BIBLIOGRAPHY

GALAO, AMIE B. APRIL 2010. Growth and Yield of Vegetable Type Pigeon Pea (*Cajanus cajan* L.) as Affected by Planting Distance. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted in Benguet State University Horticulture Experimental Station, La Trinidad, Benguet from October 2008 to May 2009 to determine the effect of the different planting distance on the growth and yield of pigeon pea and to determine the best planting distance for pigeon pea production. The study was carried out in factorial experiment, with pigeon pea accessions as factor A and planting distance as factor B. Two accessions of vegetable type pigeon pea were evaluated, ICPL 87091 and ICPL 87119, under five different planting distances.

Result of the study showed that ICPL 87091 significantly flowered and was harvested earlier. ICPL 87119 on the other hand, were significantly taller, has more lateral branches, and produced more pods per plant. No significant differences were noted on the total number of harvests and on the yield between the two accessions of pigeon pea.

Plants spaced at 30 cm x 20 cm grew taller and had the highest yield per plot. Spacing pigeon peas at 30 cm x 40 cm leads to earlier flowering and harvesting.

No significant interaction effect between the variety and planting distance used were noted.

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INTRODUCTION

Pigeon pea is used in a wide diversity of farming systems internationally, mainly involving subsistence agriculture (Wallis, *et al*., 1983). In the Philippines, this crop is of local importance and is even regarded as "poor man's crop" (Barroga, 2005).

The crop is chiefly grown for its nutritive value. It is even one of the most important food sources in arid countries. In India, it is widely grown food legume next to chickpea.

Among other food legume, pigeon pea could withstand drought and it can resist lodging and shattering. However, it is also susceptible to water logging, frost, and insect attack particularly pod borer.

Low yield is one problem that the farmers encounter in the production of pigeon pea which could be attributed to various agro ecological and management constraints. Thus, proper cultural management of pigeon pea should be determined such as the ideal planting distance.

Determining the appropriate planting distance for pigeon pea could lead to increase of yield with the maximum land utilization.

The results of the study would serve as a guide for farmers who are engaged or who are interested in the production of pigeon pea as sole crop. It could also serve as baseline information for other researchers who would like to improve the cultural practice in growing this crop.

The study was conducted with the following objectives: to determine the appropriate planting distance for vegetable type pigeon pea production; and to determine

the effect of different planting distance on the growth and yield of vegetable type pigeon pea.

This study was conducted at the Horticulture Experimental Station, Benguet State University, La Trinidad, Benguet from October 2008 to May 2009.

Yield Performance of Six Strawberry Cultivars Grown Inside Greenhouse from April to November 2008 at Balili, La Trinidad, Benguet. / Herson A. Felipe. 2009

REVIEW OF LITERATURE

Description of Pigeon Pea

Pigeon pea (*Cajanus cajan* L.) belongs to the family *Fabaceae*. It is a glandular – pubescent, short-lived perennial shrub that is usually grown as an annual crop. It has many slender branches. The leaves are alternate, trifoliate and glandular punctuate. Flowers are pseudocracemes, sometimes concentrated and synchronous, usually scattered and flowering over a long period and papillionaceous. The fruits are straight or sickle-shaped pod with globose to ellipsoid or squarish seeds (van der Maesen and Somaatmadja, 1990).

Pigeon pea has a well developed tap root system which can extend very deep in the soil and fix appreciable quantities of atmospheric nitrogen in symbiotic association with rhizobia (Salam and Wahid, 1993).

Emergence is complete two to three weeks after sowing pigeon pea. Vegetative development starts slow. After two to three months, growth accelerates. Flowering starts 56 to 210 days after sowing. The maturity of the crop ranges from 95 to 256 days in normal conditions with rainy season and long days. With short days, growth in length is less and flowering is accelerated (van der Maesen and Somaatmadja, 1990).

There are four general maturity duration of pigeon pea; extra short duration, short duration, medium duration, and late duration. Extra short duration pigeon peas mature 120 – 140 days after sowing. Short duration varieties mature after 140 – 170 days after sowing. Medium duration and late duration pigeon peas mature 160 – 190 days and 180 – 270 days after sowing, respectively (van der Maesen and Somaatmadja, 1990).

Importance of Pigeon Pea

Pigeon pea is an important component of human nutrition, particularly vegetable-based diet. Like other legumes, pigeon pea is important for its protein, carbohydrate and mineral content (Wallis, *et al*., 1988).

Every 100 gram edible portion of pigeon pea dry seeds contain 7.0- 10.3 grams of water, 14.0- 30.0 grams protein, 1.0- 9.0 grams of fat, 36.0- 65.8 grams carbohydrates, 5.94 grams fiber, and 3.08- 8.0 grams of ash. The fresh seeds also contribute vitamins especially proVitamin A and vitamin B- complex (van der Maesen and Somaatmadja, 1990).

People use the seeds whole, dehulled, or as flour. In the Caribbean region, people eat the seed as the popular green (immature) pea, but most is processed into "Dahl", the easily stored decorticated split pea (Price, 1998).

Pigeon pea is primarily used as pulse in India. However, use of fresh seeds and even pods as vegetative sayors (spicy soups) and other side dishes is popular in Southeast Asia. It has a potential in replacing soya bean in making tempeh and tahu (fermented products) (van der Maesen and Somaatmadja, 1990).

The plant's woody stems are valuable as fire wood, thatch and fencing. The leaves are important source of organic matter and nitrogen; adding as much as 40 kilograms per hectare to the soil (Price, 1998).

Pigeon pea is also a good hedge, shade and cover crop (van der Maesen and Somaatmadja, 1990).

Climatic and Soil Requirement
of Pigeon Pea

The crop grows in wide variety of soil and it grows well at low to moderately high altitudes (Childers, *et al*., 1950).

The optimum temperature and rainfall requirement of pigeon pea ranges from 18℃– 38 ℃ and 600 – 1000 mm/ year respectively. Drained soils with 5.0 – 7.0 pH are favourable for production. It also tolerates electrical conductivity from 0.60 – 1.20 S/m (van der Maesen and Somaatmadja, 1990).

Planting Distance

The ideal spacing and plant population are those that maximize yield and quality without unduly increasing cost (AVRDC, 1990). Accordingly, as plant population per unit area increases, the yield per unit also increase until the spacing is so close that excessive competition between adjacent plants reduces the yield per plant (Mabesa and Bautista, 1986).

Plant spacing in plant design allows enough space between plants so that they have room to develop their full size (McDonald, 1993). Vegetables which have a narrow, spreading root system and small top are planted closely because they could withstand crowding and are not seriously injured by partial shade. However, plants with large leaves, trailing vines, or fruit which require direct sunlight for proper development must have more room (Ware and McCollum, 1980).

The proper distance between plants depends upon the variety, purpose of the crop, fertility of the soil, method of cultivation, spraying and harvesting (Watts, 1922).

Plant spacing greatly affects root shape and development in root crops. Increased in spacing on carrots result in large roots and is suitable for processing. Close spacing in beets produced small roots which is also desirable for processing. In heading lettuce, planting distance affects head development and yield. Close spacing reduces head size and delays maturity but may increase yield (Swiader and Ware, 2002).

In the case of sweet corn, wider row and plant spacing improved slightly the ear size and the appearance, but the number of marketable ears per acre may be reduced. Overcrowding may result to short ears and lack of tip fill (Swiader and Ware, 2002).

In potato production, it is essential to have a good stand of properly distributed plants to achieve high yield and quality. Improper seed distribution and skips cause varied plant growth and increased competition between individual plants (Hess, *et al*, 1999; Holland, 1991; Rupp and Thornton, 1992). By obtaining seed spacing accuracy of 75% or higher, farmers can expect a 5% to 10% yield increase and a 20% improvement of crop quality (Hess *et al*., 1999; Harris, 1997; Holland, 1991, 1994).

Close spacing is used to increase and produce small fruits of pineapple for canning; for the fresh fruit market, large fruit is often preferred thus wider spacing is suitable (Williams, 1975).

Wider spacing in yacoon tends to promote earlier flowering that resulted to earlier harvesting (Camlas, 2008).

Sugar beets spaced at 10 cm x 10 cm and 15 cm x 15 cm produced the heaviest yield per plot compared to the plants spaced at 35 cm x 35 cm (Balas, 2005).

Spacing at 20 cm x 20 cm markedly increased the marketable and computed sprig yield in sweet basil (Degala, 2003).

MATERIALS AND METHODS

The materials used in the study were pigeon pea seeds, fertilizers, pesticides, irrigation implements, knapsack sprayer, weighing scale, measuring tools and identifying tags.

Experimental design and treatment. The experiment was laid out in a randomized complete block design (RCBD) in factorial arrangement with four replications. Factor A was the accessions while factor B was the planting distance. The treatments were as follows:

Factor A (Accessions)	Factor B (Planting distance)
A_1- ICPL 87091	D_1- 30x20 cm
A_2- ICPL 87119	D_2-30x25 cm
	D_3-30x30 cm
	D_4-30x35 cm
	D_5-30x40 cm

Land preparation. An area of 200 m^2 was thoroughly prepared and divided into plots measuring 1 m x 5 m (Figure 1). The plots were levelled and holes were done based on the planting distance specified in the treatments.

Planting. The seeds were germinated first in seed trays to ensure 100% field emergence (Figure 2). Two week old seedlings were transplanted in the field.

Care and management. Weeding, fertilizer application, irrigation and crop protection were employed to ensure optimum growth, development and yield of the crop.

Harvesting. Pigeon peas were hand harvested just before the pods start to lose their green color.

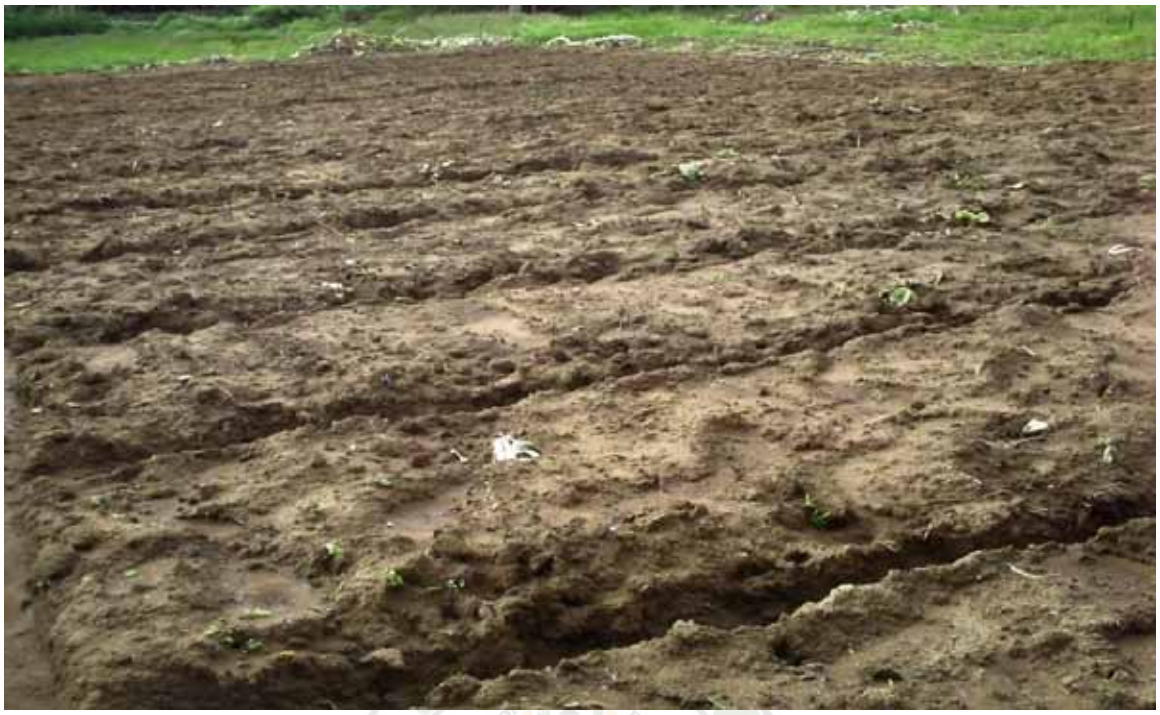


Figure 1. Overview of the prepared area for planting

ICPL 87119 ICPL 87091

Figure 2. Pigeon pea seedlings ready for transplanting

The data gathered were as follows:

A. Vegetative Phase

1. Days from planting to 50% flowering. This was taken when the plant population reached 50% flowering by counting the number of days from transplanting to flowering.

2. Average height at flowering (cm). This was taken during the flowering stage by measuring the sample plants from the base of the stem to the tip of the plant.

3. Final height (cm). This was taken at full grown stage by measuring the sample plant from the base of the stem to the tip of the plant.

4. Days from planting to first harvest. This was taken by counting the number of days from transplanting to first harvest.

5. Average number of lateral branches at flowering. This was taken during the flowering stage by counting the lateral branches.

6. Total number of harvests. This is the total number of harvesting done in one cropping season.

B. Yield

1. Average number of pods produced per plant. This is the total number of pods produced, and this was computed by the formula;

$$\text{Average number of pods} = \frac{\text{total number of pods produced by sample plants}}{\text{number of sample plants}}$$

2. Average yield per plant (g). The yield per sample plant was weighed and computed using the formula;

$$\text{Average yield} = \frac{\text{total yield of sample plants}}{\text{number of sample plants}}$$

3. Total yield per plot (kg). This is the total yield of experimental plot from the first harvest up to the termination of the study.

4. Computed yield (t/ha). This is the yield per hectare. The total yield per plot is converted to tons per hectare using the formula;

Yield (t/ha) = Yield (Kg/5m^2) x 2

Where: 2 is a factor to convert Kg/5m^2 to t/ha.

C. Documentation

The data gathered were subjected to variance analysis and mean separation test by Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Days to 50% Flowering, and Days to First Harvest

Effect of pigeon pea accession. Table 1 show the days from planting to 50% flowering and days from planting to first harvest of the two accessions of pigeon pea. Significant difference was noted between ICPL 87091 and ICPL87119 on number of days from planting to flowering. Similarly, the days to first harvest were significantly affected by the accession. ICPL 87091 flowered after 75.2 days and was harvested after 115.25 days while ICPL 87119 flowered after 86.5 days from planting; and green pods were harvested after 136.55 days from planting. Figure 3 shows the two accessions of pigeon pea at flowering and fruiting stage.

Effect of planting distance. Significant differences were observed on the effect of the different planting distances on pigeon pea flowering (Table 1).

Pigeon peas spaced at 30 cm x 40 cm significantly flowered earlier with a mean of 77.375 days and green pods were harvested after 121.875 days. This was followed by plants spaced at 30 cm x 35 cm, 30 cm x30 cm, and 30 cm x25 cm which did not differ significantly with each other and plants spaced at 30 cm x 40 cm. Plants spaced at 30 cm x 20 cm were the latest to flower at 85.50 days and green pods were harvested after 130. 375 days.

Results showed that as the spacing is widened, the plants flowered earlier and was also harvested earlier.

The results coincide with the study in yacoon wherein plants at wider spacing flowered earlier and were harvested earlier (Camlas, 2008).

ICPL 87091

ICPL 87119

Figure 3. Pigeon pea accessions at flowering and fruiting stage

Table 1. Days to 50% flowering, and days to first harvest

TREATMENT	DAYS TO 50% FLOWERING	DAYS TO FIRST HARVEST
Pigeon Pea Accession		
ICPL 87091	75.20[b]	115.25[b]
ICPL87119	86.50[a]	136.55[a]
Planting Distance		
30cm x20 cm	85.50[a]	130.375[a]
30cm x 25 cm	82.625[ab]	127.500[ab]
30cm x30cm	80.50[ab]	125.625[ab]
30cm x 35 cm	79.125[ab]	124.125[ab]
30cm x 40 cm	77.375[b]	121.875[b]

Means with a common letter are not significantly different at 5% level DMRT

Interaction effect. There was no significant interaction effect of the accession and planting distance on the number of days to 50% flowering, and days to first harvest.

Plant Height

Effect of pigeon pea accession. Accession ICPL 87119 was significantly taller than ICPL 87091 at flowering and at final height (Table 2). ICPL 87091 has a height of 45.09 cm at flowering and 72.902 cm final height while ICPL 87119 has a height of 84.60 cm at flowering and 193.62 cm final height.

Effect of planting distance. No significant differences were observed on the height of plants as influenced by planting distance (Table 2). However, the height of plants

increased as the planting distance is narrowed.

Numerically, plants spaced at 30 cm x 20 cm have the tallest height with 69.52 cm at flowering and 136.640 cm final height. These were followed by plants spaced at 30 cm x 25 cm with a height of 67.82 cm at flowering and 134.4 cm final height. The shortest plants were spaced at 30 cm x 40 cm with a height of 59.54 cm at flowering and 130.875 cm final height.

Interaction effect. There was no significant interaction effect of variety and planting distance on the height of plants. Plant spacing at 30 cm x 20 cm, however, enhanced the highest plant height in both accessions.

Table 2. Plant height

TREATMENT	HEIGHT AT FLOWERING (cm)	FINAL HEIGHT (cm)
Pigeon Pea Accession		
ICPL 87091	45.09[b]	72.902[b]
ICPL87119	84.60[a]	193.620[a]
Planting Distance		
30cm x20 cm	69.82[a]	136.640[a]
30cm x 25 cm	67.82[a]	134.400[a]
30cm x30cm	65.54[a]	132.930[a]
30cm x 35 cm	61.38[a]	131.465[a]
30cm x 40 cm	59.54[a]	130.875[a]

Means with a common letter are not significantly different at 5% level DMRT

Number of Lateral Branches
at Flowering

Effect of pigeon pea accession. Significant difference was noted between the two accessions tested (Table 3). ICPL 87119 produced 10.70 branches while ICPL 87091 have 7.82 branches per plant.

Effect of planting distance. Planting distance significantly affected the number of lateral branches at flowering (Table 3). Plants spaced at 30 cm x 40 cm produced the highest number of branches which is 10.3 and plants that produced the least number of branches were spaced at 30 cm x 20 cm.

It was observed that the wider the planting distance the more branches were produced by each plant.

Table 3. Number of lateral branches at flowering

TREATMENT	NUMBER OF LATERAL BRANCHES AT FLOWEING
Pigeon Pea Accession	
ICPL 87091	7.820[b]
ICPL87119	10.700[a]
Effect of Planting Distance	
30cm x20 cm	8.245[b]
30cm x 25 cm	8.675[ab]
30cm x30cm	9.100[ab]
30cm x 35 cm	9.975[ab]
30cm x 40 cm	10.300[a]

Means with a common letter are not significantly different at 5% level DMRT

Accordingly, the degree of branching in dicotyledonous crops is determined by plant population density. And in most seed crops, any variation among varieties in the genetic potential for branching is normally masked by the effects of high plant population density (Hay and Porter, 2006).

Interaction effect. The number of lateral branches produced per plant at flowering was not significantly affected by the accession and planting distance.

Total Number of Harvests

Effect of pigeon pea accession. No significant difference was noted on the total number of harvest as influenced by accession. Numerically, however, ICPL 87091 has higher total number of harvests than ICPL 87119.

Effect of planting distance. Table 4 showed that no significant differences were noted on pigeon peas spaced at 30 cm x 20 cm, 30 cm x 25 cm, 30cm x 30 cm and 30 cm x 35 cm on the number of harvesting done. Numerically, however, plants spaced at 30 cm x 30 cm and 30 cm x 25 cm have the highest number of harvesting which is 4.750. Plants spaced at 30 cm x 40 cm significantly differed from plants spaced at 30 cm x 20 cm, 30 cm x 25 cm, and 30 cm x 30 cm.

Interaction effect. No significant interaction effect noted between the accession and planting distance on the total number of harvesting done.

Number of Pods Produced per Plant, and
Seed Yield per Plant

Effect of pigeon pea accession. Table 5 shows the average number of pods produced per plant and seed yield per plant. ICPL 87091 differ significantly from ICPL 87119 in the number of pods produced per plant. ICPL 87119 produced more pods with a

number of 38.661. However, there is no significant difference between the two accessions in terms of yield per plant. ICPL 87119 produced a seed yield of 30.932 grams while ICPL 87091 has a yield of 30.22 grams. Figure 4 shows the yield of pigeon peas as affected by the different planting distance.

Effect of planting distance. No significant difference was noted in the number of pods produced per plant and the average seed yield per plant as influenced by planting distance as shown by Table 5.

However, plants spaced at 30 cm x 40 cm produced the highest number of pods, and seed yield per plant. It produced 39.547 pods which yielded 32.61 gram seeds. The least number of pods produced, and least seed yield is obtained from plants spaced at 30 cm x 20 cm.

Table 4. Total number of harvests

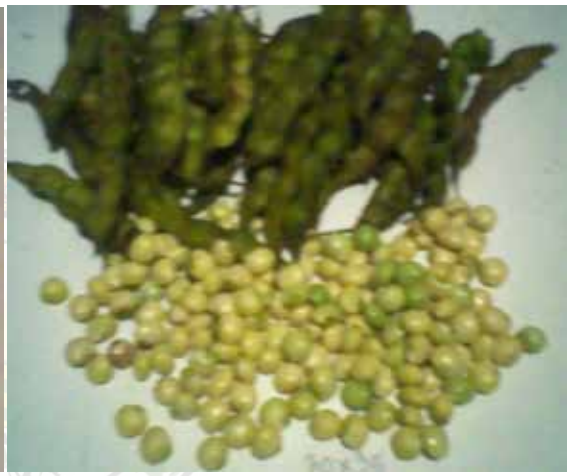
TREATMENT	NUMBER OF HARVESTS
Pigeon Pea Accession	
ICPL 87091	4.44[a]
ICPL87119	4.10[a]
Planting Distance	
30cm x20 cm	4.75[a]
30cm x 25 cm	4.75[a]
30cm x30cm	4.50[a]
30cm x 35 cm	4.00[a]
30cm x 40 cm	3.35[b]

Means with a common letter are not significantly different at 5% level DMRT

30 cm x 20 cm

30 cm x 25 cm

30 cm x 30 cm



30 cm x 35 cm

30 cm x 40 cm

Figure 4. Yield of pigeon peas as affected by different planting distance

Table 5. Number of pods produced per plant, and seed yield per plant

TREATMENT	PODS PRODUCED PER PLANT	SEED YIELD PER PLANT (g)
Pigeon Pea Accession		
ICPL 87091	35.550[b]	30.22[a]
ICPL87119	38.661[a]	30.932[a]
Planting Distance		
30cm x20 cm	33.245[a]	27.395[a]
30cm x 25 cm	35.987[a]	29.630[a]
30cm x30cm	37.972[a]	31.285[a]
30cm x 35 cm	38.778[a]	31.960[a]
30cm x 40 cm	39.547[a]	32.610[a]

Means with a common letter are not significantly different at 5% level DMRT

It was observed that the wider the planting distance the more pods is produced thus the yield per plant is also increased.

Interaction effect. There was no significant interaction effect observed between the accessions and planting distance on the average number of pods produced per plant, and the average yield per plant.

Seed Yield per Plot, and Computed Yield

Effect of pigeon pea accession. As shown in Table 6, the two accessions did not differ in their seed yield per plot and computed yield. ICPL 87119 yielded 1.062 kilograms which is higher than ICPL 87091 having a yield of 1.032 kilograms per plot. Computed yield of ICPL 87091 is 2.065 t/ha while ICPL 87119 has 2.123 t/ha.

Table 6. Seed yield per plot, and computed yield

TREATMENT	SEED YIELD PER PLOT (kg)	COMPUTED YIELD (t/ha)
Pigeon Pea Accession		
ICPL 87091	1.032[a]	2.065[a]
ICPL87119	1.062[a]	2.123[a]
Planting Distance		
30cm x20 cm	1.370[a]	2.740[a]
30cm x 25 cm	1.186[b]	2.371[ab]
30cm x30cm	1.002[c]	2.003[bc]
30cm x 35 cm	0.895[cd]	1.791[cd]
30cm x 40 cm	0.783[d]	1.566[d]

Means with a common letter are not significantly different at 5% level DMRT

Effect of planting distance. Significant difference was observed in the average seed yield produced per plant and the computed yield (Table 6). It was also noted that the wider the planting Pigeon peas spaced at 30 cm x 20 cm significantly produced the highest seed yield which is 1.370 kilograms, followed by plants spaced at 30 cm x 25 cm which yielded 1.186 kilograms. Lowest seed yield per plot was obtained from plants spaced at 30 cm x 40 cm, however; it did not differ significantly with plants spaced at 30 cm x 35 cm.

Similarly, plants spaced at 30 cm x 20 cm, significantly produced the highest computed yield which is 2.740 t/ha. This was followed by plants spaced at 30 cm x 25 cm

having a computed yield of 2.003 t/ha. The lowest computed yield was produced by plants spaced at 30 cm x 40 cm.

Similar study conducted in soy bean show that crops sown in narrow rows able to achieve full light interception sooner and with lower leaf area index than those in wide rows consequently have a higher yield (James, *et al*., 1996). Another study conducted showed that yield of vegetable soy bean increased as distance was decreased (SeungSu and ChangHo, 2008).

Close spacing in heading lettuce reduces head size and delays maturity but may increase yield. Ear size and appearance of sweet corn are improved slightly at wider row and plant spacing but the number of marketable ears per acre may be reduced (Swiader and Ware, 2002).

Interaction effect. No significant interaction effect between accession and planting distance was exhibited on the yield per plot, and on the computed yield.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted on October 2008 to May 2009 at the Horticulture Experimental Station, Benguet State University, La Trinidad, Benguet to determine the effect of the different planting distance on the growth and yield of two accessions of vegetable type pigeon pea and to determine the best planting distance for pigeon pea production.

The result of the study showed significant difference on the two accessions of pigeon pea which is the ICPL 87091 and ICPL 87119. ICPL 87091 flowered and was harvested earlier. ICPL 87119 is taller, has more lateral branches and produced more number of pods per plot. There was no significant difference between the two accessions on the total number of harvests, seed yield per plant, seed yield per plot and computed yield.

Pigeon peas spaced at 30 cm x 40 cm significantly flowered earlier (77.375 days), harvested earlier (121.875 days), and produced more number of lateral branches (10.3). Plants spaced at 30 cm x 20 cm flowered the latest, thus were harvested the latest, and has the least number of branches. Plants spaced at 30 cm x 40 cm have the lowest number of harvesting done. There were no significant effect of planting distance on plant height, number of pods produced per plant and seed yield per plant. Spacing pigeon peas at 30 cm x 20 cm produced the highest yield per plot (0.716 Kg) and is followed by plants spaced at 30 cm x 25 cm. The lowest yield per plot was obtained from plants spaced at 30 cm x 40 cm.

Result showed that the wider the planting distance the earlier the flowering and harvesting, heights of plants are shortened, more branches are produced, more pods are produced leading to higher yield per plant, and the seed yield per unit area and computed yield is lower. In contrast, narrower spacing leads to late flowering and harvesting, taller plants, less branches, lower number of pods produced per plant, and lower seed yield per plant but higher yield per unit area and computed yield.

Conclusion

Results of the study showed that close spacing of pigeon peas leads to higher yield per unit area and computed yield. Wider spacing leads to earlier flowering and harvesting, more lateral branches, but lower yield per unit area.

Recommendation

Based on the results of the study, ICPL 87119 spaced at 30 cm x 20 cm have the highest yield per unit area thus it is recommended. But then, ICPL 87091 has quite a good performance which did not differ significantly with ICPL 87119.

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APPENDICES

Appendix Table 1. Days from transplanting to 50% flowering

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	79	76	71	89	315	78.75
30 cm x 25 cm	75	74	76	80	305	76.25
30 cm x 30 cm	74	73	74	78	299	74.75
30 cm x 35 cm	73	70	75	75	293	73.25
30 cm x 40 cm	71	73	74	74	292	73.00
SUBTOTAL	372	366	370	396	1504	75.20
ICPL 87119						
30 cm x 20 cm	90	94	95	90	369	92.25
30 cm x 25 cm	87	87	94	88	356	89.00
30 cm x 30 cm	89	80	90	86	345	86.25
30 cm x 35 cm	87	76	88	89	340	85.00
30 cm x 40 cm	86	77	82	82	327	81.75
SUBTOTAL	439	414	449	435	1737	86.25
GRAND TOTAL					3241	
GRAND MEAN						81.025

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	142.750	47.583			
Accession(A)	1	1357.225	1357.225	103.3714**	4.21	7.68
Planting Distance(B)	4	318.350	79.588	6.0617**	2.73	4.11
AxB	4	26.150	6.538	0.4979^{ns}	2.73	4.11
Error	27	354.500	13.1296			
TOTAL	39	2198.975	56.384			

**- Highly significant
^{ns} - Not significant

Coefficient of variation (%) = 4.47

Appendix Table 2. Average height at flowering (cm)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	44.66	45.76	48.66	55.50	196.58	49.15
30 cm x 25 cm	49.80	43.42	45.54	46.02	184.78	46.20
30 cm x 30 cm	55.34	40.48	41.00	41.36	178.18	44.55
30 cm x 35 cm	48.90	40.50	43.00	38.2	170.60	42.65
30 cm x 40 cm	42.40	42.00	43.00	43.00	170.40	42.60
SUBTOTAL	241.10	212.16	221.20	224.08	900.54	45.03
ICPL 87119						
30 cm x 20 cm	90.50	89.16	92.35	89.90	361.91	90.48
30 cm x 25 cm	77.62	93.42	97.20	89.48	357.72	89.43
30 cm x 30 cm	79.00	90.20	90.80	86.10	346.10	86.53
30 cm x 35 cm	85.20	60.74	97.64	76.80	320.38	80.10
30 cm x 40 cm	82.22	57.16	87.40	79.10	305.88	76.47
SUBTOTAL	414.54	390.68	465.39	421.38	1691.99	84.60
GRAND TOTAL					2592.53	
GRAND MEAN						64.82

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	100.136	33.379			
Accession(A)	1	15659.828	15659.828	267.886**	4.21	7.68
Planting Distance(B)	4	593.561	148.390	2.538^{ns}	2.73	4.11
AxB	4	118.704	29.676	0.508^{ns}	2.73	4.11
Error	27	1578.349	58.457			
TOTAL	39	18050.578	462.835			

**- Highly significant
^{ns} - not significant

Coefficient of variation (%) = 11.80

Appendix Table 3. Final height (cm)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	73.00	74.00	71.00	80.80	299.60	74.90
30 cm x 25 cm	74.60	73.00	72.20	75.80	295.60	73.90
30 cm x 30 cm	85.60	73.20	70.60	65.50	294.90	73.73
30 cm x 35 cm	74.40	61.20	66.40	82.00	284.00	71.00
30 cm x 40 cm	70.00	78.50	65.40	70.00	283.90	70.98
SUBTOTAL	378.40	359.60	345.60	374.10	1458.00	72.902
ICPL 87119						
30 cm x 20 cm	188.90	194.60	204.20	205.82	793.52	198.38
30 cm x 25 cm	173.40	196.10	204.80	205.30	779.60	194.90
30 cm x 30 cm	186.90	186.40	201.80	193.40	768.50	192.13
30 cm x 35 cm	199.60	171.10	183.80	213.20	767.70	191.93
30 cm x 40 cm	186.50	203.10	184.36	189.12	763.08	190.77
SUBTOTAL	935.30	951.30	978.96	1006.84	3872.40	193.62
GRAND TOTAL					5330.40	
GRAND MEAN						133.26

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	321.657	107.219			
Accession(A)	1	145733.184	145733.184	1549.068**	4.21	7.68
Planting Distance(B)	4	174.139	43.535	0.463^{ns}	2.73	4.11
AxB	4	27.952	6.988	0.074^{ns}	2.73	4.11
Error	27	2540.11	94.078			
TOTAL	39	148797.042	3815.309			

**- Highly significant
^{ns} - not significant

Coefficient of variation (%) = 7.28

Appendix Table 4. Days from planting to first harvest

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	119	116	111	129	475	118.75
30 cm x 25 cm	115	114	116	120	465	116.25
30 cm x 30 cm	114	113	114	118	459	114.75
30 cm x 35 cm	113	111	115	115	454	113.50
30 cm x 40 cm	111	113	114	114	452	113.00
SUBTOTAL	572	567	570	596	2305	115.25
ICPL 87119						
30 cm x 20 cm	140	144	144	140	568	142.00
30 cm x 25 cm	137	137	144	137	555	138.75
30 cm x 30 cm	139	130	140	137	546	136.50
30 cm x 35 cm	137	126	137	139	539	134.75
30 cm x 40 cm	137	126	130	130	523	130.75
SUBTOTAL	690	663	695	683	2731	136.55
GRAND TOTAL					5036	
GRAND MEAN						125.90

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	128.60	42.867			
Accession(A)	1	4536.90	4536.90	324.157**	4.21	7.68
Planting Distance(B)	4	336.10	84.025	6.004**	2.73	4.11
AxB	4	36.10	9.025	0.645^{ns}	2.73	4.11
Error	27	377.90	13.996			
TOTAL	39	5415.60	138.862			

**- Highly significant
^{ns} - not significant

Coefficient of variation (%) = 2.97

Appendix Table 5. Average number of lateral branches at flowering

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	5.75	5.80	7.20	8.40	27.15	6.79
30 cm x 25 cm	8.20	5.20	8.20	6.40	28.00	7.00
30 cm x 30 cm	9.00	6.60	6.80	8.00	30.40	7.60
30 cm x 35 cm	9.00	8.60	7.00	9.80	34.40	8.60
30 cm x 40 cm	9.20	8.60	9.80	8.80	36.40	9.10
SUBTOTAL	41.15	34.80	39.00	41.40	156.35	7.82
ICPL 87119						
30 cm x 20 cm	9.40	11.00	7.40	11.00	38.80	9.70
30 cm x 25 cm	7.80	12.00	9.60	12.00	41.40	10.35
30 cm x 30 cm	9.00	10.00	11.00	12.40	42.40	10.60
30 cm x 35 cm	10.60	11.00	11.20	12.60	45.40	11.35
30 cm x 40 cm	11.00	11.00	11.80	12.20	46.00	11.50
SUBTOTAL	47.80	55.00	51.00	60.20	214.00	10.70
GRAND TOTAL					370.35	
GRAND MEAN						9.26

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	10.892	3.631			
Accession(A)	1	83.088	83.088	55.914**	4.21	7.68
Planting Distance(B)	4	23.947	5.987	4.029*	2.73	4.11
AxB	4	0.968	0.242	0.163^{ns}	2.73	4.11
Error	27	40.109	1.486			
Total	39	159.004	4.077			

**- Highly significant
* - significant
^{ns} - not significant

Coefficient of variation (%) = 13.16

Appendix Table 6. Total number of harvests

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	5	5	5	5	20	5.00
30 cm x 25 cm	6	5	5	4	20	5.00
30 cm x 30 cm	5	5	5	3	18	4.50
30 cm x 35 cm	5	4	4	5	18	4.50
30 cm x 40 cm	4	4	4	4	16	3.20
SUBTOTAl	25	23	23	21	92	4.44
ICPL 87119						
30 cm x 20 cm	4	5	5	4	18	4.50
30 cm x 25 cm	5	3	5	5	18	4.50
30 cm x 30 cm	5	4	4	5	18	4.50
30 cm x 35 cm	4	4	3	3	14	3.50
30 cm x 40 cm	4	3	4	3	14	3.50
SUBTOTAL	22	19	21	20	82	4.27
GRAND TOTAL					174	
GRAND MEAN						4.27

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	2.100	0.700			
Accession(A)	1	2.500	2.500	6.188*	4.21	7.68
Planting Distance(B)	4	6.600	1.650	4.084*	2.73	4.11
AxB	4	1.000	0.250	0.619^{ns}	2.73	4.11
Error	27	10.900	0.404			
TOTAL	39	23.100	0.592			

* -Highly significant
^{ns} - not significant

Coefficient of variation (%) = 14.89

Appendix Table 7. Average number of pods produced per plant

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x20 cm	34.00	33.60	32.53	27.59	127.72	31.930
30 cm x 25 cm	40.40	34.80	30.93	27.83	133.96	33.490
30 cm x 30 cm	36.83	42.25	35.42	30.00	144.50	36.125
30 cm x 35 cm	40.05	34.81	38.05	36.48	149.39	37.348
30 cm x 40 cm	41.67	42.00	34.75	37.00	155.42	38.855
SUBTOTAL	192.95	187.46	171.68	158.90	710.99	35.550
ICPL 87119						
30 cm x 20 cm	42.00	40.00	30.00	26.24	138.24	34.560
30 cm x 25 cm	49.07	37.96	31.90	35.00	153.93	38.483
30 cm x 30 cm	52.32	50.40	33.00	23.55	159.27	39.818
30 cm x 35 cm	50.07	46.67	34.09	30.00	160.83	40.208
30 cm x 40 cm	50.00	48.00	35.00	27.95	160.95	40.238
SUBTOTAL	243.46	223.03	163.99	142.74	773.22	38.661
GRAND TOTAL					1484.21	
GRAND MEAN						37.106

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	1189.694	396.565			
Accession(A)	1	96.814	96.814	4.426*	4.21	7.68
Planting Distance(B)	4	205.268	51.317	2.346^{ns}	2.73	4.11
AxB	4	14.321	3.580	0.164^{ns}	2.73	4.11
Error	27	590.577	21.873			
TOTAL	39	2096.674	53.761			

* - significant
^{ns} – not significant

Coefficient of variation (%) = 12.60

Appendix Table 8. Average seed yield per plant (g)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	28.90	28.56	27.65	23.45	108.56	27.14
30 cm x 25 cm	34.34	29.58	26.29	23.66	113.87	28.47
30 cm x 30 cm	31.31	35.91	30.11	25.50	122.83	30.71
30 cm x 35 cm	34.04	29.59	32.34	31.02	126.99	31.75
30 cm x 40 cm	35.42	35.70	29.54	31.45	132.11	33.03
SUBTOTAL	164.01	159.34	145.93	135.08	604.36	30.22
ICPL 87119						
30 cm x 20 cm	33.60	32.00	24.00	20.99	110.59	27.65
30 cm x 25 cm	39.26	30.37	25.52	28.00	123.15	30.79
30 cm x 30 cm	41.86	40.32	26.40	18.84	127.42	31.86
30 cm x 35 cm	40.06	37.34	27.27	24.00	128.67	32.17
30 cm x 40 cm	40.00	38.40	28.00	22.36	128.76	32.19
SUBTOTAL	194.78	178.43	131.19	114.19	618.59	30.932
GRAND TOTAL					1222.95	
GRAND MEAN						30.58

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	784.819	261.606			
Accession(A)	1	5.062	5.062	0.365^{ns}	4.21	7.68
Planting Distance(B)	4	140.515	35.129	2.531^{ns}	2.73	4.11
AxB	4	10.607	2.652	0.191^{ns}	2.73	4.11
Error	27	374.827	13.882			
TOTAL	39	1315.830	33.739			

^{ns} - not significant Coefficient of variation (%) = 12.18

Appendix Table 9. Average seed yield per plot (kg)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	1.445	1.428	1.383	1.173	5.429	1.357
30 cm x 25 cm	1.374	1.183	1.052	0.946	4.555	1.139
30 cm x 30 cm	1.002	1.149	0.964	0.816	3.931	0.983
30 cm x 35 cm	0.953	0.829	0.906	0.869	3.557	0.889
30 cm x 40 cm	0.850	0.857	0.709	0.755	3.171	0.793
SUBTOTAL	5.624	5.446	5.014	4.559	20.643	1.032
ICPL 87119						
30 cm x 20 cm	1.680	1.600	1.200	1.050	5.530	1.383
30 cm x 25 cm	1.570	1.215	1.021	1.120	4.926	1.232
30 cm x 30 cm	1.340	1.290	0.845	0.603	4.078	1.020
30 cm x 35 cm	1.122	1.046	0.764	0.672	3.604	0.901
30 cm x 40 cm	0.960	0.922	0.672	0.537	3.091	0.773
SUBTOTAL	6.672	6.073	4.502	3.982	21.229	1.062
GRAND TOTAL					41.872	
GRAND MEAN						1.047

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	1.045	0.348			
Accession(A)	1	0.009	0.009	0.818^{ns}	4.21	7.68
Planting Distance(B)	4	1.747	0.437	39.727**	2.73	4.11
AxB	4	0.013	0.003	0.273^{ns}	2.73	4.11
Error	27	0.285	0.011			
TOTAL	39	3.094	0.079			

**- Highly significant
^{ns}- not significant

Coefficient of variation (%) = 10.02

Appendix Table 10. Computed yield (t/ha)

TREATMENT	REPLICATION				TOTAL	MEAN
	I	II	III	IV		
ICPL 87091						
30 cm x 20 cm	2.890	2.856	2.766	2.346	10.858	2.715
30 cm x 25 cm	2.748	2.366	2.104	1.892	9.110	2.278
30 cm x 30 cm	2.004	2.298	1.928	1.632	7.862	1.966
30 cm x 35 cm	1.906	1.658	1.812	1.738	7.114	1.779
30 cm x 40 cm	1.700	1.714	1.418	1.510	6.342	1.586
SUBTOTAL	11.248	10.892	10.028	9.118	41.286	2.065
ICPL 87119						
30 cm x 20 cm	3.360	3.200	2.400	2.100	11.060	2.765
30 cm x 25 cm	3.140	2.430	2.042	2.240	9.852	2.463
30 cm x 30 cm	2.680	2.580	1.690	1.206	8.156	2.039
30 cm x 35 cm	2.244	2.092	1.528	1.344	7.208	1.802
30 cm x 40 cm	1.920	1.844	1.344	1.074	6.182	1.546
SUBTOTAL	13.344	12.146	9.004	7.963	42.458	2.123
GRAND TOTAL					83.744	
GRAND MEAN						2.094

ANOVA TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE	COMPUTED F	TABULAR F 0.05	TABULAR F 0.01
Replication	3	3.626	1.209			
Accession(A)	1	0.034	0.034	0.548^{ns}	4.21	7.68
Planting Distance(B)	4	6.986	1.747	28.177**	2.73	4.11
AxB	4	0.055	0.014	0.226 ^{ns}	2.73	4.11
Error	27	1.674	0.062			
TOTAL	39	12.375	0.317			

** -Highly significant
^{ns} – not significant

Coefficient of variation (%) = 11.89