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Direct and residual effect of organic manures and inorganic fertilizer application in brinjal + onion - cowpea - sunnhemp cropping system

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Abstract
Field experiment was conducted in a north western agroclimatic zone, Tamil Nadu to study the direct and residual effect of organic manures and inorganic fertilizer application on intensive vegetable based cropping system for two consecutive years 2017-18 and 2018-19. Brinjal was intercropped with onion during *kharif* followed by cowpea in *Rabi* whereas, sunnhemp was broadcasted after the harvest of preceding crop without land preparation as a summer season crop. Highest Brinjal Equivalent Yield (BEY) of 35.37 t/ha and 38.99 t/ha for the first and second year, respectively for brinjal intercropped with onion was recorded from vermicompost at 5t/ha with 100 per cent RDF (Recommended Dose of Fertilizer) plot. Higher yield in cowpea was recorded with 100 per cent RDF plot compared to 75 and 50 per cent RDF plot. Higher B:C ratio (4.51) and (6.85) was recorded with FYM at 12.5 t/ha +100% RDF plot during 2017-18 and 2018-19, respectively.

Keywords: Crop equivalent yield, farm yard manure, vermicompost, brinjal, cowpea

Introduction
Continuous use of chemical fertilizers accelerates the decomposition of soil organic matter and impairs physical and chemical properties of soil in addition to micronutrient deficiency. The use and management of crop residues, FYM and Green Manure, are an increasingly important aspect of environmentally sound sustainable agriculture [8]. A major contribution towards increased yield and sustained production could be achieved by using balanced application of fertilizers and manures. FYM is the most ancient organic matter source and has long been considered as a desirable soil amendment. It plays an important role in the improvement of physical properties of soil besides increasing the availability of other nutrients especially phosphorous through the formation of humic substances. In general well-composted FYM contains 0.5-1.0% N, 0.6% P_2O_5 and 0.5% K_2O. Incorporation of about 12.5 tonnes of FYM can supply 50-60 kg N, 25-30 kg P_2O_5 and 35-40 kg K_2O. Vermicompost applied in soil enhances the OC of soil by increasing microbial activity and microbial biomass, which are key components in nutrient recycling. Vermicompost contains micro sites rich in available carbon and nitrogen. Worm cast injected soils are also rich in water soluble phosphorous and contains two to three times more available potassium than surrounding soils[11] which encourage better plant growth.

The primary value of green manure as a source of N is realized when the green manure decomposes and its organic N is transformed into available form. If the green manure decomposes rapidly and releases its N quickly, it is an excellent source of N for the first crop following its incorporation. Otherwise, it may leave some residual effects on N supply to the future crops [6]. It was opined that 65% of the added green manure N mineralizes during the first crop, 14 % mineralizes during the second crop and so on. Nutrient recommendations for crops is usually made based on the responses of individual crops in the system without considering the total requirement of crops grown in cropping system as a whole and nutrient interactions between them. As a result, the recommendation often proved to be non-remunerative.

Therefore, for efficient nutrient management in vegetable based cropping systems, a quantitative evaluation of the role of preceding crop and the residual effect of nutrients assumes great importance. In the light of above context, an experiment was planned and investigations were carried out for two consecutive years in *kharif, rabi* and summer 2017-18 to 2018-19 to generate more information on contribution of various organic manuring and fertilizer application for brinjal intercropped with onion and then cumulative effect of both on cowpea during *Rabi* seasons along with that incorporation of sunnhemp during summer and its effects on preceding crop, altogether their effect on yield.

Materials and Methods

Field experiments were conducted on North Western agro climatic zone during 2017-18 and 2018-19 on intensive vegetable based cropping system under irrigated upland ecosystem at farmer's field of Dharmapuri located in Tamil Nadu. Brinjal was intercropped with onion in 2:1 ratio in *kharif* season followed by cowpea in *Rabi* season. Whereas, sunnhemp was broadcasted in residual fertility of cowpea without land preparation. The initial soil test values of the experiment field was low in available nitrogen (263 kg/ha), medium in available phosphorous and potassium (20.17 kg/ha and 234 kg/ha).

Recommended dose of fertilizers at different doses 100, 50 and 75 % was applied during both the seasons. Organic sources which include FYM at 12.5 t/ha and vermicompost at varying rate of 2.5, 5, 7.5 t/ha were applied to first season crop alone. Doses of FYM, vermicompost, N, P and K as per treatment were applied in the plot and the treatments details were given detailed in table 1. Nitrogen, Phosphorous and potassium were applied, as urea, single super phosphate and muriate of potash, respectively.

Brinjal hybrid *Dhuruva*, cowpea variety COCP (7) were the test varieties used in experiment. During *kharif* season, brinjal seedlings were transplanted at 30-35 DAS with the spacing of 60 cm x 45 cm. As an intercrop, Onion bulb was planted at 2 DAT of brinjal with a spacing of 20 cm x 10 cm. Two rows of intercrops were sown in between the rows of main crop as an additive series. Sole brinjal and sole onion plots were also raised with same management practices to calculate the yield advantages in non- replicated trials. The first irrigation was given immediately after transplanting to ensure proper establishment of plant. Subsequent irrigation was given at 15 days interval. Harvesting starts from 55 DAT. Fruits were harvested at tender stage at 4 – 5 days intervals.

During *Rabi* season, cowpea seeds were directly sown with the spacing of 45 cm x 15 cm. Irrigation was given immediately after sowing and life irrigation was given on the third day. Subsequent irrigations were given as and when necessary. Adequate prophylactic measures were taken to prevent pest and disease incidence. During summer season, sunnhemp seeds were broadcasted after harvesting of preceding crop cowpea in residual fertility of soil. Several passes of a rotavator and alternatively using cultivator, at intervals of a few days will then incorporate the green manure throughout the soil profile.

For brinjal and cowpea, in each treatment, five plants were randomly selected and tagged for various biometric observations. Oven dry weight of different plant parts were recorded by partition of whole part in stem, leaf and fruit/pod/bulb and the sum of mean dry weight of all the plant parts represent the total dry matter per part was calculated. For brinjal, length of the fruit from the stalk to the tip of the fruit was measured with the meter scale at 90 DAT. Fruits were carefully bundled and immersed in the measuring jar and the volume of fruits was calculated by measuring the amount of water displaced in mm. The number of fruits harvested from tagged plants in each treatment was collected during each picking counted and added together and average fruits/plant was calculated. The fresh weight of the fruit (g) was measured just after the harvesting with the help of electronic weighing machine. Fruit yield was determined by adding the total fruit weight over all the pickings from each plot and converted on hectare basis. For onion, the average weight of bulbs was taken after the harvest by taking ten bulbs from each treatment and converted to hectare basis.

For cowpea, pod length was measured with the help of meter scale and average values were worked out. The total number of seeds per pod was counted from randomly selected ten pods at the time of harvesting from each treatment. No. of pods picked from the tagged plants were counted under each plot and calculated to average number of pods/plant.

The LER was worked out by using the formula given by [1]. Area time equivalent ratio was calculated according to the formula given by [3]. Gross and net returns per hectare were computed for the cropping system as a whole, considering the prevailing market price of the inputs and produces. Benefit: cost (B:C) ratio was worked out for different treatments of this cropping systems by dividing the gross return by cost of cultivation. The data on various characters studied during the course of investigation were statistically analyzed as suggested by [2]. Wherever the treatment differences were significant ('F' test), critical differences were worked out at five percent probability level and the values were furnished.

Results and discussion

Weather parameter

Crop growth is mainly dependent on environmental factors. Fluctuations in weather conditions greatly influence growth, development and yielding potential of crop. The year to year fluctuation in yield is primarily a result of variable weather conditions that prevail in an agro climatic situation apart from soil fertility status. In this context, the weather conditions prevailed during the period of experimentation would definitely have a direct bearing on the potentiality of any crop in general and particular for brinjal in this experiment. The total rainfall received during *kharif* season was 889 mm during 2017-18 and 289 mm during 2018-19 for brinjal, flowering starts from 35 DAT and it continues to flower and set fruit as it is an indeterminate plant. Fruit set starts from 48 DAT. The total rainfall received during reproductive stage was 781 mm and 206 mm during 2017-18 and 2018-19 and given in detail (Fig 1) Heavy rainfall received during flowering stage causes flower drop that leads to decrease in number of fruits per plant and also it washes the pollen away from the plant causes poor fruit set. During whole cropping period maximum and minimum temperature ranges from 21.6^0C to 35.9^0C and 13.6^0C to 25.4^0C and from 32.4^0C to 29.1^0C and 25.9^0C to 22.0^0C during 2017-18 and 2018-19, respectively.

Growth parameters

Total dry matter production

The total dry matter production of brinjal and cowpea as influenced periodically by different treatments are presented in Fig 2. Higher dry matter production (3853 kg/ha and 3901 kg/ha) was noticed in treatment receiving vermicompost at 5 t/ha + 100% RDF (T_3) which is at par with FYM at 12.5 t/ha +100% RDF (T_1) and vermicompost at 2.5 t/ha + 100% RDF (T_2) which was followed by vermicompost at 5 t/ha + 75% RDF (T_4) and lower dry matter production (3550 kg/ha and 3598 kg/ha) was recorded in vermicompost at 7.5 t/ha + 50% RDF (T_5) during 2017-18 and 2018-19, respectively. The higher total dry matter production might be attributed to increased efficiency in nutrient availability resulting in prolonged greenness and larger leaf surface. The cumulative residual effect of organic manure along with various fertilizer dose on succeeding cowpea crop revealed that during 2017-18 and 2018-19, 100 per cent RDF (T_1) recorded higher dry matter production (6512 kg/ha and 6675 kg/ha) which is at par with T_3 and T_2 which was followed by 75 per cent RDF (T_4) where lower dry matter production (5497 kg/ha and 5716 kg/ha) respectively, was recorded in treatment 50 per cent RDF (T_5). The residual effect of organic manure especially farm yard manure has considerable influence on second season cowpea crop. During both the years, higher dry matter production was noticed in 100 per fertilizer applied plot when compared to 75 and 50 per cent RDF plot.

Yield attributes

The data related to yield attributes of both brinjal and cowpea were significantly influenced by the application of organic manures and inorganic fertilizer treatments and it is presented in Table 2 and Table 3. Generally, the yield attributing character was higher during 2018-19 than 2017-18. Higher fruit weight (5.4 kg and 6.1 kg), fruit volume (83.4 cc and 86.8 cc), number of fruits/plant (22.7 and 27.1), was recorded in FYM at 12.5 t/ha + 100% RDaF (T_1) which was comparable with vermicompost at 5 t/ha + 100% RDF (T_3) and vermicompost at 2.5 t/ha + 100% RDF (T_2) during 2017-18 and 2018-19 respectively. Lower fruit weight (4.0 kg), fruit volume (68.6 cc), number of fruits/plant (16.8) were recorded by vermicompost at 7.5 t/ha + 50% RDF (T5) during 2017-18 and 5.1 kg, 75.5 cc and 21.9 in 2018-19, respectively. Vermicompost being a rich source of micronutrients also act as chelating agent and regulates the availability of metallic micronutrients to the plants and increases the plant growth thereby providing nutrients in available form and based on crop demand [12]. Higher dry matter production and its accumulation in reproductive parts of the plants can be achieved only by sound photosynthetic structure during early periods of crop growth.

Yield attributing character of cowpea was significantly affected by different nutrient management treatments and presented in Table 3. Application of 100 per cent RDF for cowpea recorded significantly higher yield attributing characters. Higher number of pods/plant (15.4 and 16.0), pod length (18.4 cm and 20.1 cm) and no. of seeds/pod (14.1 and 14.8) during 2017-18 and 2018-19 respectively was recorded in 100 per cent RDF (T_1) residual effect of farm yard manure applied during first season. Considerable reduction was noticed in 75 and 50 per cent RDF applied plot. This might be due to the optimum supply of all nutrient plays a vital role in alleviating nutritional deficiency in plants particularly at reproductive phase which resulted in producing higher yield parameter. The data pertaining to 100 grain weight showed that it has not been influenced by different nutrient management practices during both the years of study.

Yield

Perusal of data given in Table 4 revealed that there is a significant influence of nutrient management practices on grain and stalk yield per hectare. Higher grain and stalk yields were noticed in treatment which received 100 per cent RDF which was followed by 75 per cent RDF plot. Lower grain and stalk yields were observed in 50 per cent RDF applied plot. Organic and inorganic fertilizers are an efficient exogenous source of plant nutrients [7]. When fertilizers are used insufficient and imbalanced, balanced fertilizer use, along with complementary use of organic provides much needed nutrients to the soil, thereby increasing yields. These results are in accordance with findings of [10]. The increased supply of nitrogen and its higher uptake by plant might have stimulated the rate of various physiological processes in plant and led to increase growth and yield [6]. Similar results have been reported by [9]. Among the 100 per cent RDF applied plot, FYM applied during first season (T_1) registered higher grain and stalk yield (1565 kg/ha and 5041 kg/ha) during 2017-18 and (1579 kg/ha and 5101 kg/ha) during 2018-19, respectively. Farm yard manure acts as a nutrient reservoir, upon decomposition it produces organic acids, thereby absorbed ions are released slowly during entire growth period leading to higher yield components and seed yield [5]. Harvest index was not significantly influenced by nutrient management practices during both the years of study.

Table 1: Treatment combinations for brinjal + onion - cowpea cropping system

Treatment	Treatment Combinations	
	Brinjal	Cowpea
T_1	FYM @ 12.5 t/ha + 100 % RDF	100 % RDF
T_2	VC @ 2.5 t/ha + 100 % RDF	100 % RDF
T_3	VC @ 5 t/ha + 100 % RDF	100 % RDF
T_4	VC @ 5 t/ha + 75 % RDF	75 % RDF
T_5	VC @ 7.5 t/ha + 50 % RDF	50 % RDF
*RDF	100:150:100 NPK kg/ha	25:50:25 NPK kg/ha

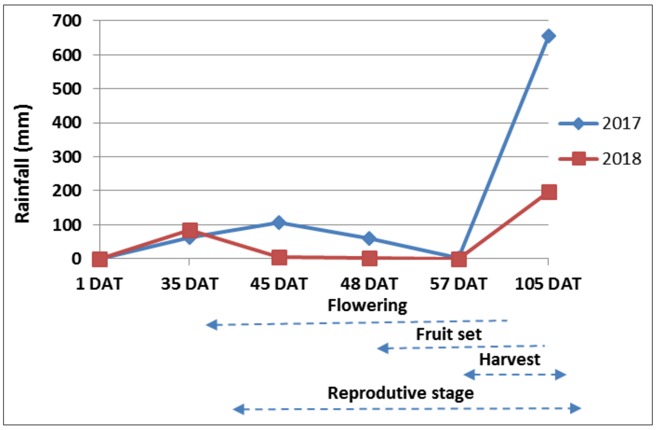

Fig 1: Effect of rainfall (mm) on different growth stage of brinjal during 2017 and 2018

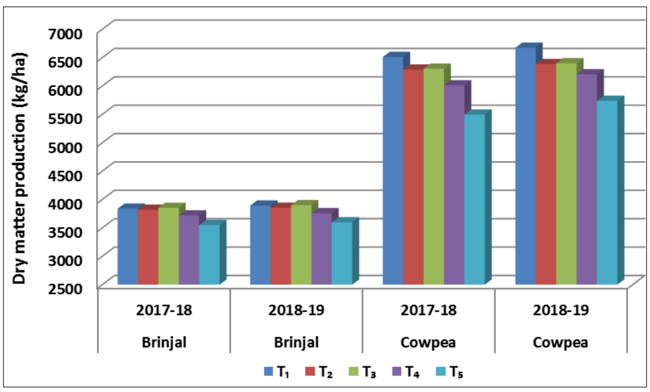

Fig 2: Effect of organic manures and inorganic fertilizer on total dry matter production (kg/ha) of brinjal and cowpea in intensive vegetable based cropping system (2017-18 and 2018-19)

Table 2: Effect of organic manures and inorganic fertilizer on yield attributes of brinjal intercropped with onion in brinjal based cropping system (2017-18 and 2018-19)

Treatment	Fruit volume (cc)		No. of fruits/plant		Fruit length (cm)		Fruit weight (kg/plant)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	77.1	83.7	20.4	24.0	6.6	7.2	5.0	5.5
T_2	81.2	80.5	20.8	24.6	6.7	7.4	5.1	5.7
T_3	83.4	86.8	22.7	27.1	6.8	7.5	5.4	6.1
T_4	74.9	79.0	17.9	22.8	6.6	7.3	4.7	5.4
T_5	68.6	75.5	16.8	21.9	6.5	7.2	4.0	5.1
SEd	3.6	3.2	0.9	1.1	0.3	0.4	0.2	0.3
CD (p=0.05)	7.9	7.1	2.0	2.5	NS	NS	0.5	0.6

Table 3: Effect of organic manures and inorganic fertilizer on yield attributes of cowpea in brinjal based cropping system (2017-18 and 2018-19)

	No. of pods/plant		No. of seeds/pod		Pod length (cm)		100 seed weight	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	15.4	16.0	14.1	14.8	18.4	20.1	12.6	12.8
T_2	14.3	15.1	13.5	14.1	15.7	17.5	12.8	12.8
T_3	14.5	14.8	13.7	14.5	16.6	18.4	12.8	12.6
T_4	10.5	11.0	9.5	10.2	13.4	15.0	12.7	12.7
T_5	9.3	10.0	8.7	9.4	10.6	12.5	12.6	12.5
SEd	0.6	0.6	0.6	0.6	0.7	0.8	0.6	0.6
CD (p=0.05)	1.3	1.4	1.2	1.3	1.6	1.7	NS	NS

Table 4: Effect of organic manures and inorganic fertilizer on yield of cowpea in brinjal based cropping system (2017-18 and 2018-19)

Treatment	Cowpea					
	2017-18			2018-19		
	Grain yield (kg/ha)	Stalk yield (kg/ha)	Harvest Index	Grain yield (kg/ha)	Stalk yield (kg/ha)	Harvest Index
T_1	1565	5041	0.24	1579	5101	0.24
T_2	1497	4775	0.24	1543	4859	0.24
T_3	1530	4823	0.24	1510	4901	0.24
T_4	1407	4626	0.23	1422	4695	0.23
T_5	1295	4294	0.23	1304	4337	0.23
SEd	70	148	0.10	71	164	0.01
CD (p=0.05)	153	323	NS	154	357	NS

Table 5: Effect of organic manures and inorganic fertilizer on intercropping productivity of brinjal in brinjal based cropping system (2017-18 and 2018-19)

Treatment	BEY* (t/ha)		LER		ATER	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1	33.57	36.39	1.17	1.20	1.87	1.92
T_2	33.12	35.63	1.17	1.16	1.87	1.86
T_3	35.37	38.99	1.24	1.21	1.99	1.93
T_4	30.66	33.74	1.18	1.16	1.89	1.86
T_5	29.03	32.60	1.14	1.18	1.82	1.93

*BEY – Brinjal Equivalent Yield

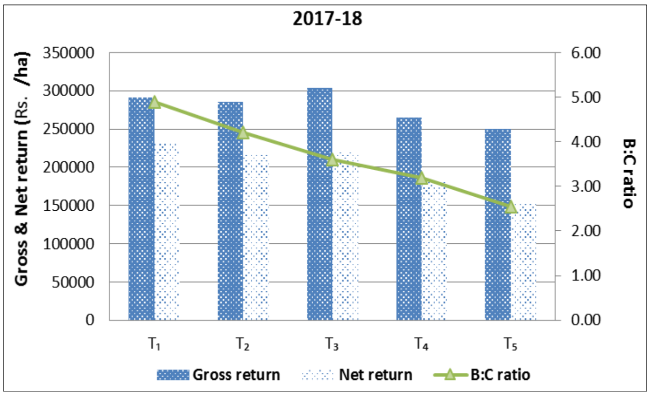

Fig 3: Effect of organic manures and inorganic fertilizer on economics of brinjal based cropping system (2017-18)

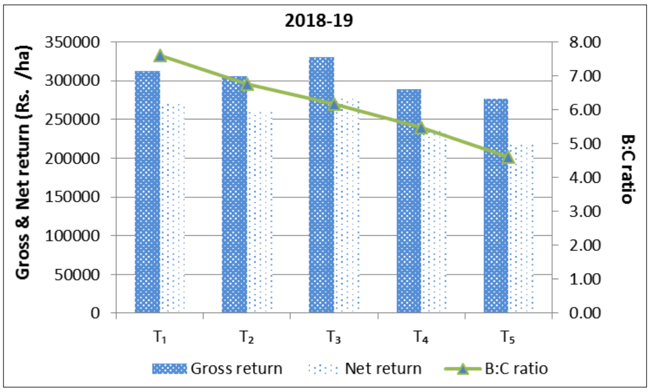

Fig 4: Effect of organic manures and inorganic fertilizer on economics of brinjal based cropping system (2018-19)

Assessment of intercropping productivity

Crop equivalent yield is an important index in assessing the performance of different crops under a given circumstance. Based on the price structure, economic yield of component crops is converted into base yield *i.e.* Brinjal Equivalent Yield. During 2017-18 and 2018-19, higher Brinjal Equivalent Yield (35.37 t/ha and 38.99 t/ha) was recorded under vermicompost at 5t/ha along with 100 per cent RDF plot. The lower brinjal equivalent yield (29.03 and 32.60) was recorded under vermicompost at 7.5 t/ha along with 75 per cent RDF plot during 2017 and 2018 respectively. This is due to better performance and yield of both the component crops and intercrop in the nutrient treatments. The present findings are in accordance with those of [4] who reported similar findings in different intercropping systems.

Land equivalent ratio reflects the advantage of intercropping over sole cropping system. The obvious reason for large yield advantage in intercropping system is that the component crops differed in their use of natural resources and utilized them more efficiently resulting in higher yields per unit area than that produced by their sole crops. In LER time factor is not taken into consideration. Area Time Equivalent Ratio will correct this conceptual inadequacy in LER and enable to assess land use efficiency along with time use efficiency in crop mixtures. Among the different nutrient management treatments higher LER and ATER was recorded in vermicompost at 5t/ha along with 100 per cent RDF plot. In the present study, LER values were greater than one, indicating efficient benefits of by intercrops compared to pure crops[1]. Higher ATER, might be due higher resource efficiency and equivalent yield.

Economics

Economics was calculated for whole cropping system *i.e.* cultivation cost, gross return, net return and B:C ratio it was averaged and presented in fig 3 and fig 4 for 2017-18 and 2018-19 respectively. During 2017-18, the economic analysis revealed that the maximum gross return (Rs. 2,92,896/ha) was obtained from treatment vermicompost at 5t/ha with 100 per cent RDF plot followed by FYM at 12.5 t/ha with 100 per cent RDF plot (Rs. 2,83,050/ha). But net return (Rs. 2,23,611/ha) and B:C ratio (4.76) was more in FYM at 12.5 t/ha with 100 per cent RDF plot followed by vermicompost at 5t/ha with 100 per cent RDF plot. Minimum gross return (Rs. 2,43,650/ha) and net return (Rs. 1,45,457 /ha), B:C ratio (2.48) was recorded in vermicompost at 7.5t/ha with 50 per cent fertilizer plot.

For 2018-19, maximum gross return (Rs. 3,22,585/ha) and net return (Rs. 2,69,013/ha) was obtained from treatment vermicompost at 5t/ha with 100 per cent RDF plot followed by FYM at 12.5 t/ha with 100 per cent RDF plot (Rs. 3,04,501/ha) and (Rs. 2,63,429/ha). But B:C ratio (7.41) was more in FYM at 12.5 t/ha with 100 per cent RDF plot followed by vermicompost at 5t/ha with 100 per cent RDF plot with B:C ratio of 6.59. Minimum gross return (Rs. 2,70,585/ha) and net return (Rs. 2,10,579/ha), B:C ratio (4.51) was observed in vermicompost at 7.5t/ha with 50 per cent fertilizer plot. Even though, net return was more in vermicompost at 5t/ha with 100 per cent RDF plot. Overall, B:C ratio was higher in FYM at 12.5 t/ha along with 100 per cent RDF plot. This might be due to lesser cost of FYM when compared to vermicompost leads to maintain higher B:C ratio. Among the two years, higher B:C ratio was maintained during 2018-19 because of higher yield in brinjal and cowpea due to incorporation of sunnhemp during summer season.

Conclusion

An integrated supply of FYM along with 100 per cent RDF leads to minimized use of chemical fertilizers to a greater extent without affecting the brinjal yield and conserved soil fertility status for succeeding crop.

Reference

1. Dhima KV, Lithourgidis AA, Vasilakoglou IB, Dordas CA. Competition indices of common vetch and cereal intercrops in two seeding ratio. Field Crop Res. 2007; 100:249-256.
2. Gomez KA, Gomez AA. Statistical Procedures for Agrl. Research. II Ed., John Wiley and Sons., New York, 1984, 381.
3. Hiebsch CK, McCollum RE. Area time equivalent ratio: A method of evaluating the productivity of intercrops. Agron. J. 1987; 79:15-22.
4. Islam MR, Rahman MT, Hossain MF, Ara N. Feasibility of intercropping leafy vegetables and legumes with brinjal. Bangladesh J Agril Res. 2014; 39:685-692.
5. Khandelwal R, Choudhary SK, Khangarot SS, Jat MK, Singh P. Effect of inorganic and biofertilizers on productivity and nutrients uptake in cowpea [*Vigna unguiculata* (L.) walp]. Legume Res. 2012; 35(3):235-238.
6. Mandal UK, Singh G, Victor US, Sharam KL. Green manuring: its effect on soil properties and crop growth under rice-wheat cropping system. Eur. J Agron. 2003; 19(2):225-237.
7. Rajasingh RS, Lourduraj AC. Growth and yield of cowpea as influenced by integrated nutrient management practices in preceding maize. Advance Res J crop Improvement. 2014; 5(1):29-33
8. Rao TSS, Sankar C. Effect of organic manures on growth and yield of brinjal. South Indain Hortic. 2001; 49:288-291.
9. Salehin F, Rahman S. Effects of zinc and nitrogen fertilizer and their application method on yield and yield components of *Phaseolus vulgaris* L. Agric. Sci. 2012; 3(1):9-13.
10. Sharma SK, Prajapat S, Raghuwanshi O. Effect of organic manures and inorganic fertilizers on yield and economics of cowpea production (*Vigna unguiculata* L.). Indian Res. J Genet. & Biotech. 2015; 7(1):152-155.
11. Sudhakar G, Christopher LA, Rangasamy A, Subbian P, Velayuthan A. Effect of vermicompost application on the soil properties, nutrient availability, uptake and yield of rice. A Review. Agricultural Review. 2002; 23(2):127-133.
12. Vinod K. Use of integrated nutrient management to enhance soil fertility and crop yield of hybrid cultivar of brinjal (*Solanum melongena* L.) under field conditions. Adv Plants Agric Res. 2016; 4(2):249-256.