Vol. 14, No. 2, pp. 156-160 (2014)
Journal of Agricultural Physics
ISSN 0973-032X
http://www.agrophysics.in

Research Article

Response of Sulphur and FYM on Soil Physico-Chemical Properties and Growth, Yield and Quality of Mustard (*Brassica Nigra L.*)

MD. SARWARE ALAM*[1], A.K. MISHRA[2*], KAILASH SINGH [2], SUNIL KUMAR SINGH[3] AND ARUN DAVID[1]

[1]*University of SHIATS, Naini, Allahabad, Uttar Pradesh*

[2]*Central Soil Salinity Research Institute, Karnal - 132 001, Haryana*

[3]*Indian Agricultural Research Institute, New Delhi - 110 012*

ABSTRACT

A field experiment was conducted during *rabi* season at the Research Farm, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. The soil bulk density, porosity, water holding capacity, pH and EC at 25° C (d Sm^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), phosphorus (kg ha^{-1}), potassium (kg ha^{-1}) and sulphur (ppm) of soil were found significant at different levels of FYM and sulphur. The application of F_5 and F_{10} increased the status of organic carbon of soil to the extent of 32 and 40%, respectively as compared to control (F_0). The application of F_{10} increased the available N, P, K and S contents of soil to the extent of 10.5, 16.5, 5.42 and 9.11%, respectively as compared to control (F_0). Crude protein and oil content were the highest with maximum level of sulphur application. The combined application of FYM @10 t ha^{-1} + 40 kg S ha^{-1} was recommended for maximizing the yield, quality (oil and protein) and economics of the farmers.

Key words: Mustard, Sulphur, FYM, Yield, Protein and Soil properties

Introduction

India is one of the largest vegetable oil economics in the world, next to USA and China. The edible oil import is likely to hit a new record in 2015-16 at 12.3 million tonnes due to high demand and extremely low domestic sources. In India, mustard is cultivated on 6.86 mha, accounting for 19.8% of the world's production and 28.3% of the global area of production (Anonymous, 2011). The major mustard growing states in India are Haryana, Madhya Pradesh, Rajasthan, and Uttar Pradesh, representing 81% of the total mustard production. While the demand for oilseeds is growing, the production of the product has not increased much over the years. Mustard oil contains a high level of sulphur compounds, and for the synthesis of oils, adequate sulphur nutrition is crucial. The sulphur content in seeds of cruciferous crops like mustard is the highest (1-1.7%) among the crops. The amount of S absorbed by crops is generally 9-15% of the N uptake, however, in mustard; the S uptake is usually one-third of the N uptake. Application of farm yard manure (FYM) improved soil physical, chemical, and biological properties (Ould Ahmed *et al*. 2010). A confirmatory trial was therefore designed to find out the effect of FYM and sulphur on soil physicochemical properties, growth, yield, oil and protein content in mustard crop.

*Corresponding author, Email: akm8cest@gmail.com

Materials and Methods

A field experiment was conducted during *rabi* 2011-12 at the crop research farm, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. The soil belongs to the order Inceptisols and is alluvial in nature. The experiment was laid out in a factorial randomized block design with three levels of sulphur (S_0, S_{20} and S_{40}: 0, 20 and 40 kg ha^{-1}, respectively as gypsum) and three levels of FYM (F_0, F_5 and F_{10}: 0, 5 and 10 t ha^{-1}). Treatments were replicated thrice. Fertilizer urea, DAP and MOP were the sources of N, P and K, respectively. A basal dose of fertilizer was applied in the respective plots according to treatment allocation; uni-furrows opened by about 5 cm depth before sowing the seeds on well prepared beds in shallow furrows at a depth of 5 cm with 30 cm × 10 cm row to row and plant to plant distance. Soil analyses were performed as: bulk density by core method (Black, 1965); pore space and water holding capacity (Black, 1965); soil pH (1:2) soil water suspension by using digital pH meter (Jackon, 1958); soil EC (dS m^{-1}) at 25°C of 1:2 soil water suspension with digital conductivity meter (Wilcox, 1950); organic carbon by wet oxidation method (Walkley and Black, 1947); available N by alkaline permanganate method (Subbaiah and Asija 1956); available P_2O_5 (kg ha^{-1}) by colorimetric method (Olsen et al., 1954); available K_2O by flame photometric method (Toth and Prince, 1949); and available S by turbidimetric method (Chesnin and Yien, 1950).

Results and Disscusion

Effect on plant growth parameters

Significant improvements in plant height, number of leaves and branches, dry weight, test weight, and grain yield were observed with increased dose of S and FYM application as compared to control treatment. Maximum plant height (86.9 and 85.0 cm), number of leaves $plant^{-1}$ (24.9 and 24.7), dry weight accumulation (4.06 and 4.05 g), test weight (3.85 and 3.88 g), and grain yield (12.9 and 12.9 q ha^{-1}) were recorded with application of 40 kg S ha^{-1} and 10 t ha^{-1} FYM (Table 1). This increment in the plant growth may be due to enhanced cell division, enlongation and setting of cell structure, because FYM is being considered as an important source of macro and micro nutrient. Increase in growth of plants under organic sources of fertilizers may be attributed to the better availability of nutrients. Considerable increase in plant height, number of branches and effective utilization of nutrient, moisture and light resulted in higher growth and yields. Similar observations have been made by others (e.g. Mandal and Sinha, 2002).

Effect of FYM and sulphur on physicochemical properties of soil

Soil pH was not influenced by different doses of FYM (Table 2). This may be due to short-term duration of the experiment. Many literatures, although suggest decline in soil pH with application of FYM in a reclaimed sodic soil at

Table 1. Growth and yield attributes under different levels of FYM and S

Treatment	Plant growth and Yield attributes					
	Plant height (cm)	No of leaves $plant^{-1}$	No of branches $plant^{-1}$	Dry wt $plot^{-1}$(g)	1000 grain wt. (g)	Grain yield (q ha^{-1})
S_0	75.25	19.11	6.55	2.52	3.74	11.42
S_{20}	82.73	24.11	8.33	3.79	3.80	12.42
S_{40}	86.89	24.88	8.88	4.06	3.85	12.87
C.D. at 5%	*4.68*	*3.11*	*1.59*	*1.00*	*0.09*	*0.86*
F_0	78.05	20.55	6.0	2.67	3.61	11.58
F_5	81.87	22.88	7.88	3.68	3.88	12.91
F_{10}	84.95	24.66	9.88	4.05	3.90	12.95
C.D. at 5%	*3.11*	*2.07*	*1.73*	*1.22*	*0.14*	*0.70*

Table 2. Influence of FYM and S levels on physicochemical parameters of soil

Treatment	Soil physicochemical parameters				
	pH	EC (1:2) (dS m^{-1})	BD (Mg m^{-3})	WHC (%)	Pore space (%)
S_0	7.43	0.58	1.48	37.3	51.1
S_{20}	7.39	0.56	1.46	37.0	53.6
S_{40}	7.43	0.48	1.45	37.7	52.8
C.D. at 5%	*NS*	*0.09*	*NS*	*NS*	*NS*
F_0	7.29	0.51	1.51	35.3	51.9
F_5	7.35	0.52	1.46	37.0	53.2
F_{10}	7.60	0.59	1.43	39.7	54.5
C.D. at 5%	*NS*	*0.06*	*0.06*	*2.0*	*1.5*

Karnal (Haryana). Yaduvanshi (2001) observed that continuous application of fertilizers, FYM and green manures for five years reduced the soil pH from initial level of 8.7 to 8.3. The EC of soil-saturation extract was significantly decreased with S, but increased with FYM dose. The bulk density of the surface layer (0-15 cm) at harvest of the crop decreased significantly with increasing levels of FYM (Table 2). Maximum bulk density (1.51 Mg m^{-3}) was obtained under the control (F_0) while minimum was recorded in F_{10}. Decrease in bulk density of the soil might be due to soil structural improvement, which also increased the porosity (F_{10}-54.5%) and water holding capacity of soil (39.7%). Similar findings were also recorded by Babhulkar *et al.* (2000). Soil organic C at harvest increased significantly with increasing levels of FYM application. Maximum organic C (0.7%) was recorded in F_{10} over the control (0.5%). The application of F_5 and F_{10} increased the status of organic C in soil to the extent of 32 and 40%, respectively compared to the control (F_0). Higher production of biomass might also increase the organic carbon content of soil (Babhulkar *et al.,* 2000). The importance of organic matter in improving soil physical properties is well documented (Goldberger, 2008). Haynes and Naidu (1998) reviewed that additions of organic manures into soil resulted in increase in water holding capacity, porosity, infiltration capacity, hydraulic conductivity and water stable aggregation and decrease in bulk density and surface crusting. Soil compaction decreased by incorporation of manure (Mosaddeghi *et al*., 2009). Soil physical structure improvement caused by the manure application is mediated by organic matter content increase, which had a dilution effect on the soil, by bonding particles, increasing soil aggregation elasticity (Mosaddeghi *et al.*, 2009).

Effect of FYM and sulphur on N, P, K and S content of soil

Available N, P, K and S content of soil increased significantly with increasing levels of FYM (Table 3). Maximum available N (253.4 kg ha^{-1}), P (20.4 kg ha^{-1}), K (290.2 kg h^{-1}) and S (20.1 ppm) was observed under F_{10}, and recorded minimum under the control (F_0). The application of F_{10} increased the availability of N, P, K and S content of soil to the extent of 10.5, 16.5, 5.42 and 9.11%, respectively as compared to control (F_0). The significant increase in available nutrient content of the soil after the harvest of the crop may be ascribed to the beneficial role of FYM in mineralization of native as well as applied nutrients, which enhanced the available nutrient pool in the soil. The favorable conditions for microbial and chemical activities due to addition of FYM integrated with other nutrients augmented the mineralization of nutrients and ultimately increased the available nutrient status of the soil. Urkurkar *et al.* (2010) reported that *in-situ* application of green manure along with 50% of recommended dose of fertilizer resulted in highest available N in surface soil; available P and K content of soil also increased significantly with

Table 3. Response of varying doses of FYM and sulphur on SOC, macronutrient and sulphur

Treatment	Available nutrients				
	SOC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Sulphur (ppm)
S_0	0.52	240.83	16.47	290.33	17.17
S_{20}	0.69	245.64	20.27	281.54	19.63
S_{40}	0.66	245.46	20.83	290.05	20.72
C.D. at 5%	*0.11*	*3.27*	*3.92*	*7.88*	*1.82*
F_0	0.50	229.34	17.52	275.27	18.45
F_5	0.66	249.19	19.64	276.47	18.93
F_{10}	0.70	253.40	20.41	290.19	20.13
C.D. at 5%	*0.14*	*13.47*	*1.33*	*10.42*	*1.30*

Table 4. Effect of FYM and S levels on oil and protein contents in mustard

Treatment	Quality analysis	
	Oil (%)	Protein (%)
S_0	28.53	6.90
S_{20}	29.64	7.20
S_{40}	30.25	7.23
C.D. at 5%	*0.84*	*0.23*
F_0	27.57	6.96
F_5	29.30	7.13
F_{10}	31.56	7.25
C.D. at 5%	*1.18*	*0.11*

FYM. Kumar and Singh (2010) reported that combined application of 100% NPK + green gram + 5.0 t FYM ha^{-1} each year resulted in significantly higher available N, P and K in post-harvest soil at the end of 6 years rice-wheat rotation.

Effect of FYM and S on oil and protein content in seeds

The oil content in seed increased significantly with successive addition of FYM and S; being highest 30.3 and 31.6 with F_{10} and S_{40}, respectively (Table 4). The increase in oil content with S fertilization may be attributed to its role in oil synthesis (Tripathi *et al*., 2010), and increase in glucosides (Singh *et al*., 2010). Increase in availability of S attributes to increased conversion of fatty acid metabolites to the end products of fatty acids as supported by Tripathi *et al.* (2010) Singh and Pal (2011). Positive effect of sulphur along with macro-nutrients on oil content is because of phosphorus, as it is a constituent of phospholipids and also essential for oil synthesis (Kumar and Yadav, 2007). The protein content in seed increased significantly with successive addition of FYM and sulphur; being highest 7.23 and 7.25 % with F_{10} and S_{40}, respectively (Table 4). The increase in protein content is due to higher N content in seeds, as increasing N levels increases the proteinaceous substance in seeds (Singh and Pal, 2011). Protein content was higher due to higher concentration of P which increased the number of seeds (Bharose *et al*., 2011). The lowest protein and oil yield was recorded in the control plot. Our results of increase in protein and oil yields are in tune with Singh *et al*. (2010) and Tomar *et al*. (1997), respectively.

Conclusions

Farmyard manure incorporation and sulphur application had individual and cumulative impacts on soil physicochemical properties, nutrient availability in soil, plant growth, yield attributes, oil and protein content of Indian mustard crop. The FYM+S increased the organic matter content, made the soil more porous and aggregated, and resulted in increase of WHC, and decrease in soil mechanical impedance. Further research on long-term impact of FYM and sulphur on soil health, crop yield and seed quality (oil and protein content) may be emphasized.

References

Anonymous 2011. Agricultural Statistics at a Glance. Dept. of Agriculture and Co-operation, Ministry of Agriculture, Govt. of India.

Babhulkar, P.S., Dineshkar, Badole, W.P. and Balpande, S.S. 2000. Effect of sulphur and zinc on yield, quality and nutrient uptake by safflower in vertisol. *J. Indian Soc. Soil Sci.* **48**: 541-543.

Bharose, R., Chandra, S., Thomas, T. and Dhan, D. 2011. Effect of different level of P and S on the yield and availability of N P K, protein and oil content in toria *(Brassica sp.)* var. P.T.-303. *J. Agric. Biol. Sci.* **6**: 31-33

Black, C.A. 1965. Methods of soil analysis vol.**2**, American Society of Agronomy, Madison, Wisconsin, U.S.A.

Chesnin, L. and Yien, C.H. 1950. Turbimetric determination of available sulphate. *Soil Sci. Soc. Amer. Proc.* **15**: 149-151.

Goldberger, J.R. 2008. Diffusion and adoption of non-certified organic agriculture: a case study from semi-arid Makueni District, Kenya. *J. Sust. Agric.* **32**: 597-609.

Haynes R.J. and Naidu, R. 1998. Influence of lime, fertilizer and manure applications on soil organic matter content and soil physical conditions: a review. *Nutr. Cycl. Agroecosys.* **51**: 123-137.

Jackson, M.L. 1958. Soil chemical analysis. 2nd edition, Indian Reprint, Prentice Hall of India, New Dehli, p. 498.

Kumar, H. and Yadav, D.S. 2007. Effect of phosphorus and sulphur levels on growth, yield and quality of Indian mustard (*Brassica juncea L.*) cultivars. *Indian J. Agron.* **55**: 154-157.

Kumar, V. and Singh, A.P. 2010. Long-term effect of green manuring and farmyard manure on yield and soil fertility status in rice-wheat cropping systems. *J. Indian Soc. Soil Sci.* **58**: 409-412.

Mandal, K.G. and Sinha, A.C. 2002. Effect of integrated nutrient management on growth, yield, oil content and nutrient uptake of Indian mustard (*Brassica juncea*) in foothills soils of eastern India. *Indian J. Agron.* **47**: 109-113.

Mosaddeghi, M.R., Mahboubi, A.A. and Safadoust, A. 2009. Short-term effects of tillage and manure on some soil physical properties and maize root growth in a sandy loam soil in western Iran. *Soil Till. Res.* **104**: 173-179.

Olsen, S.R., Cole, C.V., Watanhe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Deptt. Agr. Circ., 939.

Ould Ahmed, B.A., Inoue, M. and Moritani, S. 2010. Effect of saline water irrigation and manure application on the available water content, soil salinity, and growth of wheat. *Agric. Water Manage* **97**: 165-170.

Singh, S.P. and Pal, M.S. 2011. Effect of integrated nutrient management on productivity, quality, nutrient uptake and economicsof mustard (*Brassica juncea*). *Indian J. Agron.* **56**: 381-387.

Singh, Y., Singh, T., Singh, U.N. and Rajput, P.K. 2010. Effect of nutrient management on yield, quality and economics of irrigated Indian mustard (*Brassica juncea*). *Indian J. Agric. Sci.* **80**: 691-694.

Subbaiah, B.V. and Asija, C.L. 1956. A Rapid Procedure of the estimation of available nitrogen in soils. *Curr. Sci.* **25**: 259-260.

Tomar, T.S., Singh, S., Sandeep, S, Kumar, S. and Tomar, S. 1997. Effect of different levels of N, P and S on seed yield and oil concentration of mustard *(Brassica Juncea*) on sandy loam soil in Uttar Pradesh. *Indian J. Agron.* **42**: 152-154.

Toth, S.J. and Prince, A.L. 1949. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. *Soil Sci.* **67**: 439-445.

Tripathi, M.K., Chaturvedi, S., Shukla, D.K. and Mahapatra, B.S. 2010. Yield performance and quality in Indian mustard (*Brassica juncea*) as affected by integrated nutrient management. *Indian J. Agron.* **55**: 138-142.

Urkurkar, J.S., Tiwari, A., Chitale, S. and Bajpai, R.K. 2010. Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (*Oryza sativa*) and wheat (*Triticum aestivum*) in inceptisols. *Indian J. Agric. Sci.* **80**: 208-212.

Walkely, A. and Black, I.A. 1947. Critical examination of rapid method for determining organic carbon in soils, effect of variance in digestion conditions and of inorganic soil constituents. *Soil Sci.* **63**: 251-257.

Wilcox, L.V. 1950. Electrical conductivity. *Am. Water Works Assoc. J.* **42**: 775-776.

Yaduvanshi, N.P.S. 2001. Effect of five years of rice-wheat cropping and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. *J. Indian Soc. Soil Sci.* **49**: 714-719.

Received: 30 May 2014; Accepted: 11 August 2014