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Effect of organic sources of nutrients and weed management on weed flora, basmati rice growth and yield in Jammu region

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ABSTRACT

A field experiment was conducted during *Kharif* (rainy) seasons of 2015 and 2016 to study the response of varying organic and inorganic sources of nutrients and weed management on weed flora, basmati rice growth and yield. Application of 100% organics + vesicular-arbuscular mycorrhiza (VAM) recorded significantly higher values of growth parameters, yield attributes, grain yield, net returns and B:C ratio of rice which was statistically at par with 100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean and 100% organics (100% recommended nitrogen using different organic sources each equivalent to 1/3 of recommended nitrogen *i.e.* farm yard manure (FYM)+ vermicompost + non edible oil cake). Amongst the weed management treatments, application of mustard seed meal 5 t/ha resulted in significantly lowest weed density and biomass (species wise and total); highest weed control efficiency; lowest weed index; highest growth, yield attributes and grain yield of basmati rice which was statistically at par with application of rice bran 4 t/ha and weed free treatment. However, the highest net returns and B:C ratio were obtained in weed free plots.

INTRODUCTION

Rice (*Oryza sative* L.) is one of the main staple food crops of India, covering an area of about 43.8 million hectares with total production of 118.4 million tons and productivity of 2.7 t/ha (Anonymous 2019). Out of the total 736-thousand-hectare net cultivated area in the Jammu and Kashmir state, rice is cultivated on 274-thousand-hectare area with productivity of 3.64 t/ha. In Jammu province, rice is cultivated on 116 thousand hectares area with production of 3284 thousand quintals and productivity of 28.31 quintals per hectare (Anonymous 2016). Among the rice cultivars, basmati rice requires low nutrients for its growth as compared to course rice cultivars, therefore can best fit in the system based organic agriculture. Adoptions of organic agriculture practices address the growing global awareness on quality food, good health and safe environment and thus there has been a paradigm shift and interest to adopt organic crop production systems which are ecologically and economically viable and socially justified (Aher *et al.* 2012). Organic sources of nutrients are the best alternative for improving physical and biological properties of soil and improving crop productivity of rice based high value crops (Yadav *et al.* 2013). It has been also realized that weed infestation is the major yield limiting factor in rice production causing heavy rice yield losses (Rao *et al.* 2007), particularly in organic culture. Hence, studies were conducted on assessing the organic nutrition options and identify economical organic weed management treatment in Jammu region.

MATERIALS AND METHODS

The study was conducted at Research Farm of AICRP-IFS, Chatha, SKUAST-Jammu during *Kharif* (rainy) season of 2015 and 2016 in split-plot design with 3 replications. The soil of experimental field was clay loam having initial pH 8.04, organic carbon (0.55%) and available nitrogen (N), phosphorous (P) and potassium (K) of 220.40, 18.25 and 118 kg/ha, respectively. The treatments consisted of six sources of nutrients in main plot, *viz*. 50% recommended (Rec.) NPK using inorganic fertilizers + 50% N using farm yard manure (FYM) + inorganic source of micronutrients as per soil test, 100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e*. FYM + vermicompost + non edible oil cake, 100% organics (100% Rec. N using different

organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake)+ marigold planted on border for potato crop as trap crop and bottle guard was planted on border as trap crop for french bean in the following seasons, 50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + phosphate solubilizing bacteria (PSB 10 kg/ha), 100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM + vermicompost + non edible oil cake) + VAM, 100% Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer and sub plots comprised of four weed management treatments, *viz.* weed free, mustard seed meal 5 t/ha, Rice bran 4 t/ha and weedy check. Rice was transplanted at a spacing of 20 x 10 cm. Irrigation was applied at regular intervals in rice as per need. Mustard seed meal and rice bran were applied as pre-plant incorporation (PPI) ten days before transplanting of rice. Hand weeding (30 man days/ha) was done till the crop reaches physiological maturity in weed free plots with the help of *khurpi* hand operated small spade.

A quadrat of 1m^2 was used to take observation on species wise weed density and biomass through random sampling in each plot at 60 days after transplanting (DAT). The species wise and total number of weeds (weed density) were counted in each plot separately and analyzed after subjecting the original data to square-root transformation. For weeds dry biomass, species wise weeds were collected from 1m^2 area were dried under the sun and then in oven at 70^{o}C for 48 h and weighed at 60 DAT. Weed control efficiency (at 60 DAT) and weed index were calculated based on the data recorded in rice as per standard formula. Plant height (cm), number of tillers/m^2 and dry matter accumulation (g/m^2) were measured at flowering stage of the crop. Number of effective tillers/m^2, number of grains/panicles, 1000 grain weight (g) and grain yield was recorded just before harvesting. The grain yield was recorded from 13.2 m^2 area and rice grain yield was expressed at 14% moisture content. The net returns were computed by deducting the total cost of cultivation from the gross returns as per treatments. While the benefit: cost ratio was calculated by dividing the net returns with the cost of cultivation for different treatments. However, for better understanding, original values of weed density and biomass are given in parenthesis. While the ANOVA indicated significant treatment effects, means were separated at $p<0.05$ and adjusted with Fisher's protected least significant difference (LSD) test.

RESULTS AND DISCUSSION

Weed flora

Weed flora of the experimental plots comprised of grasses: *Cynodon dactylon, Echinocloa* spp. broad-leaved weeds: *Commelina benghalensis, Ammania baccifera, Alternanthera philoxeroides, Phyllanthus niruri* and *Sphenoclea zeylanica,* and sedge: *Cyperus* spp.

Weed density and biomass, weed control efficiency and weed index

The species wise and total weed density, species wise and total weed biomass among different sources of nutrients at 60 DAT during both the crop seasons were not different statistically (**Table 1** and **2**). The application of 100% organics + VAM recorded the lowest species wise and total weed density, biomass, highest weed control efficiency at 60 DAT. Among the organic weed management treatments, application of mustard seed meal 5 t/ha significantly reduced the species wise and total weed density and biomass and recorded highest weed control efficiency with lowest weed index which was at par with application of rice bran 4 t/ha. However, a slight decrease in species wise and total weed density and biomass was observed in the second year experimentation rice crop (2016).

This could be attributed to better efficacy and due to presence of glucosinolates in mustard seed meal and enzymatic hydrolysis to isothiocyanates, thiocyanate, nitriles and other compounds which may be partly responsible for phytotoxic effect and did not allow the weeds to germinate and even resulted, reduction in leaf area and diminution of photosynthesis process (Stevens *et al.* 2009). Thiocyanate ion is reportedly released from mustard seed meal (MSM) in the presence of myrosinase enzyme and water and may be partially responsible for the observed phytotoxicity to weeds (Borek and Morra 2005). Application of rice bran 4 t/ha also reduced the species wise and total weed density and biomass, which might be due to because of high concentration of phytotoxic substances, that reduce weeds, including organic acids, ammonia, ethylene oxide, phenolic compounds and growth inhibitors present in the rice bran (Kuk *et al.* 2001,Khan *et al.* 2007 and Bhuiyan *et al.* 2014).

Among the different sources of nutrients, lowest weed index was observed with the application of 100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean whereas, the highest weed index was recorded

in 50 % Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB during both the years of experimentation (**Table 3**). The performance of crops is directly related to the weed control efficiency and therefore inversely associated with the weed index.

Rice growth, yield attributes and grain yield

Plant growth parameters such as plant height (cm), dry matter accumulation (g/m^2) and number of tillers/m^2 were significantly influenced by organic sources of nutrients and weed management treatments during both the years of experimentation (**Table 4**). The overall growth of rice crop measured in terms of plant height, dry matter accumulation and number of tillers/m^2 was comparatively less during the first year of experimentation due to less distribution of rainfall as compared to second year. Between the various sources of nutrients, application of 100% organics + VAM recorded significantly highest plant height (cm), dry matter accumulation (g/m^2), number of tillers/m^2, no. of effective tillers/ m^2, no. of grains/panicle, 1000 grain weight, and grain yield, which was statistically at par with 100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean and 100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake (T**abble 4** and **5**). Significant increase in growth parameters of rice *i.e.* plant height, dry matter accumulation and number of tillers/ m^2 might be due to release of sufficient amounts of N by mineralization at constant level, which in turn resulted in better crop growth of rice crop (Yadav *et al.* 2009, 2013, Davari and Sharma 2010 and Pandey *et al.* 2015), and Singh *et al.* (2011). Increased radiation interception as well as better nutrition of crop plant due to organic manures application might have increased the photosynthesis rate which was reflected in significant increase in the growth characters and yield of rice (Singh and Mandal, 1997).

Among different weed management treatments, application of mustard seed meal 5 t/ha recorded significantly highest plant height, dry matter accumulation, number of tillers/m^2, highest no. of effective tillers/m^2, no. of grains/panicle, 1000 grain

Table 1. Effect of varying sources of nutrients and weed management treatments on species wise and total weed density in rice at 60 DAT

Treatment	*Cynodon dactylon*		*Echinocloa* spp.		*Commelina benghalensis*		*Ammania baccifera*		*Cyperus* spp.		Other weeds		Total weed density (no./m^2)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Sources of nutrients														
50% Rec. NPK using fertilizer + 50% N through FYM + inorganic source of micronutrients as per soil test	3.46 (12.76)	3.56 (11.49)	2.41 (5.48)	2.33 (5.04)	2.67 (7.15)	2.57 (6.60)	2.68 (7.31)	2.59 (6.75)	4.26 (20.86)	4.09 (19.13)	2.18 (4.10)	2.10 (3.73)	6.80 (57.64)	6.54 (52.76)
100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake)	3.41 (12.58)	3.50 (11.33)	2.36 (5.35)	2.27 (4.92)	2.60 (6.95)	2.50 (6.42)	2.62 (7.08)	2.51 (6.56)	4.21 (20.60)	4.03 (18.90)	2.15 (4.05)	2.06 (3.69)	6.76 (56.61)	6.51 (51.83)
100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean	3.36 (12.39)	3.47 (11.16)	2.33 (5.33)	2.26 (4.90)	2.57 (6.92)	2.49 (6.39)	2.59 (7.05)	2.50 (6.52)	4.14 (20.32)	3.98 (18.65)	2.11 (4.00)	2.05 (3.65)	6.73 (56.00)	6.46 (51.27)
50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	3.55 (13.25)	3.67 (11.93)	2.49 (5.70)	2.42 (5.24)	2.75 (7.49)	2.67 (6.90)	2.77 (7.68)	2.70 (7.08)	4.36 (21.56)	4.20 (19.76)	2.21 (4.22)	2.15 (3.84)	6.97 (59.90)	6.61 (54.77)
100% organics + VAM	3.35 (12.30)	3.49 (11.07)	2.31 (5.23)	2.27 (4.82)	2.55 (6.77)	2.49 (6.26)	2.56 (6.89)	2.51 (6.38)	4.14 (20.19)	4.00 (18.53)	2.11 (3.98)	2.07 (3.63)	6.68 (55.36)	6.41 (50.69)
100% Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer	3.52 (12.97)	3.60 (11.68)	2.46 (5.54)	2.37 (5.10)	2.71 (7.24)	2.61 (6.68)	2.74 (7.41)	2.63 (6.84)	4.32 (21.15)	4.13 (19.40)	2.20 (4.15)	2.12 (3.78)	6.95 (58.47)	6.58 (53.49)
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed management														
Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Mustard Seed Meal 5 t/ha	4.01 (15.17)	3.76 (13.23)	2.44 (4.99)	2.31 (4.35)	2.63 (6.03)	2.49 (5.25)	2.62 (5.94)	2.48 (5.18)	4.62 (20.48)	4.33 (17.86)	2.35 (4.54)	2.22 (3.96)	7.61 (57.15)	7.12 (49.83)
Rice bran 4 t/ha	4.12 (16.04)	3.86 (13.96)	2.51 (5.33)	2.37 (4.64)	2.74 (6.53)	2.58 (5.69)	2.74 (6.54)	2.58 (5.69)	4.76 (21.73)	4.46 (18.92)	2.40 (4.76)	2.27 (4.14)	7.86 (60.92)	7.34 (53.04)
Weedy check	4.53 (19.63)	4.42 (18.59)	3.52 (11.43)	3.47 (11.03)	4.09 (15.78)	4.03 (15.2)	4.18 (16.5)	4.11 (15.89)	6.47 (40.91)	6.36 (39.47)	2.83 (7.03)	2.79 (6.78)	10.59 (111.2)	10.38 (107.0)
LSD (p=0.05)	0.14	0.13	0.08	0.07	0.12	0.10	0.13	0.12	0.17	0.16	0.06	0.06	0.26	0.23

LSD = Least significant difference at the 5% level of significance; DAT - Days after transplanting; the figures in the parentheses are original values

Table 2. Effect of varying sources of nutrients and weed management treatments on species wise and total weed biomass in rice at 60 DAT

Treatment	*Cynodon dactylon*		*Echinochloa* spp.		*Commelina benghalensis*		*Ammania baccifera*		*Cyperus* spp.		Other weeds		Total weed biomass (g/m^2)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Sources of nutrients														
50% Rec. NPK using fertilizer + 50% N using FYM + inorganic source of micronutrients as per soil test	3.09 (9.81)	2.96 (9.23)	2.90 (9.21)	2.79 (8.87)	2.86 (8.71)	2.74 (8.29)	2.94 (9.13)	2.83 (8.69)	3.80 (16.30)	3.66 (15.49)	2.62 (6.89)	2.60 (6.55)	6.90 (60.05)	6.65 (57.13)
100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake)	3.03 (9.64)	2.89 (8.75)	2.83 (8.94)	2.74 (8.43)	2.79 (8.42)	2.68 (7.83)	2.86 (8.78)	2.74 (8.14)	3.76 (16.16)	3.60 (14.88)	2.61 (6.78)	2.51 (6.21)	6.78 (58.72)	6.48 (54.24)
100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean	2.98 (9.45)	2.87 (8.58)	2.79 (8.90)	2.73 (8.39)	2.75 (8.38)	2.67 (7.78)	2.74 (8.72)	2.72 (8.09)	3.72 (16.01)	3.59 (14.74)	2.58 (6.65)	2.48 (6.10)	6.72 (58.12)	6.46 (53.69)
50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	3.16 (10.27)	2.98 (9.31)	2.98 (9.67)	2.83 (9.08)	2.94 (9.19)	2.79 (8.51)	3.03 (9.71)	2.87 (8.98)	3.86 (16.67)	3.66 (15.34)	2.68 (7.21)	2.65 (6.61)	7.01 (62.73)	6.72 (57.83)
100% organics + VAM	2.96 (9.37)	2.86 (8.50)	2.76 (8.71)	2.70 (8.22)	2.74 (8.17)	2.64 (7.60)	2.78 (8.48)	2.70 (7.87)	3.71 (15.94)	3.58 (14.68)	2.58 (6.59)	2.50 (6.04)	6.67 (57.26)	6.40 (52.90)
100% Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer	3.13 (10.01)	2.94 (9.07)	2.95 (9.34)	2.77 (8.79)	2.91 (8.84)	2.75 (8.20)	2.99 (9.29)	2.82 (8.60)	3.84 (16.46)	3.63 (15.14)	2.64 (7.03)	2.62 (6.44)	6.98 (60.96)	6.62 (56.25)
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed management														
Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Mustard seed meal 5 t/ha	3.38 (10.51)	3.18 (9.15)	2.65 (6.14)	2.49 (5.33)	2.71 (6.50)	2.56 (5.65)	2.87 (7.37)	2.70 (6.40)	4.04 (15.34)	3.79 (13.37)	2.86 (7.26)	2.70 (6.32)	7.34 (53.12)	6.85 (46.23)
Rice bran 4 t/ha	3.51 (11.36)	3.31 (10.00)	2.79 (6.83)	2.64 (6.02)	2.86 (7.23)	2.70 (6.35)	3.04 (8.34)	2.87 (7.34)	4.12 (16.03)	3.88 (14.13)	2.96 (7.77)	2.80 (6.88)	7.63 (57.55)	7.17 (50.71)
Weedy check	4.25 (17.17)	4.17 (16.48)	4.95 (23.56)	4.91 (23.17)	4.66 (20.73)	4.59 (20.14)	4.62 (20.36)	4.56 (19.84)	5.88 (33.65)	5.80 (32.69)	3.66 (12.40)	3.61 (12.11)	11.35 (127.88)	11.19 (124.42)
LSD (p=0.05)	0.13	0.13	0.14	0.15	0.14	0.14	0.19	0.18	0.12	0.12	0.14	0.12	0.30	0.32

LSD = Least significant difference at the 5% level of significance; ; DAT - Days after transplanting; the figures in the parentheses are original values

Table 3. Effect of varying sources of nutrients and weed management treatments on weed control efficiency and weed index in rice

Treatment	Weed control efficiency (%) at 60 DAT		Weed index (%)	
	2015	2016	2015	2016
Sources of nutrients				
50% Rec. NPK using fertilizer + 50% N using FYM + inorganic source of micronutrients as per soil test	52.07	54.47	5.10	5.10
100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM + vermicompost + non edible oil cake)	52.63	54.80	3.98	4.07
100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean	52.71	54.88	3.44	3.47
50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	50.84	53.18	5.35	5.34
100% organics + VAM	52.80	54.95	3.60	3.64
100% Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer	51.68	53.95	5.15	5.14
LSD (p=0.05)	-	-	-	-
Weed management				
Weed free	100.00	100.00	0.00	0.00
Mustard seed meal 5 t/ha	56.08	60.65	-2.53	-2.87
Rice bran 4 t/ha	52.41	56.84	-0.91	-1.10
Weedy check	0.00	0.00	21.19	21.80
LSD (p=0.05)	-	-	-	-

LSD = Least significant difference at the 5% level of significance; DAT = Days after transplanting

Table 4. Effect of varying sources of nutrients and weed management on growth parameters of rice

Treatment	Plant height (cm)		Dry matter accumulation (g/m^2)		No. of tillers/m^2	
	2015	2016	2015	2016	2015	2016
Sources of nutrients						
50% Rec. NPK using fertilizer + 50% N through FYM + inorganic source of micronutrients as per soil test	101.50	102.84	333.85	336.24	258.50	265.76
100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake)	108.07	109.60	378.42	382.05	294.05	302.30
100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean	108.87	110.25	380.47	384.17	297.27	305.62
50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	92.27	93.35	302.82	304.30	236.27	242.87
100% organics + VAM	112.14	113.78	386.84	390.71	302.85	311.35
100 % Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer	95.22	96.38	311.80	313.53	241.77	248.53
LSD (p=0.05)	4.33	4.52	13.36	13.72	10.45	10.74
Weed management						
Weed free	105.42	106.82	355.25	358.36	276.48	284.86
Mustard seed meal 5 t/ha	108.30	109.92	366.15	370.00	285.56	294.52
Rice bran 4 t/ha	105.85	107.34	359.45	362.91	280.07	288.72
Weedy check	92.48	93.39	315.28	316.06	245.04	249.52
LSD (p=0.05)	3.63	3.72	12.26	12.58	9.68	9.93

LSD = Least significant difference at the 5% level of significance

Table 5. Effect of varying sources of nutrients and weed management treatments on yield attributes, grain yield and economics of rice

Treatment	No. of effective tillers/m^2		No. of grains/panicle		1000 grain weight (g)		Grain yield (t/ha)		Net returns ($x10^3$ Rs/ha)		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Sources of nutrients												
50% Rec. NPK using fertilizer + 50% N using FYM + inorganic source of micronutrients as per soil test	253.67	258.32	62.00	63.42	24.82	25.20	3.61	3.76	18.17	43.90	0.27	0.66
100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake)	266.55	268.55	65.33	66.59	25.81	26.23	3.81	3.96	35.33	68.58	0.49	0.95
100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean	268.88	270.95	65.75	67.02	26.13	26.56	3.88	4.04	37.52	71.40	0.52	0.99
50% Rec. N using vermicompost + biofertilizers for N + rock phosphate to substitute the P requirement + PSB	249.80	256.31	57.67	58.96	24.00	24.04	3.34	3.48	25.50	54.90	0.37	0.81
100% organics+ VAM	269.66	271.75	66.00	67.27	26.31	26.74	3.95	4.10	38.38	72.75	0.52	1.00
100% Rec. NPK + secondary and micronutrients based on soil test using inorganic fertilizer	251.02	257.57	58.17	59.47	24.05	24.10	3.37	3.51	14.50	38.68	0.22	0.60
LSD (p=0.05)	10.92	11.21	3.10	3.18	1.24	1.28	1.51	1.76	-	-	-	-
Weed management												
Weed free	261.65	266.14	64.47	66.04	25.31	25.65	3.83	3.98	65.42	96.91	1.78	2.66
Mustard seed meal 5 t/ha	267.05	271.97	66.47	68.16	26.08	26.47	3.93	4.09	-26.32	6.41	-0.20	0.05
Rice bran 4 t/ha	265.02	269.75	65.36	66.99	25.54	25.91	3.86	4.02	23.93	55.95	0.30	0.71
Weedy check	246.01	247.76	53.64	53.97	23.82	23.89	3.03	3.13	49.90	74.21	1.60	2.41
LSD (p=0.05)	9.75	10.00	2.33	2.40	1.20	1.24	1.16	1.35	-	-	-	-

LSD, least significant difference at the 5% level of significance

weight and grain yield of rice which was statistically at par with application of rice bran 4 t/ha and weed free treatment (T**abble 4** and **5**). Higher nutrient content of mustard seed meal and minimal crop-weed competition due to significant reduction in weed density and biomass leading to increase in the availability of moisture, nutrients, space and light in favour of crop rather than those of weeds as reported by Ullah *et al.* (2008), Ibrahim and Mumtaz (2014) and Boydston *et al.* (2008).

Economics

The economic feasibility and usefulness of a treatment can be effectively adjudged in terms of B:C ratio and net returns. Among the sources of nutrients, application of 100% organics + VAM fetched higher net returns (₹ 38385/ha) and B:C ratio (0.52) closely followed by the application of 100% organics + marigold for potato on border as trap crop and bottle guard as trap crop for french bean and 100% Rec. N using different organic sources each equivalent to 1/3

of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake (**Table 5**). Almost a similar trend with respect to relative economics of rice was recorded during the second year (2016) of cropping except for that an improvement in net returns and B:C ratio was observed in the second-year rice crop as also reported by Meena *et al.* (2010). Amongst weed management treatments, highest net returns of Rs. 65419/ha and B:C ratio (1.78) were obtained in weed free plots (**Table 5**). Higher grain yield of rice in weed free treatment might have been responsible for the highest net returns and B:C ratio. However, the application of mustard seed meal 5 t/ha and rice bran 4 t/ha recorded the lowest net returns (Rs. -26318/ ha) and B:C ratio (-0.20) which was due to higher cost of inputs.

It is concluded that wide spectrum weed control and higher yield of basmati rice may be obtained with 100% organics (100% Rec. N using different organic sources each equivalent to 1/3 of Rec. N *i.e.* FYM+ vermicompost + non edible oil cake) + VAM and weed free conditions, depending on labor availability.

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