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EFFECT OF SOWING DATES AND LEVELS OF SULPHUR ON GROWTH, PRODUCTIVITY AND QUALITY OF TORIA (*Brassica compestris* VAR. TORIA)

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ABSTRACT

A field experiment was conducted during the rabi 2008-09 at the Crop Research Farm, Department of Agronomy At Allahabad Agricultural Institute-Deemed University, Allahabad at Allahabad, to study effect of sowing dates (8th September, 15th September and 22nd September) and levels of sulphur (30, 45, and 60 kg S/ha) on growth and yield of two varieties of toria (T-9 and PT-303). It was found that yield attributes, seed and stalk yields, oil content were significantly higher in variety PT-303 with 60 kg sulphur/ha on 22nd September sown.

Key words : *Sowing dates, sulphur levels and varieties.*

Oil seed crops have been the back bone of agricultural economy of India from time immemorial. Among the various oil seeds rapeseed and mustard (*Brassica* sp.) is the second most important crop contributing nearly 25-30 % of the total oilseed production in the country. In India rapeseed and mustard is grown in about 7.06 m ha with a total production of 4.71 m t and a productivity of 6.67 q/ha (1).

The fourth important plant nutrient often NPK in India, which plays a significant role in increasing production especially in oilseeds. Sulphur is a component of amino acids like cystein, cystine, methionine and essential for chlorophyll formation. It is also required for protein synthesis. Oilseeds crop, therefore, needs more sulphur for their oil and protein synthesis. Studies carried out on sulphur nutrition in oilseeds indicated a considerable increase in yield and yield attributing characters (2). Sulphur plays a multiple role in the nutrition of oilseeds crop. Recently, their has been a growing concern that the pool of available 'S' in the soil have been depleted particularly in light soil with little organic matter due to increased removal of sulphur by adoption of high variety increased cropping intensity, extensive use of sulphur free fertilizers. Though toria is grown in less area, its yield is also very low under Vindhachan region of North eastern U.P. Such a low yield is the consequences of the use of low yielding cultivers, low levels of fertilization, particularly sulphur with in adequate cultural management practices. From dietic and industrial point of view, oil and protein content are of paramount importance to judge the quality of mustard oil and protein content are variable and their percentage in seed is affected due to different genotypes and sulphur fertilization (3). The information on these aspects, under North eastern U.P. region is still scanty.

Optimum time of sowing is the most important non monetary input affecting yields of the crop. Time of sowing varies with the variety, agro-climatic condition and crop growing season. Sowing at optimum time gives higher yields due to suitable environment at all the growth stages. Delayed sowing invariably reduces the yield and sowing early in the season may also not be advantages. Therefore, optimum time of sowing plays important role fore getting higher yield (4) reported that delayed sowing of crop greatly suppressed various yield components including number of siliqua per plant and number of seeds per siliqua. The seed yields decreased by the about 46 percent in delayed sowing crop are scanty. The information available for time of sowing of toria in Vindhyachan region. Keeping on the above points in view, the present experiment was carried out to find out the optimum time of sowing, sulphur levels and varieties on growth, productivity and quality of toria.

MATERIALS AND METHODS

The field experiment was carried out during rabi 2008-09 at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute-Deemed University, Allahabad. The soil was sandy loam, low in organic carbon (0.40 %), available nitrogen (182.50 kg/ha), medium in available P (12.66 kg/ha) and K (160 kg/ha).

The experiment was laid out in factorial RBD with three replications. The treatments consisted of two varieties (T-9 and PT-303), three sowing dates (8th September, 15th September and 22nd September) and three levels of sulphur (30, 45, and 60 kg S/ha). A

uniform basal dose of 30 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha were applied to all the plots before sowing and the remaining 30 kg N/ha was top dressed during flowering stage. As per treatment, full dose of sulphur was applied before sowing. Zypsum was used as a source of sulphur. The crop was sown at a spacing of 30 cm as per date of sowing (8th September, 15th September and 22nd September) treatment using the seed rate of 5 kg/ha. Thinning was done at 20 days after sowing to maintain plant to plant distance of 10 cm. The crop received one hand weeding at 30 days after sowing. Toria varieties PT-303 and T-9 were tested. Other recommended packages of practices were fallow to maintain good crop. To study the growth pattern, crop growth rate (CGR), relative growth rate (RGR) were determine during different growth period. For determining yield and yield attributes 5 randomly selected plans were used for recording yield attributes such as plant height, branches per plant, siliquae per plant, number of seeds per siliqua and 1000 seed weight. Seed yield was recorded from the net plot area of the each treatment and expressed in q/ha. Oil content was estimated in one replication by using Soxhlet apparatus through petroleum either extraction method and expressed in percentage. Oil yield was calculated by multiplying the seed yield with oil percentage under different treatments.

RESULTS AND DISCUSSION

Effect of varieties : Among the toria varieties, PT-303 recorded taller plants, number of branches per plant and higher dry matter accumulation which was significantly higher than T-9. This was because of extensive and vigorous root system for affective absorption improvement in cell division, cell elongation and favorable chlorophyll synthesis. The percentage increase in plant height, branches and dry matter in PT-303 over T-9 where 6.37, 20.74 and 15.16 respectively. The yield and yield attributes viz., siliqua per plant, seeds per siliqua, test weight and harvest index were significantly higher in PT-303 as compared to T-9. The variety PT-303 recorded significantly higher seed yield. The percentage increase in siliqua per plant, seed per siliqua and test weight in PT-303 over T-9 where 13.39, 7.49 and 3.94 respectively.

Higher seed yield and stalk yield was obtained in PT-303 which was significantly superior to T-9. The higher seed yield with PT-303 was obtained due to increase in yield attributing character viz., siliqua per plant, seed per siliqua and 1000 seed weight. The percentage increase in seed yield and stalk yield in Pt-303 over T-9 where 14.30 and 11.30, respectively. Highest seed yield was obtained in PT-303 on 22nd September with 60 kg S/ha. There was increase in crop growth rate (CGR) was recorded up to 41-60 DAS and there after CGR was decreased in both the verities. Higher CGR was recorded in variety PT-303 which was significantly higher than T-9 at all the growth stages. At 41-60 DAS, there was 1.56 g/m2/day higher in CGR in PT-303 over T-9. Higher CGR in PT-303 may be due to higher dry matter production. Highest CGR was recorded in PT-303 on 22nd September with 60 kg S/ha. Least CGR values where obtained in T-9 on 8th September with 30 kg S/ha.

Effect of sowing dates : Date of sowing had significant effect on toria plant height, branches/plants, dry weight, siliqua per plant, seeds per siliqua, seed yields and stalk yield. Taller plants were observed in 22nd September sowing as compared to early sowing of toria every week advance sowing before 22nd September resulted into significantly shorter plants as compared to 22nd September. The percent increase in plant height in 22nd September over 15th and 8th September were 11.60 and 10.87, respectively. Number of branches, dry weight, siliqua per plant, seeds per siliqua and test weight were significantly influenced by date by date of sowing. Perusal of data on 22nd September sowing recorded significantly higher yield attributes over 15th and 8th September. The percent increase in dry weight due to 22nd September over 15th and 8th September was 26.83 and 33.91 and seeds per siliqua were 16.40 and 9.80, respectively. In 22nd September sowing the reproductive phase was com- paratively longer which resulted in higher photosynthetic accumulation. The higher temperature prevailing during till 22nd September resulted less vegetative growth, shorter plants, less number of

Table-1: Losses in production of toria due to sowing dates.

Sowing dates	Seed yield			Oil yield		
	Production (kg/ha)	Percent (%)	Decrease (kg/ha/day)	Production (kg/ha)	Percent (%)	Decrease (kg/ha/day)
September 8th	863	54.20	45.40	357	58	14.20
September 15th	1181	12.70	21.40	457	27	15.40
September 22nd	1331	-	-	565	-	-

Table-2: Effect of sowing dates and levels of sulphur on the growth and yield attributing character of two varieties of toria.

Factors	Plant height (cm)	No. of branches /plant	Dry weight (g/plant)	CGR (g/m^2/day)			RGR (g/g/day)			No. of Siliqua /plant	Seeds/ siliqua	Test weight (g)	Seed yield (q/ha)	Stalk yield (q/ha)	Harvest index	SUE
				20-40	41-60	61-80	20-40	41-60	61-80							
Varieties																
T-9	97.11	19.20	30.95	10.92	22.54	14.10	0.1456	0.0188	0.0161	149.41	12.95	3.55	10.19	28.28	26.44	24.30
PT-303	103.30	20.30	35.65	12.05	24.10	18.61	0.1405	0.0191	0.0193	169.41	13.92	3.69	11.65	31.47	26.88	28.06
S. Ed. (±)	0.08	0.10	0.10	0.28	0.37	0.16	0.0065	0.0006	0.0002	5.37	0.486	0.023	0.403	0.65	0.85	0.90
CD (p=0.05)	0.16	0.2	0.20	0.57	0.76	0.33	-	-	0.0003	10.92	0.99	0.05	0.82	1.32	0.17	1.83
Date of sowing																
8th Sep.	89.84	16.93	24.74	9.85	20.05	8.17	0.1523	0.0192	0.0116	129.17	11.94	3.39	8.63	24.59	26.00	21.08
15th Sep.	99.61	20.15	33.13	11.05	23.51	16.38	0.1435	0.0183	0.0183	155.33	13.11	3.60	10.81	29.92	26.53	25.92
22nd Sep.	111.17	23.67	42.02	13.55	26.40	24.51	0.1334	0.0195	0.0230	193.72	15.26	3.86	13.31	35.11	27.44	31.56
S. Ed. (±)	0.09	0.12	0.12	0.35	0.46	0.20	0.0079	0.0007	0.0002	6.58	0.595	0.028	0.493	0.80	1.04	1.08
CD (p=0.05)	0.19	0.24	0.25	0.70	0.93	0.40	-	-	0.0004	13.38	1.21	0.06	1.00	1.63	0.21	2.20
Sulphur																
30 kg/ha	97.47	19.37	32.24	11.12	22.84	15.59	0.1446	0.0189	0.0172	150.33	13.05	3.56	10.41	28.86	26.44	34.70
45 kg/ha	100.82	20.22	33.44	11.44	23.33	16.60	0.1434	0.0189	0.0180	160.33	13.37	3.62	10.88	29.83	26.66	24.54
60 kg/ha	102.33	21.15	34.22	11.88	23.79	16.87	0.1413	0.0192	0.0178	167.56	13.89	3.67	11.47	30.93	26.87	19.29
S. Ed. (±)	0.09	0.12	0.12	0.35	0.46	0.20	0.0079	0.0007	0.0002	6.58	0.595	0.028	0.493	0.80	1.04	1.08
CD (p=0.05)	0.09	0.12	0.12	-	-	0.40	-	-	0.0004	6.58	0.60	0.03	0.49	0.80	0.21	2.20

CGR-Crop growth rate, RGR-Relative growth rate, SUE-Sulphur use efficiency.

branches etc. The optimum temperature prevailed prevailed during 22nd September sown favoured good vegetative growth in terms of height, dry matter, increasing number of branches and longer solar period for subsequent reproductive phase. The harvest index was drastically reduced in 8th and 15th September. This indicates that the conversion of biological yield into economic yield was adversely affected due to prevailing high temperature date of sowing had significantly effect on seed yield irrespective of the varieties and sulphur levels. Maximum seed yield was obtained when the crop was sown on 22nd September and there was significant reduction in yield in 15th September sowing, giving the lowest seed yield with 8th September. The mean reduction in seed yield in 8th and 15th September were 4.68 q/ha and 1.50 q/ha as compared to 22nd September. The reduction in seed yield may be due to shortening of growing period and exposure comparatively high tempera- ture during initial growth which might have resulted in poor yield attributing characters and yield.

Crop growth rate (CGR) and relative growth rate (RGR) was significantly influenced by date of sowing. CGR increased significantly in 22nd September sowing as compared to early sowing. Higher CGR and RGR were observed up to 60 DAS after that decreased in CGR were observed.

Losses in production due to sowing dates : Studies on impact of sowing dates on total production of seed yield and oil yield indicated sowing of toria September 8th reduced production of seed and oil yield by 21 and 15 kg/ha/day till September 15th reduction further increased considerately September 8th recording seed yield and oil yield losses by 45 and 15 kg/ha/day. The loss in production found to be two times higher in seed yield due to earlier sowing of September 15th.

Effect of sulphur fertilization : Sulphur application had a significant effect on all the growth and yield parameters and yield. Increase in 'S' level recorded increased in plant height up to 60 kg S/ha. This was significantly superior to 30 and 45 kg S/ ha. Higher number of branches per plant, dry weight per plant, siliqua per plant, seeds per siliqua and test weight were recorded in 60 kg S/ha, which was significantly higher than 30 and 45 kg S/ha. Sulphur plays a key role in plant metabolism, chlorophyll formation and increase in photosynthesis activity. Increase in sulphur level recorded increase in CGR and RGR at all stages. However, they were significantly at par with each other. They increase in seed yield in toria was

Table-3: Economics and quality parameters of toria varieties as influenced by sowing dates and sulphur levels.

S.No.	Treatment combinations	Description of treatment combination	Oil percent	Oil yield (kg/ha)	Cost of cultivation (Rs./ha)	Grass return (Rs./ha)	Net return (Rs./ha)	B: C ratio
T_1	$V_1D_1S_1$	T-9 + 8 September + 30 kg sulphur /ha	39.97	303.47	14077.50	18,927.00	4,849.50	1.34
T_2	$V_1D_1S_2$	T-9 + 8 September + 45 kg sulphur /ha	41.56	333.73	14265.00	19,991.00	5,726.00	1.40
T_3	$V_1D_1S_3$	T-9 + 8 September + 60 kg sulphur /ha	42.32	361.00	14452.50	21,268.33	6,815.83	1.47
T_4	$V_1D_2S_1$	T-9 + 15 September + 30 kg sulphur /ha	41.06	413.47	14077.50	25,084.67	11,007.67	1.78
T_5	$V_1D_2S_2$	T-9 + 15 September + 45 kg sulphur /ha	42.23	430.75	14265.00	25,411.33	11,146.33	1.78
T_6	$V_1D_2S_3$	T-9 + 15 September + 60 kg sulphur /ha	42.96	443.78	14452.50	25,749.83	11,297.33	1.78
T_7	$V_1D_3S_1$	T-9 + 22 September + 30 kg sulphur /ha	41.32	483.44	14077.50	29,108.17	15,030.67	2.07
T_8	$V_1D_3S_2$	T-9 + 22 September + 45 kg sulphur /ha	42.12	521.02	14265.00	30,714.83	14,449.83	2.15
T_9	$V_1D_3S_3$	T-9 + 22 September + 60 kg sulphur /ha	43.21	554.38	14452.50	31,886.83	17,434.33	2.21
T_{10}	$V_2D_1S_1$	PT-303 + 8 September + 30 kg sulphur /ha	40.24	350.09	14077.50	21,705.50	7,628.00	1.54
T_{11}	$V_2D_1S_2$	PT-303 + 8 September + 45 kg sulphur /ha	41.84	392.04	14265.00	23,360.50	9,095.50	1.64
T_{12}	$V_2D_1S_3$	PT-303 + 8 September + 60 kg sulphur /ha	42.61	407.78	14452.50	23,855.83	9,403.33	1.65
T_{13}	$V_2D_2S_1$	PT-303 +15 September + 30 kg sulphur /ha	41.84	468.35	14077.50	27,765.83	13,688.33	1.97
T_{14}	$V_2D_2S_2$	PT-303 +15 September + 45 kg sulphur /ha	42.42	483.59	14265.50	28,340.17	14,075.17	1.99
T_{15}	$V_2D_2S_3$	PT-303 +15 September + 60 kg sulphur /ha	43.31	506.73	14452.50	29,060.00	14,667.50	2.01
T_{16}	$V_2D_3S_1$	PT-303 + 22 September + 30 kg sulphur /ha	41.72	551.96	14077.50	32,863.67	18,786.17	2.33
T_{17}	$V_2D_3S_2$	PT-303 + 22 September + 45 kg sulphur /ha	42.64	592.70	14265.50	34,506.33	20,241.33	2.42
T_{18}	$V_2D_3S_3$	PT-303 + 22 September + 60 kg sulphur /ha	43.63	690.66	14452.50	39,139.33	24,713.53	2.71

obtained up to 60 kg S/ha. The percentage in increase in seed yield with 60 kg S/ha over 30 and 45 kg S/ha were 5.9 and 10.20 respectively. The rate of increase in seed yield was very low due to further increase of sulphur level beyond 45 kg S/ha. Application of 60 kg S/ha recorded significantly higher stalk yield than 45 and 30 kg S/ha. This was owing to a significant increase in plant height and branches per plant with increasing rate of sulphur application. Improvement in growth and yield contributing characters of plant owing to sulphur application is well known. Sulphur enhances cell multiplication, elongation and expansion, imparts a deep colour to leaves due to better chlorophyll synthesis. It is corroborated with the finding of (5).

Sulphur use efficiency (SUE) was significantly influenced by varieties, date of sowing and sulpher levels. PT-303 recorded higher SUE which was significantly superior to T-9 September 22nd sowing recorded higher SUE over 8th and 15th September. The sulphur use efficiency decreased with increasing rate of sulphur application. The higher seed yield with increasing rate of sulphur application is attributed to higher yield attributes.

The gross return B : C ratio was also higher in variety PT-303 with 60 kg S/ha on 22nd September sown crop which was have than other treatment combinations.

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