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Impact of vehicular pollution on nutrient status of roadside soils

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Abstract
The present study was conducted with an aim to assess the impact of vehicular pollution on nutrient status of roadside saffron soils at two sites (SI and SII) of Pampore tehsil (Galandhar and Lethpora) from March, 2018 to February, 2019. Twelve composite soil samples collected randomly from each site and each season were analysed for the assessment of available nitrogen (N), phosphorus (P) and potassium (K) as per their prescribed standard procedures. Among the study sites L4 of S II revealed the highest concentration of available N, available P and available K (197.7, 17.89 and 92.56 mg/kg) whereas L1 of site I recorded the lowest concentration (161.7, 11.94 and 72.23 mg/kg). With regard to seasons maximum concentration of available N, available P and available K (210.9, 19.54 and 97.01 mg/kg) was obtained during summer and minimum concentration (150.4, 11.03 and 67.94 mg/kg) was obtained during spring. Factor mean of available N, available P and available K was minimum at L1 (162.2, 12.10 and 72.51 mg/kg) and maximum (197.2, 17.65 and 92.94 mg/kg) at L4. Our results suggest that soils of roadside are depleted of nutrients.

Keywords: Vehicular pollution, Nitrogen, Phosphorus, Potassium, Roadside

Introduction
Soil is an active and vital natural component of lithosphere encompassing different forms of life from microscopic to huge trees. Soil contains both macro and micro nutrients which are important component for the biosphere and helps in maintaining the balance of biodiversity and habitat (County, 2014) [5]. Plants derive their life supporting nutrients and minerals from this wealth. Substantially, the vital interactions among organisms, biochemical reactions, and nutrient cycling occur in this component of lithosphere (Groffman *et al*., 2006; Li *et al*., 2018) [9, 15] and the fertility of soil is determined by the presence or absence of nutrients (Wajahat *et al*., 2006; Verma *et al*., 2011) [30, 28].

With the technological advancement and economic growth in most developing countries, there is a great deal of concern over vehicular pollution due to rapid increase in the use of vehicles for transportation. Moreover, the problem has further aggravated due to lack of emission standards and transportation regulations in these countries (Amusan *et al.*, 2003; Ibrahim, 2009; Olukanni and Adebiyi, 2012) [1, 17]. Vehicular emissions reach its peak with the increase in population, together with the rising vehicle ownership (USEPA. 2012) [27]. Unlike developed countries, most developing countries have not been able to reduce the emission of pollutants in spite of population increase. Road-vehicle emissions are a major source of air pollution. Pollutant emissions from light-duty, gasoline-powered automobiles are volatile organic compounds (VOCs), carbon monoxide (CO), and oxides of nitrogen (NO_x), whereas for heavy-duty, diesel vehicles, NO_x and fine particulate matter ($PM_{2.5}$) are of the greatest concern (Sawyer, 2010) [19]. These pollutants released from different sources spread over a large area and affect the soil, vegetation, and other natural resources.

Agricultural roadside soils are found to be contaminated as a consequence of vehicular emission and have been found to constitute one of the major causes of soil pollution. Roadside soils in urban areas all over the world are prime targets of heavy metal contamination from a variety of sources mostly of anthropogenic activities. Major metal pollutants along roadside are released from fuel burning, wear out of tyres, leakage of oils, and corrosion of batteries and metallic parts (Devi *et al*., 2015) [6].

Environmental contamination due to pollutant coming from vehicles has drawn much attention to the environmental scientists due to its implications on soil ecosystem creating serious pollution problems to the agro-ecosystems. The deposition of pollutants on soil has been known to cause undesirable changes in physico-chemical characteristics of soil. However, the deposition is controlled by range of factors such as nature of the pollutant, diameter of the particles, the roughness of the soil surfaces and atmospheric stability (Hosker and Lindberg, 1982) [10]. These pollutants have adverse environmental and health effects (EPA, 1999; Turer and Maynard, 2003) [26]. Several studies have been carried out on road side soils because they contain diverse pollutants. Changes in soil properties have been associated with environmental alteration that takes place as a result of human activity (Ibanga *et al*., 2008) [12]. Developed nations with the history of industrialization and the use of leaded fuel have been on the front with respect to the studies on the effect of air pollution on different ecosystems. Only very few of such investigations have been carried out in developing countries like India.

Therefore, the present study was carried out in pampore, the saffron bowl of Jammu and Kashmir, under field conditions and along a gradient of pollution, in order to assess the nutrient status of roadside soils of saffron amid rising concentrations of vehicular emissions.

Material and Methods

Study sites

The study was conducted at two sites (SI and SII) *viz*., Galandhar and Lethpora with each site comprising four locations selected on the basis of distance from the road (Location 1: 10-20 m, Location 2 : 21-30 m, Location 3 : 31-40 m and Location 4 (Control) : 1000m)

Soil sampling

Soil samples were collected in each season from all locations pertaining to each site. Top organic matter was removed and samples scraped from (O) horizon (0-30 cm). The soil was thoroughly mixed and gravels were removed. The soil samples were air dried and then ground using pestle and mortar and sieved through 2 mm mesh sized sieve. Powdered samples thus prepared were stored in well labelled bags for subsequent analysis.

Methods

Estimation of available nitrogen, available phosphorus and available potassium was done by the procedures given by Subbiah and Asija (1956) [23], Olsen *et al.* (1954) [16] and Jackson, (1973) [13].

Results

Data pertaining to available nitrogen, available phosphorus and available potassium is given in table 1 and graphically represented in fig.1-3. The data clearly shows that the available nitrogen, available phosphorus and available potassium was recorded highest in summer (210.9, 19.54 and 97.01 mg/kg respectively) and lowest in spring (150.4, 11.03 and 67.94 mg/kg respectively). Factor mean of location 1 from both the sites observed the lower values of available nitrogen, available phosphorus and available potassium (162.2, 12.10 and 72.51 mg/kg respectively) whereas location 4 recorded the higher values (197.2, 17.65 and 92.24 mg/kg respectively). Higher values of these nutrients were found at site II (176.2, 14.58 and 81.28 mg/kg) as compared to site I (175.3, 14.16 and 80.67 mg/kg) and was found to be significantly different.

Table 1: Effect of vehicular pollution on available nitrogen, available phosphorus and available potassium of soil at two different sites

Parameters(mg/kg)	Seasons	Site-I					Site-II					Mean	F. Mean
		L1	L2	L3	L4	S. Mean	L1	L2	L3	L4	S. Mean		
Av. Nitrogen	Spring	136.3	141.3	149.7	172.8	150.0	136.9	142.4	150.7	173.4	150.8	150.4^{D}	L1=162.2^{D}
	Summer	193.7	205.1	211.8	231.1	210.4	194.3	206.1	212.5	232.3	211.3	210.9^{A}	L2=169.0^{C}
	Autumn	169.0	174.2	179.0	202.2	181.1	170.3	174.9	180.1	203.3	182.1	181.6^{B}	L3=174.7^{B}
	Winter	147.7	153.5	156.7	181.0	159.7	149.3	154.3	157.4	181.8	160.7	160.2^{C}	L4=197.2^{A}
	Mean	161.7	168.5	174.3	196.8	175.3^{b}	162.7	169.4	175.1	197.7	176.2^{a}		
	C.D $_{(p \leq 0.05)}$ Seasons (S): 0.31Sites (ST): 0.22Locations (L): 0.31S × ST × L: 0.84												
Av. phosphorus	Spring	8.48	9.81	10.91	14.22	10.85	8.85	9.84	11.31	14.83	11.21	11.03^{D}	L1=12.10^{D}
	Summer	16.70	18.00	19.04	23.46	19.30	17.12	18.70	19.50	23.80	19.78	19.54^{A}	L2=13.39^{C}
	Autumn	12.81	14.10	14.72	16.78	14.60	13.06	14.29	14.90	17.16	14.85	14.73^{B}	L3=14.34^{B}
	Winter	9.79	10.86	11.78	15.18	11.90	10.04	11.52	12.59	15.77	12.48	12.19^{C}	L4=17.65^{A}
	Mean	11.94	13.19	14.11	17.41	14.16^{b}	12.26	13.59	14.57	17.89	14.58^{a}		
	C.D $_{(p \leq 0.05)}$ Seasons (S): 0.27Sites (ST): 0.19Locations (L): 0.27S × ST × L: 0.73												
Av. Potassium	Spring	60.26	63.14	68.22	78.90	67.63	60.97	63.62	69.00	79.43	68.25	67.94^{D}	L1=72.51^{D}
	Summer	87.84	92.71	98.14	107.85	96.63	88.43	93.35	98.96	108.78	97.38	97.01^{A}	L2=76.95^{C}
	Autumn	74.19	78.49	82.68	93.01	82.09	74.80	78.94	83.26	93.74	82.69	82.39^{B}	L3=82.19^{B}
	Winter	66.62	72.40	78.30	87.94	76.32	67.02	73.00	78.99	88.29	76.82	76.57^{C}	L4=92.24^{A}
	Mean	72.23	76.68	81.83	91.92	80.67^{b}	72.80	77.23	82.55	92.56	81.28^{a}		
	C.D $_{(p \leq 0.05)}$ Seasons (S): 0.42Sites (ST): 0.30Locations (L): 0.42S × ST × L: 1.14												

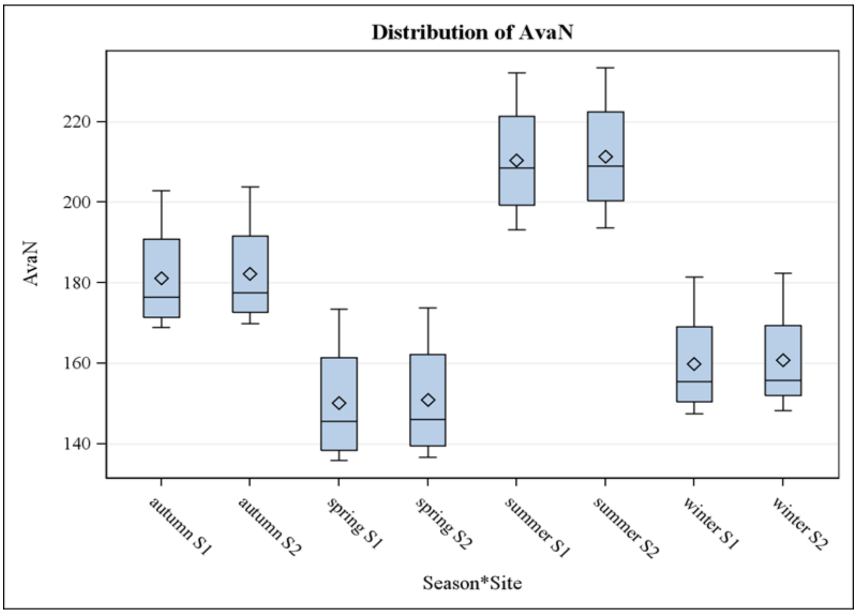

Fig 1: Effect of vehicular pollution on available nitrogen of soil at two different sites

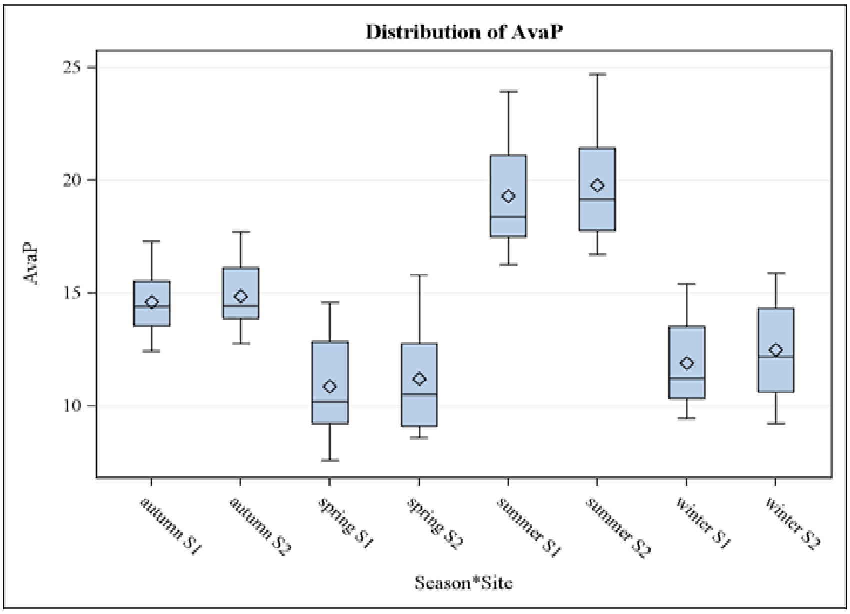

Fig 2: Effect of vehicular pollution on available phosphorus of soil at two different sites

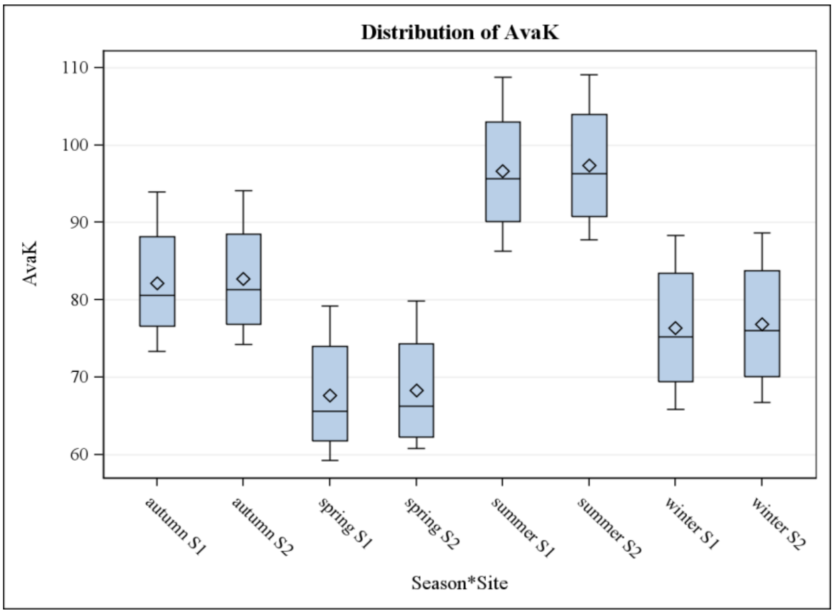

Fig 3: Effect of vehicular pollution on available potassium of soil at two different sites

Discussion

The data regarding the availability of nitrogen, phosphorus and potassium in soil as influenced by various seasons are presented in Table 1 and Fig. 1-3. Soil analysis data revealed that the available nitrogen was higher in the undisturbed area i.e., control (L4) than the disturbed area (L1) of sites S I and S II respectively. The higher concentration of available nitrogen in control (L4) may be due to high concentration of organic matter in the form of leaf foliage. The decrease in available nitrogen in roadside (L1) area may be due to decrease in organic matter and latter being the bank of soil nitrogen. Verma *et al*. (2005) [29] and Zargar *et al*. (2005) [31] also reported that significant decrease in available nitrogen in degraded soils while as, Singh (2004) [21] reported medium to high available nitrogen content in forest soils of Kashmir valley. Suge *et al.*, (2011) [24] reported that higher values of nitrogen may be attributed to the organic matter that provides substrate for microbial growth, and subsequent microbial activity.

Phosphorus is essential nutrient classified as macronutrient because of relatively large amount of phosphorus required by plants. Much of the phosphorus in the soil is not available to plants as it is influenced by soil reaction (pH) and a normal pH (6-7) promotes the most availability of phosphorus to plants (Kimura *et al.*, 2009) [14]. Phosphorus content was found highest in control (L4) area and lowest in roadside (L1) area pertaining to both the sites (S I and S II). Phosphorus availability was strongly influenced by soil pH. The higher pH at control (L4) locations may be the reason for high availability of phosphorus. It has been reported that a large proportion of phosphorus is stored in the forms that are unavailable, for example, H_2PO_4 which becomes available at low pH values and suffers from fixation by hydrous oxides and silicate minerals (Soromessa *et al*., 2004) [22]. The pH of soil is important factor for phosphorus availability and maximum availability was reported in the range of pH 6 to 7 (Tisdale *et al.*, 1997) [25]. Singh (2004) [21]; Chaudhari (2013) [4] and Rasool *et al.* (2014) [18] also observed that the available phosphorus in soil increases with increase in pH i.e. towards neutral (6-7).

Potassium is a macronutrient and also a major constituent of several soil minerals. The data revealed that control (L4) locations at each site (S I and S II) was having higher potassium content as compared to roadside (L1) area concerned to each site (S I and S II). The decrease in potassium content in roadside (L1) area could be probably due to degraded conditions. Basumatary and Bordoloi (1992) [2] and Boruah and Nath (1992) [3] found that layer of organic matter significantly improves the retention of potassium in the soils. Furthermore, degraded condition enhances the rate of leaching of minerals (like K^+) and possibly decreases the concentration of available potassium in the soil. This may be the reason for less content of potassium at roadside (L1) area and high at control (L4) locations. These findings are in accordance with Singh (2004) [21]; Zargar *et al.* (2005) [31]; Chaudhari (2013) [4]; Shah and Jeelani (2015) [20]. Ghiri*et al.* (2011) [8] reported that the distribution of the different potassium forms in the soils varied considerably. This variation may be attributed to the differences in the chemical properties of the soils and possibly the extent to which potassium salts in the different soil series have leached.

Conclusion

It is concluded from the present study that roadside soils are depleted of nutrients (N, P and k) as compared to soils away from roads. The high vehicular load has a negative impact on the vegetation leading to denudation of the area, which in turn leads to changes in the physico-chemical properties of the soil. The exhaust from the high vehicular load diminishes some essential nutrients (N, P and K) and adds toxic heavy metals (Pb^{2+}, Zn^{2+}, Ni^{2+}, Cu^{2+} and Cd^{2+}) in soil environment particularly soils nearer to the road side. The present study reflects vehicular stress on soil ecosystem.

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