IMPACT OF SEASONAL VARIATION, ALTITUDE AND DISTANCE FROM NATIONAL HIGHWAY ON DUST ACCUMULATION ON SOME COMMONLY GROWN PLANT SPECIES OF HIMACHAL PRADESH

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Abstract: In order to develop the usefulness of plants as bio indicators, an appropriate selection of plant species is required which entails an utmost importance for a particular situation. Today's growing population, rapid urbanization and industrialization have resulted in sudden increase in the number of vehicles. The air pollutants emitted out of motor vehicles are one of the major culprits for stress induced changes in plants. Air pollution may directly affect the plants via leaves or indirectly via soil acidification. Therefore, in the present study dust interception efficiency of some selected plant species alongside the National Highway 5 from Solan to Shimla in Himachal Pradesh was assessed. The plant species like *Debregeasia hypoleuca, Rubus ellipticus* and *Quercus leucotrichophora* which were common in occurrence along the highway were selected for the study. The dust accumulation pattern on leaves of selected plants was estimated during winter, spring, monsoon and summer seasons of the year at different distance form National highway. The amount of dust accumulated is significantly affected by season and species and distance from national highway. The highest amount of dust was accumulated by *Rubus ellipticus,* followed by *Debregeasia hypoleuca* and *Quercus leucotrichophora.*

Keywords: Dust accumulation, *Debregeasia hypoleuca, Rubus ellipticus, Quercus leucotrichophora*

Introduction: Air pollution is one of the most severe problems, the world is facing today. The air pollutants transcend across boundaries and thus pose a threat to the vegetation, human health and even buildings and monuments. Since these are easily dispersed and not confined to a particular area, they affect not only the urban areas, but even spread to the rural area which is thus affecting agriculture, wildlife and forests. Today's growing population, rapid urbanization and industrialization has resulted in sudden increase in the number of vehicles. Vehicular traffic is one of the major contributors of dust on plants growing alongside roads. Motor vehicles alone account for 60-70% of the pollution found in urban environment and thus the air pollutants emitted out of these are one of the major culprits for stress induced changes in plants (Dwivedi *et* al. 2008). Plants intercept tons of dust, absorb noise and serve as acoustic screens on busy highways and thus serve as sink by absorbing various air pollutants. The increasing number of industries and automobile vehicles are continuously adding toxic gases and other substances to the environment (Jahan and Iqbal, 1992). Industrialization and the automobiles are responsible for maximum amount of air pollutants and the crop plants are very sensitive to gaseous and particulate pollutants and these can be used as indicators of air pollution (Joshi *et al*., 2009). Plant leaves has been regarded as bio-filters as they absorb large quantities of particles from the environment CPCB (2007).The trees in urban environment improve air quality by enhancing the uptake of gases and particulate matter especially near roadways (Smith, 1971). Air pollutants damage plants, impair growth, and limit primary productivity according to their sensitiveness to pollutants (Ulrich, 1984). Removal of pollutants by plants from air is done by three means, namely absorption by the leaves, deposition of particulates and aerosols over leaf surface, and fallout of particulates on the leeward side of vegetation which ultimately is decided by air movement (Tewari, 1994; Rawat and Banerjee, 1996). Vegetation naturally cleanses the atmosphere by absorbing gases and some particulate matter through leaves and consequently improves environment quality and human health. Trees remove pollution by intercepting airborne particles. Once inside the leaves the gas diffuses into intercellular spaces and may be absorbed by water films to form acids or react with inner leaf surfaces (Smith, 1990).

Urban trees particularly low volatile organic compounds (VOC) emitting species can be a viable strategy to help reduce urban ozone levels (Cardelino and Chameides, 1990; Tanah, 1996; Nowak *et al*., 2000) particularly through tree functions that reduce air temperature, remove air pollutants and reduce building energy and consequent power plant emissions. The foliage of plants filters several numerous solid particles due to roughness and large contact area and thus can reduce the damaging effect of particulate pollution. (Meusel *et al.,* 1999).

Solan-Shimla highway is the gateway to the capital of Himachal Pradesh and is thus one of the busiest highways of the state and therefore, was chosen as the study area and no study has been done in ecologically sensitive hilly regions of the Solan-Shimla highway to study the impacts of pollution on roadside plants species. In the present study, effect of

seasonal variation and distance form national highway on dust accumulation on commonly grown plant species along the National Highway 5 have been studied. The plant species which accumulates maximum amount of dust can be grown along the highway to act as a filter for air pollutants emanating from increased traffic flow to the state.

Materials and Methods: Study area: The study was conducted along the stretch of National Highway 5 from Solan, the Mushroom city of India to Shimla, which is an important tourist destination of North India; covering various small towns and villages in a total span of 45 Kilometres (Figure 1). The stretch of this highway is situated at an altitudinal range of 1450-2000 metres above mean sea level. The average annual rainfall of the region is in the range of 1150-1600 mm and the temperature varies from around 10°C in winters to 32°C in summers. The terrain in the area is hilly with steep slopes having shallow, gravely and light textured soils with low water retentivity and is prone to soil erosion because of its fragility.

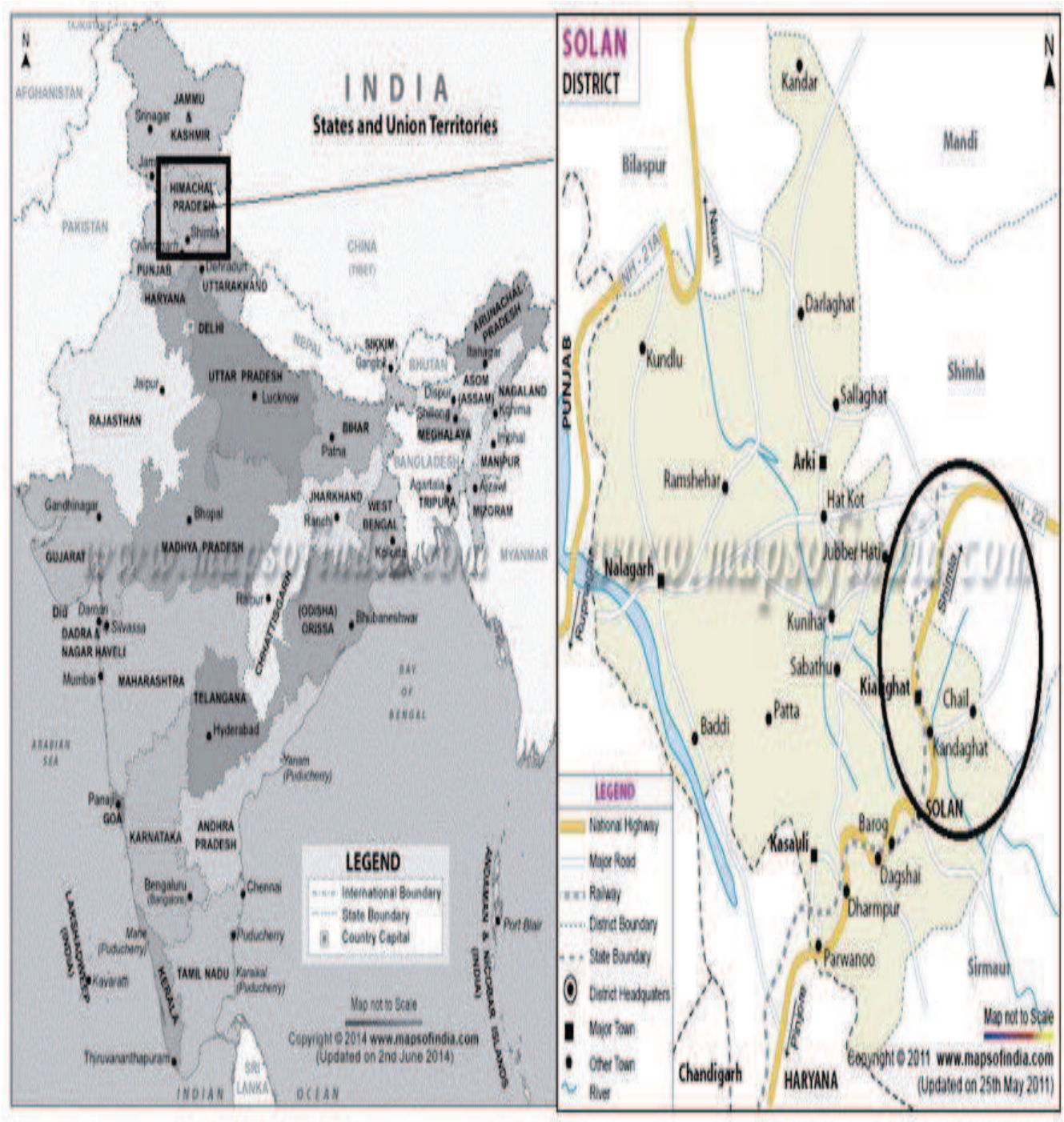

Figure 1: Location of study site

Data collection: The study was conducted on three plant species (*Debregeasia hypoleuca, Rubus ellipticus* and *Quercus leucotrichophora*) which are present throughout the National Highway. Three replications were considered for the study and data were collected during all the four seasons (winter, spring, monsoon and summer). In order to study the horizontal distribution of the dust content, three distances *viz*., 0-5 m, 5-10 m and>100m were considered.

Leaf dust accumulation: Fully matured leaves of the selected plant species were taken for the present study. The upper surfaces of the leaves were cleaned with a fine brush and identification marks were put on them. The leaves were kept undisturbed for 24 hours for dust accumulation which was collected in the pre weighed butter paper bags with the help of a fine brush. The amount of dust accumulated on leaves was weighed on top pan electronic balance and calculated by using the equation:

$W = (W_1-W_2)/A$

W is dust content (gm^{-2}), W_1 is initial weight of butter paper bag, W_2 is final weight of butter paper bag with dust, a is total area of the leaf (m^2). Leaf area was measured by randomly collecting ten leaves from each plant and leaf area was measured with Leaf area meter (Model-LI-COR-3100) and then taking the average.

Results and Discussion: The amount of dust accumulated by *Rubus ellipticus* was 0.058 g/m^2 while that of *Debregeasia hypoleuca* and *Quercus leucotrichophora* was 0.057 g/m^2 and 0.042 g/m^2 respectively (table 1). There was significant difference in the dust content in all the seasons studied, with maximum accumulation in summer season followed by spring > winter > monsoon respectively (Table 2). As shown in Table 1, the amount of dust accumulated is significantly affected by distance, season and species ($P < 0.05$. From table 1 it can also be observed that, the two way interactions viz. species × season, species × distance was found to be significant ($P<0.03$). Highest dust accumulation was observed in *Rubus ellipticus* during summer season. However, the three way interaction among distance, species and season is no significant at 5% level of significance (Table 2). The study indicates that the amount of dust accumulated by the leaves of selected plant species varies with seasons as well as the distance from the National Highway. It was observed that in all the selected plant species, the amount of dust accumulated at the control site was least followed by the distance 5-10 metres and the distance 0-5 metres showed the highest amount of dust accumulated. The maximum dust accumulation, irrespective of the season and the distance from the National highway was noticed in case of *Rubus ellipticus* while minimum dust accumulation was noticed in case of *Quercus leucotrichophora*. In case of *Rubus ellipticus*, the leaves are thorny and this might facilitate the accumulation of dust particles. Dust accumulation in case of *Debregeasia hypoleuca* may be due to larger and rough leaf surface of. In case of *Quercus leucotrichophora*, the leaves are leathery and therefore this might lead to less accumulation of dust.The present findings are in line with Walker and Everett (1987), who studied road dust and its environment impact on Alaskan taiga and tundra and reported that there is decrease in dust load on leaves with increasing distance from Highways. Spatt and Miller (1981) also reported that the dust arising from vehicular traffic settled in greatest quantities near the road with the amount rapidly decreasing away from the road.

Conclusion: The plants which are most efficient in dust accumulation can serve as a buffer zone around industries and along roadsides. Higher amount of dust accumulation by *Debregeasia hypoleuca* and *Rubus ellipticus* may be attributed to the fact that both these species have rough leaf surfaces, while *Quercus leucotrichophora* is found to have a smooth leaf surface and waxy coating. It was observed that the dust content decreased significantly with an increase from the National Highway in all the three species. These species can be recommended for plantation as they can serve as a buffer by accumulating large amount of dust.

Conclusion: The study concluded that the interception of dust varied with species as well as with the distance from the National Highway. Among the selected plant species, *Rubus ellipticus* having the highest dust efficiency can be recommended for growing alongside the highway and for green belt development in order to reduce the atmospheric concentrations of dust, thereby making the environment healthy for human beings.

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Table 1: Seasonal variation in leaf dust (g/m²) accumulation pattern of the selected plants growing alongside the National highway 5 in Himachal Pradesh

	DISTANCE												
PLANT SPECIES	0-5 m.				5-10 m.				>100 m. D_3				Mean
	Winter	Spring	Summer	Monsoon	Winter	Spring	Summer	Spring	Winter	Spring	Summer	Monsoon	
Debregeasia hypoleuca	0.076	0.093	0.105	0.039	0.052	0.061	0.080	0.039	0.032	0.041	0.047	0.016	0.057
Quercus leucotricophora	0.060	0.060	0.070	0.029	0.054	0.052	0.061	0.027	0.026	0.024	0.031	0.013	0.042
Rubus ellipticus	0.081	0.082	0.099	0.036	0.066	0.070	0.085	0.035	0.040	0.042	0.049	0.016	0.058
Mean	0.069				0.057				0.031				
$CD_{0.05}D$= 0.003 S= 0.004 D x S= 0.006 Sp= 0.003													

Table 2: Effect of horizontal distance and seasons on the leaf dust (g/m²) accumulation pattern of selected plants alongside the National Highway 5 in Himachal Pradesh

	Season				
Horizontal distance	**Winter**	**Spring**	**Summer**	**Monsoon**	**Mean**
0-5 m.	0.072	0.078	0.091	0.035	0.069
5-10 m.	0.057	0.061	0.075	0.033	0.057
>100 m.	0.033	0.036	0.042	0.015	0.031
Mean	0.054	0.058	0.070	0.028	
D x Sp= 0.005 S x Sp= 0.006 D x S x Sp= N/A					

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