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RESEARCH ARTICLE

Effect of Sulphur on Oil Content and Glucosinolate in Different Indian Mustard Genotypes

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ABSTRACT

Brassica is the most economically important genus in the *Brassicaceae* family. Indian mustard (*Brassica juncea* L. Czern & Coss) is an important source of edible oil in India. In this paper the findings of main effect and interaction effect of Indian mustard varieties and different sulphur level on oil content and glucosinolate is presented. The experiment was laid out in Factorial Randomized Block Design (FRBD) during *Ravi* season, 2013-14 and 2014-15 at Agricultural Farm, Nana ji Deshmukh New Agriculture Campus, M.G.C.G.V.V., Chitrakoot, Satna (M.P.) in the *Rabi* season of 2013-14 and 2014-15 continuous years. Results revealed that the oil (%) of Indian mustard seeds maximum was recorded in variety PUSA-Tarak along with S_{60} followed by RB-50, PUSA-Jagannath and Kranti in both consecutive years. The Glucosinolate of Indian mustard seeds were determined and the highest values were recorded in Kranti (2013-14), and same varieties Kranti in (2014-15). Lowest values were recorded in the same varieties LET-18 in 2013-14 and (2014-15), respectively. Interaction results showed that combine application of varieties and sulphur significantly affected on oil content, and glucosinolate. Maximum value of oil content and glucosinolate was recorded in 60kgha^{-1} of S in 2013-14, 2014-15 respectively.

Keywords- Oil content, Glucosinolate, Sulphur, Indian mustard

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INTRODUCTION

India is one of the largest Rapeseed-mustard growing countries in the world, occupying the third rank in showing area and second in production next to China. Rapeseed-mustard belongs to the genus Brassica in the Brassicaceae family play an important role in world agriculture. In the Mustard family (Brassicaceae)includes 338 genera and 3,709 species comprising of several species of crops, weeds, and ornamental plants as well substituted under this genera a number of medicinal plants are found in this family. Mustard is cultivated in mostly under temperate and semi-arid climates. It is withal grown in certain tropical and subtropical regions as an algid weather crop. Rapeseed-Mustard is grown in greater part of Continents with major contributing area of 8 million ha in Canada followed by 7.5 million ha in China and pertaining to 6 million ha in India. In India, Rapeseed & Mustard group of crops is grown in about 6.51 m ha with total production of about 6.84 million tons (Anonymous, 2015-16). In Madhya Pradesh mustard production reaches to 3.55 lakh tons and rapeseed production 3.80 lakh tons in this year according to Central Organization of Oil Industry and Trade (COOIT2015-16).Brassica species are grown worldwide fo r their edible oil which may also be used as a renewable source of energy. *Brassicajuncea* cultivated as a vegetable oil crop because it is derived from plants so it is called vegetable oil. Edible oil is one of the most important essential nutrients in daily diet and plays an important role in human nutrition. Mustard oil is used all over the country in household as cooking oil, baking oil, lamp oil, hair oil, and as lubricant. In industry it is used in tannin, soap, medicines and most recently in biofuel (Kaur et al. 2016),

Glucosinolate is antinutritional element in seed meal. It is not itself toxic but its degradable sulphur products cause thyroid disfunctioning in animal metabolism and enzymatic system. Myrosinase is an enzyme that breakdowns glucosinolate into sulphur containing products. Sinigrin is glucosinolate that found in mustard seeds, when glucosinolate hydrolyze to produce hydrolytic products those are responsible for the enlargement of thyroid glands and haemorrhagic liver syndrome in animals. Thus are considered as the limiting factor for utilization of Rapeseed-mustard seed meal. Many researchers are putting efforts to make zero lines varieties having glucosinolate of <30 μmoles/g. Sulfur (S) is the one of the fundamental auxiliary macronutrient required for the magnification, digestion system and advancement of all plants and is appropriately called fourth significant plant nutrient. Sulphur deficiency in agricultural soils is widespread throughout the world with the potential to threaten future food supply if left unchanged (Fertilizer, 2012). Sulphur assume a crucial part in various physiological and biochemical capacity in plants. Oil per cent and glucosinolate increases by sulphur because both are contain sulphur compounds. Sulphur is also essential for synthesis of different fatty acids (Dimree and Dwivedi 1994).Sulphur performs many physiological functions like synthesis of oil, sulphur containing amino acids (cystein and methionine),chlorophylls, certain vitamins and the glucosinolates (Bonesand Rossiter 1996).

MATERIALS AND METHODS

The Indian mustard seeds were obtained from Directorate of Rapeseed and Mustard (ICAR), Sewar, Bharatpur (Rajasthan).The experiment was laid out in Factorial Randomized Block Design (FRBD) with

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three replications for each treatments Indian mustard genotypes (PUSA-Tarak, RB-50, LET-18, PUSA-Jagannath and Kranti)and four doses of sulphur (0, 20, 40 and 60 $kgha^{-1}S$) during *Ravi* season, 2013-14 and 2014-15 at Agricultural Farm, Nana ji Deshmukh New Agriculture Campus, M.G.C.G.V.V., Chitrakoot, Satna (M.P.). The biochemical analysis of seed materials were done in triplicates for both the year. Oil content and glucosinolate was determined by non-destructive method by FT-NIRS analysis (Fourier Transform Near Infrared Reflectance Spectroscopy)which was standardized by Kumar et al. (2010) in department of biochemistry DRMR, Sewar, Bharatpur (Rajasthan)**.**A multipurpose analyzer FT-NIR spectrometer (Matrix I, Brucker Optics, Germany) was used to obtain spectra. The collected data was statistically analyzed by using statistical programCPCS-1 developed by PAU Ludhiana. Fisher's analysis of variance technique (ANOVA) was employed to test the overall significance of the data.

RESULT AND DISCUSSION

Oil content Oil content is an important parameter that determines economy of the crop. From the experiment under different levels of sulphur applications (0, 20, 40, $60kgSha^{-1}$) it was found that there was conspicuous change in oil content value. During the first year of our experiment the oil content was found to vary from in per cent under control condition ($0kgSha^{-1}$) to per cent under $60kgSha^{-1}$. The variation was found between different varieties and within the varieties, it was observed that oil content among the sulphur level, both year shown highly significant effect and significantly during 2013-14 and 2014-15, respectively while within the sulphur level significant effect. The data pertaining to the oil content in Indian mustard seeds are elaborated in the Table-1, and Table-2**.**It was estimated that oil content in different Indian mustard varieties pooled mean of two years data ranged from 32.34 per cent (LET-18) to 35.77 per cent (PUSA-Tarak). It was found that the oil per cent of Indian mustard varieties ranged from 35.93 per cent (LET-18) to 40.57(PUSA-Tarak) in the year 2013-14 and 36.89 (LET-18) to 39.89 per cent (PUSA-Tarak) in the year 2014-15. Interaction effect within twenty treatments showed significant in both years 2013-14 and 2014-15, respectively. The pooled data of oil content interaction effect ranged from 30.92 (LET-18 S_0) to 36.90 (PUSA-TarakS_{60}) while ranged from 34.08 (LET-18 S_0) to 42.12 (PUSA-TarakS_{60}) and 35.68 (LET-18 S_0) to 40.88 (PUSA-TarakS_{60}), in 2013-14 and 2014-15, respectively. It is observed that the maximum and minimum oil content ranged PUSA-TarakS_{60} which was at par with RB-50, PUSA-Jagannath and Kranti. The maximumoil content during overall value was recorded in the variety LET-18. PUSA-Tarak, RB-50, contain high amount of oil it is good for oil yield /oil production. Sulphur (S) application may result in increased oilcontent in the seeds of mustard (*Brassica juncea* (L.). This increase may be associated with the increase in acetyl-CoA carboxylase activity through the enhancement in acetyl-CoA concentration, as the later is the substrate of the former. The most important role of 'S' in plant metabolism comes from its essential participation in the making of proteins, including acetyl-CoA carboxylase. First, S is a constituent of methionine (21per cent S), the first amino acid incorporated during the protein synthesis (acetyl-CoA carboxylase).Finding similar to earlier researcher (Ahmad and Abdin, 2000) reported that sulfur availability may influence photosynthetic rate since

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ferredoxin and acetyl-CoA contain S and play a significant role in the reduction of CO_2 and production of organic compounds. Also, sulfur is necessary for enzymatic reactions, chlorophyll formation, synthesis of certain amino acids and vitamins, hence, it helps to have a good vegetative growth leading to have a high yield (Marschner, 1995). Aulakh et al. (1980) demonstrated that 6% more oil content and 07 q per ha more oil yield in *Raya*with the application of 60kgSha^{-1} over control. Similarly our finding highly supported by Lakkineni and Abral (1992) reported that 60kgSha^{-1} increase seed yield per plant 20.4 g and oil content 40.2% over control, Oil 39.5 in control. *Brassica juncea* cv. 'Varuna' showed 7.4 and 4.94% higher oil content than 'NDR 8501' during the first and second years, respectively, increase in the seed yield and oil content due to application of 15, 30 and 45 kgSha^{-1} over the control was 20.58, 42.3 and 48.0% during the first year and 22.0, 43.5 and 46.9% during the second year, whereas the increase in oil content due to 45kgSha^{-1} over the control was 11.53 and 9.02% during both year respectively. The oxidized sulphur metabolites are necessary for the biosynthesis of plant sulpholipids and fatty acids which are further incorporated in the glycerol molecule to form triglycerides (Dimree and Dwivedi 1994). Similar increase in oil content with sulphur application has been reported by Bhagat and Soni (2000), Saha and Mandal (2000) and Shukla et al. (2005) (in brassicas). Singh et al. (2010) reported that the oil content increased significantly with the application of sulphur (38.73 %) and highest (42.05 %) at 60 kgSha^{-1}. Increase in oil content on addition of sulphur resulted due to increase in glucosides.

Glucosinolate

The data pertaining to the glucosinolate in Indian mustard seeds are elaborated in the Table 1 and 2. It was observed that glucosinolate among the sulphur level, both year shown highly significant effect and significantly during 2013-14 and 2014-15, respectively while within the sulphur level significant. From this report we have observed a variation of glucosinolate concentration among the varieties and within the varieties. Interaction effect within twenty treatments has shown significant in both years and significantly during 2013-14 and 2014-15, respectively. In this studies under different levels of S application different varieties corresponding to increase in glucosinolate concentration at different rates of sulphur application glucosinolate in pooled range varied from 12.96 µmoles/g under control to 84.86 µmoles/g (Kranti) at 60 kgSha^{-1} however the glucosinolate interaction effect range from 16.51 (LET-18 S_0) to 95.22 (Kranti S_{60}) and 12.62 (LET-18 S0) to 93.46 (Kranti S_{60}), in 2013-14 and 2014-15, respectively. All five varieties showed an increase in glucosinolate concentration at 60 kgSha^{-1}with maximum accounting to Kranti in year 2013-14, 2014-15 and pooled similarly.

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Table-1: Main effect of variety and sulphur level on Oil content (%) and Glucosinolate (µmoles/g) on Indian mustard

Treatment	Oil content		Glucosinolate (µmoles/g)	
A-Variety	2013-14	2014-15	2013-14	2014-15
PUSA-Tarak	40.57	39.89	83.56	82.94
RB-50	39.57	39.33	72.35	73.31
LET-18	35.93	36.89	18.21	14.92
PUSA-Jagannath	39.39	39.34	84.18	82.79
Kranti	38.97	38.68	94.74	92.40
CD 5%	0.47	0.43	0.21	0.32
B-Sulphur (kgha^{-1})				
S_0	37.84	37.78	69.85	68.25
S_{20}	38.51	38.51	70.36	68.9
S_{40}	39.28	39.18	70.81	69.63
S_{60}	39.92	39.83	71.41	70.29
CD 5%	0.42	0.39	0.19	0.28

Table-2: Interaction effect of variety and sulphur level on Oil content (%) and Glucosinolate (µmoles/g) of Indian mustard

	Oil content (%)								Glucosinolate(µmoles/g)							
									Sulphur level				Sulphur level			
Treatment	S_0	S_{20}	S_{40}	S_{60}	S_0	S_{20}	S_{40}	S_{60}	S_0	S_{20}	S_{40}	S_{60}	S_0	S_{20}	S_{40}	S_{60}
Variety	2013-14				2014-15				2013-14				2014-15			
PUSA-Tarak	38.63	39.69	41.83	42.10	38.57	39.73	40.37	40.88	83.11	83.45	83.56	84.10	82.33	82.71	83.11	83.61
RB-50	39.27	39.14	39.31	40.60	38.82	38.53	39.17	40.81	72.06	72.24	72.47	72.60	72.53	73.18	73.42	74.09
LET-18	34.08	35.50	36.53	37.60	35.68	36.36	37.55	37.96	16.51	17.70	18.77	19.90	12.62	14.23	15.86	16.95
PUSA-Jagannath	38.51	39.45	39.67	39.91	38.24	38.83	39.68	40.60	83.35	83.79	84.37	85.20	82.27	82.58	82.96	83.34
Kranti	38.69	38.74	39.04	39.40	37.58	39.10	39.14	38.90	94.24	94.62	94.89	95.20	91.51	91.80	92.81	93.46
CD 5%	0.95				0.87				0.42				0.63			

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Among five varieties LET-18 has 30µmoles/g> glucosinolate therefore it is internationally accepted and better for nutrition although Kranti has high glucosinolate so it is better for industrial purpose. Inconsistent response of sulphur for glucosinolates in our study is in line with Schnug (1989 and 1990), who reported that the application of 40 and 80 kgSha^{-1} yielded non-significant differences for the glucosinolate content of oilseed rape. However, linear relationship was found between sulphur fertilization and glucosinolate content of mustard. Zukalova and Vasak (2002), Velasco, (1998) Ahmad et al,. (2007) glucosinolate content increased from 13.6 to 24.6 µmol per g as S rate was increased from 0 to 30kgha^{-1}. Falk*et al.*, (2007) reported that sulphur used as soil fertilizer increased the total content of glucosinolates, including their alkene forms. These results confirmed previous findings showing that S mainly altered the alkenyl group derived from methionine (Zhao et al. 1994).

Sanyal et al. (2011) highly supported our results the high supply of sulfate leads to increased sulfur pools within plant tissues.

The sulfur related metabolites represent an integral part of plant metabolism with multiple interactions; increasing sulfur induces a number of adaptive responses, which is coordinated. Methionine, in plants, is converted to aliphatic GSL via the aliphatic glucosinolate pathway & addition of sulphur should increase the concentration of amino acid & GSL as a consequence of up regulation of sulphur metabolism. The observed increase in levels of GSL gave evidence for an increase of metabolic activity under conditions of increased sulfur supply.

CONCLUSION

The oil (%) of Indian mustard seeds were estimated and the highest values were recorded in PUSA-Tarak in (2013-14), and also in (2014-15). LET-18 showed the lowest oil (%) value in 2013-14 andalsoin 2014-15. Among the treatment maximum oil (%) was recorded in variety PUSA-Tarak along with S_{60} followed by RB-50, PUSA-Jagannath and Kranti in both consecutive years. Among all five varieties PUSA-Tarak is superior for this character. The Glucosinolate of Indian mustard seeds were determined and the highest values were recorded in Kranti (2013-14), and same varieties Kranti in (2014-15). Lowest values were recorded in the same varieties LET-18 in 2013-14 and (2014-15), respectively. Among the treatments Kranti S_{60} in both years gave highest concentration of glucosinolate. LET-18 is superior variety among all five variety which contain 30µmol/g> glucosinolate which is international standard. <30µmol/g glocosinolate is also not avoided since it is very useful for food industry and chemical production for crop protection.

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REFERENCE

Ahmad, A., Khan, I., Anjum, N. A., Abrol, Y. P., & Iqbal, M. (2005). Role of sulphate transporter systems in sulphur efficiency of mustard genotypes. *Plant Science*, 169(5): 842-846.

Ahmad, G., Jan, A., Arif, M., Jan, M. T., & Khattak, R. A. (2007). Influence of nitrogen and sulfur fertilization on quality of canola (Brassica napus L.) under rainfed conditions. *Journal of Zhejiang University Science B*, 8(10): 731-737.

Altaf Ahmad, M.Z. Abdin, (2000).Effect of sulphur application on lipid, RNA and fatty acid content. in developing seeds of rapeseed (*Brassica campestris* L.). *Plant Science*, 150: 71–76.

Aulakh, M.S., Pasricha, N.S., and Sahota, N.S.(1980). Yield, nutrient concentration and quality of mustard crops as influenced by nitrogen and sulphur fertilizer. *J. Agric. Sci. Camb*., 94: 454-449.

Aulakh, M. S., Pasricha, N. S., & Ahuja, K. L. (1995). Effect of nitrogen and sulphur application on grain and oil yields, nutrient uptake and protein content in transplanted gobhi sarson (Brassica napus subsp oleifera var annua). *The Indian Journal of Agricultural Sciences*, 65(7).

Dimree S, Divedi K N. 1994. Response of sulphur and phosphorus on groundnut. *Journal of Oilseeds Research* 11(2): 193–195.

Bhagat K L and Soni K C. 2000. Effect of nitrogen and sulphur on growth, seed and oil yield of mustard (*Brassica juncea*). *Journal of Oilseeds Research* 17 (1): 96–9.

Falk, K. L., Tokuhisa, J. G., & Gershenzon, J. (2007). The effect of sulfur nutrition on plant glucosinolate content: physiology and molecular mechanisms. *Plant Biology*, 9(05): 573-581.

Fertiliser International, (2012), *Enhancing Soil Sulphur Status*, 447: March-April.

Food and Agriculture Organization Statistics. (2015). (http://faostat.com/).

Annonymous (2016). Agricultural Statistics at a Glance. Directorate of Economics and Statistics, Ministry of Agriculture, GOI, New Delhi.

King, S.P., Badger, M.R, Furbank, R.T, (1998) CO_2 refixation characteristics of developing canola seeds and silique wall. *Aust J Plant Phys* 25: 377–386.

Kaur, M., and Sharma, V. S. P. (2016). Quality of component crops as influenced by intercropping of canola oilseed rape (Brassica napus) and Ethiopian mustard (Brassica carinata) with Indian rape (Brassica rapa var. Toria). *Journal of Oilseed Brassica*, 1(1): 38-44.

Kumar, S., Chauhan, J. S., & Kumar, A. (2010). Screening for erucic acid and glucosinolate content in rapeseed-mustard seeds using near infrared reflectance spectroscopy. *Journal of food science and technology*, 47(6): 690-692.

Kumar, S., & Andy, A. (2013). Fourier transform-near infrared reflectance spectroscopy calibration development for screening of oil content of intact safflower seeds. *International Food Research Journal*, 20(2): 759-762.

DOI: https://doi.org/10.24163/ijart/2017/2 (1):36-43

Lakkineni, K. C. and Abrol, Y. P. (1992). Sulphur requirement of rapeseed-mustard, groundnut and wheat: a comparative assessment.*J. Agron. Crop Sci*. 169: 281–285.

Marschner, A., 1986. *Mineral Nutrition of Higher Plants*, p. 356. Academic Press Inc., London, UK.

Saha A and Mandal B K. (2000). Growth and yield of yellow Sarson and mustard in relation to sulphur nutrition in low land entisol under rainfed condition. *Journal of Oilseeds Research* 17(2):307–14.

Schnug, E. (1989). Double low oilseed rape in West Germany: sulphur nutrition and glucosinolate levels. *Aspects Appl. Biol* 23: 67-82.

Sanyal Sibaji Kumar, Venu Gopal S K, Singh B K. (2011). Biochemical impact of sulphur addition on the metabolism of glucosinolates in Brassica juncea- Revealed by metabolome analysis, BIOTECHNOLOGY.

Singh Rajesh Kumar, Singh Amitesh Kumar And Kumar Rakesh (2010) Effect Of Fertility Level On Nutrient Uptake, Yield And Quality Of Indian Mustard (*Brassica juncea* (L.) Czern and Coss). Varieties under Late Sown Condition. *Environment & Ecology* 28 (3a): 1764-1767.

Zhao FJ, Evans EJ, BilsboITOW PE, and Syers JK (1994). Influence of nitrogen and sulphur on the glucosinolate profile of rapeseed *(Brassica llaplIS* L). *1. Sci. Fuod Agric.*, 64: 295-304.

Zukalova H. and Vasak J. (2002), The role and effects of glucosinolate in brassica species-review. *Rostlinná Výroba*, 48(4): 175–180.