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EFFECT OF ORGANIC NUTRIENT MANAGEMENT ON NUTRIENT UPTAKE BY CROP, NUTRIENT DEPLETION BY WEEDS AND ECONOMICS OF RAPESEED

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ABSTRACT

An experiment was carried out at the Instructional-cum Research Farm, Assam Agricultural University during the *rabi* season of 2018-19 in order to assess the effect of organic nutrient amendments on nutrient uptake by crops, depletion by weeds and the economics. The experiment was laid out in randomized block design (RBD) with eleven different treatments of organic management along with one control plot. Results revealed that the maximum nutrient uptake by crop was observed under the treatment receiving vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (54.450 N kg/ha, 12.230 P kg/ha and 24.397 K kg/ha) being statistically at par with the treatment of FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (52.403 N kg/ha, 11.783 P kg/ha and 24.427 K kg/ha). Considerably, the highest nutrient depletion by weeds were observed under the control plots (1.213 N kg/ha, 0.740 P kg/ha and 1.113 K kg/ha) over all the treatments. In terms of economics, the treatment vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha recorded the highest gross return (Rs. 108880/ha) while the net return was maximum under FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (Rs. 55660/ha), both being closely followed by each other. Contrarily, the highest benefit- cost ratio (B: C) was observed under FYM @10 t/ha (2.600).

***Keywords*:** Organic nutrient management, nutrient uptake, crop, nutrient depletion, weed, economics of rapeseed

Introduction

India ranks as the third-largest producer of rapeseed-mustard globally, following China and Canada. This crop is crucial for the country's agricultural economy, contributing nearly one-third of India's edible oil production (Kumar *et al.,* 2015). Rapeseed-mustard holds significant importance in India's oilseed sector, ranking third after soybean and groundnut, and making up approximately 27.8% of the nation's oilseed economy. On the global stage, rapeseed and mustard production totals around 38-42 million tonnes, with an oil yield ranging from 12-14 million tonnes (Rai *et al.,* 2016). India plays a substantial role in this economy, accounting for 28.3% of the global area and 12% of the production. The country's annual rapeseed-mustard production is about 7.9 million tonnes, with an average yield of 11.02 quintals per hectare. Despite this, India lags behind China and the European Union, where production levels range between 11-12 million tonnes and 10-13 million tonnes, respectively (Hegde, 2012).

India's involvement in the global mustard industry is significant, yet it faces challenges in meeting future demand. By 2050, the country's population is expected to reach 1.685 billion, requiring the production of 17.84 million tonnes of vegetable oils to satisfy nutritional fat needs (Anonymous, 2014). Meeting this target under current agricultural practices and technology levels is a daunting task. Therefore, enhancing oilseed productivity is essential for India to achieve self-sufficiency in edible oils. The increasing demand for food grains and oilseeds has led farmers to focus on boosting crop yields, often relying heavily on chemical fertilizers. However, the indiscriminate use of these fertilizers, aimed at supplying essential nutrients, poses risks to both food quality and soil health. The continuous application of inorganic inputs has resulted in the depletion of critical micronutrients, such as boron and zinc, particularly in rainfed regions. This depletion has not only reduced soil productivity but also adversely affected soil fertility and microbial activity (De *et al.,* 2009; Kumar *et al.,* 2018).

Over the years, various organic inputs, including compost, farmyard manure (FYM), vermicompost, crop residues, green manures, green leaf manuring, and biofertilizers, have been employed to increase soil organic carbon, supply essential plant nutrients, and improve soil properties (Yadav *et al.,* 2013; Hadiyal *et al.,* 2017). Animal manure, in particular, has long been recognized for its ability to enhance soil fertility. It provides a cost-effective and environmentally friendly alternative to mineral fertilizers. Effective nutrient management through organic sources is crucial for maintaining soil health by increasing soil organic matter and promoting the activity of beneficial microbes and enzymes. The long-term application of organic materials has been shown to boost organic matter content, crop productivity, and soil biological activity. However, despite the advantages of organic nutrient sources, their impact on crop yields may not always be immediately cost-effective. Rapeseed-mustard, one of India's most important edible oilseed crops, suffers from low average yields in Assam compared to other regions of the country. This low yield is primarily due to the use of low-yielding varieties, poor soil fertility, and inadequate nutrient management practices (Hutchison *et al.,* 2005). These challenges are further compounded by crop intensification under organic farming, aimed at achieving self-sufficiency in oilseed production.

In this context, nutrient management emerges as a critical technology for maintaining and enhancing the production potential of rapeseed-mustard under organic farming systems. Given the challenges posed by lower yields in Assam, a strategic approach to nutrient management, including the judicious use of organic inputs, is essential for improving soil health, sustaining productivity, and achieving desired levels of self-sufficiency in oilseed production (Collins *et al.,* 1992). Organic farming practices, when properly managed, can offer a sustainable solution to the challenges faced in rapeseed-mustard production. This ensures that India continues to contribute significantly to the global mustard industry while meeting its domestic nutritional needs. Moreover, continuous and intensive cropping practices are depleting the soil's nutrient reserves, leading to multiple nutrient deficiencies that negatively impact both soil health and crop yields. Therefore, to fully realize the potential benefits of various organic amendments, an experiment was initiated to study the growth and yield effects of *rabi* rapeseed under different organic treatments. This study underscores the importance of integrating organic nutrient sources into the agricultural practices for rapeseed-mustard, ensuring long-term sustainability and productivity in this vital sector of India's economy.

Materials and Methods

A field experiment was conducted during the *rabi* season of 2018-19 at the ICR farm of Assam Agricultural University (AAU), Jorhat, located at 26°44' N latitude, 94°10' E longitude, and 91.0 meters above mean sea level. The study aimed to investigate the effect of spontaneous organic management techniques on the growth and yield of rapeseed. The climate of Jorhat is characterized as subtropical humid, with hot summers where temperatures range between 34-37°C and cold winters with temperatures between 8-10°C. The region experiences monsoon rains from June to September. During the crop season, the maximum temperatures ranged from 21.3°C to 27.2°C, while the minimum temperatures varied between 8.1°C and 14.2°C. The relative humidity was high, averaging between 90-99% in the morning and 53-77% in the evening. The area received an average rainfall of 75.6 mm, compared to the total evaporation of 134.4 mm, and bright sunshine averaged 6.64 hours per day. The soil in the experimental area was found to be acidic, with a pH of 5.1. It had medium levels of organic carbon (0.53%), available nitrogen (274.2 kg/ha), available phosphorus (26.9 kg/ha), and available potassium (192.0 kg/ha). These soil conditions, combined with the region's climatic factors, provided the basis for studying the impact of organic management practices on rapeseed growth and yield in this specific agro-climatic context. The experiment was laid out in a randomized block design with three replications and consisted of 10 levels of organic nutrient management treatments along with control treated plot viz., Control (T0), FYM @ 10 t/ha (T1), Vermicompost @ 5 t/ha (T2), Poultry Manure @ 5 t/ha (T3), FYM @ 5 t/ha + Vermicompost @ 2.5 t/ha (T4), FYM @ 5 t/ha + poultry manure @ 2.5 t/ha (T5), Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha (T6), FYM @ 5 t/ha + Vermicompost @ 2.5 t/ha + mustard oil cake @ 1 t/ha (T7), FYM @ 5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha (T8), Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha (T9), FYM @ 5 t/ha + Vermicompost @ 1.25 t/ha + poultry manure @ 1.25 t/ha + mustard oil cake @ 1 t/ha (T10), respectively. The TS-67 variety of rapeseed was sown at a rate of 12 kg per hectare in shallow furrows, maintaining a 30 cm distance between the furrows. The seeds were sown as uniformly as possible, at a depth of 4-5 cm, to ensure optimal growth conditions. Prior to sowing, the experimental plots were designated for different organic treatments, including farmyard manure (FYM), vermicompost, poultry manure, and other organic inputs. The required amounts of each manure, calculated based on dry weight, were applied uniformly across the respective plots according to the treatment plans. This application was carried out three days before sowing, with the organic inputs thoroughly incorporated into the soil to enhance nutrient availability and soil structure. This careful preparation aimed to evaluate the impact of various organic management techniques on the growth and yield of the rapeseed crop. The crop was harvested from the net plot, on 21st February, 2019, when most of the siliquae turn into brown in colour and started drying. The plants from the entire net-plot area were pulled out by hand, tied into bundles for the individual plot, labelled as per treatments and were carried to the threshing floor. Regulat biometric observations and yield parameters were observed before the harvest oof the crop from five randomly selected plants. Weed population/m^2, weed dry weight as well as nutrient content and uptake in seed and stover were worked out for the crop and weed by the method as outlined by Jackson (1973). Economic analysis were also carred out using the prevailing market price. All relevant data from the present investigation were statistically analyzed using a randomized block design. The analysis followed the 'analysis of variance' (ANOVA) method as outlined by Panse and Sukhatme (1985). To determine the significance of variance due to treatment effects, the corresponding 'F' values were calculated.

Results and Discussions

Weed parameters and nutrient in weeds: Significantly lower weed population per unit area (m^2) and dry weight of weeds were observed with different organic nutrient treatments compared to the control (Table 1). Although the dry weight of weeds did not vary greatly among the organic treatments, the combination of vermicompost 2.5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha (50.67/m^2), as well as FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha (54.67/m^2), resulted in notably lower weed populations. The enhanced crop vigor, growth, and development likely suppressed weed growth, despite adequate soil moisture and nutrient availability. Muriel and Meynard (2008) also reported that rapeseed can absorb high amounts of soil nutrients, particularly nitrogen, thereby reducing weed competition.

Furthermore, the application of different organic nutrient sources led to significantly higher N, P, and K contents in weeds compared to the control (Table 1). Although there was no significant difference in P content among the treatments, the application of vermicompost 2.5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, as well as FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, resulted in relatively higher N and K contents in weeds. Previous studies by Naderi and Ghadiri (2013) have shown that weeds are highly competitive for soil nutrients, especially nitrogen, which can reduce its availability to crops. Consequently, higher nutrient availability in the soil also led to higher nutrient content in the weeds.

The nutrient uptake of N, P, and K by weeds (Table 1) was significantly lower in treatments involving FYM 5 t/ha, vermicompost 2.5 t/ha, and mustard oil cake 1 t/ha, as well as vermicompost 2.5 t/ha and poultry manure 2.5 t/ha, compared to other organic nutrient sources and the control. However, treatments with FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, as well as vermicompost 2.5 t/ha and poultry manure 2.5 t/ha, also resulted in lower but comparable nutrient uptake by weeds. The reduced dry matter of weeds associated with these treatments likely contributed to the lower nutrient uptake.

Table 1 : Effect of organic nutrient amendments on weed parameters, nutrient content and uptake by weeds

Treatment	Weed population/ m^2	Dry weight of weeds (g/m^2)	N		P		K	
			Content (%)	Uptake (kg/ha)	Content (%)	Uptake (kg/ha)	Content (%)	Uptake (kg/ha)
T_0	8.85* (77.33)**	3.30 (9.93)	1.223	1.213	0.747	0.740	1.120	1.113
T_1	7.55 (56.00)	2.90 (7.45)	1.257	0.937	0.780	0.580	1.137	0.847
T_2	7.71 (58.67)	2.68 (6.31)	1.260	0.797	0.783	0.493	1.140	0.720
T_3	8.66 (74.00)	2.48 (5.18)	1.257	0.653	0.777	0.403	1.140	0.590
T_4	8.13 (65.33)	2.89 (7.42)	1.263	0.937	0.787	0.583	1.143	0.847
T_5	7.97 (62.67)	2.34 (4.48)	1.260	0.567	0.787	0.350	1.143	0.513
T_6	7.97 (62.67)	2.06 (3.25)	1.267	0.407	0.783	0.253	1.140	0.370
T_7	8.22 (66.67)	1.90 (2.64)	1.263	0.333	0.790	0.207	1.143	0.300
T_8	7.46 (54.67)	2.48 (5.18)	1.270	0.660	0.790	0.410	1.147	0.590
T_9	7.19 (50.67)	2.49 (5.24)	1.270	0.667	0.793	0.417	1.147	0.600
T_{10}	7.55 (56.00)	2.67 (6.14)	1.267	0.780	0.790	0.483	1.140	0.697
SEm±	0.20	0.20	0.005	0.045	0.008	0.030	0.005	0.041
CD (P= 0.05)	0.59	0.59	0.015	0.132	0.024	0.089	0.014	0.120

*$\sqrt{x+1}$ transformed values ** Original values in parentheses

Nutrient content and uptake in plant: The impact of different organic nutrient sources on the percentage of N, P, and K content in both seed and stover (Table 2) was generally similar, with a few exceptions in P content. These nutrient contents were significantly higher compared to the control treatments. Although variations in N, P, and K contents between the different organic sources were not substantial, the treatments involving FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha (2.450%) and vermicompost 2.5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha (2.427%) showed comparatively higher N content in the seeds.

Table 2 : Effect of organic nutrient amendments on nutrient content by seed and stover of rapeseed

Treatment	N content (%)		P content (%)		K content (%)	
	Seed	Stover	Seed	Stover	Seed	Stover
T_0	2.027	0.617	2.027	0.617	0.430	0.517
T_1	2.207	0.627	0.460	0.150	0.453	0.540
T_2	2.190	0.637	0.470	0.160	0.467	0.553
T_3	2.190	0.650	0.457	0.150	0.447	0.533
T_4	2.240	0.643	0.477	0.170	0.460	0.560
T_5	2.193	0.647	0.470	0.153	0.470	0.563
T_6	2.290	0.643	0.467	0.163	0.467	0.547
T_7	2.387	0.633	0.480	0.173	0.460	0.563
T_8	2.450	0.643	0.457	0.183	0.473	0.567
T_9	2.427	0.647	0.477	0.173	0.460	0.547
T_{10}	2.440	0.660	0.490	0.190	0.480	0.583
SEm±	0.085	0.006	0.007	0.010	0.008	0.012
CD (P= 0.05)	0.252	0.019	0.020	0.029	0.025	0.035

The uptake of N, P, and K by both seed and stover, as well as the total nutrient uptake (Table 3), was significantly higher in these treatments compared to other organic sources and the control. Enhanced crop growth, nutrient influx, and photosynthetic rate, resulting from adequate nutrient supply through these organic combinations likely contributed to the increased absorption and translocation of nutrients to the seed and stover, as suggested by De *et al.* (2014).

The significantly higher seed and stover yields of rapeseed observed under the treatments vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (13.61 and 33.16 kg/ha) and FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (12.87 and 32.39 kg/ha), were also associated with higher nutrient uptake by seed and stover, and total crop uptake. Adesodun *et al.* (2005) found that applying poultry manure to soil increased soil organic matter, N and P levels, and aggregate stability, while Ewulo *et al.* (2008) observed improvements in soil physical properties, soil organic matter content, and soil moisture, likely due to enhanced soil structure and macro porosity, as noted by Aluko and Oyedele (2005). These findings suggest that the improved soil nutrient content, resulting from the addition of organic manures, led to increased uptake of N, P, and K by the rapeseed plants.

Table 3 : Effect of organic nutrient amendments on weed parameters, nutrient content and uptake by weeds

Treatment	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)			Gross Return (Rs. /ha)	Net Return (Rs. /ha)	B:C
	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total			
T_0	6.417	4.997	11.413	1.383	1.147	2.527	1.360	4.190	5.550	25280	16480	1.873
T_1	18.670	11.113	29.790	3.893	2.670	6.563	3.833	9.533	13.370	67680	48880	2.600
T_2	21.627	12.980	34.607	4.650	3.257	7.907	4.620	11.290	15.907	79040	30240	0.620
T_3	18.047	12.217	30.260	3.757	2.823	6.580	3.670	10.033	13.707	65840	42040	1.766
T_4	22.403	14.807	37.217	4.750	3.903	8.653	4.577	12.930	17.510	79760	45960	1.360
T_5	18.910	13.697	32.603	4.047	3.403	7.450	4.043	12.070	16.113	68880	47580	2.234
T_6	20.783	14.237	35.023	4.233	3.603	7.833	4.223	12.097	16.320	72560	36260	0.999
T_7	24.170	15.837	40.007	4.847	4.337	9.193	4.647	14.110	18.763	80880	21080	0.353
T_8	31.573	20.830	52.403	5.870	5.917	11.783	6.083	18.340	24.427	102960	55660	1.177
T_9	33.013	21.437	54.450	6.490	5.743	12.230	6.270	18.127	24.397	108880	46580	0.748
T_{10}	25.580	15.923	41.500	5.147	4.553	9.697	5.060	14.047	19.107	84160	30610	0.572
SEm±	1.439	1.905	2.239	0.206	0.567	0.586	0.220	1.736	1.735	-	-	-
CD (P= 0.05)	4.246	5.619	6.605	0.607	1.672	1.729	0.649	5.120	5.118	-	-	-

Economics: The economic analysis of different organic nutrient sources (Table 3) showed that the total cost of production and gross returns were notably higher with the application of vermicompost 2.5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, amounting to Rs. 62,300/ha and Rs. 1,08,880/ha, respectively. However, the net return was highest under the treatment with FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha (Rs. 55,660/ha), followed by FYM 10 t/ha (Rs. 48,880/ha), outperforming other treatments. The elevated cost of inputs, particularly vermicompost and mustard oil cake, significantly contributed to the higher production costs in the vermicompost-based treatment, which, despite yielding a higher gross return, resulted in a lower net return.

In contrast, the higher net returns observed with FYM 5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, as well as FYM 10 t/ha, were likely due to the relatively lower total cultivation costs combined with higher seed yields. Previous studies have also reported higher gross and net returns from rapeseed with the application of FYM 5 t/ha and vermicompost 5 t/ha, as well as higher returns and a better benefit-cost ratio in Indian mustard with the use of cattle dung manure 4 t/ha and poultry manure 2 t/ha (De *et al.,* 2014; Ramesh *et al.,* 2009). The lower total cost of cultivation associated with FYM 10 t/ha alone likely contributed to the highest benefit-cost ratio in this treatment.

Conclusion

The study concluded that organic nutrient sources like FYM, vermicompost, poultry manure, and mustard oil cake significantly enhanced rapeseed growth, yield, and economic returns compared to control. The combination of vermicompost 2.5 t/ha, poultry manure 2.5 t/ha, and mustard oil cake 1 t/ha, and FYM 5 t/ha with poultry manure and mustard oil cake, produced the highest nutrient uptake. These treatments also effectively reduced weed population. While vermicompost increased costs, FYM 5 t/ha with poultry manure and mustard oil cake yielded the highest net returns, making it the most cost-effective treatment.

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