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IMPACT OF SULPHUR DIOXIDE (SO_2) – AS A POLLUTANT ON THE GROWTH OF SUNFLOWER (*Helianthus annuus* L. cv. PAC-36)

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ABSTRACT

Among the various air pollutants, sulphur dioxide (SO_2) is one of the principal contaminants. In the gaseous form it is called as primary pollutant but when it binds moisture from the air and forms aerosols of sulphuric- and sulphurous acid which are deposited as acid rain, it acts as secondary pollutant. Plants after exposure to SO_2 show altered growth patterns. The oil-yielding cultivar cv.PAC-36 of *Helianthus annuus* L.(family Asteraceae) on fumigation with four cumulative doses 2612, 3265, 3918 and 4571µg m^{-3} of SO_2 manifested a decline in the length, fresh weight and dry weight of shoot, root and whole plant respectively. These growth attributes were studied at 30^{th}, 50^{th}, 70^{th} and 90^{th} day of the fumigated cultivar along with a control set. The concentration of pollutant and duration of exposure measure the severity of injury in the fumigated plants. The cultivar studied exhibit acute injuries in advanced stages of growth with higher concentrations and cumulative doses, i.e., the damage caused by 2612 and 3265µg m^{-3} SO_2 were lesser in comparison to 3918 and 4571µg m^{-3} SO_2 and the pollutant produced more appreciable effects on 90d old plants than 70d, 50d and 30d old plants.
Keywords: SO_2, aerosols, *Helianthus*, growth, pollutant

INTRODUCTION

Among the various air pollutants, sulphur dioxide (SO_2) is one of the principal contaminants. Sulphur dioxide cause severe damage to vegetation under natural and control conditions (Verma and Agarwal,1996).Acute and chronic exposure to SO_2 can result in the general disruption of photosynthesis, respiration, as well as, other metabolic and fundamental cellular processes (Ewald and Schlee,1983).Sensitivity of SO_2 varies within and amongst plant species (Yusuf et al.,1985) and also depends upon the plant age, its development and various ecological conditions like solar radiation, temperature, humidity and edaphic factors (Heck and Dunning,1978).In the present study, long term effects of different concentrations of SO_2 were studied on various growth parameters (length, fresh weight and dry weight of shoot, root and whole plant respectively) of the oil-yielding cultivar, cv.PAC-36 of *Helianthus annuus* L.(family Asteraceae).

MATERIAL AND METHODS

Seeds of *Helianthus annuus* cv.PAC-36 were procured from IARI, New Delhi. The seeds were sown in polythene bags filled with sandy loam soil. The plants were treated with 2612, 3265, 3918 and 4571 µg m-3 SO_2 for 2h daily from 11th day to maturity of the crop using 1m3 polythene chambers in which circulation of air was maintained by a small fan to facilitate thorough mixing of air inside the chambers. The SO_2 gas was prepared chemically by reacting sodium sulphite with concentrated sulphuric acid. A control set was also run in identical conditions but without exposure to SO_2.The plant samples were studied at 30th, 50th, 70th and 90th day for various growth parameters (length of shoot, root and whole plant, fresh weight of shoot, root and whole plant, dry weight of shoot, root and whole plant).The individual plants were dug out from the soil carefully having the root and shoot system intact. The plants were washed thoroughly with tap water to detach soil mass adhering to the roots followed by air drying on blotting papers. The length of shoot and root was measured separately and their total was considered as whole plant height. Later, shoot and root was weighed separately for their fresh weight. For dry weight estimation, plant parts were dried in an oven at 80^{o}C for 24h and weighed. Fresh- and dry weight of the whole plant was estimated by mere addition of fresh- and dry weight of shoot and root respectively.

RESULTS AND DISCUSSION

Findings regarding the effect of pollutant revealed that SO_2 affected the studied cultivar adversely. It was noted that higher was the concentration of the pollutant, more prominent were the effects(Table -1).A pronounced reduction in shoot, root and total plant height was observed. However, the root length was found to be decreased more than the shoot length. Plant height in 90d old plants at 4571 µg m^{-3} of SO_2 showed 46.44% reduction(Fig.1).Fresh weight of shoot, root and whole plant showed appreciable decrease with roots showing more losses in comparison to shoot and the reductions were significant at 1% level from the age of 30d onwards at concentration 4571 µg m^{-3} of SO_2 (Fig.2).Dry matter accumulation revealed that dry weights of shoot, root and whole plant showed more appreciable reductions as compared to their fresh weights(Fig.3).However, decrease in dry weight of root was more than that of shoot.78.26% decrease was recorded in root dry weight at 30d old plants at 4571 µg m^{-3} of SO_2.

The present investigation revealed that sulphur dioxide act as a kind of stress to plants and its fumigation caused considerable reduction in different growth attributes. Similar findings were reported by Padhiet.al.(2013). A response in shoot length is a convenient and relatively sensitive parameter of plant growth. However reduction in root length was more than in shoot, which can be explained by the fact that roots come in contact with the pollutant earlier than shoot (Wali, 2000). Phytomass is an additional and better measure of growth in comparison to height because it incorporates all the tissues whereas height measures only the tallest part of the plant. In the present case, reduction was higher in roots in comparison to shoots. Reduction in root biomass of the plant is due to slow translocation of metabolites in the roots as photosynthetic activity is depressed by the pollutant (Saxe, 1983).

It is quite clear from the observations that the magnitude of damage caused by 2612,3265 µg m^{-3} of SO_2 were lesser in comparison to 3918, 4571 µg m^{-3} SO_2.Moreover,the pollutant produced more appreciable effects on 90d old plants than 70,50 and 30d old plants. Such effects of SO_2 with increasing age of the plants have also been reported by Bell (1982) in grasses and Prasad and Rao (1982) in legumes and cereals.

Table 1: Growth response of *Helianthus annuus* L.cv.PAC-36 on exposure to different concentrations of SO_2.

Plant age,d	SO_2 ($\mu g\ m^{-3}$)	Attributes					
		Shoot length (cm)	Root length (cm)	Shoot fresh wt(g)	Root fresh wt(g)	Shoot dry wt(g)	Root dry wt(g)
30	0	59.14	25.32	26.88	3.810	4.778	0.888
	2612	53.36	15.92	23.34	2.898	3.944	0.645
	3265	51.08*	14.44**	20.67*	2.408*	3.092	0.432*
	3918	47.52**	11.40**	18.20**	1.974**	2.545*	0.287**
	4571	41.60**	9.700**	16.14**	1.515**	1.859**	0.193**
	CD5%	6.072	3.010	5.117	1.186	1.854	0.338
	CD1%	8.514	3.254	7.175	1.663	2.600	0.475
50	0	97.40	32.96	41.41	9.185	9.080	2.111
	2612	82.88*	18.74**	33.98*	7.101	8.078	1.824
	3265	77.82**	16.98**	29.21**	6.231*	7.226**	1.519
	3918	75.00**	13.80**	24.10**	4.973**	6.056**	1.240**
	4571	67.74**	10.60**	18.83**	3.095**	4.928**	0.854**
	CD5%	12.66	3.450	6.766	2.902	1.087	0.667
	CD1%	17.74	3.729	9.486	3.137	1.524	0.720
70	0	136.64	47.48	61.15	17.81	13.67	4.430
	2612	115.74*	26.40**	47.09**	12.85*	11.37	3.232
	3265	104.74**	23.92**	41.02**	9.533**	10.45**	2.923*
	3918	97.76**	17.42**	35.15**	7.171**	8.999**	2.103**
	4571	93.38**	14.66**	27.43**	6.146**	7.993**	1.783**
	CD5%	16.60	4.469	7.967	3.567	2.313	1.389
	CD1%	23.28	4.831	8.611	5.002	3.244	1.948
90	0	157.80	65.30	76.90	20.88	17.61	7.042
	2612	130.02*	35.84**	58.29**	14.34**	14.83**	5.517*
	3265	118.76**	31.28**	49.17**	11.15**	12.85**	4.544**
	3918	109.84**	22.36**	42.84**	9.591**	11.50**	3.767**
	4571	101.42**	18.06**	32.80**	7.578**	10.29**	2.411**
	CD5%	20.48	5.862	7.119	2.810	1.933	1.626
	CD1%	28.72	6.336	7.695	3.038	2.090	1.758

CD – Critical difference

*Significant at 5% level.

**Significant at 1% level.

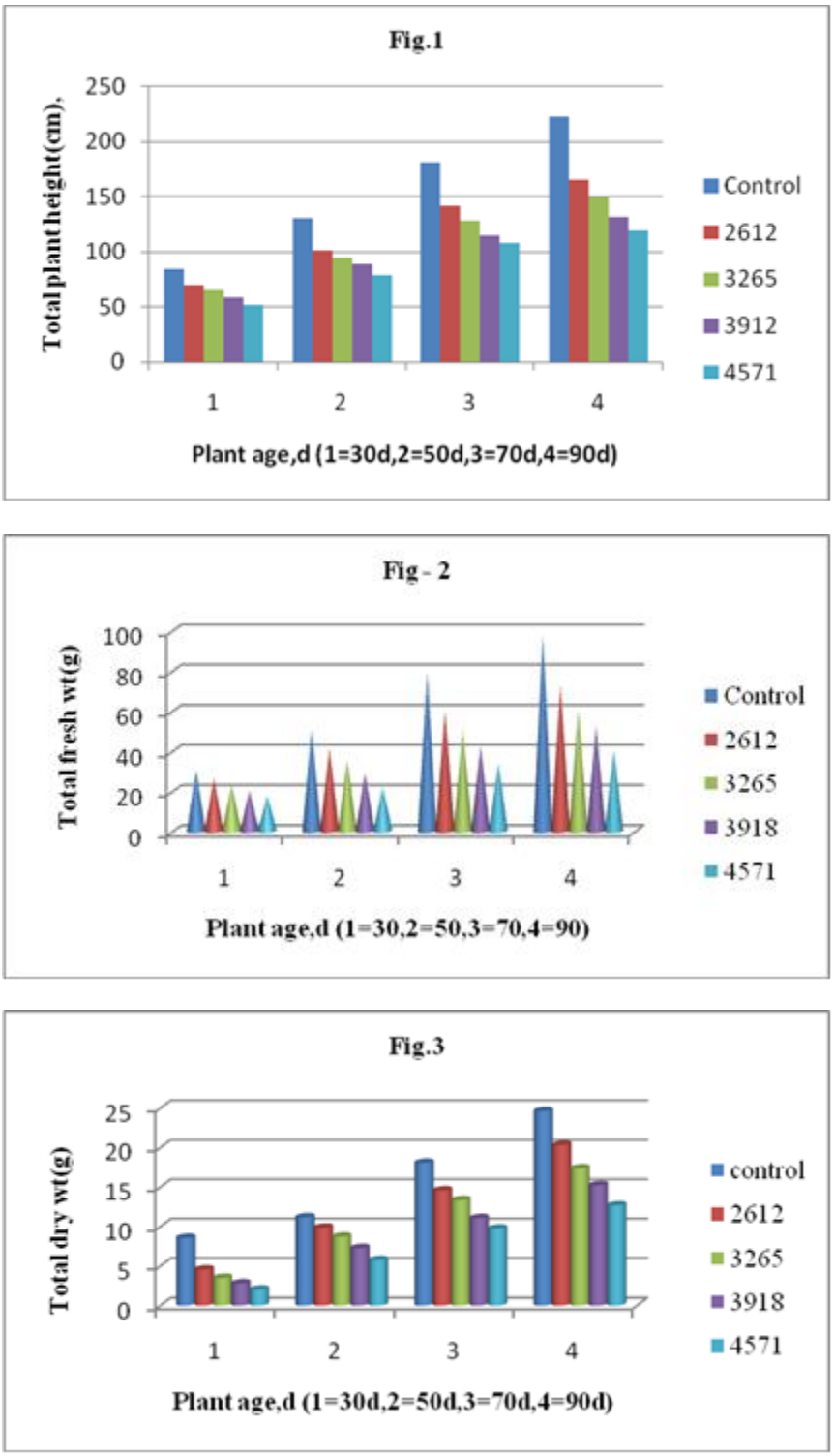

Fig 1, 2 & 3: Effect of four concentrations of sulphur dioxide(2612,3265,3918&4571µg m^{-3}) on total plant height(cm),total fresh wt(g) & total dry wt(g) of *Helianthus annuus* L.cv.PAC-36 in comparison to control.

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