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EFFECT OF ORGANIC FERTILIZER IN COMBINATION WITH SOME SAFETY COMPOUNDS ON GROWTH AND PRODUCTIVITY OF POTATO PLANTS GROWN IN WINTER SEASON

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ABSTRACT

Two field experiments were carried out during the two successive winter seasons of 2013/2014and 2014/2015 in a private sector farm at Kafr Elsohbi Village, Qalubia Governorate, Egypt to investigate the effect of different levels of organic fertilizer (compost) at 35.7, 47.6 and 59.5 ton/ha. in presence of mineral and bio fertilizers and foliar spray with salicylic acid (SA) at 200 ppm, putrescine at 200 ppm, monopotassium phosphate at 2g/l and ascorbic acid at 200 ppm as well as their combinations on vegetative growth characters, chemical constituents, total yield and quality of potato (*Solanum tuberosum* L.) cv. Lady Rosetta during winter season. Obtained results showed that, fertilizing potato plants with compost at different used rates significantly increased all measured vegetative growth traits, chemical constituents of plant foliage, total produced tuber yield and its components, large and medium size tubers as well as chemical constituents of produced tubers. However, it decreased nitrate and total sugars percentage of produced tubers. Moreover, using the highest compost rate (59.5ton/ha.) exhibited the highest values in all aforementioned traits. Also, spraying potato plants four times starting one month from planting and every two weeks by interval with putrescine at 200 ppm and monopotassium phosphate at 2g/l reflected the highest values of vegetative growth aspects and chemical constituents of plant foliage as well as total produced tuber yield and its quality without significant differences among them compared with other tested growth stimulants and the control. In this respect, fertilizing potato plants grown under sandy loam conditions with compost at 59.5 ton/ha. combined with spraying the plants four times with either monopotassium phosphate at 2g/l or putrescine at 200ppm exhibited the highest values of total produced tuber yield and its components with best quality.

Key words: Potato, organic fertilizer, growth stimulants, growth, chemical composition, tuber yield and quality.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the major world food crops. The contribution of potato in world food basket is only after wheat, rice and maize. Potato is an economical food and it provides a source of low cost energy to the human diet. It is the rich source of starch, vitamin C, B and minerals. It also contains good amounts of essential amino acids (Paul Khurana and Naik, 2003). According to the recorded data obtained from the Department of Agricultural Economics and Statistics, Ministry of Agriculture and land Reclamation, Egypt, the cultivated area of potato in 2013/2014 reached about 172,073 hectare (409.535 faddans), which yielded 4,611,065 tons of tubers with an average of about 26.796 tons per hectare.

Organic manures, particularly compost have traditionally been used by potato farmers. The use of organic matter to meet the nutrient requirement of crops would be an inevitable practice in years to come, particularly for resource poor farmers. Furthermore, ecological and environmental concerns over the increased and indiscriminated use of inorganic fertilizers

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have made research on use of organic materials as a source of nutrients very necessary (Upadhyaya *et al.,* 2003). Organic manures like compost can play an important role in potato productivity. These sources can reduce the diffecency of soil nutrient and improve soil organic matter, humus and overall soil productivity (Jenssen, 1993). Soil organic matter acts as "cement" for water holding clay and soil particles together, this contributing to the crumb structure of the soil providing resistance against soil erosion, binds micronutrient metal ions in the soil to check leaching out of surface soils. Organic constituents in the humic substances also act as plant growth stimulants (Jenssen, 1993; Palm *et al*., 1993). Biofertilizers are easy to apply, low-cost in nature and eco-friendly. A judicious combination of organic manures, inorganic fertilizers and biofertilizers might be helpful in obtaining high potato productivity and good soil health for sustainability. Therefore, an integrated nutrient management (INM) in which organic manures, inorganic fertilizers and biofertilizers are used simultaneously has been suggested as the most effective method to maintain a healthy and sustainable soil system as well as increasing crop productivity (Mondal *et al.*2008). There is evidence from field research that high and sustainable yields are possible with integrated use of organic fertilizers, inorganic fertilizers and biofertilizers (Singh *et al*., 2007).

Polyamines (putrescine) play an important role in protecting plants against various abiotic stresses. They are potent reactive oxygen spices (ROS) scavengers and inhibitors of lipid peroxidation. The diamine putrescine can alleviate harmful drought effects in plants grown under water and temperature stress by many ways including : polyamines (PAs) which may be involved in free radical scavenging (Drolet *et al.,* 1986). Polyamines are regulators of antioxidant enzymes and it is considered as components of stress-signaling system which can modulate functions of RNA, DNA, nucleotide triphosphates, proteins synthesis and protect macromolecules under stress conditions (Kuznetsov and Shevyakova, 2007). High accumulation of polyamines (putrescine) in plants during abiotic stress has been well documented and is correlated with increased tolerance to such stress (Ahmad *et al*., 2012; Kuznetsov and Shevyakova, 2007).

Recently, the group of substances known as antioxidants or oxygen free radical scavengers were applied to protect against adverse effects of environment, reactive oxygen spices (ROS) and oxidative stress such as ascorbic acid, citric acid and vitamins (Chen and Gallie, 2006). On the other hand, antioxidants are one of the new methods that enhanced plant growth and development, increased photosynthetic pigments thereby increased chlorophyll and productivity as well (Inskbashi and Iwaya, 2006). Ascorbic acid is known as growth regulating factor that influences many biological processes. Ascorbic acid increased nucleic acids content, especially RNA and it also influences the synthesis of enzymes and protein. It acts as coenzyme in metabolic changes (Price, 1966). Salicylic acid naturally occurs in plants in very low amounts and participates in the regulation of physiological processes in plant such as stomatal closure, nutrient uptake, chlorophyll synthesis, protein synthesis and inhibition of ethylene biosynthesis, transpiration and photosynthesis (Khan *et al.,* 2003). Salicylic acid play an important role in protection biotic and abiotic stresses by regulating the antioxidant system (He and Zhu, 2008).

Many authors demonstrated that growth and flowering of many vegetables plants are greatly influenced by different fertilization foliar spray treatments among which monopotassium phosphate. Monopotassium phosphate (KH_2PO_4) (P_2O_5 : 52% - K_2O : 34%). MPP is a potential substitute for ammoniated forms of P. This fertilizer has been studied as a foliar nutrient spray (Chapagain and Wiesman, 2004). Another potential benefit of MPP has shown foliar sprays can induce systemic protection against foliar pathogens; such as powdery mildew (Bryan *et al*., 2010). In addition, Salama (2015) found that foliar spray with monopotassium phosphate at 3 g/l significantly increased vegetative growth, total chlorophyll content, chemical constituents of plant foliage, fruit yield and quality of cantaloupe plants.

Therefore, the present study was an attempt to improve the growth and productivity of potato plants grown under low temperature stress during the winter season by using organic fertilizer in presence of bio and chemical fertilizers in combining with some growth stimulants foliar spray.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons of 2013/2014 and 2014/2015 in a private Sector Farm at Kafr Elsohbi Village, Qalubia Governorate, Egypt, to investigate the effect of different levels of organic fertilizers (compost) in presence of mineral and bio fertilizers and foliar spray with salicylic acid (SA), putrescine, monopotassium phosphate and ascorbic acid as well as their combinations on vegetative growth characters, chemical constituents, total yield and quality of potato (*Solanum tuberosum* L.) cv. Lady Rosetta during the winter season. Physical and chemical characters of the used soil as average of both seasons are shown in Table a. Physical analysis was estimated according to Jackson (1973) whereas, chemical analysis was determined according to Black *et al*. (1982). While, air temperature and relative humidity in Qalubia region are shown in Table b. Potato tubers were planted on 18^{th} and 24^{th} of October in the first and second seasons, respectively. This experiment was set up in a split plot design with three replicates in both seasons of study. Each experimental plot included one row 30m length and 70 cm width with an area of $21m^2$. A drip irrigation system with nozzles of 30 cm apart was adopted for fertigation.

Potato tubers were planted 30 cm apart on one side of ridges. Cultural management, disease and pest control programs were followed according to the recommendations of the Egyptian Ministry of Agriculture.

Organic Fertilizer Treatments

Organic manure (compost) at the rates of 35.7, 47.6 and 59.5 tons/ha., were added during soil preparation in both seasons. The chemical properties of the used compost are shown in Table c.

The plants received chemical fertilizers at the recommended doses of NPK (357:75:357 N: P_2O_5 : K_2O actual Kg/ha.) in the form of (ammonium nitrate 33.5 N%, phosphoric acid 80% P_2O_5 and potassium sulphate 48% K_2O). Chemical fertilizers doses were added throughout drip irrigation system during the two seasons of this study.

Bio Fertilizer Treatments

A mixture of nitrobein + phosphorein + potassin contained efficient strains of nitrogen fixing bacteria (*Azotobacter chroococcum*) + phosphate dissolving bacteria(PDB) (*Bacillus megaterium var phosphaticum*) + silicate dissolving bacteria (SDB) (*Bacillus circulans)* which were supplied by the department of Microbiology, Agric. Res. Center, Giza was added at the rate of 9.52 l/ha., through drip irrigation three times at two weeks by interval, starting 18^{th} and 24^{th} of November(one month from planting) in the first and second seasons, respectively. The strains were characterized by a good ability to infect its specific host plant and by its high efficiency in N-fixation, phosphate solubilizing and silicate dissolving bacteria. The experimental design was split plot design where the organic fertilizer treatments were distributed in the main plots, while the growth stimulants foliar spray treatments were located randomly in the sub plots.

This experiment included 20 treatments resulted from the combinations between four organic fertilizer treatments and five growth stimulants treatments as follows:

Organic fertilizers treatments

1. Control (recommended dose of mineral NPK (RD)
2. RD+ 35.7 ton/ha. compost + bio-fertilizer
3. RD+ 47.6 ton/ha. compost + bio-fertilizer
4. RD+ 59.5 ton/ha. compost + bio-fertilizer

Growth stimulants spray treatments

1. Control treatment (spray with tap water).
2. Salicylic acid (SA) at 200ppm.
3. Putrescine at 200ppm.
4. Monopotassium phosphate at 2g/l.
5. Ascorbic acid at 200ppm.

The volume of the spraying solution was maintained just to cover completely the plant foliage until drip. Potato plants were subjected to foliar spray with the aforementioned growth stimulants four times, each at two weeks by interval, the first one was after one month from planting time in both seasons. A surfactant (Tween 20) at a concentration of 0.01% was added to all tested solutions including the control.

Table a. Physical and chemical analyses of the used soil

Physical analysis		Chemical analysis			
		Cations (meq/l)		Anions (meq/l)	
Coarse sand	18.8%	Ca^{++}	8.23	CO_3^{--}	Zero
Fine sand	36.3%	Mg^{++}	3.45	HCO_3^-	4.49
Silt	27.6%	Na^+	4.13	Cl^-	5.51
Clay	17.3 %	K^+	1.21	SO_4^{--}	7.19
Texture class: Sandy loam					
Soil pH	7.4	Available N	25.2 mg/kg		
E.C (dS/m)	1.71	Available P	12.3 mg/kg		
Organic matter	2.16%	Available K	164 mg/kg		

Table b. Monthly air temperature and relative humidity in Qalubia region during two seasons of the experimental

	First season (2013/2014)			Second season (2014/2015)		
	Temperature °C		R.H (%)	Temperature °C		R.H (%)
Months	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**
October	34.9	15.6	58	36.9	13.9	60
November	30.5	10.7	64	30.2	12.8	72
December	30.2	6.2	65	23.5	7.2	74
January	28.7	3.7	56	29.2	1.5	76
February	29.9	5.5	55	31.5	2.4	80

Table c. Chemical properties of the used compost

Parameter	Ec $dS.m^{-1}$ (1:5)	pH (1:5)	Total C (%)	Total N (%)	Total P (%)	Total K (%)	Ca (%)	Mg (%)	Total Fe (ppm)	Total Zn (ppm)	Total Mn (ppm)	Total Cu (ppm)	C:N ratio
Reading	2.73	6.71	21.98	1.19	0.68	1.29	1.72	0.78	1398	368	104.9	14.92	18:1

Data Recorded

Vegetative growth characters

Vegetative growth aspects of potato plants were estimated 80 days after planting. Representative sample of three plants from each experimental plot was taken for measuring the vegetative growth parameters as follows: Plant height (cm), number of branches/plant as well as fresh and dry weight g/plant.

Chemical constituents of plant foliage

Total carbohydrates, nitrogen, phosphorus and potassium (%) were determined according to Herbert *et al.* (1971), Pregl (1945), John (1970) and Brown and Lilleland (1946), respectively.

Total yield and its components

Number of tubers/plant, average tuber weight (g), total yield (ton/ha). The produced tubers for each experimental unit were graded into three sizes *i.e.,* large (>55 mm), medium (35-55 mm) and small (<35 mm). Potato tuber size for different gardes were calculated in percentage form.

Tuber chemical constituents

Tuber samples were taken at harvest time and dried in an electric oven to constant weight at 70°C. In addition, the digested dry matter of each sample was taken for chemical determination of total N, total protein, P, K, total amino acids, total starch, total sugars and nitrate content were determined according to the methods described by Pregl (1945), John (1970), Brown and Lilleland (1946), Rosen (1957), AOAC (1990), Juliano (1971) and Cataldo *et al.* (1975), respectively.

Statistical Analysis

All obtained data in both seasons of study were subjected to analysis of variance as factorial experiments in split plot design. Duncan's analysis was used to differentiate means according to Snedecor and Cochran (1991).

RESULTS AND DISCUSSION

Vegetative Growth Parameters

Data in Table 1 show that using all applied rates of organic fertilizer (compost) in presence of bio-fertilizers, *i.e.,* N-fixing, PDB and SDB significantly increased all measured vegetative growth parameters of potato plants, *i.e.,* plant height, branche number /plant, both fresh and dry weights of plants when compared with the control treatment (the recommended dose of mineral fertilizer) in the two seasons. In addition, it was found that there was positive relationship between the values of vegetative growth parameters and organic fertilizer rates, whereas increasing the rate of organic fertilizer, increased linearly the values of vegetative growth parameters. Moreover, the maximum increases were connected with the highest rate used (59.5 t/ha.) in the two seasons. In this regard, the tallest plants (54.46 and 58.10 cm), the most branch number/plant (4.18 and 3.96) and the heaviest fresh (278.8 and 269.0g) and dry (39.34 and 38.28g) weights/plant were recorded by RD+59.5 ton compost + bio-fertilized plants, in the first and second seasons, respectively. Such increments in all measured vegetative growth traits of potato plants as a results of using organic fertilizer (compost) may be attributed to the main role of compost in improving soil physical characteristics, increasing soil fertility and water holding capacity, rising soil temperature and enhancing the soil pH that consequently increased the nutrient elements availability and absorption, which in turn positively affected plant growth parameters. These results are in agreement with those reported by Haase *et al.* (2007), Kumar *et al.* (2012), Mohammadi *et al.* (2013) and Malash *et al.* (2014) on potato plants.

As for the effect of growth stimulants foliar spray, data in the same Table indicate that all tested growth stimulants increased the studied vegetative growth parameters compared to the control treatment. In this respect, potato plants especially those received putrescine at 200 ppm reflected the highest values, followed in descending order by those sprayed with monopotassium phosphate at 2g /l and salicylic acid at 200 ppm in the two seasons. The increments in vegetative growth parameters as a result of using growth stimulants may be due to the effect of such substances on cell division and cell elongation and their role in protection of plants against low temperature during winter and keeping the plants more healthy and delayed the senesces of plants. Stenzel *et al.* (2006), Bryan *et al.* (2010), Silvia *et al.* (2011), Abo-Hinna and Merza (2012), Jeffrey *et al.* (2015) and Upadhyaya *et al.*(2015) on potato reported similar results.

Regarding the interaction effect between organic fertilizer and growth stimulants foliar spray, data in Table 1 declare that the application of 59.5 ton compost /ha. showed to be the most effective treatment for inducing the highest values of the tested vegetative growth parameters, especially in case of the combination with those received putrescine at 200 ppm as they gave 56.20 and 59.20 cm for plant height, 4.40 and 4.20 for branche number/plant, 284 and 279g for fresh weight/plant and 40.6 and 39.8g for dry weight/ plant in the first and second seasons, respectively. Furthermore, the combinations of 47.6 ton compost /ha. with putrescine foliar spray, resulted in highly increments in this concern, followed by the combinations of 35.7 ton compost/ha., in the two seasons. On the contrary, the lowest values of these parameters were scored by the combinations of the control

Table 1. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato vegetative growth characters during 2013/2014 and 2014/2015 seasons

Treatment		First season (2013/2014)				Second season (2014/2015)			
Fertilizers	Growth stimulants	Plant height (cm)	No. of branches / plant	Fresh weight/ plant (g)	Dry weight/ plant (g)	Plant height (cm)	No. of branches /plant	Fresh weight/ plant (g)	Dry weight/ plant (g)
Control (RD mineral NPK)		49.92c	2.48d	188.4d	26.56d	52.50d	2.43d	171d	24.8d
RD+ 35.7 ton compost +bio-fertilizer		51.39b	3.09c	237.4c	33.58c	54.06c	2.71c	190c	26.92c
RD+ 47.6 ton compost +bio-fertilizer		53.16a	3.60b	262.6b	37.34b	56.16b	3.23b	227b	32.10b
RD+ 59.5 ton compost +bio-fertilizer		54.46a	4.18a	278.8a	39.34a	58.10a	3.96a	269a	38.28a
	Control	50.40c	3.07d	227d	32.03d	54.20b	2.90d	205c	28.8c
	Salicylic acid at 200ppm	52.72ab	3.35bc	242bc	34.13bc	55.30ab	3.09bc	212bc	30.0bc
	Putrescine at 200ppm	53.45a	3.57a	256a	36.55a	56.10a	3.22a	224a	31.9a
	Monopotassium phosphate at2g/l	52.94ab	3.45b	247b	35.08b	55.42ab	3.16ab	219ab	30.9ab
	Ascorbic acid at 2g/l	51.65bc	3.24c	236c	33.25cd	55.00ab	3.04c	212bc	30.1bc
Control (Mineral NPK)	Control	48.10h	2.10p	157l	21.90j	51.20k	2.30i	163i	22.7m
	Salicylic acid at 200ppm	50.20f-h	2.50o	191jk	27.10i	52.40jk	2.45hi	171hi	24.10klm
	Putrescine at 200ppm	51.30d-g	2.80mn	215i	30.50gh	53.60g-k	2.50g-i	178f-i	25.3i-l
	Monopotassium phosphate at2g/l	50.80e-h	2.60no	197j	27.7hi	53.10i-k	2.48g-i	174g-i	24.5j-m
	Ascorbic acid at 2g/l	49.20gh	2.40o	182k	25.6i	52.20jk	2.42hi	169i	23.8lm
RD+ 15ton compost + bio-fertlizer	Control	49.50f-h	2.90lm	217i	30.3g	53.40h-k	2.60f-h	186e-h	26.1h-l
	Salicylic acid at 200ppm	51.80c-g	3.10j-l	238gh	33.5ef	54.30e-j	2.73f	189e-g	26.7h-j
	Putrescine at 200ppm	52.40b-f	3.30h-j	257ef	36.7cd	54.90d-j	2.80f	198e	28.2j-h
	Monopotassium phosphate at2g/l	51.77c-g	3.20i-k	249fg	35.3de	53.90e-k	2.78f	192ef	27.1hi
	Ascorbic acid at 2g/l	51.20d-h	2.99k-m	226hi	31.8fg	53.80f-k	2.67fg	188e-g	26.5h-k
RD+ 47.6 ton compost + bio-fertilizer	control	51.30d-g	3.40g-i	259ef	36.9cd	55.40c-i	3.10e	214d	30.0fg
	Salicylic acid at 200ppm	54.20a-d	3.60e-g	261d-f	37.1b-d	56.40a-g	3.20de	219d	30.8ef
	Putrescine at 200ppm	53.90a-e	3.80d-e	269b-e	38.4a-c	56.70a-f	3.40cd	241c	34.3cd
	Monopotassium phosphate at2g/l	53.80a-e	3.70d-f	264c-e	37.4b-d	56.10b-h	3.30de	236c	33.3de
	Ascorbic acid at 2g/l	52.60b-f	3.50f-h	260e-f	36.9cd	56.20b-h	3.18e	228cd	32.1d-f
RD + 59.5 ton compost + bio-fertilizer	Control	52.40b-f	3.90cd	275a-d	38.7a-c	56.80a-e	3.60c	259b	36.5bc
	Salicylic acid at 200ppm	54.70a-c	4.20ab	278a-c	38.8a-c	58.10a-c	4.00ab	271ab	38.4ab
	Putrescine at 200ppm	56.20a	4.40a	284a	40.6a	59.20a	4.20a	279a	39.8a
	Monopotassium phosphate at2g/l	55.40ab	4.30ab	281ab	39.9ab	58.60ab	4.10ab	274ab	38.9ab
	Ascorbic acid at 2g/l	53.60a-e	4.10bc	276a-c	38.7a-c	57.80a-d	3.90b	266ab	37.8ab

Means of the same column followed by the same letters were not significantly different according to Duncan MRT at 5%.

treatment, particularly those untreated with growth stimulants foliar spray "tap water only" in the two seasons.

Chemical Constituents of Plant Foliage

Data presented in Table 2 indicate that all determined chemical constituents of plant foliage (total nitrogen, phosphorus, potassium and carbohydrates) were significantly increased due to increasing the applied amounts of compost/ha., compared with the chick treatment in the two seasons. Moreover, the highest N, P, K and total carbohydrates values were gained by using 59.5 ton compost /ha., followed by 47.6 ton compost /ha., in the two seasons. Irrespective of the control treatment, the lowest values in this concern were recorded by 35.7 ton compost/ ha., in the two seasons. Obtained results may be due to that addition of the compost and its decomposition on a long period increased the concentration and availability of macro-elements in roots zone leading to more absorption and uptake by plant and consequently increased its accumulation in plant tissues and so increased assimilation rate which, in turn, increased carbohydrates content. Similar findings, on potato, were reported by Haase *et al.*(2007), Kumar *et al.*(2012), Mohammadi *et al.* (2013) and Malash *et al.*(2014).

Respecting the effect of growth stimulants foliar spray, data in Table 2 indicate that all studied growth stimulants tended to increase leaves N, P, K and total carbohydrates contents with non-significant differences in most cases when compared with the control in the two seasons. Anyway, the richest leaf nitrogen content was scored by 200 ppm putrescine-sprayed plants, whereas the greatest P, K and total carbohydrates contents were registered by 2g/l monopotassium phosphate-sprayed plants in the two seasons. Obtained results are connected with the positive effect of growth stimulants on vegetative growth parameters of plant foliage. These results are in agreement with those reported by Stenzel *et al.* (2006), Bryan *et al.* (2010), Silvia *et al.*(2011), Abo-Hinna and Merza (2012), Jeffrey *et al.* (2015) and Upadhyaya *et al.* (2015) on potato plants.

Referring to the interaction effect between organic fertilizers and growth stimulants foliar spray, data in the same Table show that all resulted combinations succeeded in increasing N, P, K and total carbohydrates contents in plant foliage, with superior effect for the combination of 59.5 ton compost/ha. and spraying the plants using putrescine, monopotassium phosphate and salicylic acid in the first season and putrescine, monopotassium phosphate only in the second one followed by the combinations of 47.6 tons compost/ha., in the two seasons. However, the highest values of N% were obtained by the combinations of 59.5 ton compost/ ha., especially those sprayed with 200 ppm purtrescine as it gave 1.76 and 1.87% in the first and second seasons, respectively. Whereas, the highest values of P (0.152 and 0.179%), K (2.38 and 2.24%) and total carbohydrates (16.21 and 15.82%) contents were recorded also by the combination of 59.5 tons compost/ha., particularly with those sprayed with 2g/l monopotassium phosphate in the first and second seasons, respectively. On the reverse, the lowest values of these parameters were gained by the combination of the control treatment, especially with those untreated with growth stimulants sprays in the two seasons.

Yield Parameters

Data in Table 3 reveal that the number of tubers/plant, average tuber weight and total yield/ha., were significantly and continuously increased by increasing organic fertilizer rates when compared with the control treatment in the two seasons. Moreover, the highest number of tubers/plant (11.40 and 12.00), the heaviest tuber weight (73.4 and 72.6g) and the highest yield/ha., (39.97 and 41.51ton) were scored by the highest rate of organic fertilizer (59.5 ton compost/ha.), followed by using the medium rate (47.6 ton compost/ha) and the low rate (35.7 ton compost/ha) which significantly increased these parameters compared with mineral fertilizer source at the recommended rate in the first and second seasons, respectively. Such increases in total produced yield as a result of using high rates of compost were connected with the increases in vegetative growth measurements (Table 1) and assayed macro-elements and total carbohydrates (Table 2) as well as number of tubers produced by plants, average tuber weight (Table 3) as well as increasing the percentage of both large and medium size grade (Table 4) of tubers which led to increase the produced yield. These results are in agreement with those reported by Haase *et al.* (2007), Kumar *et al.* (2012), Mohammadi *et al.* (2013) and Malash *et al.* (2014) on potato.

Table 2. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato chemical constituents (%) of plant foliage during 2013/2014 and 2014/ 2015 seasons

Treatment		First season (2013/2014)				Second season (2014/2015)			
Fetilizers	Growth stimulants	N	P	K	Total carbohydrate	N	P	K	Total carbohydrates
Control (Mineral NPK)		1.36d	0.116b	1.66d	12.17d	1.44d	0.125c	1.60d	11.64d
RD+ 35.7 ton compost +bio-fertilizer		1.47c	0.126ab	1.81c	13.25c	1.54c	0.138bc	1.75c	12.80c
RD+ 47.6 ton compost +bio-fertilizer		1.58b	0.136ab	2.04b	14.35b	1.63b	0.154ab	1.89b	13.80b
RD+ 59.5 ton compost +bio-fertilizer		1.73a	0.148a	2.32a	16.07a	1.81a	0.176a	2.16a	15.14a
	Control	1.51a	0.129a	1.90b	13.75a	1.57b	0.146a	1.81b	13.10a
	Salicylic acid at 200ppm	1.53a	0.131a	1.94ab	13.94a	1.60ab	0.147a	1.84a-d	13.26a
	Putrescine at 200ppm	1.56a	0.132a	1.98a	14.04a	1.64a	0.149a	1.87ab	13.40a
	Monopotassium phosphate at 2g/l	1.54a	0.134a	2.01a	14.08a	1.62ab	0.151a	1.89a	13.67a
	Ascorbic acid at 2g/l	1.53a	0.131a	1.95ab	13.98a	1.60ab	0.147a	1.85ab	13.28a
Control (Mineral NPK)	Control	1.34m	0.114a	1.64i	12.14e	1.41k	0.121d	1.58k	11.37f
	Salicylic acid at 200ppm	1.35lm	0.115a	1.66hi	12.16e	1.44i-k	0.126b-d	1.59k	11.64f
	Putrescine at 200ppm	1.39i-m	0.117a	1.68g-i	12.18e	1.47h-k	0.127b-d	1.62i-k	11.72f
	Monopotassium phosphate at 2g/l	1.37j-m	0.119a	1.69g-i	12.21e	1.45i-k	0.129a-d	1.64h-k	11.94ef
	Ascorbic acid at 2g/l	1.36k-m	0.119a	1.65i	12.17e	1.43jk	0.124cd	1.61jk	11.53f
RD+ 15ton compost + bio-fertlizer	Control	1.46h-l	0.124a	1.78f-i	13.21de	1.52g-j	0.136a-d	1.72g-j	12.61d-f
	Salicylic acid at 200ppm	1.48f-j	0.126a	1.81e-g	13.23de	1.54e-i	0.137a-d	1.75f-h	12.76d-f
	Putrescine at 200ppm	1.49e-i	0.127a	1.82e-g	13.26c-e	1.58d-g	0.139a-d	1.76e-h	12.86d-f
	Monopotassium phosphate at 2g/l	1.47g-k	0.129a	1.84ef	13.29c-e	1.56d-h	0.141a-d	1.79d-g	12.94c-f
	Ascorbic acid at 2g/l	1.46h-l	0.125a	1.80f-h	13.24c-e	1.53f-j	0.138a-d	1.74g-i	12.81d-f
RD+ 47.6 ton compost + bio-fertilizer	Control	1.56d-h	0.134a	1.95de	13.85cd	1.61d-g	0.154a-d	1.87c-f	13.64b-e
	Salicylic acid at 200ppm	1.58d-g	0.136a	2.01cd	14.34cd	1.64d-e	0.152a-d	1.89cd	13.79b-e
	Putrescine at 200ppm	1.61b-d	0.137a	2.09cd	14.54b-d	1.66cd	0.156a-d	1.90cd	13.86b-d
	Monopotassium phosphate at2g/l	1.59d-f	0.138a	2.13bc	14.62bc	1.65d	0.158a-d	1.92c	13.97a-d
	Ascorbic acid at 2g/l	1.60c-e	0.135a	2.04cd	14.38cd	1.63d-f	0.153a-d	1.88c-e	13.72b-e
RD+ 59.5 ton compost + bio-fertilizer	Control	1.71a-c	0.146a	2.26ab	15.81ab	1.76bc	0.173a-c	2.08b	14.78a-c
	Salicylic acid at 200ppm	1.73a	0.148a	2.29a	16.02a	1.79ab	0.175a-c	2.14ab	14.83a-c
	Putrescine at 200ppm	1.76a	0.150a	2.35a	16.17a	1.87a	0.177ab	2.21a	15.17ab
	Monopotassium phosphate at 2g/l	1.74a	0.152a	2.38a	16.21a	1.84ab	0.179a	2.24a	15.82a
	Ascorbic acid at 2g/l	1.72ab	0.147a	2.32a	16.14a	1.81ab	0.176ab	2.17ab	15.08ab

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at 5%.

Table 3. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato yield parameters during 2013/2014 and 2014/2015 seasons

Treatment		First season (2013/2014)			Second season (2014/2015)		
Fertilizers	Growth stimulants	Number of tubers/ plant	Average tuber weight (g)	Total yield ton/ha.	Number of tubers/ plant	Average tuber weight (g)	Total yield ton/ha.
Control (RD mineral NPK)		7.76d	60.2d	22.26d	8.1d	60.3d	23.24d
RD+ 35.7 ton compost +bio-fertilizer		9.52c	66.6c	30.21c	9.7c	63.8c	29.53c
RD+ 47.6 ton compost +bio-fertilizer		10.40b	71.6b	35.47b	11.1b	67.8b	35.70b
RD+ 59.5 ton compost +bio-fertilizer		11.40a	73.4a	39.97a	12.0a	72.6a	41.51a
	Control	9.47d	67.1b	30.63c	10.1c	65.6a	31.62d
	Salicylic acid at 200ppm	9.82b	68.1ab	32.16b	10.3ab	66.1a	32.63bc
	Putrescine at 200ppm	9.82b	68.5ab	32.33b	10.3a	66.5a	33.01ab
	Monopotassium phosphate at2g/l	10.07a	68.8a	33.31a	10.4a	66.7a	33.33a
	Ascorbic acid at 2g/l	9.65c	67.7ab	31.47bc	10.1bc	65.9a	32.16cd
Control (Rd mineral NPK)	Control	7.4m	58.5d	20.62j	7.9h	59.6e	22.39i
	Salicylic acid at 200ppm	7.8kl	60.4cd	22.44hi	8.3g	60.0e	23.69h
	Putrescine at 200ppm	7.9jk	61.2cd	23.01hi	8.2gh	61.1de	23.84h
	Monopotassium phosphate at2g/l	8.1j	61.6c	23.75h	8.3g	61.2de	24.18h
	Ascorbic acid at 2g/l	7.6lm	59.3cd	21.46ij	8.1gh	59.9e	23.11hi
RD+ 15ton compost + bio-fertlizer	Control	9.2i	65.4b	28.63g	9.6f	63.4cd	28.96g
	Salicylic acid at 200ppm	9.5h	66.6b	30.13fg	9.7f	63.8cd	29.45g
	Putrescine at 200ppm	9.6h	67.1b	30.65ef	9.8f	64.1c	29.89g
	Monopotassium phosphate at2g/l	9.9j	67.8b	31.95e	9.8f	64.2c	29.94g
	Ascorbic acid at 2g/l	9.4hi	66.4b	29.70fg	9.7f	63.7cd	29.42g
RD+ 47.6 ton compost + bio-fertilizer	Control	10.1fg	71.2a	34.23d	10.8e	67.4b	34.64f
	Salicylic acid at 200ppm	10.5de	71.6a	35.78cd	11.1c-e	67.8b	35.81d-f
	Putrescine at 200ppm	10.4e	71.8a	35.54cd	11.2cd	68.0b	36.26de
	Monopotassium phosphate at2g/l	10.7d	71.9a	36.62c	11.3c	68.2b	36.67d
	Ascorbic acid at 2g/l	10.3ef	71.8a	35.21cd	10.9de	67.7b	35.13ef
RD+ 59.5 ton compost + bio-fertilizer	Control	11.2c	73.2a	39.03b	11.8b	72.1a	40.48c
	Salicylic acid at 200ppm	11.5ab	73.6a	40.30ab	12.0ab	72.8a	41.58a-c
	Putrescine at 200ppm	11.4a-c	73.9a	40.12ab	12.1ab	73.0a	42.06ab
	Monopotassium phosphate at2g/l	11.6a	74.1a	40.92a	12.2a	73.2a	42.50a
	Ascorbic acid at 2g/l	11.3bc	73.4a	39.49ab	11.9ab	73.3a	40.95bc

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at5%.

Concerning the effect of growth stimulants foliar spray, data in the same Table clearly show that all growth stimulants treatments increased number of tubers/plant, average tuber weight and total tuber yield /ha. when compared with the control in both seasons. In this regard, spraying plants with monopotassium phosphate at 2 g/l in the first season exhibited the highest values in total produced yield and its components, also in the second season both monopotassium phosphate and putrescine at 200 ppm reflected the highest values without significant differences among them. Obtained results have been connected with the effect of such treatments on vegetative growth and its chemical constituents which positively affected produced yield. Stenzel *et al*. (2006), Bryan *et al*. (2010), Silvia *et al*. (2011), Abo-Hinna and Merza (2012), Jeffrey *et al*. (2015) and Upadhyaya *et al.* (2015) reported similar results on potato plants.

Furthermore, the number of tubers/plant, average weight of tuber and total yield/ha., were statistically increased by all studied combinations between organic fertilizer and growth stimulants, particularly the combination of 59.5 ton compost/ha., with spraying the plants with monopotassium phosphate at 2g/l and putrescine at 200 ppm during both seasons as compared with the combination of the control treatment. Moreover, the highest number of tubers/plant (11.6 and 12.2), the heaviest tuber weight (74.1 and 73.2 g) and the highest total yield /ha. (39.49 and 40.95 ton) were registered by the combined treatment between 59.5 ton compost/ha., and 2 g/l monopotassium phosphate-sprayed plants in the first and second seasons, respectively. Besides, the combination of 47.6 ton compost /ha. statistically increased these parameters, followed by the combination of 35.7 ton compost/ha. in the two seasons. On the contrast, the lowest value of yield parameters were scored by the combination of the control treatment, especially those untreated with growth stimulants sprays in the two seasons.

Tubers Quality Parameters

Tubers quality of potato plants that expressed as large > 55mm, medium 35-55mm and small < 35mm in diameter were greatly affected by all rates of organic fertilizer when compared with the control treatment in the two seasons. In addition, using the highest rate of organic fertilizer (59.5 ton compost/ha.) scored the highest values of large tubers as it gave 45.5 and 47.2% as well as medium size which scored 41.8 and 42.5%, but it recorded the lowest values of small size tubers as it registered 12.7 and 10.3% in the first and second seasons, respectively. In addition, 47.6 ton compost/ha. increased the values of large and medium size of potato tubers, followed by 35.7 ton compost/ha., but both organic treatments decreased the values of small size tuber when compared with the control plants which produced the lowest values of large and medium sizes and scored the highest values of small size tubers in the two seasons. These results are in agreement with those reported by Haase *et al.* (2007), Kumar *et al.* (2012), Mohammadi *et al.* (2013) and Malash *et al.* (2014) on potato plants.

Concerning the effect of growth stimulants foliar spray, data in Table 4 clear that all growth stimulants treatments improved tubers quality of potato plants, with superiority of 2 g/l monopotassium phosphate treatment which induced the highest values of large size tubers (39.5 and 41.1%) and medium size tubers (34.8 and 36.2 %), but it reduced the values of small size tubers (25.7 and 22.7 %) in the first and second seasons, respectively. Also, 200 ppm putrescine -sprayed plants were statistically improved tuber sizes in the two seasons as compared with the other treatments. Stenzel *et al*. (2006), Bryan *et al*. (2010), Silvia *et al*. (2011), Abo-Hinna and Merza (2012), Jeffrey *et al*. (2015) and Upadhyaya *et al*. (2015), on potato plants, came to similar results.

With respect to the interaction effect, data in Table 4 reveal that apart of growth stimulants all resulted combinations enhanced tubers size of potato plants, with the superiority of adding 59.5 ton compost/ha., when compared with the remained combinations in the two seasons. Anyway, the highest tubers quality were scored by plants fertilized by 59.5 ton compost/ha., and sprayed with monopotassium phosphate at 2 g/l, putrescine at 200ppm and salicylic acid at 200 ppm as they gave the highest values of large and medium sizes as well as the lowest values of small size tubers, with insignificant differences among them in most cases in the two seasons. On the contrary, the lowest values of large and medium tuber size were recorded by combination of the control treatment, especially those untreated with growth stimulants sprays, but they scored the greatest values of small tuber size in the two seasons.

Table 4. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato tuber size (%) during 2013/2014 and 2014/2015 seasons

Treatments		First season (2013/2014)			Second season (2014/2015)		
Fetilizers	Growth stimulants	Large (>55mm)	Medium (35-55) %	Small (<35mm)	Large (>55mm)	Medium (35-55) %	Small (<35mm)
Control (RD mineral NPK)		29.9 d	24.2d	45.9a	32.3d	25.3d	32.4a
RD+ 35.7 ton compost +bio-fertilizer		36.4c	31.7c	31.9b	37.1c	33.1c	29.8b
RD+ 47.6 ton compost +bio-fertilizer		41.5b	36.5b	22.0c	43.1b	37.7b	19.2c
RD+ 59.5 ton compost +bio-fertilizer		45.5a	41.8a	12.7d	47.2a	42.5a	10.3d
	Control	37.4c	32.7b	29.9a	39.1b	33.8d	27.1a
	Salicylic acid at 200ppm	38.1bc	33.3b	28.6ab	39.6b	34.2b	26.2ab
	Putrescine at 200ppm	38.8ab	33.7ab	27.5bc	40.2ab	34.8ab	25.0b
	Monopotassium phosphate at2g/l	39.5a	34.8a	25.7c	41.1a	36.2a	22.7c
	Ascorbic acid at 2g/l	37.8bc	33.2b	29.0ab	39.8b	34.2b	25.9ab
Control (RD mineral NPK)	Control	28.6g	23.4e	48.0a	31.2e	24.7f	44.1a
	Salicylic acid at 200ppm	29.4fg	23.8e	46.8a	31.9de	24.9f	43.2a
	Putrescine at 200ppm	30.9fg	24.3e	44.8ab	32.4de	25.4f	42.2ab
	Monopotassium phosphate at2g/l	31.8f	25.9e	42.3b	33.7d	26.8f	39.5b
	Ascorbic acid at 2g/l	29.1g	23.9e	47.0a	32.4de	25.1f	42.5ab
RD+ 15ton compost + bio-fertlizer	control	35.9e	31.2d	32.9c	36.7c	32.1e	31.2c
	Salicylic acid at 200ppm	36.0e	31.4d	32.6c	36.9c	32.4e	30.7c
	Putrescine at 200ppm	36.6e	31.8d	31.6c	37.2c	33.4e	29.4cd
	Monopotassium phosphate at2g/l	37.4e	32.9cd	29.7c	38.1c	34.9de	27.0d
	Ascorbic acid at 2g/l	36.1e	31.3d	32.5c	36.8c	32.6e	30.6cd
RD+ 47.6 ton compost + bio-fertilizer	control	40.8d	35.3bc	23.9d	42.0b	36.8cd	21.2e
	Salicylic acid at 200ppm	41.4d	36.4b	22.2d	42.7b	37.4cd	19.9ef
	Putrescine at 200ppm	41.9cd	36.9b	21.2d	43.9b	38.1c	18.0ef
	Monopotassium phosphate at2g/l	42.3b-d	37.8b	19.9d	44.2b	39.2bc	16.6f
	Ascorbic acid at 2g/l	41.1d	36.2b	22.7d	43.1b	37.1cd	19.8ef
RD+ 59.5 ton compost + bio-fertilizer	control	44.3a-c	41.1a	14.6e	46.5a	41.8ab	11.6g
	Salicylic acid at 200ppm	45.4a	41.8a	12.8ef	47.0a	42.3a	10.7gh
	Putrescine at 200ppm	46.1a	42.1a	11.8ef	47.3a	42.4a	10.3gh
	Monopotassium phosphate at2g/l	46.8a	42.8a	10.4f	48.2a	43.9a	7.9h
	Ascorbic acid at 2g/l	44.9ab	41.6a	13.5ef	47.1a	42.1a	10.8gh

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at 5%.

Tubers Chemical Composition Determinations

Data in Tables 5 and 6 indicate that all tested rates of organic fertilizer significantly increased tubers N, P, K, total protein, total amino acids and total starch, but they decreased tubers nitrate and total sugar contents as compared with the control treatment (recommended dose of mineral fertilizers) in the two seasons. On the other side, it was interest to note that there was a positive relationship between the rates of organic fertilizer and the content of tubers from N, P, K, total protein, total amino acids and total starch so as the rates of organic fertilizer increased the values of the aforementioned chemical constituents increased till reach to the maximum concentration at the highest added rate of organic fertilizer (59.5 ton compost/ha.) as it scored 4.48 , 4.71; 0.271, 0.319; 3.14 , 2.89; 14.00 , 14.74; 0.91, 0.95; 14.80 and 14.38 for N (%), P (%), K (%), total protein (%), total amino acids (%) and total starch (%), in the first and second seasons, respectively. On the contrast, there was a negative relationship between the rates of organic fertilizer and the values of tubers nitrate and total sugar contents, since as the rates of organic fertilizer increased the values of tubers nitrate and total sugars were decreased until they reached its minimum values at the highest rate of organic fertilizer as it scored 0.81and 0.78% for tuber nitrate content as well as 0.74% and 0.67% for total sugars content, in the first and second seasons, respectively. These results are in agreement with those reported by Haase *et al.* (2007), Kumar *et al*. (2012), Mohammadi *et al*. (2013) and Malash *et al.* (2014) on potato plants.

With respect to the effect of growth stimulants foliar spray, data in Tables 5 and 6 indicate that all studied growth stimulants increased total N, P, K, total protein, total amino acids and starch percentages in tubers. While, it decreased tubers nitrate and total sugar percentages in both seasons when compared with the control. Such effects did not reach the level of significance in case of phosphorus, starch and sugars percentages in the two seasons and total amino acids in the second one only. However, the highest records of N (%) (4.18 and 4.42), total protein (%) (13.06 and 13.83) and total amino acids (%) (0.81 and 0.82) were registered by 200 ppm putrescine-sprayed plants, whereas the highest recorded of P(%) (0.243 and 0.276), K (%) (2.77 and 2.60) and total starch (%) (14.02 and 13.48) were recorded by 2 g/l monopotassium phosphate-sprayed plants, in the first and second seasons, respectively. In this connection, all examined growth stimulants decreased tubers nitrate and total sugars contents, with the superiority of 200 ppm salicylic acid-sprayed plants as it scored 0.95 and 0.88% for tubers nitrate and 0.81 and 0.76% for tubers total sugars, in the first and second seasons, respectively. In this regard, Stenzel *et al*. (2006), Bryan *et al*. (2010), Silvia *et al*. (2011), Abo-Hinna and Merza (2012), Jeffrey *et al*. (2015), Upadhyaya *et al.* (2015), on potato plants, reported similar results.

Considering the interaction effect between organic fertilizer and growth stimulants treatments, data in Tables 5 and 6 declare that all resulted combinations succeeded in increasing tubers N, P, K, total protein, total amino acids and total starch contents, but they decreased tubers nitrate and total sugars contents as compared with the control combination in the two seasons. In this connection, the highest value of tubers N (%) (4.59 and 4.81), total amino acids (%) (0.93 and 0.97) and total protein (%) (14.35 and 15.03) were gained by the combined treatment between 59.5 ton compost/ha., and 200 ppm putrescine-sprayed plants, while the highest tubers P% (0.276 and 0.334), K (%) (3.29 and 2.96), total starch (%) (14.94 and 14.51) were scored by the treatment of 59.5 ton compost/ha. supplemented with 2g/l monopotassium phosphate-sprayed plants in the first and second seasons, respectively. Moreover, the combined treatment between 59.5 ton compost/ha. and 200 ppm salicylic acid-sprayed plants scored the lowest tubers nitrate (%) (0.78 and 0.75) and total sugars (%) (0.73 and 0.66) in the first and second seasons, respectively. On the contrary, the lowest values of tubers N, P, K, total protein, total amino acids and total starch (%) as well as the highest tubers nitrate and total sugars (%) were recorded by the combination of the control treatment, particularly those untreated with growth stimulants spray in the two seasons.

Conclusion, under such conditions, fertilizing potato plants with 59.5 ton/ha in the presence of bio-fertilizers and the recommended dose of mineral fertilizers (357:75:357) N : P_2O_5 : K_2O kg/ha. and foliar spray with monopotassium phosphate at 2g/l or putrescine at 200 ppm are recommended to obtain the highest produced tuber yield with best quality of potato grown in winter season.

Table 5. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato chemical constituents of tubers (%) during first season 2013/2014.

Fertilizers	Growth stimulants	N	P	K	No3	Total protein	Total amino acids	Total starch	Total sugars
Control (RD mineral NPK)		3.63d	0.222c	2.20d	1.14a	11.35d	0.66d	12.77c	0.93a
RD+ 35.7 ton compost +bio-fertilizer		3.91c	0.227bc	2.44c	1.04b	12.22c	0.74c	13.45b	0.86b
RD+ 47.6 ton compost +bio-fertilizer		4.18b	0.240b	2.84b	0.93c	13.08b	0.84b	14.33a	0.78c
RD+ 59.5 ton compost +bio-fertilizer		4.48a	0.271a	3.14a	0.81d	14.0a	0.91a	14.80a	0.74d
	Control	3.93c	0.232a	2.58c	1.01a	12.28c	0.76b	13.61a	0.85a
	Salicylic acid at 200ppm	4.02b	0.236a	2.63bc	0.95b	12.58b	0.79ab	13.80a	0.81a
	Putrescine at 200ppm	4.18a	0.238a	2.68b	0.98ab	13.06a	0.81a	13.92a	0.84a
	Monopotassium phosphate at 2g/l	4.07b	0.243a	2.77a	0.98ab	12.72b	0.80ab	14.02a	0.83a
	Ascorbic acid at 2g/l	4.05b	0.239a	2.63bc	0.97b	12.67b	0.79ab	13.82a	0.82a
Control (RD mineral NPK)	control	3.46j	0.206e	2.16k	1.16a	10.81j	0.64h	12.64g	0.97a
	Salicylic acid at 200ppm	3.53ij	0.209e	2.18jk	1.12a-c	11.03ij	0.66gh	12.76fg	0.91a-c
	Putrescine at 200ppm	3.84gh	0.213e	2.21i-k	1.14ab	12.0gh	0.69f-h	12.84fg	0.94ab
	Monopotassium phosphate at 2g/l	3.71hi	0.219c-e	2.28h-k	1.13ab	11.59hi	0.68f-h	12.91fg	0.93a-c
	Ascorbic acid at 2g/l	3.62ij	0.214de	2.19jk	1.15a	11.31ij	0.67f-h	12.69g	0.92a-c
RD+ 15ton compost + bio-fertlizer	Control	3.86f-h	0.224b-e	2.36g-j	1.07b-d	12.06f-h	0.71e-h	13.24eg	0.88a-d
	Salicylic acid at 200ppm	3.89f-h	0.226a-e	2.39g-i	1.01d-f	12.15f-h	0.75d-g	13.41d-g	0.84c-g
	Putrescine at 200ppm	3.98fg	0.229a-e	2.48fg	1.05cd	12.44fg	0.76c-f	13.52c-g	0.87b-e
	Monopotassium phosphate at 2g/l	3.92fg	0.231a-e	2.59f	1.04d	12.25fg	0.76c-f	13.61b-g	0.86b-e
	Ascorbic acid at 2g/l	3.91fg	0.227a-e	2.41f-h	1.03de	12.22fg	0.74e-g	13.48c-g	0.85b-f
RD+ 47.6 ton compost + bio-fertilizer	control	4.04ef	0.235a-e	2.78e	0.96e-g	12.62ef	0.80b-e	13.94a-f	0.81d-h
	Salicylic acid at 200ppm	4.18de	0.240a-e	2.84e	0.91gh	13.06de	0.85a-c	14.21a-e	0.76f-h
	Putrescine at 200ppm	4.31cd	0.239a-e	2.86de	0.94fg	13.47cd	0.87ab	14.47a-d	0.80d-h
	Monopotassium phosphate at 2g/l	4.20de	0.246a-e	2.94c-e	0.95fg	13.12de	0.84a-d	14.64a-c	0.79d-h
	Ascorbic acid at 2g/l	4.21de	0.241a-e	2.81e	0.93gh	13.25de	0.86ab	14.39a-e	0.78e-h
RD+ 59.5 ton compost + bio-fertilizer	control	4.36b-d	0.265a-d	3.04b-d	0.86hi	13.62b-d	0.91a	14.64a-c	0.75gh
	Salicylic acid at 200ppm	4.51ab	0.269a-c	3.11a-c	0.78j	14.10ab	0.91a	14.82a	0.73h
	Putrescine at 200ppm	4.59a	0.274ab	3.17ab	0.82ij	14.35a	0.93a	14.86a	0.75gh
	Monopotassium phosphate at 2g/l	4.46a-c	0.276a	3.29a	0.83ij	13.94a-c	0.92a	14.94a	0.74h
	Ascorbic acid at 2g/l	4.48a-v	0.274ab	3.12a-c	0.79ij	14.0a-c	0.91a	14.73ab	0.75gh

Treatments: Fertilizers, Growth stimulants; First season (2013-2014).

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at 5%.

Table 6. Effect of organic fertilizers and growth stimulants foliar spray and their interaction treatments on potato chemical constituents of tubers (%) during second season 2014/ 2015

Treatments		Second season (2014/2015)							
Fertilizers	Growth stimulants	N	P	K	No_3	Total protein	Total amino acids	Total starch	Total sugars
Control (RD mineral NPK)		3.80d	0.223c	2.17d	1.08a	11.88d	0.69d	12.36d	0.90a
RD + 35.7 ton compost + bio-fertilizer		4.20c	0.241c	2.38c	0.94b	13.13c	0.77c	13.13c	0.81b
RD+ 47.6 ton compost + bio-fertilizer		4.48b	0.276b	2.70b	0.86c	14.02b	0.83b	13.59b	0.72c
RD + 59.5 ton compost +bio-fertilizer		4.71a	0.319a	2.89a	0.78d	14.74a	0.95a	14.38a	0.67d
	Control	4.19c	0.256a	2.47b	0.94a	13.11c	0.79a	13.24a	0.79a
	Salicylic acid at 200ppm	4.28b	0.262a	2.51b	0.88c	13.38b	0.81a	13.34a	0.76a
	Putrescine at 200ppm	4.42a	0.266a	2.55ab	0.92ab	13.83a	0.82a	13.40a	0.78a
	Monopotassium phosphate at 2g/l	4.33b	0.276a	2.60a	0.93ab	13.54b	0.81a	13.48a	0.78a
	Ascorbic acid at 2g/l	4.27bc	0.264a	2.54ab	0.90bc	13.35bc	0.81a	13.36a	0.78a
Control (RD mineral NPK)	Control	3.71k	0.214i	2.12i	1.12a	11.59k	0.68f	12.27g	0.92a
	Salicylic acid at 200ppm	3.74k	0.219hi	2.16hi	1.04bc	11.69k	0.69ef	12.34g	0.89a-d
	Putrescine at 200ppm	3.96ij	0.230g-i	2.18hi	1.09ab	12.37ij	0.71d-f	12.41fg	0.90a-c
	Monopotassium phosphate at 2g/l	3.84jk	0.231g-i	2.22g-i	1.11ab	12.0jk	0.70d-f	12.48fg	0.91ab
	Ascorbic acid at 2g/l	3.76k	0.224g-i	2.17hi	1.06ab	11.75k	0.69ef	12.31g	0.90a-c
RD+ 15ton compost + bio-fertlizer	Control	4.06hi	0.236f-i	2.31f-h	0.97cd	12.69hi	0.74c-f	12.92ef	0.84b-e
	Salicylic acid at 200ppm	4.21gh	0.243e-i	2.34fg	0.91d-h	13.15gh	0.78b-e	13.18c-e	.79e-g
	Putrescine at 200ppm	4.32e-g	0.238f-i	2.41f	0.94d-f	13.50e-g	0.79b-d	13.10d-e	0.81ef
	Monopotassium phosphate at 2g/l	4.24fg	0.249e-i	2.46f	0.95de	13.25fg	0.78b-e	13.26c-e	0.83c-e
	Ascorbic acid at 2g/l	4.19gh	0.241e-i	2.39f	0.93d-g	13.19gh	0.76b-f	13.19c-e	0.82de
RD+ 47.6 ton compost + bio-fertilizer	Control	4.38d-f	0.264d-i	2.63b	0.89e-i	13.69d-f	0.82bc	13.52cd	0.73g-i
	Salicylic acid at 200ppm	4.49cd	0.274b-g	2.69c-e	0.83i-l	14.03cd	0.82bc	13.54c-d	0.70hi
	Putrescine at 200ppm	4.61bc	0.283b-f	2.72c-e	0.86g-k	14.41bc	0.84b	13.62c-d	0.74f-h
	Monopotassium phosphate at 2g/l	4.53cd	0.291a-e	2.79b-d	0.87f-j	14.16cd	0.83bc	13.69bc	0.72g-i
	Ascorbic acid at 2g/l	4.42de	0.269c-h	2.68de	0.85h-k	13.81de	0.84b	13.75cd	0.73g-i
RD+ 59.5 ton compost + bio-fertilizer	control	4.64bc	0.311a-d	2.84a-c	0.81j-m	14.50bc	0.94a	14.24ab	0.68hi
	Salicylic acid at 200ppm	4.69ab	0.314a-d	2.88ab	0.75m	14.65ab	0.96a	14.29a	0.66i
	Putrescine at 200ppm	4.81a	0.316a-c	2.89ab	0.80j-m	15.03a	0.97a	14.49a	0.67hi
	Monopotassium phosphate at 2g/l	4.73ab	0.334a	2.96a	0.79k-m	14.78ab	0.96a	14.51a	0.69hi
	Ascorbic acid at 2g/l	4.71ab	0.324ab	2.92ab	0.77lm	14.72ab	0.95a	14.38a	0.68hi

Means of the same column followed by the same letter were not significantly different according to Duncan MRT at 5%.

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تأثيـر التســميد العضــوي والــرش ببعـض المــركبــات الآمنــة علــى نمـــو وإنتــاجيـــة نبــاتــات البطــاطــس النــاميـــة في العروة الشتوي

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أجريت تجربتان حقليتان خلال الموسمين الشتويين لعامي ٢٠١٤/٢٠١٣و ٢٠١٥/٢٠١٤ في مزرعة خاصة بقرية كفر الصهبى- شبين القناطر محافظة القليوبية، لدراسة تأثير مستويات مختلفة من التسميد العضوي (الكمبوست) بمعدل ٣٥,٧، ٤٧,٦ و٥٩,٥ طن/هكتار فى وجود التسميد المعدني والحيوي، وكذلك الرش الورقي بكل من حمض السلسليك بتركيز ٢٠٠ جزء فى المليون، والبترسين بتركيز ٢٠٠ جزء في المليون، وأحادي فوسفات البوتاسيوم بتركيز ٢جم/لتر وحمض الاسكوربيك بتركيز ٢جم/لتر، وكذلك التفاعل بينهما على النمو الخضري، والتركيب الكيماوى، والمحصول الكلى، وجودة درنات البطاطس صنف ليدى روزيتا خلال الموسم الشتوى، وقد أوضحت النتائج المتحصل عليها أن تسميد نباتات البطاطس بالكمبوست بمختلف الكميات المستخدمة أدى إلى حدوث زيادة معنوية فى قياسات النمو الخضري (طول النبات - عدد الأفرع/النبات - الوزن الطازج والجاف للنبات)، والتركيب الكيمياوي للمجموع الخضرى (النتروجين - الفوسفور- البوتاسيوم - الكربوهيدرات الكلى)، والمحصول الكلى للدرنات ومكوناته (عدد الدرنات/النبات - متوسط وزن الدرنة - ونسبة الدرنات الكبيرة والمتوسطة)، وكذلك التركيب الكيمياوى للدرنات (النتروجين الكلى - الفوسفور- البوتاسيوم- البروتين الكلى- الأحماض الأمينية ونسبة النشا) بينما قللت نسبة النترات والسكريات الكلية للدرنات، وعلاوة على ذلك فقد أدى استخدام أعلى معدل للكمبوست (٥٩,٥طن/هكتار) إلى الحصول على أعلى القيم في القياسات السابقة، كما أدى رش نباتات البطاطس أربع مرات بعد الزراعة بشهر ومرة كل أسبوعين بكل من البترسين بتركيز ٢٠٠ جزء في المليون وأحادي فوسفات البوتاسيوم بتركيز ٢جم/لتر إلى الحصول على أعلى القيم لقياسات النمو الخضري، والتركيب الكيمياوى للمجموع الخضري، والمحصول الكلى، وصفات الجودة للدرنات الناتجة وذلك بدون وجود فروق معنوية بينهما بالمقارنة بباقي المواد المستخدمة ومعاملة الكنترول، وفى هذا الشأن أدى تسميد نباتات البطاطس النامية في أرض رملية بالكمبوست بمعدل ٥٩,٥طن/هكتار بالإضافة إلى رش النباتات أربع مرات بكل من أحادى فوسفات البوتاسيوم بتركيز ٢ جم/لتر أو البترسين بتركيز ٢٠٠ جزء فى المليون إلى الحصول على أعلى محصول كلى وبأحسن صفات للجودة للدرنات الناتجة.

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