Ann. Pl. Soil Res. 14(2): 113-115 (2012)

NITROGEN AND SULPHUR REQUIREMENT OF MUSTARD UNDER DIFFERENT CROP SEQUENCES

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Received: June, 2012

ABSTRACT

A field experiment was conducted during rabi season of 2005-07 to evaluate the nitrogen and sulphur requirement of mustard under different crop sequences on sandy loam soil at Bichpuri (Agra). The results revealed that the maximum seed and stover yield, yield attributes and growth characters of mustard were recorded in mung bean-mustard sequence. The oil and protein content and uptake of N and S by the crop were also maximum under this crop sequence. Application of 80 kg N ha^{-1} significantly increased the growth, yield attributes and yield, protein percentage and uptake of N and S over lower level of N. Yield estimates, protein percentage and uptake of N and S in mustard also improved significantly with S application. The oil content increased with S level but reduced at higher level of N (80 kg ha^{-1}). Uptake of P and K by mustard increased with graded levels of nitrogen and sulphur.

Keywords: Nitrogen, Sulphur, crop sequence, mustard, yield, quality, fertility status

INTRODUCTION

Mustard [*Brassica juncea* (L) czern) & Cosson] is one of the important oil seed crops grown extensively in Agra region of Uttar Pradesh but its production in the existing agro-climatic condition is very low. Among many factors responsible for low production, nitrogen and sulphur management occupy a dominant position. An inclusion of legume in cropping system improves nitrogen status of soil and helps in increasing the yield of base as well as succeeding oil seed crop. Thus, the preceding rainy season crop may bring about some change in nitrogen and sulphur requirement of mustard. The high yielding varieties of mustard have been reported to be highly responsive to nitrogen application. An adequate supply of nitrogen results in vagorous growth and dark green colour of the plant. Sulphur is essential for sunthesis of proteins, vitamins and sulphur containing essential amino acids and is also associate with nitrogen metabolism. Besides, sulphur application in mustard has also been reported to increase the yield and oil percentage. Keeping this in view, the percent study was undertaken to evaluate the response of mustard to nitrogen and sulphur application.

MATERIAL AND METHODS

A field experiment was conducted during 2005-06 and 2006-07 at RBS College Research Farm Bichpuri, Agra. The soil was sandy loam, alkaline (pH 8.1) in reaction and low in available nitrogen (170 kg ha^{-1}) phosphorus (9.5 kg ha^{-1}) and medium in potassium (150 kg ha^{-1}) status. The experiment was laid out in split plot design with 3 replications. The main plots consisted of four crop sequences, viz. fallow Indian mustard, mung bean (*Phaseolus radiates* L)- Indian mustard, sorghum (*Sorghum bicolor*)– Indian mustard and pearl millet (*Pennisetum glaucum* (L) R. Br. Emend. Stunt)- Indian mustard, and subplots of N and S (0, N_{40}, N_{80}, S_{30}, S_{60}) levels. The kharif crops, viz fallow, mung bean (K 851), sorghum (M.P. Chari) and pearl millet (86 M32) were raised as per packages. Nitrogen and sulphur as per treatments were applied in mustard through urea and elemental sulphur, respectively. Phosphorus (60 kg P_2O_5 ha^{-1}) and K (40 kg K_2O ha^{-1}) were applied at the time of sowing through triple superphosphate and muriate of potash, respectively. Mustard (Rohini) was sown in the second week of October in the both seasons. At maturity seed and stover yields were recorded. Nitrogen was estimated in seed and stover using Kjeldahl method (Jackson 1973). For P, K and S, seed samples were digested in a di-acid mixture and P in the extract was determined by vanadomolybdate yellow colour method (Jackson 1973). Sulphur content in the same extract was determined by turbidimetric method (Chesnin and Yien 1951). Potassium in the extract was determined by flame photometer. The uptake of nutrients was calculated by multiplying seed and stover yield by respective percentage of the nutrients. The growth characters and yield attributes were recorded at harvest. Oil content in seed was determined by soxhlet extraction using petroleum ether as an extractant. Protein content was calculated by multiplying N content by the factor 6.25.

RESULTS AND DISCUSSION

The highest seed yield of Indian mustard was obtained in mung bean- Indian mustard sequence.

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Although, growing mustard after fallow resulted in significantly lower yield than mung bean - mustard sequence. Seed yield of Indian mustard decreased significantly to the lowest when it was grown after pearl millet. Similarly, plant height, siliquae/plant and seed/siliqua were at their maximum in mungbean - mustard sequence. The 1000 seed weight was significantly higher over that recorded in pearl millet -Indian mustard sequence only (Table 1). Sharma and Jain (2002) also reported similar results. Seed yield increased significantly upto 80 Kg N ha-1, the magnitude of superiority to 0.0 N ha^{-1} being 84.5 percent. Plant height also increased significantly by successive increments of N up to 80 kg ha^{-1}. Yield attributing characters, viz siliquae/plant, seeds/siliqua and and 1000-seed weight were at their maximum with 80 kg N/ha application (Table 1). These results are in conformity with Sharma and Jain (2002), Rana and Rana (2003). The overall improvement in growth of mustard with increased nitrogen could be ascribed to its pivotal role in several physiological and biochemical processes which are of cital importance for growth and development of plant. Beneficial effect of nitrogen addition on growth parameters have also been reported in mustard by Reager et al. (2011). The data (Table 1) show that application of sulphur increased the growth and yield attributes of mustard over no S addition. This increase might be due to better root development with increasing levels of sulphur. Application of 60 kg S ha^{-1} increased the seed yield by 75.1 percent over no sulphur. Higher S level was responsible for increased leaf-area and chlorophyll content of leaves, causing higher photosynthesis and assimilation, metabolic activities which were responsible for overall improvement in vigour and many growth characters, yield attributes and finally seed yield of mustard. Rana and Rana (2003) and Jat and Mehra (2007) also reported an increase in growth and yield of mustard due to S application.

Table 1: Effect of crop sequence, nitrogen and sulphur levels on growth yield attributes and yield

Treatments	Height (cm)	Dry matter/ Plant (g)	Length of siliqua (cm)	Siliqua/ plant	Seed/ Siliqua	Test weight (g)	Yield (q ha^{-1})		Protein (%)	Oil (%)
							Seed	Stover		
Crop rotation										
Fallow mustard	132.0	69.82	4.50	380.7	15.1	5.91	18.06	62.86	22.6	41.54
Pearlmillet mustard	102.8	63.35	4.14	353.5	13.4	5.58	13.91	48.59	21.8	41.44
Urdbean-mustard	145.0	77.80	4.96	402.5	16.9	6.01	21.89	74.71	23.1	41.75
Sorghum-mustard	109.7	66.84	4.29	364.7	14.3	5.77	14.51	50.82	22.1	41.47
CD (P=0.05)	7.36	0.99	0.14	4.67	0.60	0.14	0.58	2.56	0.86	0.15
N and S										
Control	100.7	66.41	3.78	120.2	12.0	3.97	10.35	36.19	19.2	39.14
40 kg N ha^{-1}	123.2	69.16	4.50	383.4	15.1	5.85	17.80	61.16	22.9	41.56
80 kg N ha^{-1}	139.7	71.45	4.93	505.7	17.2	6.93	19.10	66.61	25.3	41.36
30 kg S ha^{-1}	117.0	68.25	4.32	323.6	13.8	5.18	17.45	59.51	22.1	42.22
60 kg S ha^{-1}	129.2	70.68	4.67	470.6	16.1	6.30	18.13	63.08	24.3	42.58
CD (P=0.05)	3.11	1.10	0.05	3.18	0.41	0.130	0.48	1.69	0.98	0.173

The seed protein and oil contents were significantly influenced by levels of N and S over control (Table 1). Increasing N and S levels increased the protein content positively from 19.2 to 25.3 and 19.2 to 24.3 %, respectively. Higher oil content was recorded under 60 kg S ha^{-1}. The increase in oil content under influence of S addition seems to be due to increased S content in seed, which has a significant role in overall biosynthesis of oil. Findings of Singh and Meena (2003) in mustard also provided support to findings of the present investigation. The low oil content under 80 kg N ha^{-1} was due to more availability of N which increased proteinous substances in the seed under high N supply, large proportion of photosynthates may have diverted to protein formation leaving a potential deficiency of carbohydraites, to be degraded to 'acetyl co-engyme A' for the synthesis of fatty acids. Similar results were reported by Singh and Meena (2003). The increase in oil content with S application over nitrogen may be attributed to its role in oil synthesis. These results are in close conformity with the findings of Tripathi et al. (2010).

Urdbean-mustard crop sequence recorded significantly higher uptake of nutrients (NPKS) as compared to other crop sequences. On the other hand, the lowest amounts of nutrients were utilized by pearl millet- mustard crop sequence. This could be due to increased yields and enhanced fertilizer use efficiency in this system. There was a significant increase in the total uptake of nutrients due to application of N and S. The N and S uptake increased significantly with subsequent increase in N application up to 80 kg N ha^{-1}. Sulphur application caused significant increase in N and S uptake only up to 60 kg S ha^{-1}. The total P and K uptake by the system was highest with 80 kg N ha^{-1}. The application of 60 kg S ha^{-1} also gave higher total uptake of P and K. The increase in uptake of nutrients due to N and S application could be ascribed to variation in the availability of these nutrients in the soil, their priming effect on the growth and development of the plants. Similar results were reported by Rana and Rana (2003) and Jat and Mehra (2007).

Table 2: Effect of crop sequence, nitrogen and sulphur levels on uptake of nutrients and status of nutrients in soil after harvest of the crops

Treatments	Nutrient uptake (kg ha^{-1})				Available nutrients (kg ha^{-1})			
	Nitrogen	Phosphorus	Potassium	Sulphur	Nitrogen	Phosphorus	Potassium	Sulphur
Crop rotation								
Fallow mustard	65.6	15.5	16.5	17.9	160	9.8	145	12.1
Pearlmillet mustard	48.9	11.6	12.5	13.8	174	12.7	167	13.2
Urdbean mustard	81.3	19.0	20.1	21.9	220	13.7	186	13.9
Sorghum mustard	51.8	12.3	13.1	14.4	160	12.5	169	13.1
CD (P=0.05)	2.65	0.47	0.49	0.57	11.5	0.60	9.5	0.42
N and S kg ha^{-1}								
Control	31.9	8.1	8.2	8.6	126	11.4	145	8.8
40 kg N ha^{-1}	62.3	15.8	16.3	18.3	166	12.4	167	10.8
80 kg N ha^{-1}	74.8	17.2	18.0	19.9	216	12.8	182	10.9
30 kg S ha^{-1}	60.2	14.3	15.6	17.0	157	11.9	163	14.1
60 kg S ha^{-1}	68.9	15.3	16.9	17.9	209	12.4	174	18.8
CD (P=0.05)	2.35	0.36	0.44	0.45	10.2	0.53	8.41	0.37

Available NPK and S in soil after harvest of mustard were significantly influenced by crop sequences. However, it improved over the initial status in crop sequences where the fertilizers were applied, though the magnitude of increase varied across the crop sequences (Table 2). The beneficial effects of N and S application on the status of available nutrients in soil were registered over control. The magnitude of increase in available NPK was greater with N application as compared to sulphur. On the other hand, sulphur levels registered higher S availability in soil as compared to applied nitrogen. Thus, it can be concluded that higher yield of mustard can be increased by growing mustard in mung-bean-mustard crop sequence by addition of 80 kg N and 60 kg S ha^{-1}.

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