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Effects of road side pollution on physio-morphology of apple (*Malus pumila* Miller.) at District Kalat Balochistan, Pakistan

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Abstract

Road side (vehicular exhaust) pollution induced significant adverse effects on all types of organisms including plants, animals and humankind. This study was mainly conducted to assess both the quantitative and qualitative damages of vehicles exhaust pollution on road side fruit crops (*Malus pumila* Miller.) of District Kalat, Balochistan. An experiment was conducted at 5 sites along the national highway, NH-25, Karachi to Chaman. Results revealed that under investigated plant showed significant ($P \leq 0.01$) variation both in its physiological and morphological characteristics with respect to the control site samples. Over all reducing % age in leaf length (27.09%), breath (22.95%), petiole length (26.68%), leaf area (36.47%), numbers of fruits plant^{-1} (46.51%) and fruits and stem diameters (42.0 & 11.3%) and canopy (20.80%) were found in polluted site samples. Similarly consequences indicated that dust fall on leaf surface and relative water contents (RWC) in leaf increased by 82.01 and 18.09 % at polluted sites with respect to their control, respectively. However, *M. pumila* displayed decrease in, photosynthetic rate, transpiration rate and stomatal conductance with an enhanced level of sub stomatal CO_2 concentration, free amino acids and total antioxidant activity at various sites along roads. All these parameters indicate that the road side pollution accumulate on plants may cause perilous effects on the growth, yield, physiological and morphological characteristics of the commercially valuable plants. It can be concluded that as the traffic density is inversely proportional to the growth, yield and other performances of the plant.

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Introduction

It has been observed from the last few decades that due to increasing human population the industrialization and number of vehicles are increasing day by day. These vehicles and industries released a variety of air pollutants which may cause the environmental degradation, destruction of all types of road side crops and shortening of the life span of trees. The nature of harmful effects can vary to some extents, depending on the pollutant and tolerance of the species. According to the Rajput & Agarwal (2004) and Chauhan & Joshi (2010) gasses emitted from vehicles, industries and urbanization cause serious environmental stress to crop. The major cities of the developing countries are suffering from urban air pollution which is a major environmental concern (Leghari *et al.*, 2013). Vehicular traffic emission contributes up to 90% air pollution in the road side areas (Aslam *et al.*, 2013; Anon, 2016). Road side plantation is adversely affected by the air quality legislation (Honour *et al.*, 2009). Uppal, (1988) stated that the plants are initial accepters of the air pollution because they are directly exposed to the environment (Gratani *et al.*, 2000). Automobile exhaust influence the CO_2, intensity of light, precipitation, yield and nutrient quality of plants (Ashmoreand Marshall, 1999; Emberson *et al.*, 2001; Wangand Xie, 2009; Achakzai *et al.*, 2010; Bhandarkar, 2013). Leghariand Zaidi (2013) reported that the plants from polluted sites not only showed morphological alterations including color, size, shape and leaf areas and petiole length. Traffic dust injures the stomata (Martin *et al.*, 1988), which reduces the respiration, photosynthesis and transpiration as a result physiological injury appears (Farmer, 1993).Many studies have revealed that the higher concentration of air pollution may cause reduction in photosynthetic pigments (chlorophyll a and b), fats, soluble protein and carotenoid contents in medicinal and economically important plants (Joshi and Swami, 2009; Leghari *et al.*, 2015; Khalid *et al.*, 2017). Apple (*Malus pumila* Miller.) Belong to the plant family Rosaceae. It is mainly used as a cash crop of the study areas cultivated near the road side.

Therefore, the main objective of this study was to assess the effect of road side pollution on plant morphological, physiological and biochemical parameters.

Materials and methods

Description of study sites

Five locations *viz.,* A, B, C, D and E on heavily trafficked National High Way NH-25 were selected for study. This road is 813 km long and it connects Karachi to Chaman. It lies 23 km in Sindh and 790 km in Balochistan. It Passes from Uthal, Bela, Wadh, Khuzdar, Kalat, Mangocher, Mustung, Quetta, Khuchlakh, Killa Abdullah and Chaman. This strategic road connects central Asia through Afghanistan to Pakistan. It was known as Regional Co-ordination Development RCD. Five locations on road were diverse in the level of auto types and number of vehicles. The vehicles consist of buses, vans, trucks, container, loaders, cars and rickshaws. So RCD remained busy round the clock with these vehicular movements. Further that study sites (5 locations) were near district Kalat. District Kalat is situated in the central part of Baluchistan. It lies between latitude 28°.57 and east longitude 29°.25 and 67°.30. It is extended on 6,621sq.km. The climate of district Kalat is arid with hot summer and cold winter. The commercial cash crops of this district are apple, cherry, peach, grapes, apricot, potato, onion, tomato etc.

Sample collection

For the investigation of auto-exhausts pollution effects on morphological, physiological and biochemical parameters, the leaf and fruit sample of apple plants were collected from road side growing plants (1-2 meters away from the edge of the road) and for the comparison samples were also taken from 250m away from the road side of the same crop considered as a control (Ma *et al.*, 2009). Sampling sites on the road were selected after a walk through inspection of various sites and on the basis of assessment of traffic density, level of visible auto emissions fumes/smoke, road dust. The collections were made on the same day and time from both sites (polluted and control). The study was conducted during summer season of the year 2017.

The leaves and fruit sample were collected randomly from the base, middle and upper portion of the plants around all four sides (north, south, east and west) for the accuracy. The samples were packed in labeled plastic bags and placed in an iced cooler and brought to laboratory for the following morphological, physiological and biochemical analysis.

Leaf morphology

The quantitative characters for instance length (cm), breadth (cm), area (cm^2) and petiole length (cm) of leaf were taken with the help of ruler and leaf area meter (CI-202 USA). The Leaf morphological characteristics for example leaf abnormalities, change in color (chlorosis, browning, yellowing, spotting or change in leaf's normal pigment) and shape (normal and deformed/modified) of mature and young leaves were also observed following the procedure used by Leghariand Zaidi (2013).

Relative water contents (RWC)

The relative water contents were measured by gravimetric method as proposed by Singh (1977). The samples were collected and packed in pre-weighed and labeled zipper locked plastic bags and placed in the ice cooler. The fresh weight (FW) was calculated by digital balance. The fresh leaves in the plastic bags were filled with 20ml distilled water to immerse them for 6 to 9 hours and dried by blotting them to get turgid weight (TW). The turgid leaves were dried in overnight at 70ºC in an oven and reweighed as dry weight (DW) and then RWC was obtained by the formula given below:

$$\text{RWC} = \frac{\text{FW} - \text{DW}}{\text{TW} - \text{DW}} \times 100$$

Leaf dust fall

The selected leaf surface was cleaned nicely by cotton and tagged at the lower branches. After 15 days the marked leaves were packed in the pr-weighed (b) bags and sealed thoroughly. The weight of the leaf along with pack was noted (a). Then the leaves were washed properly with distilled water in the laboratory of botany department and cleaned leaves were weighted (c).

The deposit dust on the leaf was calculated with the help of formula [a-(b+c)] and then dust fall on the leaf area were express µg/cm^2 (Gamiand Parel, 2015).

Fruit size and number of fruits

Fruit size was measured by Vernier caliper and number of the fruits was counted attentively.

Fruit moisture content

The fruit moisture content was measured by using formula described by AOAC (2005)

$$\text{Moisture Content (\%)} = \frac{\text{Fresh Weight} - \text{Dry Weight}}{\text{Fresh Weight}} \times 100$$

Stem diameter and plant height

The plant DBH was measured by measuring tape and height was determined by using Clinometer.

Plant canopy

The number of the branches were counted carefully the canopy of the plants at each sites were measured with measuring tape by measuring the tree cover from east to west (A) and North to South (B) and the canopy was taken by the formula as Canopy= AxB.

Gas exchange characteristics and water use efficiency

The gas exchange parameters i.e. photosynthesis, stomatal conductance, transpiration rate and sub-stomatal CO_2 conductance were measured by using portable infrareds gas analyzer (IRGA) (model LCA-4ADC). All the measurements were taken on sunny and shiny day during 10 am to 4pm. Water use efficiency was calculated by the formula used by Agbaire and Esiefarienrhe (2009).

$$\text{WUE} = \frac{\text{photosynthetic rate µmol } CO_2}{\text{Transpiration rate nmole } H_2O}$$

Traffic counting

The vehicles passing along the selected road were counted for 12 peak hours from 8 am to 8 pm for three consecutive days of every month at each 5 sites on National High Way NH-25. Busses, trucks, vans, cars, motor bikes, rickshaws container and loaders were classified and counted separately (Leghari *et al.*, 2013; Kalid *et al.*, 2017).

Results and discussion

Leaf shape and color

The plants grown near the road sides are directly exposed to the pollutants (oxides of carbon, nitrogen and sulphers, lead and dust particles), released by vehicles resulted alteration in physico- morphological characteristics of plants. Facts in Table 1 indicated that leaves of the studied plants showed some changes in their shape and color. These changes in color and shapes in polluted sites plants might's be due to vehicular pollution. Similar observation was also reported by Ozenl *et al.* (2012) and Leghari and Zaidi (2013). They found significant morphological changes in different road side plant species.

Table 1. Effects of roadside pollution on leaf morphological characteristics of *Malus pumila* Miller. During different growth stages.

Sites	Growth stage	Color		Shape	
		Polluted	Non-Polluted	Polluted	Non- Polluted
A	Mature	Yellowish	Dark Green	Deformed	Typical
	Young	Light Green	Light Green	Deformed	Typical
B	Mature	Yellowish Green	Dark Green	Deformed	Typical
	Young	Light Green	Dark Green	Deformed	Typical
C	Mature	Yellowish	Dark Green	Deformed	Typical
	Young	Light Green	Dark Green	Deformed	Typical
D	Mature	Yellowish	Dark Green	Deformed	Typical
	Young	Light Green	Dark Green	Deformed	Typical
E	Mature	Yellowish	Dark Green	Deformed	Typical
	Young	Light Green	Dark Green	Deformed	Typical

Table 2. Effects of air pollution on leaf length, breadth and petiole length (cm) of *Maluspumila* Miller.

Sites	Leaf length			Leaf breadth			Petiole length		
	PS	NPS	Rd%	P	NP	Rd %	P	N.P	Rd%
A	8.0±0.9	11.5±1.2	30.6^{***}	5.2±1.1	7.1±0.4	27.3^{***}	2.6±0.4	3.7±0.3	29.9^{***}
B	8.3±1.3	11.6±0.9	28.4^{***}	5.3±0.9	7.1±0.4	26.4^{***}	2.7±0.4	3.8±0.4	30.0^{***}
C	8.5±0.8	11.8±0.9	27.3^{***}	5.4±0.7	7.2±0.5	24.3^{***}	2.9±0.3	3.9±0.2	27.2^{***}
D	8.7±1.0	11.9±1.2	26.9^{***}	5.7±0.8	7.2±0.6	20.5^{**}	2.9±0.2	3.9±0.3	25.9^{***}
E	9.2±1.0	12.0±1.1	22.7^{*}	6.1±0.4	7.3±0.6	16.4^{ns}	3.1±0.3	4.0±0.2	22.5^{**}

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at p<0.05, **significant= p<0.02,*** highly significant= p<0.01, ns= not significant.

Leaf length, breadth and petiole length

The minimum leaf length, breadth and petiole length (8.0to 9.2, 5.2 to 6.1 and2.6to 3.1cm) was noted at polluted sites plants with respect to the non-polluted sites, where the maximum mean values were in the range of;11.5to 12.0, 7.1to 7.3 and 2.6to 3.1 cm, respectively (Table 2).

The statistical analysis indicated that the plants of all five sites (A,B,C, D and E) showed significant (p<0.05) reduction in their leaf length, breadth and petiole length with respect to control site (Table 2), while overall reducing percentage was noted;27.09, 22.95 and 26.68% (Fig. 1) respectively. Similar results were also found by Shafiq *et al.*, (2009) and Preeti (2000). Many plants have exhibited reduction in their leaf length and breadth in highly polluted areas as resulted by Leghari and Zaidi (2013).

Table 3. Effects of roadside air pollution on leaf area (cm^2) and dust fall level ($\mu g/cm^2$) on leaves of *Malus pumila* Miller.

Sites	leaf area			Dust fall on leaf		
	PS	NPS	Rd %	PS	NPS	Inc %
A	31.2 ±8.3	54.5±5.7	42.9***	5.28±1.9	1.93±1.0	63.5***
B	32.9 ±8.2	55.4 ±4.9	40.6***	4.55±1.9	0.36±0.2	92.1***
C	34.9±6.3	56.2±6.9	37.9***	3.63±1.5	0.42 ±0.4	88.4 **
D	37.6 ±8.1	57.2 ±7.4	34.2**	2.87±1.3	0.36±0.1	87.5***
E	42.5 ±4.7	58.7 ±8.2	27.6*	2.57±1.2	0.35 ±0.3	86.4***

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at $p<0.05$, ** significant= $p<0.02$, *** highly significant= $p<0.01$, ns= not significant.

Table 4. Effects of road side air pollution on leaf and fruit moisture contents of *Malus pumila* Miller.

Sites	Fruit Moisture Content (%)			Leaf Relative Water Content (%)		
	PS	NPS	Rd%	PS	NPS	Inc %
A	57.7±2.5	79.3±2.9	27.2*	75.2± 3.5	61.8±3.1	17.9*
B	58.9±3.4	78.8±3.2	25.3*	78.6±6.2	53.9±6.1	31.4*
C	59.4±3.4	78.9±3.6	24.7*	72.5±2.6	64.6±2.4	10.9*
D	69.3±1.2	79.8±2.6	13.1ns	70.9±3.6	63.1±2.6	11.1ns
E	72.4±2.1	82.8±1.3	12.5ns	68.6±5.1	56.3±5.8	17.9*

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at $p<0.05$, ** significant= $p<0.02$, *** highly significant= $p<0.01$, ns= not significant.

They also found decline in the leaf length, breadth and area of *Eleagnus angustifolia* L and *Pistacia vera* L. In addition Preeti (2000) reported that the compound leaf exhibited maximum reduction as compare to simple leaf at polluted side.

The significant reducing %age in petiole length was also reported in other plant species by many other researchers Jahanand Iqbal (1992); Zaidi and Leghari (2004); Shafiq *et al.*, (2009).

Table 5. Effects of roadside air pollution on number and diameter of fruit and diameter of stem of *Malus pumila* Miller.

Sites	Number of fruitsplant^{-1}			Fruit diameter (cm)			Average stem diameter (inches)		
	PS	NPS	Rd%	PS	NPS	Rd%	PS	NPS	Rd%
A	221.0±14.4	464.8±18.3	52.5***	4.54±0.4	8.2±0.6	44.6***	32.8±1.3	38.1±1.3	13.8***
B	288.2±18.6	542.4±10.1	46.9***	4.74±0.4	8.6±0.9	44.8**	55.1±1.6	62.6±2.1	11.9***
C	305.0±34.5	596.8±23.7	48.9***	4.94±0.4	8.4±0.7	40.9*	53.2±1.6	60.7±2.0	12.3**
D	346.4±23.5	612.0±20.1	43.4***	5.16±0.4	8.9±0.4	42.0*	53.2±2.7	60.7±3.1	12.3**
E	183.8±15.5	297.6±11.9	38.2***	5.60±0.3	9.1±0.2	38.2 ns	33.4±1.8	35.0±1.1	4.5ns

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at $p<0.05$, ** significant= $p<0.02$, *** highly significant= $p<0.01$, ns= not significant.

Table 6. Effects of roadside air pollution on plant height and canopy.

Sites	Plant height (feet)			Tree canopy feet^2		
	PS	NPS	Rd%	PS	NPS	Rd%
A	8.6±0.2	10.0 ±0.3	14.2***	109.3±13.8	156.8±18.2	30.3***
B	10.6±0.3	12.0±0.3	11.8***	164.6±33.2	256.0±30.4	35.7***
C	13.6±0.3	15.1±0.4	9.7***	243.8±28.7	296.0±15.9	17.6ns
D	13.8±0.5	14.8±0.8	7.0 ns	272.6±13.3	304.5±7.4	10.5ns
E	8.8±0.5	9.3±0.8	5.2 ns	87.1±8.0	94.5±6.5	7.9 ns

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at $p<0.05$, ** significant= $p<0.02$, *** highly significant= $p<0.01$, ns= not significant.

Leaf area and dust fall on leaf

Data regarding leaf area and dust fall on leaf are presented in Table3 and Fig. 2, which showed significant variation between two sites plants (polluted and non-polluted). Results indicated that minimum leaf area was found in the range of 31.2to42.5 cm^2at polluted site plants and dust fall (0.35to 1.9 µg/cm^2) at non polluted sites, while maximum leaf area was found in the range of 54.5to58.7 cm^2in non-polluted site and maximum dust fall on leaf was in between 2.6 to 5.3 µg/cm^2at polluted site. Statistical analysis (t-test) indicated that leaf area and dust fall on sites A, B, C, D and Exhibited highly to slightly significant variations (Table 3). The variation within different sites might be due to deviation in number of vehicles, as the data shown in Table 8 are in support this opinions, where the maximum number of vehicles (1104.5/h) was found at location A and lowest were noted (335.5/h) at location E.

Table 7. Effects of roadside air pollution on photosynthetic and transpiration rate and water use efficiency of *Malus pumila* Miller.

Sites	Photosynthetic Rate µmole CO_2 A			Transpiration Rate mmole H_2O E			Water use Efficiency µmole CO_2/mmole H_2O		
	PS	NPS	Rd%	PS	NPS	Rd%	PS	NPS	Rd%
A	8.6±1.5	22.2±1.9	61.3***	1.2±0.1	2.8±0.3	56.8***	7.4±2.3	8.0±0.4	7.60^{ns}
B	9.4±2.7	22.8±1.9	58.8***	1.3±0.2	2.8±0.2	54.3***	7.4±2.3	8.2±0.7	9.20^{ns}
C	10±2.1	23.0±0.7	56.5***	1.3±0.1	2.7±0.2	51.9***	7.7±1.8	8.6±0.6	9.90^{ns}
D	13±3.5	23.2±0.8	44^{ns}	2.0±0.4	2.8±0.2	27.7^{ns}	7.2±3.3	8.2±0.4	12.40^{ns}
E	17.2±2.3	23.6±0.5	27.1^{ns}	2.4±0.1	2.8±0.2	13.0^{ns}	7.3±1.4	8.6±0.5	14.6^{ns}

Each value is the mean of three replicates, PS= polluted site, NPS= Non-polluted site, Rd=Reducing %, Inc= Increasing %, ± = standard deviation, *slightly significant at $p<0.05$, ** significant= $p<0.02$, *** highly significant= $p<0.01$, ns= not significant.

Table 8. Average traffic density on NH-25 5 different locations of District Kalat.

Sites	Number of vehicles per hour			
	2 and 3-Wheeler	4-Wheeler	≥6 Wheeler	Sum
A	673.8 ±178.38	373±113.08	57.8 ±12.5	1104.5±296.11
B	532.8 ±165.35	319±142.48	53.5±09.2	0905.3 ±304.45
C	436.8 ±171.10	285 ±140.25	54.3 ±14.6	0775.5±298.42
D	333.0 ±153.17	264±105.34	56.0 ±11.6	0653.0 ±243.36
E	118.5±060.93	156±055.03	61.0 ±22.3	0335.5±090.95

The observation reported by Gupta & Ghouse (1988); Qadir & Iqbal (1991) and Jahan & Iqbal (1992) are also in the favor of our results. In present investigation at polluted site the overall decreasing % age in leaf area was noted 36.47 % and increasing % age of leaf dust fall was found 82.01% (Fig. 2). This significant decrease in leaf area at polluted site plants as compared to the non-polluted site may be due to higher level of dust fall on leaf which cause clogging of stomata and may reduce the photosynthesis and transpiration rate resulted in the reduction of leaf area. Reductionin leaf area of *Rosa indica* L. (57.98%) and *ficuscarica* (22.66%) at polluted site was also reported by Leghari and Zaidi (2013).

Relative water contents (RWC) in leaves and fruits

Relative water contents in leaves and fruits of polluted site were found in the range of 68.56to 78.58and 57.73to 72.41, respectively while at non-polluted site it was 53.93to 64.61and 79.29to 82.77, respectively. Results indicated that RWC in leaves were significantly higher at polluted site as compared to non-polluted site and in fruit it was vice versa (Table 4).

The higher level of water contents in leaves at polluted site might be due to more dust accumulation which prevents the transpiration rate.

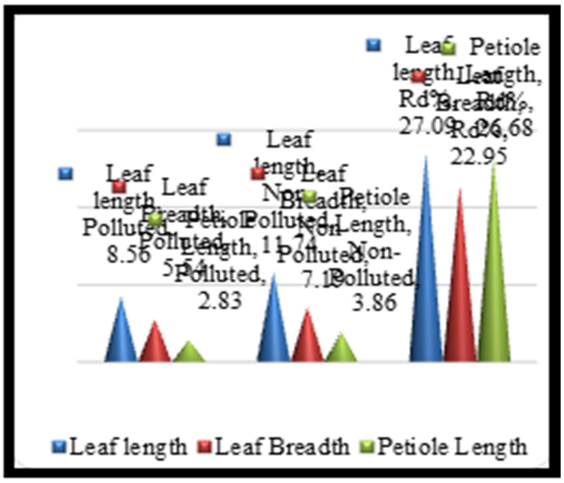

Fig. 1. Overall decrease in leaf length, leaf and petiole length parameters at all polluted site.

At polluted site overall increasing percentage in leaf water content was found 18.09%, and decreasing %age of water in fruit was noted as20.48%. Similar observations were also reported in *Pinus halpensis* Miller. *Fraxinus xanthoxyliods* and *Vitis vinifera* (Saura-Mas & Lloret, 2007; Leghari *et al.*, 2011 and 2013). Paulsamy *et al.*, (2000) also observed higher RWC in *A. indica*at polluted site.

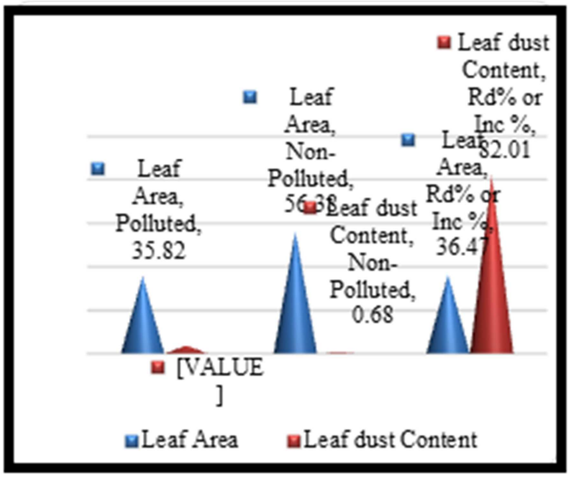

Fig. 2. Over all decreas in leaf area (Cm² and increase in leaf dust (µg/Cm² at all polluted site.

The consequences of statistical t-test exhibited that average RWC in leaf and fruit at site A,B and C showed significant ($p<0.05$) variations, while D and E showed non-significant difference.

These differences may be due to different number of vehicle at different study locations.

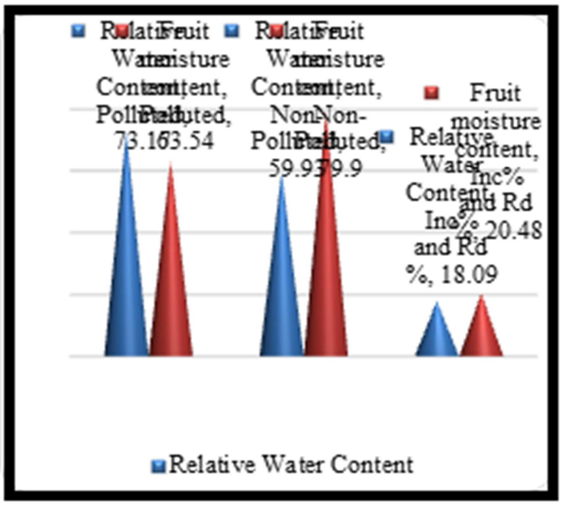

Fig. 3. Overall increased leaf and fruit moisture contents at five locations.

Number of fruitsplant⁻¹ and fruit and stem diameter

Data regarding number of fruitsplant^{-1} and fruit and stem diameter were disclosed in Table 5 and Fig. 4 & 5.Statistical analysis (t-test) indicated that except location E all the other locations (A, B, C and D) showed highly to slightly significant variation in their number of fruits and fruit and stem diameter with respect to their control sites.

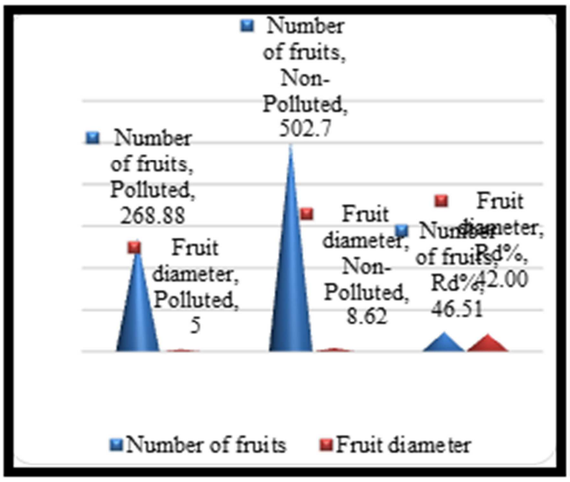

Fig. 4.overall decrease in number and fruit diameter at all polluted sites.

At polluted site the number of fruits plant^{-1}and fruit and stem diameter were found in the range of 183.8 to 346.4, 4.5 to 5.6cm and 32.8 to 55.1inches, while at non polluted site these were; 297.6 to 612/plant, 8.2 to 9.1cm and 35 to 62.6inches, respectively.

Olszyk, (1989) and Olszyk *et al*., (1990) predicted that the SO_2 reduces the number of fruit by (23 to 35%). Thompson *et al*., (1970) reported that exposure of 0.25ppm of NO_2cause reduction in the fruit yield of citrus plants.

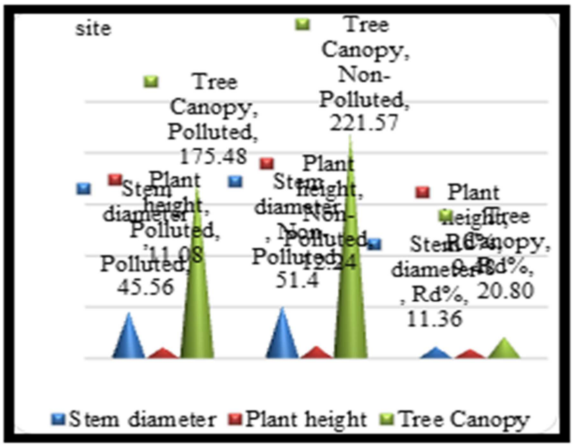

Fig 5.overall decrease in stem diameter, plant height and canopy at all polluted.

Over all decreasing %age in number of fruit, fruit size and stem diameter at polluted sites were recorded; 46.51, 42.0 and 11.36 %, respectively. Similar results were found by Snyder *et al*., (1991), they noted 20.8% reduction in watermelon [*Citrullus lanatus* (Thunb)] at polluted site in India. In our study the non-significant variation at point E might be due to low traffic density as reflect by the Table 8.

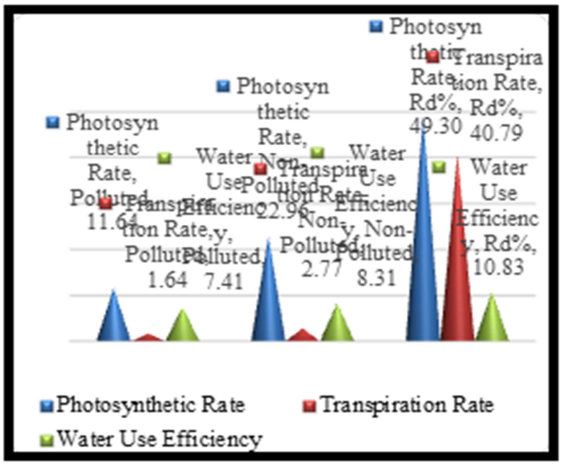

Fig 6.overall decrease in P. rate, T. rate and WuE at all polluted sites.

Plant height and canopy

Plant height and canopy at polluted site was noted between; 8.58to 13.76feetand 87.08to 272.6feet² and at non-polluted site it was 9.3to 15.1and 94.54 to 304.5, respectively (Table 6).

Highly significant ($P<0.01$) differences was found in average height of plants at site A, B and C, however D and E showed non-significant results. Similarly plant canopy exhibited highly significant variation at locations A and B, while C, D and E showed non-significant as compared to the control site (Table 6). Overall reducing %age at all the polluted sites were;9.5 and 20.8% respectively (Fig.5).The reduction in invested plant height and canopy at polluted sites might be due to higher level of air pollution.

Photosynthetic and transpiration rate and water use efficiency

Data regarding photosynthetic and transpiration rate and water use efficiency are shown in Table 7.The photosynthetic and transpiration rates at polluted sites plants were found in the range of 8.6 to 17.2 and 1.2 to 2.4, respectively however at non-polluted site plants the range was22.2to 23.6 and 2.7to 2.8, respectively. The low photosynthetic and transpiration rates at polluted site plants might be the cause of higher accumulation of dust fall on leaves. Similar observation was also reported by Shukla *et al*., (1990), they found that the accumulation of cement dust on near about plants reduced the photosynthetic and transpiration rates and clog of stomata. Furthermore Nanos & Illias (2007) reported reduction in stomatal conductance and transpiration of olive tree due to road side dust accumulation on leaf surface. Due to effect of road side dust cotton showed lower rate of transpiration at stage of growth (Zia-Khan *et al*., 2015).Statistical analysis of the results indicated highly significant ($p<0.01$)higher at polluted site as compared to control site at points A, B, C, while locations D and E showed non-significant for both parameters (photosynthetic and transpiration rate). The water use efficiency at polluted and non-polluted sites were in the range of; 7.2to7.4 and 8.0to 8.6respectively, which showed non-significant variation. Overall decreasing %age at polluted site in photosynthetic rate, transpiration rate and water use efficiency were; 49.3, 40.8 and 10.8%.Observation reported by Thomson *et al*., (1984) are in the support of our results. They studied the effect of dust fall on road side plants and found reduction in photosynthetic and transpiration rates at polluted sites.

Conclusion

This investigation established a diversity of replies presented by *Malus pumila* Miller. to road side pollutants. The consequences evidently designated the hypothetically harmful effects produced by roadside air pollution on morphology and physiology of *M. pumila*. The scale of influences formed by roadside pollution on *M. pumila* was diverse by level. *M. pumila* displayed decrease in photosynthetic rate, transpiration rate and stomatal conductance with an enhanced level of sub-stomatal CO_2 concentration, at various sites along both roads. So on the basis results of this study it can be concluded that the road side pollution significantly reduced the quantity and quality road side fruit plants. The biological qualities determined in this investigation obviously specify that they might be used as bio-indicator basis for nursing and forecast of early properties of air born roadside pollution.

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