

Soil health management for enhancing productivity of Indian mustard (*Brassica juncea* L.)

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(Received: 3 August 2020, Revised: 15 October 2020, Accepted: 20 November 2020)

Abstract

Indian mustard is the third most important oilseed crop in India. The mustard crop and its produce are critical in country's food security, nutritional security and over-all financial security. The challenge in satisfactory level of mustard production lies in the fact that multi-nutrient deficiencies being critical to mustard production, often is prevalent in mustard growing regions of the country which continuously possess hurdles in the way of enhanced mustard productivity along with other soil health related issues. These issues needs to be immediately dealt with site-specific nutrient management practices along with addressing the multi-nutrient deficiencies in mustard growing regions to achieve good productivity. A good nutrient management approach not only improves soil health, and nutrient supplying capacity, but also improves the productivity and quality of seeds in mustard. In the present review, different nutrient management approaches and their effects on soil health and mustard productivity is discussed.

Keywords: Integrated nutrient management, Indian mustard, organic manures, sulphur fertilization

Introduction

Indian mustard (*Brassica juncea* L.) is a major oilseed crop belonging to *Cruciferae* family. India is ranked third in production of rapeseed-mustard after Canada and China. Mustard is the third most important oilseed crops after soybean and groundnut in India occupying 5.96 Mha acreage, 8.32 MT production and the average productivity of 1.39 t/ha (Fig. 1) (GOI, 2019). Major states producing mustard are Rajasthan, Punjab, Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, West Bengal and Gujarat. Rajasthan ranks first in both area and production of mustard. Among oilseed *Brassica* species, *Brassica juncea* covered major area which contributes about 80%

of the total rapeseed-mustard grown in the country. Its seed contains 37 to 49 per cent oil. The oil cake is used as cattle feed and manure, which contains about 4.9 per cent nitrogen, 2.5 per cent phosphorus and 1.5 per cent potash.

The role of soil health and fertility on crop production in Indian condition is gaining topical importance nowadays. Constant decline in soil fertility status is considered as one of the serious second-generation problems of post-Green Revolution era (Dwivedi and Meena, 2015). Recently, Indian soils have been assessed based on coordinated soil samples on sulphur (S) and micronutrient delineation and the report indicated that more than 41% soils are deficient in S, 43% in Zn, 14.4% in Fe, 6.1% in Cu, 7.9% in Mn and 20.6% deficient in B (Shukla *et al.*, 2016a; Shukla *et al.*, 2016b). The exhaustive removals of nutrients by crops from the soils as well as use of inadequate and imbalanced fertilizer are resulting in multi-nutrient deficiencies in soils and plants. In major mustard growing areas of the country, widespread multi-nutrient deficiencies have been reported involving 2 to 6 nutrients including NK, NKS, NKB, NPKS, NKSZn and NPKSZnB in the 14 agro-ecological sub-regions (Meena *et al.*, 2017). For mustard crop, S is the most important nutrient due to its role in metabolic processes of plant and oil synthesis in seeds. Majority of mustard growing soils of India are deficient in S, in turn limiting the crop production. Major

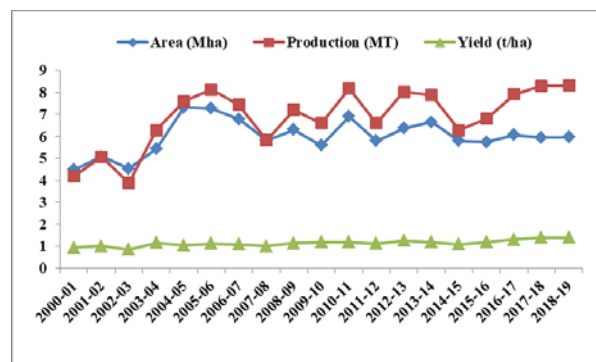


Fig. 1: Area, production and yield of mustard in India

reasons for S deficiency in soils of mustard growing areas are: light texture soils, low organic C content, excessive S leaching, growing of high-yielding crop varieties capable of heavy nutrient mining, use of S free fertilizers and ignoring the use of organic manures (Meena *et al.*, 2006a). There are reports that indicated that productivity of mustard can be achieved more than 2 t/ha in well managed field (Meena *et al.*, 2017; Mehta *et al.*, 2013). This gap can be minimized through best management of soil health specifically nutrient supplying capacity of soil (Meena *et al.*, 2016).

In this context, integrated nutrient management has proven as an effective tool to enhance the productivity of oilseed crops in general and mustard in particular (Dwivedi *et al.*, 2009). In the present era of multi-nutrient deficiencies, balanced fertilization no longer means prefixed NP or NPK application (Singh *et al.*, 2012, Meena *et al.*, 2017). The fertilization schedules should invariably include all deficient major, secondary and micronutrients. Integrated nutrient management improves the soil physico-chemical properties and release of macro as well as micronutrient in good proportion which improves crop yields and quality as well as soil health. Therefore, the present article highlights the best management practices for improving soil health *vis-à-vis* mustard productivity in Indian conditions. Main approaches/practices *i.e.* integrated nutrient management (INM), organic farming, balanced use of fertilizers will be discussed hereby.

1. Best soil management practices for mustard productivity

Several technological components are needed for achieving high mustard productivity like improved varieties, plant protection measures, use of balanced fertilizers including sulphur and micronutrients, thinning to remove excess plants/sqm, irrigation, timely weeding and chemical weed control. Rapeseed-mustard requires good amount and timely nutrient supply for better growth and high seed yield. The total amount of nutrients removal by a crop for producing 4.5 t/ha of seed yield (in kg): N 300–350, P₂O₅ 120–140, K₂O 300–400, Mg 30–50 and S 80–100 kg (Meena *et al.*, 2016) The deficiency of nutrients causes negative impact on plant health and yield level. Management of both macro- and micronutrient is a challenging aspect for sustainable production in India because most of soils are deficient. Different approaches of nutrient and soil management are discussed here under sub-heads as:

1.1. Integrated nutrient management

Integrated nutrient management (INM) options have been

Table 1: Best options of integrated nutrient management (INM) for mustard

Treatment	Seed yield (t/ha)	Oil content (%)	Location	Variety	Reference
50 kg N + 30 kg N (FYM) + <i>Azotobacter</i> (SI)	2.04	-	Allahabad (UP)	Dhara	Reddy and Singh (2018)
50 kg N + 30 kg N (VC) + <i>Azotobacter</i> (SI)	2.32	-			
50 kg N + 30 kg N (PM) + <i>Azotobacter</i> (SI)	2.37	-			
25% RDF + 1.5t/ha FYM	2.90		Baghpat (UP)	Pusa mustard-25	Tomar <i>et al.</i> (2018)
NP+FYM 5t/ha	2.16	36.3	Anand (Gujarat)	GME-2	Meena <i>et al.</i> (2006b)
NP+FYM 10 t/ha- + sewage sludge 10 t/ha	1.73	37.0	Anand (Gujarat)	GME-2	Meena <i>et al.</i> (2013)
NP+FYM 10 t/ha + Sewage sludge 5t/ha	1.71	37.1	Anand (Gujarat)	GME-2	Meena <i>et al.</i> (2008)
75% NPK +40 kg S ha ⁻¹ + 10 t FYM ha ⁻¹	1.54	45.8	Moradabad (UP)	JKMS-8001	Kumar <i>et al.</i> (2017)

FYM: Farm yard manure, VC: Vermicompost, PM: Poultry manure, RDF: Recommended dose of fertilizer, SI: Seed inoculation

evidenced for enhancing mustard productivity in different regions. The main ingredients of INM are organic manures, composts, legumes, crop residues, industrial by-products and bio-fertilizers. As INM plays an important key role in maintaining soil fertility and nutrient supply at an optimum level to increase the crop productivity. Substituting 25-50% of chemical fertilizers through using of organic manures proves better to get higher yield and fertilizer use efficiency in oilseed crops. Several studies showed that mustard yield can be increased up to considerable extent (1.54 to 2.90 t/ha) through combined use of organic and inorganic sources of nutrients (Table 1). Bio-fertilizers or microbial inoculants are extensively used for N-fixation, and P solubilization and mobilization in mustard for enhancing N and P use efficiency. Application of farmyard manure (FYM) in Indo-Gangetic plains (IGP) during winter crop with 50–75% of recommended fertilizers in all the crops that are in rotation can cause significant increase in production level (Khanda *et al.*, 2005, Mandal *et al.*, 2013). Reddy and Singh (2018) reported that seed yield of mustard can be enhanced significantly up to 2.37 t/ha with 50 kg N (Urea) + 30 kg N (poultry manure) + *Azotobacter* (seed inoculation). Yield increasing attributes could be the beneficial effects of INM options on improving the nutrient availability under poultry manure and *Azotobacter* application. Tomar *et al.* (2018) reported that 15t FYM/ha with 25% RDF significantly improved seed yield over 100% RDF. Addition of bio-fertilizer with 15 t FYM, further improved seed yield under both set of treatments. The more number of branches under above treatment may be correlated with the more plant height and dry matter accumulation as a result of better nutrient supply to the crop resulting in profuse branching. Kumar *et al.* (2017) observed that 75% NPK+ 40 kg S/ha+ 10t FYM/ha proved excellent performance and recorded highest seed (1.54 t/ha) and stover yield over the other treatment. Application of 2 t FYM + 40 kg S/ha along with RDF resulted in significant increase in mustard yield by 18.2% over RDF (1.69 t/ha) alone (Tripathi *et al.* 2010). Better utilization efficiency of NPKS in presence of FYM was reflected in greater vegetative growth and increase growth enzymatic activity. Integration of organic sources with chemical fertilizers could be enhanced system net returns as compared to sole chemical fertilizers. Meena *et al.* (2013) reported that use of 80 kg N+ 40 kg P₂O₅ +10 t FYM + 10 t sewage sludge/ha registered significantly higher seed yield (1.73 t/ha) than NP+FYM (1.62 t/ha) and NP (1.47 t/ha), but statistically similar NP+10 t FYM+5.0 t sewage sludge/ha (1.71 t/ha). Such beneficial effect of FYM and sewage sludge on mustard yield has also been reported by Singh

and Agrawal (2008). The highest oil content (37.1%) in mustard grain was recorded with 10 t FYM+5.0 t sewage sludge/ha. However, the differences among treatments were not significant. The addition of FYM and sewage sludge at a lower rate might have exerted beneficial effect on biochemical properties that enhanced the root demand for absorption of the nutrients as well as minimize the adverse effect of chemical loads.

1.2 Balanced use of NPK fertilization

In the present era of multi-nutrients deficiencies, blanket recommendations of fertilizers are not economical and have adverse impact on soil health and environment. Till date people are following these blanket recommendations in majority of the crops which is a major factor for decline in soil organic C, soil biota and crop productivity. Nutrient application through fertilizers should be site-specific as per nutrient supplying capacity, soil conditions and crop productivity. Majority of research works have been done on the basis of blanket recommendations with slightly modifications like varying levels of a particular nutrient at a fixed level of other two primary nutrients. It is well documented that application of inorganic fertilizers significantly influenced mustard seed yield. Nitrogen application from 40 to 80 kg/ha increased the mustard seed yield by 43% whereas increment in seed yield was 18.9% due to varying P rate from 8.7 to 17.4 kg/ha but it was just 5.4% due to K application (Premi *et al.* 2013). The combined application of N:P₂O₅:K₂O::80:40:40 synergistically increased the seed yield by 82.1% over lowest dose combination. Similarly, Kansotia *et al.* (2016) reported that the application of 80 kg N + 40 kg P₂O₅/ha significantly increased seed and stover yield, % protein, % oil content, and net return (Table 2).

Hardev *et al.* (2013) also reported that the application of N:P₂O₅:K₂O::80-60-0 significantly increased seed, % oil content, and net return. Mustard seed yield was increased significantly with increasing levels of phosphorus up to 60 kg/ha (1.01 t/ha), thereafter, there was significant decrease with further increase of phosphorus level up to 80 kg P₂O₅/ha (0.94 t/ha) which was at par with 40 kg P₂O₅/ha (0.93 t/ha) (Chetry *et al.*, 2018). Mir *et al.* (2010) also registered the highest seed yield with the application of 60 kg P₂O₅/ha. The seed yield increased with increased level of K application, up to 40 kg K₂O/ha (1.01 t/ha) but, thereafter, the seed yield significantly decreased with further increase of K level up to 60 kg K₂O/ha (0.93 t/ha). Reviewed literature, indicated that application of balanced NPK is considered as most important for the mustard crop to activate metabolic activity, transformation of energy, synthesis of chlorophyll resulted in maximum growth, yield attributed and which could enhanced the

Table 2: Best nutrient (NPKS) management options for mustard

Treatment (N:P ₂ O ₅ :K ₂ O:S)	Seed yield (t/ha)	Oil content (%)	Location	Variety	Reference
60-60-40-0	1.01	37.5	Jorhat (Assam)	Binoy (B-9)	Chetry <i>et al.</i> (2018)
80-40-0-0	1.34	39.9	Bikaner (Rajasthan)	-	Kansotia <i>et al.</i> (2016)
80-60-0-0	1.79	36.5	Faizabad (UP)	Maya	Hardev <i>et al.</i> (2013)
80-40-0-0	2.25	41.1	Bharatpur (Rajasthan)	Rohini	Premi <i>et al.</i> (2013)
80-40-40-0	2.36	41.3			
80-40-0-0	1.80	34.83	Anand (Gujarat)	GM-2	Meena <i>et al.</i> (2006b)
80-40-0-20	2.06	36.55			
100-30-0-30	1.58	39.6	Vidisha (MP)	-	Jaga (2013)
80-40-20-30	1.33	39.3	Gorakhpur (UP)	NDR 8501	Tomar and Singh (2007)
80-40-40-45	1.55	39.1	Kolkata (WB)	Varuna (T-59)	Ray <i>et al.</i> (2015)

mustard productivity and profitability without affecting the soil health.

1.3 Use of sulphur and micronutrients

Mustard being an oilseed crop is very sensitive to deficiency of S, Zn and B in general and particularly of Mo in acid soils. Sulphur has recognized fourth major essential plant nutrient severely limiting the oilseed production in India. Sulphur being a constituent of amino acids *i.e.* cysteine, cystine and methionine and other metabolites which contribute in oil synthesis and stress repair in oilseed crops. In general mustard growing Indian soils are deficient in S (Meena *et al.*, 2017). Therefore, adequate S management is very critical for higher crop productivity and quality. Mustard requires S application @ 20 to 45 kg/ha on the basis of productivity level. Economic response of S application in mustard is well recognized. Research findings indicated that application of S increased seed yield of irrigated and rainfed mustard by 12 to 48% and 17 to 124% respectively. The agronomic efficiency increases ~ 7.7 kg seed yield/ kg of S application (Shekhawat *et al.*, 2012). Similarly, Jaga (2013) reported 17 to 60% response of S application in mustard seed yield in irrigated condition under on-farm trials at Vidisha, M.P. Meena *et al.* (2006a) evaluated S response by mustard in loamy sand soil of Anand, and found that application of S @ 20 kg/ha as direct application is beneficial with improvement by 9% of mustard seed yield over NP, and at the same level of S, 14% enhancement recorded by Mehta *et al.* (2013).

The Zn is very important essential micronutrient that affects the mustard productivity and quality. About 1500 on-station field trials summarized for Zn response in different crops of India indicated an increment of 110 to 360 kg/ha (11 to 40%) in the yield of oilseed crops due to additional Zn application (Singh, 2008). Meena *et al.* (2006b) develop a novel approach for preparation of Zn

and Fe enriched FYM to enhance Zn use efficiency and mustard productivity. Study revealed that mustard seed yield can be enhanced by 12% through enriched FYM over straight application of Zn and Fe. The significant effect of Zn and Fe enriched FYM might be due to the fact that the enhanced micronutrients availability through complexation or chelation and thereby preventing their reaction with soil mineral constituents (Latha *et al.*, 2001, Rathod *et al.*, 2012) and protecting them from fixation. General recommendation of zinc sulphate application is 12.5 to 25 kg/ha if soils are deficient in available Zn. A study recorded 8.5% more seed yield with 12.5 kg ZnSO₄/ha application over no-Zn. The response of various ideotype to the applied micronutrients varies considerably. The response of Indian mustard varieties, *viz.* 'Pusa Bold' and 'Vardan' to applied zinc was found higher as compared to Varuna, RH- 30 and Aravali (Shekhawat *et al.*, 2012).

Boron is another essential micronutrient which constraints the productivity and quality of mustard produce. Boron plays important roles in cell division, pollen germination, root development, root nodules, translocation of carbohydrates in plant tissues. The range between deficiency and toxicity level of B in plant always considered very narrow and the excess B application may give adverse impact on growth and development. Requirement of B in oilseeds is about 250 to 300 g/ha. Similarly, the seed yield increased significantly (16–47%) with the application of boron (Singh, 2008). The average response to boron application ranged from 21 to 31%. The yield increase was due to 27% and 10% increase, respectively, in seeds/silique and 1000 seed weight, indicating the importance role in seed formation. Combined application of S and B gave synergetic effects on growth and productivity of mustard.

Molybdenum deficiency appeared earlier in mustard than

in other plants grown on Mo deficient soil which indicates high demand of Mo of the family *Brassicaceae*. Molybdenum deficiency in Indian soil is about 11%, and mainly dominated in acid soils. As soil pH increases from 3, the solubility of Mo increases through decrease in adsorption of metal oxides. Deficiency of Mo decreases protein content and increases the accumulation of nitrate N in mustard plant due to depressed activity of cytochrome oxidase and nitrate reductase. Lime application to acid soils has been an important approach to enhance soil pH and increase the Mo availability. Majority of studies on Mo response in mustard indicated that application of Mo (2 to 4.0 kg/ha) significantly increased the yield attributes and seed yield. Molybdenum has both synergetic as well as antagonistic effects along with other nutrients. Study concluded that application of combined S and Mo decreases mustard seed yield (Mehta *et al.*, 2013). The minimum grain yield was recorded with $S_{80}Mo_2$ treatment (1.81 t/ha), which showed 21.1% reduction in the yield over $S_{20}Mo_0$.

1.4. Organic nutrient management

Manures are definitely helpful in providing energy for microbes, reducing the losses of nutrient and moisture from soil and ultimately improving overall soil health. The efficacy of manures in terms of providing nutrients and crop productivity is mainly governed by carbon: nitrogen (C:N) ratio. Manures having narrow C:N (<20:1) ratio are always performed better in maintaining the nutrient availability and crop productivity. Application of different organic manures were able to achieve 1.46 to 2.19 t/ha mustard productivity (Table 3). Kansotia *et al.* (2016) reported that application of vermicompost @ 4 and 6 t/ha significantly increased seed and stover yields, % protein, % oil content and net return. Premi *et al.* (2013) reported that the seed yield of mustard was significantly influenced due to inclusion of organic treatments. The pooled yield data of five years indicated that the *Sesbania* (GM)

significantly increased mustard seed yield by 41.8% over control (1.34 t/ha). Supplementary incorporation of mustard residue 2.5 t/ha increased the seed yield by 15.3% over *Sesbania* (GM) alone (1.90 t/ha) and 63.9% over control. This is attributed to the gradual build-up of major, secondary and micronutrients in rhizosphere and thus balanced nutrient supply to the plants, improved soil conditions through higher microbial biomass and more stable organic C fractions resulting better growth, development and higher yield (Sinsinwar *et al.* 2005). *Sesbania* (GM) recorded almost a uniform increase in seed yield over control throughout the study period. A consistent increase in mustard seed yield was observed with the increasing fertility levels under different organic sources treatments and highest seed yield (2.90 t/ha) was recorded. Singh and Singh (2014) studied that the increasing application of FYM from 2.5 to 5.0 t/ha and combined application of PSM or *Azospirillum* or both with farmyard manure also increased seed and stover yield of mustard. Maximum seed yield was recorded with the application of 5.0 t FYM/ha along with PSM and *Azospirillum* which was significantly superior over sole application of 2.5 t FYM/ha. On an average, the combined application of 5.0 t FYM/ha along with PSM and *Azospirillum* recorded 13.8% higher seed yield than sole application of 2.5 t FYM/ha. It seems that application of low dose of FYM alone could not supply sufficient nutrients at critical growth stages of the crop. With the increment in supply of essential nutrients to Indian mustard, their availability, acquisition, mobilization and influx into the plant tissues increased and thus improved yield components and finally the yield. The literature indicated that sole application of organic manure could not meet the nutrient requirement of the mustard, therefore, an integration of all possible sources like organic manures, green manuring, seed treatment with *Azospirillum* & *Trichoderma* and phosphate solubilizing microbes (PSM) are needed in sufficient quantities for

Table 3: Best options of organic farming for mustard

Treatment	Seed yield (t/ha)	Oil content (%)	Location	Variety	Reference
Vermicompost (6 t/ha)	1.46	40.6	Bikaner (Rajasthan)	-	Kansotia <i>et al.</i> (2016)
FYM (10 t/ha)	1.67	37.2	Faizabad (UP)	Maya	Hardev <i>et al.</i> (2013)
<i>Sesbania</i> (GM)	1.90	41.2	Bharatpur (Rajasthan)	Rohini	Premi <i>et al.</i> (2013)
<i>Sesbania</i> (GM) + mustard residue 2.5 t/ha	2.19	40.9			
FYM 2.5 t/ha	1.65	-	Varanasi (UP)	Maya	Singh and Singh (2014)
FYM 2.5 t/ha + PSM + <i>Azospirillum</i>	1.88	-			

GM: Green manuring, *Biofertilizers*: Phosphate solubilizing microorganisms (PSM) and *Azospirillum*

producing good organic mustard in the country.

2. Soil health under best soil management practices

Adoption of best soil management practices could enhance soil nutrient supplying capacity, biodiversity and productivity without any adverse impact on environment. Integrated nutrient management and balanced fertilization have been proved to enhance soil health parameters. After adoption of INM practices in mustard, soil organic C (SOC) increased by 81% in NP+ 5 t FYM/ha (Meena *et al.*, 2006b), 87% in 25% RDF+15t FYM/ha (Tomar *et al.*, 2018) and 41% in NP+ 10 t FYM + 10 t sewage sludge/ha (Meena *et al.*, 2013) application over initial soil value (0.21, 0.23, 0.32%, respectively) (Fig. 2). Meena *et al.* (2006b) reported that soil pH and EC under INM did not show any significant changes but application of NP+FYM improved SOC status of soil significantly by 31% over no FYM (0.29%). Kansotia *et al.* (2016) reported that organic management option as vermicompost application significantly increased SOC after harvest of the mustard. These beneficial roles of organic manures along with nutrients have been well documented and indicated improving soil physical, biological and chemical properties and thereby increasing nutrient availability in soil.

Application of organic manures improves the general soil fertility parameters. Availability of N, P and K can be enhanced through INM options by 16-44, 26-60 and 8-18%, respectively over their initial value in soil (Table 4) under mustard crop. Organic management options also help in increasing the nutrient availability in soil as 3-22, 4-72 and 14-18%, respectively over initial values.

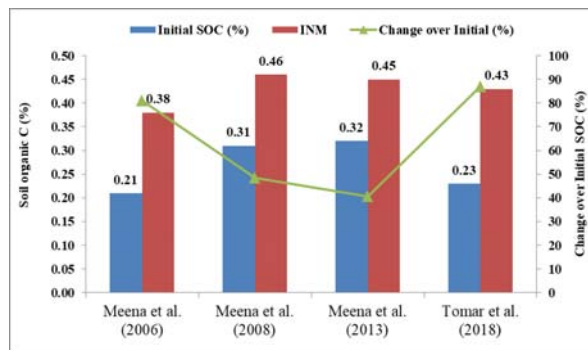


Fig. 2: Improvement of soil organic C under INM over initial soil OC content

Contradictory results were also recoded under organic management options especially for K availability in soil after mustard (Premi *et al.*, 2013). The approach of enrichment of the organic manures also favorably influenced the content of available nutrient in soil (Meena *et al.*, 2006b, Rathod *et al.*, 2012) which might be due to better mineralization of organically bound nutrients under the influence of organic acids and thereby improvement in available nutrients status. The availability of P is mainly governed by SOC build-up in the soil. Addition of P with organic manures might be enriching the organic pools of phosphorus in soils. This has been confirmed by positive and significant relationship between soil organic carbon and available P ($r = 0.78^{**}$). The increase in P content may be ascribed to the capacity of organics to form a cover of sesquioxide which reduces the phosphate fixation. Besides primary nutrients, organic sources contributed sizeable quantity of secondary and micronutrients also and improves soil fertility. The overall increase in availability of micronutrients could also be

Table 4: Nutrient availability under different soil management options under mustard-based systems

Treatment	Avail. N	Avail. P (kg/ha)	Avail. K (kg/ha)	Reference (kg/ha)
INM options				
25% RDF +15t/ha FYM	151(130)	15.2(12.1)	145.3(123.7)	Tomar <i>et al.</i> (2018)
NP+FYM 5t/ha	174(149)	72.1(36)	184(170)	Meena <i>et al.</i> (2006b)
NP+FYM 10 t/ha- + sewage sludge 10 t/ha	223(155)	41.6(26)	268(230)	Meena <i>et al.</i> (2013)
Organic management options				
Sesbania (GM)	113(95.4)	20.1 (12.4)	294(320)	Premi <i>et al.</i> (2013)
Sesbania (GM) + mustard residue 2.5 t/ha	116(95.4)	21.3(12.4)	311(320)	
FYM 2.5 t/ha	197(191)	19.3(18.5)	207(182)	Singh and Singh (2014)
FYM 2.5 t/ha + PSM + <i>Azospirillum</i>	206(191)	21.5(18.5)	214(182)	

Values in parentheses () indicated initial value of the parameters

attributed to the formation of stable organometallo complexes of micronutrients with organic matter (Meena *et al.*, 2006b, Rathod *et al.*, 2012), especially during the enrichment process to last for a longer time and release the nutrients slowly in the soil system in such a way that the nutrients are protected from fixation and made available to the plant root system during crop growth (Appava *et al.*, 2000).

Conclusion and future perspectives

Indian mustard being the third most prevalent oilseed crop in our country, is critical to food, nutritional and also financial sufficiency of the country. The prevalence of 4 to 6 nutrients deficiencies in the mustard growing regions of country often pose as a constraint to the mustard productivity. The improved state-of-the-art nutrient management approaches *viz.*, INM, SSNM, PNM improved soil fertility and health, which in turn has a beneficial effect on mustard productivity. The addition of organics helps to maintain the soil health, and nutrient supplying capacity. Nutrient application in synchrony with crop demands leads to synergistic interaction and better use efficiency of the applied nutrients.

Therefore, it is high time to popularize the soil testing based state-of-the-art nutrient management approaches in the mustard growing regions of the India. A holistic approach encompassing all the stakeholders should be acquired. More *in-depth* research needs to be done to assess the effect of different nutrient management practices, fertilizer products, and methods of fertilizer application on productivity, and quality of produce of Indian mustard.

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