RESPONSE OF BLACK GRAM (*PHASEOLUS MUNGO* L.) TO SULPHUR DIOXIDE

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Abstract

A pot experiment was carried out to observe the response of black gram (*Phaseolus mungo* L) to SO_2. The plants were exposed to different concentrations of SO_2 (0.0, 0.05, 0.1 and 0.2 ppm). The symptoms - chlorosis, necrotic spots, marginal burning caused by SO_2 were appeared on the leaves. Plant growth, yield and photosynthetic pigments were suppressed greatly in all the treatments. The suppressions were directly proportional to the exposure levels of SO_2 on the plants.

Key words: Concentration, effect, growth, pigment, response, symptoms, yield.

Introduction

Today air pollution is one of the most serious problems to all living organisms. Among the air pollutants sulphur dioxide ($SO_{2)}$ is the most harmful gas. It causes many visible symptoms in the plant like yellowing, chlorosis and browning of leaf surface (Heck et al., 1986; Kausar, 2007; Mustabeen et al., 2007) and some especific injury to a particular plant (Mustabeen et al., 2008). Gimeno and Deltoro (2000) observed the harmful effect of SO_2 on cell culture and photosynthetic performance in liverwort, *Frullaria dilata.* SO_2 declined the photosynthetic rate and reduced chlorophyll concentration in most of the plant species (Ali, 1998; Iqbal et al., 2000; Mustabeen et al., 2008). This research aimed to study the effect of SO_2 on plant growth, yield and photosynthetic pigment of urd popularly known as black gram (*Phaseolus mungo* L).

Material and methods

Generation of SO_2 Gas and Treatments

Sulphur dioxide gas was generated by SO_2 generator through the reaction of sodium sulphite (Na_2SO_3) and sulphuric acid (10% H_2SO_4) solutions under controlled condition. The amount of Na_2SO_3 was taken according to the different concentrations (i.e. 0.05, 0.1 and 0.2 ppm) needed. The outlet of SO_2 generator was connected to the fumigation chamber by the PVC pipe. The plants were kept in fumigation chamber for exposure. For the experiment three doses, 0.05, 0.1 and 0.2 ppm of SO_2 were prepared for the following treatments:

T_0 = 5 pots with plant only (control)
T_1 = 5 pots with plant + 0.05 ppm SO_2 exposure
T_2 = 5 pots with plant + 0.1 ppm SO_2 exposure
T_3 = 5 pots with plant + 0.2 ppm SO_2 exposure

Plant Culture and Exposure of Plant

Seeds of urd variety 'T-9' were surface sterilized (dipped in 0.01% $HgCl_2$ solution) for 15 minutes followed by three washings with distilled water. Five seeds were sown (15 Jan., 2008) in each autoclaved clay pots. After germination, seedlings were thinned

to maintain single seedling per pot. Each treatment was replicated five times along with a control set. After 10 days plants were exposed to different doses of SO_2 (0.05, 0.1 and 0.2 ppm) separately for 3 hrs twice in a week till 70 days. After each exposure all pots were kept on benches in glass house and arranged in complete randomized block design. The temperature was maintained at 27/23^oC (day/ night). The pots were irrigated on alternate day. The experiments were terminated after 80 days (5 April, 2008) and plants were uprooted carefully. Roots were washed thoroughly using tap water to remove soil particles and debris**.** Plant growth and yield were measured. The photosynthetic pigments (chl a, chl b, total chl a + b and carotenoids) were examined before maturation of crop (Just after exposures finished). Data were analyzed statistically for significance.

Results and discussion

The specific symptoms - yellowing and marginal burning of leaves of urd caused by SO_2 were observed. Singh and Singh (1990) have also observed the visible injuries in the form of chlorosis and necrosis in *Vigna mungo* when fumigated to SO_2, which were proportional to SO_2 concentration.

In general, SO_2 caused significant reductions in plant growth (length, fresh and dry weights of shoot and root, no. of nodules) and yield (number of pods / plant, number of seeds / pod, fresh and dry weights of pods, and weight of 20 seeds) as compared to control (Tables 1 and 2). All concentrations of SO_2 were found harmful to this crop. The reductions caused by 0.2 ppm were greater than 0.1 ppm and 0.05 ppm. The reductions in above parameters were on concentration depended. As concentration was increased, the plant growth and yield were decreased (Tables 1 and 2). Several investigators have also observed that SO_2 has an adverse effect on the plants like cucumber, maize, coriander, tobacco etc. (Dodd and Dolley, 1998; Mejstric, 1980; Mishra, 1980 ; Mustabeen et al., 2008). Sprugel et al. (1980) found significant reduction in yield of soybean due to loss in both seed weight and number of seeds produced by plants when exposed to SO_2. Kuasar et al. (2006) exposed the five wheat varieties to 0.2 ppm of SO_2. The plant growth and yield parameters were suppressed greatly with responses of different concentrations of SO_2. Reduction in growth and yield has also been observed on sunflower by SO_2 (Mustabeen, et al., 2007).

Number of leaves and photosynthetic pigments (chl a, chl b, total chl a+b) and carotenoids were reduced significantly by SO_2 as compared to control in the present study (Table 3). Actually SO_2 penetrates the more delicate inner structure of the leaves and effects photosynthesis of the plant (Carlson, 1983; Heck et al.,1986). SO_2 also induces premature senescence of flowers and fruits and suppression of fruit setting (Linzon, 1978; Thompson et al., 1984; Khan and Khan, 1993).

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Table 1: Effect of different concentrations of sulphur dioxide on plant growth of *Phaseolus mungo* var.'T-9'

Treatment (ppm)	PLANT GROWTH						
	Length (cm)		Fresh wt. (g)		Dry wt. (g)		No of nodules
	Shoot	Root	Shoot	Root	Shoot	Root	
Control	23.5	18.1	6.10	1.89	1.13	0.73	27
0.05	21.8	16.4	5.70	1.14	1.04	0.56	17
0.1	19.6	13.7	4.12	0.89	0.85	0.35	12
0.2	17.2	10.8	2.00	0.46	0.59	0.15	8
P = 0.05	0.96	1.23	1.11	0.22	0.13	0.18	2.4
P = 0.01	1.35	1.72	1.42	0.31	0.18	0.25	3.5

Each value is a mean of five replicates.

Table 2: Effect of different concentrations of sulphur dioxide on yield of *Phaseolus mungo* var. 'T-9'

Treatment (ppm)	YIELD				
	No of pods	Fresh wt. of pods (g)	Dry wt. of pods (g)	No. of seeds / pod	Wt. of 20 seeds (g)
Control	11	3.64	0.99	9	0.86
0.05	9	2.41	0.71	6	0.69
0.1	6	1.65	0.34	5	0.52
0.2	4	0.90	0.18	2	0.31
P = 0.05	1.21	0.49	0.08	1.36	0.07
P = 0.01	1.69	0.63	0.12	1.92	0.10

Each value is a mean of five replicates.

Table 3: Effect of different concentrations of sulphur dioxide on photosynthetic pigments of *Phaseolus mungo* var. 'T-9'

Treatment (ppm)	No of leaves	Photosynthetic Pigment (mg / g Fresh wt)			
		Chl a	Chl b	Total chl (a+b)	Carotenoids
Control	53	0.6603	0.9254	1.5853	0.0525
0.05	42	0.4836	0.8165	1.3002	0.0415
0.1	37	0.3814	0.7193	1.1004	0.0401
0.2	30	0.2739	0.6179	0.8918	0.0353
P = 0.05	3.11	0.0436	0.0499	0.0928	0.0008
P = 0.01	4.36	0.0612	0.0701	0.1302	0.0012

Each value is a mean of five replicates.