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Effect of Organic Manures, Green Manures and Liquid Organic Manure on Yield, Economics, Energy use Efficiency and Energy Productivity in Cotton

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ABSTRACT: *The field experiment was carried out at MARS, Dharwad during* Kharif, *2010-11 and 2011-12 to study the "Effect of organic manures, green manures and liquid organic manure on yield, economics, energy use efficiency and energy productivity in cotton" The results of the two years pooled data revealed that, combined application of compost (50%) + vermicompost (50%) equivalent to RDF + green leaf manure as mulch with application of jeevamrutha @ 500 l/ha recorded higher kapas yield (1640 kg) and it is superior over RDF alone (1522 kg/ha). Combined application of crop residue (50%) + vermicompost (50%) equivalent to RDN with lucerene with jeevamrutha @ 500 l/ha surface application recorded significantly higher net returns (Rs. 60009 ha^{-1}) over other combinations. Among the nutrient management practices, application of compost (50%) + vermicompost (50%) equivalent to RDN recorded significantly higher energy use efficiency and energy productivity (1.80 and 0.151 kg MJ^{-1}, respectively) over FYM @ 5 t ha^{-1} + RDF (1.65 and 0.14 kg MJ^{-1}, respectively). Application of GLM @ 7.5 t ha^{-1} with surface application of jeevamrutha @ 500 l ha^{-1} recorded significantly higher energy use efficiency and energy productivity (1.78 and 0.151 kg MJ^{-1}, respectively) as compared to sunnhemp green manuring alone and was on par with lucerne green manure + surface application of jeevamrutha @ 500 l ha^{-1}. Combined application of compost (50%) + vermicompost (50%) equivalent to RDN + GLM with surface application of jeevamrutha @ 500 l ha^{-1} recorded significantly higher energy use efficiency and energy productivity (1.84 and 0.156 kg MJ^{-1}, respectively over RDF alone (1.60 and 0.135 kg MJ^{-1}, respectively).*

Keyword: *Organic manures, Yield and energy productivity*

INTRODUCTION

Currently, the energy crises associated with hike in prices of N, P_2O_5 and K_2O fertilizers has made the use of chemical fertilizers in crop production not only costly but also in short supply. It is imperative to develop and make use of on-farm organic sources of nutrients to maintain healthy crop growth and obtain sustainable yield and quality apart from reduction in cost of chemical fertilizers. It is worth to note that nutrient management through organics play a major role in maintaining soil health due to build up of soil organic matter, beneficial microbes and enzymes, besides improving soil physical, chemical and biological properties. To achieve sustainable soil fertility and crop productivity, the role of green manures, organic manures, biofertilizers and other nutrient sources like use of fermented organic nutrients mainly panchagavya, jeevamruth, cow urine, vermiwash, bio-digester etc, are becoming popular among the farmers. Modern agriculture largely depends on the use of fossil fuel based inputs such as chemical fertilizers, pesticides and labour saving energy intensive farm machinery. The applications of such high input intensive technologies have undoubtedly increased the production and labour efficiency, but, there is a growing concern over their adverse effects on soil productivity and environmental quality. The intensive cultivation and monocropping are associated with problems mainly soil fertility degradation, micronutrient deficiencies, poor soil physical condition, soil biological activity and the out break of pest and diseases. All these posing serious threat to our food security and livelihood supporting systems. These problems are mainly due to abandoning the natural and ecological principles. Organic agriculture in the world has

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emerged as an alternative to the chemicals oriented intensive modern agriculture. In this context, to make the organic cotton production more sustained the field studies were carried out to study the yield, economics and energy use efficiency in organic production system.

MATERIAL METHODS

A Field experiment was conducted at MARS, Dharwad during 2010-11 and 2011-12 to study the "Nutrient management practices for organic cotton production". The soil of the experiment site was clay, having medium carbon (0.41%) and available NPK (264.70: 24.80:285.30 NPK kg ha^{-1}). The experiment was laid out in split plot design with three replications. The main plot comprises of five manurial treatments as M1 : Recommended dose of fertilizer (RDF) (80:40:40 N:P_2O_5:K_2O kg ha^{-1}+ FYM @5 t ha^{-1}), M2: Crop residues equivalent to 50% RDN with compost culture + vermicompost equivalent to 50% RDN M3: Crop residues equivalent to 50% RDF with Compost culture + vermicompost equivalent to 50% RDF, M4: Compost equivalent to 50% RDN + vermicompost equivalent to 50% RDN, M5: Compost equivalent to 50% RDF + vermicompost equivalent to 50% RDF and sub plot consists of six green manures treatments are S1 : Gliricidia GLM mulch @ 7.5 t ha$^{-1,}$ S2: Gliricidia GLM mulch @ 7.5 t ha^{-1}+ Soil application of jeevamrutha @ 500 lit ha^{-1} at sowing, 30, 60 and 90 DAS, S3 : Lucerne GM alone as inter crop (1:2 row proportion), S4 : Lucerne GM as inter crop + Soil application of Jeevamrutha @ 500 lit ha^{-1}, S5 : Sunnhemp GM alone as inter crop (1:2 row proportion), S6: Sun hemp GM as inter crop + Soil application of jeevamrutha @ 500 lit ha^{-1}, two control treatments are T1: Recommended dose of fertilizer (RDF) (80:40:40 N:P_2O_5:K_2O kg ha^{-1}+ FYM @ 5 t ha^{-1}) and T2: Recommended dose of fertilizer (RDF)(80:40:40 N:P_2O_5:K_2O kg ha^{-1}) only. As per the treatments the organic manures equivalent to RDN and RDF through farm yard manure, cotton stalks (50%), compost (50%), green leaf manure were applied 15 days before sowing and 50% vermicompost was spot applied to the soil before dibbling of cotton seeds and top dressing with remaining 50% of vermicompost was done at 60 DAS. The chemical fertilizers as per the recommended package alone and along with farm yard manure were applied to the check treatments. The seeds were treated with cou urine, *Azospirilum*, Phosphate solubalizing bacteria, *Pseudomonas striata,* Trichoderma and cou dung slurry before sowing. The seed of Hybrid cotton DHB-915 was obtained from ARS Dharwad, Hebballi farm and were hand dibbled with two cotton seeds per hill on 12, july, 2010 and 15 june, 2011. Two rows of sunnhemp and lucerne at 30 cm apart were grown as a green manure crops in between two rows of cotton (90 cm). Sunnhemp was cut at 30-35 DAS was mulched in between the rows where lucerne was regularly harvested (3 times during the year) at 30 to 35 days interval and used as mulch between the rows. Gliricidia green leaf manures @ 7.5 t ha^{-1} were mulched in between the cotton row at 30 DAS. The energy use efficiency was worked out in terms of kg crop yield (main crop) produced per 1000 MJ energy consumption in the cropping system (Padhi *et al.*, 2001).

RESULTS AND DISCUSSION

The complimentary use of organic manures mainly vermicompost, compost and liquid organic manures complimented each other and produced higher yield and sustained the soil fertility and crop productivity. Poole data indicated that, combined application of compost (50%) + vermicompost (50%) equivalent to RDF recorded (Table 1) significantly higher kapas yield (1579 kg/ha) over other organic manurial treatments but was on par with crop residue (50%) + vermicompost (50%) equivalent to RDF. The higher kapas yield in this treatment might be due to higher mean boll weight (4.42 g) and kapas weight per plant (107.96 g). The higher yield parameters in organic treatments was mainly due to vermicompost, compost and crop residues can supply both macro, micro nutrients in addition they have growth promoting substances like cytokine and GA available throughout growing period of cotton and these organic supplement the nutrient requirement of crops apart from conservation of more rain water and its supply as these treatments noticed higher available soil moisture content (Raut and Mehetre, 2008 and Lokesh *et al.,* 2008). Among the green manuring treatments, application of gliricidia green leaf manure @ 7.5 t per ha with jeevamrutha @ 500 l/ha surface applied recorded significantly higher kapas yield (1621 kg/ha) over other green manuring treatments and was on par with lucerne green manure + jeevamrutha, gliricidia green leaf manure and lucerne green manure alone. Higher kapas yield in this green manuring treatment mainly due to higher mean boll weight (4.46 g) and kapas weight per plant (109.08 g), The growth and yield parameters were higher in these green manures mainly due to least competition for nutrients, space, light and moisture during initial period of growth and also produced organic acids and CO_2

during their decomposition, which accelerates weathering process and will make unavailable P into available P and release of K in to soil solution and also enhance beneficial soil organisms. These results were in agreement with those of Satyanarayana Rao and Janawade (2009).

Among the organic combinations application of compost (50%) + vermicompost (50%) equivalent to RDF + green leaf manure as mulch with application of jeevamrutha @ 500 l/ha recorded higher kapas yield (1640 kg) and it is superior over RDF alone (1522 kg/ha). However it was on par with RDF + FYM (1722 kg/ha). Higher yield in this organic treatment is mainly due these organic manure provides essential plant nutrients including micronutrients and it also improves soil physical, chemical and biological environment of soil for favourable crop growth and yield. The organic manures also increase the adsorptive power of soil for cations and anions particularly phosphates and nitrates and these are released slowly for the benefit of crop during the entire crop growth period leading to higher yield. The less yield in RDF alone treatment was mainly due fertilizer are highly concentrated source of nutrients, they supply the nutrients in large quantities often not commensurate with gradual requirement of plant growth. The supply of nutrients often exceeds the inherent capacities of the soil to store the nutrients for future use, for the reason, most of applied fertilizers are wasted resulting into low nutrient use efficiency (Ravankar *et al*. (2000). To work out the economics of cotton, we considered 20% premium price for organically grown cotton as compared to conventional cotton. Pooled data indicated that, among the nutrient management practices application crop residue (50%) + vermicompost (50%) equivalent to RDF recorded (Table 2) significantly higher net returns (Rs. 57220) and B:C ratio (2.80) over other manurial treatments but was on par with crop residue (50%) + vermicompost (50%) equivalent to RDN and compost (50%) + vermicompost (50%) equivalent to RDF . Higher net returns and B:C ratio in this treatment mainly due to lower cost of cultivation as crop residue supply 50% nitrogen as required by cotton. Among the green manuring treatments, application of green leaf manure (GLM) @ 7.5 t per ha with jeevamrutha @ 500 l/ha surface applied recorded significantly higher Net returns (Rs. 55890) and B:C ratio (2.7) over other green manures. Among the different treatment combinations, application of crop residue (50%) + vermicompost (50%) equivalent to RDF with lucerene with jeevamrutha @ 500 l/ha surface application recorded significantly higher net returns (60009) over other combinations but was on par with crop residue (50%) + vermicompost (50%) equivalent to RDF with GLM with jeevamrutha @ 500 l/ha surface application. Integrated application crop residue (50%) + vermicompost (50%) equivalent to RDF with GLM as surface mulch recorded significantly higher B:C ratio (2.87) over other combinations but was on par with crop residue (50%) + vermicompost (50%) equivalent to RDF with lucerne green manure.

Among the nutrient management practices, application of compost (50%) + vermicompost (50%) equivalent to RDN recoded significantly (Table 3) higher energy use efficiency and energy productivity (1.80 and 0.151 kg MJ^{-1}, respectively) over FYM @ 5 t ha^{-1} + RDF (1.65 and 0.14 kg MJ^{-1}, respectively). Higher energy use efficiency in organic treatment was mainly due to energy required for production of organic manures is less as compared to inorganic fertilizer. Experiment was conducted to determine the energy input and output involved in cotton production in the Hatay province of Turkey. The average energy consumption of the farms investigated in this study was 19558 $MJha^{-1}$. Of the total energy, 2.87% is direct and 71.13% is indirect. Renewable energy accounts for 12.30% and energy usage efficiency is found to be 2.36. The total energy input into the production of one kilogram of average Turkish cotton is estimated to be 4.99 MJ (Erdal *et al*., 2009). Brar *et al*. (2011) reported that highest energy out put was recorded under conventional sown wheat in 2005-06 and zero till sown wheat in 2006-07, respectively. However, energy use efficiency was maximum under zero till sown wheat during both the years of investigation because of lowest energy input under zero till sown wheat than conventional and bed planting. Nawab Ali (2005) observed higher energy productivity in maize (0.21 MJ ha^{-1}) compared to pulses (0.11-0.17 MJ ha^{-1}). Application of GLM @ 7.5 t ha^{-1} with surface application of jeevamrutha @ 500 l ha^{-1} recorded significantly higher energy use efficiency and energy productivity (1.78 and 0.151 kg MJ^{-1}, respectively) as compared to sunnhemp green manuring alone and was on par with lucerne green manure + surface application of jeevamrutha @ 500 l ha^{-1}. Combined application of compost (50%) + vermicompost (50%) equivalent to RDN + GLM with surface application of jeevamrutha @ 500 l ha^{-1} recorded significantly higher energy use efficiency and energy productivity (1.84 and 0.156 kg MJ^{-1}, respectively over RDF alone (1.60 and 0.135 kg MJ^{-1}, respectively). Padhi *et al*. (2001)

Table 1
Mean Boll Weight and Kapas Yield of Cotton as Influenced by Organic Manures, Green Manures and Liquid Organic Manures

Treatment	*2010-11*		*2011-12*		*Pooled*	
	Mean boll weight (g)	*Kapas yield (kgha^{-1})*	*Mean boll weight (g)*	*Kapas yield (kgha^{-1})*	*Mean boll weight (g)*	*Kapas yield (kgha^{-1})*
Organic Manure (M)						
M_{-1} - RDF+ FYM	4.83a	1701a	4.90a	1853a	4.87a	1777a
M_2-CR (1/2)+ VC(1/2) equi.to RDN	4.08c	1305c	3.96c	1577c	3.91c	1440c
M_3-CR(1/2) + VC (1/2) equi.to RDF	4.31b	1382b	4.55b	1725b	4.40b	1560b
M_4-C(1/2) + VC (1/2) equi.to RDN	4.20c	1316c	4.03c	1607c	4.03c	1458c
M_5-C (1/2) + VC (1/2) equi.to RDF	4.50b	1421b	4.57b	1730b	4.42b	1579b
S.Em.±	0.09	14.05	0.08	16.01	0.06	14.61
Green Manures + Liquid Manures (G)						
G_1 – Gliricidia green leaf manure	4.44a-c	1441ab	4.47a	1729a	4.36a	1584a
G_2 –GLM + jeevamrutha	4.49a	1475a	4.54a	1758a	4.46a	1621a
G_3 - Lucerne4.39a-c	1436ab	4.45a	1722a	4.36a	1579a	
G_4 - Lucerne + jeevamrutha	4.47ab	1452a	4.51a	1747a	4.42a	1608a
G_5 - Sunnhemp4.21c	1359c	4.22b	1605b	4.15b	1477b	
G_6 - Sunnhemp + jeevamrutha	4.30bc	1388bc	4.22b	1629b	4.19b	1508b
S.Em.±	0.07	25.43	0.06	25.93	0.04	18.87
Interactions (MXG)						
M_1G_1	4.92ab	1703a	4.98a	1864a	4.95a-c	1784ab
M_1G_2	5.00a	1777a	5.09a	1938a	5.05a	1858a
M_1G_3	4.78a-c	1697a	4.84a	1858a	4.82a-d	1778ab
M_1G_4	4.96a	1734a	5.02a	1895a	4.99ab	1814ab
M_1G_5	4.63a-e	1631ab	4.69a-d	1781ab	4.66c-e	1706b-d
M_1G_6	4.70a-d	1666a	4.76ab	1781ab	4.73b-e	1724bc
M2G_1	3.90gh	1334c-f	4.04e-g	1626b-d	3.97k-n	1480h-k
M_2G_2	3.94f-h	1338c-f	4.06e-g	1632b-d	4.00k-n	1485h-k
M_2G_3	3.87gh	1333c-f	4.01e-g	1624b-d	3.94k-n	1479i-k
M_2G_4	3.91gh	1335c-f	4.04e-g	1631b-d	3.98k-n	1483h-k
M_2G_5	3.72h	1203f	3.77g	1421e	3.75n	1312l
M_2G_6	3.82gh	1274d-f	3.84gh	1526de	3.83mn	1400k-l
M_3G_1	4.19d-h	1387c-f	4.68a-d	1764ab	4.44e-i	1575d-i
M_3G_2	4.35c-g	1467b-d	4.73a-c	1789ab	4.54d-h	1628c-g
M_3G_3	4.17d-h	1380c-f	4.64a-d	1743a-c	4.44e-i	1562e-j
M_3G_4	4.33c-g	1465b-d	4.72a-d	1783ab	4.52d-h	1624c-h
M_3G_5	4.12e-h	1336c-f	4.24d-g	1630b-d	4.18i-l	1483h-k
M_3G_6	4.21d-h	1340c-f	4.31b-f	1639b-d	4.26g-k	1490g-k
M_4G_1	4.04f-h	1335c-f	3.99e-g	1628b-d	4.01j-n	1482h-k
M_4G_2	4.10e-h	1356c-f	4.07e-g	1633b-d	4.09j-m	1495f-k
M4G_3	4.02f-h	1334c-f	4.13e-g	1627b-d	4.17i-l	1480h-k
M_4G_4	4.07e-h	1340c-f	4.05e-g	1631b-d	4.06j-n	1486h-k
M_4G_5	3.85gh	1221ef	4.10e-g	1560c-e	3.97k-n	1390k-l
M_4G_6	3.90gh	1276d-f	3.86e-g	1561c-e	3.88l-n	1418j-l
M5G_1	4.20d-h	1442cd	4.67a-d	1761ab	4.44e-i	1602c-i
M_5G_2	4.50a-f	1483bc	4.76ab	1797ab	4.63d-f	1640c-e
M_5G_3	4.18d-h	1434cd	4.65a-d	1758a-c	4.45e-i	1596c-i
M_5G_4	4.39b-g	1470b-d	4.74a-c	1795av-b	4.56d-g	1633c-f
M_5G_5	4.10e-h	1355c-f	4.27c-f	1634b-d	4.19i-l	1494f-k
M_5G_6	4.12e-h	1383bc	4.35b-e	1637b-d	4.24h-k	1510e-k
C_1 – RDF+ FYM	4.71a-d	1623ab	4.76ab	1820ab	4.74b-e	1722bc
C_{2-} RDF only	4.32c-g	1410c-e	4.34b-e	1633b-d	4.33f-j	1522e-k
S.Em.±	0.17	56.51	0.14	57.88	0.098	41.86

Note: CR- Crop residues; C-Compost; VC- Vermicompost ; RDF – 80 :40 :40 NPK kg + FYM @ 5 t ha^{-1} ; RDN-80:40:40 NPK kg ha^{-1}

Table 2
Net Returns and B:C ratio of Cotton as Influenced by Organic Manures, Green Manures and Liquid Organic Manures

Treatment	*2010-11*		*2011-12*		*Pooled*	
	Net returns (Rs/ha)	*B:C ratio*	*Net returns (Rs/ha)*	*B:C ratio*	*Net returns (Rs/ha)*	*B:C ratio*
Organic Manure (M)						
M_{-1} - RDF+ FYM	53530a	2.70a	51690c	2.64d	52800b	2.67bc
M_2-CR (1/2)+ VC(1/2) equi.to RDN	48270b	2.61a	55080b	2.8b	52090b	2.74a
M_3-CR(1/2) + VC (1/2) equi.to RDF	52100a	2.65a	61340a	2.93a	57220a	2.80a
M_4-C(1/2) + VC (1/2) equi.to RDN	46900b	2.48b	54900b	2.72c	51350b	2.62ab
M_5-C (1/2) + VC (1/2) equi.to RDF	51680a	2.52b	59290a	2.74c	55940a	2.64c
S.Em.±	811.9	0.026	857.3	0.026	813.2	0.025
Green Manures + Liquid Manures (G)						
G_1 – GLM only51600ab	2.65ab	58430a	2.85a	55440a	2.76a	
G_2 –GLM + jeevamrutha	52590a	2.60ab	58380a	2.77ab	55890a	2.70ab
G_3 - Lucerne51640ab	2.66a	58380a	2.87a	55430a	2.78a	
G_4 - Lucerne + jeevamrutha	52050a	2.60ab	58180a	2.78	55520a	2.70a
G_5 - Sunnhemp47180b	2.55ab	52800b	2.64b	50370b	2.65bc	
G_6 - Sunnhemp + jeevamrutha	47930ab	2.50b	52600b	2.72ab	50620b	2.58c
S.Em.±	1495.0	0.048	1390.0	25.93	1062.0	0.034
Interactions (MXG)						
M_1G_1	53965a-d	2.73ab	52545b-e	2.68b-f	53456a-f	2.71a-f
M_1G_2	56182a	2.72ab	54390a-d	2.66b-f	55487a-e	2.69a-f
M_1G_3	53965a-d	2.75a	52575b-e	2.69a-f	53471a-f	2.73a-f
M_1G_4	54298a-c	2.68ab	52725b-e	2.62c-f	53713a-f	2.65a-g
M_1G_5	51248a-e	2.69ab	49695de	2.63c-f	50659b-f	2.67a-g
M_1G_6	51515a-e	2.62ab	48210de	2.51ef	50006c-f	2.57d-g
M_2G_1	50480a-e	2.71ab	58095a-d	2.96a-c	54725a-e	2.85ab
M_2G_2	49236a-e	2.58ab	56922a-d	2.82a-e	53520a-f	2.72a-f
M_2G_3	50736a-e	2.73ab	58287a-d	2.98ab	54947a-e	2.87a
M_2G_4	49336a-e	2.60ab	57183a-d	2.85a-d	53704a-f	2.74a-f
M_2G_5	43536c-e	2.52ab	47907de	2.66b-f	46047fg	2.60b-g
M_2G_6	46276a-e	2.53ab	52113ce	2.72a-f	49573d-g	2.64e-g
M_3G_1	51906a-e	2.66ab	63798a	3.03a	58417ab	2.87a
M_3G_2	55206ab	2.68ab	63644a	2.93a-c	59908a	2.82a-d
M_3G_3	51806a-e	2.67ab	62996ab	3.02a	57946a-c	2.86a
M_3G_4	55406ab	2.71ab	63656a	2.95a-c	60009a	2.84a-c
M_3G_5	49786a-e	2.64ab	57476a-d	2.88a-d	54072a-f	2.77a-e
M_3G_6	48512a-e	2.52ab	56480a-d	2.76a-f	52945a-f	2.66a-g
M_4G_1	48760a-e	2.55ab	56420a-d	2.79a-f	53030a-f	2.69a-f
M_4G_2	48480a-e	2.48ab	55190a-d	2.67b-f	52252a-f	2.59c-g
$M4G_3$	48980a-e	2.58ab	56630a-d	2.81a-e	53244a-f	2.71a-f
M_4G_4	47840a-e	2.47ab	55382a-d	2.69a-f	52048a-f	2.59b-g
M_4G_5	42780de	2.40ab	53621a-e	2.75a-f	48709e-g	2.60b-g
M_4G_6	44580b-e	2.39ab	52184c-e	2.63c-f	48810e-g	2.52e-g
$M5G_1$	52890a-d	2.57ab	61276a-c	2.81a-e	57561a-d	2.71a-f
M_5G_2	53830a-d	2.53ab	61756a-c	2.75a-f	58265ab	2.65a-g
M_5G_3	52690a-d	2.58ab	61432a-c	2.83a-e	57547a-d	2.72a-f
M_5G_4	53350a-d	2.53ab	61952a-c	2.77a-f	58139a-b	2.66a-g
M_5G_5	48550a-e	2.48ab	55318a-d	2.68b-f	52352a-f	2.59b-g
M_5G_6	48750a-e	2.42ab	53998a-d	2.57d-f	51755b-f	2.51f-g
C_1 – RDF+ FYM	50767a-e	2.67ab	52065c-e	2.67a-f	51254a-f	2.68a-f
$C_{2\ -}$ RDF only	40832e	2.53b	45285e	2.61f	44229g	2.58g
S.Em.±	3263.0	0.104	3044.0	0.096	2333.0	0.073

Note: CR- Crop residues; C- Compost; VC- Vermicompost ; RDF – 80: 40: 40 NPK kg + FYM @ 5 t ha^{-1} ; RDN-80:40:40 NPK kg ha^{-1}

Table 3
Energy use Efficiency and Energy Productivity of Cotton as Influenced by Organic Manures, Green Manures and Liquid Organic Manures

Treatment	*Energy use efficiency*	*Energy productivity (kg MJ^{-1})*
Organic Manure (M)		
M_1 - RDF+ FYM	1.65b	0.140b
M_2-CR (1/2) + VC(1/2) equi.to RDN	1.78a	0.151a
M_3-CR(1/2) + VC (1/2) equi.to RDF	1.67b	0.141b
M_4-C(1/2) + VC (1/2) equi.to RDN	1.80a	0.152a
M_5-C (1/2) + VC (1/2) equi.to RDF	1.68b	0.143b
S.Em.±	0.017	0.0012
Green Manures + Liquid Manures (G)		
G_1 - GLM alone	1.74a	0.148a
G_2 - GLM + jeevamrutha	1.78a	0.151a
G_3 - Lucerne alone	1.74a	0.147a
G_4 - Lucerne + jeevamrutha	1.76a	0.150a
G_5 - Sunnhemp alone	1.62b	0.137b
G_6 - Sunnhemp + jeevamrutha	1.66b	0.140b
S.Em.±	0.018	0.0016
Interactions (MXG)		
M_1G_1	1.66c	0.140c
M_1G_2	1.73a-c	0.146a-c
M_1G_3	1.65c	0.140c
M_1G_4	1.69a-c	0.143a-c
M_1G_5	1.59c	0.134c
M_1G_6	1.60c	0.136c
M_2G_1	1.83ab	0.155ab
M_2G_2	1.83ab	0.155a
M_2G_3	1.83ab	0.155ab
M_2G_4	1.83ab	0.155a
M_2G_5	1.62c	0.137c
M_2G_6	1.73a-c	0.147a-c
M_3G_1	1.68a-c	0.143a-c
M_3G_2	1.74a-c	0.147a-c
M_3G_3	1.67bc	0.143bc
M_3G_4	1.73a-c	0.147a-c
M_3G_5	1.58c	0.134c
M_3G_6	1.59c	0.135c
M_4G_1	1.83ab	0.155ab
M_4G_2	1.84a	0.156a
M_4G_3	1.83ab	0.155ab
M_4G_4	1.83ab	0.155ab
M_4G_5	1.72a-c	0.145a-c
M_4G_6	1.75a-c	0.148a-c
M_5G_1	1.71a-c	0.145a-c
M_5G_2	1.75a-c	0.148a-c
M_5G_3	1.70a-c	0.144a-c
M_5G_4	1.74a-c	0.147a-c
M_5G_5	1.59c	0.136c
M_5G_6	1.61c	0.136c
C_1 – RDF+ FYM	1.62c	0.136c
C_2 - RDF alone	1.60c	0.135c
S.Em.±	0.048	0.0040

Note: CR- Crop residues; C- Compost; VC- Vermicompost; RDF – 80: 40: 40 NPK kg + FYM @ 5 t ha^{-1}; RDN-80:40:40 NPK kg ha^{-1}

from Kalimela (Orissa) reported that intercropping of maize with french bean in 2:2 ratio had higher output energy (174.81 x 1000 MJ ha^{-1}), energy output/ input ratio (12.26) and energy use efficiency (446.7 kg 1000 MJ^{-1}) than other intercropping systems. Finally concluded that, combinationed application of compost (50%) + vermicompost (50%) equivalent to RDF + green leaf manure as mulch with application of jeevamrutha @ 500 l/ha recorded yield, economics and energy use efficiency.

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