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Effect of different urban compost applications on the morphological and biochemical responses of potato plants (*Solanum tuberosum* L.)

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Abstract The physiological and biochemical features of the potato leaves are demonstrated a high importance of flavonoids and thiols. The morphological parameters, chlorophyll and carotenoid content, malondialdehyde, proline, enzymatic activities as well as antioxidant activities were slightly changed. The total content of phenols, flavonoids and thiols was confirmed the claim that the use of organic fertilizers (composts) is stimulated potato growth and strengthens their resistance system, including their resistance to abiotic stress. The study showed that compost found to be a suitable option in a long-term process ensuring good protection of potato metabolism, thus presenting an important economic and technical aspect of the environmental sustainability of agriculture.

Keywords: Antioxidant activities, Biochemical parameters, Compost, Organic waste, Potato

Introduction

Soil fertility can yield effective agriculture results and provide secure food worldwide. Recently, most research has given importance to soil and crop quality, focusing on factors likely to lead to decreased soil productivity such as pollution and urban expansion (McBratney *et al*., 2017).

In general, Mediterranean soils are characterised by low levels of organic carbon and nutrient features. Indeed, the total nitrogen and organic carbon content of the soil has a crucial impact on soil quality, crop production and environmental protection (Madejón *et al*., 2016). The organic matter content of soil can be improved by using organic amendments. The use of organic techniques like composting can be seen as an improvement in soil quality (Scotti *et al*., 2016).

In addition, compost is used as an organic fertilizer for the remediation of environmental pollution (Luo *et al*., 2018) and such a suppressive substance for

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soil-borne plant diseases in agricultural production (Wilson *et al*., 2018b). In fact, the advantage of this method lies in improving the antioxidant capabilities of plants (Santos *et al*., 2016).

This is of interest to consumers who are interested in the nutritional and health properties of food. The effective role of phytochemical compounds in human health is therefore increased, due to their superior antioxidant capacity and their usefulness in combating many diseases (Tavarini *et al*., 2011).

Nowadays, potato (*Solanum tuberosum* L.) is concedered as an essential non-grain food crop worldwide and is recognised as fourth most important food crop after wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.) and corn (*Zea mays* L.) (FAO, 2017). Potatoes can include a variety of phytochemicals (secondary metabolites) that act as antioxidants. The potato includes compounds essential for health promotion, including caffeic acid, flavonoids, carotenoids, as well as tuber reserve proteins which themselves prevent the formation of free radicals (Mahgoub *et al.,* 2015). In addition, potatoes provide key nutrients to the diet, including vitamin C, potassium and dietary fiber (Burgos *et al.,* 2011). In their work, Zhou *et al*. (2019) reported that the nutritional importance of different cultivars of potato planted in different locations indicated significant nutritional differences that could be related to soil, climate and cultivation technologies.

The objective was to examine the short-term impact of two types of composts used at different doses on certain physiological and biochemical parameters as well as on the antioxidant capacity of the potato plant (*Solanum tuberosum* L. Var Sylvana) grown in open field conditions.

Materials and methods

Plant material, field experiment design and culture conditions

An experiment was carried out at the Mazagran farm in Mostaganem (west Algeria) (35° 53' 30.2" N and 0° 05' 00.1" E). Potato (*Solanum tuberosum* L., variety Sylvana) tubers were sown in mid-January 2019 and harvested in May 2019 at the mature stage. Two different types of compost were used: MSWB (Municipal Solid Waste of Sidi Bel-Abbes) and MSWO (Municipal Solid Waste of Oran). Physical and chemical characterisations of both composts, MSWB and MSWO, are reported in Table 1. In a complete randomised design, three doses of compost were applied, with four treatments per compost: control (no compost addition); 10 t.ha-1 compost addition (D1); 15 t.ha-1 compost addition (D2); and 20 t.ha-1 compost additions (D3). Three replicates were made for each treatment, and total of 24 elementary plot of 96

m2 (2 m × 2 m each with 1 m separation from each other) were randomly arranged leaving 90 cm between the rows of potatoes and 30 cm between the planted tubers. The potato was obtained from the market and planted by placing five plants in each row. After 87 days of growth, the plants were harvested for analysis of different physiological and biochemical features, with samples collected from the potato leaves at the harvest stage. All measurements were taken in triplicate. Standard growing conditions and pesticide treatments were used to cultivate the plants.

Table 1. Physico-chemical analysis of the two composts used in this research (MSWB and MSWO)

Parameters	MSWB	MSWO
Generally (structure)		
Humidity (%)	22,60	9,45
Content matter dry (%)	78,40	90,55
Organic matter (%)	18,20	12,90
Ph 1:2.5 (V/V)	8,29	8,34
Macro-nutrients		
Total Nitrogen (g .Kg^{-1})	1,01	0,97
Total Phosphorus (g .Kg^{-1})	0,18	0,58
Total Potassium (g .Kg^{-1})	1,62	2,67
Total Organic Carbon (%)	10,57	7,47
C/N ratio	10,38	7,78
Heavy metals		
Cd (mg .Kg^{-1})	0,24	< 0,01
Hg (mg .Kg^{-1})	0,029	< 0,01
Pb (mg .Kg^{-1})	22	< 0,01
Cu (mg .Kg^{-1})	29	< 0,01

For all the following tables, each value is presented as mean ± standard deviation (n = 3). As well, MSWB refers to the Municipal Solid Waste of Sidi Bel-abbes while MSWO refers to the Municipal Solid Waste of Oran.

Morphological and yield parameters

Ten plants were selected for each type of treatment related to the growth of vegetative features: plant height (cm), number of leaves in addition to the number of aerial stems/plant. The plant height was measured from the soil line to the tip of the potato plant's main stem. Yield measures such as the average

tuber weight per plant (kg), total yield per hectare (tonne) and number of tubers per plant were evaluated at the harvest of ten plants for each treatment.

Photosynthetic pigment content

The technique of Lichtenthaler and Buschmann (2001) was followed to examine and measure chlorophyll a, chlorophyll b and carotenoid. The absorbance effect was measured by a UV/Vis spectrophotometer (Model 6715 UV/VIS, Jenway, UK) at 646.8, 663.2 and 470 nm. The chlorophyll concentration and carotenoid content by using the following equations:

Chlorophyll a (µg/ml) = (12.25 A663.2-2.79 A646.8);

Chlorophyll b (µg /ml) = (21.21 A646.8 -5.1 A663.2);

Total Chlorophyll (µg /ml) = Chlorophyll a + Chlorophyll b;

Carotenoid (µg /ml) = ((1000A470-1.8 Chlorophyll a-85.02 Chlorophyll b)/198).

Determination of total phenolic and flavonoid content

The total phenolic content was determined according to the technique of Singleton and colleagues (Singleton *et al.,* 1965). The Total flavonoid content of the extracts was determined according to the protocol claimed by Zhishen and colleagues (Zhishen *et al*., 1999).

Determination of enzyme activities

Fresh material (0.3 g) was blended in an extraction buffer containing 50 mm potassium phosphate buffer (pH 7.0), 1 mm EDTA and 1% (w/v) polyvinylpolypyrrolidone. The mixture was centrifuged at 12000 x g for 20 min at 4 °C, and the supernatant was used to quantify the total protein concentration (Bradford, 1976). Catalase activity (CAT) was assessed following the method outlined by Aebi (1984). Ascorbate peroxidase (APX) activity was evaluated using the protocol described by Nakano and Asada (1981). Phenylalanine ammonia lyase activity (PAL) was measured according to the procedure detailed by Beaudoin-Eagan and Thorpe (1985).

Evaluation of lipid peroxidation

The amount of malondialdehyde was determined using the method of Heath and Packer (1968). It was calculated based on its molar extinction coefficient (155 $mM^{-1} \cdot cm^{-1}$) and the results were expressed as nmol MDA/g FW.

Measurement of proline and thiol contents

The proline content was estimated using the acid-ninhydrin method as described by Bates and colleagues (Bates *et al*., 1973). The absorbance was read at 520 nm. The thiol concentration was determined using the method of Sedlak and Lindsay (1968). The absorbance was measured at 412 nm and the total thiol content was expressed as mmol·g^{-1} FW.

Free radical scavenging capacity (DPPH)

The DPPH test was performed according to the method of Shimada and colleagues (Shimada *et al.,* 1992). The absorbance measurement was carried out at 517 nm. The percentage of free radical scavenging effects was calculated as follows:

% DPPH scavenging effect= [1- (Asample/ A control)] × 100

Ferric reducing antioxidant power (FRAP) assay

The FRAP assay was done accordingly with the method of Rosales and colleagues (Rosales *et al.,* 2006). The action of absorbance was read at 593 nm. Results were calculated by using a standard curve with freshly prepared ammonium ferrous sulfate (25–1600 µmol L−1 ferrous ions).

Statistical Analysis

All results were analyzed using two-way analysis of variance (ANOVA), followed by post-hoc comparisons of mean values using Tukey's honestly significant difference test, with significance declared at the $P < 0.05$ level. Data were reported as mean ± SD (n = 3); “SD” refers to the standard deviation.

Results

Effect of MSW compost on the morphological and yield parameters

Vegetative growth and yield characteristics, including the number of aerial stems per plant, plant height (cm), number of leaves, tuber weight (kg) per plant, tuber number per plant and total yield per hectare (tonne) of potato cultivars with different types and doses of compost, were investigated (Table 2). The measured parameters showed no significant difference between the two composts compared to the non-amended soil.

Table 2. The effect of compost products on the number of leaves/plant, plant height (cm) and the number of aerial stems/plant

Parameters	Composts	Control	10 t .ha^{-1}	15 t .ha^{-1}	20 t .ha^{-1}
Number of leaves/plant	MSWB	30,47 ± 4,38^{a}	29,65 ± 2,60^{a}	34,2 ± 6,91^{a}	29,83 ± 0,90^{a}
	MSWO	30,89 ± 5,65^{a}	31,47 ± 4,35^{a}	31,33 ± 9,89^{a}	28,83 ± 6,42^{a}
Plant height (cm)	MSWB	31,72 ± 2,73^{a}	30,04 ± 3,35^{a}	31,38 ± 1,71^{a}	32,67 ± 3,08^{a}
	MSWO	27,35 ± 4,71^{a}	30,65 ± 3,62^{a}	29,78 ± 5,82^{a}	27,07 ± 3,70^{a}
Number of aerial stems/plant	MSWB	2,3 ± 0,50^{a}	2,2 ± 0,30^{a}	2,63 ± 0,55^{a}	2,6 ± 0,36^{a}
	MSWO	2,17 ± 0,29^{a}	2,37 ± 0,25^{a}	2,37 ± 0,21^{a}	2,17 ± 0,31^{a}
Number of tubers/plant	MSWB	7,81 ± 0,81^{a}	7,37 ± 0,64^{a}	8,07 ± 1,27^{a}	7,53 ± 0,81^{a}
	MSWO	7,51 ± 0,99^{a}	7,07±0,91^{a}	6,8 ± 1,18^{a}	7,34 ± 0,91^{a}
Total yield/plant (kg)	MSWB	1,19 ± 0,21^{a}	0,95 ± 0,05^{a}	1,2 ± 0,13^{a}	1,16 ± 0,02^{a}
	MSWO	0,97 ± 0,24^{a}	1,02 ± 0,21^{a}	0,98 ± 0,29^{a}	0,96 ± 0,10^{a}
Total yield/hectare (tonne)	MSWB	29,63 ± 5,23^{a}	23,87 ± 1,34^{a}	30,12 ± 3,16^{a}	29,12 ± 0,56^{a}
	MSWO	24,34 ± 6,03^{a}	25,6 ± 5,14^{a}	24,48 ± 7,19^{a}	23,94 ± 2,52^{a}

For variables with the same letter, the difference is not statistically significant 5% (means of three replicates) level of significance.

Effect of MSW compost on the photosynthetic pigment content

The evaluated composts did not significantly affect the concentration of total chlorophylls and carotenoids in potato leaves, except for D2 and D3 with MSWO for chlorophylls, where it started to be lower when using D1 and D2 compost with MSWB. Nevertheless, the carotenoid content was higher in plants grown in MSWB than those grown in MSWO, which was contrary to the total chlorophyll content (Table 3).

Table 3. The effects of composts on the total chlorophyll, carotenoid, phenolic compound and flavonoid content of potato leaves

Parameters	Composts	Control	10 t. ha^{-1}	15 t .ha^{-1}	20 t. ha^{-1}
Total chlorophyll (µg,g^{-1} fresh weight)	MSWB	783 ± 64^{a}	710 ± 94^{a}	751 ± 145^{a}	894 ± 47^{a}
	MSWO	2496 ± 139^{c}	2052 ± 213^{bc}	1693 ± 136^{b}	1814 ± 6^{b}
Carotenoids (µg,g^{-1} fresh weight)	MSWB	313 ± 55^{ab}	293 ± 68^{ab}	355 ± 28^{b}	345 ± 15^{b}
	MSWO	304 ± 12^{ab}	159 ± 40^{a}	182 ± 68^{ab}	250 ± 36^{ab}
Phenolics (mg,g^{-1} fresh weight)	MSWB	73,9 ± 9,19^{e}	8,85 ± 0,49^{a}	22,9 ± 3,11^{ab}	32,8 ± 6,36^{bc}
	MSWO	68,65 ± 2,76^{de}	26,55 ± 4,45^{ab}	46,85 ± 5,87^{c}	52,1 ± 0,57^{cd}
Flavonoids (mg,g^{-1} fresh weight)	MSWB	0,078 ± 0,015^{a}	0,082 ± 0,017^{a}	0,128 ± 0,023^{ab}	0,143 ± 0,010^{b}
	MSWO	0,143 ± 0,006^{b}	0,172 ± 0,010^{b}	0,177 ± 0,004^{b}	0,246 ± 0,019^{c}

Different letters (a - c) by column shows significant statistical difference 5% (means of three replicates) level of significance.

Effect of MSW compost on the total phenolic content (TPC) and flavonoids

Both composts, MSWO and MSWB, induced a significant reduction in the total phenolic content (TPC) in the leaves compared to the control. The TPC varied according to the type and dose of compost, ranging from 8.8 to 73.9 mg GAE/g (Table 3). In comparison to the untreated control treatment, a reduction in the TPC was observed at the dose 1 (D1). This decline was estimated at 81% and 74% for MSWB and MSWO composts, respectively. The flavonoid content ranged from 0.078 to 0.246 mg QE/g FW (Table 3). It was higher in plants grown at 20 T•ha^{-1} for both composts compared to the untreated control treatment, and the MSWO compost induced a higher flavonoid content than the MSWB compost.

Effect of MSW compost on the enzyme activities

Compared to the non-amended soil, Catalase (CAT) and Ascorbate peroxidase (APX) activities showed no significant ($p < 0.05$) differences among various levels of different types and doses of compost (Table 4).

Table 4. The ffect of composts on the antioxidant enzymes of potato leaves

Treatment	Catalase (µm, min^{-1}, mg Protein^{-1})		Phenylalanine ammonia lyase (mm, min^{-1}, mg Protein^{-1})	
	MSWB	MSWO	MSWB	MSWO
Control	13,146 ± 0,037^{a}	13,306 ± 0,417^{a}	0,413 ± 0,096^{a}	0,322 ± 0,087^{a}
10 t.ha^{-1}	16,030 ± 0,027^{a}	13,747 ± 0,568^{a}	0,404 ± 0,010^{a}	0,368 ± 0,018^{a}
15 t.ha^{-1}	16,534 ± 2,321^{a}	16,371 ± 5,859^{a}	0,425 ± 0,008^{a}	0,684 ± 0,006^{a}
20 t.ha^{-1}	17,875 ± 0,596^{a}	19,578 ± 0,423^{a}	0,579 ± 0,092^{a}	0,824 ± 0,079^{a}

Different letters (a and b) by column show significant statistical difference 5% (means of three replicates) level of significance.

Phenylalanine ammonia lyase (PAL) activity increased compared to the control, with the same trend for both composts. However, APX activity decreased only in MSWO-treated potato leaves, with the exception of D3 (Table 5). MSWB slightly increased the APX compared to the untreated control treatment.

Table 5. The effect of composts on ascorbate peroxidise in potato leaves

Treatment	Ascorbate Peroxidase (µm, min^{-1}, mg Protein^{-1})					
	MSWB			MSWO		
Control	56,196	±	9,852^{a}	100,101	±	20,094^{b}
10 t.ha^{-1}	56,369	±	2,583^{a}	91,928	±	0,082^{b}
15 t.ha^{-1}	71,867	±	2,842^{ab}	56,857	±	0,703^{a}
20 t.ha^{-1}	72,043	±	0,745^{ab}	101,825	±	0,714^{b}

Different letters (a and b) by column show significant statistical difference 5% (means of three replicates) level of significance.

The effects of MSW compost on malondialdehyde (MDA), proline and thiol content

The amount of malondialdehyde in the plants decreased with the addition of both composts compared to the control (Table 6). These results clearly showed that there was no significant difference in MDA levels between plants grown with MSWB and MSWO compared to the control. The proline content varied according to the type and dose of compost, ranging from 6.23 to 13.79 µmol proline/g of FW.

Table 6. The effect of composts on malondialdehyde and proline contents in potato leaves

Treatment	Malondialdehyde (MDA) (nmol g^{-1} fresh weight)		Proline (µmol g^{-1} fresh weight)	
	MSWB	MSWO	MSWB	MSWO
Control	0,787 ± 0,007^{ab}	1,108 ± 0,007^{b}	9,64 ± 1,067^{ab}	11,82 ± 1,605^{ab}
10 t.ha^{-1}	0,919 ± 0,027^{ab}	0,721 ± 0,021^{ab}	7,96 ± 1,660^{ab}	13,79 ± 2,299^{b}
15 t.ha^{-1}	0,755 ± 0,205^{ab}	0,769 ± 0,021^{ab}	8,54 ± 2,198^{ab}	7,16 ± 0,835^{ab}
20 t.ha^{-1}	0,721 ± 0,007^{ab}	0,619 ± 0,192^{a}	10,10 ± 3,441^{ab}	6,23 ± 0,232^{a}

Different letters (a and b) by column show significant statistical difference 5% (means of three replicates) level of significance.

Different doses of compost did not affect the proline content in potato leaves. Total thiol content was slightly increased by the addition of both composts compared to the untreated control treatment (Table 7). The levels of thiol content were higher in plants grown with MSWO than those grown with MSWB.

Table 7. The effect of composts on the thiol content in potato leaves

Treatment	Thiols (mmol g^{-1} fresh weight)	
	MSWB	MSWO
Control	42,684 ± 1,924^{a}	54,338 ± 1,768^{ab}
10 t.ha^{-1}	54,89 ± 1,404^{ab}	75,956 ± 1,456^{c}
15 t.ha^{-1}	64,301 ± 1,092^{bc}	70,294 ± 3,432^{c}
20 t.ha^{-1}	53,309 ± 8,735^{ab}	76,765 ± 0,728^{c}

Different letters (a and c) by column show significant statistical difference 5% (means of three replicates) level of significance.

Effect of MSW compost on the DPPH and FRAP capacity

Maximum DPPH activity was observed in plants treated with 10 t.ha−1 of MSWB and MSWO, compared to the untreated control treatment and all other treatments (Table 8). DPPH antioxidant capacity did not vary significantly under the different treatments with both composts compared to the control, while DPPH scavenging activity was higher in plants grown in the MSWO than in those grown in the MSWB. By adding the MSWO compost, the ferric reducing antioxidant power (FRAP) activity was increased by 12, 22 and 40% in 20, 15 and 10 t.ha-1, respectively. Nevertheless, MSWB slightly decreased

FRAP activity by 3, 24 and 28% at rates of 10, 20 and 15 t.ha-1, respectively. The different compost levels were not significantly affected the FRAP for both composts compared to the untreated control. A wider range in FRAP values was observed among potato leaves, showing values of 299 to 442 µmol of ascorbic acid/g for both composts.

Table 8. The effects of composts on the biochemical contents of potato leaves

Treatment	Ferric-Reducing Antioxidant Power (FRAP) (µm g−1 fresh weight)		Radical Scavenging Activity DPPH%	
	MSWB	MSWO	MSWB	MSWO
Control	409,214 ± 2,122[a]	316,071 ± 91,419[a]	35,782 ± 5,027[a]	57,109 ± 3,016[b]
10 t.ha^{-1}	398,571 ± 38,386[a]	442,857 ± 103,036[a]	41,706 ± 0,335[a]	59,953 ± 6,367[b]
15 t.ha^{-1}	299,643 ± 83,338[a]	387,857 ± 21,213[a]	41,232 ± 1,340[a]	58,294 ± 0,670[b]
20 t.ha^{-1}	313,571 ± 4,041[a]	356,786 ± 5,556[a]	37,204 ± 3,016[a]	58,294 ± 2,681[b]

Different letters (a and b) by column shows significant statistical difference 5% (means of three replicates) level of significance.

Discussion

Both compost additions in 10, 15 and 20 tonne.ha-1 were not significantly differed in plant growth characteristics and yield parameters (the number of aerial stems per plant, plant height (cm), number of leaves, tuber weight (kg) per plant, tuber number per plant and total yield per hectare (tonne)) when compared with the control treatment. The results of our study are consistent with those of Arthur and his colleagues (Arthur *et al*., 2012), who mentioned that potato yield did not significantly increase with compost treatment. This phenomenon has been explained by other studies showing similar differences during the initial year of experimentation (Domínguez *et al.,* 2019), suggesting that nutritional benefits may not be effective in the immediate period after compost application (Wilson *et al*., 2018a). The optimal agronomic performance of compost is typically achieved as a slow-release nitrogen fertilizer, with its effectiveness being relatively limited during the first year of application (Warman *et al*., 2011). Nitrogen influences the productivity of potato crops in several ways (Marshall and Vos, 1991). The Chlorophyll content of leaves is an important variable because it plays a fundamental role in photosynthesis and plant functioning (Kooistra and Clevers, 2016). Plants cultivated on MSWB with different doses showed total chlorophyll levels

similar to those of the control. These results are in agreement with studies conducted by Santos *et al*. (2016) on lettuce plants with compost and on pepper leaf plants with vermicompost (Luján-Hidalgo *et al*., 2017). The addition of MSWO compost decreased the total chlorophyll content in potato leaves compared to the control with doses D2 and D3. Tavarini and colleagues (Tavarini *et al*., 2011) reported similar results in a study on the application of green compost to spinach and lettuce.

The carotenoid contents in potato leaves grown with different types and doses of compost were statistically similar to those in the control. The current results are similar with studies conducted by Santos *et al*. (2016) on lettuce plants. This information suggests that different soil amendments, with different types and doses of compost, do not have a negative influence on the chlorophyll and carotenoid content of potato leaves. Moreover, the addition of both composts decreased the polyphenol content in potato leaves compared to the control. The same results were claimed by Tavarini and colleagues (Tavarini *et al.,* 2011) in a study on the application of green compost to spinach and lettuce.

The concentration of phenolic compounds in plants, depending on their maturity stage, genetic factors, variety and others factors, may have different levels for the same plant grown in different soil conditions (Luján-Hidalgo *et al*., 2017). This is due to the self-defense mechanisms of plants against microorganisms (Adhikari *et al.,* 2019), or to agronomic factors (Ezekiel *et al.,* 2013). On the other hand, flavonoid content increased with both composts obtained in the D3 treatment. These results are in agreement with the studies made by Lakhdar *et al*. (2011) on Mesembryanthemumedule plants. Flavonoids act by neutralizing reactive oxygen species (ROS) before these molecules can inflict damage on cells (Luján-Hidalgo *et al*., 2017). Flavonoids are considered a secondary defense mechanism for scavenging reactive oxygen species (ROS) in plants (Shivashankara *et al*., 2016). Generally, Plants in the field are subjected to various stress factors that influence their productivity (Georgieva and Vassileva, 2023). These environmental adversities induce the accumulation of reactive oxygen species (ROS) (Panda *et al.,* 2024). The balance between the production and detoxification of reactive oxygen species is maintained through the action of both enzymatic and non-enzymatic antioxidants (Nemmiche, 2017). Several antioxidant enzymes, including (CAT and APX), are responsible for the elimination of various types of ROS (Hajiboland, 2014). The application of both composts did not significantly affect enzymatic activities (CAT and PAL) compared to the control. This suggests that the two composts do not have a significant negative impact on the growth of potato plants, leading to a comparable oxidative stress response under most cultivation conditions.

Plant cell lipids and proteins are the primary targets of oxidative damage induced by reactive oxygen species (ROS). The oxidative degradation of polyunsaturated lipids in the plasma membrane, known as "lipid peroxidation", occurs in all organisms and is often considered an indicator of lipid damage under stress conditions (Nemmiche, 2017). Our results indicated that the malondialdehyde (MDA) levels in plants treated with both composts did not differ significantly. The same results were found in potato cultivars when treated with compost, which reduced the MDA level (Kammoun *et al*., 2017). In this study, we used MDA levels as an indicator of plant stress in response to both composts. In response to stress, proline accumulates in plants in high amounts, mainly due to increased synthesis (Shivashankara *et al*., 2016). The proline concentration measured in the leaves of the plants exhibited no significant difference depending on the different rates of compost used in potato culture. Our finding is in agreement with the work published by Kammoun *et al*. (2017), where proline was not affected by vermicompost and compost. Proline is an antioxidant that scavenges hydroxyl radicals and singlet oxygen (Shivashankara *et al*., 2016). Total protein thiol concentration was higher at D1, D2 and D3, when compared to the control, in both composts (MSWB and MSWO). This could be due to the role of thiol compounds in defense systems and their participation in plant responses to environmental stress (Tausz *et al*., 2003). The total protein thiol content in leaves reflects the degree of plant's response to stress.

The antioxidant capacity assays (FRAP and DPPH) did not show any significant change with the addition of the two composts compared to the unamended control. This is in accordance with the results of Taravini *et al.* (2011) obtained with lettuce, where no variation in DPPH values was observed depending on the presence of compost in the soil. The antioxidant activity of plants is well related to phenolic compounds in some plants (Luján-Hidalgo *et al.,* 2017). In our study, the use of compost for potatoes showed no difference in antioxidant capacity, consistent with the results of Tavarini *et al.* (2011).

The results of this study showed that the MSWB (Municipal Solid Waste of Sidi Bel-abbes) and the MSWO (Municipal Solid Waste of Oran) composts stimulated the secondary metabolism in potato leaves and significantly affected the levels of polyphenols, flavonoids, thiols and ascorbate peroxidase (APX). Morphological and yield parameters, antioxidant activity and enzymatic activities (CAT and PAL) showed slight variations depending on the type of compost and application doses. This research is represented a preliminary approach to a fundamental topic, which involved the impact of agricultural practices, such as the use of composts, on crop growth and quality. On the other

hand, the use of compost is represented a very important economic and technical aspect of sustainable agriculture.

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Conflicts of interest

The authors and the advocators asserted that there was no conflict of interest.

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