Oil yield and quality different varieties of Indian mustard (*Brassica juncea* L.) as influenced by organic manures and biofertilizers.

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ABSTRACT

The study was conducted at the Central Research Field of Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad during 2016-17 and 2017-18. The experiments consisting of two factors *viz*., 5 varieties and 10 fertilizer treatments was laid out in a factorial randomized block design with replicated thrice. The results of the study revealed that the oil yield was significantly highest with Rani variety while the oil content did not vary significantly amongst different varieties. The fatty acid composition such as palmitic acid, stearic acid, oleic acid, linoleic & linolenic acid, and arachidic acid contents showed non-significant variations amongst varieties. The biochemical characters *viz*., total chlorophyll, total soluble sugars and proline content was recorded at 45 and 60 DAS were significantly higher in Rani variety. Both protein content and protein yields were also significantly highest in Rani variety. Application of 75% N through vermincompost produced significantly highest oil content and oil yield, protein content and protein yield, biochemical characters total chlorophyll, total soluble sugars and proline content recorded at 45 and 60 DAS, while palmitic acid, stearic acid and oleic acid were significantly highest with application of recommended dose of chemical fertilizers. Linoleic acid was significantly maximum with fertilizer treatment of 50% N through vermicompost + Azotobacter + Both linolenic and arachidic acid contents remained unaffected by the fertilizer treatments.

Keywords: *Oil yield, oil quality, biochemical, Indian mustard, protein.*

INTRODUCTION

It is the major *rabi* oilseed crop of India. Mustard is the second most important edible oilseed crop and it constitutes one fourth of oilseeds grown in India. Among the seven annual edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6 percent in the total production of oilseeds. The main purpose of growing mustard is to fulfill the need of oil consumption. It is a rich source of oil and protein. The oil content varies from 37 to 49 %[1]**.** The imbalanced and continuous use of chemical fertilizers in the cropping system is

leading to imbalance of nutrients in soil which have an adverse effect on soil health, growth, yield and quality of crops, besides causing environmental pollution. In additions the high cost of chemical fertilizers is unaffordable for the farmers to purchase them.

Organic agricultural practices aims to enhance biodiversity, biological cycles and soil biological activity so as to achieve optimal natural systems that are socially, ecologically and economically sustainable. Manure management is a process aiming to combine profitable agricultural production with minimum nutrient losses from manure, for the present and in the future. The manures apart from increasing yield and quality of crops improve soil health, make nutrients available to the plant and facilitate better uptake of nutrients by the crop. During recent years biofertilizers have emerged as a promising component of integrating nutrient supply system in agriculture. Certain strains of soil microbes referred to as plant growth promoting rhizo-bacteria that include species of Azotobacter and Azospirillum both of which provide direct and indirect effects on the plant growth and pest resistance.

The aim of present study was to test the effects of chemical fertilizers, organic manures and biofertilizers on the protein and oil content and yield, fatty acid composition and biochemical characters like total chlorophyll, total soluble sugars and proline content in the fresh leaves of Indian mustard (*Brassica juncea* L.) varieties.

MATHERIALS AND METHODS

A field experiment was conducted at the Central Research Field of Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad [25.41°N,81.51°E] during 2016-17 and 2017-18 to study the "Oil yield and quality of different varieties of Indian mustard (*Brassica juncea* L.) as influenced by organic manures and biofertilizers. (*Brassica juncea* L.) The experiment consisting of two factors *viz.*, 5 varieties (V_1 = Rudra 99-D, V_2 = Shikhar, V_3 =

Rani, V_4=Varuna and V_5 = Yellow Goldey) and 10 fertilizer levels (T_1 = control, T_2 = Recommended dose of fertilizer (RDF), T_3 = 75% N through Farm Yard Manure, T_4 = 75% N through Vermicompost, T_5 = 50% N through Farm Yard Manure+ Azotobacter, T_6 = 50% N through Farm Yard Manure+ Phosphate Solubilising Bacteria, T_7 = 50% N through vermicompost + Azotobacter, T_8 = 50% N through Vermicompost + Phosphate Solubilising Bacteria, T_9 = 25% N through Farm Yard Manure + Azotobacter + Phosphate Solubilising Bacteria and T_{10} = 25% N through vermicompost + Azotobacter + Phosphate Solubilising Bacteria was laid out in a factorial randomized block design with replicated thrice, the seed was sown in lines at 30 cm row spacing at the rate of 7.5kg ha^{-1} as per treatment. The crop was thinned twice to maintain plant to plant spacing of 15 cm. The crop was harvested on 2-02-17 and 4-05-2018 during 2016-17 and 2017-18, respectively. Oil content in seed sample was determined using Soxhlet apparatus. Fatty acid analysis was done by following procedure described by[2]**.** Protein content was determined by the method described by[3]**.** The biochemical characters *viz*; total chlorophyll content, total soluble sugars and proline contents in seed were determined by the methods given by[4,5,6]**,** respectively. The data was analysed by the method described by[7]**.**

RESULTS AND DISCUSSION

The data (table 1) revealed that Rani variety recorded significantly higher yield, while the oil content did not show any significantly variation amongst varieties. The results are in line with the findings of[2] who did not observe any significant variation in the oil content of SEJ2 and Pusa Bold mustard varieties. The significant variation in the oil yield an amongst varieties attributed to the higher seed yield recorded by Rani variety as oil yield is the product of seed yield and respective oil content. The study also indicated that amongst fertilizer treatments, application of 75% N through vermicompost + Azotobacter recorded significantly highest oil content and oil yield. These results corroborate the findings of[9] who reported that application of 5t FYM ha^{-1} along with inorganic

fertilizers and biofertilizers recorded significantly highest oil content and yield in mustard. Non significant variation was noticed amongst varieties with regard to saturated and unsaturated fatty acids (Table 2 and 3). The investigation also revealed that the palmitic acid, stearic acid and oleic acid were significantly maximum with fertilizer treatment of recommended fertilizer dose, while linoleic acid was significantly highest with the treatment 50% N through vermicompost + Azotobacter + PSB. Both linolenic and arachidic acid content remained unaffected by fertilizer treatments. There was a strong negative relationship between linoleic and oleic acid concentrations which is similar to the results obtained earlier by [10,11] also reported that the biofertilizers singly or combination of two along with organic manures decreased saturated fatty acids (Palmitic and stearic acids) while significantly increased unsaturated fatty acids. Further, they also reported that oil and oleic acid content was negative due to adverse effect of nitrogen. Both protein content and yield were significantly highest in Rani variety (Table- 1) this may be attributed to genetic potential of the varieties with regard to the accumulation of nitrogen[12] also found higher protein content and yield in RLC1 variety than other mustard varieties tested. It was also noticed that application of 75% N through vermicompost + Azotobacter recorded significantly highest protein content and yield. The high nitrate supply from the treatment might have increased amino acid synthesis in leaves which stimulated accumulation of protein in seed.[13] also reported similar findings. Moreover,vermocompost also balance nutrition under favourable environment might have helped in increased chlorophyll content at flowering stage .

The data (Table-4) showed that the biochemical characters *viz*., total chlorophyll content total soluble sugars and proline content recorded at 45 and 60 DAS were significantly higher in Rani variety. These results may be attributed to significant variation in the level of biosynthesis of chlorophyll and photosynthesis depending on genetic potential of mustard varieties. Further, the differential response of varieties to environmental stress and different levels of osmatic

adjustment might have produced significant variation in proline content. [14] have also found significant variation in total chlorophyll content amongst different mustard varieties. [15] recorded variation in total soluble sugar content in leaves of Iris. [16] reported significant variation in the proline content of different mustard varieties. The study also revealed that significantly highest biochemical characters were recorded by the treatment 75% N through vermicompost + Azotobacter. The results are in agreement with those of [17 , 18]. The increase in total chlorophyll content may be attributed to increased uptake of magnesium from soil in the form of Mg^{+2} under the influence of bio-fertilizer. Further, higher biosynthesis of chlorophyll and photosynthesis of mustard crop under Azotobacter treated plots might have resulted towards higher level of sugar in leaves. The higher accumulation of proline in leaves of mustard might be attributed towards the response of biofertilizer treated crop to mitigate and stimulating of draught tolerance.

Conclusion

From the above results it is concluded that Indian mustard variety 'Rani' supplied with of 75% N through vermicompost and Azotobacter produced significantly highest protein and oil yields and biochemical characters *viz*., chlorophyll, total soluble sugars and proline content in fresh leaves whereas, recommended fertilizer dose of N P and K recorded significantly the highest concentration of saturated fatty acids. The oleic acid being significantly highest under 100% N dose through vermicompost.

Table 1: Protein content/protein yield and oil content/oil yield as affected by Indian mustard varieties and organic manures /biofertilizers

Treatment	N content in seed (%)		Protein content in seed (%)		Protein yield (Kg ha^{-1})		Oil content (%)		Oil yield (Kg ha^{-1})	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Varieties										

V_1	2.98	2.97	18.62	18.56	216.18	221.23	37.88	37.75	440.16	431.26
V_2	2.88	2.89	18.00	18.06	182.34	188.00	37.47	37.45	379.57	387.67
V_3	3.01	3.02	18.81	18.87	222.15	228.33	38.07	37.96	452.27	459.32
V_4	2.92	2.94	18.25	18.37	208.96	215.30	37.67	37.54	431.32	439.97
V_5	2.95	2.96	18.44	18.50	212.61	218.30	37.73	37.63	434.65	444.03
SE (m) ±	0.039	0.042	0.207	0.224	2.956	2.996	0.429	0.389	13.238	14.375
CD (P=0.05)	0.11	0.12	0.58	0.63	8.30	8.41	NS	NS	37.16	40.35
Fertilizers/ Biofertilizers										
T_1	2.40	2.41	15.00	15.06	135.75	140.81	36.28	36.18	328.33	338.28
T_2	3.14	3.15	19.62	19.69	232.50	239.23	37.34	37.24	442.48	452.47
T_3	2.71	2.70	16.93	16.87	179.12	183.21	37.72	37.57	399.08	409.64
T_4	2.72	2.71	17.00	16.94	186.83	190.91	37.90	37.69	416.52	424.77
T_5	3.21	3.22	20.06	20.12	241.72	248.08	38.52	38.40	465.17	473.47
T_6	2.82	3.82	17.62	17.62	198.40	203.69	37.50	37.40	422.25	432.34
T_7	3.24	3.23	20.25	20.19	246.24	251.36	38.66	38.60	470.10	480.57
T_8	2.83	2.84	17.69	17.75	203.43	209.45	37.62	37.56	4732.63	443.21
T_9	3.20	3.21	20.00	20.06	235.60	211.92	38.04	38.00	448.11	458.28
T_{10}	3.21	3.22	20.06	20.12	237.51	244.05	38.06	38.02	450.63	461.18
SE (m) ±	0.053	0.060	0.292	0.317	4.68	4.225	0.605	0.549	18.668	20.271
CD (P=0.05)	0.15	0.17	0.82	0.89	11.70	11.86	1.70	1.54	52.4	56.9

V_1 = Rudra 99-D	T_1 = control	T_2 = RDF
V_2 = Shikhar	T_3 = 100%N Through FYM	T_4 = 100%N Through Vermicompost
V_3 = Rani	T_5 = 75%N Through FYM+ Azotobacter	T_6 = 75%N Through FYM+ PSB
V_4 = Varuna	T_7 = 75%N Through vermicompost + Azotobacter	T_8 = 75%N Through Vermicompost + PSB
V_5 = Yellow Goldy	T_9 = 50% N through FYM + Azotobacter+ PSB	T_{10} = 50% N through vermicompost + Azotobacter + PSB

RDF: Recommended dose of fertilizers
FYM: Farm yard manure
PSB: Phosphorus solubilising bacteria
SE: Standard error
CD: Critical difference

Table 2: Saturated and unsaturated fatty acids as affected by varieties and organic manurers /biofertilizers

Treatment	Palmitic (%)		Stearic acid (%)		Oleic acid (%)		Linoleic acid (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
V_1	5.64	5.67	3.59	3.65	36.79	36.80	45.90	45.94
V_2	5.34	5.38	3.49	3.56	36.38	36.45	45.30	45.36
V_3	5.70	5.70	3.69	3.71	36.99	37.01	46.10	46.15
V_4	5.42	5.45	3.49	3.54	36.48	36.54	45.60	45.64
V_5	5.60	5.64	3.59	3.62	36.58	36.62	45.81	45.81
SE (m) ±	0.139	0.135	0.096	0.085	0.328	0.339	0.399	0.409
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
T_1	4.34	4.36	3.05	3.08	34.20	34.22	42.60	42.63
T_2	6.83	6.87	4.46	4.52	37.10	37.16	45.87	45.92
T_3	5.28	5.32	3.27	3.29	38.60	38.62	44.74	44.77
T_4	5.32	5.36	3.26	3.19	38.62	38.68	44.64	44.69
T_5	5.70	5.71	3.61	3.72	36.85	36.89	45.25	45.30
T_6	5.66	5.69	3.59	3.61	36.70	36.74	45.10	45.15
T_7	5.72	5.73	3.73	3.74	36.90	36.92	45.32	45.36
T_8	5.65	5.69	3.68	3.70	36.75	36.81	45.15	45.19
T_9	5.40	5.43	3.50	3.54	35.80	35.35	49.33	49.36
T_{10}	5.51	5.54	3.58	3.59	35.40	35.43	49.42	49.44
SE (m) ±	0.196	0.189	0.135	0.121	0.463	0.748	0.563	0.577
CD (P=0.05)	0.55	0.53	0.38	0.34	1.30	1.33	1.58	1.62

V_1 = Rudra 99-D	T_1 = control	T_2 = RDF
V_2 = Shikhar	T_3 = 100%N Through FYM	T_4 = 100%N Through Vermicompost
V_3 = Rani	T_5 = 75%N Through FYM+ Azotobacter	T_6 = 75%N Through FYM+ PSB
V_4 = Varuna	T_7 = 75%N Through vermicompost + Azotobacter	T_8 = 75%N Through Vermicompost + PSB
V_5 = Yellow Goldy	T_9 = 50% N through FYM + Azotobacter+ PSB	T_{10} = 50% N through vermicompost + Azotobacter + PSB

RDF: Recommended dose of fertilizers
FYM: Farm yard manure
PSB: Phosphorus solubilising bacteria

Table 3: Linonic acid and oleic acid concentrations in mustard oil (fatty acid) as affected by varieties, inorganic and organic fertilizers and biofertilizers

Treatment	Oleic acid (%)		Linoleic acid (%)	
	2016-17	2017-18	2016-17	2017-18
Varieties				
V_1	0.32	0.33	0.92	0.94
V_2	0.31	0.31	0.91	0.92
V_3	0.32	0.33	0.92	0.94
V_4	0.31	0.32	0.91	0.92
V_5	0.31	0.32	0.91	0.93
SE (m) ±	0.007	0.007	0.012	0.012
CD (P=0.05)	NS	NS	NS	NS
Fertilizers/ Biofertilizers				
T_1	0.30	0.31	0.89	0.92
T_2	0.32	0.32	0.90	0.93
T_3	0.31	0.31	0.92	0.92
T_4	0.31	0.31	0.92	0.92
T_5	0.32	0.32	0.91	0.93
T_6	0.30	0.32	0.90	0.92
T_7	0.33	0.34	0.93	0.94
T_8	0.31	0.32	0.90	0.92
T_9	0.31	0.32	0.90	0.93
T_{10}	0.31	0.32	0.90	0.93
SE (m) ±	0.011	0.011	0.017	0.017
CD (P=0.05)	NS	NS	NS	NS

V_1 = Rudra 99-D	T_1 = control	T_2 = RDF
V_2 = Shikhar	T_3 = 100%N Through FYM	T_4 = 100%N Through Vermicompost
V_3 = Rani	T_5 = 75%N Through FYM+ Azotobacter	T_6 = 75%N Through FYM+ PSB

V_4 = Varuna	T_7 = 75%N Through vermicompost + Azotobacter	T_8 = 75%N Through Vermicompost + PSB
V_5 = Yellow Goldy	T_9 = 50% N through FYM + Azotobacter+ PSB	T_{10} = 50% N through vermicompost + Azotobacter + PSB

RDF: Recommended dose of fertilizers
FYM: Farm yard manure
PSB: Phosphorus solubilising bacteria

Table 4: Biochemical characters as affected by varieties and organic manures/biofertilizers

Treatment	Total chlorophyll (mg g^{-1} fresh weight of leaves)				Total soluble sugars (mg g^{-1} leaf fresh weight)				Proline content (mg g^{-1} fresh leaf weight)			
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS
Varieties												
V_1	2.10	1.39	2.13	1.41	8.92	9.80	8.98	9.84	10.22	10.23	10.28	10.31
V_2	1.59	1.18	1.62	1.23	8.46	9.53	8.55	9.54	9.27	9.24	9.14	9.15
V_3	2.22	1.45	2.23	1.46	9.27	10.29	9.30	10.33	10.46	10.47	10.46	10.46
V_4	1.83	1.24	1.85	1.28	8.60	9.64	8.63	9.66	9.75	9.75	9.56	9.59
V_5	1.96	1.33	1.97	1.35	8.65	9.74	8.68	9.75	9.94	9.94	9.76	9.76
SE (m) ±	1.62	1.04	1.82	1.01	1.22	1.25	1.24	1.58	1.24	1.23	1.25	1.22
CD (P=0.05)	0.44	0.26	0.45	0.25	0.33	0.37	0.36	0.40	0.36	0.35	0.37	0.34
Fertilizers/ Biofertilizers												
T_1	1.04	0.85	1.06	0.88	6.71	7.80	6.74	7.84	8.01	8015	8.00	8.12
T_2	2.49	1.64	2.53	1.67	7.43	8.44	7.47	8.46	8.60	8.73	8.43	8.54
T_3	1.43	1.03	1.44	1.08	7.52	8.53	7.56	8.54	9.49	9.59	9.40	9.28
T_4	1.49	1.06	1.53	1.10	7.56	8.58	7.59	8.59	9.60	9.50	9.62	9.73
T_5	2.89	1.85	2.93	1.86	11.74	12.75	11.77	12.77	10.70	10.60	10.45	10.25
T_6	1.64	1.13	1.65	1.15	9.35	10.36	9.37	10.38	10.25	10.50	10.20	10.05
T_7	3.09	1.91	3.10	1.94	11.92	12.93	11.95	12.94	11.40	11.21	11.25	11.40
T_8	1.72	1.14	1.74	1.17	9.41	10.41	9.42	10.44	10.55	10.38	10.46	10.58
T_9	1.75	1.22	1.76	1.24	7.83	8.86	7.87	8.86	10.20	10.32	10.22	10.16
T_{10}	1.84	1.35	1.85	1.38	8.34	9.34	8.37	9.37	10.40	10.28	10.40	10.49
SE (m) ±	1.98	1.24	2.21	1.22	1.56	2.10	2.05	2.24	2.05	1.62	2.00	1.58
CD (P=0.05)	0.52	0.37	0.64	0.36	0.47	0.53	0.51	0.57	0.51	0.49	0.52	0.48

V_1 = Rudra 99-D	T_1 = control	T_2 = RDF
V_2 = Shikhar	T3 = 100%N Through FYM	T4 = 100%N Through Vermicompost
V_3 = Rani	T_5 = 75%N Through FYM+ Azotobacter	T_6 = 75%N Through FYM+ PSB
V_4 = Varuna	T_7 = 75%N Through vermicompost + Azotobacter	T_8 = 75%N Through Vermicompost + PSB
V_5 = Yellow Goldy	T_9 = 50% N through FYM + Azotobacter+ PSB	T_{10} = 50% N through vermicompost + Azotobacter + PSB

RDF: Recommended dose of fertilizers
FYM: Farm yard manure
PSB: Phosphorus solubilising bacteria

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