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Effect of SO_2 Fumigation on Seedling Growth of *Sesamum indicum* Linn.

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A B S T R A C T

Sesame seeds were found to have positive effects on the germinability in contrast to seedling growth and biomass production. Seeds fumigated with Sulphur dioxide dose I (10 ppm for 1 h), dose II (20 ppm for 1 h) and dose III (50 ppm for 1 h) showed increased level of percentage seed germination and germination index while on the other hand the seedling growth and biomass revealed detrimental effects particularly on radicle growth. The plumule and radicle growth was decreased upto 66 and 68 percent, respectively in contrast to control. Shoot and root dry weight was inhibited upto 48 and 70 percent, respectively. The present study shows that the seed germinability may increase under low doses of SO_2 pollutant but the productivity is greatly affected under pollution stress.

***Key words*:** SO_2 fumigation, Percent seed germination, Germination index, Seedling growth, *Sesamum indicum* Linn.

Sesamum indicum Linn. is a herbaceous annual plant and commonly known as "Sesame" is one of the oldest oil seed crop belonging to the family Pedaliaceae. It is spread throughout tropical and sub-tropical areas in Asia, Africa, and South America. It is widely cultivated for its protein rich seeds and edible oil [1]. Seeds of this plant are also an important source of dietary fibres and micro nutrients such as minerals lignans, tocopherols, and phytosterols. Sesame oil have potent oxidative and anti-inflammatory effects.

Air pollutants are known to alter the composition of various biochemical activities of the plants. More importantly, among the physiological effects, seed germinability is greatly reduced by high doses of SO_2 fumigation [2]. Sulphur dioxide and nitrogen dioxide are probably the most important gases in industrialized countries besides other phototoxic gases present in atmospheric complex mixture of gases [3]. Sulphur dioxide (SO_2) is hazardous gas which is produced by the combustion of fossil fuels as well as during industrial processes as effluent and dispersed directly to the atmosphere which cause air, water and soil pollution [4]. Some amount of SO_2 taken up by plants may be converted to H_2S and returned back to the atmosphere, while some of the SO_2 may leach out of the leaves after conversion to sulphate [5]. Seed germinability is an indication of plant establishment in any environment which opens door for futuristic benefits for the welfare of human as well as animals.

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Generally, all the seeds do not germinate both in lab and open field conditions. Rate of seed germination in lab reflect more or less an imaginary picture of germinability of seed especially for those plant which are usually grown for commercial purposes. Keeping above view in centre, an attempt has been made by the authors to observe the seed germination and seedling growth under SO_2 fumigation in lab conditions. In this context [6] observed impaired seedling growth of alfalfa, bajra, mustard and radish even at very low dose of 0.09 ppm SO_2 fumigation for 3-9 h. Similar, adverse effect were also noted by [7] in case of *Abelmoschus esculentus* var. Pusa Savani, *Cyamopsis tetragonoloba*, *Crotalaria juncea* and *Trigonella foenum–graceum.* Plant SO_2 exposure has negative effect on the physiological, morphological and bio chemical responses of plants [8]. Generally, plant exposure to SO_2 has negative effects on this process due to an initial decline in physiological activities which appear after several days following SO_2 exposure. Since Sulphur is an essential nutrient for plant growth, low level SO_2 exposure has a positive impact on plants.

Sesame crop seeds selected in the present investigation is grown at the start of rainy season i.e., between June to July and harvested at end of the season (August to September). Therefore, recently harvested crop seeds were collected from National Seeds Cooperation, Sikandra, Agra to study the seedling growth and other related parameters such as percentage of seed germination, germination index, plumule and radicle length and their ratio and biomass production.

MATERIALS AND METHODS

Approximately 300 Sesame seeds (*Sesamum indicum* Linn.) were first of all soaked in freshly prepared distilled water for 24 h and spread over layers of sterilized and moistened filter paper in sterilized Petri dishes and were kept in static fumigation chamber and then exposed to the required doses of SO_2 by removing the lid of Petri dishes. Before set up of the experiment seed germinability was tested after exposing seeds at various SO_2 concentrations for different lengths of time and three doses were selected. Dose I (10 ppm for 1 h), dose II (20 ppm for 1 h) and dose III (50 ppm for 1 h) were considered for present investigation because SO_2 concentration in ambient atmosphere is usually lower than 50 ppm. Untreated seeds were considered as control in the present study.

Sulphur dioxide (SO_2) was prepared in the laboratory by heating copper turnings with concentrated sulphuric acid (H_2SO_4). The gas was taken to the experimental plot where it was applied to Petri dishes containing seeds in the morning in triplicate for each treatment. The gas was brought in and applied in chamber by keeping the volumetric flask upside down and opening the lid inside the chamber. Time to time stirring was done inside the chamber for uniform mixing of gas.SO_2gas was applied at three different concentrations i.e., 10 ppm, 20 ppm and 50 ppm for constant time of 1 h by putting Petri dishes in a specialized SO_2 chamber built in the dimension of 1 m × 1 m × 1m length, breadth and width covered with high density polythene strip. Same procedure was repeated prior to seed germination and after the seed germination [9].

Treated seeds were then incubated at 28 ± 1°C for germination and the emergence of radicle was taken as a mark of seed germination and seed establishment. Germinated seeds were counted every 24th h for five consecutive days just after the germinating seeds were observed.

The percentage germination and germination index were calculated by the formulae given by Varshney and Varshney [10] and Carley and Watson [11] respectively:

$$\text{Percent germination} = \frac{\text{No. of seed germinated}}{\text{Total No. of seed taken}} \times 100$$

$$\text{Germination Index} = 4\,(5g + 4g + 3g + 2g + g)$$

(Sequence of observations for five consecutive days)
Where g = no. of germinated seed.

The sum was multiplied by four to correct germination of the seeds to a percentage basis. The seedling growth length in terms of radicle and plumule was measured on the 5th day of the incubation in above germinability tests and after 15 days biomass was noted in term of shoot and root dry weight.

RESULTS AND DISCUSSION

Data depicted in (Table 1) shows that the lowest dose I (10 ppm for 1 h) result in not much difference in the seed germinability. Germination was stimulated on all 5 consecutive days of observation. Same observations were also noted with higher dose II and III (for 1 h). Treatment with dose II inhibited seed germination by 10 to 14 per cent up to 2nd day but there after it started increasing marginally culminating into an increased germination index on 5th day. On the other hand, dose III (50 ppm for 1 h) of SO_2 hampered about 30 per cent germination of seeds on the first day but the seed soon recovered the pollutant stress with the result that their germination started increasing and finally reached to a level of 62 per cent on the 5th day. In this way, the germination index of treated seeds was interestingly enhanced (568 to 920) in all three cases. These results show that the germinated seed absorbed Sulphur for their metabolic activities. In contrast to the above results, the seedling growth and biomass was greatly reduced with respect to all the three SO_2 doses. The radicles were more susceptible to the Sulphur dioxide than plumules. The former was reduced upto the extent 40.90, 54.54 and 68.18 per cent than the plumules by 37.50, 48.21 and 65.71 per cent following treatment by dose I, II and III respectively which clearly indicate that the increasing doses of pollutant, the seedling growth was inhibited as compared to untreated seeds. The radicle and plumule ratio (R/P) also showed adverse effect of pollutant stress. The biomass production under SO_2 doses I and II did not show any remarkable reductions but dose III (50 ppm for 1 h) greatly affected the biomass, it was reduced upto 56.80 as compared to above mentioned doses.

Table 1 Effect of Sulphur dioxide fumigation on seed germination, seedling growth after 5th day and biomass after 15th day respectively

Exposure doses		Total No. of seeds	Germinated seeds	Percent germination	Germination index	Seedling growth			Biomass*		
						Plumule length (cm)	Radicle length (cm)	Ratio (R/P)	Shoot dry wt. (mg)	Root dry wt. (mg)	Total biomass (mg)
I	U	300	131	43.66	524	2.80 (2.30–3.30)	5.50 (4.75–6.25)	1.96	3.75 (2.95–4.55)	2.50 (1.75–3.25)	6.25
	T	300	142	47.33	568	1.75 (1.55–1.95)	3.25 (2.95–3.55)	1.85	4.25 (3.25–5.25)	2.00 (1.65–2.35)	6.25
II	U	300	155	51.66	620	2.80 (2.30–3.30)	5.50 (4.75–6.25)	1.96	3.75 (2.95–4.55)	2.50 (1.75–3.25)	6.25
	T	300	178	59.33	712	1.45 (1.25–1.65)	2.50 (1.95–3.05)	1.72	3.95 (2.90–5.00)	1.50 (1.25–1.75)	5.45
III	U	300	168	56.00	672	2.80 (2.30–3.30)	5.50 (4.75–6.25)	1.96	3.75 (2.95–4.55)	2.50 (1.75–3.25)	6.25
	T	300	230	76.66	920	0.96 (0.88–1.04)	1.75 (1.25–2.25)	1.82	1.95 (1.80–2.10)	0.75 (0.50–1.00)	2.70

Dose I = 10ppm for 1 hour; Dose II = 20ppm for 1 hour and Dose III = 50ppm for 1 hour
U = Untreated seed and T= Treated seed
*Data shown in the table are average of randomly selected 20 seedlings

The per cent change in the plumule and radical lengths as well as biomass production have been shown in (Fig 1).

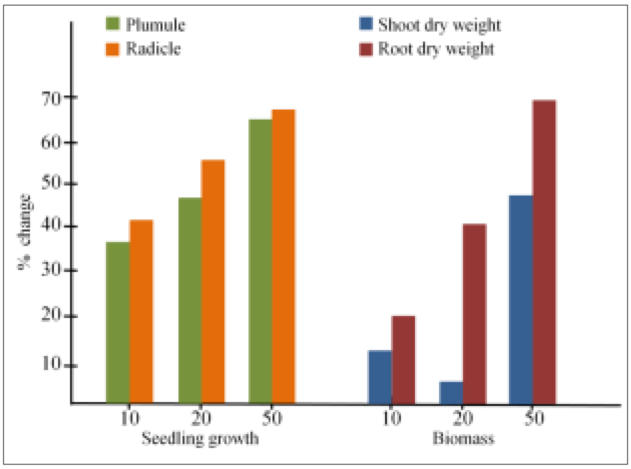

Fig 1 Percent change over control (Untreated) in seedling growth and biomass production of *Sesamum indicum*

At 20 and 50ppm doses of SO_2 fumigation, the plumule and radicle length was inhibited considerably as compared to untreated seeding growth whereas the biomass of the *Sesamum indicum* was greatly inhibited at 20 and 50ppm of SO_2 as compared to dose I, i.e., 10ppm of SO_2. Therefore, it can be concluded that both the parameters studied in the present investigation have no correlation with each other. Several workers have used germinating seeds to monitor the pollution effects in lab as well as in field conditions [12]. The long-term exposure of pollutant along with other environmental factors (abiotic and biotic) is more detrimental than the studies made in laboratory. In nature, a single pollutant does not reveal the actual effect but in combination with other pollutants may give some noticeable conclusions. They may disturb the metabolic activities of germinating seeds [13-14]. The germination index of *Sesamum indicum* seeds appreciably increased in all the three doses possibly due to the increase of high demand of Sulphur in oil seeds increased. The adverse effect on plumule was more than the radicle which indicate that such seedlings are not able to withstand like the normal plants.

CONCLUSION

From the results it could be concluded that seeds fumigated with sulphur dioxide showed increased level of percentage seed germination and germination index. Seed germinability may increase under low doses of SO_2 pollutant but the productivity is greatly affected under pollution stress.

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