

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

ABSTRACT

A field experiment entitled “Oil yield and quality of Indian mustard (*Brassica juncea* L.) as influenced by organic manures and biofertilizers” varieties was conducted at the Research Farm of Sam Higginbottom Institute 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 randomized block design 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 acid, linolenic acid and arachidic acid contents did not show any significant variations amongst varieties. The biochemical characters viz., total chlorophyll, total soluble sugars and proline content recorded at 45 and 60 DAS were significantly highest 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

Oil seed groups being next to food crops hold sizeable share of the countries gross cropped area (13%) India is the 3rd largest producer of oilseeds in the world and accounts for 19% of world’s area and 9% of the global production. (Sinha, 2003). 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.

39 During recent years biofertilizers have emerged as a promising component of integrating
40 nutrient supply system in agriculture. Certain strains of soil microbes refer RDF to as plant
41 growth promoting rhizo-bacteria that include species of Azotobacter and Azospirillum both
42 of which provide direct and indirect effects on the plant growth and pest resistance.

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

47 **MATERIALS AND METHODS**

48 A field experiment was conducted at the Research Farm of Sam Higginbottom
49 Institute of Agriculture, Technology and Sciences, Allahabad during 2016-17 and 2017-18 to
50 study the “Oil yield and quality of Indian mustard (*Brassica juncea* L.) as influenced by
51 organic manures and biofertilizers (*Brassica juncea* L.) varieties for two years of 2016-17
52 and 2017-18. The experiment consisting of two factors viz., 5 varieties (V_1 = Rudra 99D, V_2
53 = Shikhar, V_3 = Rani, V_4 =Varuna and V_5 = Yellow Goldey) and 10 fertilizers (T_1 = control,
54 T_2 = RDF, T_3 = 100%N Through FYM, T_4 = 100%N Through Vermicompost, T_5 = 75%N
55 Through FYM+ Azotobacter, T_6 = 75%N Through FYM+ PSB, T_7 = 75%N Through
56 vermicompost + Azotobacter, T_8 = 75%N Through Vermicompost + PSB, T_9 = 50% N
57 through FYM + Azotobacter+ PSB and T_{10} = 50% N through vermicompost + Azotobacter +
58 PSB was laid out in a randomized block design replicated thrice, the seed was sown in lines
59 at 30 cm row spacing at the rate of 25kg/ha as per treatment. The crop was thinned twice to
60 maintain plant to plant spacing of 15 cm. The crop was harvested on 2-02-17 and 4-05-2018
61 during 2016-17 and 2017-18, respectively. Oil content in seed sample was determined using
62 Soxhlet apparatus. Fatty acid analysis was done by following procedure described by AOAC
63 (1990). Protein content was determined by the method described by Jackson (1967). The
64 biochemical characters viz; total chlorophyll content, total soluble sugars and proline contents
65 in seed were determined by the methods given by Arun (1949), C. ready *et al.*(1950) and
66 Bates *et al.* (1973), respectively. The data was analysed by the method described by Cochran
67 and Cox (1963).

68 **RESULTS AND DISCUSSION**

69 The data (table 1) revealed that Rani variety recorded significantly highest at yield,
70 while the oil content did not show any significantly variation amongst varieties. The results

71 are in line with the findings of Panda *et al.* (2004) who did not observe any significant
72 variation in the oil content of SEJ2 and Pusa Bold mustard varieties. The significant variation
73 in the oil yield amongst varieties attributed to the higher seed yield recorded by Rani
74 variety as oil yield is the product of seed yield and respective oil content. The study also
75 indicated that amongst fertilizer treatments, application of 75% N through vermicompost +
76 Azotobacter recorded significantly highest oil content and oil yield. These results corroborate
77 the findings of Singh and Singh (2006) who reported that application of 5t FYM/ha alongwith
78 inorganic fertilizers and biofertilizers recorded significantly highest oil content and yield in
79 mustard. No significant variation was noticed amongst varieties with regard to saturated and
80 unsaturated fatty acids (Table 2 and 3). The investigation also revealed that the palmitic acid,
81 stearic acid and oleic acid were significantly maximum with fertilizer treatment of
82 recommended fertilizer dose, while linoleic acid was significantly highest with the treatment
83 50% N through vermicompost + Azotobacter + PSB. Both linolenic and arachidic acid
84 content remained unaffected by fertilizer treatments. There was a strong negative relationship
85 between linoleic and oleic acid concentrations which is similar to the results obtained earlier
86 by Seiler (2007). Earlier Steer and Seiler (1990) also reported that the biofertilizers singly or
87 combination of two along with organic manures decreased saturated fatty acids (Palmitic and
88 stearic acids) while significantly increased unsaturated fatty acids. Further, they also reported
89 that oil% and oleic acid % was negative due to adverse effect of nitrogen. Both protein
90 content and yield were significantly highest in Rani variety (Table-) this may be attributed to
91 genetic potential of the varieties with regard to the accumulation of nitrogen nutrient. Earlier
92 Sandhu *et al.* (2010) also found higher protein content and yield in RLC1 variety than other
93 mustard varieties tested. It was also noticed that application of 75% N through vermicompost
94 + Azotobacter recorded significantly highest protein content and yield. The high nitrate
95 supply from the treatment might have increased amino acid synthesis in leaves which
96 stimulated accumulation of protein in seed. Earlier Akbari *et al.* (2011) also reported similar
97 findings.

98 The data (Table-4) showed that the biochemical characters viz., total chlorophyll
99 content total soluble sugars and proline content recorded at 45 and 60 DAS were significantly
100 highest in Rani variety. These results may be attributed to significant variation in the level of
101 biosynthesis of chlorophyll and photosynthesis depending on genetic potential of mustard
102 varieties. Further, the differential response of varieties to environmental stress and different
103 levels of osmotic adjustment might have produced significant variation in proline content.

104 Banerji *et al.* (2012) have also found significant variation in total chlorophyll content
 105 amongst different mustard varieties. Ali (2005) recorded variation in total soluble sugar
 106 content in leaves of Iris. Ozturk and Desmir (2002) reported significant variation in the
 107 proline content of different mustard varieties. The study also revealed that significantly
 108 highest biochemical characters were recorded by the treatment 75% N through vermicompost
 109 + Azotobacter. The results are in agreement with those of Moria (2006) and Shetecoi and
 110 Tawfik (2007). The increase in total chlorophyll content may be attributed to increased
 111 uptake of magnesium from soil in the form of Mg^{+2} under the influence of biofertilizer.
 112 Further, higher biosynthesis of chlorophyll and photosynthesis of flag leaf mustard crop
 113 under Azotobacter treated plots might have resulted towards higher level of sugar in leaves.
 114 The higher accumulation of proline in leaves of mustard might be attributed towards the
 115 response of biofertilizer treated crop to mitigate and stimulating of draught tolerance.

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

122 **Table.1 Protein content/protein yield and oil content/oil yield as affected by varieties**
 123 **and organic manures /biofertilizers**

Treatment	N content in seed (%)		Protein content in seed (%)		Protein yield (Kg/ha)		Oil content (%)		Oil yield (kg/ha)	
	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

124

V ₁ = Rudra IID	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

125

126 **Table 2** Saturated and unsaturated fatty acids as affected by varieties and organic
127 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

128

V ₁ = Rudra IID	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

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130 **Table-3** Linonic acid and arachidic acid concentrations in mustard oil (fatty acid)
131 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

132

V ₁ = Rudra IID	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

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

Treatment	Total chlorophyll (mg/g fresh weight of leaves)				Total soluble sugars (mg/g leaf fresh weight)				Proline content (mg/g 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) ±												
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	8.015	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) ±												
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

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V ₁ = Rudra IID	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

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