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Foliage injury of mustard plants due to pollutants growing in viscinity of Barauni oil refinery

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Abstract
Refining of petroleum at Barauni oil refinery emits heavy load of SO_2, NO_2 and other harmful elements in the surrounding atmosphere. SO_2, NO_2 and SPM causes injury observed in the leaves of mustard plants growing around the polluted atmosphere near to oil refinery. The pollutant causes hazardous effects on vegetation, mankind, and construction material. From the study, it was observed that atmospheric pollution created around oil refinery is deteriorating the natural environment and is unsafe for human, vegetation and eco system. Injurious effects of pollutants were seen on the leaves of mustard plant as chlorotic spots, discolouration of leaves and loss of chlorophyll pigment causing deterioration in the overall growth parameter of mustard plant hindering yield also.

Keywords: Injury, chlorotic, phytotoxic, mottal, foliage

Introduction

SO_2, NO_2 and other harmful materials ejected as a result of refining of petroleum products creates a stressful environment condition for the mustard plants growing in the neighbour hood of Barauni oil refinery. SO_2 and NO_2 are the major pollutants. Exposures to high SO_2 concentration for short duration result in acute injury and that to low SO_2 concentration for long duration result in chronic injury. The acute injury is characterized by the disappearance of chlorophyll and break down of cells (Heck and Brandt, 1977) [3]. Visible plants symptoms are most commonly used to indicate the response of plants to pollutants (Van Haut and Stratmann, 1970) [7].

Interveinal chlorosis is the most common symptoms due to SO_2 injury. Pigmentation of affected tissue is severely impaired (Darley and Middleton, 1966) [2]. Tolerance of plant to SO_2 pollutants may be connected with chlorophyll synthesis and degradation (Bell and Mudd, 1976) [1], for the first visible symptoms is the disappearance of chlorophyll. Nitrogen oxides, of themselves are not phytotoxic, however in combination with sulphurdioxide, it manifests synergistic effect, (Tingey *et al.*, 1971) [6]. As the gas reaches the wax surface of parenchyma, it forms nitrous and nitric acids which injured other tissue. Depending upon the concentration and duration of exposure, plant responses to SO_2 are classified into three categories- acute injury, chronic injury and physiological and bio chemical injury. Acute injury is caused by rapid absorption of SO_2 in toxic over 1 PPM for short duration while chronic injury result from prolonged exposure of plant to sub lethal concentration of less than 0.2 ppm of SO_2 for several weeks. The leaf area injury and chlorophyll loss increased at increasing SO_2 concentration. The pre dominant symptoms of foliage injury in polluted area were mottal and chlorotic spots. Necrotic tips were rarely noted. Colour and injury patterns were characteristic of acute SO_2 injury. NO_2 applied on its own had very little effect on growth, but in combination with SO_2 it caused highly significant reduction in all growth parameters. Nandi *et al.* (1980) [5] have shown that SO_2 decreases the level of catalase enzyme in the leaves turn oxidizes chlorophyll pigment in presence of peroxidase enzyme and thereby reduce the level of chlorophyll in leaves.

Material and Methods

The Samples of SO_2, NO_2 were collected around Barauni oil refinery with help of High volume air sampler. The concentration of SO_2 in ambient air was determined by method of West and Gacke (1956) and for NO_2 method of Jacobs and Hochhesier (1958) was employed. Randomly selected 20 plants at each study sites (Four polluted sites and one non polluted reference sites) were uprooted at monthly interval. Foliage injury patterns were observed and noted. The chlorophyll content of leaves was determined with the help of method proposed by Maclachlan and Zalic, (1963). 2 gram fresh leaves from each sample were finally ground separately in 80 percent acetone till it become colourless. The mixture was strained through muslin cloth. The filtrates were then centrifuged at 3000 RPM for 15 minutes. The optical density (O.D) of this extract was measured at 645 and 663 nm wavelength in a photoelectric calorimeter. The amount of chlorophyll was calculated with the help of following equation.

$$\text{Chlorophyll 'a'} = [(12.7\,(\frac{OD}{663}) - 2.69\,(\frac{OD}{645})] \times \frac{V}{wx100}$$

$$\text{Chlorophyll 'b'} = [(22.9\,(\frac{OD}{645}) - 4.68\,(\frac{OD}{663})] \times \frac{V}{wx100}$$

Where -
V = Volume of chlorophyll extract
W= weight of leaves (grams)

Results and Discussion

Foliage injury symptoms were observed at study sites due to pollutant. The deeply incised leaves of mustard plants are dark green in colours. They turn uniformly pale at the time of senescence. A requested pattern of foliage injury seen on mustard plants have been serialized here in-

a. The first Injury symptom appeared on fairly mature leaves in the beginning of the season itself in the form of whitish- grey patches at tips and margin on the upper surface. The parches gradually turned ivory-tan in colour

b. As the patches advanced and embraced great areas they become darker in colour. In the meantime the tissue earlier affected by injury become necrosed leading to withering. The injury patches advanced first along veins but later embraced even interveinal areas.

c. The intensity of injury was greater on moderately matured leaves than on young & old leaves. The young leaves when affected remain chlorotic for quite some time while old leaves under injury stress become reddish brown or bronze accompanied by withering.

d. The injury symptoms were initiated first on the upper surfaces of leaves but later on the lower surfaces are also affected, although the intensity of injury were prominent on upper then on lower surface. Percentage of leaves showing pollution injury at different study sites is shown in table (1) Chlorophyll is a major component in photosynthetic metabolism of plants. Throughout the season, loss in chlorophyll content due to injury was greater at polluted sites than at reference site. This clearly indicates that the photosynthetic activity and consequently the whole physiological and biochemical systems were greatly impaired by the pollutants. Decrease in pigment may be either due to inhibition of chlorophyll synthesis, to destruction of chlorophyll, increased chlorphyllase activity (Malhotra, 1977) [4], formation of O_2, OH and H_2O_2 which react with thyllakoid component of chloroplast membrane causing photo oxidation of chlorophyll or conversion of chlorophyll to phaeophytin. Chlorophyll 'b' is more sensitive than chlorophyll 'a' due to increase chlorphyllase activity (Malhotra, 1977) [4]. It is thus confirmed that environmental stress around Barauni oil refinery due to pollutants has the potential of causing significant injury to the leaves there by reduction in growth & yield.

Table I: Percentage of leaves showing population injury at different study sites during the year (2012-13 & 2013-14)

Months	**years**	**Study sites**				
		Simaria	**Saboura**	**Deona**	**Mahna**	**Gomanpur**
November	2012	3.580	7.260	8.890	14.750	21.440
	2013	4.760	12.600	16.570	26.490	14.420
Average		4.170	9.930	12.730	20.620	17.930
December	2012	7.520	23.330	32.200	23.030	41.640
	2013	9.720	31.350	40.580	54.430	21.800
Average		8.620	27.340	36.390	38.730	34.210
***change over Nov-Value**		4.450	17.410	24.060	18.110	16.290
January	2013	8.580	26.750	43.550	46.180	56.330
	2014	19.960	63.330	39.950	34.120	29.310
Average		14.270	45.040	41.750	40.150	42.820
Seasonal average		9.020	27.436	30.290	33.166	31.656
Average of Change		4.757	15.013	15.717	13.830	14.273
	S.D	0.642	3.596	5.978	8.521	4.067
	S.E	0.371	2.076	3.452	4.920	2.348
Correlation with pollutant (Single and in combination)						
SO_2		-0.449	0.396	0.277	0.197	0.545
NO_2		0.002	1.000	0.314	0.998	0.424
$SO_2 + NO_2$		1.000	1.000	1.000	1.000	1.000

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