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Studies on organic nutrition in improving yield and quality of ber cv. BAU Kul-1

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ABSTRACT

The effect of organic nutrition in improving yield and quality of ber cv. BAU Kul-1 was studied at Horticulture Research Station, Mondouri, BCKV, West Bengal, India. The treatments were FYM (20 kg plant^{-1}), Vermicompost (10 kg plant^{-1}), Neem Cake (5 kg plant^{-1}), ½ (FYM + Vermicompost), ½ (FYM + Neem cake), ½ (Vermicompost + Neem cake), $^{1}/_{3}$ (FYM + Vermicompost + Neem cake) and Control i.e. RDF (N, P_2O_5, K_2O: 150, 90, 150 g/plant/year). Sole use of vermicompost or neem cake was found to be effective in improving the soil nutrient status, soil microbial population and leaf phosphorus content as compared to other treatments. But their combination i.e. ½ (Vermicompost + Neem cake) showed more beneficial effect in increasing fruit yield and available soil phosphorus content. FYM or vermicompost and their combination i.e. ½ (FYM + Vermicompost) resulted higher leaf nitrogen and potassium content. The physico-chemical characters of ber were found to be superior with FYM alone as compared to others. The sole use of neem cake or vermicompost or their combination i.e. ½ (Vermicompost + Neem cake) were much effective in improving the soil condition, leaf phosphorus content and yield of ber plants; whereas, sole application of FYM was found to be most useful in enhancing the fruit quality of ber.

Keywords **:** Ber, farm yard manure, neem cake, vermicompost

Ber or Indian jujube (*Ziziphus mauritiana* Lam) is the hardiest fruit tree cultivated all over India. Originally native to India, it adapts to warm to hot tropical climates with low to relatively high rainfall and tolerating poor soils. Fruits are quite nutritious and rich in vitamin C. Ber is richer than apple in protein, phosphorus, calcium, carotene and vitamin C (Bakhsi and Singh, 1974) and oranges in phosphorus, iron, vitamin C and carbohydrates and exceed them in calorific value. Ripe fruits provide 20.9 K calories per 100 g of pulp (Singh *et al.*, 1973). Pulp contains 12.8 – 13.6 % carbohydrates (Jawanda *et al*., 1981), 70 IU vitamin A / 100g pulp (Bal *et al*., 1978) and 70-165 mg vitamin C / 100 g pulp (Bal and Mann, 1978). In spite of tremendous importance of ber and favourable climatic condition prevails in West Bengal, the cultivation of ber has not been commercialized yet in this state. In West Bengal, ber is grown to a limited extent in the arid zone *i.e.* in red and lateritic soil of Purulia, Bankura, Birbhum and West Midnapore. But with the recent introduction of BAU Kul-1 ber variety from Bangladesh (probably originated in Thailand) to Southern district of West Bengal, this crop is gaining popularity among the progressive farmers since 2013 due to higher plant population per unit area, bearing after 6-8 months of planting with high yield and high profit.

Organic agriculture, a holistic production management system, is supportive to environment, health and sustainability. Organic farming system emphasis on the use of organic matter for enhancing soil properties, minimizing food chain associated health hazards and attaining closed nutrient cycles, the key factors for sustainable agriculture (Cardelli *et al.*, 2004). A demand in organic products is reported by Rutkoviene and Garliauskiene (2007) where, 73% of consumers declared willingness to buy organic products. Organic foods are preferred by the consumers due to its safety, quality and taste. The most marketable organic products are vegetables (79%), berries and fruits (59%). Organic culture is one of the benign alternatives. Consumers are becoming aware of the health hazards due to pollutants and the demand for organic fruits in the market is expanding. Therefore, farmers are searching alternatives to replace the chemical fertilizers by the use of vermicompost, FYM, neem cake and other organic sources of nutrients which are becoming popular among the farmers. Considering these views, the present investigation was conducted with an objective to find out the efficacy of different organic nutrients on growth, yield and fruit quality of ber.

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MATERIALS AND METHODS

The experiment was conducted during 2012-2013 at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya on 3 years old tree of ber cv. BAU Kul-1 spaced at 5×5m. The orchard soil was Gangetic alluvial with sandy loam in texture

having 6.2 pH, 0.52 % organic carbon, 132.33 kg ha^{-1} available nitrogen, 20 kg ha^{-1} phosphorus and 171.33 kg ha^{-1} potassium. The different treatments were Farm Yard Manure *i.e* FYM (20 kg $plant^{-1}$), Vermicompost (10 kg $plant^{-1}$), Neem cake (5 kg $plant^{-1}$), ½ (FYM + Vermicompost), ½ (FYM + Neem cake), ½ (Vermicompost + Neem cake), $^1/_3$ (FYM + Vermicompost + Neem cake) and Control *i.e.* RDF (N, P_2O_5, K_2O: 150, 90, 150 g $plant^{-1}$ $year^{-1}$. The experiment was laid out in randomized block design with three replications and there was single plant in each replication. The plants were uniform in growth and vigour. Full amount of FYM (20 kg $plant^{-1}$), vermicompost (10 kg $plant^{-1}$) and neem cake (5 kg $plant^{-1}$) were applied to the each plant as sole application. Half amount of each organic manure was used when applied as a combination of two organic sources where as it was one-third amount for a combination of all the three organic sources. Each control plant was fertilized with recommended dose of fertilizer (RDF) *i.e.* 150 g N, 90 g P_2O_5 and 150 g K_2O. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively. Plants were manured or fertilized just after pruning *i.e.* in the month of May. Both organic manures and inorganic fertilizers were applied in a ring of 60 cm radius away from the trunk at a depth of 15-20 cm and were mixed in the soil and covered. The nutrient content (N, P_2O_5 and K_2O) of different sources of applied organic manures was estimated in the laboratory and presented in table-1. The amount of N, P_2O_5 and K_2O was 100:80:100 g for 20 kg FYM, 100:120:80 g for 10 kg vermicompost and 250:50:70 g for 5 kg neem cake, respectively.

Table 1: Nutrient content of different sources of organic manures

Name	N (%)	P_2O_5 (%)	K_2O (%)
FYM	0.5	0.4	0.5
Vermicompost	1.0	1.2	0.8
Neem cake	5.0	1.0	1.4

The soil samples were collected at a depth of about 0-15 cm during flowering time (September) for determination of soil nutrient status and soil microbial population. Organic carbon, available nitrogen and available potassium content of soil were estimated by following the standard method (Jackson, 1973); whereas available phosphorus content was estimated by the method as described by Olsen *et al.* (1954). Soil microbial population was counted by serial dilution technique and pour plating method as described by Vincent (1970). Different media of Ashby medium (Kizilkaya, 2009), Nitrogen free semi solid medium (Bashan and Levanony, 1985), Pikovskaya's agar medium (Pikovskaya, 1948) and Aleksandrov Medium (Hu *et al.,* 2006) were used for *Azotobacter*, *Azospirillum,* PSB and K-mobilizer, respectively. *Pseudomonus striata* and *Frateuria aurantia* were counted for PSB and K-mobilizer, respectively. Freshly matured 5th and 6th leaves from growing tip were sampled during September for analysis of leaf nutrient content (*i.e.* nitrogen, phosphorus and potassium). Leaf nutrient was estimated by the method as described by Black (1965) for nitrogen, Jackson (1973) for phosphorus and Piper (1956) for potassium. The physico-chemical characters of fruits were recorded after thorough washing with tap water to remove adhering impurities. Physical characters of fruits like fruit weight and pulp weight were recorded from the average of 15 fruits for each replication using digital balance (CY 220, Citizen Scale (I) Pvt. Ltd). Bio-chemical constituents of fruits were analyzed for each replication from 15 fruits. Total soluble solids content of fruits was determined with the help of a hand refractometer (RHB-10, Huake Instrument Co. Ltd). The acidity and ascorbic acid content in fruits were estimated by following the standard method (A.O.A.C., 1984). The data obtained were analysed statistically by the analysis of variance method as suggested by Goon *et al.* (2001) and the significance of different source of variation was tested by error mean square by Fisher's 'F' test of probability level of 0.05 per cent.

RESULTS AND DISCUSSION

The results explained wide and significant variation in leaf and soil nutrient characters, yield and yield attributing characters among different treatments of organic nutrition in ber.

Microbial population

Sole use of vermicompost or neem cake or their combination showed higher microbial populations in soil (Table 2). Among them, sole use of vermicompost resulted maximum population of *Azotobactor* (220 x 10^4 cfu g^{-1} of soil) where as maximum K-mobilizer (299.33 x 10^4 cfu g^{-1} of soil) was obtained with sole use of neem cake but the combination of vermicompost and neem cake *i.e.* ½ (vermicompost + neem cake) resulted maximum population of *Azospirillum* (223.67 x 10^4 cfu g^{-1} of soil) and PSB (261.33 x 10^4 cfu g^{-1} of soil). Minimum population of microbes in soil was found with control

(RDF) and it was due to the absence of organic manures**.** The role of organic nutrients through FYM, vermicompost and neem cake along with biofertilizers in improving soil health by increasing the microbial population in the rhizosphere of litchi have been reported by Lembisana Devi, (2014).

Soil and leaf nutrient composition

It has been clearly indicated in the table -3 that sole use of either vermicompost or neem cake, resulted higher available nitrogen (146.33 and 151.00 kg ha^{-1}, respectively), phosphorus (22.33 and 23.00 kg ha^{-1}, respectively) and available potassium (197.67 and 192.00 kg ha^{-1}, respectively) content in soil though combination of vermicompost and neem cake *i.e.* ½ (vermicompost + neem cake) resulted maximum content of available soil phosphorus (25.33 kg ha^{-1}). The finding of higher soil nutrients status due to the application of vermicompost is in agreement with the findings of Sarkar (2012). It is interesting that higher organic carbon content was noted with FYM alone (0.76%) or in combination with vermicompost and neem cake (0.75%). Higher nutrient content in soil due to the application of neem cake or vermicompost or their combination might be due to the higher microbial populations. Again, Sole use of FYM or vermicompost and their combination @ ½ (FYM + vermicompost) had pronounced effect on higher nitrogen and potassium content in leaf tissue; however, maximum nitrogen (1.953 %) and potassium (1.57%) content was recorded with sole application of FYM. Maximum leaf phosphorus content (0.174%) was recorded with combined application of ½ (FYM + neem cake).

Table 2: Effect of organic nutrients on soil microbial population

Treatment	*Azotobacter* (×10^4 cfu g^{-1} of soil)	*Azospirillum* (×10^4 cfu g^{-1} of soil)	PSB (×10^4 cfu g^{-1} of soil)	K-mobilizer (×10^4 cfu g^{-1} of soil)
FYM	135.00	140.67	179.00	182.00
Vermicompost	220.00	117.33	216.00	239.67
Neem cake	194.67	141.33	256.67	299.33
½ (FYM + Vermicompost)	137.00	120.33	181.00	173.67
½ (FYM + Neem cake)	139.67	190.33	139.67	181.33
½ (Vermi+ Neem cake)	154.00	232.67	261.33	186.33
$^1/_3$ (FYM+Vermi + NC)	172.00	179.33	150.33	224.67
Control (RDF)	112.67	92.33	120.33	142.00
SE(m)±	**1.43**	**1.30**	**1.27**	**2.09**
LSD (0.05)	**4.28**	**3.90**	**3.81**	**6.27**

Note: Vermi – Vermicompost, NC-Neem cake

Table 3: Effect of organic nutrients on soil and leaf mineral content

Treatment	Soil mineral content				Leaf mineral content		
	Organic carbon (%)	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	N (%)	P_2O_5 (%)	K_2O (%)
FYM	0.76	132.67	17.67	160.00	1.953	0.153	1.570
Vermicompost	0.55	146.33	23.33	197.67	1.920	0.158	1.540
Neem cake	0.52	151.00	23.00	192.00	1.743	0.156	1.387
½(FYM +Vermi)	0.75	132.33	20.33	154.67	1.847	0.133	1.467
½ (FYM + NC)	0.67	14367	16.33	170.67	1.600	0.174	1.223
½(Vermi + NC)	0.63	134.33	25.33	178.00	1.647	0.154	1.303
$^1/_3$ (FYM+Vermi+NC)	0.58	122.33	18.33	183.67	1.487	0.151	1.147
Control (RDF)	0.45	124.33	21.33	166.00	1.670	0.147	1.390
SE(m)±	**0.01**	**0.55**	**0.55**	**0.83**	**0.02**	**0.00**	**0.01**
LSD (0.05)	**0.02**	**1.66**	**1.66**	**2.47**	**0.06**	**20.005**	**0.04**

Physico-chemical characters of fruits

It is evident from table- 4 that sole use of neem cake and vermicompost was found to be most effective in terms of number of fruits per plant (610.67 and 576.33, respectively). However, maximum yield (28.68 kg $plant^{-1}$) was obtained with the combination of ½ (vermicompost + neem cake) which is statistically *at par* with the yield under sole application of FYM, vermicompost and neem cake. Increased yield of ber with application of vermicompost in addition to inorganic or

biofertilizers were observed by Mishra *et al. (*2011) and Sarkar (2012) where as Maity *et al.* (2006) obtained higher yield of guava by application of neem cake.

Table 4: Effect of organic nutrients on physico-chemical characters of fruits

Treatment	Number of fruits plant^{-1}	Yield (kg plant^{-1})	Fruit weight (g)	Pulp weight (g)	TSS (^{0}Brix)	Titratable acidity (%)	TSS / acid ratio	Ascorbic acid (mg ^{100}g pulp)
FYM	529.33	25.73	48.67	45.00	18.40	0.133	138.07	81.23
Vermicompost	576.33	24.41	42.33	38.90	18.57	0.152	122.48	54.77
Neem cake	610.67	25.44	41.67	38.23	16.93	0.163	103.95	64.97
½(FYM +Vermi)	416.33	17.04	41.00	37.50	18.33	0.144	127.67	46.56
½ (FYM + NC)	355.67	14.48	40.67	37.13	17.67	0.189	93.64	77.59
½(Vermi + NC)	480.00	28.68	45.00	41.23	17.33	0.134	129.07	66.93
$^{1}/_{3}$ (FYM+Vermi+NC)	423.67	18.06	42.67	38.90	17.90	0.178	100.54	71.79
Control (RDF)	403.00	15.83	39.33	35.87	17.03	0.182	93.63	51.93
SEm(±)	**31.24**	**2.29**	**1.04**	**1.03**	**0.41**	**0.002**	**2.72**	**1.46**
LSD (0.05)	**93.64**	**6.86**	**3.12**	**3.08**	**NS**	**0.006**	**8.16**	**4.38**

Neem cake not only provides nutrition to the plant, but also controls soil- borne pests, diseases and nematodes. It also acts as a nitrification inhibitor, helps reparatory activity, increases the population of earthworms and produced organic acids, which help in removing the alkalinity of soil. Neem cake contains more sulphur (1.07 to 1.30%) than any other cake as well as reduced nitrogen loss through leaching and de nitrification. All these properties of neem cake lead to increased growth and yield of plant (Neem Foundation, 2013). The advantages of vermicompost over FYM are that it is rich in vitamins, antibiotics and growth hormones –and hence promote plant growth. It is also rich in beneficial microbes, prevents the growth of phylopathogenic organisms, provides structural stability to soil and improves water holding capacity of soil (Kumar *et al.,* 2005). Physico-chemical characters of fruits in the present experiment varied significantly due to different treatments of organic nutrients except TSS content where the variation was insignificant. Sole application of FYM showed maximum beneficial effect on fruit weight (48.67 g), pulp weight (14.0 g), ascorbic acid (81.23 mg/100 g pulp) and TSS/acid ratio (138.07) with least titratable acidity (0.133 %). Maity *et al.* (2006) also noted better quality fruits with FYM treated plants.

It may be concluded from the above findings, that sole use of neem cake or vermicompost or their combination *i.e.* ½ (vermicompost + neem cake) were much effective in improving the soil condition, leaf phosphorus content and yield of ber; however, application of FYM is most useful for improving the fruit quality.

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