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Agro-biochemical, microbiological parameters and economics of mustard (*Brassica juncea* L.) as influenced by nutrient sources under semi-arid environment

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Abstract
An experiment was carried out during *rabi* 2019-20 and 2020-21 to assess the impact of nutrient sources on agronomic, biochemical, microbiological parameters and economic of mustard. The experiment was laid out in randomized complete block design with three replications. The treatment comprised of **1**00% RDF through chemical fertilizers, **1**00% RDN through vermicompost, 100% RDN through FYM, 100% RDN through mushroom compost, 100% RDN through biogas slurry, 100% RDN through improved FYM, 50% RDF through chemical fertilizers, 50% RDN through vermicompost +50%RDF, 50% RDN through FYM +50%RDF, 50% RDN through mushroom compost +50%RDF, 50% RDN through biogas slurry +50%RDF, 50% RDN through improved FYM +50%RDF. Application of 100% RDF resulted in the highest seed yield, which was similar to 50% RDN through improved FYM +50% RDF through chemical fertilizers but was significantly higher than all rest treatments. The lowest values of yield attribute and yield was recorded with 50% RDF through chemical fertilizers. However, different nutrient sources could not cause any significant variation in the protein and nutrient content in seed and stover. The higher value of dehydrogenase activity was found with the application of manures or their combination with lower doses as compared to sole application of chemical fertilizers.

Keywords: Economics, glucosinolate, improved FYM, mustard, nutrient sources, productivity, quality

Introduction

Oilseeds are considered as the second largest agricultural commodity after cereals in India, which plays a significant role in India's agrarian economy (Dubey *et al.* 2021) [11]. Among oilseed crops, mustard is one of the most popular edible oilseed and oil in meals, have an important role to relieving mineral nutrition and caloric nutrition of human being and animals (Maurya *et al.* 2020) [7]. The area under mustard production in India occupies more than 70% of the area under rapeseed-mustard group. However, mustard raised under rainfed conditions in India with low or minimal input leads to a lower productivity level (Kumar *et al.*, 2017; Dubey and Shukla 2020) [5, 10]. Indian soils have generally been reported to be low in nitrogen, phosphorus and Sulphur. Because of multiple cropping and introduction of high yielding varieties, the deficiency of these nutrients in soil is becoming wider (Maurya *et al.* 2020) [7]. To revitalize soil health and to enhance productivity, it is inexorable to enrich the soil using organic matter the simplest method to amend with nutrient management practices thereby improving the nutrient cycle. The inclusion of organic manures with chemical fertilizers has directly influenced plant growth, yield, and nutritional values. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties (Chaudhary *et al*, 2004) [3]. The organic acids produced during decomposition of organic waste can exchange with adsorbed P and increase its availability to plants. As organic manures influence soil productivity through their effect on soil physical, chemical and biological properties (Ram Bharaose *et al.* 2018) [9]. Farmyard manure and vermicompost are the most available animal manures. Application of FYM increased the activity of acid and alkaline phosphatase, phosphodiesterase, inorganic pycophosphatase and dehydrogenase leading to faster hydrolysis of easter-bond P to plant available P (Dinesh *et al*, 2003) [4]. Yield potentials of the crop, can be realized by balanced and efficient use of organic and inorganic sources of nutrient (Meena *et al.*, 2016) [8]. Therefore, the most efficient and practical way to mobilize all the available, accessible, and affordable plant nutrient sources to optimize the productivity of the crops/cropping systems and economic return to the farmer is through nutrient management practices.

Materials and Methods

Field experiment was conducted for two consecutive *rabi* seasons (2019-20 and 2020-21) at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar (29°10 north latitude and 75°46 east longitude at an elevation of 215.2 m above mean sea level). The soil of the experimental field was sandy loam in texture, low in organic C and available N, medium in available P, high in available K and slightly alkaline in reaction. The soil of the experimental field had no salinity or drainage problem and the water table did not interfere in the root-zone of the crop. The climate is semiarid and subtropical, hot and dry summer with mean rainfall of 400 mm. Rainfall being monsoonal in nature, 70–80% is received during the months of July, August and September. The treatment comprised of 100% RDF through chemical fertilizers, 100% RDN through vermicompost (2.4 t/ha), 100% RDN through FYM (10 t/ha), 100% RDN through mushroom compost (4.35 t/ha), 100% RDN through biogas slurry (4.7 t/ha), 100% RDN through improved FYM (4.35 t/ha), 50% RDF through chemical fertilizers, 50% RDN through vermicompost (1.2 t/ha) +50% RDF, 50% RDN through FYM (5 t/ha) +50% RDF, 50% RDN through mushroom compost (2.2 t/ha) +50% RDF, 50% RDN through biogas slurry (2.35 t/ha) +50% RDF, 50% RDN through improved FYM (2.2 t/ha) +50% RDF. The required quantity of organic manures *viz.* mushroom compost, farmyard manure (FYM) and vermicompost (VC) as per the treatments was applied in the field 15 days before sowing of the crop on dry weight basis. The nutrient content of the organic manure used are given in Table1. The experiment was laid out in randomized block design. Mustard variety RH 725 was sown on a well-prepared seedbed with drilling method using seed rate of 5 kg ha^{-1}. All other agronomical practices were followed as per the recommended package and practices given by CCS Haryana Agricultural University, Hisar, Haryana, India. Crop was harvested at maturity and the yield parameters were recorded. Data regarding number of branches per plant, siliquae length, number of siliquae per plant, number of grains per siliquae, 1000 grain weight and seed yield were recorded from each net plot (6.0 m × 8.0 m). Seed and straw samples of crop were collected, digested and analyzed for N, P and K. Standard procedures were adopted to record data, to compute the B-C ratio and analysis of N, P and K in seed and stover. Crude oil content was estimated by A.O.A.C. method, (1995) [1]. Glucosinolate have been estimated by colorimetric using the method of Kumar *et al.* [2004] [6] and the dehydrogenase activity by colorimetric method (Casida *et al.*,1964) [2]. The recorded data on growth attributes and yield of mustard collected during study years were analysed statistically for randomized block design and presented at 5% significant level ($P \leq 0.05$). The data were pooled and were subjected to analysis of variance using online statistical analysis package of OPSTAT (Sheoran *et al.* 1998) [12].

Results and Discussion

Tallest plants were recorded with the application of recommended dose of fertilizers, which were similar o 100% RDN through improved FYM and 50% RDN through improved FYM (2.2 t/ha) + 50% RDF. The shortest plants were observed in the treatment of application of 50% RDF through chemical fertilizers (Table 2). Significantly higher yield attributes were recorded with the application of recommended dose of fertilizer and it was statistically similar to the treatment of 50% RDN through improved FYM (2.2 t/ha) +50% RDF in respect of number of branches per plant, siliquae length from the treatment 50% RDN through improved FYM (2.2 t/ha) +50% RDF. Similarly, significantly higher values of number of seed per siliqua and number of siliquae per plant were recorded with the application of RDF over other treatments except 100% RDN through mushroom-compost, 100% RDN through improved FYM, 50% RDN through vermicompost +50% RDF, 50% RDN through mushroom compost +50% RDF and 50% RDN through improved FYM +50% RDF. Different treatments did not differ significantly in respect of test weight. Significantly higher value of seed yield was produced with the application of 100 per RDF over other treatment except 50% RDN through improved FYM +50% RDF. The lowest values of yield attributes and yield was recorded with 50% RDF through chemical fertilizers (Table 3). The higher yield might be ascribed to improvement in growth and yield parameters and the increased availability of nutrients at initial stage through fertilizers in addition to nutritional and other benefits from organic manures at later stages might have created favourable effect on vegetative growth and yield attributes. These trends clearly indicates that organic manures *per se* is not sufficient to supply nutrients in soil but availability to plants during initial growth stages through their mineralization is required. There was a strong and positive correlation between number of branches per plant, siliquae length, number of siliquae per plant, number of seeds per siliquae and seed yield indicating that treatment having higher yield attributes produced higher seed yield (Fig.1- 4). Different nutrient sources did not bring any significant variation in the protein content, nutrient content and nutrient uptake in seed and stover (Table 4). The highest value of benefit cost ratio was observed under the treatment 100% RDF through chemical fertilizers followed by 50% RDN through improved FYM + 50% RDF and 50% RDN through mushroom compost + 50% RDF. The lowest value in this respect was registered with 100% RDN through vermicompost (Fig.5). Among the treatments, the oil content values varies from 39.2 to 40.1 percent (Fig. 6) whereas the Glucosinolate content varies from 69.11 to 70.1 µmole/g defatted meal (Fig. 7). The higher value of dehydrogenase activity was found with the application of manures or their combination with lower doses as compared to sole application of chemical fertilizers (Fig.8). Addition of organic matter might have increased the biological activity of the soil and decrease of microbial processes and dehydrogenase activity by chemical fertilization may be due to poor physical conditions and lack of organic substrates in the soils.

Table 1: Nutrient details of various organic sources

Source	N (%)	P (%)	K (%)
Vermicompost	2.5	1	1.5
FYM	0.62	0.2	0.5
Biogas slurry	1.28	0.72	0.7
Mushroom compost	1.38	0.37	0.3
Improved FYM (made by waste decomposer)	1.38	0.26	0.6

Table 2: Pearson Correlation Matrix- Mustard

	No. of branches per plant	Siliquae length	No. of seed per siliqua	No. of siliquae per plant	Test weight	Seed yield
No. of branches per plant						
Siliquae length	0.971**					
No. of seed per siliqua	0.882**	0.907**				
No. of siliquae per plant	0.905**	0.918**	0.949**			
Test weight	0.846**	0.886**	0.911**	0.966**		
Seed yield	0.903**	0.907**	0.922**	0.991**	0.945**	

Table 3: Effect of organic sources of nutrients on yield attributes and yield of mustard crop (pooled of two years)

Treatment	Plant height (cm)	No. of branches per plant	Siliquae length (cm)	No. of seed per siliqua	No. of siliquae per plant	Test weight (g)	Seed yield (kg/ha)
100% RDF through chemical fertilizers	251	9.1	5.8	13.4	297.7	6.1	2547
100% RDN through vermicompost (2.4 t/ha)	233	6.9	4.9	11.7	244.8	5.7	1672
100% RDN through FYM (10 t/ha)	229	6.1	4.8	11.5	232.9	5.6	1479
100% RDN through mushroom compost (4.35 t/ha)	233	6.8	4.8	12.2	248.8	5.6	1830
100% RDN through biogas slurry (4.7 t/ha)	232	6.6	4.8	11.7	239.7	5.6	1578
100% RDN through improved FYM*(4.35t/ha)	245	7.4	5.2	13.0	266.1	5.8	1977
50% RDF through chemical fertilizers	221	5.6	4.4	10.2	210.3	5.3	1288
50% RDN through vermicompost (1.2 t/ha) +50%RDF	239	6.9	5.1	12.7	267.5	5.9	2062
50% RDN through FYM (5 t/ha) +50%RDF	233	6.5	4.9	11.8	252.1	5.7	1848
50% RDN through mushroom compost (2.2 t/ha) +50%RDF	241	7.1	5.0	12.6	281.8	6.0	2245
50% RDN through biogas slurry (2.35 t/ha) +50%RDF	235	6.9	5.0	12.1	258.8	5.8	1965
50% RDN through improved FYM (2.2 t/ha) +50%RDF	248	8.0	5.4	13.1	287.6	5.9	2333
CD@ 5%	7.0	1.3	0.6	1.2	36.5	NS	251

Table 4: Effect of organic sources of nutrients on protein and nutrient content of mustard

Treatment	Protein content (%)	Nutrient content (%)					
		Seed			Straw		
		N	P	K	N	P	K
100% RDF through chemical fertilizers	19.8	3.16	0.74	1.10	0.45	0.27	1.72
100% RDN through vermicompost (2.4 /ha)	16.6	2.65	0.59	0.89	0.37	0.25	1.48
100% RDN through FYM (10 t/ha)	16.8	2.68	0.70	0.94	0.39	0.25	1.52
100% RDN through mushroom compost (4.35 t/ha)	15.8	2.53	0.64	0.86	0.29	0.25	1.43
100% RDN through biogas slurry (4.7 t/ha)	16.6	2.65	0.71	0.92	0.36	0.25	1.54
100% RDN through improved FYM* (4.35 t/ha)	17.1	2.74	0.72	0.95	0.41	0.26	1.63
50% RDF through chemical fertilizers	15.1	2.42	0.58	0.82	0.31	0.23	1.42
50% RDN through vermicompost (1.2 t/ha) +50%RDF	16.5	2.64	0.69	0.92	0.41	0.25	1.56
50% RDN through FYM (5 t/ha) +50%RDF	17.4	2.78	0.71	0.98	0.42	0.26	1.61
50% RDN through mushroom compost (2.2 t/ha) +50%RDF	16.3	2.61	0.65	0.92	0.32	0.25	1.50
50% RDN through biogas slurry (2.35 t/ha) +50%RDF	17.0	2.72	0.72	0.99	0.39	0.26	1.61
50% RDN through improved FYM (2.2 t/ha) +50%RDF	17.9	2.87	0.73	1.03	0.42	0.27	1.65
CD@ 5%	NS	NS	NS	NS	NS	NS	NS

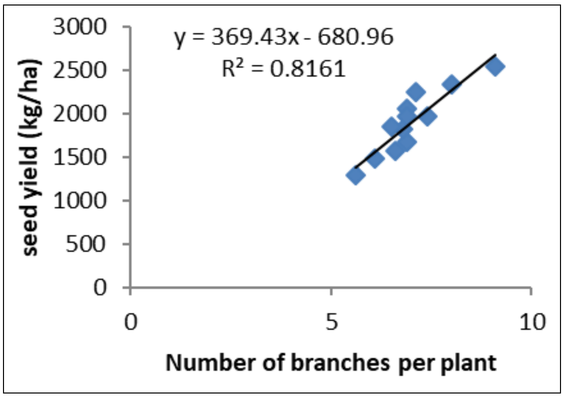

Fig 1: Relationship between number of branches per plant and seed yield of mustard

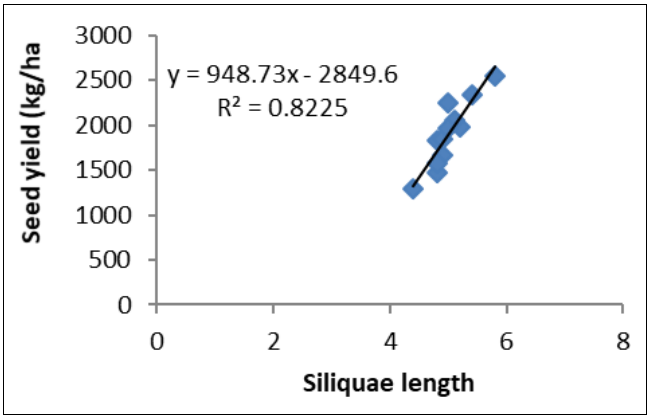

Fig 2: Relationship between siliquae length and seed yield of mustard

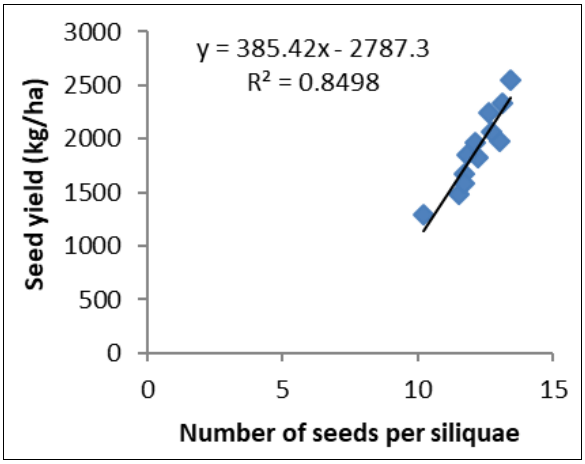

Fig 3: Relationship between number of seeds per siliquae and seed yield of mustard

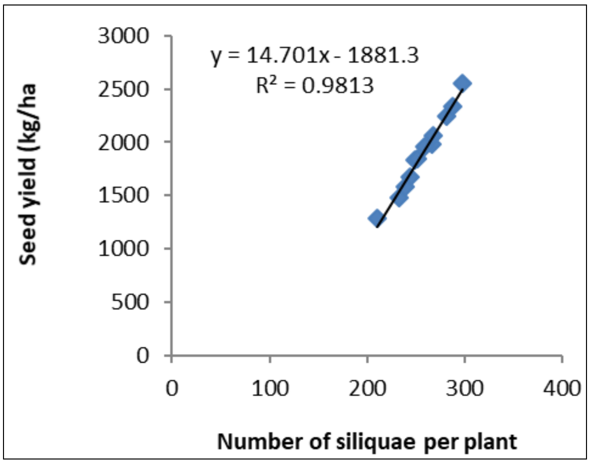

Fig 4: Relationship between number of siliquae per plant and seed yield of mustard

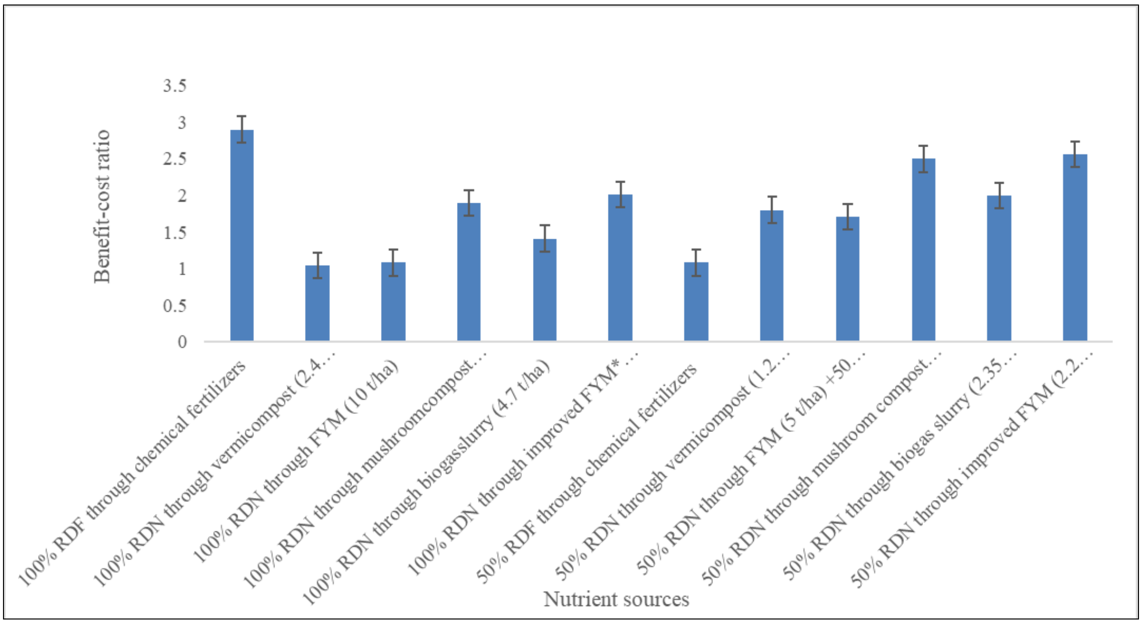

Fig 5: Impact of organic sources on the benefit cost ratio of mustard crop

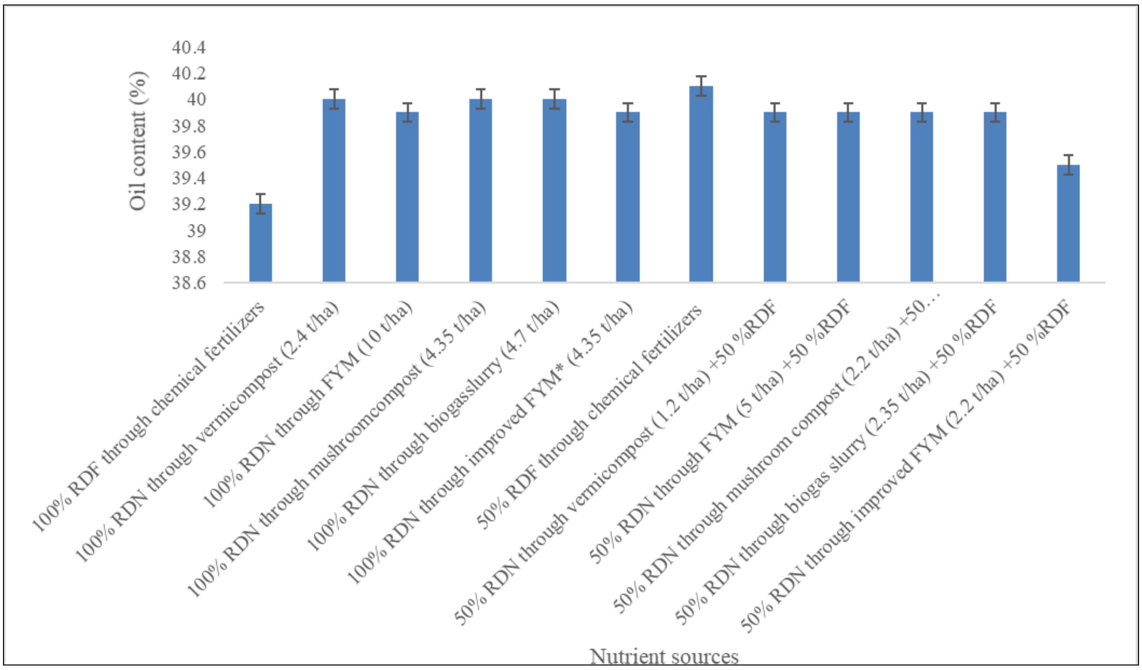

Fig 6: Impact of nutrient sources on oil content in mustard crop

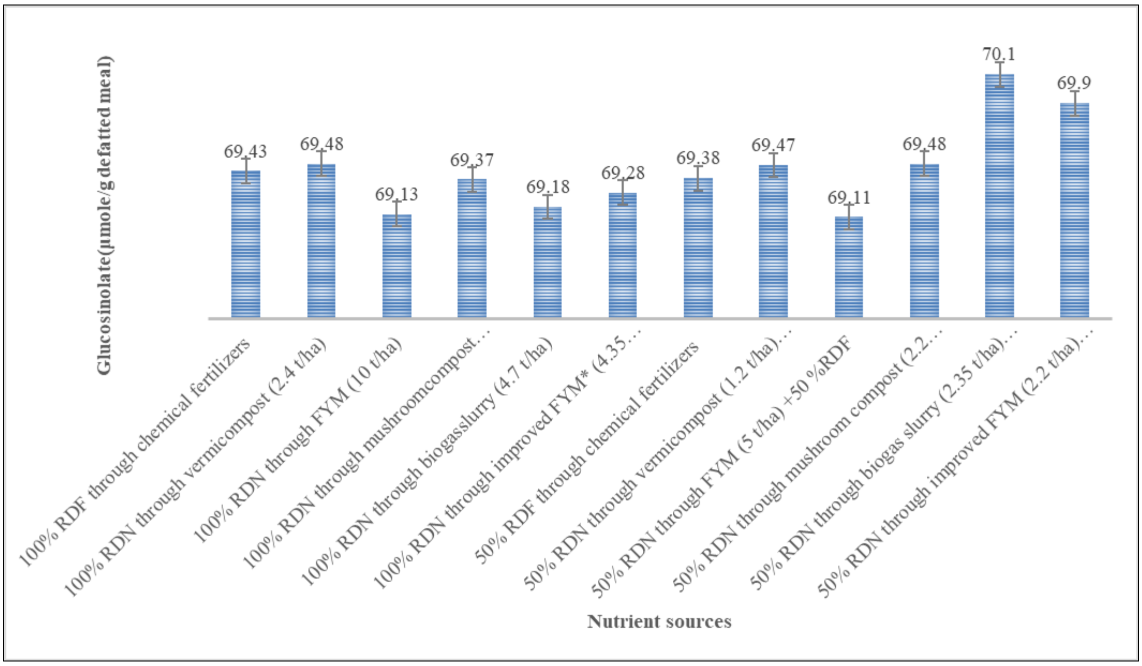

Fig 7: Impact of organic sources on the Glucosinolate(µmole/g defatted meal) of mustard crop

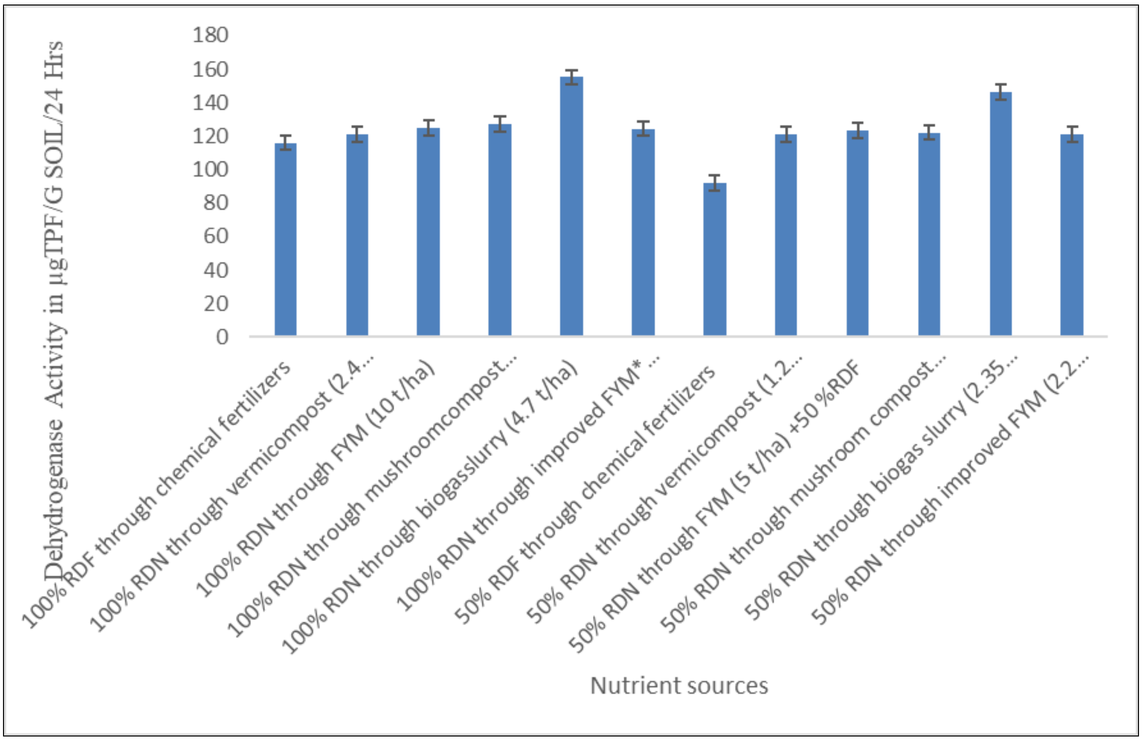

Fig 8: Impact of organic sources on the Dehydrogenase Activity in µgTPF/G SOIL/24 Hrs of mustard crop

Conclusion

On the basis of two year study, it may be concluded that different nutrient sources did not bring any significant variation in the protein and nutrient content in seed and stover. However, application of manures or their combination with lower doses of chemical fertilizers increased biological activity of the soil and had higher dehydrogenase activity in comparison to sole chemical fertilization.

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