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# Effect of nitrogen and sulphur on content and uptake of nutrient by mustard crop under the loamy sand soil of North Gujarat

R.M. PARMAR[1], J.K. PARMAR* AND M.K. PATEL[1]
Department of Agricultural Chemistry and Soil Science, Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA (Email : jayesh_jkp@yahoo.co.in)

## ABSTRACT

**A field experiment was conducted at Agronomy Farm of C.P.College of Agriculture, Sardar Dantiwada Agricultural University, S. K. Nagar in a randomized block design (factorial) to study the response of mustard to nitrogen and sulphur application under loamy sand soil of north Gujarat. Three levels each of N (50, 75 and 100 kg N $ha^{-1}$) and four levels of S (control, 15, 30 and 45 kg S $ha^{-1}$) were tried. Total twelve treatment combinations were replicated four times. The results revealed that the application of N at the rate of 100 kg N $ha^{-1}$ significantly increased N and P content in seed and stover; K content in seed and S content in stover; uptake of N, P, K, S by seed and stover. Application of nitrogen at the rate of 75 kg $ha^{-1}$ significantly increased K content in stover. Further, the application of sulphur at the rate of 45 kg $ha^{-1}$ significantly increased N, P and S content in seed and stover; uptake of N, P, K, S by seed and stover. The interaction effects showed that application of 100 kg N $ha^{-1}$ and 45 kg S $ha^{-1}$ significantly increased N content in seed and stover and S content in stover over other treatment combination. The treatment combination $N_3S_4$ also affected significantly on P content in seed and stover, K content in seed and stover, S content in seed, uptake of N, P, K, S by seed and stover. The treatment combination gave maximum values but they were not significantly different from other combinations.**

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**Key words :** Nitrogen and sulphur Nutrient, Content, Uptake, Mustard

## INTRODUCTION

Mustard is one of the most important oilseed crops of India but despite of recommended quantities of fertilizers, its average yield is low. In past few years sulphur has received increasing attention and about 90 districts of the country have been found deficient in sulphur. Sulphur deficiency and consequent crop responses have been observed in many crops especially in oilseed crops. Yield increase brought about by S application in India is wide spread, significant and economically attractive. A few years ago sulphur was considered as a nutrient of academic interest. But today it is of much importance to Indian agriculture. Sulphur is considered as a fourth nutrient after NPK because crops in general require sulphur just slightly less than they require P. In case of oilseeds, however, sulphur requirements can exceed those of phosphorus especially in rapeseed and mustard. In general response of mustard to S application is positive (Tandon, 1995). Wide spread 'S' deficiency is prevailing ranging from 15 to 56 per cent (Average 37 per cent) in different types of soils of Gujarat (Meisheri and Patel, 1996). Sadarasania (1992) also reported that 'S' deficiency is as high as 81 per cent in the light textured soil of North, North-West zones of Gujarat state. Nitrogen is also found insufficient in most of the Indian soils. In recent decades over 50 per cent increase in food production has been credited to fertilizer use in which nitrogen has played a major role. The interaction between nitrogen and sulphur is reported to be synergetic. Aulakh *et al.* (1980) obtained maximum yield of mustard when high rates of nitrogen and sulphur were applied together and reported significant positive nitrogen x sulphur interaction. Therefore, the experiment was conducted to study the effect of N and S on content and uptake of nutrients was studied on mustard crop on loamy sand soil of north Gujarat.

## MATERIALS AND METHODS

The field experiment was conducted to study the response of mustard [*Brassica juncea* (L.) Czern and Coss] (var. GM-2) to nitrogen and sulphur application under North Gujarat Condition at the Agronomy Industrial Farm, C.P. College of Agriculture, Sardar Dantiwada Agricultural University, S. K. Nagar. The field experiment was tried under the FRBD design and replicated four times to test the different level of N (50, 75 and 100 kg $ha^{-1}$) and S (0, 15, 30 and 45 $kg^{-1}$).

The representative surface (0-15 cm) soil sample

* Author for correspondence.
[1] Office of Extension Educationist, Diploma School of Agriculture, Junagadh Agricultural University, HALVAD (GUJARAT) INDIA

was collected from the experimental site and analyzed for physico-chemical characteristics (Table 2) as per standard methods as given Table 1.

**Table 1 : Method followed for various physico-chemical analysis**

| Sr. No. | Determination | Methods followed |
|---|---|---|
| 1. | **Soil analysis** | |
| | Organic carbon | As per walkley and black titration method (Jackson,1973) |
| | **Available nutrients** | |
| | Nitrogen | Alkaline potassium parmanganate (Subbaiah and Ashija, 1656) |
| | Sulphur | Expraction of heated sample was done with 1 per cent NaCl followed by turbidimetric methid (Wiliams and Steinbergs, 1959) |
| | Calcium and magnesium | Titration of $Ca^{++}$and $Mg^{++}$ was carried out with standard EDTA solution. Versenate method (Schwarzenbauch and Biedemann, 1948) |
| 2. | **Plant analysis** | |
| | Nitrogen | Micro-Kheldahl's method (Waranke and Barber, 1974) |
| | Potassium | Jackson, 1973 |
| | Phosphorus | Jackson, 1973 |
| | Sulphur | Turbidimetric method. |

**Table 2 : Physico-chemical characteristics of soil of experimental field**

| Sr. No. | Soil characteristics | Value |
|---|---|---|
| 1. | **Mechanical composition** | |
| | 1. Coarse sand (%) | 50.25 |
| | 2. Fine sand (%) | 35.75 |
| | 3. Silt (%) | 8.11 |
| | 4. Clay (%) | 5.65 |
| | 5. Textural class | Loamy sand |
| 2. | **Fertility** | |
| | 1. pHs. (1:2.5) (soil : water) | 7.82 |
| | 2. ECe ($dsm^{-1}$) (1:2.5) at $25^0C$ | 0.09 |
| | 3. Organic carbon (%) | 0.17 |
| | 4. Available N (kg $ha^{-1}$) | 172 |
| | 5. Available $P_2O_5$ (kg $ha^{-1}$) | 35.55 |
| | 6. Available $K_2O$ (kg $ha^{-1}$) | 270 |
| | 7. Heat soluble sulphur (ppm) | 5.8 |

Five plants were randomly collected and prepared to assess the concentration and uptake of N, P, K, S, Fe and Zn by the mustard crop. Plant samples were digested in di-acid mixture. The extract prepared after digestion was used for estimation of nutrients content as per method standard analytical procedure (Table 1).

## RESULTS AND DISCUSSION

The results obtained from the present investigation have been discussed in the following sub heads:

### Nitrogen effect :

The results revealed that the application of N significantly increased the N, P. K and S content and uptake by seed and stover. The content of N, P, K and S in seed and stover were linearly and significantly increased by the application of nitrogen at the rate of 100 kg $ha^{-1}$ except K content in stover and S content in seed (Table 3 to 6). The maximum values of nutrient content of N, P, K and S in seed were 3.19, 0.77, 0.103 and 1.64, respectively while the values of stover were 0.578, 0.21, 0.130 and 0.59, respectively due to appliction of 100 kg N $ha^{-1}$.

The uptake values of N, P, K and S by seed and stover were increased up to the highest level of nitrogen (100 kg $ha^{-1}$) application. The highest uptake values of N, P, K and S by seed were 61.11, 14.79, 1.98 and 31.30 kg $ha^{-1}$, respectively, which were 44, 46, 38 and 39 per cent higher than lowest level of nitrogen ($N_{50}$). Similar results were also obtained for N (27.26 kg $ha^{-1}$), P (9.74 kg $ha^{-1}$), K (6.12 kg $ha^{-1}$), and S (27.66 kg $ha^{-1}$) uptake by stover, which were 30, 35, 26 and 45 per cent higher than the application of 50 kg N $ha^{-1}$ (Table 7 to 10).

The positive effect of nitrogen on nutrient content and uptake might be due to increase in the photosynthesis which resulted into the accumulation of higher quantity of carbohydrates in the vegetative portion of the plants and ultimately enhancing the plant growth, yield and uptake of nutrients (Singh *et al.,* 1991). Nitrogen fertilization is also known to increased root proliferation and root cation exchange capacity (Biswas *et al.,* 1995). Synergistic effect of nitrogen with P, K and S levels to increase in content of nutrients is also support the results. Similar results were also reported by Dubey *et al.* (1992); Parihar and Tripathi (1989); Kumar *et al.* (1989).

### Sulphur effect :

The nutrient content of N, P, K and S in seed and stover were increased by the application of sulphur. The application of 45 kg S $ha^{-1}$ significantly increased N (3.18 and 0.583 per cent), P (0.74 and 0.23 per cent), K (0.102 and 0.130 per cent) and S (1.65 and 0.61 per cent) content in seed and stover over the control (Table 3 to 6).

The uptake of all the nutrients by seed and stover were significantly and linearly increased up to the highest

**Table 3 : Effect of N and S levels on nitrogen content in seed and stover of mustard at harvest**

| Nitrogen content in seed (%) | | | | | | Nitrogen content in stover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 2.75 | 2.80 | 2.90 | 2.95 | 2.85 | $N_1$ | 0.500 | 0.503 | 0.525 | 0.563 | 0.523 |
| $N_2$ | 2.95 | 3.00 | 3.20 | 3.25 | 3.10 | $N_2$ | 0.535 | 0.540 | 0.570 | 0.580 | 0.556 |
| $N_3$ | 3.05 | 3.10 | 3.25 | 3.35 | 3.19 | $N_3$ | 0.555 | 0.558 | 0.590 | 0.608 | 0.578 |
| Mean | 2.92 | 2.97 | 3.12 | 3.18 | | Mean | 0.530 | 0.533 | 0.562 | 0.583 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.008 | 0.009 | 0.016 | S.E. ± | | | 0.002 | 0.003 | 0.006 |
| C.D. (P=0.05) | | | 0.023 | 0.026 | 0.046 | C.D. (P=0.05) | | | 0.006 | 0.009 | 0.017 |
| C.V. % | | | | 1.23 | | C.V. % | | | | 2.23 | |

**Table 4 : Effect of N and S levels on phosphorus content in seed and stover of mustard at harvest**

| Phosphorus content in seed (%) | | | | | | Phosphorus content in stover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 0.62 | 0.64 | 0.70 | 0.74 | 0.68 | $N_1$ | 0.13 | 0.15 | 0.20 | 0.22 | 0.18 |
| $N_2$ | 0.64 | 0.69 | 0.74 | 0.75 | 0.71 | $N_2$ | 0.15 | 0.17 | 0.22 | 0.23 | 0.19 |
| $N_3$ | 0.75 | 0.77 | 0.78 | 0.79 | 0.77 | $N_3$ | 0.17 | 0.18 | 0.23 | 0.24 | 0.21 |
| Mean | 0.67 | 0.70 | 0.74 | 0.76 | | Mean | 0.15 | 0.17 | 0.22 | 0.23 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.008 | 0.009 | 0.016 | S.E. ± | | | 0.002 | 0.002 | 0.004 |
| C. D. (P=0.05) | | | 0.023 | 0.026 | 0.046 | C. D. (P=0.05) | | | 0.006 | 0.006 | 0.012 |
| C.V. % | | | | 4.25 | | C.V. % | | | | 4.06 | |

**Table 5 : Effect of N and S levels on potassium content in seed and stover of mustard at harvest**

| Potassium content in seed (%) | | | | | | Potassium content in stover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 0.096 | 0.097 | 0.097 | 0.098 | 0.097 | $N_1$ | 0.120 | 0.121 | 0.122 | 0.123 | 0.122 |
| $N_2$ | 0.097 | 0.100 | 0.101 | 0.102 | 0.100 | $N_2$ | 0.121 | 0.128 | 0.130 | 0.132 | 0.128 |
| $N_3$ | 0.097 | 0.104 | 0.105 | 0.106 | 0.103 | $N_3$ | 0.123 | 0.130 | 0.132 | 0.134 | 0.130 |
| Mean | 0.097 | 0.100 | 0.101 | 0.102 | | Mean | 0.121 | 0.126 | 0.128 | 0.130 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.001 | 0.001 | 0.001 | S.E. ± | | | 0.001 | 0.001 | 0.002 |
| C. D. (P=0.05) | | | 0.002 | 0.002 | 0.004 | C. D. (P=0.05) | | | 0.002 | 0.003 | 0.005 |
| C.V. % | | | | 2.83 | | C.V. % | | | | 2.51 | |

**Table 6 : Effect of N and S levels on sulphur content in seed and stover of mustard at harvest**

| Sulphur content in seed (%) | | | | | | Sulphur content in stover (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 1.38 | 1.40 | 1.58 | 1.63 | 1.50 | $N_1$ | 0.40 | 0.42 | 0.50 | 0.56 | 0.47 |
| $N_2$ | 1.40 | 1.42 | 1.60 | 1.65 | 1.52 | $N_2$ | 0.48 | 0.49 | 0.59 | 0.60 | 0.54 |
| $N_3$ | 1.58 | 1.63 | 1.65 | 1.68 | 1.64 | $N_3$ | 0.52 | 0.54 | 0.62 | 0.66 | 0.59 |
| Mean | 1.45 | 1.48 | 1.61 | 1.65 | | Mean | 0.47 | 0.48 | 0.57 | 0.61 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.011 | 0.013 | 0.022 | S.E. ± | | | 0.005 | 0.006 | 0.010 |
| C. D. (P=0.05) | | | 0.032 | 0.037 | 0.063 | C. D. (P=0.05) | | | 0.014 | 0.017 | 0.029 |
| C.V. % | | | | 2.89 | | C.V. % | | | | 3.76 | |

levels of sulphur application (45kg ha$^{-1}$). The highest uptake of N (65.42 and 28.28 kg ha$^{-1}$), P(15.61 and 11.15 kg ha$^{-1}$), K (2.10 and 6.28 kg ha$^{-1}$) and S (33.93 and 29.41 kg ha$^{-1}$) were recorded with the application of 45kg S ha$^{-1}$, which were 76, 43, 81, 86, 72 40, 82 and 68 per cent higher than the control, respectively (Table 7 to 10).

The significantly increased in content and uptake of nutrients by sulphur application might be due to profuse vegetative growth and root growth there by activating absorption of nutrients. The uptake of N, P, K and S both in seed and stover were increased, this might be due to the enhanced availability of nutrients in soil with application of S as soil was deficient in sulphur which in turn increased the concentration of nutrients and dry matter accumulation . It seemed that seed and stover yields were more deciding factors for uptake of these nutrients. The increase in uptake of these nutrients by the crop under the influence of S seems partly due to increased contents of N, P and S in seed and stover increased dry matter production (Tandon, 1995).

**Interaction N x S effect :**

The interaction of N and S on nutrient content and uptake showed positive effect and the maximum contents and uptake were observed at higher levels of nutrient application.

The results on interaction effect of nitrogen and sulphur showed that the application of 100 kg N ha$^{-1}$ with

**Table 7 : Effect of N and S levels on nitrogen uptake by seed and stover of mustard**

| Nitrogen uptake by seed (kg ha$^{-1}$) | | | | | | Nitrogen uptake by stover (kg ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 26.13 | 33.60 | 50.75 | 58.28 | 42.19 | $N_1$ | 15.25 | 17.61 | 23.89 | 26.88 | 20.91 |
| $N_2$ | 36.88 | 53.25 | 58.24 | 66.30 | 53.67 | $N_2$ | 19.53 | 22.55 | 26.33 | 27.93 | 24.09 |
| $N_3$ | 48.80 | 58.13 | 65.81 | 71.69 | 61.11 | $N_3$ | 24.42 | 26.09 | 28.47 | 30.04 | 27.26 |
| Mean | 37.27 | 48.33 | 58.27 | 65.42 | | Mean | 19.73 | 22.08 | 26.23 | 28.28 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 1.392 | 1.608 | 2.785 | S.E. ± | | | 0.485 | 0.559 | 0.969 |
| C. D. (P=0.05) | | | 4.008 | 4.629 | 8.018 | C. D. (P=0.05) | | | 1.396 | 1.610 | 2.790 |
| C.V. % | | | | 10.76 | | C.V. % | | | | 8.05 | |

**Table 8 : Effect of N and S levels on phosphorus uptake (kg ha$^{-1}$) by seed and stover of mustard**

| Phosphorus uptake by seed (kg ha$^{-1}$) | | | | | | Phosphorus uptake by stover (kg ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 5.89 | 7.68 | 12.25 | 14.62 | 10.11 | $N_1$ | 3.97 | 5.25 | 9.10 | 10.51 | 7.21 |
| $N_2$ | 8.00 | 12.25 | 13.47 | 15.30 | 12.26 | $N_2$ | 5.48 | 7.10 | 10.16 | 11.07 | 8.45 |
| $N_3$ | 12.00 | 12.44 | 15.80 | 16.91 | 14.79 | $N_3$ | 7.48 | 8.42 | 11.10 | 11.86 | 9.74 |
| Mean | 8.63 | 11.46 | 13.84 | 15.61 | | Mean | 6.01 | 7.30 | 9.99 | 11.15 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.383 | 0.442 | 0.766 | S.E. ± | | | 0.168 | 0.194 | 0.335 |
| C. D. (P=0.05) | | | 1.103 | 1.273 | 2.206 | C. D. (P=0.05) | | | 0.484 | 0.559 | 0.965 |
| C.V. % | | | | 12.39 | | C.V. % | | | | 7.91 | |

**Table 9 : Effect of N and S levels on potassium uptake (kg ha$^{-1}$) by seed and stover of mustard**

| Potassium uptake by seed (kg ha$^{-1}$) | | | | | | Potassium uptake by stover (kg ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 0.91 | 1.16 | 1.70 | 1.94 | 1.43 | $N_1$ | 3.66 | 4.24 | 5.55 | 5.87 | 4.84 |
| $N_2$ | 1.21 | 1.78 | 1.84 | 2.08 | 1.73 | $N_2$ | 4.42 | 5.34 | 6.01 | 6.36 | 5.53 |
| $N_3$ | 1.55 | 1.95 | 2.13 | 2.27 | 1.98 | $N_3$ | 5.41 | 6.08 | 6.37 | 6.62 | 6.12 |
| Mean | 1.22 | 1.63 | 1.89 | 2.10 | | Mean | 4.50 | 5.22 | 5.98 | 6.28 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.042 | 0.048 | 0.084 | S.E. ± | | | 0.098 | 0.113 | 0.196 |
| C. D. (P=0.05) | | | 0.121 | 0.138 | 0.242 | C. D. (P=0.05) | | | 0.282 | 0.324 | 0.564 |
| C.V. % | | | | 9.79 | | C.V. % | | | | 7.14 | |

**Table 10 : Effect of N and S levels on sulphur uptake (kg ha$^{-1}$) by seed and stover of mustard**

| Sulphur uptake by seed (kg ha$^{-1}$) | | | | | | Sulphur uptake by stover (kg ha$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | N/S | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $N_1$ | 13.11 | 16.80 | 27.65 | 32.19 | 22.44 | $N_1$ | 12.20 | 14.70 | 22.75 | 26.74 | 19.10 |
| $N_2$ | 17.50 | 25.21 | 29.12 | 33.66 | 26.37 | $N_2$ | 17.52 | 20.46 | 27.26 | 28.89 | 23.53 |
| $N_3$ | 25.28 | 30.56 | 33.41 | 35.95 | 31.30 | $N_3$ | 22.88 | 25.25 | 29.92 | 32.60 | 27.66 |
| Mean | 18.63 | 24.19 | 30.06 | 33.93 | | Mean | 17.53 | 20.14 | 26.64 | 29.41 | |
| | | | N | S | N/S | | | | N | S | N/S |
| S.E. ± | | | 0.829 | 0.957 | 1.657 | S.E. ± | | | 0.415 | 0.480 | 0.831 |
| C. D. (P=0.05) | | | 2.387 | 2.756 | 4.771 | C. D. (P=0.05) | | | 1.195 | 1.382 | 2.393 |
| C.V. % | | | | 12.41 | | C.V. % | | | | 7.09 | |

45 kg S ha$^{-1}$ ($N_3S_4$) recorded the maximum values of N, P, K and S content in seed and stover and over all, it was at par with the combination of lower level of nitrogen and sulphur levels (Table 3 to 6). Similar results were also obtain in case of N, P, K, and S content in seed and stover as influenced by N and S interaction The uptake of nutrients by seed and stover increased linearly with the combined application of N and S at higher rates. The treatment combination $N_3S_4$ significantly resulted in the maximum N uptake (71.69, 30.04 kg ha$^{-1}$), P (16.91 and 11.86 kg ha$^{-1}$), K (2.27 and 6.62 kg ha$^{-1}$) and S (35.95 and 32.60 kg ha$^{-1}$) by seed and stover, respectively (Table 7 to 10). Effect of N and S on the higher uptake of N, P and S in seed and stover are closely correlated with their increased yields (Kumar *et al.,* 1989). These findings are in line with those noted by Singh and Singh (1980). Sachdev and Deb (1990), Malik *et al.* (1993) and Panchal (1998).

## Conclusion:

The mustard is an oil seed crop and its oil has great value due to several protein, fatty acid and amino acid. The nitrogen is encouraged synthesis of protein and fatty acid and also plays role in constituent of enzyme and energy metabolism. Sulphur plays role in formation of amino acids (methionine, cysteine and cystine), synthesis of proteins, chlorophyll and oil in oil seed crops. Therefore, the content and uptake of nutrients especially N and S are very important for the mustard crop. Thus, Over all, the results revealed that the application 100 kg N ha$^{-1}$ and 45 kg ha$^{-1}$ content and uptake of N, P, K, S by seed and stover. While, the interaction effects showed that application of 100 kg N ha$^{-1}$ and 45 kg S ha$^{-1}$ significantly increased N content and uptake of N, P, K, S by seed and stover. So, the as the N and S uptake increased by seed and stover, increased the nutritional value of mustard crop.

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