reported that significantly the highest pods and grain yield per plant were produced under widest spacing (30 x 60 cm) followed by 20 x 60 cm and 10 x 60 cm plant spacings.

Ahlawat and Saraf (1981) carried out an experiment at I. A. R. I., New Delhi, involving three plant densities viz., 50×10^3, 100×10^3 and 150×10^3 plants/ha. From the results, they reported that number of branches, number of pods and grain yield per plant and test weight were markedly reduced with the increased plant density from 50×10^3 to 150×10^3 plants/ha.

Chauhan and Singh (1981) at Bichpuri, Agra reported that the number of branches and pods per plant and test weight were recorded more when crop was sown at 80 cm row spacing as compared to narrow row spacings (40 cm and 60 cm).

While working at I. G. F. R. I., Jhansi (U.P.), Masood Ali (1981) observed that number of pods per plant and test weight were not differed significantly due to row spacings. However, 60 cm row spacing recorded higher number of pods per plant than 45 cm inter-row spacing.

Rowden et al. (1981) carried out an experiment at Queensland Research Farm, Red land bay with four plant densities (2×10^5, 3×10^5, 5×10^5 and 1×10^6 plants/ha). They reported that number of pods per plant declined asymptotically from 32 to 7 at the highest plant density (1×10^6 plants/ha).

While studying the effect of different spacings (0.9 x 0.4, 0.6 x 0.4 and 0.6 x 0.2 m) under Ibadan condition Nigeria, Toyo (1982) found that the widest spacing (0.9 x 0.4 m) produced significantly the highest pods/plant and seeds/pod over other two spacings (0.6 x 0.4 m and 0.6 x 0.2 m).

Patel (1983) conducted an experiment at College Agronomy Farm, G. A. U., Anand on pigeonpea cultivar T-15-15 grown at three different spacings viz., 150 x 30, 150 x 60 and 150 x 90 cm. He observed that an intra-row spacing of 90 cm produced significantly higher number of branches and pods per plant, grain yield per plant and test weight as compared to those of 60 amd 30 cm intra-row spacing. But he observed reverse trend in respect of harvest index.

From the results of an experiment conducted at Rajendranagar (A.P.) on vertisol, Reddy et al. (1984) noticed that the highest number of branches, number of pods per plant and test weight were recorded at 60 x 20 cm spacing (0.83 lakh plants/ha), while the lowest values of the same characters were recorded at 30 x 10 cm spacing (3.33 lakh plants/ha).

Field investigation conducted by Singh et al. (1984) at I. A. R. I., New Delhi indicated that closer spacing reduced the total number of pods per plant and grain yield per plant.

Ahlawat et al. (1985) carried out an experiment at I. A. R. I., New Delhi involving three levels of plant densities viz. 50×10^3, 100×10^3 and 150×10^3 plants/ha (100 x 20, 75 x 20 and 50 x 20 cm, respectively). From the results, they reported that the highest branches/plant and test weight were obtained with the lowest plant density of 50×10^3 plants/ha (100 x 20 cm).

Bisnoi and Phogat (1986) while conducting an experiment at Hissar, reported that the spacing of 50 x 20 cm with 1,00,000 plants/ha was found to be superior in case of yield attributes viz., number of branches/ plant, seed yield/plant and 1000 seed weight over rest of the spacings (50 x 30 and 25 x 30 cm).

Tripathi (1986) observed that the highest branches and pods per plant were recorded with 90 cm row spacing followed by 75, 60 and 45 cm row spacing, but the reverse trend was observed in case of plant height. He also noticed that harvest index was significantly reduced as spacing increased beyond 75 cm.

While working at I. A. R. I., New Delhi, Govil _et al_. (1988) showed that pigeonpea crop sown at 75 x30 cm spacing tooks more days to maturity (123.9 days) as compared to crop sown at 50 x 10 cm (119.6 days) spacing.

Shankaralingappa and Hegde (1989) observed that days to 50% flowering and maturity were not affected by plant population, however, the plant height increased significantly with plant population.

Sarvaiya (1990) conducted an experiment on clayey soil of the college Agronomy Farm, G. A. U., Navsari during _Kharif_ 1989-90. From the results, he reported that increased row spacing from 60 to 120 cm was resulted in progressive improvement in number of branches per plant, number of pods per plant, seed yield per plant and 100-seed weight, though the plant height decreased significantly with widening of the row spacing.

2.2.4 Effect of crop geometry on protein content of pigeonpea

Singh _et al_. (1971) while conducting an experiment at Jabalpur, reported that protein content were not significantly affected by row spacing and plant population.

At I. A. R. I., New Delhi, Manjhi et al. (1973) observed that protein content of dry seeds were not significantly altered due to row spacing or plant population.

Singh and Kalra (1980) observed that crops grown at 10 x 60 cm spacing gave higher protein content than that grown at 20 - 30 x 60 cm spacings.

Patel (1983) reported that the highest protein content (25.71%) was recorded under 90 cm intra-row spacing over 60 and 30 cm intra-row spacings.

2.3 INTERACTION EFFECT OF CULTIVARS x CROP GEOMETRY

Narayanan and Sheldrake (1979) carried out an experiment at ICRISAT, Patancheru (A.P.) during 1975 and 1976, consisting of six pigeonpea cultivars (Pusa ageti-early, T-21-early, ICP-1-Medium, C-11-Medium, NP (WR)-15 and ICP-7065-late) and four spacings viz., 20 x 5, 27 x 7, 40 x 10 and 57 x 7 cm. They reported that cultivars did not differ significantly due to varying in spacings.

A field trial was carried out with short duration pigeonpea cultivars (Prabhat, Pant.A-1, BS-1, T-21) by Panwar and Singh (1979) to study the effect of plant population (1,60,000, 1,20,000 and 80,000 plants/ha) at Kalyanpur (U.P.) during Kharif 1976-77. From the results, they observed that variety T-21 out yielded at high level of plant population. But at medium level, it was statistically at par with pant.A-1 and BS-1. The variety Pant.A-1 and Prabhat performed better at medium level of plant poppulation.

An investigation undertaken at dry land project I. G. F. R. I., Jhansi (U.P.) on red loamy soil by Masood Ali (1981) during Kharif 1977 with two pigeonpea varieties (Hy-1 and Pusa ageti) and two row spacings (45 and 60 cm). They found that Hy-I gave significantly higher grain yield (10.23 q/ha) than Pusa ageti (8.43 q/ha) at 60 cm row spacing, but at 45 cm spacing both cultivars were at par with each other. Hy-1 produced significantly more branches and pods per plant at 60 cm row spacing than that at 45 cm spacing.

At the University Farm, Kalyani, Sinha and Bhattacharya (1982) conducted an experiment under rainfed condition involving three pigeonpea varieties (Upas-120 early, Hy-3C-medium and B-517-late) and four spacings (30 x 15-18, 50 x 15-18, 70 x 15-18, and 90 x 15-18 cm). They found suitable row spacing of 70-90 cm, 50-70 cm and 30-50 cm for the late, medium and early maturing varieties of pigeonpea, respectively found to be the best.

Shrivastava (1984) carried out an experiment at Ranchi Agricultural College Farm, Kanke during 1979-80 and 1980-81 to study the effect of spacing (25 x 20 and 37.5 x 13.3 cm) on pigeonpea cultivars (Bahar, Laxmi and T-21). They observed that variety bahar and T-21 gave higher yield when sown at a spacing of 25 x 20 cm, where as yield of Laxmi was not affected by variation in row spacing.

Chauhan et al. (1984) carried out an experiment at ICRISAT, Patancheru (A.P.) during 1982 with three extra early cultivars (ICPL-4, ICPL-81 and ICPL-87) and four spacings (50 x 12, 37.5 x 10, 30 x 8 and 25 x 6). From the results, they reported that ICPL-4 and ICPL-81 gave more yield at the closer spacing, while IPCL-87 gave higher seed yield at wider spacings.

An experiment was conducted at ICRISAT, Patancheru (A.P.) by Venkataratnam et al. (1984) on vertisol to study the effect of plant population (125,000, 250,000, 500,000 and 10,00,000 plant/ha) on certain pigeonpea varieties (T-21-early, C-11-Medium, T_7-late). They reported that there was no significant interaction between cultivars and plant populations. However, lowest population (125,000 plants/ha) was suboptimal for the early (T-21) and medium cultivars (C-11), but the yield of late cultivar (T_7) was more or less same from 125,000 to 500,000 plants/ha.

Yadahalli and Reddy (1987) conducted an experiment to find out the yield potential of two short duration pigeonpea genotypes (DL-82 and ICPL-8332) under four levels of spacings (30 x 5, 30 x 10, 45 x 5 and 45 x 10 cm) during summer 1985 at Hebbal, Bangalore (Karnataka) clay loam soil after harvest of paddy crop. They found that both genotypes did not significantly differ in seed yield to the different spacings, however, ICPL-8332 indicated a trend of higher seed yield with closer spacing.

An experiment conducted at Junagadh during Kharif 1990-91 to study the response of four promising pigeonpea genotypes (ICPL-8719, MTH-12 and C-11) to row spacings (45 x 10 cm and 60 x 10 cm). Resuts revealed that different genotypes and row spacing interaction was failed to exert any significant effect on grain yield of pigeonpea. However, maximum grain yield was obtained to the tune of 2526 kg/ha by cultivar hybrid MTH-12 when it was spaced at 60 cm apart (Anon., 1991b).

From the above cited review, it is observed that the cultivar and spacing interaction had no any significant effect on grain yield of pigeonpea, However, among the references, only few references marked a significant influence of cultivars x spacing interaction. Generally, early maturing cultivars of pigeonpea gave higher yield at closer spacing, while medium and late maturing cultivar of pigeonpea gave higher yield at wider row spacing.

MATERIALS AND METHODS

Table 3.1 : Mean weekly weather parameters recorded at the Meteorological Observatory, Gujarat Agricultural University, Anand Campus, Anand for the crop season of kharif 199-91

Month	Meteoro-logical week	Date	Average Temperature (°C)		Average relative humidity (%)	Sun shine (hrs.)	Rain fall (mm)	Rainy days
			Maximum	Minimum				
July 90	27	2-8	30.7	25.7	80.5	0.6	78.3	4
	28	9-15	33.6	26.2	69.5	5.3	1.0	-
	29	16-22	31.8	25.4	80.0	3.5	47.0	4
	30	23-29	31.7	25.4	77.0	3.5	31.2	2
	31	30-5 Aug.	30.7	24.9	83.0	2.4	19.4	3
Aug. 90	32	6-12	31.4	25.3	80.0	4.5	50.4	2
	33	13-19	31.4	25.3	82.5	2.9	215.6	3
	34	20-26	29.1	24.5	89.0	2.2	342.5	5
	35	27-2 Sep.	30.1	24.8	84.0	4.5	45.3	3
Sept. 90	36	3-9	31.2	24.3	83.0	7.3	138.8	3
	37	10-16	31.4	24.3	76.5	6.5	15.4	2
	38	17-23	33.3	24.3	71.5	9.2	1.8	-
	39	24-30	31.9	24.1	81.0	5.1	91.3	2
Oct. 90	40	1-7	33.2	23.9	71.5	9.4	0.8	-
	41	8-14	35.7	22.3	60.5	9.4	0.0	-
	42	15-21	36.0	18.6	55.0	10.2	0.0	-
	43	22-28	34.9	20.1	59.0	10.3	0.0	-
	44	29-4 Nov.	34.2	19.0	53.5	10.3	0.0	-
Nov. 90	45	5-11	33.2	15.1	50.5	10.1	0.0	-
	46	12-18	33.1	16.1	49.5	10.3	0.0	-
	47	19-25	29.8	17.8	66.5	9.0	7.5	1
	48	26-2 Dec.	31.0	16.9	59.0	9.1	0.0	-
Dec. 90	49	3-9	27.8	16.3	61.5	7.8	16.0	1
	50	10-16	28.8	12.5	63.5	9.8	0.0	-
	51	17-23	28.3	12.7	58.5	9.8	0.0	-
	52	24-31	28.5	11.3	60.5	9.3	0.0	-
January 91	1	1-7	23.1	6.6	53.0	9.7	0.0	-
	2	8-14	25.6	9.7	60.5	9.6	0.0	-
	3	15-21	25.6	9.4	46.5	10.1	0.0	-
	4	22-28	32.8	11.7	57.5	10.2	0.0	-

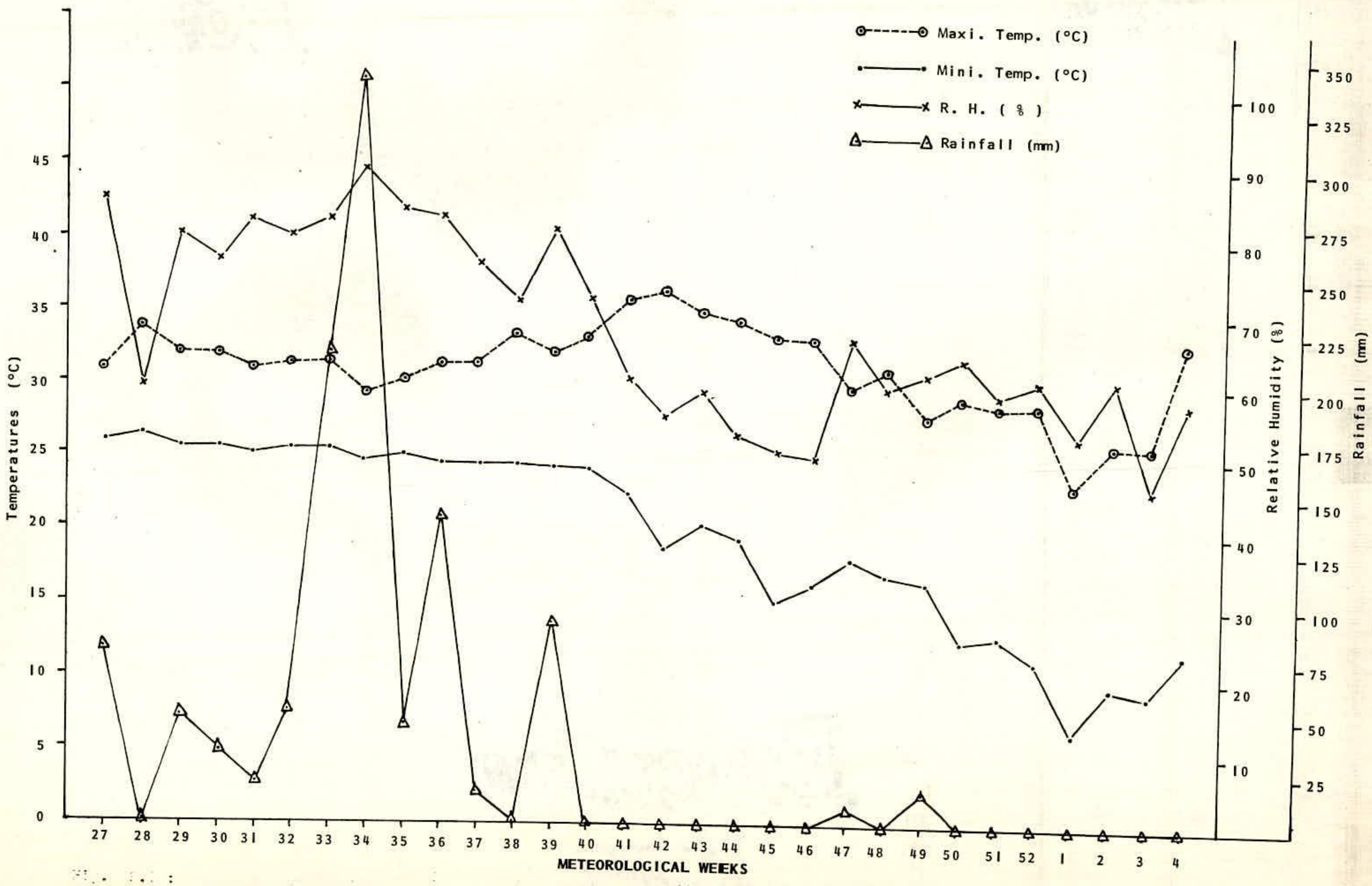


Fig. 3.1 : WEATHER PARAMETERS UP TO THE DURATION OF PIGEONPEA (JULY 1990 TO JANUARY 1991)

Table 3.2 : Physico-chemical properties of soil of experimental site

Particulars	Value at soil depth (cm) 0-15	15-30	Method of analysis
Physical parameters			
Course sand (%)	0.42	0.5	International pipette method (Piper, 1950)
Fine sand (%)	80.92	85.9	-do-
Silt (%)	10.5	8.6	-do-
Clay (%)	5.5	2.7	-do-
Texture class - Loamy sand			
Chemical parameters			
Soil pH (1 : 2.5)	7.6	7.7	Buckman pH metre
Organic matter (%)	0.40	0.34	Walkly and Black method (Piper, 1950)
Total nitrogen (%)	0.034	0.028	Kjeldhal method (Jackson, 1967)
Available P_2O_5 (kg/ha)	43.5	38.9	Olsen's method (Jackson, 1967)
Available K_2O (kg/ha)	261.4	270.0	Flame Photometric method (Jackson, 1967)

4

Table 3.3 : Cropping history of the experimental plot

Year	Season	Crop	Fertilization (kg/ha)		
			N	P_2O_5	K_2O
1989-89	Kharif	Cowpea/Urid	20	40	0
	Rabi	Fallow	-	-	-
	Summer	Groundnut	25	50	0
1989-90	Kharif	Pigeonpea	20	40	0
	Rabi	Continue	-	-	-
	Summer	Groundnut	25	50	0
1990-91	Kharif	Present investigation on pigeonpea	25	50	0
	Rabi	Continue			

Table 3.4 : Characteristics of the different pigeonpea cultivars

Sr. No.		ANDT-1	ANDT-2	BDN-2	T-15-15
1	Growth habit	Determinate	Determinante	Non-determinate	Non-determinate
2	Plant height (cm)	140-150	135	125-135	190-220
3	Days to 50% flowering	88	84	110-115	120-230
4	Days to maturity	155	147	160-175	185-200
5	No. of branches plant	13-14	11	10-11	15-20
6	No. of seeds/pod	3-4	3.7	3-4	4-5
7	Length of pod (cm)	4.5	4.4	4-5	4-5
8	100-seed weight (g)	9.8	9.5-10.0	9.5-10.0	11-12

3.5.2 Treatments details

There were twelve treatment combinations involving four pigeonpea cultivars and three levels of crop geometry. The details of the treatment combinations are given in Table 3.5.

A. Main plot	: Cultivars : Four		
	1.	ANDT-1	V_1
	2.	ANDT-2	V_2
	3.	BDN - 2	V_3
	4.	T-15-15	V_4
B. Sub-plot	: Crop geometry : Three		
	1.	60 x 30 cm	S_1
	2.	70 x 30 cm	S_2
	3.	90 x 30 cm	S_3

3.5.3 Design of the experiment

The field experiment was laid out in split plot design. Cultivars were kept as main plot treatments, while crop geometry as sub-plot treatments.

3.5.4 Layout plan

The plan of layout was adopted as shown in Fig. 3.2. The other experimental details are as under:

1. Number of treatment : 12
2. Number of replication : 4
3. Number of total plots : 48
4. Plot size

Crop geometry :	60 x 30 cm,	75 x 30 cm	90 x 30 cm
Gross plot	: 9.0 x 6.0 m,	9.0 x 6.0 m,	9.0 x 6.0 m
Net plot	: 7.8 x 4.8 m,	7.5 x 4.8 m,	7.2 x 4.8 m

Table 3.5 : Details of the treatment combinations

Sr. No.	Treatment symbol	Pigeonpea cultivars	Crop geometry (cm)	Plant density (lakh plants/ha)
1	V_1S_1	ANDT-1	60 x 30	0.555
2	V_1S_2	ANDT-1	75 x 30	0.444
3	V_1S_3	ANDT-1	90 x 30	0.370
4	V_2S_1	ANDT-2	60 x 30	0.555
5	V_2S_2	ANDT-2	75 x 30	0.444
6	V_2S_3	ANDT-2	90 x 30	0.370
7	V_3S_1	BDN-2	60 x 30	0.555
8	V_3S_2	BDN-2	75 x 30	0.444
9	V_3S_3	BDN-2	90 x 30	0.370
10	V_4S_1	T-15-15	60 x 30	0.555
11	V_4S_2	T-15-15	75 x 30	0.444
12	V_4S_3	T-15-15	90 x 30	0.370

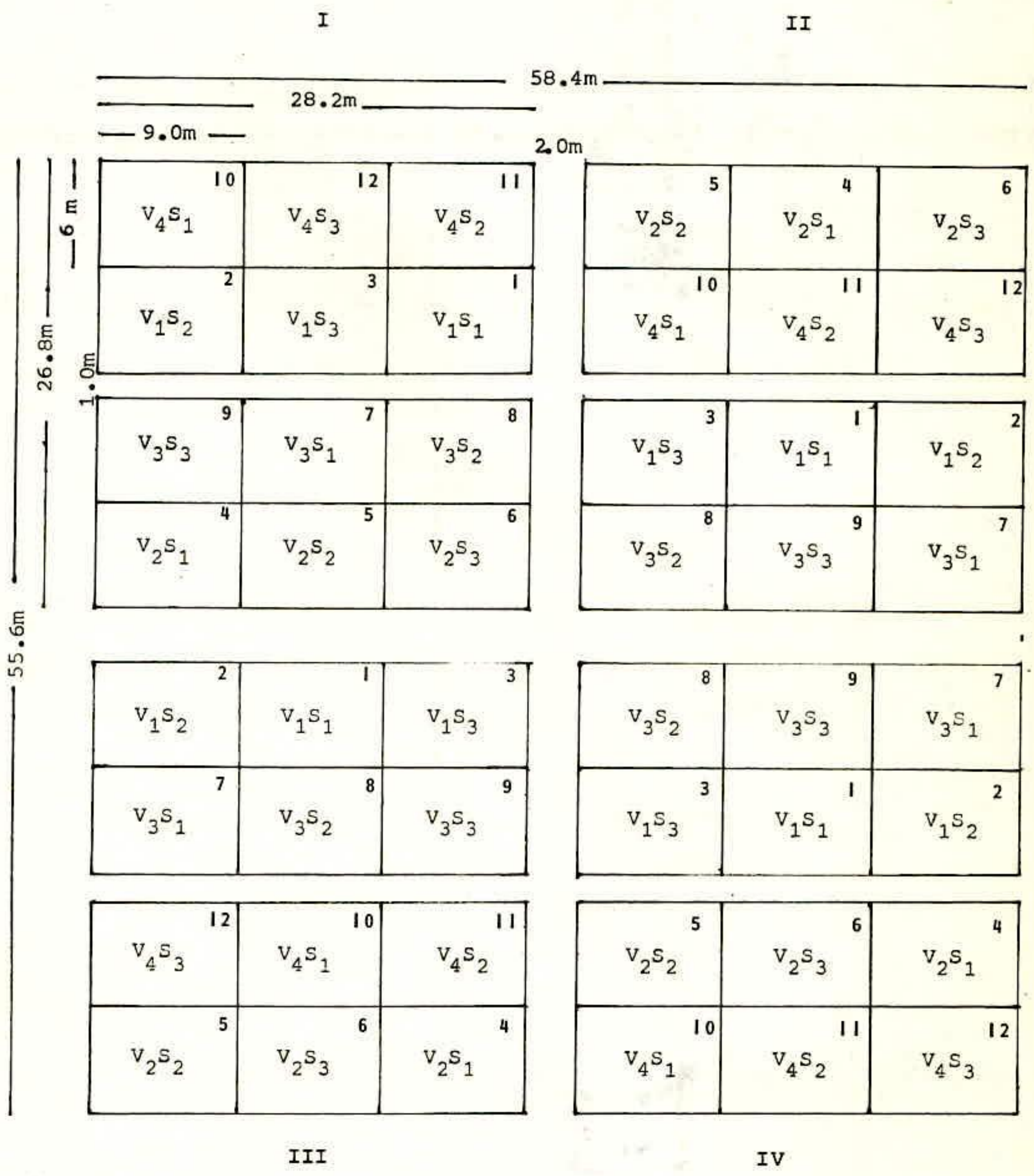


Fig. 3.2: LAYOUT PLAN OF THE FIELD EXPERIMENT

5. Block size :28.2 x 26.8 m

6. Area in one replication : 755.76 m^2

7. Total area under experiment:3247.04 m^2

8. Direction of crop rows : N - S

9. No. of lines and plants/plot

Number of lines and number of plants of pigeonpea per plot were given in Table 3.6.

Table 3.6 : No. of lines and plants/plot

Crop geometry (cm)	No. of lines	No. of plants/line	Total no. of plants
Gross plot			
60 x 30	16	20	300
75 x 30	12	20	240
90 x 90	10	20	200
Net plot			
60 x 30	13	16	208
75 x 30	10	16	160
90 x 30	8	16	128

3.5.5 Sowing time, method and technique

Sowing time, method and technique adopted in this investigation are given in Table 3.7.

Table 3.7 : Sowing details of pigeonpea

Date of sowing	Crop geometry (cm)	Method of sowing	Seed rate (kg/ha)
15.7.1990	60 x 30	Dibbling	17.00
	75 x 30	Dibbling	15.00
	90 x 30	Dibbling	13.00

3.6 CULTURAL OPERATIONS

The calender of cultural operations carried out for the crop of pigeonpea is given in Table 3.8.

3.6.1 Prepatory tillage

After removal of residues of the previous crop, field was ploughed once by tractor drawn plough and harrowed once by bullock drawn implement and land was planked with the help of bullocks.

3.6.2 Application of fertilizer

The fertilizers were applied uniformly in the form of urea for N and Diammonium phosphate for both N and P_2O_5 before sowing in the opened furrows. The pigeonpea was fertilized with a common recommended dose of fertilizer, (25-50-0 kg N-P-K/ha) irrespective of crop geometry of the pigeonpea cultivars.

3.6.3 Sowing

After the preparation of land and the application of fertilizers, cross marking was done at 30 cm apart on

Table 3.8 : Calender of cultural operations carried out during the course of investigation

Sr. No.	Cultural operation	Date
1	**Prepatory tillage**	
	i. Tractor plowing	3.7.90
	ii. Harrowing and planking	5.7.90
2	**Layout**	
	i. Preparation of seedbed	10.7.90
	ii. Marking as per the crop geometry treatments	11.7.90
	iii. Opening furrows by Kudali	12.7.90
3	**Fertilizer application**	
	i. Before sowing (in opened furrow)	13.7.90
4	**Covering furrows** (Manually)	13.7.90
5	**Cross marking**	14.7.90
6	**Dibbling seeds**	15.7.90
7	**Irrigation**	
	i. First	17.7.90
	ii. Second	12.11.90
8	**After care operations**	
	i. Gap filling	27.7.90
	ii. Thining	31.7.90
	iii. Interculturing by	
	(a) Manually (Hand Hoe)	27.7.90
	(b) Bullock power (First)	10.8.90
	(c) Bullock power (Second)	2.9.90

(Contd.)

(Contd.)

Sr. No.	Cultural operation	Date
	iv. Weeding	
	(a) First	7.8.90
	(b) Second	25.9.90
9	**Plant protection measures**	
	i. Spraying Thiodan 35 EC (First spray)	8.11.90
	ii. Spraying Thiodan 35 EC (Second spray)	24.11.90
	iii. Spraying Nuvacron 40 EC (Third spray)	
10	**Harvesting**	
	i. ANDT-1 and ANDT-2	5.1.91
	ii. BDN-2	9.1.91
	iii. T-15-15	21.1.91
11	**Threshing and cleaning**	
	i. ANDT-1 and ANDT-2	15.1.91
	ii. BDN-2	20.1.91
	iii. T-15-15	2.2.91

previously fertilized open furrows. Two to three pigeonpea seeds were dibbled at each cross.

3.6.4 Irrigation

During the life span of the crop, only two irrigations were given according to the crop requirements. The first irrigation was given just after sowing to ensure better germination, while second irrigation was given after about three months, and 25 days of the first irrigation.

3.6.5 Aftercare operations

Gap filling was done about twelve days of sowing of the crop in order to obtain uniform plant stand. The crop was thinned out keeping only one plant per hill after about 15 days of sowing. Hand weeding and interculturing operations were carried out two times during the life span of crop. Besides this hand hoeing was done once during crop season.

3.6.6 Plant protection measures

In the initial stage, the crop was not attacked by any insect-pests, but later on Thiodan (35 EC) was sprayed as a preventive measure against the attack of Tur-pod-borer in the second week of November. Tur-pod-borer attack was observed in the fourth week of November which was protected by the second spray of Thiodan (35 EC). Tur-pod fly attack was noticed in the first week of December and was checked by spraying of Nuvacron (40 EC).

3.6.7 Harvesting and threshing

Harvesting operation was performed when all the pods on the plants were completely matured. The plants from the ring area were harvested first and removed from the experimental plots and kept for sun drying. Then the plants from the net plot area were harvested and left in the respective plots for sun drying. After about 10 days from the date of harvesting, threshing was done by beating pods and stem with wooden sticks and grains were separated by hand winnowing and the weight of cleaned grains was recorded separately for each experimental plots. The stalks were left in the respective plots for further drying. After the complete drying of the stalks, plot wise weight of dry stalks were recorded only when two consecutive weights were found constant.

3.7 MORPHOLOGICAL PARAMETERS

The particulars regarding the morphological parameters studied during the course of investigation are narrated as under.

3.7.1 Plant height

Five pigeonpea plants per net plot were selected randomly and height of each plant was measured from the base of the plant to the apex of the main stem at 45, 75 and 105 DAS and prior to harvesting of crop and average of each was computed.

3.7.2 Number of branches per plant

Number of branches per plant from five ramdomly selected plants were counted at 75, 90 and 105 DAS and prior to crop harvesting and recorded separately for each of the plots and the mean was calculated.

3.7. 3 Days to first flower

Days to first flower were recorded by counting the days from seeding to opening of first flower on any plant of each experimental plot.

3.7.4 Days to maturity

Number of days taken from seeding to the dry of all pods on each of the five randomly selected plants were counted and recorded separately for each of the plots and average number of days to maturity were worked out and recorded separately.

3.8 YIELD AND ITS ATTRIBUTES

3.8.1 Number of pods per plant

Total number of matured pods on each of five randomly selected plants were counted and recorded separately for each of the plots and average number of matured pods per plant was computed.

3.8.2 Number of seeds per pod

Five pods were randomly selected from each previously selected plant and average number of seeds per pods were recorded.

3.8.3 Seed yield per plant

Dry pods from five randomly selected plants were harvested and threshed by beating with wooden stricks. The seeds were cleaned, winnowed and then weight of the cleaned seeds was recorded for each of the plots. Mean seed yield per plant for all the plots were recorded separately.

3.8.4 Seed yield

Seed yield of each net plot was recorded separately and converted into kg per hectare by multiplying it with conversion factor.

3.8.5 Stalk yield

After threshing, the stalks were allowed to dry for six days in open place and stalk weight was recorded and converted into kg/ha multiplying it with conversion factor.

3.8.6 Dry fodder yield

The mixture of broken pieces of stems, pods and dry leaves which were left out in the process of winnowing and cleaning was weighed and recorded as dry fodder for each of the plots. Then these were converted into kg/ha.

3.8.7 100-seed weight (Test weight)

In order to know the treatment effect on development of grains, sample of seeds was drawn from the produce of each net plot and the weight of one hundred seeds was recorded for each treatment and average was worked out.

3.8.8. Harvest Index

The harvest index was calculated by the following formula :

$$\text{Harvest index (\%)} \quad \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The biological yield refers to total dry matter weight (seed + stalk + dry fodder) whereas, economical yield refers to the economically useful part (grain) of biological yield. As it is difficult to get correct weight of all the roots at harvest stage, the roots were not included into the biological yield.

3.9 QUALITY CHARACTER

3.9.1 Protein content of grains

A representative seed sample from the produce of each experimental plot was drawn. The samples were analysed to find out nitrogen content in grain by Kjeldah's digestion method (Jackson, 1967) and crude protein content in grain as calculated by multiplying nitrogen percentage with the conversion factor 6.25 (protein content = Nitrogen percentage in grain x 6.25).

3.10 ECONOMICS

The gross and net monetary realization per hectare were worked out treatment wise by taking into consideration the total yield of seed, stalks and dry fodder and their prevaling prices in the market during the month of February, 1991. Similarly, the cost of cultivation involving all the cost factors from preparatory tillage to crop harvesting along with threshing, winnowing and cleaning etc. were worked out. The cost of cultivation was then decucted from the gross realization to work out net realization under each treatment and recorded accordingly. The cost benefit ratio was calculated on the basis of the following formula:

$$\text{CBR} = \frac{\text{Total realization (Rs.)}}{\text{Total expenditure (Rs.)}}$$

3.11 STATISTICAL ANALYSIS

Statistical analysis of the data of the different individual characters was carried out as per the procedure of split-plot design by computer system. Significance of difference between mean for different treatments was tested through critical difference (CD) values and comparison between different treatment effects were made. The value of co-efficient of variation (C.V.%) was also calculated.

3.12 ABBREVIATIONS FOLLOWED

The details of abbreviations followed in the present manuscript are described in Appendix - II.

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The present investigation was carried out with a view to study the "crop geometry of certain short duration pigeonpea cultivars" during <u>Kharif</u> season of the year 1990 at the College Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand, dist. Kheda. The experimental results concerning the response of different cultivars and crop geometry on the growth, yield and yield components as well as plant characters like plant height, number of branches per plant, number of pods per plant, number of grains per pod, 100-seed weight are presented in this chapter along with statistical informations.

Data of all the main effects and only the significant interactions have been presented in the succeeding paragraphs. The results have also been presented graphically wherever necessary.

The details of various yield and yield attributing characters, morphological parameters, quality and economics are listed below.

4.1 MORPHOLOGICAL PARAMETERS

i. Plant height (cm)

ii. Number of branches per plant

iii. Days to first flower

iv. Days to maturity

4.2 YIELD AND ITS ATTRIBUTES

i. Number of pods per plant

ii. Number of seeds per pod

iii. Seed yield per plant (g)

iv. 100-seed weight (g)

v. Seed yield (kg/ha)

vi. Stalk yield (kg/ha)

vii. Dry fodder yield (kg/ha)

viii. Harvest index (%)

4.3 QUALITY

i. Protein content of grains (%)

4.4 ECONOMICS

i. Net realization (Rs./ha)

ii. Cost benefit ratio

4.1 MORPHOLOGICAL PARAMETERS OF PIGEONPEA

4.1.1 Effect of treatments on plant height

The data on plant height as influenced by different pigeonpea cultivars and crop geometry treatments are presented in Table 4.1 and also graphically illustrated in Fig. 4.1.

1. Plant height at 45 DAS

It was observed from the data presented in Table 4.1 that the differences in plant height due to different cultivars were significant. Cultivar V_4 (T-15-15) recorded the highest plant height 51.92 cm and was found

Table 4.1 : Periodical plant height as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Plant height (cm)			
	45 DAS	75 DAS	105 DAS	At harvest
Cultivars				
ANDT-1 (V_1)	41.33	113.25	119.92	125.42
ANDT-2 (V_2)	43.58	113.42	119.58	125.08
BDN-2 (V_3)	41.17	104.00	120.67	125.92
T-15-15 (V_4)	51.92	126.75	178.83	198.67
S. Em. ±	0.773	1.625	1.867	1.306
C. D. at 5 %	2.472	5.200	5.973	4.178
C. V. %	6.02	4.92	3.4	3.15
Crop geometry :				
60 x 30 cm (S_1)	46.06	115.56	139.63	149.69
75 x 30 cm (S_2)	45.00	116.00	134.69	142.13
90 x 30 cm (S_3)	42.44	111.50	129.94	139.50
S. Em. ±	0.711	1.287	0.823	0.956
C. D. at 5 %	2.077	3.757	2.402	2.800
C. V. %	6.39	4.50	2.44	2.67
Significant interaction	-	V x S	V x S	V x S

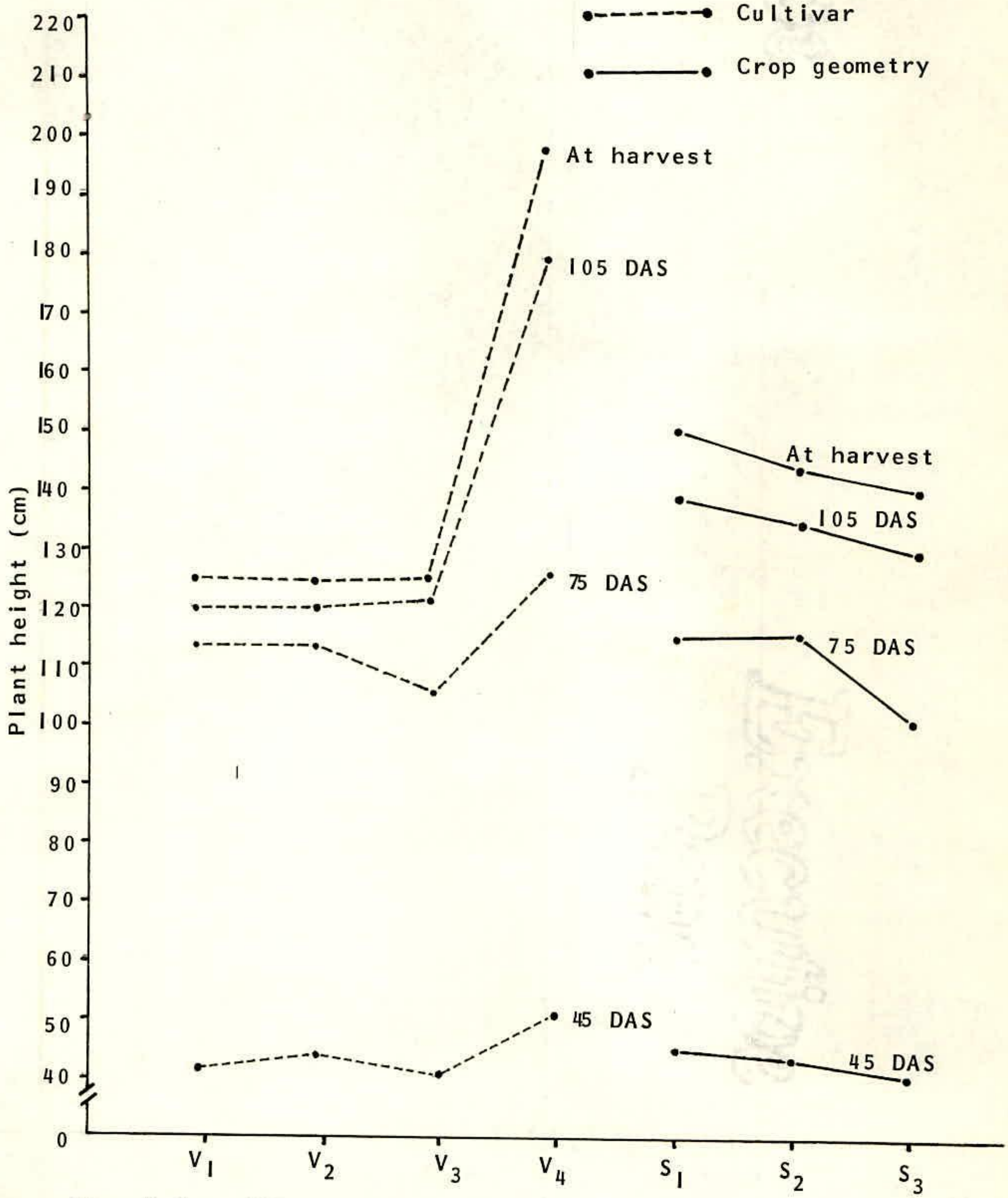


Fig. 4.1 : PERIODICAL PLANT HEIGHT AS INFLUENCED BY DIFFERENT TREATMENTS

significantly superior to rest of the cultivars. The lowest plant height (41.17 cm) was obtained with the cultivar V_3 (BDN-2), but statistically at par with V_1 (ANDT-1) and V_2 (ANDT-2) treatments.

Data shown in Table 4.1 further indicated that the different crop geometry treatments exhibited their significant influence on plant at 45 DAS. The treatment S_1 (60 x 30 cm) registered significantly higher plant height 46.06 cm as compared to S_3 (90 x 30 cm), but statistically at par with S_2 (75 x 30 cm) treatment. The lowest plant height 42.44 cm was recorded with S_3 (0 x 30 cm) treatment.

II. Plant height at 75 DAS

It is appear from the data (Table 4.1) that the different cultivars had significant influence on plant height at 75 DAS. The cultivar V_4 (T-15-15) gave significantly the highest plant height (126.75 cm). The lowest plant height was recorded with the cultivar V_3 (104.00 cm), whereas, the cultivars V_1 (113.25 cm) and V_2 (113.42 cm) were statistically at par in respect of plant height.

The data (Table 4.1) further revealed that the effect of different crop geometries on plant height at 75 DAS were significant. The treatment S_2 (75 x 30 cm) had produced maximum plant height (116.00 cm). However, it was at par with treatment S1 (115.56 cm). The lowest plant height was recorded under the treatment S_3 (111.50 cm).

The effect of cultivar x crop geometry interaction on plant height at 75 DAS was found significant. The data presented in Table 4.2 indicated that the treatment combination V_4S_1 gave significantly the highest plant height (133.50 cm) over rest of the treatment combinations. The lowest plant height was recorded under the treatment combination V_3S_1 (100.25 cm), but it was statistically at par with the treatment combinations V_3S_3 (103.00 cm).

Table 4.2 : Plant height (cm) at 75 DAS at influenced by V x S interaction

Cultivars (V)	Crop geometry (S)		
	S_1	S_2	S_3
V_1	111.25	118.00	110.50
V_2	117.25	112.75	110.25
V_3	100.25	108.75	103.00
V_4	133.50	124.50	122.25
S. Em. ±	2.574	C.D.at 5%	7.514

III Plant height at 105 DAS

It is evident from the data (Table 4.1) on plant height at 105 DAS indicated that the differences due to cultivars were significant. The cultivar V_4 (T-15-15) produced maximum plant height (178.83 cm) and was significantly superior over rest of the cultivars. Significantly the lowest plant height (119.58 cm) was recorded with the cultivar V_2. However, it was at par with the cultivars V_1 (119.92 cm) and V_3 (120.67 cm).

From the data (Table 4.1), it was observed that the effect of different crop geometries on plant height at 105 DAS were significant. All the treatments differed significantly among themselves in respect of plant height. The highest plant height (139.63 cm) was recorded under the treatment S_1 (60 x 30 cm) followed by the treatment S_2 (134.69 cm) and S_3 (129.94 cm).

The effect of interaction V x S in respect of plant height at 105 DAS was found to be significant. The data given in Table 4.3 revealed that the highest plant height (189.75 cm) was recorded with the treatment combination V_4S_1 and was significantly superior to the rest of the treatment combinations. The lowest plant height (114.75 cm) was recorded under the treatment combination V_2S_3, however, it was at par with the treatment combinations V_2S_2 (118.75 cm), V_1S_3 (115.50 cm and V_3S_3 (118.50 cm).

Table 4.3 : Plant height (cm) at 105 DAS as influenced by V x S interaction

Cultivars (V)	Crop geometry (S)		
	S_1	S_2	S_3
V_1	122.00	122.25	115.50
V_2	125.25	118.75	114.75
V_3	121.50	122.00	118.50
V_4	189.75	175.75	171.00
S. Em. ±	1.646	C.D.at 5%	4.804

IV Plant height at harvest

The data presented in Table 4.1 revealed that the differences in plant height at harvest were significant due to different cultivars. The cultivar V_4 (T-15-15) gave significantly the highest plant height (198.67 cm) over rest of the cultivars. The lowest plant height (125.08 cm) was recorded with the cultivar V_2 (ANDT-2). However, it was statistically at par with the cultivars V_1 (125.42 cm) and V_3 (125.92 cm).

The data presented in Table 4.1 further revealed that the differences in plant height at harvest were significant due to different crop geometries. The highest plant height (149.69 cm) was registered under the treatment S_1 (60 x 30 cm) and was significantly superior to rest of the treatments. The lowest plant height was recorded with the treatment S_1 (139.50 cm), however, it was statistically at par with the treatment S_2 (142.13 cm).

The effect of interaction V x S on plant height at harvest was found to be significant. The mean data (Table 4.4) indicated that the highest plant height (210.00 cm) was recorded with the treatment combination V_4S_1 and was significantly superior to rest of the treatment combinations. The lowest plant height (121.75 cm) was recorded with the treatment combination V_3S_3, however, it was at par with the treatment combinations V_1S_3 (122.00 cm), V_2S_3 (122.50 cm), V_1S_2 (125.25 cm), V_2S_2 (123.00 cm) and V_3S_2 (126.00 cm).

Table 4.4 : Plant height (cm) at harvest as influenced by V x S interaction

Cultivars (V)	Crop geometry (S)		
	S_1	S_2	S_3
V_1	129.00	125.25	122.00
V_2	129.75	123.00	122.50
V_3	130.00	126.00	121.75
V_4	210.00	194.25	191.75
S. Em. ±	1.918	C.D. at 5%	5.600

4.1.2 Effect of treatments on number of branches per plant

Data on periodical observations on number of branches per plant as influenced by different cultivars and crop geometries are presented in Table 4.5 and graphically depicted in Fig. 4.2.

(i) Number of branches at 75 DAS

It was evident from the Table 4.5 that the differences in number of branches per plant at 75 DAS were significant due to different cultivars. The cultivar V_4 (T-15-15) produced significantly the highest number of branches per plant (12.93) over rest of the cultivars. The

Table 4.5 : Periodical number of branches per plant as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Number of branches per plant			
	75 DAS	90 DAS	105 DAS	At harvest
Cultivars				
ANDT-1 (V_1)	9.27	10.42	11.15	12.83
ANDT-2 (V_2)	9.40	10.10	10.83	11.69
BDN-2 (V_3)	9.47	10.38	11.50	12.83
T-15-15 (V_4)	12.93	14.40	15.58	19.37
S. Em. ±	0.171	0.128	0.204	0.321
C.D. at 5%	0.545	0.410	0.652	1.027
C. V. %	5.75	3.92	5.76	7.84
Crop geometry				
60 x 30 cm (S_1)	9.05	9.85	10.80	12.41
75 x 30 cm (S_2)	10.32	11.14	11.99	13.52
90 x 30 cm (S_3)	11.43	12.99	14.01	16.61
S. Em. ±	0.186	0.158	0.145	0.222
C. D. at 5%	0.543	0.461	0.422	0.649
C. V. %	7.24	5.58	4.71	6.27
Significant interaction	-	-	V x S	V x S

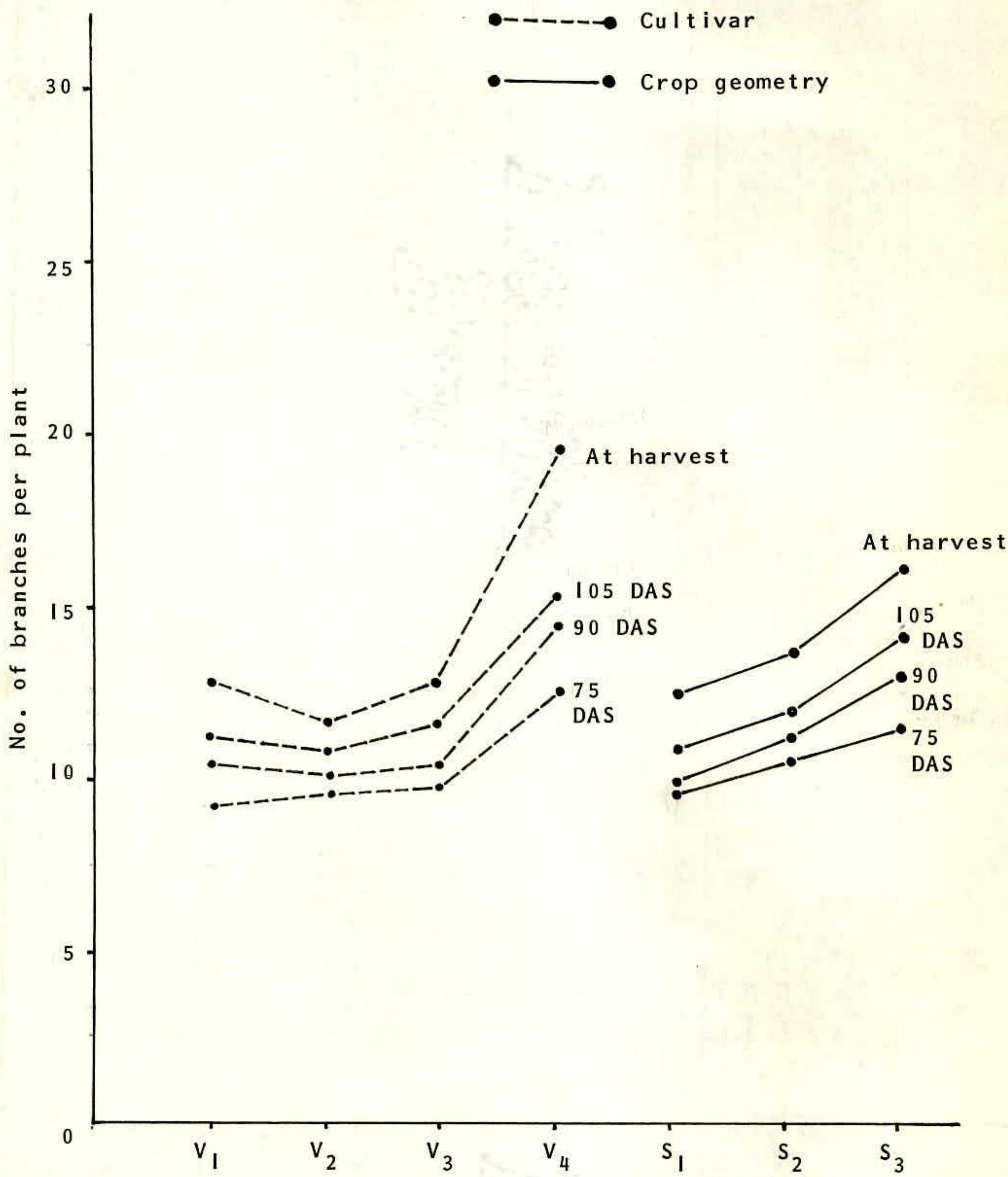


Fig. 4.2 : PERIODICAL NUMBER OF BRANCHES PER PLANT AS INFLUENCED BY DIFFERENT TREATMENTS

lowest number of branches per plant (9.27) was recorded with the cultivar V_1. However, it was at par with the cultivars V_2 (9.40) and V_3 (9.47) in respect of number of branches per plant.

The results further revealed that the differences in branches per plant at 75 DAS were significant due to different crop geometries. All the treatments differed significantly among themselves in respect of number of branches per plant at 75 DAS. The highest number of branches per plant was obtained with the treatment S_3 (11.43) followed by the treatments S_2 (10.32) and S_1 (9.05).

(ii) Number of branches at 90 DAS

The data presented in Table 4.8 indicated that the number of branches per plant at 90 DAS was significantly influenced by different cultivars. The cultivar V_4 (T-15-15) produced significantly the highest number of branches per plant (14.4). Whereas, the lowest number of branches per plant (10.10) was obtained with the cultivar V_2 (ANDT-2), however, it was statistically at par with the cultivars V_1 (10.42) and V_3 (10.38).

The significant difference was observed in number of branches per plant at 90 DAS due to different crop geometries. All the crop geometry treatments were differed significantly from each other. The treatments S_3 produced significantly higher number of branches per plant (12.99) followed by treatments S_2 (11.14) and S_1 (9.85).

(iii) Number of branches at 105 DAS

A perusal of data (Table 4.5) on number of branches per plant at 105 DAS indicated that the differences due to different cultivars were significant. The cultivar V_4 (T-15-15) recorded significantly the highest number of branches per plant (15.58) over rest of the cultivars. The lowest number of branches per plant (10.83) was recorded under the cultivar V_2. However, it was statistically at par with the cultivar V_1 (11.15). The number of branches per plant recorded under the cultivar V_3 (11.50) was significantly higher than V_2, but it was at par with the cultivar V_1.

The data (Table4.5) further revealed that the number of branches per plant at 105 DAS were significantly influenced by the different crop geometries.All the crop geometry treatments differed significantly at 105 DAS in respect of number of branches per plant. The treatment S_3 produced significantly the highest number of branches per plant (14.01) followed by the treatments S_2 (11.99) and S_1 (10.08).

The effect of interaction between cultivar and crop geometry were found significant with respect to number of branches per plant at 105 DAS. The data presented in Table 4.6 indicated that the treatment combination V_4S_3 produced the highest number of branches per plant (17.50) and was significantly superior over rest of the treatment combinations. The lowest number of branches per plant were obtained under the treatment combinations V_1S_1 (9.90) and V_2S_1 (9.90). However, they were at par with the treatment combinations V_3S_1 (10.00), V_1S_2 (10.70) and V_2S_2 (10.15).

Table 4.6 : Number of branches per plant at 105 DAS as influenced by V x S interaction

Cultivars (V)	Crop geometry (S)		
	S_1	S_2	S_3
V_1	9.90	10.70	12.85
V_2	9.90	10.15	12.45
V_3	10.00	11.25	13.25
V_4	13.40	15.85	17.50
S. Em. ±	0.289	C. D. at 5% 0.844	

(iv) Number of branches at harvest

The data (Table 4.5) on number of branches per plant at harvest revealed that the differences due to different cultivars were significant. The cultivar V_4 (T-15-15) gave significantly the highest number of branches per plant (19.37) over rest of the cultivars. The lowest number branches per plant (11.69) was recorded with the cultivar V_2 (ANDT-2) and it was significantly lower than the cultivars V_1 (12.83) and V_3 (12.83).

Number of branches per plant at harvest was also significantly influenced due to different crop geometries. All the crop geometry treatments were significantly differed from each other. The treatment S_3 (90 x 30 cm) produced significantly the highest number of branches per plant (16.61) followed by the treatments S_2 (13.52) and S_1 (12.41).

The differences in number of branches per plant at harvest due to V x S interaction was found to be significant . The mean data (Table 4.7) showed that the treatment combination V_4S_3 produced significantly higher number of branches per plant (23.00) than rest of the treatment combinations. The lowest number of branches per plant (10.45) was registered under the treatment combination V_2S_1, but it was statistically at par with the treatment combinations V_2S_2 (10.73), V_1S_1 (10.90) and V_3S_1 (11.15).

Table 4.7 : Number of branches per plant at harvest as influenced by V x S interaction

Cultivars (V)	Crop geometry		
	S_1	S_2	S_3
V_1	10.90	13.00	14.60
V_2	10.45	10.73	13.90
V_3	11.15	12.40	14.95
V_4	17.15	17.95	23.00
S. Em. ±	0.445 C.D. at 5% 1.298		

4.1.3 Effect of treatments on days to first flower

The data on days to first flower as influenced by various treatments are presented in Table 4.8.

The results presented in Table 4.8 showed that significant differences were found due to different cultivars in respect of days to first flower. The cultivar (V_1) took minimum days to first flower (71.00 days), but it was statistically at par with the cultivar V_2 (71.08 days). Further, it was found that significantly more days to first flower (104.33 days) were taken by cultivar V_4 followed by V_3 (90.00 days).

While, the different crop geometries were not significantly differed in respect of days to first flower.

4.1.4 Effect of treatments on days to maturity

The data concerning to the days to maturity as affected by different pigeonpea cultivars and crop geometries are shown in Table 4.8.

The data (Table 4.8) indicated that days to maturity was significantly affected due to cultivars. All the cultivars differed significantly from each other in respect of days to maturity. The earliest maturity (147.92 days) was recorded for the cultivar V_2 (ANDT-2). Whereas, the most delayed maturity (185.75 day) was observed under the cultivar V_4 (T-15-15). The cultivars V_1 (ANDT-1) and V_3 (BDN-2) held intermediate position with regard to

Table 4.8 : Days to first flower and days to maturity as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Days to first flower	Days to maturity
Cultivars		
ANDT-1 (V_1)	71.00	151.08
ANDT-2 (V_2)	71.08	147.92
BDN-2 (V_3)	90.00	162.75
T-15-15 (V_4)	104.33	185.75
S. Em. ±	0.620	0.403
C. D. at 5%	1.983	1.291
C. V. %	2.55	0.86
Crop geometry		
60 x 30 cm (S_1)	83.06	159.69
75 x 30 cm (S_2)	83.94	161.94
90 x 30 cm (S_3)	85.31	164.00
S. Em. ±	0.753	0.319
C. D. at 5%	NS	0.932
C. V. %	3.58	0.79
Significant interaction	-	-

NS - Not significant.

maturity. Thus, the cultivar V_2 (ANDT-2) matured earlier by 3.16, 14.83 and 37.83 days than V_1, V_3 and V_4, respectively.

It was also noticed from Table 4.8 that maturity of cultivars was significantly influenced by different crop geometries. The maturity was significantly enhanced by reduced crop geometry. The earlierst maturity (159.69 days) was observed under the treatment S_1 followed by the treatments S_2 (161.94 days) and S_3 (164.00 days).

4.2 YIELD AND ITS ATTRIBUTES OF PIGEONPEA

4.2.1 Effect of treatments on number of pods per plant

The data pertaining to the number of pods per plant as influenced by different cultivars and crop geometries are presented in Table 4.9.

It is revealed from the data presented in Table 4.9 that the difference in number of pods per plant due to different cultivars were significant. The cultivar V_2 (ANDT-2) produced significantly the highest number of pods per plant (98.17) over rest of the cultivars. The lowest number of pods per plant (75.79) was observed under cultivar V_4, however, it was at par with cultivar V_1 (78.07). Number of pods per plant recorded under cultivar V_3 (91.93) was significantly differed from all other cultivars.

It is also revealed from data (Table 4.9) that the number of pods per plant was significantly influenced by different crop geometries. All the crop geometry

Table 4.9 : Number of pods per plant and number of seeds per pod as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Number of pods per plant	Number of seeds per pod
Cultivars		
ANDT-1 (V_1)	78.07	3.87
ANDT-2 (V_2)	98.17	3.75
BDN-2 (V_3)	91.93	3.69
T-15-15 (V_4)	75.79	4.01
S. Em. ±	1.669	0.043
C. D. at 5%	5.340	0.138
C. V. %	6.72	3.90
Crop geometry		
60 x 30 cm (S_1)	77.73	3.73
75 x 30 cm (S_2)	84.99	3.83
90 x 30 cm (S_3)	95.26	3.93
S. Em. ±	1.836	0.033
C. D. at 5%	5.361	0.096
C. V. %	8.54	3.42
Significant interaction	-	-

treatments differed significantly each other. The highest number of pods per plant (95.26) was recorded with treatment S_3 followed by the treatments S_2 (84.89) and S_1 (77.73).

4.2.2. Effect of treatments on number of seeds per pods

The data concerning to the number of seeds per pod as influenced by different cultivars and crop geometries are presented in Table 4.9.

The data given in Table 4.9, indicated that the effect of different cultivars in respect of number of seeds per pod were significant. The cultivar V_4 (T-15-15) produced the highest number of seeds per pod (4.01) and it was superior over rest of the cultivars. The lowest number of seeds per pod (3.69) was recorded with the cultivar V_3 (BDN-2), but it was statistically at par with V_2 (3.75). The number of seeds per pods recorded under cultivar V_1 (3.87) was significantly higher than V_3, however, it was at par with the cultivars V_2 (ANDT-2) and V_4 (T-15-15).

The results (Table 4.9) further indicated that the effect of different crop geometries on number of seeds per pod was significant. The treatment S_3 had recorded significantly the highest number of seeds per pod (3.93) followed by the treatments S_2 (3.83) and S_1 (3.73).

4.2.3 Effect of treatments on seed yield per plant

The data regarding the seed yield per plant as influenced by different cultivars and crop geometries are furnished in Table 4.10.

Table 4.10 : Seed yield per plant as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Seed yield per plant (g)
Cultivars	
ANDT-1 (V_1)	23.23
ANDT-2 (V_2)	27.83
BDN-2 (V_3)	25.62
T-15-15 (V_4)	24.67
S. Em. ±	1.092
C. D. at 5 %	NS
C. V. %	14.93
Crop geometry	
60 x 30 cm (S_1)	22.59
75 x 30 cm (S_2)	24.31
90 x 30 cm (S_3)	29.12
S. Em. ±	1.092
C. D. at 5%	2.770
C. V. %	14.98
Significant interaction	-

NS - Not significant.

Table 4.11 : 100-seed weight as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	100-seed weight (g)
Cultivars	
ANDT-1 (V_1)	9.99
ANDT-2 (V_2)	9.76
BDN-2 (V_3)	9.86
T-15-15 (V_4)	11.49
S. Em. ±	0.105
C. D. at 5%	0.335
C. V. %	3.53
Crop geometry	
60 x 30 cm (S_1)	10.14
75 x 30 cm (S_2)	10.20
90 x 30 cm (S_3)	10.49
S. Em. ±	0.069
C. D. at 5 %	0.200
C. V. %	2.670
Significant interaction	-

A perusal of data presented in Table 4.10 indicated that the differences in seed yield per plant due to different cultivars were not significant.

While, the significant differences in seed yield per plant was observed due to different crop geometries. The highest seed yield per plant (29.12 g) was recorded under the treatment S_3 (90 x 30 cm) and it was significantly superior over rest of the treatments. The lowest seed yield per plant (22.59 g) recorded under the treatment S_1, however, it was at par with the treatment S_2 (24.31 g).

4.2.4 Effect of treatments on 100-seed weight

The data pertaining to the 100-seed weight as influenced by different cultivars and crop geometries are presented in Table 4.11.

It is revealed from the data presented in Table 4.11 that different cultivars had significant influence on the 100-seed weight. The cultivars V_4 (T-15-15) had recorded the highest 100-seed weight (11.49 g) and it was significantly superior over rest of the cultivars. The lowest 100-seed weight (9.76 g) was obtained with the cultivar V_2 (ANDT-2), however, it was at par with the cultivars V_1 (9.99) and V_3 (9.86 g).

The data (Table 4.11) further indicated that the differences in 100-seed weight due to different crop geometries were significant. The treatment S_3 (90 x 30 cm) gave significantly the highest 100-seed weight (19.49 g).

The lowest 100-seed weight (10.14 g) was obtained with treatment S_1 (60 x 30 cm), but it was statistically at par with the treatment S_2 (10.20 g).

4.2.5. Effect of treatments on seed yield

The data pertaining to the seed yield as influenced by different cultivars and crop geometries are presented in the Table 4.12 and graphically depicted in Fig. 4.3.

A perusal of data presented in Table 4.12 indicated that the seed yield was not significantly influenced by different cultvars. However, cultivar V_2 (ANDT-2) gave numerically higher seed yield (691.81 kg/ha)over all other cultivars.

It was also observed from the data presented in (Table 4.12) that difference in seed yield were significant due to different crop geometries. The treatment S_1 (60 x 30 cm) gave significantly higher seed yield (659.80 kg/ha) than treatment S_3, however, it was statistically at par with the treatment S_2 (584.63 kg/ha). The lowest seed yield (545.92) was obtained with the treatment S_3 (90 x 30 cm), but it was statistically at par with the treatment S_2 (75 x 30 cm).

4.2.6 Effect of treatments on stalk yield

The data on stalk yield as influenced by different cultivars and crop gemoetries are presented in Table 4.12 and graphically depicted in Fig. 4.4.

Table 4.12 : Seed, stalk and dry fodder yield as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Yield (kg/ha)		
	Seed	Stalk	Dry fodder
Cultivars			
ANDT-1 (V_1)	514.36	1713.15	956.70
ANDT-2 (V_2)	691.81	1683.03	682.78
BDN-2 (V_3)	639.47	1755.55	685.24
T-15-15 (V_4)	541.50	3946.02	976.18
S. Em. ±	56.098	56.192	93.467
C. D. at 5 %	NS	179.756	NS
C. V. %	32.56	8.56	39.13
Crop geometry			
60 x 30 cm (S_1)	659.80	2403.51	911.06
75 x 30 cm (S_2)	584.63	2266.67	828.56
90 x 30 cm (S_3)	545.92	2153.14	742.80
S. Em. ±	25.988	35.127	15.334
C.D. at 5%	75.856	102.535	44.76
C. V. %	17.42	6.18	7.41
Significant interaction	-	-	-

NS : Not significant

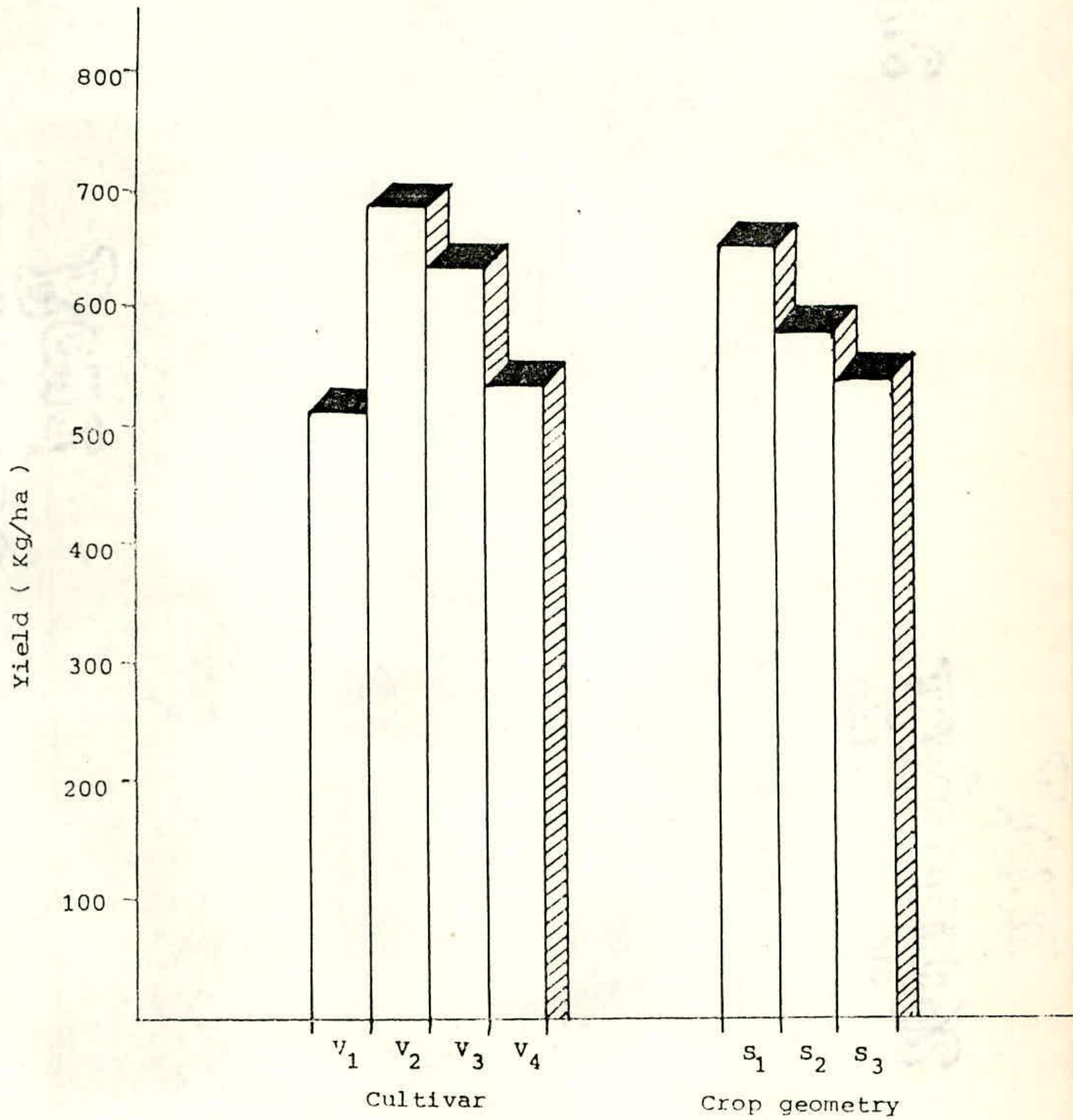
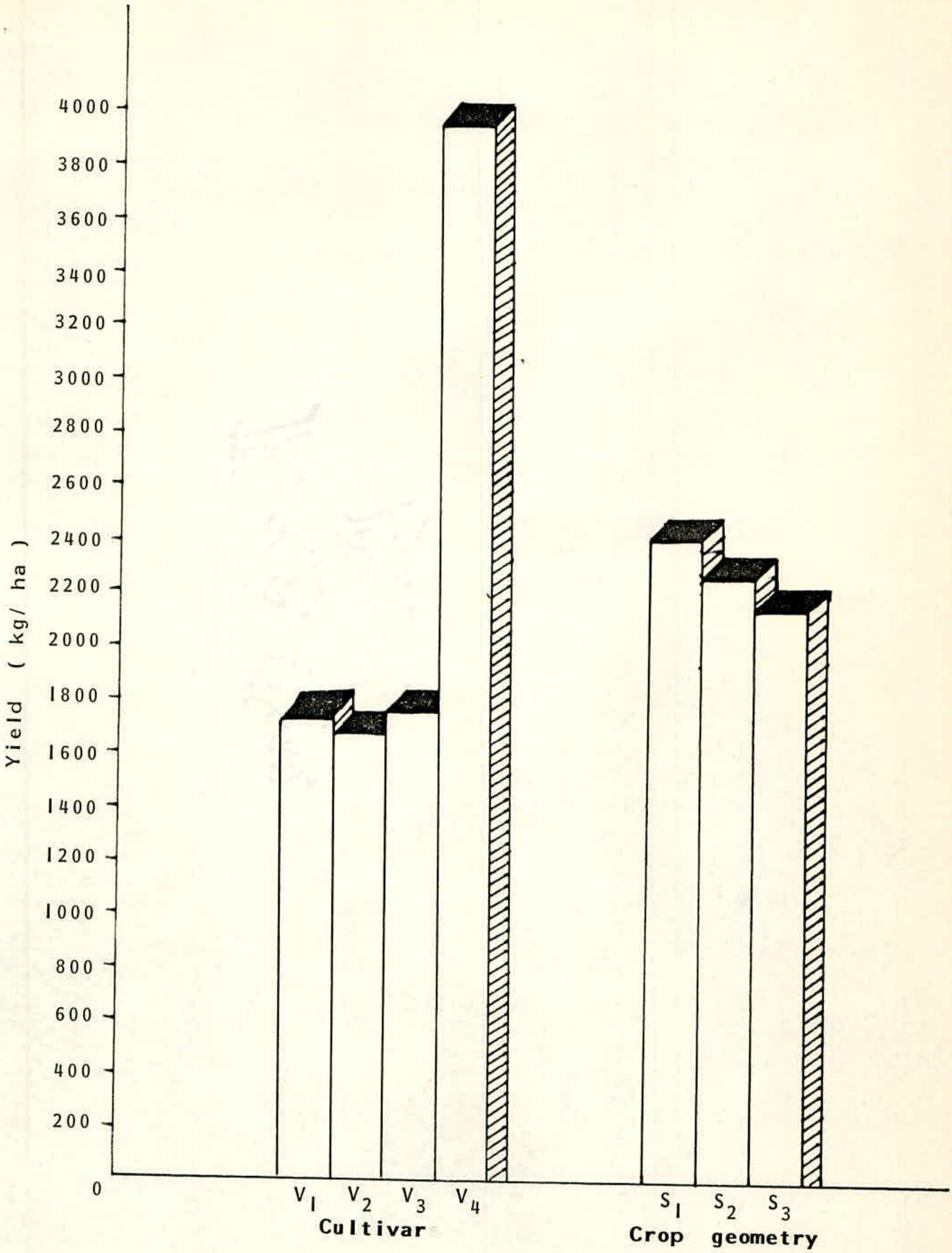


Fig. 4.3:EFFECT OF DIFFERENT TREATMENTS ON SEED YIELD OF PIGEON PEA



F.g. 4.4 : EFFECT OF DIFFERENT TREATMENTS ON STALK YIELD OF PIGEONPEA

An appraisal of data presented in (Table 4.12) indicated that the differences in stalk yield were significant due to different cultivars. The cultivar V_4 (T-15-15) produced the highest stalk yield (3946.02 kg/ha) and it was significantly superior over rest of the cultivars. The stalk yield obtained under cultivars V_1, V_2 and V_3 was 1713.15, 1683.03 and 1755.55 kg/ha, respectively.

The data further revealed that different crop geometries had significant influence on stalk yield. All the crop geometry treatments differed significantly with each other. The treatment S_1 (60 x 30 cm) gave significantly the highest stalk yield (2403.51 kg/ha) followed by S_2 (2266.67 kg/ha) and S_3 (2153.14 kg/ha) in that descending order.

4.2.7 Effect of treatments on dry fodder yield

The data pertaining to the dry fodder yield as influenced by different cultivars and crop geometries are presented in Table 4.12 and graphically depicted in Fig. 4.5.

The data presented in Table 4.12 indicated that the dry fodder yield was not significantly influenced due to different cultivars.

As regards to crop geometries, significant difference was observed in respect of dry fodder yield.

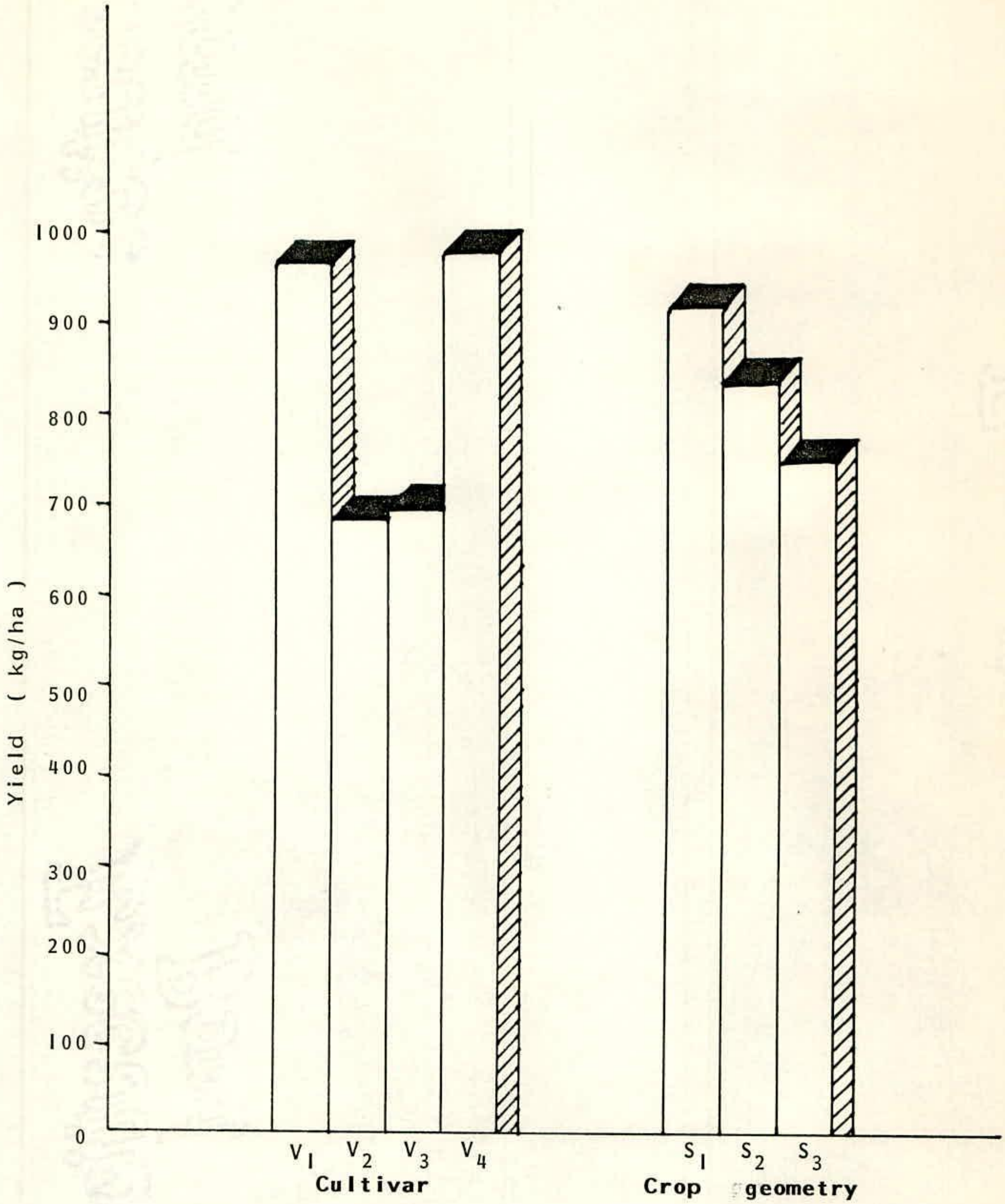


Fig. 4.5 : EFFECT OF DIFFERENT TREATMENTS ON DRY FODDER YIELD OF PIGEONPEA

All the crop geometry treatment differed significantly from each other in respect of dry fodder yield (kg/ha). Significantly the highest dry fodder yield (911.06 kg/ha) was recorded in S_1 (60 x 30 cm) treatment followed by S_2 (828.56 kg/ha) and S_3 (742.80 kg/ha) in the descending order.

4.2.8 Effect of treatments on harvest index (%)

The data pertaining to the harvest index as influenced by different cultivars and crop geometries are presented in Table 4.13.

It is evident from Table 4.13 that the differences in harvest index were significant due to different cultivars. The highest harvest index (22.16 %) was obtained with cultivar V_2 (ANDT-2). However, it was statistically at par with the cultivar V_3 (20.64%). The lowest harvest index (9.62) was obtained with the cultivar V_4 (T-15-15). The harvest index obtained with cultivar V_1 (15.29%) was significantly differed from all other cultivars.

The data presented in (Table 4.13) further revealed that the differences in harvest index were not significant due to different crop geometries. The harvest index obtained with the different treatment viz., S_1, S_2 and S_3 were 17.48, 16.61 and 16.70 per cent, respectively.

Table 4.13 : Harvest index and protein content of grains as influenced by different pigeonpea cultivars and crop geometry treatments

Treatments	Harvest index (%)	Protein content of grains (%)
Cultivars		
ANDT-1 (V_1)	15.29	21.01
ANDT-2 (V_2)	22.16	21.97
BDN-2 (V_3)	20.64	22.02
T-15-15 (V_4)	9.62	22.52
S. Em. ±	1.486	0.121
C. D. at 5%	4.753	0.386
C. V. %	30.40	1.91
Crop geometry		
60 x 30 cm (S_1)	17.48	21.45
75 x 30 cm (S_2)	16.61	21.91
90 x 30 cm (S_3)	16.70	22.29
S. Em. ±	0.541	0.092
C. D. at 5 %	NS	0.269
C. V. %	12.79	1.68
Significant interaction	-	-

NS : Not significant

Table 4.14 : Effect of different treatments on net realization and CBR

Treatment combinations	Yield in kg/ha			Gross realization (Rs./ha)	Cost of cultivation (Rs./ha)	Net realization (Rs./ha)	CBR
	Seed yield	Stalk yield	Dry fodder yield				
V_1S_1	553.35	1838.27	1025.64	4343	2785	1558	1 : 1.55
V_1S_2	531.46	1761.77	956.32	4168	2637	1531	1 : 1.58
V_1S_3	458.27	1540.07	915.15	3607	2548	1059	1 : 1.41
V_2S_1	793.60	1724.76	821.31	5982	2785	3197	1 : 2.14
V_2S_2	652.69	1674.31	678.47	4971	2637	2334	1 : 1.88
V_2S_3	629.15	1650.03	548.54	4788	2548	2240	1 : 1.87
V_3S_1	699.93	1861.65	766.83	5348	2785	2563	1 : 1.92
V_3S_2	633.72	1734.72	688.33	4851	2637	2514	1 : 1.83
V_3S_3	584.77	1670.28	600.55	4487	2548	1939	1 : 1.76
V_4S_1	592.33	4189.37	1030.45	5087	2785	2302	1 : 1.82
V_4S_2	520.66	3896.53	991.17	4523	2637	1886	1 : 1.71
V_4S_3	511.49	3752.17	906.97	4421	2548	1873	1 : 1.73

Selling price of produce

Seed @ 7.0 Rs./kg; Stalk @ 0.20 Rs./kg; Dry fodder @ 0.10 Rs./kg

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combination V_2S_1 and it was followed by the treatment combinations V_3S_1 (Rs. 2563/ha), V_3S_2 (Rs. 2514/ha), V_2S_2 (Rs. 2334/ha), V_4S_1 (Rs. 2302/ha) and V_2S_3 (Rs. 2240/ha). The treatment combination V_1S_3 gave the lowest net realization (Rs. 1059/ha).

The data for the mean effect on net realization presented in Table 4.15 revealed that the highest net realization of Rs. 2590/ha was recorded with the cultivar V_2 (ANDT-2) followed by the cultivars V_3 (Rs. 2239/ha) and V_4 (Rs. 2021/ha). While, the lowest net realization (Rs. 1382/ha) was obtained under the cultivar V_1 (ANDT-1).

With regards the crop geometry, the highest net realization of Rs. 2405/ha was recorded with the crop geometry S_1 (60 x 30 cm) followed by S_2 (75 x 30 cm) and S_3 (90 x 30 cm) which gave the net realization of Rs. 1991 and Rs. 1778 per hectare, respectively.

4.4.2 Effect on cost benefit ratio (CBR)

The data on CBR obtained by various treatments are presented in Table 4.14.

It was revealed from the Table 4.17 that the highest CBR was obtained with the treatment combination V_2S_1 (1: 2.14) followed by V_3S_1 (1 : 1.92), V_2S_2 (1 : 1.88), V_2S_3 (1 : 1.87) and V_3S_2 (1 : 1.83). The lowest CBR was recorded under the treatment combination V_1S_3 (1 : 1.41) followed by V_1S_1 (1 : 1.55) and V_1S_2 (1 : 1.58).

The mean CBR values for different cultivars presented in Table 4.15 indicated that the cultivar V_2 (ANDT-2) recorded the highest CBR (1 : 1.97) followed by the cultivars V_3 (1 : 1.84) and V_4 (1 : 1.76). Whereas, the lowest CBR (1 : 1.52) was obtained under the cultivar V_1 (ANDT-1).

The mean CBR values for different crop geometry presented in Table 4.15 revealed that the treatment S_1 (60 x 30 cm) gave the highest CBR (1 : 1.86) followed by the treatments S_2 (1 : 1.75) and S_3 (1 : 1.69).

Table 4.15 : Mean effect of different treatments on net realization and cost benefit ratio (CBR)

Treatments	Net realization (Rs./ha)	Cost benefit ratio(CBR)
Cultivars		
ANDT-1 (V_1)	1382.00	1 : 1.52
ANDT-2 (V_2)	2590.00	1 : 1.97
BDN-2 (V_3)	2239.00	1 : 1.84
T-15-15 (V_4)	2021.00	1 : 1.76
Crop geometry		
60 x 30 cm (S_1)	2405	1 : 1.86
75 x 30 cm (S_2)	1991	1 : 1.75
90 x 30 cm (S_3)	1778	1 : 1.69

NOTE:

Irrigation charges	12.00 Rs/hr
Labour charge	15.00 Rs/day
Tractor charge	45.00 Rs/day
Bullock Charge	20.00 Rs/day
Spraying of insecticide	40.00 Rs/day
Urea	122.80 Rs/50 kg
DAP	188.00 Rs/50 kg
Nuvacron 40 E.C.	222.00 Rs/litre
Endosulfan 35 E.C.	140.00 Rs/litre

V DISCUSSION

The results of the present study reported in the previous chapter are discussed in the subsequent text. Efforts have been made to establish the effect and cause relationship in light of the available evidence in the literature reviewed.

The meteorological data (Table 3.1) recorded during the course of investigation showed that the weather was favourable for normal growth and development of pigeonpea crop during the season. The maximum and minimum temperatures were ranges from 23.1 to 36.0^{o}C and 6.6 to 26.2^{o}C, respectively during the course of study. There was an unseasonal rain during the month of November and December which favours the incidence of insect-pests like Tur pod fly, pod borers etc. However, it was controlled by suitable plant protection measures. Hence whatever variations observed in the investigation are, attributed to the various treatments employed in the experiment.

The entire discussion has been partitioned into the following major heads:

1. Effect on morphological parameters of pigeonpea
2. Effect on yield and yield attributes of pigeonpea
3. Effect on quality character
4. Effect on economics

Different crop geometries had also significant influence on plant height at all growth stages viz., 75 and 105 DAS and at harvest (Table 4.1). The crop geometry of 60 x 30 cm (S_1) and 75 x 30 cm (S_2) were statistically at par and showed significantly higher plant height than widest crop geometry S_3 (90 x 30 cm) at 45 and 75 DAS. While, at 105 DAS, all the crop geometries were significantly differed with the highest plant height registered under the narrow crop geometry of 60 x 30 cm (S_1).

The final plant height at harvest showed increasing trend with decreased levels of crop geometry. The crop geometry S_1 (60 x 30 cm) showed higher plant height to the tune of 5.32 and 7.30 per cent over crop geometry S_2 (75 x 30 cm) and S_3 (90 x 30 cm), respectively. This might be due to inter-plant competition for light in higher densities results in more mutual shading leading to more elongation of cells and thus increased plant height. These results are in conformity with those reported by Hammerton (1971), Tripathi (1986), Shankaralingappa and Hegde (1989), and Sarvaiya (1990), who observed that the plant height increased significantly with plant population.

Results reported in previous chapter (Table 4.1) revealed that the interaction effect (V x S) was found not significant at 45 DAS. This indicated that during early growth phase there was no combined effect of particular cultivar and crop geometry. But interaction effect for plant height at 75 and 105 DAS as well as at harvest (Table 4.2, 4.3 and 4.4) found significant.

The combinations of cultivars with lower levels of crop geometry were either at par with or significantly superior to the combination of cultivars with higher levels of crop geometry in respect of plant height at 75 and 105 DAS as well as harvest, except the treatment combination V_3S_2 (BDN-2 with the crop geometry of 75 x 30 cm) which exhibited reverse trend in case of plant height at 75 DAS.

The combination of cultivar T-15-15 (V_4) with the crop geometry of 60 x 30 cm (S_1) produced the tallest plant at all the growth stages. The highest final plant height (210.00 cm) was obtained under the combination of cultivar T-15-15 and crop geometry of 60 x 30 cm (S_1). This might be due to inter-plant competition for light under higher plant population and inherent characteristics of the cultivar.

5.1.2 Effect of treatments on number of branches per plant

The data presented in Table 4.5 revealed that number of branches per plant at different growth stages viz., 75, 90 and 105 DAS and at harvest was significantly influenced by different cultivars. The cultivar T-15-15

(V_4) had recorded significantly the higher number of branches per plant at all the growth stages.

The cultivar T-15-15 (V_4) gave significantly the highest number of branches per plant (19.37) at harvest which was higher by 50.97, 65.69 and 50.97 per cent over the cultivars ANDT-1, ANDT-2 and BDN-2 respectively. This variation might be due to genetic make up of the cultivars. Such a varietal differences were also reported by Lenka and Satpathy (1976), Dhingra *et al*. (1980), Patel *et al*.(1984) and Dwivedi and Patel (1988).

The data (Table 4.5) further revealed that the different crop geometries had also significant effect on number of branches per plant at different growth stages viz., 75, 90 and 105 DAS and at harvest. The crop geometry of 90 x 30 cm (S_3) produced significantly the highest number of branches per plant over rest of the crop geometries through out the growth period.

The widest crop geometry of 90 x 30 cm (S_3) had recorded significantly the highest total number of branches per plant (16.61) and it was 22.85 and 33.84 per cent higher over medium S_2 (75 x 30 cm) and narrow S_1 (60 x 30 cm) crop geometries respectively. This increase in number of branches per plant with increased levels of crop geometry attributed to more availability of space per plant which resulted in efficient utilization of natural resources like water, nutrients and light which contributed for more number of branches per plant. These results are in accordance with the findings of Ahlawat et al. (1975), Dringra et al. (1980), Chauhan and Singh (1981), Patel, (1983), Tripathi (1986) and Sarvaiya (1990); who noticed higher number of branches per plant under wider spacings.

The effect of interaction between cultivars and crop geometry (V x S) on number of branches per plant at 75 and 90 DAS (Table 4.5) was not significant, but interaction effect on number of branches per plant at 105 DAS (Table 4.6) and harvest (Table 4.7) was found significant.

The combination of cultivars with higher levels of crop geometry registered more number of branches per plant at 105 DAS and harvest. The combination of cultivar T-15-15 (V_4) with the crop geometry of 90 x 30 cm gave significantly the highest number of branches per plant (23.00) over rest of the treatment combinations at harvest. This is probably because of longer duration (190 days) cultivar which might have efficient utilization of natural resources like nutrients and water under higher crop geometry resulted in better vegetative growth. These results are in agreement with those reported by Masood Ali (1981). The lowest number of branches per plant obtained with the treatment combination V_2S_1 might be due to short duration (140-150 days) of cultivar and lower space availability per plant under high population pressure.

5.1.3 Effect of treatments on days to first flower and maturity of pigeonpea

It was observed from the data (Table 4.8) that number of days to first flower and maturity were significantly influenced by different pigeonpea cultivars.

Regarding days to first flower, the cultivar ANDT-1 showed first flower earlier than cultivars BDN-2 and T-15-15 by 19.0 and 33.33 days, respectively. However, the first flower observed in cultivar ANDT-2 was utmost on the same day as in the cultivar ANDT-1. This might be due to genetical character and environmental influence. These results are more or less in conformity with the findings of Dhingra *et al*. (1980), Roy Sharma *et al*. (1980), and Malik *et al*. (1981).

Further in case of maturity days, the cultivar ANDT-2 took minimum days to maturity (147.92 days), while the most delayed maturity occurred with cultivar T-15-15. Thus, the cultivar ANDT-2 matured earlier by 3.6, 14.83 and 37.83 days than ANDT-1, BDN-2 and T-15-15, respectively. This variation might be due to genetic make up of cultivars and environmental influence. Such a varietal differences were also reported by Veeraswamy *et al*. (1975), Dhingra *et al*. (1980) and Bhosale *et al*. (1982).

The cultivar ANDT-2 produced significantly the highest number of pods per plant over rest of the cultivars. This might be due to genetic make up of the plant. Such as varietal differences were also reported by Ahuja (1984), Bishoi and Phogat (1986) and Yadahalli and Reddy (1987). Whereas, higher number of seeds per pod were recorded by cultivars T-15-15 and ANDT-1 as compared to cultivars BDN-2 and ANDT-2. These results are in agreement with the findings of Patel *et al*. (1984). The lowest number of pods per plant in cultivar T-15-15 may be because of low water availability during pod setting period. These results are confirmed with the findings of Patel *et al*. (1988), who reported that lesser pod sett in late maturing varieties was due to low water availability during peak flowering period.

As regards to 100-seed weight, cultivar T-15-15 recorded significantly the highest 100-seed weight (11.49 g), however, all other cultivars were at par. The higher 100-seed weight under cultivar T-15-15 might be due to bolder size of seed and genetical make up of the seed itself. These results are in accordance with the findings of Patel *et al*. (1984). Though cultivars ANDT-2 and BDN-2 had higher pods per plant; higher seeds per pod and 100-seed weight in cultivars ANDT-1 and T-15-15 might have compensatory effect resulted in to no marked differences in seed yield per plant.

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The data further indicated that different crop geometry had significant influence on yield attributes viz., number of pods per plant and seeds per pod (Table 4.9), seed yield per plant (Table 4.10) and 100-seed weight (Table 4.11).

In general, all these yield attributes had shown positive trend with increasing levels of crop geometry. The crop geometry of 90 x 30 cm (S_1) gave the highest values of yield attributes viz., number of pods per plant (95.26), seeds per pod (3.93), seed yield per plant (29.12 g) and 100-seed weight (10.49 g); however, the seed yield per plant and 100-seed weight obtained with the crop geometries S_1 (60 x 30 cm) and S_2 (75 x 30 cm) were statistically at par. The crop geometry of 90 x 30 cm (S_1) gave 12.08 and 22.55 per cent higher number of pods per plant, 2.61 and 5.36 per cent higher seeds per pod, 19.78 and 28.90 per cent higher seed yield per plant, 2.84 and 3.45 per cent higher 100-seed weight over other two crop geometries i.e., (75 x 30 cm) and S_1 (60 x 30 cm) respectively. This might be due to fact that more space availability per plant under wider crop geometry have resulted in better growth and development of plant utilizing the natural resources more efficiently. These results are in confirmity with those reported by Ahlawat *et al*. (1975), Dhingra *et al*. (1980), Toyo (1982), Reddy *et al* (1984), Singh *et al*. (1984) and Sarvaiya (1990).

5.2.2 Effect of treatments on seed yield

The results presented in Table 4.12 indicated that different cultivars failed to show significant differences in seed yield. However, cultivar ANDT-2 gave numerically higher seed yield (691.81 kg/ha) to the tune of 34.49, 8.18 and 27.75 per cent over cultivars ANDT-1, BDN-2 and T-15-15, respectively. This might be due to no marked differences in seed yield per plant among cultivars.

There was scanty literature available concerning to the cultivars tried under present investigation. However, such a non-significant differences among cultivars were also reported by Anonymous (1983-84), Anonymous (1985b), Dhingra *et al.* (1980), yadahalli and Reddy (1987), Puste and Jana (1988) and Patra (1989).

While, different crop geometries had significant influence on seed yield (Table 4.12). The narrow crop geometry of 60 x 30 cm (S_1) was found superior as compared to S_2 (75 x 30 cm) and S_3 (90 x 30 cm) crop geometries, however, it was statistically at par with S_2 (75 x 30 cm). The seed yield obtained with the crop geometry S_1 (60 x 30 cm) was higher to the tune of 12.85 and 20.86 per cent over S_2 (75 x 30 cm) and S_3 (90 x 30 cm) crop geometries, respectively. The reduction in seed yield due to wider crop geometry may be because of lower plant population per unit area, although pods per plant, seeds per pod and 100 seed weight were higher with widest crop geometry. This increase could not compensate for the increase with highest plant population 0.555 lakh plants/ha (60 x 30 cm). The results corroborate the findings of Rathi *et al*. (1974), Dhingra *et al*. (1980), Wallis *et al*. (1983), Singh *et al*. (1984), Ahlawat *et al*. (1985) and Goyal *et al*. (1989).

5.2.3 Effect of treatments on stalk yield

The data presented in Table 4.12 indicated that differences in stalk yield were significant due to different cultivars. Cultivar T-15-15 produced significantly the highest stalk yield (3946.02 kg/ha) which was higher to the tune of 130.33, 134.45 and 124.77 per cent over cultivars ANDT-1, ANDT-2 and BDN-2, respectively. This higher stalk yield might be due to comparatively longer duration of cultivar resulting into better vegetative growth. These results are in confirmity with those reported by Patel *et al*. (1984).

Results (Table 4.12) further revealed that different crop geometries had significant influence on stalk yield. In general, increasing trend in stalk yield was observed with decreased levels of crop geometry. The narrow crop geometry of 60 x 30 cm (S_1) produced significantly the highest stalk yield over rest of the crop geometries. The seed yield obtained with the narrow crop geometry (60 x 30 cm) was higher by 6.03 and 11.62

per cent than wider crop geometries i.e., S_2 (75 x 30 cm) and S_1 (90 x 30 cm) respectively. This may be attributed to the increased plant population per unit area and taller plants under narrow crop geometry. These results are in accordance with the findings of Marchi et al. (1981), Rowden et al. (1981). Tripathi (1986), Singh and Prasad (1987), who noticed highest stalk yield with narrow spacings.

5.2.4 Effect of treatments on dry fodder yield

The results presented in previous chapter showed that different cultivars did not show appreciable differences, in dry fodder yield, although T-15-15 and ANDT-1 gave numerically higher dry fodder yield than ANDT-2 and BDN-2.

However, different crop geometries had exert a significant influence on dry fodder yield. Increased level of crop geometry resulted in a appreciable reduction in dry fodder yield. The crop geometry of 60 x 30 cm gave significantly the highest dry fodder yield over rest of the crop geometries. The dry fodder yield obtained with the narrow crop geometry (60 x 30 cm) was 9.95 and 22.65 per cent higher over S_2 (75 x 30 cm) and S_3 (90 x 30 cm) crop geometries, respectively. This might be due to higher plant population per unit area.

5.2.5 Effect of treatments on harvest index

Data presented in the forgoing chapter (Table 4.13) indicated that differences in harvest index (%) due to different cultivars were significant. The cultivar ANDT-2 exhibited the highest harvest index (22.16 %) over rest of the cultivars, however, it was statistically at par with the cultivar BDN-2. This higher harvest index might be due to numerically higher seed yield and lower vegetative yield. These results are quite in agreement with the findings of Narayanan and Sheldrake (1979), who reported that medium cultivars had higher harvest index than late cultivars.

While, different crop geometries did not exert a significant effect on harvest index. The harvest index obtained with the crop geometries viz., S_1 (60 x 30 cm), S_2 (75 x 30 cm) and S_3 (90 x 30 cm) was 17.48, 16.61 and 16.70 per cent, respectively.

5.3. EFFECT ON QUALITY CHARACTER

5.3.1 Effect of treatments on protein content of grains

Data presented in Table 4.13 indicated that differences in protein content were significant among different cultivars. The cultivar T-15-15 contained the highest protein content (22.52%) over rest of the cultivars, while, it was minimum in case of ANDT-1. The differences in protein content was due to genetic make up of seed itself. Similar observations were reported by Veeraswamy *et al*. (1975).

Results (Tale 4.13) further revealed that the highest level of crop geometry i.e., 90 x 30 cm (S_3) noticed significantly the highest protein content (22.29) over rest of the crop geometries. The crop geometry of 90 x 30 cm (S_3) showed an increase in protein content by 1.73 and 3.91 per cent over S_2 (75 x 30 cm) and S_1 (60 x 30 cm) crop geometries, respectively. These results are in confirmity with those reported by Patel (1983).

5.4. EFFECT OF TREATMENTS ON ECONOMICS

It was observbed that highest net realization (3197 Rs./ha) and CBR (1 : 2.14) were obtained under the treatment combination V_2S_1 (Table 4.14) i.e., cultivar ANDT-2) with narrow crop geometry (90 x 30 cm).

Among the different cultivars, the cultivar ANDT-2 gave the highest net realization (2590 Rs./ha) and CBR (1 : 1.97), because of numerically higher seed yield. The lowest net realization (1382 Rs./ha) and CBR (1 : 1.52) was obtained with the cultivar ANDT-1 (Table 4.15).

With regards to the different crop geometries, the crop geometry of 60 x 30 cm (S_1) gave the highest net realization (2405 Rs./ha) and CBR (1 : 1.86), because, this crop geometry produced maximum seed yield.

SUMMARY AND CONCLUSIONS

VI SUMMARY AND CONCLUSIONS

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is the main legume crop of middle Gujarat occupying 33.9 per cent of the total area of the state. At present, BDN-2 and T-15-15 are the recommended cultivars which takes medium-long duration for maturity. Thus, it is not feasible to take second crop in the *Rabi* season. Increasing irrigation facilities have opened the avenue for multiple cropping in this potentially productive region. There is little information available on suitable cultivars and their crop geometry requirement for this region. Therefore, newly evolved and promising strains of pigeonpea crop are need to be compared with appropriate crop geometry for middle Gujarat condition.

Therefore, with a view to study the crop geometry of certain short duration cultivars, an experiment was conducted on loamy sand soil of College Agronomy Farm, Gujarat Agricultural University, Anand Campus, Anand during *Kharif* season of 1990-91. Twelve treatment combinations comprising four pigeonpea cultivars viz. ANDT-1, ANDT-2, BDN-2 and T-15-15; three levels of crop geometry viz., 60 x 30 cm, 75 x 30 cm and 90 x 30 cm were laid out in split-plot design with four replications. Pigeonpea cultivars were kept as main plot treatments and crop geometries as sub-plot treatments.

The results presented and discussed in the preceding chapter are summarized as under:

6.1 EFFECT OF PIGEONPEA CULTIVARS

The cultivar ANDT-1 and ANDT-2 took less days to first flower as compared to the cultivars BDN-2 and T-15-15. In respect of days to maturity, the cultivar ANDT-2 showed earliest maturity and was matured earlier by 3.16, 14.83 and 37.83 days than the cultivars ANDT-1, BDN-2 and T-15-15, respectively.

Cultivar T-15-15 produced higher plant height, number of branches per plant, number of seeds per pod, 100-seed weight and protein content of grains. While, the higher number of pods per plant and harvest index were obtained with the cultivar ANDT-2. The seed yield per plant did not differed significantly among the cultivars.

The seed yield and dry fodder yield were not differed significantly among different pigeonpea cultivars, however, ANDT-2 had given numerically higher seed yield (691.81 kg/ha) to the tune of 34.49, 8.18 and 27.75 per cent over cultivars ANDT-1, BDN-2 and T-15-15, respectively. Whereas, the cultivar T-15-15 produced the highest stalk yield (3946.02 kg/ha) over rest of the cultivars. The cultivar ANDT-2 gave maximum net realization (Rs. 2590/ha) and CBR (1 : 97) over rest of the cultivars

6.2 EFFECT OF CROP GEOMETRY

Different crop geometries had failed to exert significant effect on days to first flower. However, days to maturity was significantly reduced with decreased levels of crop geometry. The earliest maturity (159.69 days) was noticed with the crop gemoetry of 60 x 30 cm (S_1).

The widest crop geometry of 90 x 30 cm (S_3) had recorded the highest number of branches per plant, pods per plant, seeds per pod, 100-seed weight, seed yield per plant and protein content of grains. whereas, the closest crop geometry of 60 x 30 cm (S_1) gave the highest plant height and numerically higher harvest index.

The narrow crop geometry of 60 x 30 cm (S_1) was found superior in respect of seed yield (659.80 kg/ha), stalk yield (2403.51 kg/ha) and dry fodder yield (911.06). This narrow crop geometry (60 x 30 cm) gave higher seed, stalk and dry fodder yield to the tune of 12.85, 6.03 and 9.95 per cent over medium crop geometry (75 x 30 cm) and 20.86, 11.62 and 22.65 per cent over widest crop geometry (90 x 30 cm), respectively. The narrow crop geometry (60 x 30 cm) gave the highest net realization (Rs. 2405/ha) and CBR (1 : 1.86) over rest of the crop geometries.

6.3 INTERACTION EFFECT

Interaction effect was found significant only in respect of plant height and number of branches per plant. The treatment combination V_4S_1 i.e., cultivar T-15-15 with lowest level of crop geometry (60 x 30 cm) produced the tallest plant of pigeonpea at 75 and 105 DAS and at harvest. While, in respect to number of branches per plant, the treatment combination V_4S_3 i.e., cultivar T-15-15 with the highest level of crop geometry (90 x 30 cm) was found superior at 105 DAS and at harvest over rest of the treatment combinations.

The highest net realization Rs. 3197/ha) and CBR (1 : 2.14) was recorded under V_2S_1 treatment combination. Thus, the data indicated that to secure maximum net profit from pigeonpea crop, the crop should be sown using the cultivar ANDT-2 at the crop geometry of 60 x 30 cm.

CONCLUSIONS

Based on the results obtained from the experiment conducted for one crop season, it can be concluded that the short duration cultivar ANDT-2 secured maximum yield and net realization when sown at the crop geometry of 60 x 30 cm under middle Gujarat Agro-climatic conditions. Not only the short-duration cultivar ANDT-2 was marginally superior in yield, but also maturing earlier thereby vacate the field by the middle of December and make it feasible to take the second crop in rabi season.

FUTURE LINE OF WORK

The following suggestions are made for the future line of work on the basis of the present research findings.

1. To find out suitability of the cultivar under middle Gujarat Agro-climate condition, such experiment should be repeated for two or more seasons.
2. The experiment should be conducted involving more short duration cultivars along with crop geometries.
3. To find out optimal crop geometry, an experiment should be planned with more levels of crop geometry along with short duration cultivars.
4. The experiment should be repeated atleast three years to judge the interaction effects of cultivars and crop geometry under irrigated as well as rainfed condition.
5. The experiment should be conducted to study the advantages of short duration pigeonpea cultivars in groundnut/pigeonpea inter-cropping systems.
6. The experiment should be conducted to study the potential of short duration pigeonpea-wheat rotation under middle Gujarat conditions.

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* Original not reffered.

APPENDICES

Appendix I : Cost of cultivation for different treatments during <u>kharif</u> 1990-91

Sr. No.	Treatments	Common expenditure	Cost of seeds (Rs./ha)	Cost of fertilizer application (Rs./ha)	Cost of sowing (Rs./ha)	Cost of harvesting (Rs./ha)	Cost of threshing (Rs./ha)	Total cost (Rs./ha)
1	V_1S_1	1923	270	33	99	110	330	2785
2	V_1S_2	"	252	22	77	99	264	2637
3	V_1S_3	"	234	17	66	88	220	2548
4	V_2S_1	"	270	33	99	110	330	2785
5	V_2S_2	"	252	22	77	99	264	2637
6	V_2S_3	"	234	17	66	88	220	2548
7	V_3S_1	"	270	33	99	110	330	2785
8	V_3S_2	"	252	22	77	99	264	2637
9	V_3S_3	"	234	17	66	88	220	2548
10	V_4S_1	"	270	33	99	110	330	2785
11	V_4S_2	"	252	22	77	99	264	2637
12	V_4S_3	"	234	17	66	88	220	2548

APPENDIX II LIST OF ABBREVIATIONS

@	At the rate of
C. D.	Critical difference
Cm	Centimetre
C. V.	Co-efficient of variation
CBR	Cost benefit ratio
CV.	Cultivar
DAP	Diammonium phosphate
DAS	Days after sowing
°C	Degree centigrade
E. C.	Emulsifiable concentratation
et al.	et allii, and others
Fig.	Figure
g	Gram
ha	Hectare
kg	Kilogram
Max.	Maximum
m	metre
Mini.	Minimum
viz.,	Namely
No.	number
/	Per
%	Per cent
qt	Quintal
Rs.	Rupees
S. Em.	Standard error of mean
i. e.	That is
t	Tonne