Indian Journal of Agricultural Sciences **92** (6): 794–6, June 2022/Short Communication
https://doi.org/10.56093/ijas.v92i6.115830

Effect of nitrogen and sulphur on mustard (*Brassica juncea*) in an inceptisol

SUKIRTEE[1]*, Y V SINGH[2], K RISHI RANJAN[2] and P K BHARTEEY[2]

Banaras Hindu University, Varanasi, Uttar Pradesh 221 005, India

Received: 23 September 2021; Accepted: 23 February 2022

Keywords: Content, Dose, Mustard, Nitrogen, Sulphur, Seed yield, Uptake, Yield attributes

Mustard [Brassica juncea (L.) Czern & Cosson.] is an important oil-seed crop of Uttar Pradesh as well as India. In India, mustard rank second and contributes 27.8% in the Indian oilseed's economy and 80% of *Rabi* oilseed production. It is cultivated in an area of 5.96 million ha with the production of 8.32 million tonnes and productivity of 1397 kg/ha (GOI 2018). Both nitrogen (N) and sulphur (S) are essential elements realizing better growth, yield and quality of mustard. Nitrogen imparts dark green colour to plants simultaneously promote vegetative growth and act as a constituent of structural protein and protoplasm. Sulphur is required for biosynthesis of S containing essential amino acids and is also associated with N metabolism in plant (Kacjan Marsic *et al*. 2021). It has significant influence on seed oil content in oilseed crops. Assimilatory pathways of nitrogen (N) and sulphur (S) believed to be functionally integrated and well-coordinated with each other (Kabdal *et al.* 2018). Deficiency of S is increasing in many crops due to continuous use of high analysis S-free fertilizers and higher uptake of S from soil due to increasing cropping intensity with high yielding cultivars. Studies have indicated both synergistic and antagonistic relationship between N and S depending upon their rate of application and ratio in plants (Mansoori 2012). Information on the effect of combined application of N and S on yield, quality and uptake in mustard is rather limited. Therefore, present investigation was undertaken to study the interactive effects of N and S application on yield, growth and nutrients content in mustard.

A pot experiment was conducted with mustard variety varsha during 2016–17 using 10 kg of soil per pot in a net house (semi- controlled) on sandy loam Typic Ustochrept soil at the research farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. Before sowing and after harvesting soil samples were analyzed for basic physio-chemical properties of the soil. Available N by alkaline permanganate method (Subbiah and Asija 1956) and available P in the extracts of 0.5 M $NaHCO_3$ buffered at *p*H 8.5 by spectrophotometer at wavelength 780 nm using blue colour method (Olsen *et al*. 1954) were determined. Available K was determined in the extracts of 1N ammonium acetate at *p*H 7.0 solution using flame photometer (Jackson 1973). Available S was determined by turbid metric method (Chesnin and Yien 1950). The soil was slightly alkaline in reaction (*p*H 8.30), low in organic carbon (0.37 %), CEC (6.63 mol (p^+)/kg) and medium in available P (10.5 kg/ha) and low in available S (14.3 kg/ha), respectively.

The 12 treatments consisted combinations of four levels of N (0, 50, 100 and 150 N kg/ha) and three levels of S (0, 25 and 50 kg S/ha). Treatments were replicated thrice in a factorial randomized design. Ten seeds of mustard were sown during the third week of November and after thinning five plants per pot were maintained for study. Measurements of yield and yield contributing characters were taken after 30, 60 and 90 days after sowing. At harvest, seed and stover yields were recorded. The harvested plant samples at maturity were washed well with distilled water, dried in the air and then in an oven at 60^0C to a constant weight. Stover and seed samples were ground to pass a 1 mm sieve to facilitate easy digestion. Seeds were digested in a mixture of HNO_3:$HClO_4$ (3:1). After proper dilution the digestate was analysed for P and S by colourimetric and K by flame photometric methods (Jackson 1973). For N determination, plant material was digested separately in diacid mixture of H_2SO_4 and $HClO_4$ (9:1) and analysed by Kjelteck Auto Analyzer. Protein content was computed by multiplying the N content by a factor 6.25 (Greenfield and Southgate 2003). Increasing levels from 0 to 150 kg N/ha and 0 to 50 of kg S/ha showed significant effect on number of seeds/siliqua and 1000 seed weight of mustard. Application of N and S together (100 kg N/ha with 25 kg S/ha) resulted in maximum number of seeds/siliqua (10.7) and 1000 seed weight (3.9), the increase was 18.9% and 26.5% over control, respectively.

Interaction effect of N and S was synergistic for both seed and stover yield, maximum synergistic effect was found with 100 kg N/ha and 25 kg S/ha (Table 1). The magnitude of increase in seed and stover yield was 78.5%

[1]ICAR-Central Soil Salinity Research Institute Karnal, Haryana; [2]Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. *Corresponding author email: spsukirtee35@gmail.com

Table 1 Effect of different levels of N and S on seed and stover yield of mustard

N levels (N kg/ha)	S levels (kg/ha)							
	0	25	50	Mean	0	25	50	Mean
	Seed yield (g/pot)				Stover yield (g/pot)			
0	10.58	10.78	12.56	11.31	46.73	48.13	50.50	48.45
50	10.87	12.96	13.20	12.34	52.27	54.34	55.74	54.11
100	11.51	18.89	14.07	14.82	51.72	60.25	58.20	56.72
150	13.10	17.94	15.33	15.45	57.60	56.05	55.00	56.21
Mean	10.51	15.14	13.79		52.08	54.69	54.86	
CD (P=0.05)	N=1.45	S=1.25	N*S=2.51		N=1.07	S=0.93	N*S=1.86	

Table 2 Effect of different levels of N and S on protein content and N: S ratio in seed and stover of mustard

N levels (N kg/ha)	Seed				Stover			
	S levels (kg/ha)							
	0	25	50	Mean	0	25	50	Mean
Protein content (%)								
0	16.96	17.75	18.39	17.70	3.45	3.66	3.89	3.66
50	19.50	20.33	20.56	20.13	3.66	3.83	3.66	3.71
100	19.14	22.14	22.00	21.09	4.16	4.91	4.72	4.59
150	21.39	20.06	20.00	20.48	4.41	4.31	3.91	4.21
Mean	19.24	20.07	20.23		3.92	4.17	4.04	
CD (P=0.05)	N=0.74	S=0.64	N*S=1.28		N=1.04	S=0.90	N*S=1.81	
N:S								
0	16.59	16.70	16.71	16.66	16.66	16.83	17.24	16.91
50	16.68	16.79	16.78	16.74	17.23	17.23	17.30	17.25
100	16.78	17.29	16.87	16.98	17.50	17.54	17.66	17.56
150	16.92	17.03	17.25	17.06	17.73	17.77	17.90	17.80
Mean	16.74	16.95	16.90		17.28	17.34	17.52	
CD (P=0.05)	N=0.77	S=0.06	N*S=0.13		N=0.052	S=0.045	N*S=0.09	

and 28.9%, respectively over control. This increase in seed and stover yield may be due to balanced doses of N and S which promoted growth and development by availability of more photo-assimilates. Sardana and Sheoran (2011) also reported similar finding where with the application of 100 kg N/ha with 20 kg S/ha gave highest mean seed and oil yield. Maximum protein content in seed and stover was recorded when 100 kg N/ha applied in combination with 25 kg S/ha. The increase in N and protein content in mustard may be due to higher nutrient concentration in soil, higher nutrient mobility and their absorption. Role of N and S for protein synthesis is highly inter-related (Jamal *et al*. 2010). Nitrogen to sulphur ratio in the plant tissue is reported to give a good indication of S optima. In this study, N:S ratio ranged from 16.59:1 to 17.29:1 and 16.66:1 to 17.90:1 in seed and stover, respectively, widening trend being associated with the application of 25 kg S/ha (Table 2). Dev *et al.* (1981) reported that application of 20 kg S/ha lowered N:S ratio in mustard seeds from a range of 14:1–16:1 to 11:1–12:1 and it was further reduced to 10:1, when S was applied at 40 kg/ha. Sheoran *et al*. (2014) observed that over fertilized condition of S for maximum output did not bring any significant advantage and yield remains identical if the fertilizers are not used in a balanced proportion.

Available N, P, K and S increased by 24.1%, 77.9%, 9.6% and 21.4% from control. Increase in levels of available P and K may be a result of synergistic effect of N and S as the biomass increases significantly and decomposition of old and dead tissues including both root and shoot increases nutrient content of soil. Kothari and Jethra (2002) also reported that the available N, P, K and S increased with increased levels of sulphur application. Seed yield showed positive and highly significant relationship with N availability, these findings were similar as recorded by Sheoran *et al.* (2013) and Sheoran *et al.* (2016).

SUMMARY

A pot experiment was conducted at Research farm of Banaras Hindu University, Varanasi Uttar Pradesh to assess

the interactive effect of nitrogen (N) and sulphur (S) on productivity, nutrient content and uptake of mustard. The 12 treatments consisted combinations of four levels of N (0, 50, 100 and 150 N kg/ha) and three levels of S (0, 25 and 50 kg S/ha), were replicated thrice in a factorial randomized design. Results showed that seed and stover yield increased significantly by 78.5% and 28.9% over control along with this 18.9% and 26.5% increment was observed in seeds/siliqua and 1000 seed weight over control, respectively with increasing nitrogen and sulphur level up to 100 kg N/ha and 25 kg S/ha. Mustard responds to application of N and S but the response is not always synergistic for productivity of mustard and depends on the amount of nutrient present in the soil and proportion in which these two nutrients are taken up by the plant.

REFERENCES

Chesnin L and Yien C H. 1950. Turbidimetric determination of available sulphur. *Soil Science Society of America Proceeding* **14**: 149–51.

Dev G, Sagar S and Bajwa M S. 1981. Nitrogen-sulfur relationship in raya (*Brassica juncea* L.) as influenced by sulfur fertilization. *Journal of the Indian Society of Soil Science* **29**: 397–99.

GOI. 2018. Agricultural statistics at a glance, Agricultural Statistics Division: Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, New Delhi, pp. 139–40.

Greenfield H and Southgate D A T. 2003. Food composition data. *Production, Management and Use*, 2nd edn. Food and Agriculture Organization of the United Nations, Rome.

Jackson M L. 1973. *Soil Chemistry Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jamal A, Moon Y S and Abdin M Z. 2010. Enzyme activity assessment of peanut (*Arachis hypogea*) under slow-release sulphur fertilization. *Australian Journal of Crop Science* **4**: 169–74.

Kabdal P, Saxena S C and Mahapatra B S. 2018. Nitrogen and sulphur fertilization on yield and nutrient-uptake pattern of Indian mustard (B. juncea) under Mollisols of Uttarakhand. *Indian Journal of Agronomy* **63**: 201–04.

KacjanMarsic N, Moze, K S, Mihelic R, Necemer M, Hudina M and Jakopic J. 2021. Nitrogen and Sulphur Fertilisation for Marketable Yields of Cabbage (*Brassica oleracea* L. var. Capitata), Leaf Nitrate and Glucosinolates and Nitrogen Losses Studied in a Field Experiment in Central Slovenia. *Plants* **10**(7): 1304.

Kothari M L and Jethra J K. 2002. Response of wheat to sulphur application in loamy sand soil. *Annals of Arid Zone* **41**: 191–94.

Mansoori I. 2012. Response of canola to nitrogen and sulphur fertilizers. *International Journal of Agriculture and Crop Sciences* **4**: 28–33.

Olsen S R, Cole C V, Frank S W and Dean L A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. United States Department of Agriculture, Circular number 939.

Sardana V and Sheoran P. 2011. Production potential of canola oilseed rape (*Brassica napus*) cultivar in response to nitrogen and sulphur nutrition. *Indian Journal of Agricultural Sciences* **81**(3): 280–82.

Sheoran P, Sardana V, Singh S, Sheoran O P and Dev Raj. 2013. Optimizing sulphur application in sunflower (*Helianthus annuus* L.) under irrigated semi-arid tropical conditions. *Journal of Agronomy* **58**(3): 384–90.

Sheoran P, Sardana V, Singh S, Kumar A, Mann A and Sharma P. 2016. Agronomic and physiological assessment of nitrogen use, uptake and acquisition in sunflower. *International Journal of Plant Production* **10**(2): 109–22.

Subbiah B and Asija G L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Current Science* **25**: 259–60.