International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; SP4: 96-98

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

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

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

Effects of pollutants on seed germinability, reproductive capacity and yield of mustard plant

Nidhi Kumari

Abstract
Pollutants ejected as a result of rapid industrialization, urbanization transport are real threats to the present environment. The environment surrounding any industries contains impure air that is loaded with pollutants ejecting from industry making tough conditions for the plants to survive. The present investigation was on Barauni Oil refinery which was located in Bihar, polluting the atmosphere in the forms of gaseous like SO_2, NO_2 & suspended particulate matter liberated as a result of refining of crude petroleum. Effects of these pollutants were studied on mustard plant at sites near to oil refinery considered as polluted site and comparison with reference site i.e far away from reference site. The present investigation concludes that pollutants impair seed germinability reproductive capacity & yield of mustard plant. So adaptive methods should be practiced to control pollution.

Keywords: pollutants, germination, reproductive capacity, yield, chlorophyll

Introduction
Increase in both industrialization and urbanization and associated air pollution threaten urban food production and the quality. It is one of the most serious problems confronting mankind. We can no longer expect clean air to be the normal environment for plant and animal growth. Transportation, Industry, power generation, space heating, surface healing, surface burning etc. emit wide array of toxic substances including gases, particulates and radioactive materials in the atmosphere which ultimately affect our food supply, health, plant, human life and economy (Hesketh, 1973) [3]. The atmosphere polluted by SO_2 is toxic to mankind, destructive to vegetation and construction materials (Ismail et.al., 1978) [4]. The other important gaseous air pollution is nitrogen dioxide. It is considered to be most important component of NO_2 in relation to plant growth (Fowler and Cape. 1982) [2] Nitrogen oxides, of themselves, are not phytotoxic. However in combination with sulphur dioxide it manifests synergistic effects (Tingey *et al.*, 1971) [7]. As the gas reaches the wax surface of parenchyma, it forms nitrous and nitric acids which injure the other tissue. The particulate pollutants disturb photosynthesis by reducing the quantum of light and raising surface temperature of leaves (Rao, 1972; Kumawat and Dubey, 1988) [6]. The adverse effect of industrial pollutants may also cause plant injury (Vora and Bhatnagar, 1972) Light, temperature and humidity strongly influence the uptake of the pollutants by plants 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) Number of tillers, phytomass, ratio of dry weight of root and shoot are all affected by pollutants. All these aspects revealing the plant growth were studied in field condition at the study sites during the present investigation. Seed germination and germination index are more affected due to the combination of pollutants than alone (Boralkar and Dafedar, 1983) [1] Reduction in seed germination is the general observation (Darley and Middleton, 1966), Treshaw (1971) and Edwards (1972) reported significant reduction in the yield of plants growing in highly polluted cities. The impairment of flowering under pollution stress

has been reported by Feder (1975), Murdy (1979) and Dubay and Murdy (1983), Nitrogen dioxide, applied on its own had very little effect on growth but in combination with SO_2, it caused highly significant reductions in almost all the growth parameter measured (Pande and Mansfield, 1985b) [5]. Plant damage and reduction of crop yield due to industrial air pollution. The reduced seed number was primarily due to reduced pod number (Heagle *et al.*, 1983, Kress *et al.*, 1986). Therefore all these yield parameters such as flowering, fruiting, seed yield and oil contents were taken into consideration presently. Yield and vegetation growth are also very sensitive to sulphur dioxide. Plant responses to different environmental parameters vary during their growth and development. Flowering fertilization and fruit selling and seed development appear to be influenced by sub-lethal exposure to sulphur dioxide.

Materials and Method

Five study site were selected for field observation, there were Saboura, Deona, Mohna, Gomanpur and Simaria (Reference Site)

Percent Seed germination

One hundred seeds of freshly harvested mustard crop were randomly selected for testing their germinability. The seeds were kept in petridishes lined with 3-4 layers of sterilized moist filter paper at the rate of 10 seeds per plate, the petri dishes were then incubated at 28 ± 1 ^{0}C for 5 days. Number of seeds germinated on each day was noted.

Germination Index

The germination index was calculated by using the following formula of Carley and Watson (1968)

$$GT = 4(5g + 4g + 3g + 2g + g)$$

Where,

G, represent number of germinated seeds after 24 hours.

GI - Germination index

The sum was multiplied by 4 to correct germination of seeds to a percentage basis.

Reproductive capacity

Reproductive capacity of mustard plant was calculated with the help of formula given by Salisbury (1942) as the products of average seed out put the fraction represented by the average percentage of germination by the following formula

$$R.\,C = \frac{\text{Average seed output x Average percent seed germination}}{100}$$

Result and Discussion

The problems of atmospheric pollution are rapidly growing in most parts of the world on account of high demand for energy. Within the complex of air pollution some gaseous components are very phytotoxic. The present gaseous pollutant (SO_2-NO_2) mixtures first reported causing foliar injury because both are the components of fossil fuel. During the present investigation wide spread foliage injury was noted at polluted site but not or very few at reference site. Among the injury symptoms shiny soaked areas were frequently observed on the injured leaves. Chlorosis and necrosis were the other symptoms that were frequently observed on the injured leaves at polluted sites. The essential feature sums to be that the gases are accumulated within the leaves until a toxic concentration is built up and then cells from epidermis to epidermis collapse and are killed. 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. Germinating seeds have been used by a large number of workers to monitor the pollution effects (Beg, 1980). During the present study, the seeds from the reference spot displayed 93.4 percent germination where as those from polluted sites showed 50.0 to 62.5 percent germination Table -1, similarly the germination index at the polluted sites varied between 360 to 553 in contrast to 926 at Simaria (Reference site).

Boralkar and Defedar (1983) [1] asserted that reductions in these parameters are indicative of adverse effect of SO_2 (Pollutants). It also implies that the pollutants disturb the metabolic activities of germinating seeds. The polluted atmosphere at the study sites contains both SO_2 and NO_2 the combined effect of which may be instrumental in retarding the seed germ inability to this extent. There was were lesser numbers of flowers and even much lesser number of pods per plant at the polluted sites than at non-polluted sites, which indicate that the pollutants interfered not only with intensity of flowing but even with the degree of fruit setting (Table -II). The magnitude of foliage injury, reductions in chlorophyll content, photosynthetic area, accumulation of sulphates in the leaves and even reduction in overall growth of the plant exposed were bound to be reflected in loss of yield potentiality of the plants exposed at polluted sites. Thus, there seems to a close relationship between atmospheric level of SO_2 and yield of plant as seen in mustard. Even sub lethal exposure to SO_2 as was the case in present study, appear to be sufficient enough to influence fruit and seed development.

Reduction in flowering and fruit setting might suggest the effect, of pollutants on pollen dispersal or their germination. The present polluted atmosphere at polluted site contained very high concentration of suspended particulate matter and this might have also played its role in inhibiting flowering and fruit setting although the same did not happen at reference site under similar condition. The reduced flowering and pod formation are primarily responsible for reduction in number of seeds per plant at polluted sites in comparison to control site. The reduction in growth and loss of photosynthetic area noted in the present polluted atmosphere implies huge reduction in the weight of 1000 seeds. There was a reduction in oil content of the seeds obtained from polluted sites. The overall effect of the pollutants can be assessed by their effects on the reproductive capacity of plants. Thus represents a very drastic reduction in the reproductive capacity of the plants exposed to chronic or at the most moderate concentration of the pollutants in the ambient atmosphere at these study sites. It, thus support the concentration that even low pollutant concentration may cause considerable yield reduction and may cause damage or economic losses.

Table I: Germinability and germination indices of seeds obtained from different study sites during the year (2012-13 & 2013-14) Study Sites

Parameters	years	Simaria	Saboura	Deona	Mahna	Gomanpur
Percent Seed	2013	90.000	87.000	68.000	79.000	77.000
Germination	2014	96.800	38.000	33.000	21.000	29.000
Average	-	93.400	62.500	50.500	50.000	53.000
Germination	2013	956.000	810	428.000	618.000	636.000
index	2014	896.000	296.000	292.000	242.000	286.000
Average	-	926.000	553.000	360.000	430.000	461.000

Table II: Average number of pods per plant in different month of the season at study sites during the year (2012-13 & 2013-14)

Months	years	Study sites				
		Simaria	**Saboura**	**Deona**	**Mahna**	**Gomanpur**
November	2012	14.660	10.620	11.800	9.540	5.470
	2013	15.740	10.200	7.960	8.900	8.590
Average		15.200	10.410	9.880	9.220	7.030
December	2012	40.250	34.200	14.070	11.830	22.550
	2013	171.290	116.000	69.090	47.850	59.790
Average		105.770	75.100	41.580	29.840	41.170
*change over Nov-Value		90.570	64.690	31.700	20.620	34.140
January	2013	68.430	51.760	44.180	22.420	38.400
	2014	412.490	120.500	150.000	107.600	117.140
Average		240.460	86.130	97.090	65.010	77.770
*change over Dec.-Value		134.690	11.030	55.510	35.170	36.600
Seasonal average		120.476	57.213	45.516	34.690	41.990
Average of Change		80.153	28.710	32.363	21.670	25.923
	S.D	49.335	25.443	18.634	10.620	13.397
	S.E	28.483	14.690	10.759	6.131	7.735
Correlation with pollutant (Singly and in combination)						
SO_2		0.029	-0.616	0.893	-0.491	0.228
NO_2		0.476	0.453	0.874	-0.926	-0.947
$SO_2 + NO_2$		1.000	1.000	1.000	1.000	1.000

References

1. Boralkar DB, Dafedar SD. Effects of ozone and sulphur dioxide alone and in combination on seed Germination Ind. J Air Pollut. Contr. 1983; 4(4):46-47
2. Foweler D, Cope JN. Air pollutants in agriculture and horticulture. In "Effect of gaseous pollutants in agriculture and horticulture". Proc. School in Agric Sci., University of Nottingham, 32nd, ed. by M.H unworthy and D.P. Ormrod. 3-26, London, Butter worth, 1982.
3. Hesketh HE. "Understanding and controlling Air Pollution". Ann. Arbor. Sci. Publ. Ann Arbor, Michigam, 1973.
4. Ismail MI, ABD HEI, Kikuta M, Diwani GE. Control of health hazards due to sulphur dioxide pollution. J Environ. Sci. Health, Al$_{3.}$ 1978; (8):533-543
5. Pande PC, Mansfield TA. Responses of spring barley to S0$_2$ and No$_2$ Pollution. Environ. Pollut. (Ser. A). 1985b; 38:87-97
6. Rao MV, Dubey PS. Plant response against sulphur dioxide in field conditions. Asian Environment, First quarter, 1988.
7. Tingey DT, Reinert RA, Dunning JA, Heck WW. Vegetation injury from the interactions of NO_2 and SO_2, 1971.