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Influence of different levels and combinations of sulphur nutrition on growth, yield and economics of Toria (*Brassica campestris* L.)

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Abstract
Field research was conducted at the Department of Agriculture research farm, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala while the *Rabi* season of 2022. with eight treatments, In order to set up the experiment, a randomised block design was used: T_1: (Recommended dose of urea + SSP (S 15), T_2: (Recommended dose of urea + double dose of SSP (S 30), T_3: (Single dose of DAP remaining N through urea + Bentonite (S 15), T_4: (Single dose of DAP remaining N through urea + Bentonite (S 30), T_5: (Single dose of DAP remaining N through urea + Bentonite (S 45), T_6: (Double dose of DAP remaining N through urea + Bentonite (S 15), T_7: (Double dose of DAP remaining N through urea + Bentonite (S 30) and T_8: (Double dose of DAP remaining N through urea + Bentonite (S 45). In this research the hybrid variety of Rapeseed (*Brassica campestris* L.) (sagar-86) was taken. The results from the data under this research revealed that by the application of (Double dose of DAP + Bentonite (S 45) the recorded highest in all parameters like growth attributes, yield and its attributes and economics. Highest grain yield, stover yield and biological yield was (1.60, 2.88 and 4.48 t ha^{-1}) respectively. Among all the treatments, the application of (Double dose of DAP remaining N through urea + Bentonite (S 45) recorded highest in all plant height at harvest, at 30, 60, and 90 DAS, as well as when dry matter builds up occasionally, are examples of growth parameters. Yield and its attributes like test weight, grain yield and stover yield and biological yield was also observed under T_8 (Double dose of DAP remaining N through urea + Bentonite (S 45).

Keywords: combinations, sulphur nutrition, economics, *Brassica campestris* L.

Introduction
Toria (*Brassica campestris* L.) a significant oilseed crop during the *Rabi* season frequently referred to as lahi or sarson. Oils and fats play as significant role in human life from birth to death. In addition to being significant sources of raw materials for a wide variety of industrial products, they provide great energy and transport A, D, E, and K, which are fat-soluble vitamins. Over 80% of the vegetable oils and fats needed for our country are produced by seven edible annual oil seed crops: groundnut, rapeseed mustard, sesame, sunflower, Niger, and soybean. Linseed and castor are two non-edible oil seed crops. Twenty-nine million hectares or 12% of the nation`s total cultivable land is taken up by oilseeds, which also include the two-plantation crop oil palm and coconut. Rapeseed and mustard are often cultivated with minimal input. As a result, these crops produced very less (750 kg ha^{-1}). The two most crucial components of any crop's agronomics are the management of water and nutrients. When these elements are carefully included into crop husbandry, maximum output is possible. Several researchers have reported that water has positive benefits on rapeseed mustard (Banerjee *et al.*, 1997) [2]. However, depending on the variety utilised, the type soil, and the environment, different toria will respond to applied water in different ways. Recently, sulphur insufficiency has received lot of attention, especially in places with light-textured soils and intensive agriculture. Less than 10 ppm of accessible sulphur is present in large number of alluvial soils, the majority of which are used for agriculture (Naik and Das, 1964) [9]. Among the nutrients, nitrogen and sulphur have a significant role in the production of seed protein and oil. The research that has been done thus far points to a beneficial effect for both of these nutrients in enhancing toria seed quality and yield. But the quantum effect changes according to the agro-ecosystem that the crop uses.

Materials and Methods

The "Response of toria (*Brassica campestris* L.) to different levels of sulphur nutrition" field experiment was carried out through the 2022 *Rabi* growing season at the research farm of the Department of Agriculture at Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana. The resources and methods utilised in this experiment are covered in detail in this chapter. the maximum temperature was observed at 7th standard mean weak (35.9 °C) nonetheless, the lowest temperature was recorded at 14th standard mean weak (14.3 °C). The maximum relative humidity at morning was observed at about (99) on 1st and 4th standard mean weak. On the evening time the maximum relative humidity (81) was observed on the 3rd standard mean weak. The maximum sunshine hours (8.7) were observed on the 11th standard mean weak on the other hand minimum sunshine hours (0.8) was observed on the 1st standard mean weak. The rainfall was favourable to the crop, the maximum rainfall (5.7 mm) was recorded on 1st standard mean weak whereas the minimum rainfall (0.2 mm) was observed on 52nd standard mean weak. In order to set up the experiment, a randomised block design was used: T_1: (Recommended dose of urea + SSP (S 15), T_2: (Recommended dose of urea + double dose of SSP (S 30), T_3: (Single dose of DAP remaining N through urea + Bentonite (S 15), T_4: (Single dose of DAP remaining N through urea + Bentonite (S 30), T_5: (Single dose of DAP remaining N through urea + Bentonite (S 45), T_6: (Double dose of DAP remaining N through urea + Bentonite (S 15), T_7: (Double dose of DAP remaining N through urea + Bentonite (S 30) and T_8: (Double dose of DAP remaining N through urea + Bentonite (S 45). In this research the hybrid variety of Rapeseed (*Brassica campestris* L.) (sagar-86) was taken. Dried weeds and stubble were removed from the experimental field using a tractor-drawn disc. The ground was once more ploughed by a cultivator to produce healthy soil tilth. The test plots were levelled. The sowing was carried out using a tractor-drawn seed drill at a row-to-row spacing of 30 cm. The seeds were planted 4-5 cm deep.

Result and Discussion

Growth Studies

Table 1: Effect of different levels of sulphur on growth attributes of rapeseed crop

Symbol	Treatment	Plant height (CM)			Dry matter accumulation (g m^{-2})		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T1	RDF + SSP (S 15)	27.3	67.5	90.1	30.76	40.35	131.6
T2	RDF + double dose of SSP (S 30)	29.5	70.2	99.3	31.2	44.57	134.56
T3	Single dose of DAP remaining N through urea + Bentonite (S 15)	29.3	69.6	96.2	30.89	42.54	132.25
T4	Single dose of DAP remaining N through urea + Bentonite (S 30)	30	80.9	99.6	31.34	45.33	137.25
T5	Single dose of DAP remaining N through urea + Bentonite (S 45)	39.7	89.7	111	31.63	55.87	141.34
T6	Double dose of DAP remaining N through urea + Bentonite (S 15)	39.4	83.6	102	30.87	51.43	139.4
T7	Double dose of DAP remaining N through urea + Bentonite (S 30)	40.4	94.8	108.6	31.7	61.09	142.65
T8	Double dose of DAP remaining N through urea + Bentonite (S 45)	41.1	101.7	124.7	31.72	62.59	148.33
	SE(m)	0.5	0.6	0.7	0	0	0.03
	C.D. at 5%	1.4	1.6	2.1	0.01	0	0.09

Data in relation to growth parameters have shown that the maximum plant height was influenced by the application of double dose of DAP remaining N through urea + Bentonite S (45) at 30, 60 and 90 DAS in T8 was 41.1, 101.7, and 124.7 cm. Followed by T7 in which double dose of DAP remaining N through urea + Bentonite (S 30) was applied. On the other hand, the lowest height of plants was observed in T1. similar results have been noticed by (Lalrammawii *et al.*, 2021) [6], (Kumar *et al.*, 2018) [5] and (Devi *et al.*, 2022) [3].

Maximum dry matter accumulation at 30, 60 and 90 DAS was observed in crop receiving double dose of DAP remaining N through urea + Bentonite S (45) T8 (31.72, 62.59, and 148.33 g m^{-2}) respectively, followed by T7 (31.70, 61.09, and 142.65 g m^{-2}). Whereas, the lowest DMA was observed in T1 where (Recommended dose of urea + SSP (S 15) was applied. similar findings can be seen by (Singh and Thenua 2016) [11].

Yield attribute and yield studies

T_8 (Double dose of DAP remaining N through urea + Bentonite (S 45) had the highest test weight (3.56 g), which was followed by T_7 (Double dose of DAP remaining N through urea + Bentonite (S 30) (3.35 g), while T_1 (Recommended dose of urea + SSP (S 15) had the lowest test weight (2.17 g).

Double dose of DAP remaining N through urea + Bentonite (S 45) recorded the highest grain yield (1.60 t ha^{-1}), followed by T7 (1.58 t ha^{-1}). On the other hand, T1 (1.15 t ha^{-1}) had the lowest grain production. The highest yield of straw was noted in T_8 (2.88 t ha^{-1}), followed by T_7 (2.79 t ha^{-1}), while the lowest yield was noted in T_1 (2.44 t ha^{-1}). Same results are noticed by (Awal *et al.*, 2020) [1], (Islam *et al.*, 2018) [4] and (Singh *et al.*, 2017) [10].

Table 2: Effect of different levels of sulphur on yield and yield attributes of rapeseed crop

Symbol	Treatment	Yield and yield attributes			
		Grain yield	Stover yield	Biological yield	Test weight (gm)
T1	RDF + SSP (S 15)	1.15	2.44	3.59	2.17
T2	RDF + double dose of SSP (S 30)	1.34	2.62	3.96	2.3
T3	Single dose of DAP remaining N through urea + Bentonite (S 15)	1.33	2.54	3.87	2.28
T4	Single dose of DAP remaining N through urea + Bentonite (S 30)	1.39	2.67	4.1	2.4
T5	Single dose of DAP remaining N through urea + Bentonite (S 45)	1.53	2.83	4.41	3.5
T6	Double dose of DAP remaining N through urea + Bentonite (S 15)	1.43	2.74	4.18	2.29

T7	Double dose of DAP remaining N through urea + Bentonite (S 30)	1.58	2.79	4.27	3.35
T8	Double dose of DAP remaining N through urea + Bentonite (S 45)	1.6	2.88	4.48	3.56
	SE(m)	0.04	0.01	0.02	0.01
	C.D. at 5%	0.04	0.03	0.05	0.04

Table 3: Effect of different levels of sulphur on economics calculated for rapeseed

Symbol	Treatment	Economics			
		cost of cultivation	gross return	net return	B: C ratio
T1	RDF + SSP (S 15)	64,535	33,182	31,353	1.94
T2	RDF + double dose of SSP (S 30)	75,140	34,685	40,455	2.17
T3	Single dose of DAP remaining N through urea + Bentonite (S 15)	74,252	33,039	41,213	2.25
T4	Single dose of DAP remaining N through urea + Bentonite (S 30)	77,740	35,679	42,061	2.18
T5	Single dose of DAP remaining N through urea + Bentonite (S 45)	85,093	36,999	48,094	2.30
T6	Double dose of DAP remaining N through urea + Bentonite (S 15)	79,888	35,714	44,174	2.24
T7	Double dose of DAP remaining N through urea + Bentonite (S 30)	87,883	37,034	50,849	2.37
T8	Double dose of DAP remaining N through urea + Bentonite (S 45)	89,280	38354	50,926	2.33

Economics

Among all the treatments, T_8 (Double dose of DAP remaining N through urea + Bentonite (S 45) recorded maximum gross return (89,280 ₹ ha^{-1}), net return (50,926 ₹ ha^{-1}) and B:C ratio (2.37) followed by T_7 (Double dose of DAP remaining N through urea + Bentonite (S 30) and the minimum was recorded in T_1 (Recommended dose of urea + SSP (S 15) (1.94). The findings of (Piri *et al.*, 2012) [8], (Vijayeswarudu *et al.*, 2021) [12], and (Mahor *et al.*, 2022) [7] are consistent with this result.

Conclusion

From the present study and its findings have shown that by the application of Double dose of DAP remaining N through urea + Bentonite (S 45) enhanced the growth parameter, yield and its attributes and economics. Thus, application of sulphur at the rate 45kg S ha^{-1} through bentonite has been proved superior over other sources and levels of sulphur.

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