Int.J.Curr.Microbiol.App.Sci (2017) *6*(1): 922-932

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 1 (2017) pp. 922-932**
Journal homepage: http://www.ijcmas.com

Original Research Article http://dx.doi.org/10.20546/ijcmas.2017.601.109

Effect of Integrated Nutrient Management on Growth and Yield of Mustard (*Brassica juncea L.*) in Irrigated Condition of Upper Gangetic Plain Zone of India

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Keywords

Mustard, FYM, vermicompost, integrated nutrient management

Article Info

Accepted:
28 December 2016
Available Online:
10 January 2017

A B S T R A C T

A field experiment was conducted during rabi season 2011-2012 at Student Instructional Farm (SIF), C.S.A.U.A&T Kanpur. Eight treatments were tested in three replicated Randomized Block Design. Result found that significantly better growth attributes, yield attributes and grain yield (22.75 q/ha) was obtained with combined application of RDF + vermicompost @ 5.0 t/ha over rest of the treatments. The minimum grain yield (19.15 q/ha) was received in treatment RDF(120:60:40:30 Kg/ha NPKS). The application of RDF + vermicompost @ 5.0 t/ha was also found significantly higher gross income (Rs 81575) and net profit (Rs 35725) over rest of the treatments. While Benefit:Cost ratio was significantly higher (1.96) with application of RDF(120:60:40:30 Kg/ha NPKS) over rest of the treatments except at par with RDF + vermicompost @ 2.0 t/ha. The minimum gross income (Rs 69419/ha) was received in treatment RDF(120:60:40:30 Kg/ha NPKS) while the minimum net income and B:C ratio was found in treatment RDF + FYM @ 6.0 t/ha.

Introduction

Oilseeds, the second largest agricultural commodity after cereals in India, play a significant role in India's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. A range of oilseed crops viz. groundnut, rapeseed and mustard, soybean, sesame, sunflower, safflower and niger (edible) and linseed and castor (non edible) are cultivated in the country (Hegde and Sudhakara, 2011).Mustard is important edible oil next to groundnut. It's oil is used often for cooking and rapeseed mustard also valued for vegetable, condiments, fodder and medicinal purposes for remedy against stomach and skin disease etc. In India the overall area under rape mustard has increased by 1.85 lakh ha to 67.17 lakh hectares while the production is expected to jump by 12.32

lakh tonnes to 71.12 lakh tonnes. The average yield of rapeseed and mustard in country is 1103 Kg./ha. In India, Rajasthan ranks first both in area (26.74 lakh ha) and production (33.80 lakh metric tonnes). Gujarat state has the highest productivity (1485 Kg. ha^{-1}) of rapeseed mustard. In Uttar Pradesh, mustard is grown on 8 lakh hectare area with production of 10 lakh metric tonnes and productivity of 1250 Kg. ha^{-1}(Anonymous 2013). The indiscriminate application of inorganic fertilizer contributed to soil degradation. Major constraints responsible for low yield of rapeseed mustard in India are lack of high yielding biotic stress resistant varieties, cultivation under rainfed situation with imbalanced use of nutrient and poor dissemination of transfer of technology.

Randhawa (1992) stated that continuous application of chemical fertilizer create acidity resulting in phyto toxicity in crops. Hence modern Integrated Nutrient Management(INM) approach is need of the hour which involves efficient and judicious use of all the major components of plant nutrient sources viz. chemical fertilizer in conjunction with animal manures, compost, green manures, legumes in cropping system, biofertilizers, crop residues, or recyclable waste and other locally available nutrient sources for sustaining soil fertility, health and productivity. The integrated supply and use of plant nutrients from chemical fertilizer and organic manures has been found to produce higher crop yield than when each is applied alone. Vermicompost is a good organic source of plant nutrient supply. It is a rich source of nitrogen (1.6%), phosphorus (0.54%), potassium (0.80%), calcium (0.44%), Magnesium (0.15%), sulphur (0.45%), zinc (24.43ppm), iron (175.2ppm) vitamins and growth hormone which enhance plant growth and microbial population. In contrary to synthetic fertilizers, vermicompost reduce soil toxicity by buffering action, prevent soil degradation and enhance soil fertility status.

Besides this FYM supplies N, P and K in available form to the plant through mineralization as it contains 0.5-1.5, 0.4-0.8 and 0.5-1.9 per cent of N, P and K respectively. Sulphur is an important secondary plant nutrient which is essential for proper growth and functioning of the plant. Mustard plant need sulphur in a great amount because of it's presence in the sulphur containing amino acid like methionine, cystine. It also results in a considerable amount of increase in growth and yield of mustard along with an increase in the oil content of mustard varieties.

Keeping in view above facts, the present study was carried out to investigate on effect of integrated nutrient management on growth and yield of mustard (Brassica *juncea* l.) in irrigated condition of upper gangetic plain zone of India

Materials and Methods

The field experiment was conducted during *rabi* seasons of 2011-12 at Student's Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur (U.P.) India The soil texture of experimental field was sandy loam having 0.24 per cent organic carbon, EC (0.20 dSm^{-1}), 120.0 kg/ha available N, 12.0 kg available P, 183.0 kg available K and pH 8.44. The eight treatment viz. RDF (120:60:40:30 NPKS kg/ha), RDF + vermicompost @ 2.0 t/ha, RDF + vermicompost @ 3.0 t/ha, RDF + vermicompost @ 5.0 t/ha, RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha, RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha, RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha, RDF + FYM @ 6.0 t/ha were replicated three times in Randomized Block Design. In experimental field well

decomposed FYM and vermicompost is applied by broad casting and soil mixed properly by hand according to the particular treatment required just day before sowing. The 50% of N and full dose of P_2O_5, K_2O and sulphur was applied as basal dose. Remaining 50% dose of N is applied as top dressing. The crop variety used for sowing was vardan. The simultaneous thining and weeding by manual labour was completed within 20 days stage of crop. Two irrigation were applied at peak vegetative stage and at pod filling stage .Dusting of malathion @ 25 kg/ha at once at once against aphid attack was followed. During the experiment the average temperature ranged between 11.30° C-24.16° C. As far as total amount of rainfall is concerned, 9.65 mm rain were recorded during whole growth period. The average relative humidity ranged between 47.85-89.71 mm/day. The crop was harvested at physiological maturity on 22nd March, 2012. The data regarding growth characters, yield attributes and yield were analysed with statistical analysis and significance of treatments were tested with the help of 'F' test.

Results and Discussion

The data regarding growth character viz. plant stand, plant height, fresh and dry weight of crop plant, number of branches depicted in table 1, table 2, table 3 and table 4respectively whereas data regarding yield attributes presented in table 5 upto table8.Data regarding yield and economics in table 9 and 10 respectively. The data regarding growth clearly shows remarkable effect on growth parameters under different combination viz. plant height, fresh and dry weight of crop plant, no. of branches has shown significant result with the application of RDF+vermicompost @5.0 t/ha except in case of plant stand. The data presentented in table 1 shows that various treatments have not influenced the plant population/m^2 but the RDF + vermicompost @ 5.0 t/ha was observed statistically with more number of initial (28.67), after thinning (20.77) and final plant population/m^2 (20.77)

As depicted in table 2 that at 60 DAS the highest plant height (135.33) and at was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (130.55) and the minimum plant height was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) treatment with mean value (121.99) whereas at 110 DAS of the crop the highest plant height was recorded in RDF + vermicompost @ 5.0 t/ha (143.10) followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (142.22) and the minimum plant height was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value 126.33.

It is evident from Table 3 that the fresh weight per plant at 60 DAS Maximum fresh weight per plant at 60 DAS was recorded in RDF + vermicompost @ 5.0 t/ha (97.74g) and minimum average fresh weight per plant was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (72.82 g). Maximum fresh weight per plant at 110 DAS was recorded in RDF + vermicompost @ 5.0 t/ha (92.88)) and minimum average fresh weight per plant was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (51.66). Maximum dry weight per plant at 60 DAS was recorded in RDF + vermicompost @ 5.0 t/ha (21.33) and minimum average dry weight per plant was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (12.67). Maximum dry weight per plant at 110 DAS was recorded in RDF + vermicompost @ 5.0 t/ha (24.37) and minimum average dry weight per plant was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (11.58).The reason behind more dry matter in integrated nutrient supply may be the proper

establishment of crop plants, increased height and larger vegetative growth. These results are in close conformity of Premi*et al.* (2005) and Singh and Pal (2011).

The data in table 4.shows that60 DAS the maximum primary branches 8.10 per plant were recorded in RDF + vermicompost @ 5.0 t/ha and minimum number of primary branches per plant (5.89) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS). The maximum secondary branches 13.22 per plant were recorded in RDF + vermicompost @ 5.0 t/ha followed and minimum number of secondary branches per plant (5.99) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS). The maximum tertiary branches 5.78 per plant were recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (4.44) and minimum number of tertiary branches per plant (1.88) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS). The maximum total number of branches 27.10 per plant were recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (24.21) and minimum number of total branches per plant (13.76) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS). This may be due to the better establishment of plants under this treatment compared to other remaining treatments and it might be also due to improvement in nutrient availability particularly those of vermicompost and NPKS by same reported by Singh *et al.* (2011).

As depicted in table 5 that 110 DAS the maximum primary branches 5.66 per plant were recorded in RDF + vermicompost @ 5.0 t/ha. The maximum number of secondary branches 8.99 per plant were recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (7.94) The maximum number of tertiary branches 4.99 per plant were recorded in RDF + vermicompost @ 5.0 t/ha) and minimum number of tertiary branches per plant (1.77) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS). the maximum number of total branches 19.64 per plant was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (16.97) and minimum number of total branches per plant (8.79) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS)

The data presented in table 6 shows that the maximum number of siliquae on primary branch per plant (164.61) was noted with application of RDF + vermicompost @ 5.0 t/ha. The maximum number of siliquae on secondary branch per plant (102.38) was noted with application of RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (97.22). and minimum number of siliquae on secondary branch per plant was noted in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (80.40). The maximum number of siliquae on tertiary branch per plant (24.36) was noted with application of RDF + vermicompost @ 5.0 t/ha and minimum number of siliquae on tertiary branch per plant was noted in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (14.58). The maximum number of total siliquae per plant (286.53) was noted with application of RDF + vermicompost @ 5.0 t/ha.Thus resulted in more translocation of nutrients through vermicompost towards sink development by Mandal and Singh (2004) and Singh *et al.* (2011)

The data presented in table 7 shows that the maximum length of siliqua (4.66) was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (4.64) and minimum length of siliqua was noted in RDF (120 : 60 :

40 : 30 kg/ha NPKS) with mean value (4.36) The maximum weight of siliquae (125.29) was recorded in RDF + vermicompost @ 5.0 t/ha and minimum weight of siliqae was noted in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (77.21). The maximum number of seeds per siliqua (12.81) was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (12.68) and minimum number of seeds per siliqua was noted in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (11.75). The maximum silqiua girth (0.75) was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost and minimum siliqua girth was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (0.66).The use of organic manure consequently had more siliqua length, siliquae weight, seed per siliqua and siliqua girth has also been reported by Singh and Singh (2006) and Kashved*et al.* (2010).

As depicted in table 8 the maximum seed weight (12.99) per plant was recorded in RDF + vermicompost @ 5.0 t/ha. The maximum number of seeds of mustard (3665.73) per plant was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (3637.52). The maximum 1000 seed weight (g) of mustard was in RDF + vermicompost @ 5.0 t/ha (3.71) and minimum 1000 seed weight (g) was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (2.20). Since the plant had larger vegetative growth on account of better root development and congenial moisture situations the seed size must have been increased due to more carbohydrates, synthesis process etc. under integrated nutrient supply by Mandal and Sinha (2004) and Kashved*et al.* (2010).

Table.1 Effect on initial, after thinning and final plant stand/m2 of mustard as influenced by treatments

Treatments	Initial plant stand/m^2	Plant stand/m^2 after thinning (20 DAS)	Plant stand/m^2 at harvesting (110 DAS)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	26.25	18.41	17.24
T_2 [RDF + vermicompost @ 2.0 t/ha]	26.74	18.55	18.18
T_3 [RDF + vermicompost @ 3.0 t/ha]	26.99	18.66	18.59
T_4 [RDF + vermicompost @ 5.0 t/ha]	28.67	20.77	20.77
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	27.13	19.05	18.81
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	27.62	19.56	19.44
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	28.03	20.55	20.33
T_8 [RDF + FYM @ 6.0 t/ha]	26.51	18.53	17.581
S.E. (d)	1.30	1.32	1.91
C.D. at 5%	N.S.	N.S.	N.S.

Table.2 Effect on plant height (cm) at successive stages of mustard crop

Treatments	Plant height at flowering (60 DAS) cm	Plant height at maturity (110 DAS) cm
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	121.99	126.33
T_2 [RDF + vermicompost @ 2.0 t/ha]	124.10	131.55
T_3 [RDF + vermicompost @ 3.0 t/ha]	125.44	132.99
T_4 [RDF + vermicompost @ 5.0 t/ha]	135.33	143.10
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	126.77	139.33
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	129.99	139.66
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	130.55	142.22
T_8 [RDF + FYM @ 6.0 t/ha]	123.99	131.10
S.E. (d)	2.87	4.70
C.D. at 5%	6.16	10.08

Table.3 Effect on fresh weight per plant (g) at flowering (60 DAS), dry weight per plant (g) at flowering (60 DAS), fresh weight per plant at maturity (110 DAS) and dry weight per plant (g) at maturity (110 DAS)

Treatments	Fresh weight/ plant at flowering (60 DAS) (g)	Dry weight/ plant at flowering (60 DAS) (g)	Fresh weight/ plant at maturity of (110 DAS) (g)	Dry weight/ plant at maturity (110 DAS) (g)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	72.32	12.67	51.66	11.58
T_2 [RDF + vermicompost @ 2.0 t/ha]	80.46	14.19	57.10	14.35
T_3 [RDF + vermicompost @ 3.0 t/ha]	85.21	15.20	65.88	17.74
T_4 [RDF + vermicompost @ 5.0 t/ha]	97.74	21.33	92.88	24.37
T_5[RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	87.32	16.32	70.77	18.96
T_6[RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	90.56	17.57	78.24	19.48
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	94.10	18.99	83.18	20.89
T_8 [RDF + FYM @ 6.0 t/ha]	75.88	13.05	54.5	13.25
S.E. (d)	4.27	1.03	2.34	1.31
C.D. at 5%	9.15	2.22	5.03	2.81

Table.4 Effect on number of primary, secondary, tertiary and total branches per plant at flowering (60 DAS) in mustard crop.

Treatments	No. of primary branches/ plant at flowering (60 DAS)	No. of secondary branches/ plant at flowering (60 DAS)	No. of tertiary branches/ plant at flowering (60 DAS)	Total No. of branches/ plant at flowering (60 DAS)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	5.89	5.99	1.88	13.76
T_2 [RDF + vermicompost @ 2.0 t/ha]	6.33	7.44	2.66	16.43
T_3 [RDF + vermicompost @ 3.0 t/ha]	6.44	8.22	2.99	17.65
T_4 [RDF + vermicompost @ 5.0 t/ha]	8.10	13.22	5.78	27.10
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	6.55	9.55	3.22	19.32
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	6.67	10.21	4.35	21.23
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	7.67	12.10	4.44	24.21
T_8 [RDF + FYM @ 6.0 t/ha]	5.99	6.77	2.44	15.20
S.E. (d)	0.36	0.41	0.23	1.09
C.D. at 5%	0.77	0.89	0.49	2.35

Table.5 Effect on number of primary, secondary, tertiary and total branches per plant at maturity (110 DAS) in mustard crop

Treatments	No. of primary branches/ plant at maturity (110 DAS)	No. of secondary branches/ plant at maturity (110 DAS)	No. of tertiary branches/ plant at maturity (110 DAS)	Total No. of branches/ plant at maturity (110 DAS)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	3.04	3.98	1.77	8.79
T_2 [RDF + vermicompost @ 2.0 t/ha]	3.61	4.92	1.99	10.52
T_3 [RDF + vermicompost @ 3.0 t/ha]	3.83	5.57	2.10	11.50
T_4 [RDF + vermicompost @ 5.0 t/ha]	5.66	8.99	4.99	19.64
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	4.13	6.42	2.22	12.77
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	4.49	7.19	2.77	14.45
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	4.93	7.94	4.10	16.97
T_8 [RDF + FYM @ 6.0 t/ha]	3.29	4.47	2.00	9.7
S.E. (d)	0.24	0.47	0.21	0.53
C.D. at 5%	0.51	1.01	0.47	1.15

Table.6 Effect on number of siliquae on primary, secondary, tertiary branches per plant and total number of sliquae per plant in mustard crop

Treatments	No. of siliquae on primary branch/plant	No. of siliquae on secondary branch/plant	No. of siliquae on tertiary branch/plant	Total No. of siliquae/ plant
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	130.24	80.40	14.58	225.34
T_2 [RDF + vermicompost @ 2.0 t/ha]	137.44	87.41	16.53	241.38
T_3 [RDF + vermicompost @ 3.0 t/ha]	139.33	90.98	18.19	248.50
T_4 [RDF + vermicompost @ 5.0 t/ha]	164.61	102.38	24.36	286.53
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	145.88	93.66	19.54	260.50
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	147.44	95.11	20.96	265.22
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	159.77	97.22	22.67	281.35
T_8 [RDF + FYM @ 6.0 t/ha]	135.42	84.36	15.48	235.26
S.E. (d)	7.25	5.49	1.09	12.67
C.D. at 5%	15.56	11.79	2.35	27.18

Table.7 Effect on siliqua length (cm), weight of siliqua per plant (g), number of seeds per siliqua and siliqua girth (cm) in mustard crop

Treatments	Siliqua length (cm)	Weight of siliqua/plant (g)	No. of seeds/siliqua	Siliqua girth (cm)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	4.36	77.21	11.75	0.66
T_2 [RDF + vermicompost @ 2.0 t/ha]	4.44	86.30	12.28	0.68
T_3 [RDF + vermicompost @ 3.0 t/ha]	4.46	93.33	12.258	0.69
T_4 [RDF + vermicompost @ 5.0 t/ha]	4.66	125.29	12.81	0.75
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	4.52	96.79	12.52	0.70
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	4.60	112.96	12.57	0.71
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	4.64	116.60	12.68	0.73
T_8 [RDF + FYM @ 6.0 t/ha]	4.39	82.20	11.95	0.67
S.E. (d)	0.07	5.0	0.31	0.0155
C.D. at 5%	0.15	10.95	0.66	0.0332

Table.8 Effect on seed weight per plant (g), number of seeds per plant and 1000 seed weight (test weight) of mustard

Treatments	Seed weight per plant (g)	No. of seeds/plant	1000 seed weight (Test weight) (g)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	7.540	2644.55	3.20
T_2 [RDF + vermicompost @ 2.0 t/ha]	9.53	2906.37	3.30
T_3 [RDF + vermicompost @ 3.0 t/ha]	9.98	2945.67	3.40
T_4 [RDF + vermicompost @ 5.0 t/ha]	12.99	3665.73	3.71
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	10.16	3269.05	3.51
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	11.01	3313.25	3.56
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	11.37	3637.52	3.65
T_8 [RDF + FYM @ 6.0 t/ha]	8.37	2812.49	3.26
S.E. (d)	0.49	96.69	0.14
C.D. at 5%	1.05	207.40	0.30

Table.9 Effect on grain yield(q/ha), stover yield(q/ha), biological yield(q/ha) and harvest index (%) of mustard crop

Treatments	Grain yield (q/ha)	Stover yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	19.15	57.45	76.60	25.00
T_2 [RDF + vermicompost @ 2.0 t/ha]	20.15	64.48	84.63	23.80
T_3 [RDF + vermicompost @ 3.0 t/ha]	20.25	68.26	88.01	23.31
T_4 [RDF + vermicompost @ 5.0 t/ha]	22.75	79.26	102.41	21.83
T_5 [RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	20.95	71.23	92.18	22.72
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	21.05	73.46	94.51	22.27
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	21.30	76.68	97.98	21.73
T_8 [RDF + FYM @ 6.0 t/ha]	20.03	61.68	81.91	24.45
S.E. (d)	0.71	4.65	6.06	0.13
C.D. at 5%	1.52	9.98	13.01	0.29

Table.10 Effect of gross income, net profit and benefit : cost ratio influenced by treatment

Treatments	Gross income Rs/ha)	Net profit (Rs/ha)	Benefit : cost ratio
T_1 [RDF (120 : 60 : 40 : 30 kg/ha NPKS)]	69419.00	34049.00	1.96
T_2 [RDF + vermicompost @ 2.0 t/ha]	73447.00	33837.00	1.85
T_3 [RDF + vermicompost @ 3.0 t/ha]	75820.00	34210.00	1.82
T_4 [RDF + vermicompost @ 5.0 t/ha]	81575.00	35725.00	1.77
T_5[RDF + vermicompost @ 2.0 t/ha + FYM @ 3.0 t/ha]	76782.00	33812.00	1.78
T_6 [RDF + vermicompost @ 2.0 t/ha + FYM @ 4.0 t/ha]	77337.00	33367.00	1.75
T_7 [RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha]	78491.00	33281.00	1.73
T_8 [RDF + FYM @ 6.0 t/ha]	72788.00	30938.00	1.73
S.E. (d)	1177.21	678.18	0.05
C.D. at 5%	2531.55	1454.49	0.11

The maximum grain yield of mustard (22.75) per hectare was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (21.30) and minimum grain yield was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (19.15). The maximum stover yield of mustard (79.26) per hectare was recorded in RDF + vermicompost @ 5.0 t/ha followed and minimum stover yield was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (57.45). The maximum biological yield of mustard (102.41) per hectare was recorded in RDF + vermicompost @ 5.0 t/ha followed by RDF + vermicompost @ 2.0 t/ha + FYM @ 5.0 t/ha (97.98) and minimum biological yield was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) with mean value (76.60). The maximum harvest index was recorded in RDF (120 : 60 : 40 : 30 kg/ha NPKS) (25.00) followed by RDF + FYM @ 6.0 t/ha (24.45).The most probable reason for this phenomenon may be longer plant and increased dry matter, more vegetative growth under organic and inorganic nutrient supply. This might had resulted to increase straw yield, grain yield and consequently total biomass production by Chand and Ram (2007), Tripathi*et al.* (2010) and Premi*et al.* (2005) reported similar result as yields.

The maximum gross income`/ha (81575) and maximum net profit of mustard `/ha (35725) of mustard was noted with the application of RDF + vermicompost @ 5.0 t/ha treatment. The maximum benefit : cost ratio of mustard (1.96) was recorded with the application of RDF (120 : 60 : 40 : 30 kg/ha NPKS) followed by RDF + vermicompost @ 2.0 t/ha (1.85).The findings are in close conformity of Rao (2003) and Kumpawat*et al.* (2004) and Ramesh *et al.* (2009).

In conclusion, on the basis of above findingsit can be concluded that treatment T_4 [RDF + vermicompost @ 5.0 t/ha] shows the best results with respect to significantgrowth attributes, yield attributes and yield. From the economical point of view, the same treatment gave higher net proft(Rs 35725) over rest of the treatments. While benefit:cost ratio was significantly higher (1.96) with application of RDF(120:60:40:30 Kg/ha NPKS) over rest of the treatments except being at par with RDF + vermicompost @ 2.0 t/ha. Therefore treatment T_4 [RDF + vermicompost @ 5.0 t/ha] is recommended for higher net return and yield in mustard cultivation.

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How to cite this article:

Thaneshwar, Vishram Singh, Jai Prakash, Manoj Kumar, Sateesh Kumar and R.K. Singh. 2017. Effect of Integrated Nutrient Management on Growth and Yield of Mustard (*Brassica juncea* L.) in Irrigated Condition of Upper Gangetic Plain Zone of India. *Int.J.Curr.Microbiol.App.Sci.* 6(1): 922-932. doi: http://dx.doi.org/10.20546/ijcmas.2017.601.109