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EFFECT OF PARTICULATE POLLUTION ON *PISUM SATIVUM* L.

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The effect of particulate pollution on morphology and biochemistry of *Pisum sativum* was studied. The results were compared with non-polluted plants. In polluted plants, there is a reduction of 51.89% in height of shoot, 62.05% in phytomass and 64.10% in yield. Chlorophyll content in polluted plants exhibit a reduction of 38.32%. Stomatal index and trichome frequency increases and stomatal frequency decreases in polluted plants.

Keywords : Particulate pollution; Phytomass; Chlorophyll; *Pisum.*

Introduction

The deteriorating quality of the environment is causing worldwide concern and mankind is facing newer and unimaginable kinds of environmental problems. The present work is an attempt to record the response of *Pisum sativum* to cement kiln dust (particulate) pollution.

Materials and Methods

Pisum sativum L. seeds were obtained from Gujarat Agricultural University. Seedlings were raised in University Botanical Garden in two seprate plots. The plants in one plot served as control (non-polluted), whereas those in the other were uniformly dusted with cement kiln dust (polluted). Growth analysis and biochemical estimations were carried out in non-polluted and polluted plants, simultaneously. The Methods followed for various estimations were : Chlorophyll content–Mac Lachlan and Zalik (1963); Protein – Layne (1957); Starch–Mc Creddy *et al.* (1950); Lipid–Folch *et al* (1957) and Bragdon (1951); Amino acid–Moore and Stein (1948); Total sugars–Dubois *et al* (1956); Reducing sugars–Miller (1972); Total phenols–Bray and Thorpe (1954); O.D. phenol–Arnow (1937). Epidermal peels were taken from the leaflets by direct peel method and stained with Delafield's haematoxylin. Stomatal index was calculated as defined by Salisbury (1927, 1932).

Results and Discussion

In polluted plants, there is a reduction of 51.89% in height of shoot; 33.33% in root length; 50% in number of leaflets and 62.05% in phytomass. There is an increase of 41.18% in root/shoot ratio of polluted plants. There is 66.67% and 61.10% of reduction in numbers of flowers and fruits, respectively, in polluted plants (Table 1).

Chlorophyll content exhibited a reduction of 32.16% in polluted plants. In polluted plants, there is a reduction of 45.59% protein, 21.94% starch, 24.05% total sugar, 24.79% reducing sugars, 41.30% lipid, 28.33% amino acids, 37.62% total phenols and 33.51% O.D. phenol contents (Table 2).

Epidermal cells are polygonal with wavy anticlinal walls. A reduction is observed in and stomatal frequencies, while stomatal index and trichome frequency increased in polluted plants. Leaves are amphistomatic with anomocytic stomata as the dominant type on both surfaces in non-polluted and polluted plants. Stoma with single subsidary cell is common in non-polluted and polluted plants. However, in polluted plants its percentage increases alongwith abnormal stomatal types like stoma with single guard cell and contiguous stomata etc. Only eglandular trichomes were observed only on abaxial surface of both non-polluted and polluted plants (Table 3).

Schonbeck (1960) observed that physiological balance in affected plants were altered by dust increasing susceptibility to infection. In the present study, cement kiln dust was found to reduce shoot length. The inhibition in growth might be attributed to the reduced intensity of light energy available for photosynthesis through coating of leaves (Indhirabai *et al.*, 1988, 1989). The root length was reduced in polluted plants along with the reduction in nodulation up to 60%. This might be due to increased pH of soil. The number of branches in polluted plants was found to be decreased due to decrease in shoot length. Appreciable reduction in shoot length and number of branches in polluted plants results in considerable decrease in number of leaflets per plant (Darely, 1966).

The phytomass and net primary productivity values of cement kiln dust polluted plants show decreased values. Darely (1966) and Lerman (1972) noted that the reduction in phytomass is due to interruption in gaseous exchanges on a result of stomatal clogging which leads to reduction in photosynthesis. The root/shoot ratio values in polluted

Table 1. Morphological parameters of non-polluted and polluted plants (average of five replicates)

age of plant (days)		Height of shoot (cm)	Length of root (cm)	Number of leaves	Total phyto-mass (gm)	NPP gm/ plant/ day	Root shoot ratio	Number of flowers	Number of fruits
20	NP	40	9	9	1.860	0.093	0.23	3	—
	P	35	8	7	1.322	0.066	0.23	2	—
40	NP	55	13	21	9.778	0.244	0.24	17	4
	P	42	10	18	5.529	0.138	0.24	10	2
60	NP	112	15	170	19.613	0.327	0.13	30	19
	P	65	10	68	9.578	0.160	0.15	19	8
80	NP	162	18	250	53.530	0.670	0.11	85	40
	P	80	14	120	20 358	0.254	0 18	40	15
100	NP	185	19	180	40.157	0 402	0.10	12	78
	P	89	15	90	15 240	0 152	0 17	4	28

Table 2 :Biochemical parameters of non-polluted and polluted plants (average of five replicates)

Age of plant (days)		Total chloro- phyll content	Protein content mg/gm	Starch content mg/gm	Total sugar mg/gm	Reduc- ing sugar mg/gm	Lipid content mg/gm	Amino acid content mg/gm	Total phenol content mg/gm	O.D. phenol content mg/gm
20	NP	0.977	0.115	0.961	5.431	1.142	0.646	0.715	0.786	0 293
	P	0.782	0.098	0.890	4.686	0.896	0.518	0.621	0.642	0.221
40	NP	1.949	0.152	1.544	11.140	3.514	1.032	1.038	0.981	0.410
	P	1.434	0.115	1.350	9.117	2.257	0.729	0.786	0.765	0.295
60	NP	2.828	0.188	2.575	16.493	7.148	1.536	2.348	1.238	0.550
	P	1.896	0.126	1.909	12.280	3.999	1.022	1.526	0.927	0 377
80	NP	3.265	0.242	3.728	18.232	8.412	2.121	4.251	1.627	0.743
	P	2.014	0.151	2.595	13.307	5.754	1.324	2.178	1.015	0.494
100	NP	1.281	0.193	1.121	15.341	7.368	2.421	7.171	1.815	0.908
	P	0.869	0.105	0.875	11.652	5.541	1.421	5.064	1·521	0.661

NPP=Net primary productivity; NP = Non-polluted; P = Polluted.

Table 3 : Empidermal features of non-polluted and polluted plants (average of five replicates)

		Epidermal cell frequency	STOMATA								TRICHOME	
			Stomatal index	Stomatal frequency	Stomatal types						Trichome frequency	Eglandular trichomes
					Paracytic	Anisocytic	Anomocytic	Diacytic	Stoma with single S.C.	Abnormal		
Ad	NP	726	18.6	166	6.0	—	73.0	3.0	18.0	—	—	—
	P	396	23.4	121	5.0	—	66.0	2.0	22.2	4.8	—	—
Ab	NP	730	15.8	137	5.6	4.0	67.0	4.3	19.1	—	28	100
	P	488	18.4	110	7.3	3.0	61.4	2.3	24.8	1.2	33	100

Ad = Adaxial; Ab = Abaxial; NP = Non-polluted; P = Polluted.

plants were always higher than non-polluted plants (Singh and Rao, 1981). Number of flowers and number of fruits per plant exhibited a reduction in polluted plants. The cement kiln dust polluted microenvironment provides unfavourable ecological conditions for pollen germination and fertilization (Czaja, 1962). Borka (1980) stated that the damaging effects of cement kiln dust were not only a reduction in vegetative parts, but also a reduction in the formation of reproductive organs and consequently in fertilization.

One of the most characteristic biochemical features of cement kiln dust polluted plants is a reduction in the total chlorophyll content, as reported by a number of workers (Czaja, 1962; Darely, 1966; Borka, 1986). The reduction in chlorophyll content is due to the influence of pollution (Gilbert, 1978). The absorption of soluble portion of cement kiln dust into leaf tissue and damage to the chloroplasts leads to a reduction in total chlorophyll content (Singh, 1980).

Present observation on the reduction in protein content in polluted plants is parallel to the results of many workers (Pawer *et al.*, 1982; Mandre and Kangur, 1986). It thus appears that the total protein content is also a suitable indicator of particulate pollution level.

Ting and Mukerji (1971) reported a reduction in total sugar content in polluted plants which may be due to reduced photosynthetic rate. Lipid content decreases in polluted plants (Grunwald, 1981). The direct relation between the phenolic content and age of plant indicates that this parameter could serve as an index of increasing pollution load.

Increase in stomatal frequency in polluted plants is reported by Chakraborty and Gupta (1981) and Jafri *et al.* (1979). Sharma and Butler (1973) suggested that the high density of trichomes in polluted plants may be a protection mechanism to prevent direct exposure of leaf parts to sun rays, thus lowering the leaf temparature and reducing the rate of some metabolic reactions.

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References

Arnow L E 1937, *J. Biol. Chem.* **118** 531

Borka G 1980, *Environ. Pollut.* **22** 75

Borka G 1986, *Acta. Agr Hung.* **30** 289

Bragdon J H 1951, *J. Biol. Caem.* **190** 513

Bray H G and Thorpe W V 1954, *Meth. Bio-Chem. Anal.* **1** 27

Chakraborty T and Gupta D 198 , *Indian Acad. Sci. (Pl. Sci.)* **90** 305

Gzaja A T 1962, *Staub.* **22** 228

Darely E F 1966, *J. Air Pollu', Contr. Ass,* **16** 145

Dubois M, Gilles K A, Hamilton J K. Roberts P A and Smith F 1956, *Analyt. Chem.* **28** 350

Folch J, Less M and Stanley G H S 1957, *J. Biol. Chem.* **226** 497

Gilbert O L 1978, *New Phytol.* **67** 15

Grunwald C 1981, *Pl. Pysiol.* **68** 867

Indhirabai K, Dhanalakshmi S and Lakshmanan K K 1988, *APSI* **1** 91

Indhirabai K, Dhanalakshmi S and Lakshmanan K K 1989, *Geolbos* **16** 189

Jafri S, Srivastava K and Ahmad K J 1979. *Ind. J. Air Pollut Control* **2** 74

Layne E 1957 *Methods in Enzymology* Academic press, New York

Lerman S L 1972, Ph. D. Dissertation, University of California

Mac Lachlan S and Zalik S. 1963, *Can. J. Bot.* **41** 1053

Mandre M and Kangur A 1986, *Proc. of the Acad. of Sci. of the Estonian SSR* 35 1222

Mc Creddy R M, Guggloz J Silviera V and Owens H S 1950, *Anal. Chem,* **22** 1156

Miller G L 1972, *Anal. Chem.* **31** 426

Moore S and Stein W H 1948 *J. Biol.* Chem. **176** 367

Pawar K, Trivedi L and Dubey P S 1982, *Int. J. Environ, Studies* **19** 221

Salisbury E J 1927, *Phil. Trans. R. Soc.* B. **26** 1

Salisbury E J 1932, *Beih. Bot. Zentralb.* **49** 408

Schonoback H 1960, *Nordsk. Westfol. Bochum* 89

Sharma G K and Butler. J. 1973, *Environ. Pollut.* **5** 287

Singh S N 1980, *J. Exp. Bot.* **31** 1701

Singh S N and Rao D N 1981, *Ind. J. Environ. Hlth.* **20** 258

Ting J P and Mukerji S K 1971, *Am. J. Bot.* **58** 497.