International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; SP4: 99-101

Nidhi Kumari
Plant Pathology laboratory
University department of
BotanyBRA Bihar University
Muzaffarpur, Bihar, India

(Special Issue -4)
International Conference on Food Security and Sustainable Agriculture
(Thailand on 21-24 December, 2018)

Physiological changes and biochemical aspects due to impact of air pollutants on mustard plants

Nidhi Kumari

Abstract
Pollutants due to rapid industrialization eg - refining of petroleum product exerts stress on growth & development of mustard plant. Biochemical indicator of stressful environment were noted in mustard plant. Major pollutants liberated as a result of refining of petroleum products at Baruni Oil Refinery are SO_2, NO_2, suspended particulate matter (S.P.M) & other harmful substances. SO_2 & NO_2 together have synergistic effect causing more injury to plants. Pollutants impair normal metabolism of plants causing physiological and Bio-chemical changes in mustard plants. Pollutants in impair normal metabolism of plant causing physiological and bio-chemical changes in mustard plant. Chlorophyll is the major component in photosynthetic metabolism of plants. Increase level of SO_2 oxidizes chlorophyll pigments in presence of peroxidase enzyme, thereby reduction in the level of chlorophyll of leaves hindering the photosynthetic metabolism. Peroxidase is involved in cellular growth of plant. Increase in peroxidise activity is an indicator of stress environment created by pollutants. Catalase enzyme level is decreased at polluted site which further leads to accumulation of H_2O_2, which in term oxidizes chlorophyll pigment thereby reduction in chlorophyll level. If the level of pollutants crosses the threshold value of plant resistance then it will be finally cause injury to plants leading productivity loss.

Keywords: Pollutants, Catalase, Peroxidase, chlorophyll

Introduction
Air pollutants may act as a ecological factors. Pollutants may cause plant injury and may pre-dispose plants to infection by certain pathogens. Major pollutants include So_2 depends upon its oxidation and hydration products. $So_2$is first oxidised to sulphite and than to sulphate. At higher concentration, this system fails to cope with oxidation process which results into foliar and metabolic injuries when No_2 enters into the plants, it is thought to react with water to form nitrous and nitric acids and then nitrites and nitrates ions. Damage is caused by accumulation of nitrates amounting to more than the cells can tolerate. Chlorophyll is a major component in photosynthetic metabolism of the plants loss in chlorophyll content due to injury was greater at polluted sites. Decrease in pigments has been ascribed either inhibition of chlorophyll synthesis to destruction of chlorophyll, increased chlorophyllase activity formation of O_2, OH and H_2O_2 which react with thylakoid component of chloroplast membrane causing photoxidation of chlorophyll or conversion of chlorophyll to phaeophytin. Chlorophyll 'b' is more sensitive than chlorophyll 'a'. Differential sensitivity of chl 'a' and 'b' is due to acidification of the cell content due to SO_2 fumigation.
The concentration of reducing sugars and amino acids were appreciably enhanced in injured leaves. The increase in reducing sugars was found to be associated with depletion of starch or breakdown of polysaccharides into simple reducing sugars. Increase in amino acids contents after pollutants exposure were attributed to enhanced hydrolysis of pectin. Amount in phenols due to pollutant stress was much lesser from the leaves of mustard plant at polluted site at reference site (non-polluted site). Pollutants induce increase in peroxidase activity. Which may eventually lead to detoxification of the phenols causing reductions in its level in leaves.

Correspondence
Nidhi Kumari
Plant Pathology laboratory
University department of
Botany BRA Bihar University
Muzaffarpur, Bihar, India

Sulphate level was higher in mustard plant growing at polluted site than reference site SO_2 taken up by plants may be converted to H_2S and returned to atmosphere and some may be leached out of the leaves after it is converted to sulphate causing foliage injury. Peroxidase an enzyme involved with cellular growth and development. Peroxidase activity was high at polluted site than at reference site. Increase in peroxidase activity is an indicator of stress condition with in the plants such as exposure to gaseous air pollutants.

This increase might also be a method by which sulphite is oxidised to a less toxic sulphate in the plants.

Catalase, an iron containing enzyme is highly sensitive to even very low level of SO_2. Catalase activity was declined at polluted site. Nandi *et al*. (1984) [13] and Agarwal *et al*. (1987) [2] have also shown that SO_2 decreased the level of catalase enzyme in leaves leading to H_2O_2accumulation in chloroplast which inturn oxidises chlorophyll pigment in presence of peroxidase enzyme and thereby reduced the level of chlorophyll in plant leaves.

Materials & Method

Mustard plant were studied near Barauni Oil refinery and physiological and biochemical aspects due to impact of air pollutants were noticed over month November to January Four polluted sites namely Saboura, Deona, Mahna, Gomanpur and one polluted sites and one reference site (Simaria) were selected for field observations. The chlorophyll contents of leaves were determined with the help of the method proposed by MacLauchlan and Zalik (1963) [3] phenol content was determined by using the method of Farkas and Kiraly (1962) [5]. The method of Kokkinakis and Brooks (1979) [8] was utilized to determine the peroxidase activity. Catalase activity was estimated according to the method of Mccune *et al*. (1964) [12]. All the experimental result obtained were tabulated and laboratory finding were done at plant pathology laboratory University Department of Botany, B.R.A.B.U., Muzaffarpur.

Results and Discussion

Plant responses to air pollutants have been the subject of increasing concern during the past two decades. Recently plant scientist have become more acutely aware of the potential serious changes occurring in plants subjected to mixture of air pollutants in experimental exposure and ambient air environment (Mansfield, 1976, Guderian, 1977) [9, 5].

The amount of chlorophyll degradation is related to the sensitivity of plants towards pollution (Boralkar and Chapheka, Rao and Dubey. Pollutants interfere with physiological and biochemical processes and productivity losses (Heagle *et al.*, 1974) [7] It is well known thatlowering of PH will cause the loss of mg^{++} from chlorophyll to form phaeophytin and thus degradation of chlorophyll can be explained on this basis (Arndt, 1971) [4]. Nandi *et al.* (1980) [14] have shown that SO_2 decreases the level of catalase enzyme and thereby reduce the level of chlorophyll in plant leaves Table – (i) and Table – (ii) shows respectively peroxidase and catalase activity in mustard leaves at different study sites. Average concentration of sugar (Reducing) and amino acids in healthy and injured leaves at study sites is shown in table – (iii).

From the above observation it seems that air pollutants liberated as a result of refining of petroleum causes stress on the mustard plant resulting in physiological and biochemical disturbances in plant which caused injury to plants resulting in growth retardation and production losses.

Table I: Peroxidase activity (? OD/gm fresh weight/minute) in mustard leaves at different study sites during the years 2012-13 & 2013-14 Study Sites

Months	Years Simaria	Saboura	% increase over Saboura	Deona	% increase over Saboura	Mahna	% increase over Saboura	Gomanpur	% increase over Saboura
November	20120.112	0.225	100.892	0.244	117.857	0.226	101.785	0.128	14.285
	20130.091	0.015	-83.516	0.042	-53.846	0.023	-74.725	0.099	8.791
Average	0.101	0.120	18.811	0.143	41.584	0.124	22.772	0.113	11.881
December	20120.195	0.245	25.641	0.393	101.538	0.309	58.461	0.294	50.769
	20130.182	0.151	-17.032	0.198	8.791	0.205	13.186	0.162	-10.989
Average	0.188	0.198	5.319	0.295	56.914	0.257	36.702	0.228	21.276
January	20130.163	0.187	14.723	0.169	3.680	0.175	7.361	0.187	14.723
	20140.129	0.126	-2.325	0.137	6.201	0.164	27.131	0.151	17.054
Average	0.146	0.156	6.849	0.153	4.794	0.169	15.753	0.169	15.753
Seasonal Average	0.145	0.158	8.965	0.197	35.862	0.183	26.206	0.170	17.241

Table II: Catalase activity (? OD/gm fresh weight/minute) in mustard at monthly interval during the years 2012-13 & 2013-14 Study Sites

Months	Years Simaria	Saboura	% increase over Saboura	Deona	% increase over Saboura	Mahna	% increase over Saboura	Gomanpur	% increase over Saboura
November	20120.141	0.139	1.418	0.058	58.865	0.113	19.858	0.083	41.134
	20130.158	0.126	20.253	0.112	29.113	0.123	22.151	0.106	32.911
Average	0.149	0.132	11.409	0.085	42.953	0.118	20.805	0.094	36.912
December	20120.144	0.111	22.916	0.116	19.444	0.130	9.722	0.104	27.777
	20130.138	0.121	12.318	0.096	30.434	0.101	26.811	0.088	36.231
Average	0.141	0.116	17.730	0.107	24.113	0.115	18.439	0.096	31.914
January	20130.148	0.127	14.189	0.137	7.432	0.139	6.081	0.116	21.621
	20140.161	0.139	13.664	0.130	19.254	0.116	27.950	0.128	20.496
Average	0.154	0.133	13.636	0.133	13.636	0.127	17.532	0.122	20.779
Seasonal Average	0.148	0.127	14.189	0.108	27.027	0.120	18.918	0.104	29.729

Table III: Average concentration of sugars and amino acids in healthy and injured leaves (mg/100 mg dry weight) at Study Sites

Months	Years	Study Sites				
		Simaria	Saboura	Deona	Mahna	Gomanpur
Reducing	H	6.000	6.500	4.000	4.800	5.200
Sugars	I	7.400	8.400	6.400	8.400	7.600
	% increase	23.330	29.330	60.000	75.000	46.150
Non-reducing H						
Sugars	I	2.400	3.400	2.400	4.700	4.960
	% decrease	-54.160	--97.050	-70.830	-51.060	-49.160
	H	0.016	0.016	0.006	0.020	0.022
Amino	I	0.017	0.018	0.011	0.033	0.045
acids	% increase	6.250	12.500	83.330	65.000	104.540

H = Healthy
I = Injured

References

1. Agarwal M, Nandi PK, Rao DN. Synergistic action of O_3 and SO_2 pollutants on Panicum miliaceum, Proc. Symp. Air Pollut. Contr. 1983; 1:190-196.
2. Agarwal SB, Agarwal M, Nandi PK, Rao DN. Effect of Sulphur dioxide and ekalux (EC 25) singly and in combination on the photosynthetic pigments of Oryza sativa plants. J Environ. Biol. 1987; 8(4):315-321.
3. Agarwal M, Singh B, Rajput M, Marshall M, Bell F. JNB Effect of air pollution on Periurban agricultural, a case study environmental pollution. 2003; 126:323-329.
4. Arndt U. Konzentration on derungenbel Slattfarbstoffen unterdem sinfluss van Luftverunreinigungen. Sin Diskussionsbeltrag zur Pigmentanalyses. Environ. Pollut, 1971.
5. Farkas GL, Kiraly Z. Role of phenolic Compounds in the physiology of plant disease and disease resistant, 1962.
6. Guderian R. Air Pollution: Phytotoxicity of acidic gases and its signification in air pollution control. Springer, Berlin, 1977.
7. Heagle AS, Body DE, Neely GE. Injury and Yield responses of soybeans to chronic doses of ozone and sulphur dioxide in the field. Phytopathology. 1974; 64:132-136
8. Kokkinakis DM, Brooke L. Tomato Peroxidases purification characterization and catalytic properties. Plant physioly, Lancastic 1979; 63:93-99
9. Mansfield TA. "Effect of air pollution on plants". Cambridge University Press, Cambridge, 1976.
10. Mansfield TA, Whitmore ME, Law RM. Effect of nitrogen oxides on plants. Two case studies. In "Air pollution by nitrogen oxides". Ed. By T. Schneider and L. Grant, 1982, 511-520.
11. McLachlan S, Zalik S. Plastid structures, chlorophyll concentration and free amino acid composition of a chlorophyll mutant of barley. Can. J Bot. 1963; 41:1053-1062.
12. Mccune DC, Weinstein LH, Jcobson JS, Hitchcock AE. Some effects of atmospheric Fluoride on plant metabolism. J Air Pollut. Contr. Contr. Ass. 1964; 14:465-468
13. Nandi PK, Agrawal M, Rao DN. SO_2 induced Enzymatic changes and ascorbic acid oxidation in oryza, 1984.
14. Nandi Pk, Singh N, Rao DN. Effects of Ozone, Sulphurdioxide and their mixture on germination. Indian J Air Pollut. Contr. 1980; 3(2):50-55
15. Sativa. Water Air Pollut., 21:25-32.