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EFFECT OF AUTO-EXHAUST POLLUTION ON SOME PHYSIOLOGICAL PARAMETERS OF ROADSIDE *TRITICUM AESTIVUM* AND *HORDEUM VULGARE*

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Abstract

Air pollution is a worldwide problem which increases day by day by different human activities. The enormous increase in vehicle numbers running on roads is one of the most important causes of air pollution. This study was performed to determine the impact of road side auto-exhaust pollution on the growth of two economically important crops in Egypt (*Triticum aestivum* and *Hordeum vulgare*). It was found that yield parameters, carbohydrate, soluble protein of plant seeds grown on road side were significantly decreased compared with plants away from road side by distance of at least 1 meter. Lead concentration was higher in plant seeds grown on road side and this was reflected on the ionic concentrations of Ca, K, Mg and Fe. Total amino acids content of seeds was highly increased in response to air pollution, so the amino acids profile can be taken as a bioindicator of auto-exhaust air pollution.

Key words: Air pollution, Lead toxicity, Proline, Yield parameters, Carbohydrates, Proteins, Minerals, Amino acids.

Introduction

In the last few decades all over the world, there has been a sharp increase in air pollution. There is many fold increase in the number of cars running on roads and highways. Petrol and diesel driven motor vehicle emit pollutants like Co, oxides of nitrogen, suspended particulate matter, benzene, Sulphur dioxide, smoke, dust and metals (Pb, Co, Cu, Cd, etc.). The ultra-fine particles when emitted, quickly aggregate into large particles by reaction with other pollutants like nitrogen oxides, sulphur dioxide, volatile organic compounds and ammonia (Street *et al.,* 1996). Different studies have indicated that metals such as Cd, Pb and Ni cause many diseases, which have lethal effects on animals and man (Giddings, 1973; Gustav, 1974). Plants which are growing along road sides are exposed to many pollutants emitted from automobiles. Plants have a large surface area and their leaves are considered as devices for trapping pollutants (Sirajuddin *et al.,* 2012). The use of plants for monitoring air pollution has long been considered as plants are established the initial acceptors of air pollutant. Chlorophyll is the principal photoreceptor in photosynthesis process. One of the most important effects of air pollution is the decrease in chlorophyll and a concomitant yellowing of leaves, which associated with a reduction in the photosynthesis process (Joshi & Swami, 2007). Air pollutants affect the stomatal opening of the road side plants (Zeb *et al.,* 2017) and it also affects the stomatal number (Shrivastava, 2017). The presence of So_2, carbon monoxide, nitrogen oxides and other pollutant in the air content of vehicular traffic leads to an increase in the proline content of plants. Proline is of special importance because of its large accumulation in plants subjected to different environmental stresses (Wang *et al.,* 2009). The present investigation examines the effect of road side air pollution on two economically important plants in Egypt.

Materials and Methods

In the present study, plants were obtained from a polluted area which have a high traffic density in Tanta city (the average daily traffic density were 5,500 vehicles). Plants were collected from the road edge (plants which were found in contact directly with auto-exhaust fumes), inwards up to 50 cm and 100 cm away from the road sides. Each plant sample was replicated 5 times. The samples were kept in a suitable paper bags and the following measurements were carried out. (1) Yield parameters (number of grains per spike, spike weight, grains weight per spike and weight of 1000 grains). (2) analysis of total carbohydrates, total soluble proteins, amino acids content and some mineral contents in the dry grains.

Estimation of total carbohydrates: Pipette 1ml of the sugar solution, add 1ml of 5% aqueous phenol solution, then 5ml of conc. Sulphuric acid, stand for 20 minutes, at room temperature. The absorbance was evaluated at 485nm (Dubois *et al.,* 1956).

Estimation of total soluble proteins: The total soluble proteins were measured in the borate buffer extract by using the method of Bradford (1976). The protein contents were calculated as mg/g dry weight by using a calibration curve of Bovine Serum Albumin protein.

Estimation of amino acids: The contents of amino acids in the fine powder of dry seeds were determined by HPLC as described by Weibull *et al.,* (1990).

Determination of minerals content: Dry seeds powder (0.1g) was digested in HNO_3 and H_2O_2 (3:2). Total contents of different elements were estimated in the digested solution by using Perkin Elemer Emission Spectrophotometer-6000 Series, Thermo Scientific as described by Allen *et al.,* (1997).

Statistical analysis

The presented results were statistically analyzed to determine the degree of significance between the different treatments. Analysis of variance (ANOVA) was determined according to the methods of Bishop (1983).

Results and Discussion

The results of the present study showed the impact of vehicular pollution on the plants growing along the road side. As shown in (Table 1) all the yield parameters were highly increased by moving away from the road side. In *Triticum aestivum* plant, there was a highly significant increase in spike weight 63.5% at 100 cm distance away from the plants growing at the road side compared with 10.3% increase in *Hordeum vulgare*. Also, seeds number per spike were increased by 57.5% in *Triticum aestivum* compared with 30.4% in *Hordeum vulgare*, seeds weight per spike increased by 66.6% in *Triticum aestivum* compared with 24.2% in *Hordeum vulgare* and the weight of 1000 seeds was increased by 18.8% in *Triticum aestivum* compared with 14.1% in *Hordeum vulgare*. The results of this investigation are supported by the findings of Ahmed *et al.*, (2016) and Nithamathi and Indira (2005) who found that air pollutants affect seeds germination, number of flowers in inflorescence and fruit production. The vegetation injury and losses in the crop yield of plants growing along road sides may be attributed to many pollutants and gases emitted from automobiles.

Wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) are an important cereal crops in Egypt, so we must avoid and prevent any factors that affect their productivity. In the present investigation, we found that when we increase the distance away from the road side up to 100 cm there was a gradual significant increase in carbohydrate content of seeds (Fig. 1) and protein content of seeds (Fig. 2) of both wheat and barley. The protein content of wheat seeds (Fig. 2) seems to be less affected by air pollution than carbohydrate. Lead (Pb) is a strong environmental pollutant and it is toxic even in very small concentrations (Levine *et al.*, 1989). The exhaust fumes of automobiles contain large amounts of Pb (Elick *et al.*, 1999). Lead alters the quantity and activity of the key enzymes of different metabolic pathways such as those found in the photosynthetic Calvin cycle reactions (Stevens *et al.*, 1997), nitrogen metabolism and protein synthesis (Kumar & Dubey 1999), and sugar metabolism (Verma & Dubey 2003).

The pattern and concentration of amino acids of wheat and barley seeds as influenced by road side auto-exhaust pollution and plants grown away from the road side are shown in (Figs. 3a,b) and (Table 2). The results indicated 429.1% increase in the total amino acids in wheat seeds affected by air pollution on road side compared with plants grown away from the road side by 100 cm. In barley seeds, we found an increase with 174.4%. Proline is considered one of the most common amino acids and it has a special interest because of its pronounced accumulation in plants under environmental stress (Wang *et al.*, 2009). In the present study we found 400% increase in proline in wheat seeds at road side compared with plants away from the road side by 100 cm. In barley seeds, the increase was by 174.4%. These findings were in accordance with (Patidar *et al.*, 2016). The harmful effects of auto-exhaust pollutants may be caused by the accumulation of Reactive Oxygen Species (ROS) in plants, which results in destruction of cell contents. It has been reported that proline acts as a free radical scavenger works to protect plants away from damage by oxidative stress.

From the results of this investigation, it was found that Lead (Pb) concentrations in both wheat and barley seeds at road side were high (0.019 mg/g dry wt in wheat and 0.015 mg/g dry wt in barley) compared with plants grown away from the road edge by 100 cm (0.007 mg/g dry wt in wheat and 0.006 mg/g dry wt in barley) (Table 3). The high concentration of Pb detected in plants grown beside the road side decreases the concentration of other minerals (Ca, K, Mg and Fe) which increase by moving away from the road side (Table 3). Lead element is a major pollutant emitted from automobiles, as it is obvious that plants which are growing near high ways are usually exposed to more Pb than other sites (Paivoke, 2002). Lead has the ability to decrease photosynthesis, changes hormonal balance, affects membrane structure and permeability and disturbs mineral nutrition (Hadi & Aziz 2015). Pb inhibits chlorophyll formation by reducing the uptake of most essential elements such as Fe and Mg by plants (Burzynski, 1987). In this concern, Asghar *et al.*, (2004) found that, Pb concentration was significantly higher in road side plants which resulted to a significant effect on the ionic concentrations of Mg, Ca, K and P. Also, Amusan *et al.*, (2003) concluded that the concentration of heavy metals decreases with increasing horizontal distance away from the road edge.

Table 1. Effect of the distance away from the road-edge (cm) on the yield parameters of *Triticum aestivum* and *Hordeum vulgare* (Mean ± SD, n=5).

Parameter	*Triticum aestivum*			*Hordeum vulgare*		
	0	50 cm	100 cm	0	50 cm	100 cm
Spike weight (gm)	0.938 ± 0.1	1.72 ± 0.1**	2.57 ± 0.3**	3.93 ± 0.2	4.12 ± 0.3	4.38 ± 0.4
Seeds number per spike	17 ± 1.4	30.4 ± 2.2**	40 ± 2.5**	48 ± 1.8	57.8 ± 1.9*	69 ± 2.1*
Seeds weight per spike (gm)	0.618 ± 0.1	1.196 ± 0.1**	1.849 ± 0.2*	2.92 ± 0.3	3.52 ± 0.4	3.85 ± 0.4
Weight of 1000 seeds (gm)	35.9 ± 1.2	42.7 ± 1.7*	44.2 ± 1.5	52.3 ± 1.4	56.3 ± 1.8*	60.9 ± 1.9*

*Significant at 0.05 level and **Significant at 0.01 level of significance

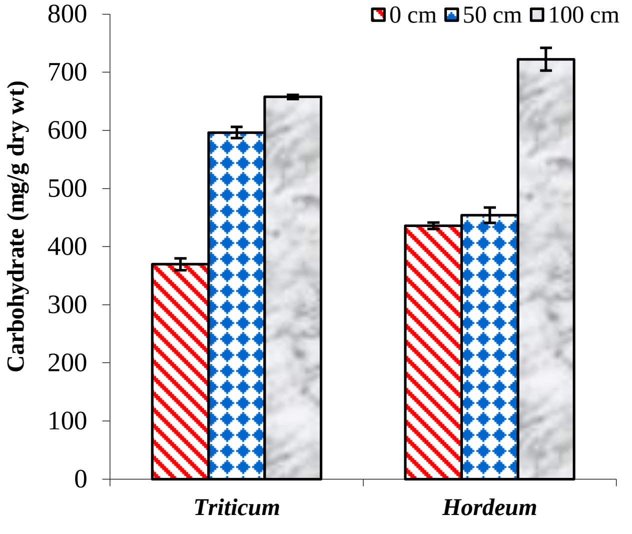

Fig. 1. Effect of the distance away from the road-edge (cm) on the carbohydrate contents (mg/g dry wt) of *Triticum aestivum* and *Hordeum vulgare* seeds.

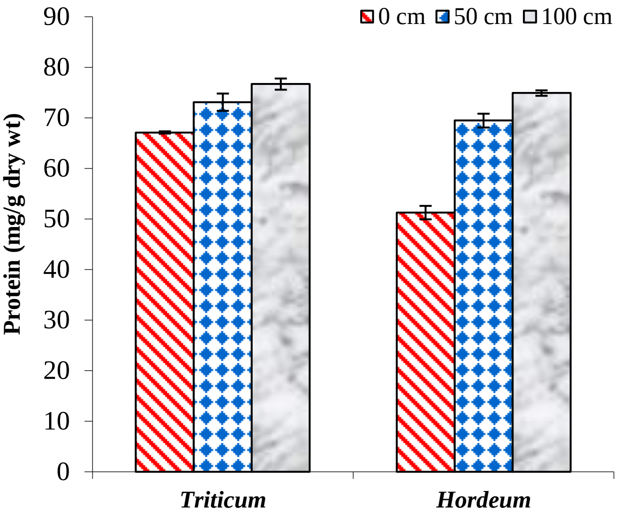

Fig. 2. Effect of the distance away from the road-edge (cm) on the soluble proteins (mg/g dry wt) of *Triticuma estivum* and *Hordeum vulgare* seeds.

Table 2. Effect of the distance away from the road-edge (cm) on the amino acids composition (% conc ppm / 1gm dry wt) of *Triticumaestivum*and *Hordeumvulgare*seeds.

Amino acids	*Triticum aestivum*			*Hordeum vulgare*		
	0	50 cm	100 cm	0	50 cm	100 cm
Aspartic	0.277	0.120	0.050	0.077	0.063	0.027
Threonine	0.120	0.057	0.020	0.037	0.030	0.010
Serine	0.190	0.090	0.030	0.040	0.037	0.013
Glutamic	1.337	0.580	0.203	0.287	0.267	0.103
Proline	0.600	0.247	0.120	0.247	0.233	0.090
Glycine	0.193	0.087	0.030	0.040	0.037	0.013
Alanine	0.240	0.107	0.067	0.047	0.040	0.017
Valine	0.150	0.067	0.040	0.043	0.037	0.013
Methionine	0.043	0.020	0.013	0.010	0.013	0.004
Isoleucine	0.110	0.050	0.027	0.027	0.023	0.010
Leucine	0.270	0.120	0.060	0.063	0.057	0.023
Tyrosine	0.073	0.037	0.013	0.020	0.020	0.007
Phenylalanine	0.190	0.083	0.027	0.053	0.047	0.020
Histidine	0.123	0.053	0.023	0.033	0.030	0.013
Lysine	0.100	0.047	0.023	0.033	0.030	0.010
Argnine	0.180	0.087	0.047	0.047	0.040	0.013
Total amino acids	**4.196**	**1.852**	**0.793**	**1.104**	**1.004**	**0.386**

Table 3. Effect of the distance away from the road-edge (cm) on the mineral content (mg/g dry wt) of *Triticum aestivum* and *Hordeum vulgare*seeds.

Minerals (mg/g dry wt)	*Triticum aestivum*			*Hordeum vulgare*		
	0	50 cm	100 cm	0	50 cm	100 cm
Ca	2.781	3.750	3.363	2.240	3.882	3.831
K	5.118	5.484	6.135	4.080	5.058	6.306
Mg	2.035	2.291	2.354	1.045	1.182	1.630
Fe	0.235	0.241	0.391	0.246	0.408	0.381
Zn	0.156	0.145	0.110	0.098	0.078	0.064
Cu	0.218	0.200	0.165	0.168	0.139	0.132
Pb	0.019	0.020	0.007	0.015	0.014	0.006

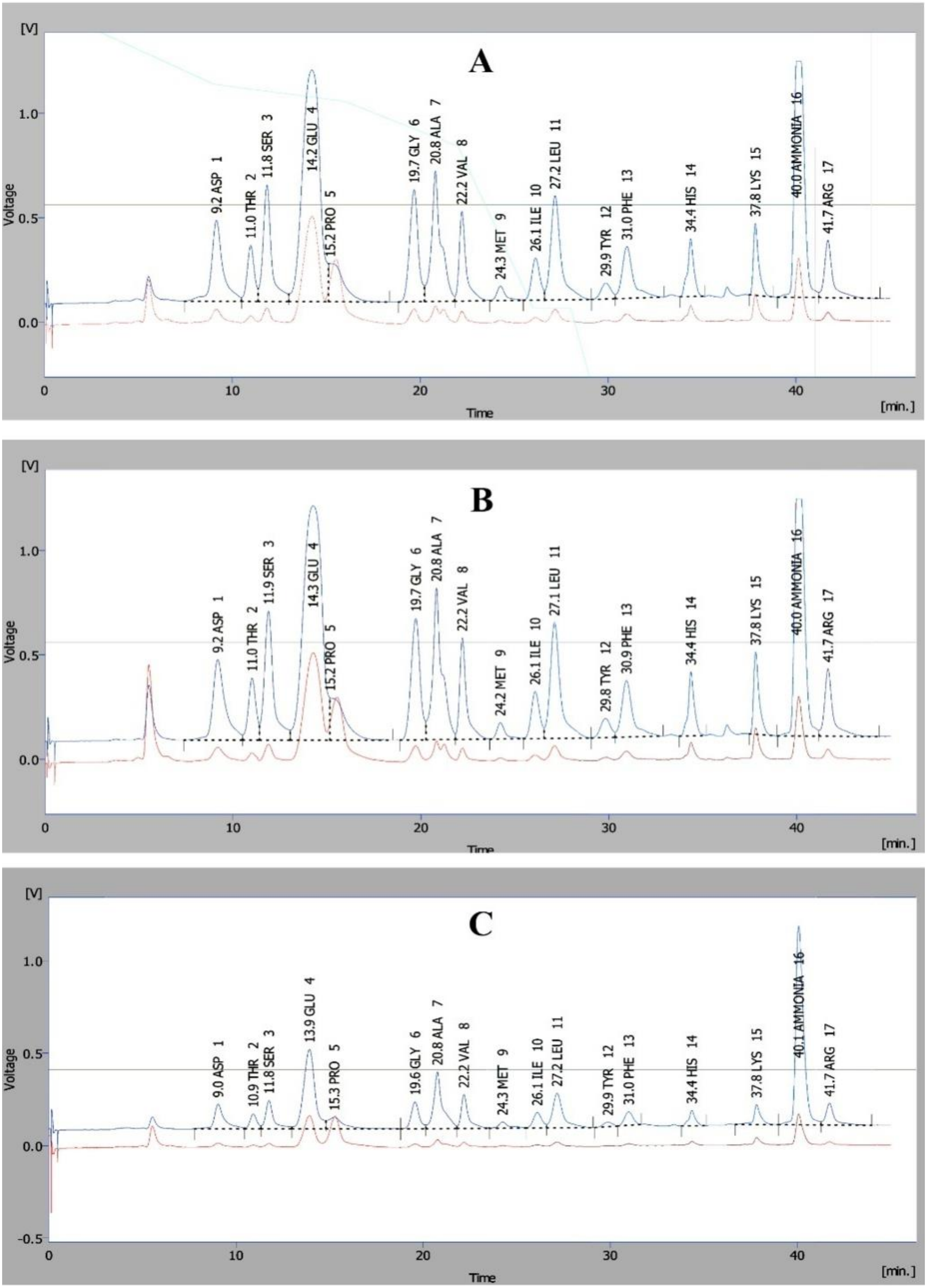

Fig. 3a. HPLC analysis of free amino acids extracted from *Triticum aestivum* seeds.
Plants at the road edge B. Plants at distance of 50cm C. Plants at distance of 100cm

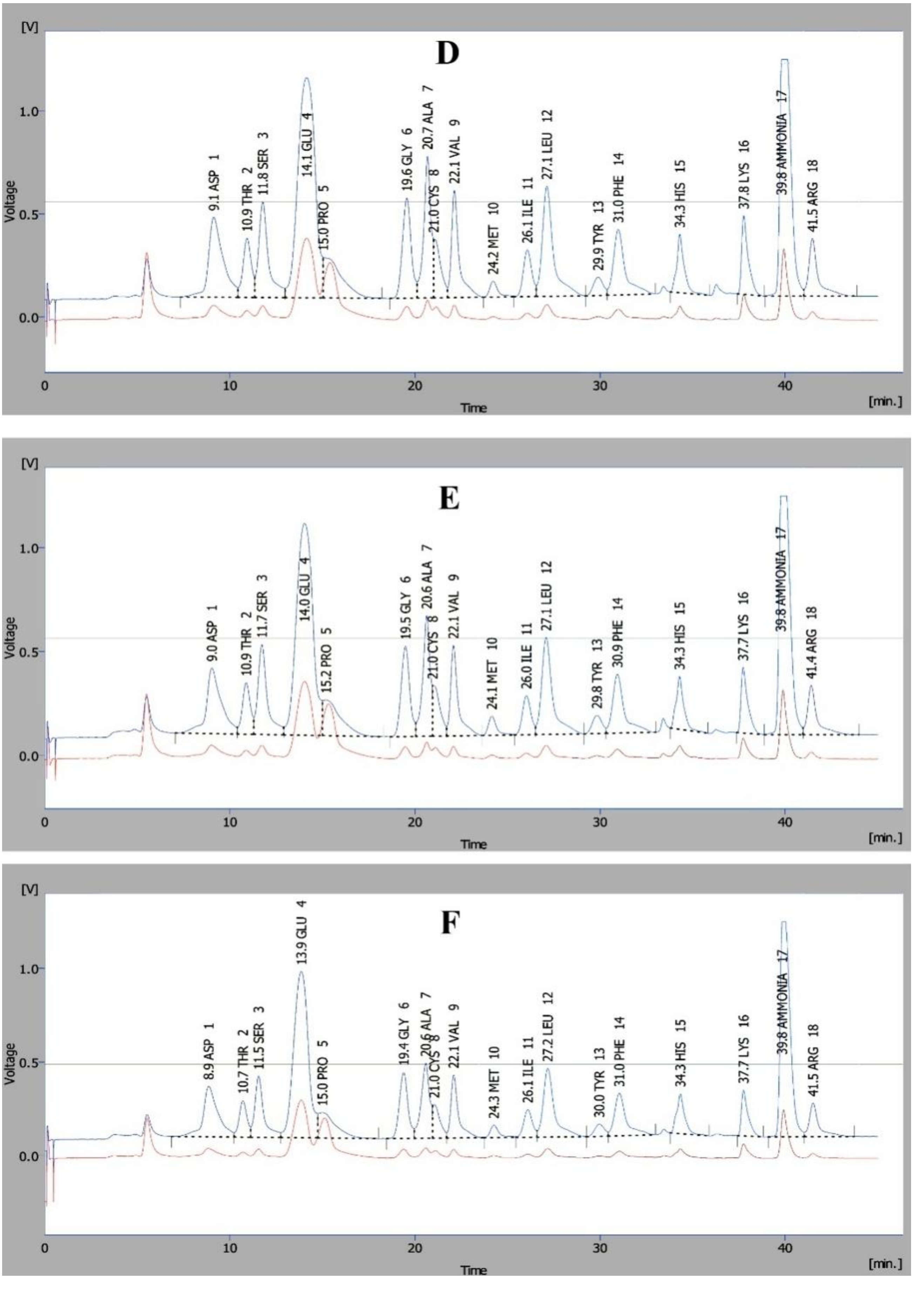

Fig. 3b. HPLC analysis of free amino acids extracted from *Hordeum vulgare* seeds.
D. Plants at the road edge E. Plants at distance of 50cm F. Plants at distance of 100cm

Conclusion

The seeds are the economically important part in both wheat and barley plants. All the measured yield parameters, carbohydrates, soluble proteins, amino acids and mineral content of both wheat and barley seeds were affected with auto-exhaust pollution. Total amino acids content not only proline was increased on plants grown on road sides so, we can take it as a bioindicator of air pollution. This is the responsibility of various environmental control agencies and Government to control air pollution in order to promote crop yield. Finally, avoid to take plants found on road sides with high traffic density especially edible ones. We must go away few meters or centimeters.

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