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Impact of variable concentrations of SO_2 exposure on growth and morphological characters in *Vigna radiata cv.* BM-2003-02

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Abstract : Sulphur dioxide is a hazardous gas and an important constituent of air pollution. Being an important pollutant it adversely affects the metabolic and physiological process of the plants. Due to these the overall reductions in growth and yield is reported (Black and Unsworth,1979). The present study was undertaken to analyse the effects of sulphur dioxide exposure on morphological and growth attributes of *Vigna radiata*. To analyse the effects of different concentrations (0.1ppm, 0.3ppm, 0.5ppm and 0.7ppm) of sulphur dioxide on *Vigna radiata*, the observations were made regarding morphological and growth parameters. The observations revealed that the plants exposed to variable concentrations of sulphur dioxide exhibited variable results. The plants (*Vigna radiata*) showed a slight decrease in morphological and growth attributes under low doses of SO_2 while a considerable decrease was reported when the plants were exposed to higher doses of sulphur dioxide.

(**Keywords:** Sulphur Dioxide, Morphological Attributes, Growth Attributes, Exposure, Variable Concentrations, *Vigna radiata*)

Introduction

Due to adverse effects on vegetation and animals, the pollution is receiving more attention at National and International forums. Pollution is burning issue at present as compare to past when its extent was low. To fulfill the basic needs of population the exploitation of natural resources is being carried out unplanned. Due to this the air is being polluted day by day. The other causes of environmental pollution are rapid industrialization and unplanned urbanization. Different types of pollutions affect plants and animals in different ways. Out of these, air pollution is major threat to vegetation and animals. The major constituents of air pollution are many gases out of them sulphur dioxide is more destructive. The sources of sulphur dioxide from where it enters in to environment are automobile exhaust (Dwivedi and Tripathi, 2007), combustion of fuels (Ramadan *et al*., 2008) like coal, petroleum etc. besides these sources refining process and smelting of sulphur containing ores (Shang *et al*., 2008) are good sources of sulphur dioxide. SO_2 also enters into environment through volcanic eruption and oceanic activities.

Review of Literature

Sulphur dioxide is an important pollutant and is hazardous in nature resulting in considerable reduction in growth and yield. The SO_2 present in air enters into leaves through stomata and reaches to mesophyll cells (Majernik and Mansfield, 1971). After entering into mesophyll cells it accumulates and causes foliar injuries. These foliar injuries appear in the form of patches. According to Costonis, (1971), Chaphekar *et al.*,(1974) and Reinert and Handerson, (1980), the metabolic changes occur due to accumulation of sulphur dioxide in mesophyll cells resulting in reduction in growth. Similar observations regarding exposure of plants to different SO_2 concentrations were also made by Singh, L.P.(2002) in *Oryza sativa* and observed a significant decrease in growth and yield attributes. The effect of sulphur dioxide exposure on *Zea mays* revealed a significant decrease in biomass and Net Primary Productivity (Chaudhary and Srivastav, 2005), Bhardwaj, M.K. *et al*.,(2009, 2010) made similar findings in *Tegete serecta*. Anil

Bhushan,(2018)reported the restricted growth and yield in different vegetable crops when exposed to sulphur dioxide pollution.

The effect of particulate and sulphur dioxide pollution on growth and yield on *Triticum vulgare* and *Hordeun vulgare* was studied by PoonamYadav *et al.,*(2019) and they reported the reduction in growth and yield.

Materials and Methods

For present study the seeds of *Vigna radiata cv*. BM-2003-02 were procured from certified seed agency IARI Pusa, New Delhi. For sowing of seeds polythene bags of appropriate sizes were prepared. In each polythene bags five to six seeds were sown and after proper establishment of seedlings except one rest of seedlings were uprooted. After that the fumigation of plants was carried out at regular interval with sulphur dioxide. The sulphur dioxide was produced using Rao and Le Blanc, (1966) method. Following Singh and Rao (1986), method the desired concentrations of sulphur dioxide were obtained. For the fumigation of plants with desired concentrations of SO_2 four chambers of $1m^3$each were made with the help of perspex sheet. Plants were fumigated for 5hrs a day upto the age of 45 days. To make the observations five plants from each sets i.e. control, 0.1ppm, 0.3ppm, 0.5ppm and 0.7ppm were taken out and observations were made periodically i.e. after 15 days regarding growth and morphological attributes.

Results and Discussion

The observations made during present work clearly showed that when the plants were exposed to variable concentrations i.e. 0.1, 0.3, 0.5 and 0.7 ppm of sulphur dioxide a significant reduction was observed in growth and morphological parameters. The data collected is given in Table-1, clearly indicates that when plants were exposed to sulphur dioxide a considerable reduction was observed in different parameters of growth, root-shoot length, fresh weight, dry weight, Net Primary Productivity and Phytomass. It was observed that when plants were exposed to higher doses of sulphur dioxide (0.5 and 0.7ppm), the reduction was significant as compared to those plants which were exposed to lower concentrations i.e. 0.1 and 0.3ppm. It was also observed that aged plants show more reduction as compared to young plants.

Similar findings were also observed by other workers regarding parameters taken under consideration during present work. Out of them some important references are quoted here. In 1986, Kumar and Singh, observed the reduction in growth in *Pisum sativum* and *Vigna sinensis*, when both crops were exposed to higher doses of sulphur dioxide. Similarly, Khalil M.S. *et al*., reported a significant reduction in growth of *Oryza sativa*, when these plants were grown under sulphur dioxide stress. The data regarding reduction in growth fresh and dry weight were of significant value. The observations made by us are in conformity with the work done by other workers.

For the proper growth of plants mineral elements are necessary. These elements are categorized as micro and macro nutrients depending on the amount and volume in which they are required by plants. Out of different macro nutrients sulphur is an important mineral element necessary for proper growth of plants but when it becomes in excess then it adversely affects the plant metabolism and results in a reduction in growth and other aspects of plants. In air sulphur is found in the form of oxides which are very hazardous for plants. These oxides are main pollutants of air pollution. When plants are exposed to sulphur dioxide then sulphur dioxide enters into leaves through stomata and accumulate in mesophyll cells. In mesophyll cells sulphur dioxide reacts with water and forms H_2SO_4.The sulphuric acid dissociates into its ionic form and forms H^+ and HSO_3^- ions. The H^+ ions replace the Mg^{++} in chloroplast. Due to this

Table-1
Influence of different concentrations of SO_2 on growth parameters of *vigna radiata* .

Age of Plants	15 Days					30 Days				
SO_2 Conc. (ppm)	0	0.1	0.3	0.5	0.7	0	0.1	0.3	0.5	0.7
Parameters										
Root Length (cm)	13.861 ±0.849	13.823 ±0.930	13.500 ±0.859	13.300 ±0.726	13.040 ±0.384	41.000 ±1.908	40.843 ±2.029	37.961 ±3.109	37.620 ±3.053	37.040 ±3.164
Shoot Length (cm)	24.201 ±2.382	24.105 ±2.705	23.085 ±2.050	22.262 ±2.102	21.761 ±1.892	48.124 ±9.641	46.125 ±7.510	44.702 ±6.001	42.503 ±6.491	42.022 ±4.162
Fresh weight of root (g)	0.687 ±0.033	0.671 ±0.075	0.653 ±0.060	0.647 ±0.048	0.583 ±0.067	2.793 ±0.418	2.601 ±0.512	2.541 ±0.447	2.301 ±0.587	2.180 ±0.462
Fresh weight of shoot (g)	8.531 ±1.653	8.284±1. 651	8.032 ±1.253	7.156 ±1.095	6.873 ±1.163	22.875 ±3.714	22.482 ±3.832	21.663 ±3.752	20.586 ±3.875	19.875 ±3.725
Dry weight of root (g)	0.141 ±0.008	0.129 ±0.012	0.119 ±0.011	0.111 ±0.013	0.098 ±0.014	0.668 ±0.051	0.645 ±0.081	0.616 ±0.103	0.546 ±0.112	0.524 ±0.105
Dry weight of shoot (g)	1.312 ±0.226	1.244 ±0.251	1.225 ±0.172	1.085 ±0.072	1.045 ±0.102	4.653 ±1.125	4.564 ±1.135	4.315 ±1.153	4.176 ±1.085	4.034 ±1.063
Phytomass (g)	1.435 ±0.228	1.365 ±0.186	1.338 ±0.182	1.183 ±0.085	1.136 ±0.115	5.315 ±1.173	5.203 ±1.225	4.925 ±1.205	4.713 ±1.913	4.556 ±1.165
Whole plant fresh weight (g)	9.217 ±1.683	8.951 ±1.725	8.683 ±1.312	7.797 ±1.138	7.453 ±1.227	25.081 ±4.342	24.206 ±4.197	22.886 ±4.457	22.665 ±4.128	22.056 ±4.182
Length of whole plant (cm)	38.065 ±3.229	37.923 ±3.635	36.586 ±2.909	35.565 ±2.824	34.815 ±2.274	89.123 ±9.544	86.962 ±9.539	82.666 ±9.109	80.126 ±9.543	79.065 ±7.324
No of roots	45.806 ±4.609	43.605 ±5.856	42.406 ±3.206	41.605 ±4.396	40.203 ±2.945	110.406 ±6.265	103.602 ±6.465	97.605 ±9.836	95.806 ±6.305	91.005 ±7.906
Number of Leaves /Plants	9.406 ±1.146	9.209 ±0.835	9.165 ±0.836	8.806 ±0.844	8.407 ±0.546	11.206 ±0.446	10.408 ±0.546	10.206 ±0.412	9.809 ±0.839	9.608 ±0.546
Net primary Productivity	0.095 ±0.001	0.090 ±0.001	0.088 ±0.002	0.082 ±0.004	0.075 ±0.004	0.179 ±0.003	0.173 ±0.002	0.166 ±0.003	0.157 ±0.004	0.152 ±0.005

replacement of Mg^{++} by H^+ ions the chloroplast turns into its inactive form phaeophytin.Due to this conversion of chloroplast into phaeophytin photosynthesis stops and growth isretarted (Rao and Le Blanc 1966). Further Wardlaw (1968) attributed the growth reduction due to reduced translocation of photosynthetic products from shoot. The reduction in growth occurs due to entry of sulphur dioxide into mesophyll cells in which sulphur dioxide converts into sulphite and it is responsible for the inhibition of the activity of RuBP and PEP carboxylase enzymes. Both these enzymes have an important role in photosynthesis.Thus the inhibition of these enzymes results in inhibition of photosynthesis which causes reduction in growth.

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