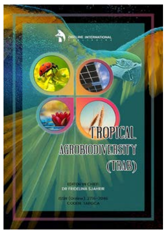
ZIBELINE INTERNATIONAL PUBLISHING

ISSN: 2716-7046 (Online)
CODEN: TARGCA

Tropical Agrobiodiversity (TRAB)

DOI: http://doi.org/10.26480/trab.02.2020.52.56



RESEARCH ARTICLE

RESPONSE OF SULPHUR AND ZINC NUTRITION TO THE SEED YIELD AND OIL CONTENT OF MUSTARD (CV. BARI SARISHA-14)

Rashida Sultana, Swapan Kumar Paul, Md. Abdur Rahman Sarkar, Shubroto Kumar Sarkar*

Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202.
****Corresponding Author's Email: shubroto.agronomy@bau.edu.bd***

ARTICLE DETAILS

Article History:

Received 28 May 2020
Accepted 15 June 2020
Available online 18 June 2020

ABSTRACT

The role of different nutrient elements is well established in plant metabolism. However, different crops respond differently in relation to their growth and yield. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to evaluate the response of sulphur and zinc nutrition to the seed yield and oil content of mustard (cv. BARI Sarisha-14). It, laid out in RCBD with three replications was consisted of four levels of sulphur (0, 20, 40 and 60 kg ha^{-1}) and Zn (0, 1, 2, 3 kg ha^{-1}). It was observed that 60 kg Sulphur ha^{-1} gave significantly highest seed yield, oil content and harvest index owing to the highest number of branches plant^{-1}, siliqua plant^{-1}, seeds siliqua^{-1} and 1000-seed weight. Conversely, 0 kg Sulphur ha^{-1} provided the lowest seed yield and oil content of mustard. Again, the highest number of braches plant^{-1}, siliqua plant^{-1} and seeds siliqua^{-1} was found at 3 kg zinc ha^{-1} which resulted in the highest seed yield, oil content and harvest index. The lowest performance of the yield components and yield was observed at 0 kg zinc ha^{-1}. Interaction effect between 60 kg sulphur ha^{-1} and 3 kg zinc ha^{-1} provided the highest seed yield and stover yield because of the highest number of branches plant^{-1} and seeds siliqua^{-1} and the worst yield performance was a observed at the control treatment. Therefore, the application of sulphur and zinc at the rate of 60 kg ha^{-1} and 3 kg ha^{-1}, respectively could be applied for BARI sarisha-14 for higher seed yield.

KEYWORDS

sulphur, zinc, mustard, oil, yield

1. INTRODUCTION

Mustard (*Brassicsa juncea* L.) is an important oilseed crop of the family cruciferae and dominates the oilseed crop production in Bangladesh. It occupies about 67% (759,874 acres) of land out of 1,121,617 acres of land under oilseed cultivation in this country (BBS, 2019). Depending on the varieties, mustard seed contains about 40-44% oil having around 40% protein in its cake which always seeks attention of the farmers as well as the researchers (BARI, 2019). Every year, Bangladesh has to import a considerable amount of mustard seeds to cope with its increasing demand because of the high oil content of seeds and protein-rich oilcake as feed for the animals. In spite of having some high yielding varieties developed by the different agricultural research institutes in Bangladesh, the average yield of mustard is still not that much higher. The average production of rapeseed-mustard is 739 kg ha^{-1} in the country whereas the world average is 1575 kg ha^{-1} (FAO, 2011). The inadequate yield of mustard might be grounded by several factors like improper cultural practices, insufficient nutrient management, soil nutrient depletions and so on. Crop yield reductions are strongly related with soil quality degradation, particularly nutrient depletions which can be attributed to either insufficient fertilizer use or imbalanced fertilization (Roy et al., 2013; Haque et al., 2013; Tan et al., 2005; Chaudhary et al., 2007). Fertilizers have effect on yield and yield attributes of crops and justified fertilizers and resource use is crucial to maintain productivity of crops (Sultana et al., 2019; Sultana et al., 2015). In recent years, deficiency of sulphur has been aggravated in the soil of Bangladesh because of the continuous removal by intensive cropping and tendency to apply NPK fertilizers which is devoid of sulphur. Sulphur is the fourth major plant nutrient after nitrogen, phosphorus and potassium for agriculture. It is essential for synthesis of amino acids, proteins, oils, a component of vitamin A and activates enzyme system in plant. Three amino acids viz. methionine (21%S), cysteine (26% S) and cystine (27%S) contain S which are the building blocks of proteins. About 90% of sulphur is present in these amino acids. It is essential for the synthesis of sulphur containing essential amino acids, associated with nitrogen metabolism and is also involved in the formation of chlorophyll, glucosides and glucosinolates (mustard oils), activation of enzymes and sulphydryl (SH-) linkages that are the source of pungency in oilseeds (Kumar et al., 2018).

Zinc is one of the first micronutrients recognized as essential for plants that transported to plant root surface through diffusion (Maqsood et al., 2009). It is a micronutrient and in case of its severe deficiency the symptoms may last throughout the entire crop season (Asad and Rafique, 2000). Zn deficient plant also appears to be stunted. Better zinc nutrition of crop helped in branching both primary and secondary branches resulting in higher stover yield at harvest (Torun et al., 2000). The grain yield can be improved by addition of Zn fertilization (Maqsood et al., 2009). A researcher also suggested that the application of Zn has become necessary for improved crop yields (Kutuk et al., 2000). It plays significant role in various enzymatic and physiological activities of the plant system. It plays a role in the synthesis of nucleic acid and protein. It also helps in the utilization of phosphorus and nitrogen along with physiology of seed formation (Upadhyay et al., 2016).

Since adequate information is lacking on the choice of sulphur and zinc fertilizer doses for mustard, facts on sulphur and zinc fertilization

Quick Response Code	Access this article online	
	Website: www.trab.org.my	**DOI:** 10.26480/trab.02.2020.52.56

Cite the Article: Rashida Sultana, Swapan Kumar Paul, Md. Abdur Rahman Sarkar, Shubroto Kumar Sarkar (2020). Response of Sulphur and Zinc Nutrition to The Seed Yield and Oil Content of Mustard (Cv. Bari Sarisha-14). *Tropical Agrobiodiversity, 1(2): 52-56.*

response of BARI Sarisha-14 would be useful for increasing the yield and oil content. Therefore, the present research plan was formulated to find the effect of different sulphur and zinc fertilization as well as their interactions to the seed yield and oil content of mustard (cv. Bari sarisha-14).

2. MATERIALS AND METHODS

The research was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during November 2016 to February 2017 in the *Rabi* season. The experimental site is located at 24^0 75' N latitude and 90^0 50' E longitude at an elevation of 18 m above the mean sea level. It is characterized by non-calcareous dark grey floodplain soil belonging to the Sonatola soil series under the old Brahmaputra floodplain (AEZ-9) (UNDP and FAO, 1988). The land type was medium high with silty loam in texture. BARI Sarisha-14, a high yielding variety of *Brassica junica* developed by the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur was used for the experiment. The experiment was laid out in a two factor RCBD design with three replications. The treatments comprised of four levels of sulphur (0, 20, 40 & 60 kg S ha^{-1}) and four levels of zinc (0, 1, 2 & 3 kg Zn ha^{-1}) fertilization. There were 48 unit plots, each of $5m^2$ (2m × 2.5m) maintaining a distance of 75cm between plot to plot and 1m between block to block.

2.1 Crop Husbandry

The land was finally prepared on 10 November 2016 after ploughing and cross ploughing followed by laddering. The plots were laid out in the field on 11 November 2016. The N, P and K fertilizer were applied at the rate of 250, 180 and 100 kg/ha according to Fertilizer Recommendation Guide as Urea, Triple super phosphate (TSP) and muriate of potash (MOP), respectively (BARC, 2012). One third (1/3) of whole amount of Urea and full amount of MP and TSP were applied at the time of final land preparation. The remaining Urea was top dressed in two equal installments at 25 days after sowing (DAS) and 40 DAS respectively. The seeds of (BARI Sarisha-14) were sown, on 12 November 2016 continuously @ 7 kg ha^{-1} by hand as uniform as possible in the 30 cm apart lines allowing 200 plant per plot. The first weeding and thinning were done manually on 30 November 2016. The final weeding and thinning were done after 25 days of sowing. Three irrigations were given at 25 DAS, 35 DAS (maximum flowering stage) and 50 DAS (seed formation stage). The crop was infested with aphids (*Lipaphis erysimi*) at the time of siliqua filling and was controlled successfully by spraying, Malathion 50 EC @ 2ml /L water thrice. The crop was kept under constant observations from sowing to harvesting. The crop was harvested on 08 February 2017 when 90% siliquae were matured.

2.2 Data Collection

Five plants from each plot were selected at random and were tagged for the data collection. The sample plants were uprooted prior to harvest and dried properly in the sun. After collecting sample plants, the harvested plants were tied into bundles and carried to the threshing floor and then sun dried by spreading the bundles on the threshing floor. The seeds were separated from the stover by beating the bundles with bamboo sticks. After threshing and cleaning, the yields of seed and straw per plot were recorded, converted and expressed as Kg ha^{-1}.

2.3 Data Analysis

The recorded data were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done following the RCBD with the help of computer package MSTAT. The mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Response of Sulphur

The entire yield components, seed yield, oil content, stover yield as well as harvest index responded significantly to various levels of sulphur fertilization (Table 1). The highest number of branches $plant^{-1}$ (5.33), the maximum siliqua $plant^{-1}$ (261.8), the highest number of seeds $siliqua^{-1}$ (17.58), the highest 1000-seed weight (3.03 g), the highest seed yield (1160 kg ha^{-1}), the maximum amount of oil content (39.35%) and the highest stover yield (2535 kg ha^{-1}) was found at the application of 60 kg S ha^{-1}. The highest harvest index (31.50%) was also found at the same treatment which was at par with the treatment of 40 kg ha^{-1} (31.50%) and 20 kg ha^{-1} (30.66%), respectively. The highest seed yield of BARI Sarisha-14 was the cumulative effect of the highest performance of all the yield contributing characters (Table 1). The boosting up of seed yield and oil content of mustard might be due to its crucial role of S on different biochemical and physiological functioning responsible for growth and yield of mustard. Sulphur nutrition also enhances cell multiplication, elongation, expansion and imparts a deep green coloured leaves by increasing chlorophyll synthesis resulting in increased dry matter partitioning in comparison to the sulphur deficient plants (Mehriya and Khangarot, 2000). The results coincide with the findings of those who reported to have the highest performance of the vegetative and yield parameters while applying 60 kg S ha^{-1} (Sipai et al., 2015). It was also confirmed that the application of 60 kg S ha^{-1} had numerically increased the seed yield about 14.50% over control (Negi et al., 2017). On the other hand, some researchers had the highest yield performance when 40 kg S ha^{-1} was applied whereas, others found the similar trends with 45 kg S ha^{-1} (Kumar et al., 2018; Swaroop et al., 2017; Upadhyay et al., 2016; Yerma and Dawson, 2018). Statistically significant positive influence of sulphur on seed yield of mustard was also supported with the findings of several experiments (Mir et al., 2004; Malik et al., 2004; Sahu et al., 2004; Singh et al., 2004; Kumar et al., 2006; Patel et al., 2007; Hassan et al., 2007; Kumar and Yadar, 2007). The lowest number of branches $plant^{-1}$ (4.08), the lowest number of seeds $siliqua^{-1}$ (11.58), the lowest seed yield (962.5 kg ha^{-1}), the minimum amount of oil content (38.42%) and the lowest stover yield (2206 kg ha^{-1}) was found when no sulphur was applied. Besides, the lowest number of siliqua $plant^{-1}$ (245.9) and the lowest 1000-seed weight (2.98 g) was found at the same treatment which was statistically similar with those of 40 kg S ha^{-1} and 20 kg S ha^{-1}, respectively. The lowest harvest index (30.48%) was found at 0 kg S ha^{-1} which was statistically parallel to that of 20 kg S ha^{-1}. The lowest seed yield of mustard from the control (0 kg S ha^{-1}) treatment was also found by the others (Pavani et al., 2013; Verma et al., 2011).

Table 1: Effect of levels of sulphur on yield components, seed yield and oil content of mustard (cv. BARI Sarisha-14)

Levels of Sulphur	No. of branches $plant^{-1}$	No. of siliqua $plant^{-1}$	No. of seeds $siliqua^{-1}$	Seed yield (kg ha^{-1})	Oil content (%)	Stover yield (kg ha^{-1})	Harvest index (%)
S_0	4.08 c	245.9 b	11.58 d	962.5 c	38.42 c	2206 d	30.48 b
S_{20}	4.75b	250.9 b	13.52 c	1062 b	39.13 ab	2421 b	30.66 ab
S_{40}	4.67 b	251.2 b	15.25 b	1077 b	38.67 bc	2350 c	31.50 a
S_{60}	5.33 a	261.8 a	17.58 a	1160 a	39.35 a	2535 a	31.50 a
$S\bar{x}$	0.11	2.05	0.198	13.88	0.204	15.29	0.296
Level of sig.	**	**	**	**	**	**	*
CV (%)	7.75	2.81	4.74	4.51	1.82	2.23	3.32

In a column, figures with same letter (s) or without letter do not differ significantly as per DMRT
** = Significant at 1% level of probability, * = Significant at 5% level of probability

S_0 = 0 kg ha^{-1}, S_1 = 20 kg ha^{-1}, S_2 = 40 kg ha^{-1}, S_3 = 60 kg ha^{-1}

3.2 Response of Zinc

Different levels of Zinc application exerted statistically significant effect on the number of branches $plant^{-1}$, siliqua $plant^{-1}$, seeds $siliqua^{-1}$, seed yield, oil content, stover yield and harvest index (Table 2). The highest number of branches $plant^{-1}$ (5.833), the highest seed yield (1136 kg ha^{-1}) and the highest stover yield (2720 kg ha^{-1}) was found at the treatment of 3 kg Zn ha^{-1}. Furthermore, the maximum siliqua $plant^{-1}$ (258.3), the highest number of seeds siliqua^{-1} (15.42) and the maximum amount of oil content (39.36%) was found at the same treatment which was statistically similar with those of the treatment of 2 kg Zn ha^{-1}. The highest harvest index (32.80%) was found at no zinc treatment whereas non-significant effect of zinc application was observed on 1000-seed weight (Table 2). The significant improvement in seed yield of mustard due to zinc nutrition @ 3.0 kg Zn ha^{-1} could be attributed to its big importance in growth and development. Better zinc nutrition of crop helped it in branching both primary and secondary branches in present investigation resulting in higher stover yield at harvest, which in turn has affected the seed yield, which has direct bearings on the dependent characters (Sipai et al., 2015). This result accorded with some others who observed the increase in seed and stover yield of mustard due to zinc application (Sipai et al., 2015; Kumar et al., 2018; Yadav et al., 2017; Malewar et al., 2001; Kumawat and Pathan, 2002). On the other hand, the lowest number of branches plant^{-1} (3.583), the lowest number of seeds siliqua^{-1} (13.08) and the lowest stover yield (2067 kg ha^{-1}) was found at the no zinc treatment. Again, the lowest number of siliqua plant^{-1}(247.5), the lowest seed yield (1013 kg ha^{-1}) and the lowest oil content (38.39%) was found at the same treatment which was statistically similar with those of the treatment of 1 kg Zn ha^{-1}. However, the lowest harvest index (29.43%) was found at the 3 kg Zn ha^{-1} which was also statistically parallel with that of 2 kg Zn ha^{-1}. The lower performance of mustard could be due to physiological disturbances as a result of inadequate zinc application.

Table 2: Effect of levels of zinc on yield components, seed yield and oil content of mustard (cv. BARI Sarisha-14)

Levels of zinc	No. of branches plant^{-1}	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	1000- seed weight (g)	Seed yield (kg ha^{-1})	Oil content (%)	Stover yield (kg ha^{-1})	Harvest index (%)
Zn_0	3.583 d	247.5 b	13.08 c	2.97	1013 c	38.39 c	2067 d	32.80 a
Zn_1	4.250 c	251.2 b	14.33 b	2.99	1032 c	38.70 bc	2209 c	31.86 b
Zn_2	5.167 b	252.8 ab	15.08a	3.00	1081 b	39.13 ab	2516 b	30.05 c
Zn_3	5.833 a	258.3 a	15.42 a	3.02	1136 a	39.36 a	2720 a	29.43 c
$S\bar{x}$	0.105	2.05	0.198	0.013	13.88	0.204	15.29	0.296
Level of sig.	**	**	**	NS	**	**	**	**
CV (%)	7.75	2.81	4.74	1.40	4.51	1.82	2.23	3.32

In a column, figures with same letter (s) or without letter do not differ significantly as per DMRT
** = Significant at 1% level of probability, NS = Not significant

Zn_0 = 0 kg ha^{-1}, Zn_1 = 1 kg ha^{-1}, Zn_2 = 2 kg ha^{-1}, Zn_3 = 3 kg ha^{-1}

3.3 Interaction effect

All the studied parameters except 1000-seed weight and oil content were significantly influenced by the interaction effect between sulphur and zinc fertilizations (Table 3). The highest seed yield (1269 kg ha^{-1}) was found at the interaction between 60 kg S ha^{-1} and 3 kg Zn ha^{-1}. Most likely, the highest seed yield was the cumulative effect contributed by the highest number of branches plant^{-1} (6.66), seeds siliqua^{-1} (19.33) and one of the highests number of siliqua plant^{-1}(259) found at the same interaction treatment. The highest stover yield (2927 kg ha^{-1}) was also found at the interaction between 60 kg S ha^{-1} and 3 kg Zn ha^{-1}. But the highest harvest index (34.19%) was found at the interaction effect between 20 kg S ha^{-1} and 0 kg Zn ha^{-1} which was statistically similar with that of the interaction between 60 kg S ha^{-1} and 0 kg Zn ha^{-1} (33.77%), 0 kg S ha^{-1} and 1 kg Zn ha^{-1} (33.50%), and 40 kg S ha^{-1} and 0 kg Zn ha^{-1} (33.46%) (Table 3). The highest seed yield and oil content was the resultant of cumulative performance by the yield components of mustard. This could have been due to some synergistic properties of combined use of sulphur and zinc fertilization up to certain levels as reported by some researchers (Prabhuraj et al., 1983; Kumar and Singh, 1980). The synergistic response of interction between sulphur and zinc in increasing the seed yield of mustard was found in other researches also (Sipai et al., 2015; Kumar et al., 2018; Akbari et al., 2003; Meena et al., 2006; Subhash and Yadav, 2007; Singh et al., 2007). On the contrary, the lowest seed yield (811 kg ha^{-1}) was found at the interaction between no sulphur and no Zinc fertilization. The lowest seed yield at 0 kg S ha^{-1} × 0 kg Zn ha^{-1} could be the collective impact of one of the lowest number of branches plant^{-1} (3.33), siliqua plant^{-1} (238.7) and the lowest number of seeds siliqua^{-1} (8.667) found at the same treatment. The lowest stover yield (1923 kg ha^{-1}) was found at the same treatment which was similar with that of 0 kg S ha^{-1} × 1 kg Zn ha^{-1}(1971 kg ha^{-1}). The lowest harvest index (28.21%) was found at the interaction between 20 kg S ha^{-1} and 3 kg Zn ha^{-1} which was also similar with that of 0 kg S ha^{-1} and 3 kg Zn ha^{-1}(28.88%), 20 kg S ha^{-1} and 2 kg Zn ha^{-1} (29.37%),0 kg S ha^{-1} and 0 kg Zn ha^{-1}(29.77%) and 0 kg S ha^{-1} and 2 kg Zn ha^{-1} (29.79%) (Table 3). The deficiency of one or more essential plant nutrients *i.e.* sulphur and zinc could be responsible for the poor performance of the yield attributes which, in turn, hastened the lowest seed yield and oil content of mustard. The lower yield of mustard with no sulphur and zinc fertilization was also observed in another study (Sipai et al., 2015).

Table 3: Interaction effect of levels of sulphur and levels of zinc on yield components, seed yield and oil content of mustard (cv. BARI Sarisha-14)

Interaction (S × Zn)	No. of branches plant^{-1}	No. of siliqua plant^{-1}	No. of seeds siliqua^{-1}	1000-seed weight (g)	Seed yield (kg ha^{-1})	Oil content (%)	Stover yield (kg ha^{-1})	Harvest index (%)
S_0Zn_0	3.33e	238.7e	8.667h	2.94	811.0 g	38.08	1923.0 i	29.77 d-f
S_0Zn_1	4.00de	238.7e	12.00g	2.99	993.0 f	37.77	1971.0 hi	33.50 ab
S_0Zn_2	4.33d	245.3c-e	12.67fg	2.99	1005.0 ef	38.77	2369.0 e	29.79 d-f
S_0Zn_3	4.66cd	261.0ab	13.00fg	2.99	1041.0 c-f	39.05	2561.0 cd	28.88ef
$S_{20}Zn_0$	3.33e	246.7c-e	13.33ef	2.99	1086.0 b-e	39.37	2090.0 g	34.19 a
$S_{20}Zn_1$	4.66d	249.3b-e	13.33ef	2.99	998.0 ef	38.82	2237.0 f	30.85 c-e
$S_{20}Zn_2$	5.33bc	252.3a-d	13.67ef	2.99	1064.0 b-f	39.11	2559.0 cd	29.37 d-f
$S_{20}Zn_3$	5.66b	255.3a-c	13.67ef	2.99	1099.0 b-d	39.22	2797.0 b	28.21 f
$S_{40}Zn_0$	3.33e	241.3de	14.33de	2.99	1034.0 c-f	37.53	2056.0 gh	33.46 ab
$S_{40}Zn_1$	3.66e	257.7a-c	15.33cd	2.99	1021.0 d-f	38.75	2234.0 f	31.34 cd
$S_{40}Zn_2$	5.33bc	247.7b-e	15.67bc	2.99	1118.0 bc	39.04	2515.0 d	30.77 c-e
$S_{40}Zn_3$	6.33a	258.0a-c	15.67bc	2.99	1134.0 b	39.38	2596.0 cd	30.41 c-e
$S_{60}Zn_0$	4.33d	263.3a	16.00bc	2.99	1121.0 bc	38.57	2197.0 f	33.77 a
$S_{60}Zn_1$	4.66d	259.0a-c	16.67b	2.99	1114.0 bc	39.46	2394.0 e	31.76 bc
$S_{60}Zn_2$	5.66b	265.7a	18.33a	3.03	1137.0 b	39.58	2620.0 c	30.25 c-e
$S_{60}Zn_3$	6.66a	259.0a-c	19.33a	3.11	1269.0 a	39.78	2927.0 a	30.23 c-e
$S\bar{x}$	0.210	4.10	0.396	0.026	27.76	0.408	30.59	0.592
Level of sig.	**	*	**	NS	**	NS	**	**
CV (%)	7.75	2.81	4.74	1.40	4.51	1.82	2.23	3.32

In a column, figures with same letter (s) or without letter do not differ significantly as per DMRT
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

S_0 = 0 kg ha^{-1}, S_1 = 20 kg ha^{-1}, S_2 = 40 kg ha^{-1}, S_3 = 60 kg ha^{-1}
Zn_0 = 0 kg ha^{-1}, Zn_1 = 1 kg ha^{-1}, Zn_2 = 2 kg ha^{-1}, Zn_3 = 3 kg ha^{-1}

4. Conclusion

The present study suggested that sulphur and zinc played a significant role in increasing seed yield and oil content of mustard. Therefore, sulphur and zinc at the rate of 60 kg $ha^{-1}$and 3 kg ha^{-1} might be applied for the higher seed yield and oil content of BARI Sarisha-14.

References

Akbari, K.N., Karan, F., Qureshi, F.M., Patel, V.N., 2003. Effect of micronutrients, sulphur and gypsum on soil fertility and yield of mustard in red loam soils of Mewar (Raj.). *Indian J. Agric. Res.,* 37 (2), Pp. 94-99.

Asad, A., Rafique, R., 2000. Effect of Zinc, Copper, Iron, Manganese and Boron on the yield and yield components of wheat crop in Tehsil Peshawar. Pakistan Journal of Biological Sciences, 3, Pp. 1815-1820.

BARC (Bangladesh Agricultural Research Council). 2012. Fertilizer Recommendation Guide, Farmgate, Dhaka-1215, Pp. 106.

BARI (Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh). 2019. *Krishi Projukti Hatboi* (Handbook on Agro-Technology), 8th edition, Pp. 88.

BBS (Bangladesh Bureau of Statistics). 2019. Yearbook of Agricultural Statistics-2018. Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Pp. 122.

Chaudhary, S.K., Thakur, S.K., Pandey, A.K., 2007. Response of wetland rice to nitrogen and zinc.Oryza, 44, Pp. 31-34.

FAO (Food and Agricultural Organization of United Nations). 2011. Production Yearbook. Food and Agricultural Organization of United Nations, Ed. FAO, Rome, Italy.

Gomez, K.A., Gomez, A.A., 1984. Statistical Procedures for Agricultural Research. John Wiley & Sons, New York.

Haque, M.M., Saleque, M.A., Sha, A.L., Waghmode, T.R., 2014. Effects of Long-Term Fertilization and Soil Native Nutrient on Rice Productivity in Double Rice Cultivation System. Aper. J. Biochemis. Biochem.Tech., 103, Pp. 1-8.

Hassan, F.U., Manaf, A., Qadir, G., Shahzad, M.A., 2007. Effects of sulphur on seed yield, oil, protein and glucosinolates of canola cultivars. *Internat. J. Agric. & Biol.,* 3, Pp. 504-508.

Kumar, H., Yadav, D.S., 2007. Effect of phosphorus and sulphur levels on growth, yield and quality of Indian mustard (Brassica juncea) cultivars. Indian J. Agron., 52 (2), Pp. 154-157.

Kumar, N., Singh, S., Singh, V., 2006. Effect of iron and sulphur levels on yield, oil content and their uptake by Indian mustard (*Brassica juncea*). *Indian J. Agron.,* 51 (1), Pp. 63-64.

Kumar, P., Dimree, S., Kumar, A., Yadav, D.D., 2018. Effect of sulphur, zinc and FYM on yield attributes and yield on mustard (*Brassica juncea* (L.) Czern and Coss). J. Pharmacognosy and Phytochemistry, 7 (2), Pp. 1093-1096.

Kumar, V., Singh, M., 1980. Interaction of sulphur, phosphorus and molybdenum in relation to uptake, utilization of phosphorus by soybean. *Soil Sci.,* 131 (1), Pp. 26-31.

Kumar, V., Tyagi, S., Paul, S.C., Dubey, S.K., Suman S., 2018. Effect of Sources and Doses of Sulphur on S Uptake and Yield of Mustard (*Brassica juncea* L.) *Int. J. Curr. Microbiol. App. Sci.* Special Issue-7, Pp. 5042-5047.

Kumawat, B.L., Pathan, A.R.K., 2002. Effect of sulphur and zinc on growth of mustard under Typicpsamment. *Acta. Ecologica*, 24, Pp. 128-131.

Kutuk, C., Gökhan, C., Abdullah, B., Başkan, O., 2000. Effect of Humic Acid on some soil properties. Bildiri Özetleri, Soil Science Department, Agricultural Faculty, Ankara University, 06110- Ankara Turkey.

Malewar, G.V., Kate, S.D., Walker, S.L., Saiyed, I., 2001. Interaction effects of zinc and boron on yield, nutrient uptake and quality of mustard (*Brassica juncea* L.) on Typic Haplustert. *J. Indian Soc. Soil Sci.,* 45, Pp. 306-310.

Malik, M.A., Aziz, I., Khan, H.Z., Wahid, M.A., 2004. Growth, seed yield and oil content response of canola (*Brassica napus* L.) to varying levels of sulphur. *Internat. J. Agric. & Biol.,* 6, Pp. 1153–1155.

Maqsood, M.A., Rahmatullah, S., Kanwal, T., Aziz, Ashraf, M., 2009. Evaluation of Zn distribution among grain and straw of twelve indigenous wheat, *Triticum aestivum* L. genotypes. Pak. J. Bot., 41 (1), Pp. 225-231.

Meena, M.C., Patel, K.P., Rathod, D.D., 2006. Effect of zinc, iron and sulphur on mustard in loamy sand soil. *Indian J. Ferti.,* 2 (5), Pp. 55-58.

Mehriya, M.L., Khangarot, S.S., 2000. Response of mustard (Brassica juncea L. Czern and Coss) to sulphur and growth regulators. An. Arid zone, 39 (1), Pp. 81-82.

Mir, H., Hafiz, M., Salroo, M.Y., Bhat, G.N., 2004. Effect of sulphur and naphthalene acetic acid on growth, yield and bio-chemical parameters of Indian mustard (*Brassica juncea*). *Plant Arch.*, 4 (2), Pp. 423-425.

Negi, A., Pareek, N., Raverkar, K.P., Chandra, R., 2017. Effect of two sulphur sources on growth, yield and nutrient use effeiciency of brassica. Int. J. Sci. Environ. Tech., 6 (1), Pp. 236 – 247.

Patel, B.T., Patel, J.J., Patel, M.M., 2007. Response of groundnut (*Arachis hypogaea* L.) to FYM, sulphur and micronutrients and their residual effect on wheat (*Triticum aestivum*). *J. Soils & Crops,* 17 (1), Pp. 18-23.

Pavani, S., Bhanu, R.K., Sudhakara, B.S.N., Madhu, M., 2013. Effect of nitrogen and sulphur on growth, yield and quality of sunflower (*Helianthus annus* L.) Crop Research, 45 (1, 2 &3), Pp. 152-154.

Prabhuraj, D.K., Badiger, M.K., Manure, G.R., 1983. Effect of P, S and Zn on growth, and yield of sunflower. *Indian J. Agron*., 38 (3), Pp. 427-429.

Roy, R.N., Misra, R.V., Lesschen, J.P., Smaling, E.M., 2003. Assessment of soil nutrient balance. Approaches and methodologies. FAO Fertilizer and Plant Nutrition Bulletin 14. Food and Agriculture Organization of the United Nations. Pp. 101. Available online at URL: http://www.fao.org/docrep/006/v5066e/v5066e00.htm.

Sahu, B., Kwatra, V., Nema, N.L. 2004. Response of mustard to phosphorus and S levels in rice low lands. *J. Oilseeds Res.,* 21(1), Pp. 181-182.

Singh, D., Jain, K.K., Sharma, S.K., 2004. Quality and nutrient uptake in mustard as influenced by levels of nitrogen and sulphur. *J. Maharashtra Agric. Univ.,* 29 (1), Pp. 87-88.

Singh, P., Kumar, M., Maurya, C.L., Swarnkar, S.K., 2007. Effect of S and Zn nutrients on growth, seed yield and quality of Indian mustard [*Brassica juncea* (L.) Czern and Coss.] varieties. *Prog. Agric.*, 7 (1/2), Pp. 124-127.

Sipai, A.H., Patel, J.J., Patel, N.I., 2015. Effect of sulphur and zinc with and without FYM on yield and yield attributes of mustard [*Brassica juncea* (L.) Czern amd Coss] grown on light textured soil of Kachchh. *Asian J. Soil Sci.*, 10 (2), Pp. 191-200.

Subhash, A., Yadav, K.K., 2007. Effect of sulphur and zinc on growth, yield, quality and net returns of mustard [*Brassica juncea* (L.) Czern and Coss]. *Curr. Agric.,* 31 (1/2), Pp. 127-129.

Sultana, B.S., Mian, M.H., Jahiruddin, M., Rahman, M.M., Siddique, M.N.E.A., Sultana, J. 2019. Amendment of Acidic Soil with Lime and Manure for Enhancing Fertility, Nutrient Uptake and Yield of Wheat-Mungbean-Monsoon Rice in the Old Himalayan Piedmont Plain. Asian Journal of Soil Science and Plant Nutrition, Pp. 1-26. https://doi.org/10.9734/ajsspn/2019/v4i230043

Sultana, J., Siddique, M.N.A., Abdullah, M.R., 2015. Fertilizer recommendation for agriculture: practice, practicalities and adaptation in Bangladesh and Netherlands. International Journal of Business, Management and Social Research, 1 (1), Pp. 21-40.

Swaroop, N., Swamy, A., Upadhayay, Y., 2017. Effects of Different Levels of

NPK and Sulphur on Growth and Yield Attributes of Mustard (*Brassica juncea* L.) Cv. Varuna Soman Singh Dhruw. *Int.J.Curr.Microbiol.App.Sci.,* 6 (8), Pp. 1089-1098.

Tan, Z.X., Lal, R., Wiebe, K.D., 2005. Global soil nutrient depletion and yield reduction. J. Sustain. Agric., 26, Pp. 123-146.

Torun, B., Bozbay, G., Gultekin, I., Braun, H. J., Ekiz, H., Cakmak, I., 2000. Differences in shoot growth and Zn concentration of 164 bread wheat genotypes in a Zn-deficient calcareous soil. J. Plant Nutr., 23, Pp. 1251–1265.

UNDP and FAO. 1988. Land Resources Appraisal of Bangladesh for Agricultural Report No. 2. Agro-Ecological Region of Bangladesh. United Nations Development Program in Food and Agriculture Organization, Pp. 212-221.

Upadhyay, Y., Swaroop, N., Sahu, Y.K., Dhruw, S.S., Verma, P.D., 2016. Interaction effects of different doses of sulphur and zinc with npk on physic-chemical properties of soil in yellow mustard (*brassica compestris* l.) Cv. Krishna super goldi. Int. J. Agril. Sci. Res. (IJASR)., 6 (2), Pp. 215-220.

Verma, H., Dawson, J., 2018. Yield and Economics of Mustard (Brassica compestris L.) as Influenced by Sowing Methods and Levels of Sulphur and Boron. Int. J. Curr. Microbiol. App. Sci., 7 (1), Pp. 380-386.

Verma, S.K., Singh, S.K., Singh, T.K., 2011. Effect of nitrogen and sulphur on growth, yield and nutrient uptake by Indian mustard (*Brassica juncea*) under rainfed condition. Indian Journal of Agricultural Sciences, 81 (2), Pp. 145-149.

Yadav, K.G., Kushwaha, C., Singh, P.K., Mukesh, K., Yadav, S.K., Nishant., 2017. Effect of nutrient management on yield and nutrient uptake by Indian mustard (*Brassica juncea* L). J. Pharmacognosy and Phytochemistry, 1, Pp. 556-559.

Cite the Article: Rashida Sultana, Swapan Kumar Paul, Md. Abdur Rahman Sarkar, Shubroto Kumar Sarkar (2020). Response of Sulphur and Zinc Nutrition to The Seed Yield and Oil Content of Mustard (Cv. Bari Sarisha-14). *Tropical Agrobiodiversity, 1(2): 52-56.*