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Nutrient Management Improves Nutrition, Quality and Economic Feasibility of Indian Mustard (*Brassica juncea* L.)

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ABSTRACT

A field investigation was carried out during Rabi seasons of 2016-2017 at S. V. P. University of Agriculture and Technology, Meerut (U.P) to the effect of fourteen treatment of (T_1) *Control*, (T_2) Bio-fertilizers (*Azotobacter* + PSB), (T_3) 100% RDF (120:60:60: 40, N:P:K:S, kg/ha), (T_4) 100% RDF + Bio-fertilizers, (T_5) 75% RDF + FYM 6 t/ha, (T_6) 75% RDF + FYM 6 t/ha + Bio-fertilizers, (T_7) 75% RDF + Vermicompost 2 t/ha, (T_8) 75% RDF + Vermicompost 2 t/ha + Bio-fertilizers, (T_9) 50% RDF + FYM 12 t/ha, (T_{10}) 50% RDF + FYM 12 t/ha + Bio-fertilizers, (T_{11}) 50% RDF + Vermicompost 4 t/ha, (T_{12}) 50% RDF + Vermicompost 4 t/ha + Bio-fertilizers, (T_{13}) 50% RDF+ FYM 6 t/ha + Vermicompost 2 t/ha and (T_{14}) 50%RDF+ FYM 6 t/ha + Vermicompost 2 t/ha+ bio-fertilizer on Indian Mustard *(Brassica juncia* L.*),* variety Pusa Mustard 30 (LES-43). The nutrition's, quality and economic feasibility significantly with the application of 50%RDF+ FYM 6 t/ha + Vermicompost 2 t/ha+ bio-fertilizer. The use of RDF only but in application of FYM and Vermicompost improved the physio chemical properties of soil which may improves the sustainability of production system.

Introduction

Rapeseed-mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm (*Elaeis guineensis* Jacq.) oil. Among the seven edible oilseed cultivated in India, rapeseed-mustard (*Brassica spp*.) contributes 28.6% in the total production of oilseeds. In India, it is the second most important edible oilseed after groundnut sharing 27.8% in the India's oilseed economy. The share of oilseeds is 14.1% out of the total cropped area in India, rapeseed-mustard accounts for 3% of it. The global production of rapeseed-mustard and its oil is around 38–42 and 12–14 mt, respectively.

India contributes 28.3% and 19.8% in world acreage and production. India produces around 6.7 mt of rapeseed-mustard next to China (11-12 mt) and EU (10–13 mt) with significant contribution in world rapeseed-mustard. It is a major winter season oilseed crop of India and is known to respond to applied fertilizers. Nutrient management is one of the most important agronomic factors that affect the yield of Indian mustard (*Brassica juncia* L.). Farm yard manure (FYM) improves the soil physico-chemical properties along with direct release of macro as well as micronutrient; ultimately the crop yields and finally crop yields increase (Bhatia and Shukla, 1982 & Singh and Kumar, 2009).

Indian mustard is more responsive to chemical fertilizers especially nitrogen and up to considerable extent to sulfur, for sustainability of mustard production in the view of soil health and ecological balance, in great extent. Escalating prices of chemical fertilizer, there is strong need of hours to search out suitable alternative sources nutrients especially N, alternative source of N, especially.

Integration of all possible nutrient sources for common cause is only key to success to meet our growing demand of oil seeds and to reduce the burden on the foreign exchange as oil import bill is increasing at alarming rates. Integration of chemical fertilizers along with FYM and Bio fertilizers could be serving the purpose, as they are cheap pollution free and renewable. Non symbiotic bacteria like *Azotobacter* and azospirillum are potential bio-fertilizers.

These are capable of contributing N to a number of non-legumes by tapping aerial nitrogen. Moreover, activity of bio-fertilizers may be influenced by supply of nutrients like N to the soil. The present investigation was therefore carried out to study the effect of integrated nutrient management on performance of Indian mustard (*Brassica juncia* L. czernj & cosson).

Materials and Methods

A field experiment was conducted at the Instructional Farm of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). India, during the *Rabi* 2016-2017 using mustard as the test crop. The soil at the start of the experiment was sandy loam with pH having 8.25, EC 0.19 dS m-1, organic carbon 0.41%, available N 180.60 kg ha-1, P 16.80 kg ha-1, potassium 231.47 kg ha-1and sulphur 7.38 kg-1.

Fourteen treatment of (T_1) *Control*, (T_2) Bio-fertilizers (*Azotobacter* + PSB), (T_3) 100% RDF (120:60:60: 40, N:P:K:S, kg/ha), (T_4) 100% RDF + Bio-fertilizers, (T_5) 75% RDF + FYM 6 t/ha, (T_6) 75% RDF + FYM 6 t/ha + Bio-fertilizers, (T_7) 75% RDF + Vermicompost 2 t/ha, (T_8) 75% RDF + Vermicompost 2 t/ha + Bio-fertilizers, (T_9) 50% RDF + FYM 12 t/ha, (T_{10}) 50% RDF + FYM 12 t/ha + Bio-fertilizers, (T_{11}) 50% RDF + Vermicompost 4 t/ha, (T_{12}) 50% RDF + Vermicompost 4 t/ha + Bio-fertilizers, (T_{13}) 50% RDF+ FYM 6 t/ha + Vermicompost 2 t/ha and (T_{14}) 50%RDF+ FYM 6 t/ha + Vermicompost 2 t/ha+ bio-fertilizer. The crop received N, P_2O_5, K_2O and S @ 120, 60,60 and 40 kg/ha, respectively half of the nitrogen and whole of phosphatic and potassic fertilizers were supplied at the time of sowing, and the rest half of N a month after sowing. The crop was sown in lines (45 cm) in the last week of October and was harvested in the second week of March. Variety used was 'Pusa mustard 30 (LES-43)'.

Soil analysis

Soil samples were collected from 0-15 cm. Depth from each plot. These samples were processed and analyzed for various physico-chemical properties in the laboratory of department of soil science, in Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Soil pH (1:2.5 soil water) was determined by pH meter (Jackson, 1973). EC (dS m^{-1} at $25C^{o}$) (1:2.5 Soil: Water) was determined EC meter (Bower and Wilcox, 1965). Organic carbon (%) was determined by (Walkley and Black, 1934) method Available nitrogen in soil was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956).

Available phosphorus was determined by Ascorbic acid method (Olsen *et al.,* 1954). Available K in the soil was determined by extraction method (Hanway and Heidal, 1952). Available sulphur was determined by the turbid metric procedure (Williams and Steinberg, 1969).

Plant analysis

Nitrogen, phosphorus and potassium contents were analyzed in plant sample at the harvest of the crop by adopting modified micro-kjeldahl method for nitrogen, vanado-molybdate yellow colour method for phosphorus and flame photometer method for potassium as described by Jackson (1973).

Nitrogen

In plant total Nitrogen was determined by Kjeldhals method. In a digestion tube 0.5 gm finally powdered plant samples was taken and added 10 ml of concentrated H_2SO_4 + 1gm. digestion mixture (K_2SO_4 + catalyst), and kept for overnight, than heating was done in digestion chamber till the clear colorless solution appears. Cooled digest was shifted to distillation unit. The content was distilled for 10 minutes using 40% NaOH and distillate was collected in a conical flask containing 4% Boric acid mixture. The distillate was finally titrated against standardized H_2SO_4, once the colour change from bluish green to permanent pale pink colour note the burette reading.

Digestion for P and K sample

0.5 gm. dried and powdered plant samples was taken in a digestion tube and 10ml of Di-acid mixture (4:1, HNO_3:$HClO_4$) was added and kept for overnight. It was than digested on a black digester till the colourless solution was obtained. The flask was cooled and 25ml of distilled water added into solution after than the solution was filtrated into a 50ml of volumetric flask and make up volume by distilled water.

Colour develop for P

5 ml of aliquot was taken into 50 ml volumetric flask and 10ml of Vandate-molybdate solution were added and diluted to 50ml mixed well and read the intensity of yellow colour on spectrophotometer by using blue filter at 420 nm wavelength a blank reading was also run without sample simultaneously (Jackson, 1967).

Potassium

For determination of K digested extract was used directly with Flame-photometer. The potassium content in digest sample is determination by Flame-photometer. The nutrient uptake (kg ha^{-1}) of seed and Stover was calculated by using their nitrogen, phosphorus, potassium and sulphur, content values and yield of crop on hectare basis.

$$\text{Uptake (kg ha}^{-1}) = \frac{\text{Nutrient content (\%)} \times \text{Yield of grain or stover (kg ha}^{-1})}{100}$$

Protein content

The protein content (percent) was determined 'as is' via the standard Kjeldahl method using the nitrogen-protein conversion factor of 6.25, the accepted standard. (Kjeldahl, 1883) were as follows:

Grain protein content (%) = Nitrogen content (%) X 6.25

Oil content

Seed samples were collected from each number of plot and analyzed for oil content (%) in seeds with the help of Soxhlet apparatus method taking petroleum ether as a solvent. (Licitra *et al*., 1996) were as follows:

$$\text{Oil (\%)} = \frac{\text{Weight of oil (g)}}{\text{Weight of sample (g)}} \times 100$$

Cost of cultivation (Rs ha^{-1})

Cost of different operation was worked out separately. The actual manual and mechanical power emerged for different operation was recorded on hectare basis and cost was calculated the different items by multiplying the rates prevail up at that time similarly cost of all inputs was also calculated. The total cost was computed by adding all expenditure involved as per treatment on hectare basis.

Gross returns (Rs ha^{-1})

The monetary value of grain and straw yield was computed in rupees using support price of outputs. Gross return was obtained by adding monetary values of grains and straw.

Gross Return (Rs ha^{-1}) = Grain yield (q ha^{-1}) × price ((Rs. q^{-1}) + Straw yield (q ha^{-1}) × price ((Rs. q^{-1})

Net returns (Rs ha^{-1})

Net return for each treatment combination was calculated by deducting the cost of cultivation from the respective gross return.

Net Return (Rs. ha^{-1}) = Gross return – Cost of cultivation

Results and Discussion

The maximum oil and protein content in grain (40.56%) and (18.56%) was found in (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers), which was 22.16 and 10.80 percent highest than T_1 and remain higher than all of the treatments except treatment, Minimum oil content in grain (33.20%) and (16.75%) was recorded in (Control)

Application of nutrient management treatment significantly improved the available nitrogen, phosphorus and potassium in soil over control. It indicated that highest available N. P and K 191.25, 19.50 and 233.78 in soil recorded with the treatment application (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers), significantly higher than the rest of the treatments. Lowest available N. P and k 160.73, 16.38 and 203.49 was recorded in control plots.

The highest available sulphur and organic carbon 9.75 and 0.49 in soil recorded with the treatment application of (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers) was significantly higher than the rest of the treatment. Lowest available sulphur 7.40 and 0.40 was recorded in control plots.

Nutrient content (%)

The NPK and S content in grains ranged from (2.68 to 2.97), (0.53 to 0.75), (0.55 to 0.89) and (0.44 to 0.69) and Stover (0.26 to 0.45 %), (0.18 to 0.26 %), (1.31 to 1.62 %) and (0.23 to 0.35 %) under different treatments.

The maximum NPK and S content 2.97, 0.75, 0.89 and 0.69 in grain recorded with the treatment (50% RDF + FYM 6 t ha^{-1} + vermicompost 2 t ha^{-1} + bio-fertilizers) significantly higher than the remaining treatments. Highest nitrogen content 0.45, 0.26, 1.62 and 0.35 in Stover was recorded in treatment (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers) was significantly higher than the remaining treatments. Lowest NPK and S content in grain 2.68, 0.53, 0.55 and 0.44 was recorded in control plots. Similarly lowest nitrogen NPK and S was found in control plot 0.26, 0.18, 1.31 and 0.23 in Stover.

Nutrient uptake (kg ha^{-1})

The NPK and S uptake by grain and ranged from 21.70 to 62.96, 4.18 to 15.90, 4.34 to 18.86 and 3.47 to 14.62 and uptake by Stover ranged 6.93 to 33.70, 4.80 to 19.62, 34.96 to 121.32 and 6.13 to 26.21 kg ha^{-1} under different treatments.

Maximum NPK and S uptake 62.96, 15.90, 18.86 and 14.62 in grain recorded with the application of (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers) was statistically similar to 50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha and significantly higher than rest of the treatments. Highest NPK and S uptake 33.70, 19.62, 121.32 and 26.21 in Stover recorded in treatment (50% RDF + FYM 6 t ha^{-1} + Vermicompost 2 t ha^{-1} + bio-fertilizers) which was higher than rest of the treatments.

Lowest NPK and S uptake by grain 21.70, 4.18, 4.34 and 3.47 and Stover 6.93, 4.80, 34.96 and 6.13 was recorded in control plots.

The data indicates maximum cost of cultivation, Gross returns, Net return and B: C ratio (Rs. 26104), (Rs. 84126), (Rs. 58022) and 2.2 was obtained in T_{14} 50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers followed by 50% RDF + FYM 6 t/ha + Vermicompost 2 t/h. The minimum cost of cultivation was noted) (Rs. 13529), (Rs. 31336), (Rs. 178.07) and 1.31 in control.

Table.1 Nutrient management improves nutrition on oil content and protein content (%) of mustard

Treatment	Oil content (%)	Protein content (%)
Control	33.20	16.75
Bio-fertilizers (*Azotobacter* + PSB)	34.50	17.00
100%RDF (120:60:60:40,N:P:K:S,kg/ha)	38.20	17.31
100%RDF + Bio-fertilizers	38.70	17.68
75% RDF + FYM 6 t/ha	37.06	17.18
75% RDF + FYM 6 t/ha + Bio-fertilizers	38.20	17.43
75% RDF + Vermicompost 2 t/ha	38.10	17.00
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	38.80	17.37
50% RDF + FYM 12 t/ha	37.90	17.31
50% RDF + FYM 12 t/ha + Bio-fertilizers	38.66	17.62
50% RDF + Vermicompost 4 t/ha	38.30	17.50
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	39.10	18.25
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	39.30	18.31
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers	40.56	18.56
SEm ±	*0.55*	*0.32*
CD (P= 0.05)	*1.52*	*0.95*

Table.2 Nutrient management improves nutrition on available N, P and K

Treatment	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Control	160.73	16.38	203.49
Bio-fertilizers (*Azotobactor* + PSB)	164.35	16.53	213.12
100%RDF (120:60:60:40,N:P:K:S,kg/ha)	173.22	17.54	220.15
100%RDF + Bio-fertilizers	178.21	17.88	227.65
75% RDF + FYM 6 t/ha	172.41	17.24	214.73
75% RDF + FYM 6 t/ha + Bio-fertilizers	173.32	17.46	215.94
75% RDF + Vermicompost 2 t/ha	172.37	17.26	213.33
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	178.61	18.15	220.65
50% RDF + FYM 12 t/ha	176.45	18.53	219.59
50% RDF + FYM 12 t/ha + Bio-fertilizers	177.62	18.71	224.42
50% RDF + Vermicompost 4 t/ha	173.18	17.96	222.88
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	179.05	18.77	229.17
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	184.35	18.85	230.50
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers	191.25	19.50	233.78
SEm ±	4.15	0.31	1.45
CD (P= 0.05)	*12.47*	*0.90*	*4.21*
Initial value	180.60	16.80	231.47

Table.3 Nutrient management improves nutrition on available sulphur and organic carbon

Treatment	Available sulphur (kg ha^{-1})	Organic carbon (%)
Control	7.40	0.40
Bio-fertilizers (Azatobactor + PSB)	7.56	0.41
100% RDF (120:60:60:40,N:P:K:S,kg/ha)	8.50	0.42
100% RDF + Bio-fertilizers	8.70	0.43
75% RDF + FYM 6 t/ha	7.85	0.42
75% RDF + FYM 6 t/ha + Bio-fertilizers	8.20	0.44
75% RDF + Vermicompost 2 t/ha	8.10	0.43
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	8.38	0.45
50% RDF + FYM 12 t/ha	8.17	0.43
50% RDF + FYM 12 t/ha + Bio-fertilizers	8.55	0.44
50% RDF + Vermicompost 4 t/ha	8.38	0.42
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	9.30	0.44
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	9.50	0.47
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio- fertilizers.	9.75	0.49
S Em ±	*0.32*	*0.02*
CD (P= 0.05)	*0.91*	*0.05*
Initial value	7.38	0.41

Table.4 Nutrient management improves nutrition on N and P content and uptake by grain and Stover in mustard

Treatment	Nitrogen Content (%)		Nitrogen Uptake (kg ha^{-1})		Phosphorus Content (%)		Phosphorus Uptake (kg ha^{-1})	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
Control	2.68	0.26	21.17	6.93	0.53	0.182	4.18	4.80
Bio-fertilizers (*Azotobacter* + PSB)	2.72	0.28	24.88	9.46	0.56	0.189	4.24	6.38
100% RDF (120:60:60:40,N:P:K:S,kg/ha)	2.77	0.32	48.75	19.92	0.62	0.203	10.91	12.63
100% RDF + Bio-fertilizers	2.81	0.37	52.97	25.80	0.66	0.215	12.35	14.99
75% RDF + FYM 6 t/ha	2.75	0.30	49.36	19.09	0.59	0.207	10.59	13.17
75% RDF + FYM 6 t/ha + Bio-fertilizers	2.79	0.31	51.47	21.18	0.60	0.210	11.07	14.34
75% RDF + Vermicompost 2 t/ha	2.72	0.30	49.83	20.55	0.58	0.205	10.62	13.98
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	2.78	0.34	52.68	23.86	0.65	0.225	12.21	15.79
50% RDF + FYM 12 t/ha	2.77	0.33	49.63	20.93	0.63	0.230	11.28	14.59
50% RDF + FYM 12 t/ha + Bio-fertilizers	2.80	0.38	53.15	26.61	0.65	0.237	12.25	16.60
50% RDF + Vermicompost 4 t/ha	2.79	0.38	52.22	26.46	0.63	0.227	11.47	15.81
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	2.92	0.40	58.16	29.06	0.69	0.248	13.74	18.01
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	2.93	0.43	59.77	31.63	0.73	0.257	14.89	18.90
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers	2.97	0.45	62.96	33.70	0.75	0.262	15.90	19.62
SEm ±	*0.06*	*0.02*	*1.96*	*1.59*	*0.02*	*0.01*	*0.47*	*0.58*
CD (P= 0.05)	*0.18*	*0.06*	*5.61*	*4.80*	*0.07*	*0.02*	*1.42*	*1.67*

Table.5 Nutrient management improves nutrition on K and S content and uptake by grain and Stover in mustard

Treatment	Potassium Content (%)		Potassium Uptake (kg ha^{-1})		Sulphur Content(%)		Sulphur Uptake (kg ha^{-1})	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
Control	0.55	1.31	4.34	34.96	0.44	0.23	3.47	6.13
Bio-fertilizers (*Azotobacter* + PSB)	0.58	1.40	5.30	47.32	0.47	0.26	4.30	8.78
100% RDF (120:60:60:40,N:P:K:S,kg/ha)	0.66	1.47	11.61	91.50	0.52	0.28	9.15	17.43
100% RDF + Bio-fertilizers	0.73	1.52	13.66	107.41	0.59	0.30	11.04	20.92
75% RDF + FYM 6 t/ha	0.62	1.44	11.29	91.65	0.50	0.27	8.97	17.18
75% RDF + FYM 6 t/ha + Bio-fertilizers	0.64	1.47	11.80	100.44	0.53	0.28	9.99	19.13
75% RDF + Vermicompost 2 t/ha	0.62	1.45	11.35	98.67	0.51	0.26	9.34	17.81
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	0.68	1.49	12.88	106.70	0.56	0.28	10.61	19.65
50% RDF + FYM 12 t/ha	0.66	1.50	11.82	95.17	0.54	0.27	9.67	17.13
50% RDF + FYM 12 t/ha + Bio-fertilizers	0.78	1.51	14.70	108.57	0.61	0.31	11.49	21.71
50% RDF + Vermicompost 4 t/ha	0.76	1.53	14.17	105.86	0.58	0.29	10.81	20.19
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	0.83	1.57	16.53	114.06	0.63	0.32	12.54	23.24
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	0.86	1.59	17.54	116.96	0.66	0.34	13.46	25.01
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers	0.89	1.62	18.86	121.32	0.69	0.35	14.62	26.21
SEm ±	*0.03*	*0.03*	*0.66*	*3.83*	*0.02*	*0.01*	*0.52*	*0.76*
CD (P= 0.05)	*0.08*	*0.09*	*2.01*	*10.95*	*0.07*	*0.04*	*1.55*	*2.18*

Table.6 Nutrient management improves nutrition on cost of cultivation, gross income, net income and benefit cost ratio of mustard

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
Control	13529	31336	17807	1.31
Bio-fertilizers (*Azotobactor* + PSB)	13644	36567	22923	1.68
100% RDF (120:60:60:40,N:P:K:S,kg/ha)	20809	69854	49045	2.35
100% RDF + Bio-fertilizers	20924	74918	53994	2.58
75% RDF + FYM 6 t/ha	21989	71271	49282	2.24
75% RDF + FYM 6 t/ha + Bio-fertilizers	22104	73765	51661	2.33
75% RDF + Vermicompost 2 t/ha	22989	73281	50292	2.18
75% RDF + Vermicompost 2 t/ha + Bio-fertilizers	23104	75767	52663	2.27
50% RDF + FYM 12 t/ha	23169	71136	47967	2.07
50% RDF + FYM 12 t/ha + Bio-fertilizers	23284	75406	52122	2.23
50% RDF + Vermicompost 4 t/ha	25169	74666	49497	1.96
50% RDF + Vermicompost 4 t/ha + Bio-fertilizers	25284	79446	54162	2.14
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha	25989	81213	55224	2.12
50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers	26104	84126	58022	2.22

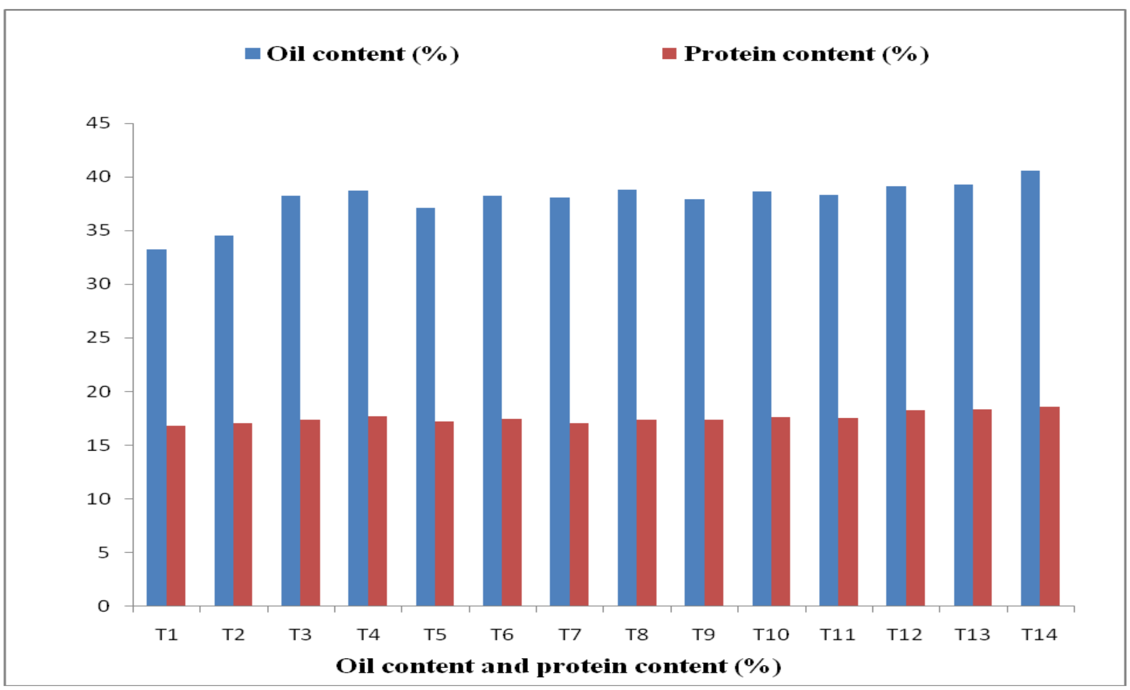

Fig.1 Oil content and protein content (%)

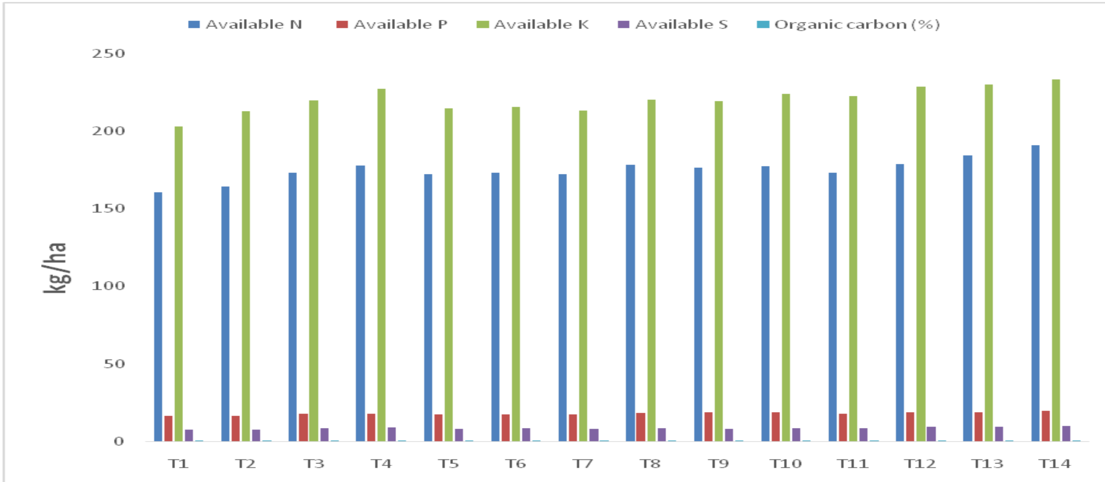

Fig.2 Available N, P, K, S and Organic carbon

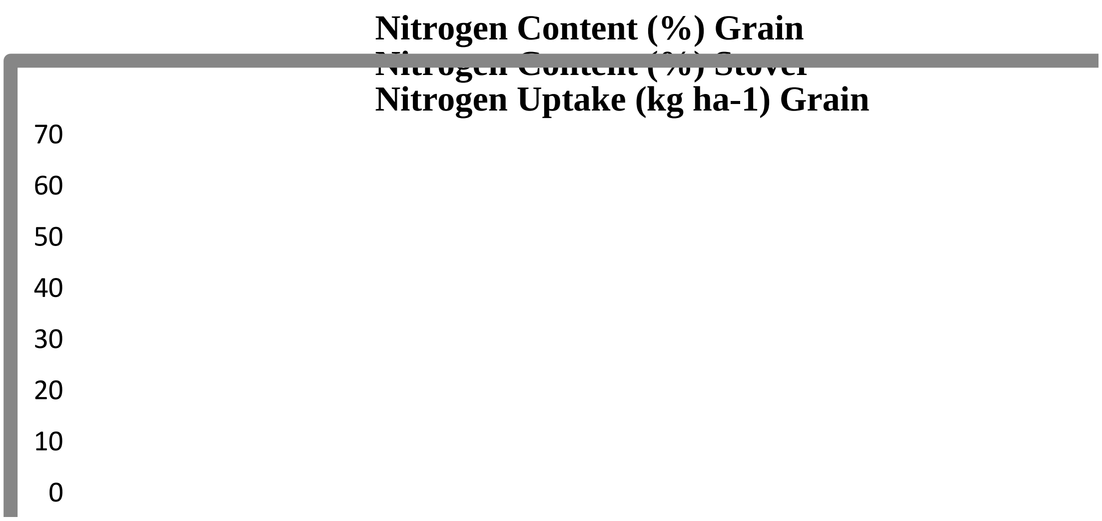

Fig.3 Nitrogen content (%)

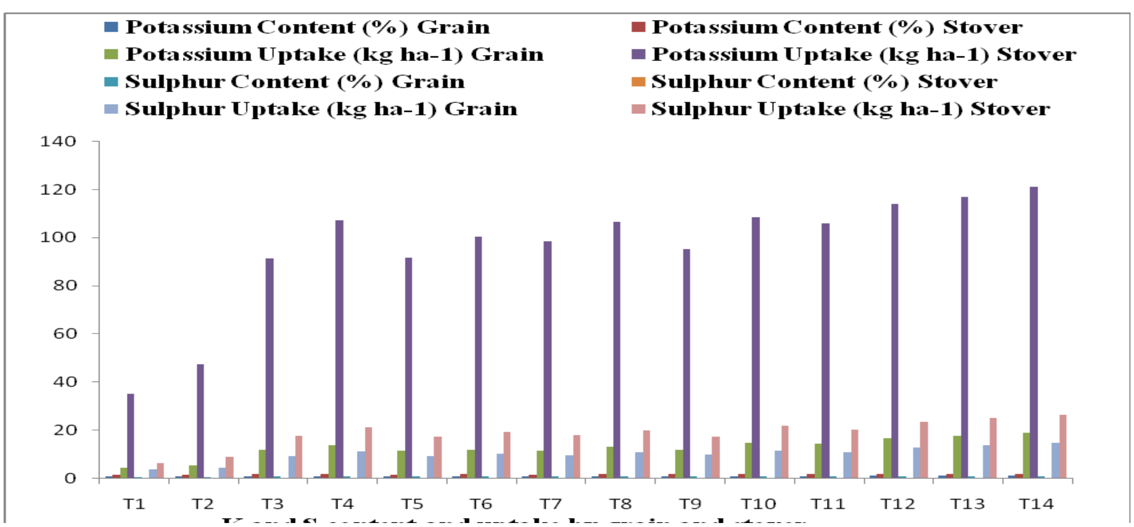

Fig.4 K and S content and uptake by grain and stover

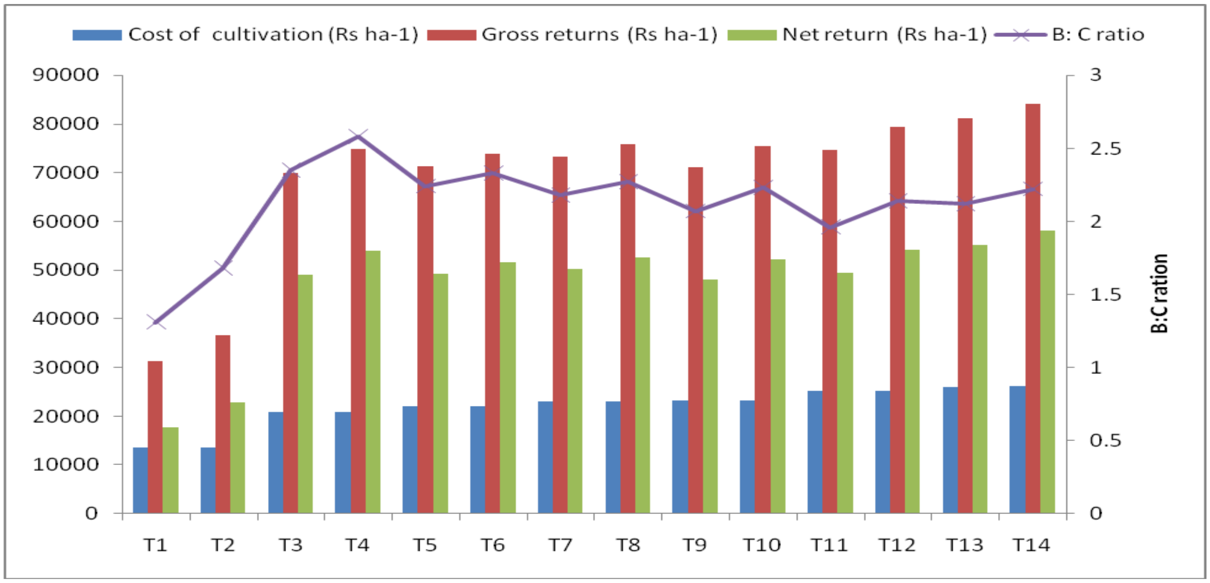

Fig.5

A study was conducted during winter (Rabi) seasons of 2016–17 to find out the response of Indian mustard. Application of 50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers significantly improved nutrients uptake, protein content, oil content, and economics of Indian mustard. Maximum net returns and benefit: cost ratio were observed with the application of 50% RDF + FYM 6 t/ha + Vermicompost 2 t/ha+ Bio-fertilizers, respectively.

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