Current Horticulture **13**(4): 67–72, October–December 2025
DOI: 10.5958/2455-7560.2026.00010.2
Received: 10 October 2024; Revised: 17 November 2025; Accepted: 05 December 2025

Effect of spacing and foliar spray of novel (banana pseudostem -based organic liquid nutrients) on cowpea (*Vigna unguiculata*) production under mango-based agroforestry system

Mehfuza Patel[1], M. B. Tandel[1], S. M. Patel1, M. K. Desai[1], M. P. Ahir[2] and Y. A. Garde[3]

Department of Horticulture, SKN College of Agriculture (SKN Agriculture University), Jobner (Jaipur), Rajasthan, India

Abstract

The study was undertaken to check economic possibility of cowpea [Vigna unguiculata (L.) Walp.] under mango-based agroforestry system with various spacings and foliar sprays of novel (banana pseudostem - based organic liquid nutrients) during 2021-22 at ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India. The trial was framed with eight treatment combinations of two factors which contain two levels of spacings and four foliar sprays of fertilizers (after initiation of flowering and 15 days after first spray) under mango orchard and open growing condition in a randomized block design with factorial concept consisting of three replications. Under mango-based agroforestry system and in open condition, highest net realization (₹ 1,57,437/ha and ₹ 1,89,259/ha, respectively) and BCR (2.58 and 1.98, respectively) were obtained in S2F4 [45 cm × 45 cm spacing and novel plus (banana pseudostem - based organic liquid nutrients + botanical pesticides) sprayed at 1 %].

Key words: Economics, Mango, Cowpea, Agroforestry system, BCR

A number of fruit-based agroforestry systems have been developed in almost all the regions of India (Kumar and Chaturvedi, 2017). Integration of annual crops with fruit trees yields multiple outputs that ensures production and income generation in a sustainable manner (Randhawa, 1990). Fruit-based agroforestry system integrates cultivation of vegetable and fruit crops and silvi component. Nowadays, use of organic fertilizers in vegetable production is also increasing by researchers and farmers. Thus, there is a need to generate the information regarding tree-crop interaction with use of organic fertilizers on cowpea under commercial fruit tree canopies. Therefore, study was intended to investigate the effect of various spacing and foliar sprays of novel (banana pseudostem- based organic liquid nutrients) on economics of cowpea under mango-based agroforestry system.

MATERIALS AND METHODS

The field trail was conducted during 2021-22 at ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat (for mango-based agroforestry system) and College Farm, N. M. College of Agriculture, NAU, Navsari (for open condition). Navsari is geographically situated at latitude of 20° 57' N and longitude of 72° 54' E and at an altitude of about 10 m above the mean sea-level. The soil of south Gujarat is locally known as 'black cotton soil'. The experimental soil was deep moderately drained clayey soils classified as deep black soil predominated with montmorillonite clay mineral by its origin. It is medium in fertility.

The experiment comprised eight treatment combinations of two factors which contains two levels of spacing, *viz.* S_1: 30 cm x 30 cm and S_2: 45 cm x 45 cm and four levels of foliar spray of novel organic liquid fertilizers, *viz.* F_1: control, F_2: novel @ 1 % (banana pseudostem based organic liquid nutrients), F_3: novel prime @ 1 % (banana pseudostem-based organic liquid nutrients + botanical fungicide) and F_4: novel plus @ 1 % (banana pseudostem-based organic liquid nutrients + botanical pesticides) with three replications and analyzed as per randomized block design with factorial concept (Panse and Sukhatme, 1985). The same treatments were applied in both growing conditions, *i.e.* under mango-based agroforestry system and open condition.

Cowpea variety Anand was grown under 10 years old mango orchard planted at 9 m x 9 m spacing. For applying recommended dose of N, P, K (20:40:00 kg/ha) to cowpea, commercial grade of neem coated urea and di-ammonium phosphate (DAP) were used. Novel plus and novel prime (banana pseudostem-based organic liquid nutrients, *i.e.* patented product of NAU) were procured from banana pseudostem unit, soil and water management research unit, NAU, Navsari. Different novel solutions collected,

Corresponding author : tandelmb@nau.in
[2] Horticulture Polytechnic, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat
[3] Department of Agricultural Statistics, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat

were considered as 100% in concentration and used to prepare the required solution according to treatments. Various cultural operations, *viz*. tillage, application of FYM, rotavator, layout, bed preparation, fertilizer application (½ N + full P), application of pre-emergence weedicide, sowing of seeds, irrigation, weeding, hoeing, remaining (½ N) fertilizer application was carried out in both the growing conditions.

For the purpose of economic analysis, yield parameters of cowpea were recorded at each picking and then total of all pickings were averaged out. Various yield and economic parameters were calculated as per the procedure given below: Total weight of pods harvested from the randomly selected and tagged five plants in each net plot was recorded in each picking and summed up. The average weight of pods per plant was multiplied by number of plants in each net plot of each replication. Then it was converted according to the size and number of plants in gross plot. Then, yield per plot was converted into the yield in tonne per hectare for each plot in each replication.

To obtain marketable yield, unmarketable yield (affected by insect and pest) was subtracted from total yield. The cost of cultivation for each treatment was worked out by considering the cost of all operations right from the preparation of land to the harvesting of crop. The price of cowpea vegetable was accounted on the basis of prevailing market rate. The cost of fertilizers is taken as form the current market price. The gross realization in terms of rupees per hectare was worked out on the basis of marketable crop yield. The prevailing market price of inputs and outputs was accounted to calculate the gross returns.

The net returns per hectare was calculated by deducting the cost of cultivation from gross returns per hectare. The benefit cost ratio (BCR) was calculated by an incremental cost of different treatment and benefit obtain through an increase in production due to the respective treatment.The benefit cost ratio was calculated as per following formula:

$$Benefit{:}cost\ ratio = \frac{Net\ realization}{Cost\ of\ cultivation}$$

RESULTS AND DISCUSSION

The maximum total yield (3.73, 4.61 and 4.17 tonnes/ha) respectively in 2021, 2022 and pooled analysis and marketable yield (3.50, 4.36 and 3.93 tonnes/ha, respectively) was obtained in treatment combination of S_2F_4 (45 cm x 45 cm; novel plus @ 1 % (banana pseudostem based organic liquid nutrients + botanical pesticides) under mango-based agroforestry system (Table 1). In open condition, maximum total yield (9.21, 10.75 and 9.98 tonnes/ha) respectively in 2021, 2022 and pooled analysis and marketable yield (8.76, 10.24 and 9.50 tonnes/ha, respectively) were also obtained in the same treatment combination S_2F_4 (45 cm x 45 cm; novel plus @ 1 % (banana pseudostem based organic liquid nutrients + botanical pesticides). Among different treatment combinations, maximum gross realization was obtained from treatment combination S_2F_4 (₹ 2,82,850/ ha), followed by S_2F_3 (₹ 2,77,100/ha) under mango-based agroforestry system (Table 2). However, minimum gross realization was received from treatment combination of S_1F_1 (₹ 2,41,800/ha).

In open condition, treatment combination S_2F_4 gave highest gross realization (₹ 2,85,000/ ha), followed by treatment combination of S_1F_4 (₹ 2,75,750/ha). The lowest gross realization (₹ 2,03,450/ha) was received from treatment combination of S_1F_1 (30 cm x 30 cm; control) (Table 2). Under mango-based agroforestry system, highest net realization of ₹ 1,57,437/ha was registered in treatment combination of S_2F_4, followed by S_2F_3 (₹ 1,51,687/ha). The lowest net return was obtained with S_1F_1 (₹ 1,14,223/ha).

In open condition, maximum net realization (₹ 1,89,259/ha) on account of cowpea pod production was obtained with treatment combination S_2F_4, followed by S_2F_3 (₹ 1,76,309/ha). However, minimum net return of ₹ 1,03,381/ha was earned from S_1F_1.

Under mango-based agroforestry system, treatment combination of S_2F_4 registered maximum BCR (2.58), followed by S_2F_3 (2.46). However, minimum benefit: cost ratio (BCR) (1.66) was obtained in S_1F_1 treatment combination.

In open condition, highest BCR (1.98) was obtained in treatment combination of S_2F_4 (45 cm x 45 cm spacing and novel plus @ 1 %), followed by S_2F_3 (45 cm x 45 cm spacing and novel prime @ 1 %) with BCR (1.84). The lowest BCR (1.03) was found in S_1F_1 (30 cm x 30 cm spacing and without foliar spray of novel fertilizers). The higher yield, gross realization, net realization and benefit: cost ratio were observed with wider spacing in comparison to closer spacing under mango-based agroforestry system as well as in open condition might be due to less competition for light, moisture and nutrients associated with wider spacing and thereby having an edge in producing more reproductive parts when compared to higher plant population density (Karukonda *et al*., 2020). Similar trend of result is also reported by Shukla and Singh (2021) in cluster bean (*Cyamopsis tetragonoloba*).

The plants which received foliar spray of banana pseudostem-based organic liquid nutrients had produced more yield than those without foliar application. The increase in yield might be due to supply

Table 1: Yield of cowpea as affected by spacing and foliar spray of fertilizers under mango-based agroforestry system and in open condition

Treatment	2021		2022		Pooled	
	Total yield (tonnes/ha)	Marketable yield (tonnes/ha)	Total yield (tonnes/ha)	Marketable yield (tonnes/ha)	Total yield (tonnes/ha)	Marketable yield (tonnes/ha)
Cowpea cultivated under mango						
S_1F_1	2.35	2.17	3.17	2.96	2.76	2.56
S_1F_2	2.56	2.37	3.16	2.94	2.86	2.65
S_1F_3	2.80	2.60	3.44	3.21	3.12	2.91
S_1F_4	3.25	3.04	4.02	3.76	3.64	3.40
S_2F_1	2.59	2.41	3.32	3.11	2.96	2.76
S_2F_2	3.18	2.99	3.83	3.61	3.51	3.30
S_2F_3	3.53	3.32	4.39	4.15	3.96	3.74
S_2F_4	3.73	3.50	4.61	4.36	4.17	3.93
Cowpea cultivated in open condition						
S_1F_1	6.35	6.00	7.97	7.56	7.17	6.78
S_1F_2	7.09	6.71	8.93	8.49	8.01	7.60
S_1F_3	7.95	7.55	9.90	9.44	8.93	8.50
S_1F_4	9.08	8.65	10.25	9.73	9.67	9.19
S_2F_1	6.95	6.58	8.95	8.52	7.95	7.55
S_2F_2	7.77	7.37	9.43	8.97	8.60	8.17
S_2F_3	8.74	8.32	10.29	9.82	9.52	9.07
S_2F_4	9.21	8.76	10.75	10.24	9.98	9.50

Table 2: Economics of cowpea as affected by spacing and foliar spray of fertilizers under mango-based agroforestry system and open condition

Treatment	Marketable yield (tonnes/ ha)	Fixed cost (₹/ha)	Variable cost (₹/ha)	Total cost of cultivation (₹/ha)	Gross realization (₹/ha)	Net realization (₹/ha)	BCR	BCR (including mango)
Mango								
Mango	5.50			76825	165000	88175	1.15	
Cowpea under mango-based system								
S_1F_1	2.56	43952	6800	50752	76800	26048	0.51	1.66
S_1F_2	2.65	43952	7986	51938	79550	27612	0.53	1.68
S_1F_3	2.91	43952	8236	52188	87200	35012	0.67	1.82
S_1F_4	3.40	43952	8236	52188	102000	49812	0.95	2.10
S_2F_1	2.76	43952	3200	47152	82800	35648	0.76	1.91
S_2F_2	3.30	43952	4386	48338	98900	50562	1.05	2.20
S_2F_3	3.74	43952	4636	48588	112100	63512	1.31	2.46
S_2F_4	3.93	43952	4636	48588	117850	69262	1.43	2.58
Cowpea in open condition								
S_1F_1	6.78	86469	13600	100069	203450	103381	1.03	-
S_1F_2	7.60	86469	15972	102441	228100	125659	1.23	-
S_1F_3	8.50	86469	16472	102941	254850	151909	1.48	-
S_1F_4	9.19	86469	16472	102941	275750	172809	1.68	-
S_2F_1	7.55	86469	6400	92869	226450	133581	1.44	-
S_2F_2	8.17	86469	8772	95241	245200	149959	1.57	-
S_2F_3	9.07	86469	9272	95741	272050	176309	1.84	-
S_2F_4	9.50	86469	9272	95741	285000	189259	1.98	-

Selling rate of cowpea @ ₹ 30.0/kg Selling rate of mango @ ₹ 30.0/kg

Table 3: Cost of cultivation of cowpea under mango orchard and open condition (₹/ha)

Description			Rate	Cost (₹)	
	Under Mango	Open condition		Under mango [cultivated area of cowpea is 6,000 m²]	Open condition [cultivated area of cowpea is 10,000 m²]
Preparatory tillage					
Ploughing by tractor with cultivator	2 x 4 = 8 hrs	2 x 8 = 16 hrs	@ ₹ 300/hr	2400	4800
Ploughing by tractor with Rotavator	2.5 hrs	5 hrs	@ ₹ 650/hr	1625	3250
			Total	**4025**	**8050**
Layout and sowing					
Layout, Preparation of beds and channel	5 labours for 2 days	10 labours for 2 days	@ ₹ 268/ labour/day	2680	5360
Seed sowing	10 labours for 1 day	20 labours for 1 day	@ ₹ 268/ labour/day	2680	5360
Gap filling	3 labours for 1 day	5 labours for 1 day	@ ₹ 268/ labour/day	804	1340
			Total	**6164**	**12060**
Manures and fertilizers					
FYM	7.5 tonnes/ha	15 tonnes/ha	@ ₹ 800/ tonne	6000	12000
DAP	43.5 kg	87 kg	@ ₹ 27/ kg	1175	2349
Urea	6.61 kg	13.21 kg	@ ₹ 5.9/ kg	39	78
Expenditure on manures application	5 labours for 1 day	10 labours for 1 day	@ ₹ 268/ labour/day	1340	2680
Expenditure on fertilizer application	2 labours for 1 day	3 labours for 1 day	@ ₹ 268/ labour/day	536	804
			Total	**9090**	**17911**
Intercultural operations					
Weeding	5 labours 3 times	10 labours 3 times	@ ₹ 268/ labour/day	4020	8040
			Total	**4020**	**8040**
Irrigation application					
Irrigations	10 (@ 10 hr for 1 ha)	10 (@ 20 hr for 1 ha)	@ ₹ 40/hour	4000	8000
Irrigation application charges	13 labours	25 labours	@ ₹ 268/ labour/day	3484	6700
			Total	**7484**	**14700**
Plant protection					
Labour for spraying	(2 labours spray^{-1}) 2 days	(2 labours spray^{-1}) 3 days	@ ₹ 268/ labour/day	1072	1608
Pendimethalin 30.0 % EC	1 spray 500 ml ha^{-1}	1 spray 1 litre ha^{-1}	@ ₹ 230/ litre	115	230
Imidacloprid 17.8 % SL	2 spray of 75 ml ha^{-1}	2 spray of 150 ml ha^{-1}	@ ₹ 1,750/ litre	263	525
			Total	**1450**	**2363**
Harvesting and marketing					
Harvesting	(4 labours for 1 day) 7 times	(8 labours for 1 day) 7 times	@ ₹ 268/ labour/day	7504	15008
Uprooting the plants	5 labours for 1 day	10 labours for 1 day	@ ₹ 268/ labour/day	1340	2680
			Total	**8844**	**17688**
			Total fixed cost	**41077**	**80812**
			Interest on working capital @ 7 %	**2875**	**5657**
			Gross total	**43952**	**86469**

of more nutrients at critical stage (flowering and fruit setting). Which ultimately resulted in higher yield, net realization and BCR. The probable reason behind higher yield under novel plus foliar spay might be due to higher content of major and micro nutrients as compared to others (Desai *et al.*, 2016 and Champaneri *et al.*, 2021). Present findings are similar with the results of Kavitha *et al.* (2019), Mandaliya (2021) and Rabade *et al.* (2022) in cowpea; Selvarani *et al.* (2021) and Akshika Bhawariya *et al.* (2022) in cluster bean (*C. tetragonoloba*), Meena *et al.* (2017) in urd bean (*Vigna mungo*), Parikh *et al.* (2020) in turmeric, Sowmya *et al.* (2024) in garlic, Dongre and Choudhary (2024) in guava and Bhatt *et al.* (2025) in potato.

Table 4: Photosynthetically active radiation (µ mol/m²/s) under mango-based agroforestry system and open condition

Treatment	Mango-based agroforestry system			Open condition		
	S_1: 30 cm x 30 cm	**S_2:** 45 cm x 45 cm	**Mean**	**S_1:** 30 cm x 30 cm	**S_2:** 45 cm x 45 cm	**Mean**
F_1: Control	358.24	358.09	**358.16**	1352.58	1307.53	**1330.05**
F_2: Novel (1 %)	344.55	329.81	**337.18**	1313.24	1331.87	**1322.55**
F_3: Novel prime (1 %)	307.45	323.46	**315.45**	1333.33	1286.60	**1309.97**
F_4: Novel plus (1 %)	335.78	353.00	**344.39**	1322.41	1277.06	**1299.73**
Mean	**336.50**	**341.09**		**1330.39**	**1300.76**	
	S	**F**	**SF**	**S**	**F**	**SF**
S.Em. ±	7.77	10.99	15.54	19.61	27.74	39.23
C.D. at 5 %	NS	NS	NS	NS	NS	NS
C.V. %		11.24			7.30	

However, net realization and benefit: cost ratio of cowpea was recorded higher when they were grown in open condition as compared to under mango-based agroforestry system (Table 2). The probable reason for highest net realization and BCR under open growing condition might be due to higher availability of photosynthetically active radiation in open growing condition as compared to mango-based agroforestry system (Table 4). The lower yield under mango-based agroforestry system was probably due to poor photosynthetic capacity of plants as they are not receiving proper sunlight under tree canopies.

CONCLUSION

Under mango-based agroforestry system and open growing condition, highest net realization and BCR were obtained in treatment combination S_2F_4 [45 cm x 45 cm spacing and novel plus (banana pseudostem based organic liquid nutrients + botanical pesticides) @ 1 %], while S_1F_1 [30 cm x 30 cm spacing and without foliar spray of novel fertilizers] recorded least net realization and BCR. Thus, growing of cowpea under mango orchard can provide additional income to mango growers until canopy intermingled.

REFERENCES

Akshika Bhawariya; Pareek N K, Sunda S L, Shri R and Bhavna Singh Rathore 2022. Effect of foliar application of organics and fertilizers on growth yield and economics of Cluster bean (*Cyamopsis tetragonoloba* L. Taub.). *Biological Forum – An International Journal* **14**(1): 608-13.

Bhatt R, Raghav M, Bhardwaj S B, Bhatt L, Bisht Y S, and Kumar M. 2025. Effect of foliar application on potato yield. *Current Horticulture* **13**(2): 84–87.

Champaneri D D, Patel N K, Desai C S and Desai D H. 2021. Efficacy of Novel organic liquid nutrient and Novel plus organic liquid nutrient on quantitative traits of Indian bean [*Lablab purpureus* (L.) Sweet]. *International Journal of Plant and Soil Science* **33**(17): 105-15.

Desai C S, Patel J M, Pawar S L, Usadadia V P, Naik V R and Savani N G. 2016. *"Value Added Products from Banana Pseudostem"*. Research Scientist, Soil and Water Management Research Unit, Navsari Agricultural University, Navsari, pp. 55-56.

Dongre R and Choudhary B. 2024. Evaluation of *Trichoderma, Psedomonos* and biofertisol as foliar application on quality and yield of guava (*Psidium guajava*). *Current Horticulture* **12**(3): 45–48.

Karukonda G, Pakalpati S R, Ganesh P and Chinmayee Patra 2020. Effects of plant density on yield parameters of Cowpea (*Vigna unguiculata* L.). *International Journal of Chemical Studies* **8**(4): 344-47.

Kavitha M P, Balakumbahan R, Prabukumar G. 2019. Effect of foliar spray and fertilizer levels on growth and yield of vegetable cowpea [*Vigna unguiculata* (L.) Walp.]. *Indian Journal of Agricultural Research* **53**(6): 745-48.

Kumar S and Chaturvedi O P. 2017. Agroforestry interventions in fruit orchards for improving productivity, profitability and sustainability. In: *Doubling Farmers Income Through Horticulture* (eds. K.L. Chadha, S.K. Singh, P. Kalia, W.S. Dhillon, T.K. Bahera and J. Prakash). Daya Publishing House, New Delhi, India, pp. 569-76.

Mandaliya J. 2021. Response of vegetable cowpea [*Vigna unguiculata* (L.) Walp.] to different bio-stimulants. M. Sc. Thesis, Navsari Agricultural University, Navsari, India, pp. 37-60.

Meena D, Bhushan C, Shukla A, Chaudhary S and Meena S S. 2017. Effect of foliar application of nutrients on biological yield and economics urdbean (*Vigna mungo* (L.) Hepper). *International Journal of Current Microbiology and Applied Sciences* **6**(5): 2658-62.

MEFCC, New Delhi (2021). State of forest report. Forest survey of India. Ministry of Environment, Forests and Climate Change, Government of India.

Panse V G and Sukhatme P V. 1985. *In: Statistical Methods for Agricultural Workers*. Fourth enlarged edition, Sukhatme, P.V. and Amble, V.N. ICAR, New Delhi. India.

Parikh R P, Bhalerao P P and Patil S J. 2020. Effect of foliar application of organic liquids on yield and quality of turmeric (*Curcuma longa*). *Current Horticulture* **11**(1): 30–32.

Rabade M, Singh R and Thakur Indu 2022. Response of biofertilizer and foliar spray of organic amendments on the growth and yield of cowpea (*Vigna unguiculata* L.). *The Pharma Innovation Journal* **11**(4): 1417-20.

Randhawa K S. (1990). Pulse based cropping system in juvenile orchards. International Symposium on Natural Resource management for sustainable Agriculture.

Selvarani K, Anushavardhini S, Jose J J and Mariselvi V. 2021. Effect of organic foliar sprays on yield of cluster bean (*Cyamopsis tetragonoloba* L. Taub) cv. Pusa Navbahar. *Acedemic Journals: Scientific Research and Essays* **16**(2): 8-14.

Shukla P K and Singh R. 2021. Effect of date of sowing and spacing on growth, forage yield and quality of cluster bean (*Cyamopsis tetragonoloba* L.). *The Pharma Innovation Journal* **10**(10): 162-66.

Sowmya K, Bhalerao P P and Patil S J. 2024. Effect of foliar application of organic liquids on yield and quality of garlic (*Allium sativum*). *Current Horticulture* **12**(3): 78–81.