



Effect of Intercropping System and Nutrient Management Through Organic Sources on Yield Attributes and Yield of Pigeonpea Crop (*Cajanus cajan* L.) Under South Gujarat Condition

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted for two consecutive years at Rambhas farm, Hill Millet Research Station, Navsari Agricultural University, Waghai, Dangs, Gujarat during *kharif* season of 2022-23 and 2023-24 to study the effect of intercropping system and nutrient management through organic

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sources on yield attributes and yield of pigeonpea crop (*Cajanus cajan* L.) under south Gujarat condition. The experiment was laid out in randomized block design with factorial concept having two factors with twenty-four treatment combinations and three replications. Yield attributes viz., number of pods per plant, pod length and number of seeds per pod of pigeonpea were recorded significantly higher under treatment I₄ (sole pigeonpea) during both the years and in pooled analysis which being at par with treatment I₃ (pigeonpea + drilled paddy). Significantly higher seed yield and stalk yield of pigeonpea were recorded in sole pigeonpea (I₄) during both years of study and in pooled analysis. Significantly higher number of pods per plant, pod length and number of seeds per pod, seed yield and stalk yield of pigeonpea were noted with application of 10 t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap (N₄) which remained statistically at par with treatment N₆ (5 t/ha vermicompost + Three spray of 2 % Enrich banana pseudostem sap) and N₁ (10 t/ha FYM) during both the years and in pooled analysis.

Keywords: Nutrient management; organic; pigeonpea growth; yield; intercropping system.

1. INTRODUCTION

“Worldwide cultivable land has been decreased due to increase of global population and industrialization, while global demand for food is increasing. Modern industrial agriculture based on use of huge quantity of chemicals has adverse effect on human and animal health, agro-ecosystem and quality of agricultural products. Furthermore, mono culture has resulted in increased yields, but at the cost of environmental well-being. In contrast, sustainable agriculture aims to simulate nature with holistic approach as the pattern for creating agricultural systems by nurturing diversity, integrating plants and animals into a diverse landscape for gratification of the human requirements for today and future. Agricultural production can only be sustained on a long term basis if the land, water and forests on which it is based are not degraded further” (Zaman et al., 2017). Creation of multiplicity and its effective execution for sustainable agriculture are very important and intercropping suggests simulating nature’s principle of diversity on crop lands. Thus, intercropping can be evaluated as pro-ecological approach of raising crops, supporting above and below ground bio-diversity and compatible crop husbandry with the aims of sustainable agriculture.

Pigeonpea (*Cajanus cajan* L. Mill sp.) is important food legume of semi-arid tropics of Asia and Africa. It occupies a prime niche in sustainable farming systems of small and marginal rainfed farmers. It occupies a prominent place in Indian rainfed agriculture. The year 2016 was declared as the international year of pulses by the sixty eighth session of the United Nations General Assembly intending to make people more aware of the nutritional value of pulses,

their contribution to sustainability and more reliable food. Also the year should promote production of pulses worldwide, improve crop rotation and improve trade in pulses. Pigeonpea is an integral component in various agro ecologies of the country, mainly inter cropped with cereals, pulses, oilseeds and millets. It is mainly consumed as dry split dal throughout the country, besides several other uses of various parts of pigeonpea plant. Enhancing the productivity of the crop assumes specific significance in India mainly to combat protein malnutrition as it is the main source of protein to the predominant vegetarian population.

“Gujarat is one among the important states in the country cultivating pigeon pea which contributes 9.64 per cent to area and 7.86 per cent to the production. Pigeon pea provides protein rich food, firewood and income for resource poor small farmers. The crop owes its popularity to the fact that being a leguminous plant; it is capable of fixing atmospheric nitrogen and thereby restores nitrogen content in the soil. Its deep root system helps in extracting nutrients and moisture from deeper soil layers thus making it suitable for rainfed condition. Pigeon pea is a long duration pulse crop mainly being cultivated in poor soils under rainfed condition and the crop has capacity to thrive well under low input and adverse condition” (Kumar and Paslawar, 2017).

“Despite a decrease in both cultivation and consumption of millets in recent decades, these grains remain crucial for the food security and nutrition of many people in India. A thorough analysis of production trends from 1968-69 to 2022-23 indicates a significant reduction in millet cultivation across the country” (Dhaniya et al., 2024). “Millets are a group of small-seeded

grasses that have been cultivated for a long time in India. Millets commonly consumed in India include pearl millet (bajra), sorghum (jowar), finger millet (madua), foxtail millet (kangni), little millet (kutki), barnyard millet (jhangora), kodo millet (kodra) and proso millet. They are called as Nutri-cereals because they are rich in key nutrients like phosphorus, potassium, magnesium, manganese, iron and niacin. Protein, fibre, important amino acids like methionine, lecithin and vitamin E are also found in them. In addition to their nutritional value, millets play a key role in sustainable agriculture and biodiversity conservation.

In Intercropping system, more biomass yield is obtained and crops utilize greater quantity of CO₂ and thus atmospheric pollution is reduced to some extent. Further, renewable solar energy is more utilized by crop mixture for biomass production. Combination of shallow and deep rooted crops are often chosen in intercropping system leading to efficient utilization of soil nutrients by crops from different layers. Combination of shallow and deep rooted crop is advantageous in intercropping not only for utilizing better use of nutrients, but efficient use of soil moisture. Experimental results indicated that finger millet may be benefited by deep rooted pigeon pea by bio-irrigation when *biofertilizer* inoculation was done with *arbuscular* mycorrhizal fungi (AMF) and plant growth-promoting rhizobacteria (PGPR) under dry land conditions" (Saharan et al., 2018).

"During recent time, organic agriculture has emerged as an economically viable option of farming because of growing demand of the organic products worldwide. In addition to that, organic agriculture has enough potential to assure agricultural sustainability. Organic farming is a holistic system designed to optimize the productivity and fitness of diverse communities in the agro ecosystem including living organisms viz. soil organisms, plants, livestock and human being etc. organic farming plays a vital role in maintaining biological diversity, decrease soil and ground water contamination, optimize biological productivity" (Watson et al., 2002), "maintain long-term soil fertility by optimizing conditions for biological activity in the soil" (Ramesh et al., 2005). "The success of organic agriculture is lying on some cultural practices of which system approach, crop diversification, inclusion of legumes in cropping system, restoration of soil fertility and reduction in degradation of natural resources and stability in

production are important. An environmentally sustainable agricultural system, such as organic agriculture, will be able to assist in maintaining a resource balance, preventing over-exploitation of resources, and safeguarding the country's soil nutritional quality and biodiversity" (Lokesha, 2023).

Under these circumstances, intercropping can play a vital role in organic agriculture for sustainable farm output and this experiment has focused on beneficial aspects of intercropping system in befitting organic agriculture. Considering all facts mentioned above, field experiment was therefore undertaken to evaluate the effect of intercropping system and nutrient management through organic sources on yield attributes and yield of pigeonpea crop (*Cajanus cajan* L.) under south Gujarat condition.

2. MATERIALS AND METHODS

The investigation on "effect of intercropping system and nutrient management through organic sources on yield attributes and yield of pigeonpea crop (*Cajanus cajan* L.) under south Gujarat condition" was planned during the kharif season of the year 2022-23 and 2023-24.

The experiment was laid out in randomized block design with factorial concept having two factors with twenty-four treatment combinations and three replications; first factor included the treatments of intercropping system i.e. I₁ (Pigeonpea + Finger millet at 1:2 row ratio), I₂ (Pigeonpea + Little millet at 1:2 row ratio), I₃ (Pigeonpea + Drilled Paddy at 1:2 row ratio) and I₄ (Sole Pigeonpea) and second factor included nutrient management practices through organic sources; i.e. N₁ (10 t/ha FYM), N₂ (5 t/ha biocompost), N₃ (5 t/ha vermicompost), N₄ (10 t/ha FYM + three spray of 2 % enrich banana pseudostem sap), N₅ (5 t/ha biocompost + three spray of 2 % enrich banana pseudostem sap) and N₆ (5 t/ha vermicompost + three spray of 2 % enrich banana pseudostem sap). The experiment was conducted for two consecutive years with same randomization on same piece of land.

2.1 Preparation of Land and Layout

To bring the field into good tilth for proper germination and establishment of the crop, the experimental field was cultivated in both the direction by tractor cultivator followed by harrowing and smoothened by planking after

removal of residues of the previous crop along with weeds. Thereafter the experiment was laid out and plots were marked as per the spacing with the help of iron marker. Bunds were prepared manually to separate the experimental units and replications. Irrigation channels were prepared by V-ditcher and furrows were opened manually at 120 and 30 cm spacing for pigeonpea and intercrops, respectively. Composite soil sample were taken for initial physical and chemical properties analysis of soil of experiment.

2.2 Application of Organic Manures

The desired quantity of solid organic manures (FYM, bio compost, and vermicompost) and liquid organic manure (NOVEL) was worked out and they were applied to the crop in accordance with the treatments and uniformly spread and mixed in that particular plot.

2.3 Seed Rate, Seed Treatment and Sowing

The seed of pigeonpea, finger millet, little millet and drilled paddy were sown at same time during both the years. On the basis of recommended seed rate, i.e. 15 kg/ha for pigeonpea, 5 kg/ha for finger millet, 2 kg/ha for little millet and 60 kg/ha for drilled paddy required quantity of seeds were calculated on area basis as per treatments for respective plots. Before sowing, seeds of pigeonpea (GT 105) were inoculated with biofertilizer (*Rhizobium* + PSB @ 10 ml each/kg seed) during both the year, i.e. 2022 and 2023. While, GN 8 variety of finger millet, Guj. Navsari Vari-3 variety of little millet and GR 16 variety of drilled paddy were treated with biofertilizer (*Azotobacter* + PSB @ 10 ml each/kg seed) during crop season, 2022 and 2023. The inoculated seeds were dried under shade and then seeds were sown manually in previously manured furrows in each plot to depth of 4-5 cm for pigeonpea and 2-3 cm for intercrops. Pigeonpea was sown at row spacing of 120 cm and two rows of intercrops were sown at row spacing of 30 cm in between two rows of pigeonpea and then seeds were cover with soil. Periodical observations were recorded for the assessment of effect of treatments on growth and development of pigeonpea and intercrops. While, samples for the observations that required destructive sampling were collected from the ring line and not from the net plot area and data obtained from the experiment was statistically analyzed by standard statistical methods.

3. RESULTS AND DISCUSSION

3.1 Effect of Intercropping on Yield Attributes

Number of pods per plant, pod length and number of seeds per pod were recorded significantly higher under treatment I₄ (sole pigeonpea) during both the years and in pooled analysis (Table 1). The higher pod length and number of seeds per pod of pigeonpea under sole pigeonpea might be due to reduced cereal-legume competition as the plants have to face neither nutrient nor moisture stress due to the absence of intercrops competition in sole cropping and because of this proper utilization of moisture, nutrient, light and space available to pigeonpea crop for growth and development which reflects in higher number of seeds per pod of pigeonpea (Pal et al. 2016).

3.2 Effect of Intercropping on Yield

Significantly higher seed and stalk yield of pigeonpea was recorded in sole pigeonpea (I₄) during both years of study and in pooled analysis. The higher seed yield of pigeonpea under sole pigeonpea (I₄) might be due to overall better plant growth as reflected from higher values of different growth and yield attributes viz., plant height, number of branches per plant, pod length and number of seeds per pod due to competition free environment and effective utilization of all the resources. Similar results were also reported by Naik et al. (2017), Biradar et al. (2020) and Shiyal et al. (2023). The higher stalk yield under sole pigeonpea might be due to lack of competition because of intercrops, as the plants have to face neither nutrient nor moisture stress condition in sole cropping which reflects in improvement of growth and yield attributes of pigeonpea crop and finally in terms of stalk yield. Similar results were also reported by Vaja & Pankhania (2023).

3.3 Effect of Nutrient Management on Yield Attributes

Results showed significant influence of nutrient management treatments on yield attributing characters of pigeonpea. Significantly higher number of pods per plant, pod length and number of seeds per pod were noted with application of 10 t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap (N₄) which remained statistically at par with treatment N₆ (5 t/ha vermicompost + Three spray of 2 % Enrich banana pseudostem sap) and N₁ (10 t/ha FYM)

during both the years and in pooled analysis. The increase in this yield attribute seems to have been brought about by adequate nutrient supply promotes photosynthetic activity and increases the production of assimilates such as sugars, which are transported to the developing pod. This might be also due to good growth of plant because of availability of nutrients leading to more accumulation of carbohydrates and proteins and their translocation to respiratory organs (Bana et al. (2016).

3.4 Effect of Nutrient Management on Yield

Significantly higher seed yield and stalk of pigeonpea was obtained under treatment N₄ (10

t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap) which remained statistically at par with treatment N₆ (5 t/ha vermicompost + Three spray of 2 % Enrich banana pseudostem sap) and treatment N₁ (10 t/ha FYM) over other treatments during both the years and in pooled analysis. The significant increase in seed yield of pigeonpea with this treatment may be due to adequate supply of essential elements which facilitated better growth and development of pigeonpea and higher values of yield attributes viz., pod length, number of seeds per pod, test weight ultimately resulted in higher seed yield of pigeonpea. The lowest seed yield and stalk yield of pigeonpea were recorded by 5 t/ha biocompost (N₂) during years 2022 and 2023 as

Table 1. Number of pods per plant, pod length and number of seed per pod of pigeonpea crop as influenced by intercropping system and nutrient management through organic sources

Treatment	Number of pods per plant			Pod length (cm)			Number of seeds per pod		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
A) Intercropping system (I)									
I ₁ : Pigeonpea + Finger millet (1:2)	233.8	228.3	231.1	5.23	5.07	5.15	4.27	4.13	4.20
I ₂ : Pigeonpea + Little millet (1:2)	237.1	241.7	239.4	5.58	5.60	5.59	4.29	4.26	4.27
I ₃ : Pigeonpea + Drilled Paddy (1:2)	249.4	249.8	249.6	5.72	5.71	5.71	4.48	4.64	4.56
I ₄ : Sole Pigeonpea	265.9	275.9	270.9	5.84	5.79	5.82	4.82	4.97	4.89
SEm ±	6.29	6.27	4.44	0.11	0.13	0.09	0.12	0.12	0.08
CD (P=0.05)	17.92	17.84	12.47	0.33	0.37	0.24	0.34	0.33	0.24
B) Nutrient Management through Organic Sources (N)									
N ₁ : 10 t/ha FYM	271.4	273.9	272.6	5.87	5.83	5.85	4.70	4.71	4.70
N ₂ : 5 t/ha Biocompost	173.9	178.5	176.2	4.62	4.31	4.46	3.48	3.55	3.52
N ₃ : 5 t/ha vermicompost	218.8	238.6	228.7	5.49	5.34	5.41	4.07	4.12	4.09
N ₄ : 10 t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap	284.5	280.0	282.3	6.03	6.14	6.09	5.38	5.28	5.33
N ₅ : 5 t/ha Biocompost + Three spray of 2 % Enrich banana pseudostem sap	249.9	241.6	245.7	5.62	5.59	5.61	4.27	4.39	4.33
N ₆ : 5 t/ha vermicompost + Three spray of 2 % Enrich banana pseudostem sap	280.9	279.5	280.2	5.86	5.84	5.85	4.89	4.93	4.91
SEm ±	7.71	7.68	5.44	0.14	0.16	0.11	0.15	0.14	0.10
CD (P=0.05)	21.94	21.85	15.28	0.40	0.45	0.30	0.42	0.41	0.29
INTERACTION EFFECT (A × B)									
SEm ±	15.42	15.35	10.88	0.28	0.32	0.21	0.30	0.29	0.21
CD (P=0.05)	S	NS	30.55	NS	NS	NS	NS	NS	NS
CV (%)	10.83	10.68	10.76	8.70	9.99	9.36	11.5	11.1	11.3

Table 2. Seed yield and stalk yield of pigeonpea crop as influenced by intercropping system and nutrient management through organic sources

Treatment	Seed yield (kg/ha)			Stalk yield (kg/ha)		
	2022	2023	Pooled	2022	2023	Pooled
A) Intercropping system (I)						
I ₁ : Pigeonpea + Finger millet (1:2)	1398	1496	1447	4178	4283	4230
I ₂ : Pigeonpea + Little millet (1:2)	1531	1541	1536	4215	4345	4280
I ₃ : Pigeonpea + Drilled Paddy (1:2)	1571	1548	1559	4536	4541	4538
I ₄ : Sole Pigeonpea	1750	1717	1734	4975	5057	5016
SEm ±	50.31	47.41	34.75	108.3	94.3	72.1
CD (P=0.05)	143.3	135.1	97.6	308.7	268.6	202.5
B) Nutrient Management through Organic Sources (N)						
N ₁ : 10 t/ha FYM	1628	1600	1614	4388	4518	4453
N ₂ : 5 t/ha Biocompost	1285	1484	1384	4297	4284	4291
N ₃ : 5 t/ha vermicompost	1525	1488	1507	4200	4449	4324
N ₄ : 10 t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap	1707	1742	1724	4990	4952	4971
N ₅ : 5 t/ha Biocompost + Three spray of 2 % Enrich banana pseudostem sap	1535	1465	1500	4236	4505	4370
N ₆ : 5 t/ha vermicompost + Three spray of 2 % Enrich banana pseudostem sap	1695	1673	1684	4746	4631	4688
SEm ±	61.64	58.09	42.56	132.7	115.5	88.3
CD (P=0.05)	175.6	165.5	119.5	378.1	329.1	248.0
INTERACTION EFFECT (A × B)						
SEm ±	123.3	116.1	85.1	265.4	231.0	176.6
CD (P=0.05)	NS	NS	S	NS	NS	S
CV (%)	13.66	12.77	13.22	10.27	8.78	9.54

well as in pooled analysis may be due to insufficient supply of nutrient for proper growth and development of pigeonpea crop. The increment in stalk yield of pigeonpea reported with these treatments might be due to soil application of organic manure alongwith foliar spray of organics at peak growth stage satisfied the nutrient requirement of crop resulted in higher plant height and higher number of branches per plant ultimately improved the stalk yield of pigeonpea. The results obtained in this experiment were in line with the findings of Seth and Kumar (2019) and Sanjay and Suganya (2024).

4. CONCLUSION

In light of results obtained from the two-year experimentation, it can be concluded that Drilled paddy or little millet as intercrop in *kharif* pigeonpea at 1:2 row proportion found more feasible for higher yield and profit than finger millet under south Gujarat condition and application of 10 t/ha FYM + Three spray of 2 % Enrich banana pseudostem sap to pigeonpea-nutri cereals (1:2 row ratio) intercropping system for profitable yield.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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