Journal of Research & Development, Vol. 5 (2005)
ISSN 0972-5407

Impact of Vehicular Pollution on Saffron (*Crocus Sativa L.*)

Arifat Jan, A. R. Yousuf and G. A. Bhat
P. G. Department of Environmental Science, University of Kashmir, Srinagar - 190006

ABSTRACT

Impact of automobile exhaust on the soil and vegetative parts of saffron plant was studied in Somboora saffron fields adjoining the National Highway at Pampore, Kashmir. The automobile pollution was observed to affect the saffron production directly through its impact on the plants as well as indirectly through its influence on the soil chemistry. There was an increase in the soil pH, conductivity, loss on ignition and exchangeable calcium and magnesium in soil and pH of leaf wash and moisture content of stigmas and a reduction in total phosphorus in soil and leaf size, flower production, chlorophyll content and corm biomass with increased automobile pollution.

Key words : Auto-exhaust, Saffron, leaf size, chlorophyll content, corm biomass, soil chemistry

INTRODUCTION

Plants growing near highways are usually exposed to more automobile emission than most other locations (Zimdahl and Hasset, 1977; Sahu and Warrier, 1985). Particulate pollutants from the automobile exhausts exert their detrimental effect by setting on the leaf surface and decreasing the active surface area and consequently decline in the assimilative capacity of the leaf. The colloidal dust blocks the stomata of plants, while the toxic dust exerts its harmful effects by interfering with the metabolic processes. There is some concern that marginal burn on leaves in urban areas might be associated with automobile emissions. Jain *et al.*, (1989) studied the impact of automobile pollution on floral abscission and pollen fertility of some ornamental plants.

The plants can also be used as pollution indicators and attempts have been made to develop certain plant strains that can be specially used for predicting a particular pollutant and can be used in bioassay techniques (Chaphekar, 1978). The pollution indicator value of the leaf has been exploited by a large number of workers. Physiological activity of leaf, like stomatal opening, can be used for indicating pollution (Unsworth *et al.*, 1972 and Bonte *et al.*, 1977). In the present paper an attempt has been made to assess the effect of automobile pollution on the soil characteristics of saffron fields and on the saffron plants in the vicinity of the Jammu - Srinagar National Highway in Somboora, Pampore (Kashmir).

MATERIAL AND METHODS

Four sampling sites were selected in the Somboora area which is situated about 17 km south of Srinagar city. Site 1 adjoined the National Highway and was in receipt of heavy automobile pollution. Site 2 was located 100 meters away from the roadside, while the Site 3 was about 200 meters away from it. Site 4 was located about 2 km away from the road side and received the least quantities of pollutants from the vehicles passing through the National Highway.

Soil samples, collected randomly from 0 - 15 cm layer at each study site on monthly basis during May – October, 2003 were analyzed for important physico-chemical parameters like pH, conductivity, field capacity, moisture content, loss on ignition, calcium, magnesium, organic carbon and total phosphorus as per the procedures given in Hooda and Kour (1999) and Gupta (2000). Various physico-chemical parameters of vegetative parts of saffron plant including chlorophyll content, pH of leaf wash, Biomass of corms, percent moisture content of stigmas and leaf size were determined in accordance with the methods given by Arnon (1949).

RESULTS AND DISCUSSION

The data obtained during the study are presented in Table 1 and 2. The pH fluctuated from 6.51 to 7.82, indicating thereby a well buffered condition throughout the study period. Borka (1980), Shukla *et al*. (1996) and Misra *et al*., (1993) did not find appreciable difference in soil pH because of auto-emissions. The automobile exhaust spreading along the National Highway around Somboora fields appeared to affect the pH of the surface soil. The samples from the roadside site exhibited generally relatively higher pH than the sites away from the road side. The dust pollutants blowing off near the highways have been reported to be alkaline (Mandre,1997). The other soil features also showed variations between the four sites to a fair degree. The conductivity values ranged from 160 µS (S 2) in spring to 360 µS (S 4) in autumn, while total phosphorus fluctuated from 50.1 mg/g at site 1 in spring to 91.02 mg/g at site 4 in autumn. Due to impact of vehicular pollution the anion exchange capacity of soil is hindered and most of the phosphates ($H_2PO_4^{-1}$ or HPO_4^{-2}) are replaced by exchangeable SO_4^{-2} anions and the phosphorus anions are leached to lower horizons of the soil. The results are in agreement with those of Borka (1980), Shukla *et al*., (1996), Misra *et al*., (1993) and Shammushauel (1995).

Although all the sites were calcium rich (0.8 – 2.98mg/g) the spatial distribution of the cation showed significant variations, being the highest at site 1 and the lowest at site 4. The organic carbon varied between 0.17% (S 1) in spring and 12.54% (S 3) in autumn. The Field capacity of the soil fluctuated in the range of 35.16% (S 4) in autumn - 49.76% (S 3) in the summer. Loss on ignition also showed a similar trend. A perusal of the data on various physico-chemical characteristics of the soil (Table 1) revealed that the substrate differed considerably at the four study sites. The site adjoining the Highway (site 1) exhibited relatively the most polluted condition in comparison to the other three sites.

Table 1: Seasonal variations in the physico-chemical characteristics of Saffron soil

Parameter	Site	Spring	Summer	Autumn
pH	I	7.82	7.8	6.51
	II	7.46	7.2	7.72
	III	7.42	7.3	7.59
	IV	6.76	6.6	7.15
Conductivity (μS)	I	330	264	320
	II	160	200	285
	III	210	186	279
	IV	320	276	362
Moisture Content (%)	I	3.85	2.08	1.98
	II	3.98	2.38	1.99
	III	4.29	2.54	2.15
	IV	4.96	8.45	2.79
Field Capacity (%)	I	42.13	46.8	44.10
	II	40.04	45.6	44.28
	III	40.96	46.2	44.93
	IV	35.16	39.2	39.47
Loss on Ignition (%)	I	6.94	6.72	7.67
	II	5.70	5.70	5.97
	III	5.48	4.86	5.02
	IV	3.30	3.39	4.05
Organic Matter (%)	I	0.17	0.22	0.57
	II	0.28	0.82	1.97
	III	0.42	0.47	0.87
	IV	1.42	1.15	2.11
Exchangeable Calcium (mg/g)	I	2.02	10.06	2.84
	II	1.52	2.36	2.25
	III	1.56	2.15	2.52
	IV	0.80	1.47	2.33
Exchangeable Magnesium (mg/g)	I	0.067	0.05	0.02
	II	0.002	0.01	0.023
	III	0.003	0.05	0.123
	IV	0.004	0.01	0.023
Total Phosphorous (mg/g)	I	50.1	58.9	78.36
	II	53.02	64.9	87.10
	III	63.04	70.41	89.52
	IV	65.02	73.95	90.72

Table 2: Mean values of physico-chemical characteristics of vegetative parts of saffron plants

Parameter	Site 1	Site 2	Site 3	Site 4
Leaf size (cm)	15.2	17	18	18.6
Moisture content of stigmas (%)	34.73	24.44	24.76	18.99
Comparison of flower production (per 12m x 6m)	4.27	7.28	8.79	10.52
pH of leaf wash	6.11	6.92	7.73	7.94
Chlorophyll content (mg/g)	0.66	1.07	1.22	1.34
Number of corms (per 36m x 36m)	15	23.83	29.83	40.5
Biomass of corms	251.79	371.34	484.41	612.32

Analysis of the saffron plant samples from the four sites showed a significant reduction in the chlorophyll content of the foliage as one moved towards the roadside, with the minimum value of 0.6 mg/g at site 1 and a maximum value of 1.34 mg/g at site 4. The leaf size, flower production, number of corms per unit area and corm biomass also showed significant decline from S 4 to S1. The moisture content of the stigmas, on the other hand, showed an increase towards the road side. This is directly attributable to the automobile pollution and is substantiated by the quantum of particulate matter deposition on the leaf surface, which was estimated to be 0.74g/m^2/day at the site adjoining the Highway (S 1), while at site 4 it was negligible. This was further supported by the pH value of leaf wash (6.11 at S 4 as against 7.94 at S 1), which showed a clear signature of automobile impact on the saffron fields in the vicinity of the National Highway.

From the data collected during the present study it may be concluded that the automobile pollution affects the saffron production in the areas adjoining the National Highway both directly through its impact on the saffron corm and indirectly through its influence on the soil characteristics.

ACKNOWLEDGEMENT

This article forms a part of the M. Sc. project work of the first author.

REFERENCES

Arnon, D. Z. 1949. Acetone method for the extraction of chlorophyll from leaf tissue. *Plant Physiologist*

24:1-15.

Bonte, J., Decermis, L. and Laugnet, P. 1977. Stomatal closure in arctic and alpine populations of *Omyria digyana*. Ecology **50**: 131 – 134.

Borka,G.,1980. The effect of dust on growth and metabolism of *Helminthus annus*. *Environmental Pollution*, **22**: 75 - 79.

Chaphekar, S. B. 1978. Biological indicators: the concept and new additions. *Intl. J. Ecol. Environ. Sci.* **4**:45 – 52.

Dean,G. 1968. Air pollution and health. *Royal Soc. Hlth Journal*. **68**: 31 - 38.

Gupta, P. K. 2000. *Methods in Environmental Analysis - Water, Soil and Air*. Agrobios (India), Jodhpur.

Hooda, S and Kour, S. 1999. *Laboratory manual for environmental chemistry*. S. Chand and Company Ltd. New Delhi.

Jain, R. K., Chauhan, S. V. S., and Kumari, S. 1989. Impact of air pollution on floral abscission and pollen fertility in some ornamental plants. *Acta Ecol.* **11**:31 – 33.

Mandre, J. M. 1997. Accumulation of the vechile generated heavy metals of the roadside soils. *Turkish Journal of Environmental Science*. **21**: 423-431.

Misra, J. Pandey, V. Singh, S. N. Singh, N. Yunus, M and Ahmad, K. J. 1993. Growth responses of *Lycopersicon esculentum* to dust treatment. *Journal of Environmental Sc. and Health A.*, **28** : 1771 - 1780.

Ormred, D. P. 1982. Air pollutant interactions in mixtures. In: *Effects of gaseous air pollution in agriculture* (D. P. Ormred ed). Bulterworth London. pp.:307 - 331.

Posthumus, A. C. 1985. Plants as bioindicators for atmospheric pollution.In "*Pollution and their ecotoxicological significance* (H. W. Numberg, ed.) John Wiley and Sons, N. Y.

Sahu, K. C. and Warrier, R. 1985. Lead, Cadmium and Copper contamination of soil and vegetation due to vehicular emission along Powal Road in North Bombay, India. *Indian J. Earth Sci.* **12** : 50 – 57.

Shukla, M. and Shukkla, K. B.1996. Potentiality of soil additive and growth Promoter in severting inhibition by dust in *Phaseolus aureas*. *Acta Ecologica*, **18**: 15 - 20.

Shammushauel, P. 1995. Effect of cement dust on stomatal structure. *Ecology and Environmental Conservation*. **1**: 7 - 9.

Srivastava, Y. N. 1989. *Environmental Pollution*. Ashish Publishing House. New Delhi

Stern A. C. 1962. *Air Pollution*. Vol. I, Academic Press, N. Y.

Unswowth, M. H., Biscoe, P. V. and Pinckney, H. R. 1972. Stomatal responses to sulphur dioxide *Nature* (London). **239**: 450 –459.

Zimdahl, R. L. and Hasset, J. J. 1977. Lead in soil pp. 93 - 99. In : *Lead in the Environment* (N. R. Bogess, ed.) National Science Foundation, Washington.