Optimization of sulphur and boron for mustard (*Brassica juncea* L. Czern. & Coss.) under eastern U.P. condition

NARENDRA SINGH[1], BHAGWAN SINGH[2] and HEMANT KUMAR GANGWAR[1]

[1]*Department of Agronomy,* [2]*Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) 224 229*

ABSTRACT : A field experiment was conducted during winter (*rabi*) season of 2012-13 and 2013-14 at Kumargunj, Faizabad, Uttar Pradesh to determine the optimum dose of sulphur and boron for mustard. The experiment was laid out in Randomized Block Design (RBD) with three replications. Sixteen treatments consisted of four levels of sulphur (0, 20, 40, 60 kg ha^{-1}) and equal levels of boron (0, 0.5, 1.0, 1.5 kg ha^{-1}). Mustard variety NDR-8501 was undertaken in the investigation. The results showed that the application of sulphur and boron significantly increased the seed yield. The increasing level of sulphur and boron increased seed yield during both the years. The maximum seed yield was recorded with application of 60 kg S ha^{-1} and 1.5 kg boron ha^{-1} whereas the minimum was in the control treatment. However, from regression analysis, a positive and quadratic relationship was observed between seed yield and sulphur and boron levels. The optimum doses of sulphur and boron was calculated to be 50.20 and 49.65 kg S ha^{-1}, and 1.17 and 1.19 kg B ha^{-1}, for Faizabad area of eastern Uttar Pradesh, during 2012-13 and 2013-14, respectively.

Key words: Boron, mustard, sulphur, yield

India is the third largest producer of mustard (*Brassica juncea* L. Czern. & Coss.) in the world after China and Canada. It is grown on an area of 5.89 mha with production and productivity of 6.60 mt and 1121 kg ha^{-1}, respectively (Anonymous, 2013). The productivity of mustard is low as compared to the yield potential of the various Brassica species due to incorrect application of agro techniques particularly nutrient management under eastern U.P condition. Therefore, the present investigation was carried out for evaluating the optimum requirement of sulphur and boron for mustard. Sulphur is a secondary plant nutrient but now considered as the fourth major plant nutrient after nitrogen, phosphorus and potash. It is essential for synthesis of several vitamins and amino acids i.e., cysteine, cystine, methonine and it also helps in photosynthesis. Soil analysis and crop response data generated by the TSI-FAI-IFA project (1997-2006) revealed that out of over 49,000 soil samples analyzed across 18 states, 46% samples were deficient in S and another 30% were medium in available S which could be considered as potentially S deficient. Soil sulphur deficiencies have been encountered in various parts of the country, and are a critical problem 57-64 million ha of the net sown area. The soils of U.P. where oilseed crops are grown are light and medium textured which are deficient in sulphur. About 64 percent of Uttar Pradesh soils are deficient in sulphur (Gosh *et al*., 2000). Boron also plays an important role in growth and development of mustard. Its deficiency or access affects the growth and yield of the crop. It plays an important role in cell differentiation and development, translocation of photosynthates and growth regulators from source to sink and growth of pollen grains thereby marked increase in seed yield of crops (Sakal *et al.,* 1991). According to National Food Security Mission report boron deficiency is most common in Bihar, Bengal, Odisha, Asom, Jharkhand, Gujarat, Karnataka, Madhya Pradesh, Chhattisgarh and Uttar Pradesh. About 24% soil samples of Uttar Pradesh are boron deficient. Hence an attempt was made for optimization the dose of sulphur and boron to achieving the goal of potential yield

MATERIALS AND METHODS

An experiment was conducted at the Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumargunj, Faizabad, U.P., India, during winter (*rabi*) season of 2012–13 and 2013–14. The soil of the experimental field was slightly alkaline reaction and silt loam, which was low in organic C (0.33%) and medium in available phosphorus (12.43 kg ha^{-1}) and potassium (221.15 kg ha^{-1}), but deficient for sulphur (2.02 kg ha^{-1}) and boron (0.30 ppm). The experiment was conducted in factorial randomized block design with three replications. The treatments consisted of 4 levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) and 4 levels of boron (0, 0.5, 1.0 and 1.5 kg ha^{-1}). The crop was fertilized with recommended dose of NPK @ 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}. As per treatment full doses of sulphur and boron, half dose of nitrogen along with full doses of phosphorus and potassium were applied as basal. Remaining half dose of nitrogen was applied through top dressing after 27 days after sowing. The source of sulphur was elemental sulphur (85% S) and for boron it was borax (20% B). The average minimum temperature range was 2.9^{0}C - 21.8^{0}C and 5.9^{0}C -23.5^{0}C during 2012-13 and 2013-14, respectively. Similarly, the maximum temperature range was 14.8^{0}C to 33^{0}C and 15.5^{0}C to 31.8^{0}C during 2012-13 and 2013-14, respectively. The crop received 85.80 and 111.8 mm rainfall during the cropping season of 2012-13 and 2013-14. Mustard variety NDR-8501 was sown in rows 45 cm apart on 01 and 03 November and harvested 16 and 20 March during 2012-13 and 2013-14 respectively. Pendimethalin (Stomp 30 EC) herbicide @ 3.3 litre ha^{-1} was applied using 500 liters water on the same day of sowing, followed by one manual weeding was done to control weeds. The thinning was carried out at 20 days after sowing to have optimum plant stand. To raise a good crop, two irrigations in first year and one irrigation in second year, were applied. In order to study the relationship between the seed yield of mustard and various levels of sulphur and boron, the yield curves were fitted for the yield data of both years of experimentation. The equation for quadratic component was fitted to the yield data of both the years are as under:

$Y = a + bx + cx^2$

Where,

Y = Expected yield of mustard
x = Unit of nutrient (kg)
a = Expected yield at 0 levels of sulphur and boron
b and c = Regression constant

RESULTS AND DISCUSSION

By the use of orthogonal polynomials and the procedure of least squares, the values of the constants and coefficients for the above equation were worked out for the both years of experimentation, which have been given in Table 1.

Using the equations as above the expected yield for the various levels of sulphur and boron were calculated and drawn in the form of a response curve and depicted in Figure 1.

Most profitable dose of sulphur and boron

The optimum dose (kg ha^{-1}) was worked out with the help of following equation prescribed by Panse and Sukhatme (1967): -

$$X = \frac{q - bp}{2\,cp}$$

Where:

X = optimum dose of nutrient (kg ha^{-1})
q = price of nutrient (per kg)
p = price of grain of mustard (per q)
b & c = constants measuring the curvature of the curve

Table 1: Values of constants and components

Components		Values	
		2012 - 13	2013 -14
For Sulphur			
	a	14.07	13.45
	b	0.1692	0.1647
	c	- 0.001534	- 0.001506
For Boron			
	a	13.81	13.41
	b	7.87	6.93
	c	- 3.09	- 2.65

Table 2: Equation for the response curve

Treatment	Equation for the response curve	
	2012 - 13	2013 -14
Levels of sulphur	$14.07 + 0.1692\,x - 0.001534\,x^2$	$13.45 + 0.1647\,x - 0.001506x^2$
Levels of boron	$13.81 + 7.87\,x - 3.09\,x^2$	$13.41 + 6.93\,x - 2.65x^2$

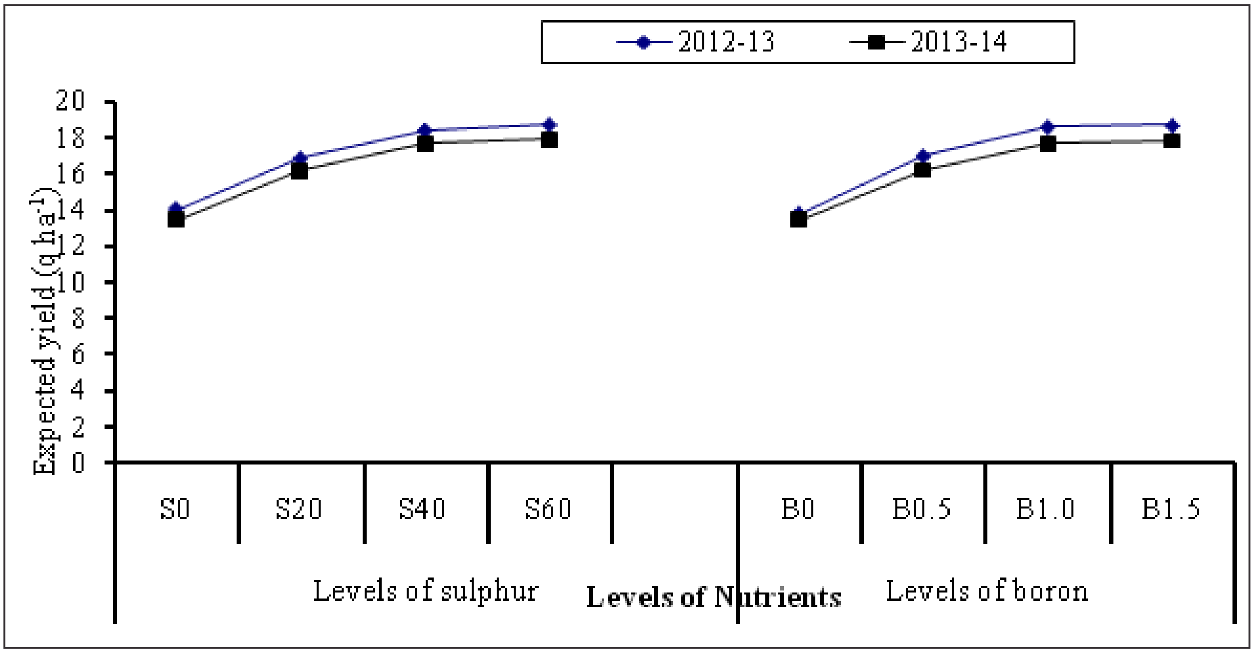

Fig. 1: Expected seed yied of mustard at different levels of...

Table 3: Expected seed yield of mustard at different levels of sulphur and boron

Levels of nutrients (kg/ha)	2012 - 13		2013 -14	
	Yield obtained ($q\ ha^{-1}$)	Expected yield ($q\ ha^{-1}$)	Yield obtained ($q\ ha^{-1}$)	Expected yield ($q\ ha^{-1}$)
A. Levels of sulphur				
S^0	14.13	14.07	13.51	13.45
S^{20}	16.68	16.84	15.97	16.14
S^{40}	18.56	18.39	17.81	17.63
S^{60}	18.65	18.70	17.85	17.91
B. Levels of boron				
B^0	13.71	13.81	13.32	13.41
$B^{0.5}$	17.26	16.97	16.47	16.21
$B^{1.0}$	18.29	18.58	17.42	17.68
$B^{1.5}$	18.75	18.65	17.92	17.83

Table 4: Response of seed yield of mustard to optimum and maximum doses of sulphur and boron

Levels of Nutrients	Optimum dose ($kg\ ha^{-1}$)			Yield at optimum dose ($kg\ ha^{-1}$)			Maximum dose ($kg\ ha^{-1}$)			Yield at maximum dose ($q\ ha^{-1}$)		
	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean	2012-13	2013-14	Mean
Sulphur	50.20	49.65	49.92	18.70	17.92	18.31	55.14	54.69	54.91	18.74	17.95	18.35
Boron	1.17	1.19	1.18	18.78	17.89	18.34	1.27	1.31	1.29	18.81	17.93	18.37

With the assumption that the response equation was a second degree *i.e* $Y = a + bx + cx^2$, the optimum dose of sulphur and boron was calculated (Table 4). The price of mustard seed was taken Rs. 3500 and Rs. 3600 per kg during 2012-13 and 2013 -14, respectively. The cost of sulphur and boron was taken Rs. 53.10 per kg and Rs. 2250.00 per kg, respectively, during both the years.

The equation revealed that the response to sulphur and boron was quadratic, and the optimum dose of sulphur and boron was 50.20 and 49.65 kg sulphur ha^{-1}, 1.17 and 1.19 kg boron ha^{-1}, during 2012-13 and 2013-14, respectively. It is evident from the table that the average optimum dose of sulphur was 49.92 kg ha^{-1} while the optimum dose of boron was 1.18 kg ha^{-1} for the mustard crop however, maximum dose of sulphur was 54.91 kg ha^{-1} and boron was 1.29 kg ha^{-1}.

On the basis of experimental findings, it may be recommended that to obtain the remunerative yield of mustard, crop may be fertilized with 49.92 kg S and 1.18 kg boron ha^{-1} in eastern Uttar Pradesh.

Symbols

S_0, 0 kg sulphur ha^{-1}, S_{20}, 20 kg sulphur ha^{-1}, S_{40}, 40 kg sulphur ha^{-1}, S_{60}, 60 kg sulphur ha^{-1}, B_0, 0 kg boron h,a^{-1}, $B_{0.5}$, 0.5 kg boron ha^{-1}, $B_{1.0}$, 1.0 kg boron ha^{-1}, $B1_{.5}$, 1.5 kg boron ha^{-1}

REFERENCES

Anomymous (2013). Directorate of Economics and Statistics, *Agricultural Statistics at a Glance*, Department of Agricultural and Cooperation. Ministry of Agriculture, Government of India (official website).

Ghosh, P.K., Hati, K.M., Mandel, K.G., Mishra, A.K.; Chaudhary, R.S. and Bondopadhyay, K.K. (2000). Sulphur nutrition in oil seeds based cropping system. *Ferti . News*, 45 (8): 27-30.

Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods for agriculture workers, 2nd edition, ICAR, New Delhi.

Sakal, R. (1991). Relative susceptibility of some important varieties of sesamum and mustard to boron deficiency in calcareous soil. *Fertiliser News,* 36 (3): 43–46.

Received: May 28, 2016
Accepted: March 27, 2017