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Effects of pollution of growth of mustard plant

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Abstract
The Study aimed to appraise the effect of different air pollutants viz SO_2, NO_2, SPM on growth of mustard plants growing at polluted sites near to Oil Refinery & at reference site (far from polluted site). Air pollution has become a serious environmental stress to mustard plants due to increasing industrialization. Pollutant impair photosynthetic activity, suppress growth parameters, foliage injury & finally growth reduction of plants measured as height of plants, Leaf area, dry shoot & root weight. Comparative study of the above growth parameter were investigated at polluted & reference site near Barauni Oil Refinery. The polluted site atmosphere contains high amount of SO2, NO2 & SPM in comparison to reference site which finally crossed the threshold resistance of mustard plant exerting injurious effect on plant.

Keywords: Pollutants, Shoot length, dry weight, tillers

Introduction
Unrelenting pollution of the atmosphere is eminent in India due to rapid industrialization and intensive urbanization. It is one of the most serious problem confronting mankind. We can no longer expect clean air to be the normal environment for plants and animal growth. Transportation, industry, Power generation, space heating, surface burning etc. emit wide array of toxic substances including gases, particulars and radioactive materials in the atmosphere which ultimately affect our food supply, health, plant, human life and economy, (Hesketh, 1973) [3] Refining of petroleum products is one of the important sources of atmospheric pollution. The major pollutants liberated by refinery of petroleum at Barauni Oil refinery are SO_2, NO_2 & Suspended particle matter.
The various effects of SO_2 and NO_2 on crop plants (Mustard Plant) are now well established (Kumar, 1987) [5]. Visible mustard plant symptoms are most commonly used to indicate the response of plants to pollutant (Van Haut and Stratma). The use of whole plant in terms of percentage of injured plants, the number of damaged leaves, the reduction in photosynthetic area, size of the plant etc. may reveal the state of pollution, producing externally visible effects on the fumigated plants (Rao, 1977) [6]
Number of tillers, phytomass, ratio of dry weight of root and shoot are all affected by pollutants, singly and in combination (Whitmore and Mansfield, 1983, Marie and ormrod, 1984; Pande and Mansfield, 1985 b). All these aspects revealing the plant growth were studied in field condition at the study sites during the present investigation. The atmosphere polluted by SO_2 is toxic to mankind, destructive to vegetation and construction materials.
The other important gasous air pollutant is nitrogen dioxide. It occurs usually in combination with sulphur dioxide (Pande and Mans Field, 1985 a & b). It is considered to be the most important component of NO_X in relation to plant growth (Flower and Cape, 1982)
The suspended particulate matter (S.P.M) is conglomerate of chemically heterogeneous substances, the particulate pollutants disturb photosynthesis by reducing the quantum of light and raising the surface temperature of leaves (Rao, 1972, Kumawat and Dubey, 1988). Light, temperature and humidity strongly influence the uptake of the pollutants by plant and their sensitivity to the pollutants (Bell, 1982). The wind speed and direction also affect the dispersion of pollutants (Agrawal and Mathur, 1983) [1]. Therefore, atmospheric temperature, relative humidity and wind velocity of the study sites were measured at monthly interval.

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Material & method

Five study sites were selected around viscinity of Barauni Oil Refinery. Four sites namely Gomanpur, Mahna, Deona, Saboura near to Oil Refinery were considered as polluted sites and fifth site namely simaria was taken as reference site.

Selected 20 plants at each study sites were uprooted at monthly interval. Their shoot length number of tillers and leaves, leaf area and length of roots were measured.

Dry weight of root and shoot were determined by over dry method. The samples were dried at 80 ^{0}C for 48 hours or till two successive weights became constant.

Results and Discussion

Growth of mustard plant symptoms were observed at study sites due to pollutant. The present gaseous pollutants (SO_2-NO_2 mixtures) first reported causing foliar injury is very important because both are component of fossel fuel combustion and thus normally occur together. During the present investigation wide spread Foliage injury was noted at polluted sites but none or very few at reference site. Among the shiny wated-soaked area were frequently observed on the injured leaves. Chlorosis and necrosis were the other symptoms that were frequently observed on the injured leaves at the polluted sites. These symptoms were found on the upper surface, on the lower surface or both the surfaces (bifacial) of the leaves. Visual observation also indicates that injury occurred most extensively to moderately develop actively photosynthesizing leaves.

On seasonal basis about 62.5 to 66.0 percent plant showed injury symptoms at polluted sites in contrast to only 9.91 percent plant at reference site

About 27.43 to 33.16 percent leaves were injured at polluted sites as compared to only 9.02 percent at reference site. Similarly, in contrast to 2.87 percent injured leaf area, 10.09 to 13.57 percent leaf areas were damaged at the polluted sites. The extent of leaf injury causing the reduction of photosynthetic area of the plant is bound to affect the photosynthesis which is related to the sensitivity of the plants to the pollutants. The height of mustard plant was appreciably suppressed at polluted sites in comparison to reference site. The root length was more severely suppressed at polluted sites. The plants reached to maximum height of 165.52 cm at simaria (reference site) in contrast to 132.70 cm to 105.42 cm at polluted sites. (Table-I) There were lesser number of tillers on plants at polluted sites.(Table-II) The plants at polluted sites had lesser number of leaves (7.4 to 7.65 leaves per plant) as compared to 8.45 leaves per plant at reference site. The reduction in leaf number could be attributed to reduction in tillering Dry weights of the shoots at polluted sites ranged from 10.91 to 12.59 gm per plant in comparison to 18.85 gm per plant at reference site .Root dry weight was more appreciably reduced than shoot dry weight. High dry matter reduction by SO_2 and NO_2 mixture are due to damaging effect to sulphite and nitrite ions on the photosynthetic membrane. The effect of SO_2 on shoot/root ratio may be dependent on environmental condition but SO_2 may affect the size of the root system without affecting the shoot. (Table-III) When shoot synthesized assimilate are too deficient to maintain normal growth of the plants, the sinks such as roots and seeds are more severely affected than the foliage. Hence the roots have high demand for photosynthates and if pollutants stress reduced the photosynthesis during this period, the growth was bound to be reduced. A reduction of the root system could be of great importance to the survival of plants in fields during the periods of droughts. High temperature can cause acute injury in the form of killing of sensitive areas on otherwise healthy leaves. High relative humidity increases the sensitivity of plants to air pollutants probably through increased stomatal conductance and uptake of pollutants by the plants. In addition to the degree of temperature and relative humidity, a high wind velocity was also noted at polluted as well as at control site. It has been suggested that wind velocity may be important because of its known effects on leaf boundary layers. Thus all three climatic factors acting in concert might have led to growth suppression at polluted sites. This study has demonstrated that even moderately polluted environment has the potential of causing significant growth suppressions of mustard plants.

Table I: Average height (cms) of plants at study sites during the years (2012-13 & 2013-14)

Months	years	Study sites				
		Simaria	**Saboura**	**Deona**	**Mahna**	**Gomanpur**
November	2012	115.020	105.140	76.650	62.520	55.740
	2013	124.240	96.400	80.890	61.240	88.000
Average		119.630	100.770	78.770	61.880	71.870
December	2012	143.050	113.840	96.050	96.500	79.750
	2013	143.850	115.840	125.090	101.740	111.050
Average		143.450	114.840	110.570	99.120	95.400
*change over Nov-Value		23.820	14.070	31.800	37.240	23.530
January	2013	161.450	116.900	116.900	101.650	85.500
	2014	169.590	148.500	149.700	109.190	112.640
Average		165.520	132.700	133.300	105.420	99.070
*change over Dec.-Value		22.070	17.860	22.730	6.300	3.670
Seasonal average		142.866	116.100	107.546	88.806	88.780
Average of Change		55.173	44.233	44.433	35.140	33.023
	S.D	45.583	40.007	24.560	22.739	28.640
	S.E	26.318	23.098	14.180	13.128	16.536
Correlation with pollutant (Single and in combination)						
SO_2		-0.378	-0.329	-0.998	0.495	-0.018
NO_2		-0.754	-0.995	-0.994	0.924	0.859
$SO_2 + NO_2$		1.000	1.000	1.000	1.000	1.000
Temperature		0.996	0.899	0.806	0.506	0.852
R.H		0.925	0.551	0.249	0.104	0.013

Table II: Average number of tillers per plant at study sites during the years (2012-13 & 2013-14)

Months	years	Study sites				
		Simaria	**Saboura**	**Deona**	**Mahna**	**Gomanpur**
November	2012	9.010	7.160	6.350	5.510	4.960
	2013	8.250	5.200	4.930	4.150	6.340
Average		8.630	6.180	5.640	4.830	5.650
December	2012	10.130	9.880	5.260	8.230	7.750
	2013	10.750	6.240	6.300	8.250	9.370
Average		10.440	8.060	5.780	8.240	8.560
*change over Nov-Value		1.810	1.880	0.140	3.410	2.910
January	2013	11.550	9.950	8.130	8.530	8.400
	2014	13.330	5.730	10.210	8.390	9.720
Average		12.440	7.840	9.170	8.460	9.60
*change over Dec.-Value		2.000	-0.220	3.390	0.220	0.500
Seasonal average		10.503	7.360	6.863	7.176	7.756
Average of Change		4.147	2.613	3.057	2.820	3.020
	S.D	3.171	2.664	2.258	1.928	2.104
	S.E	1.831	1.538	1.303	1.113	1.215
Correlation with pollutant (Singly and in combination)						
SO_2		-0.414	-0.645	-0.759	0.357	0.180
NO_2		-0.780	-0.965	-0.784	0.971	0.740
$SO_2 + NO_2$		1.000	1.000	1.000	1.000	1.000
Temperature		0.992	0.996	0.989	0.369	0.731
R.H		0.939	0.216	0.858	-0.049	-0.211

Table III: Average root shoot length ratio at study sites during the years (2012-13 & 2013-14)

Months	years	Study sites				
		Simaria	**Saboura**	**Deona**	**Mahna**	**Gomanpur**
November	2012	0.092	0.087	0.105	0.101	0.071
	2013	0.096	0.093	0.115	0.159	0.109
Average		0.094	0.090	0.110	0.130	0.090
December	2012	0.128	0.109	0.207	0.207	0.219
	2013	0.092	0.091	0.073	0.113	0.101
Average		0.110	0.100	0.140	0.160	0.160
*change over Nov-Value		0.016	0.010	0.030	0.030	0.070
January	2013	0.148	0.150	0.137	0.170	0.132
	2014	0.072	0.070	0.083	0.110	0.088
Average		0.110	0.110	0.110	0.140	0.110
*change over Dec.-Value		22.070	17.860	22.730	6.300	3.670
		0.000	0.010.-	0.030	-0.020	-0.050
Seasonal average		0.104	0.100	0.120	0.143	0.120
Average of Change		0.037	0.037	0.037	0.047	0.037
	S.D	0.041	0.038	0.057	0.062	0.062
	S.E	0.024	0.022	0.033	0.036	0.036
Correlation with pollutant (Singly and in combination)						
SO_2		-0.241	-0.365	-0.936	0.698	0.572
NO_2		-0.652	-0.998	-0.921	0.797	0.394
$SO_2 + NO_2$		1.000	1.000	1.000	1.000	1.000
Temperature		0.998	0.916	0.603	0.708	0.381
R.H		0.860	0.518	-0.039	0.352	-0.598

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