

Response of Strawberry to Salicylic Acid and Yeast Extract Applications under Different Nitrogen and Potassium Combinations

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Abstract

This study was conducted during the two successive seasons of 2011/2012 and 2012/2013 in a private farm at El-Dair village, Kalubia governorate, to investigate the response of strawberry to salicylic acid and yeast extract applications under different nitrogen and potassium fertilizers combinations. Data were recorded on vegetative growth, chemical constituents, yield and its components as well as fruit quality.

Results indicate that application of mineral fertilizers at the highest used levels (150 kg N + 200 kg K₂O or 200 kg N + 300kg K₂O) per fed. combined with spraying the plants with salicylic acid at 1g/L or yeast extract 100 ml/L exhibited the highest values in the measured growth parameters i.e., plant height, number of leaves and crowns per plant, crown diameter, average leaf area as well as fresh and dry weight per plant during both seasons. Also, the same treatments gave the highest values of phosphorus, potassium and total carbohydrates during both seasons of study. Results also show that using the highest rate of N and K fertilizers (200 kg N+ 300 kg K₂O) and spraying the plants with salicylic acid (1g / liter) reflected the highest produced yield and its components. Moreover, it reflected also the highest values of all determined physical and chemical fruit quality characters (average fruit length, diameter, weight and fruit firmness, TSS, Vitamin C, acidity, total sugars and anthocyanin) during both seasons .The study recommend adding 200 Kg N + 300 kg K₂O per fed and spraying the plants with salicylic acid at 1g /L to enhance plant growth and increase yield and its components particularly early and exportable yield as well as physical and chemical fruit characteristics, under Kalubia governorate conditions.

Keywords: Strawberry, salicylic acid, yeast extract, N, K fertilization, yield, fruit quality.

Introduction

Concerning the effect of NPK fertilizers on plant vegetative growth traits, **Abd El-Aziz (2007)** indicated that potassium fertilization had insignificant effect on plant growth characteristics except plant length. **Abo Sedera et al. (2009)** found that, using mineral -N fertilizer alone or along with compost at the recommended dose (200kg N/fed.) had better effect on the studied vegetative growth traits. **Mosalem (2010)** on strawberry indicated that application of mineral fertilizers at 125% of the recommended dose (250kg N + 100kg P₂O₅ + 300kg K₂O) reflected the highest plant height, number of leaves and secondary crowns /plant, leaf area, crown diameter, fresh and dry weight per plant. **Mohamed (2008)**, **Shafshak et al. 2010** and **Jamali et al. (2013)** found that spraying plants with natural anti disease substances i.e. salicylic acid increased plant height, number of leaves and crowns per plant, fresh and dry weight per plant as well as leaf area , **Saleh (2004)** on strawberry showed that spraying plants with 25 ml/l yeast extract plus mixture of micronutrients significantly increased number of leaves, number of crowns, fresh weight and dry weight per plant. On the other hand, **Ahmed (2011)** on strawberry found that foliar application of yeast extract at rate of 2.5% did not reflect any significant effects on all studied growth aspects except number of leaves. **Kaponski and Kaweeki (1994)** on

strawberry reported that using 90kg N and 160 kg K₂O/ ha increased leaf K and P contents. **Abd El-Aziz (2007)** on strawberry reported that there were significant increments in potassium and carbohydrates content of plant with increasing potassium fertilizer units from 250 up to 500units K₂O/ fed. In addition, non significant effect on nitrogen and phosphorus content in foliage was noticed. **Mosalem (2010)** on strawberry reported that application of mineral fertilizers at 125% of the recommended dose (250 kg N + 100kg P₂O₅ + 300kg K₂O/fed) reflected the highest values of total nitrogen, phosphorus, potassium and total carbohydrates content in plant foliage. **Karlidag et al (2009)** found that the greatest values of almost contents of all nutrients of leaves were obtained with 1.00 mM salicylic acid treatments in both saline and non-saline conditions. **Jamali et al. (2013)** on strawberry found that foliar spray with salicylic acid at rates of 1, 2, and 3 mM significantly increased nitrogen concentration within leaves. **Abd El-All (2009)** on tomato illustrated that spraying yeast extract significantly increased N, P, K, Ca and Mg concentrations of treated plants compared with the control treatment. **Ali (2010)** on common bean found that spraying plants with dry yeast at rates of 2 and 4 g/l after 20, 30 and 40 days from sowing significantly increased all macro-elements content compared with the control treatment. **EL-Shal et al. (2003)**, found that increasing NPK rate was accompanied with

significant increases in yield potentials (early yield/plant, non-marketable yield and total yield/plant).

Mosalem (2010) reported that application of mineral fertilizers (NPK) at 125% of the recommended dose (250kg N + 100kg P₂O₅ + 300kg K₂O/fed) resulted in the highest total fruit yield and its components expressed as early, exportable and marketable strawberry yield per feddan. In addition, no significant differences were noticed in total yield and its components in case of using mineral fertilizers at 100%. **Shafshak et al. (2010)** showed that spraying strawberry plants with salicylic acid at 5mM positively increased early, total and marketable fruit yield. **El Sayed (2010)** on strawberry reported that different NPK levels increased fruit length, weight and firmness. However, it increased ascorbic acid, anthocyanin and TSS. **Abd El-Aziz (2007)** indicted that application of K-fertilizer had no significant effect on physical characters of strawberry fruits. **Mosalem(2010)** on strawberry indicated that fertilizing the plants with mineral

fertilizers (NPK) at 125% of the recommended dose significantly increased all the studied physical fruit parameters, i.e., average fruit length, diameter and weight except fruit firmness which was not significantly affected. **Saleh (2004)** reported that spraying the strawberry plants with yeast extract increased vitamin C concentration.

Therefore, this study was conducted to investigate the response of strawberry to salicylic acid and yeast extract applications under different nitrogen and potassium combinations,

Materials and Methods

Two field experiments were carried out during the two successive seasons of 2011/2012 and 2012/2013 in a private farm at El-Dair village, Kalubia governorate, to investigate the response of strawberry to salicylic acid and yeast extract applications under different nitrogen and potassium combinations,

Table a. Mechanical and chemical analyses of the used soil.

Physical analysis		Chemical analysis			
		Cations meq/l		Anions meq/l	
Coarse sand	17.3%	Ca ⁺⁺	2.4	CO ₃ ⁻⁻	Zero
Fine sand	35.4%	Mg ⁺⁺	1.0	HCO ₃ ⁻	3.5
Silt	29.2%	Na ⁺	6.0	Cl ⁻	7.4
Clay	18.7%	K ⁺	7.0	SO ₄ ⁻	2.7
Texture class	clay loam				
Soil pH	7.32	Available N	21.4mg/kg		
E.C, dS/m	1.91	Available P	15.3mg/kg		
Organic matter	2.4%	Available K	210mg/kg		

The area of the experimental plot was 14m² included two beds each four meters in length and 1.20 meters in width. Each bed included four rows and the transplanting was done at 25 cm apart between transplants in the same row. Transplanting was done on 15 and 12 of September in 2011/2012 and 2012/2013, respectively. Sprinkler irrigation was used in the first month after transplanting, after that the beds were covered with 40 micron black plastic mulch. After planting the drip irrigation was used after mulching until the end of the growing season.

This experiment included 9 treatments resulted from the combination between three levels of N,K mineral fertilizer and two spray treatments (antioxidant) in addition to the control treatment on strawberry plants cv. Florida. As follows

a- N, K fertilization treatments.

- 1- 100kg N + 100kg K₂O./fed
- 2- 150kg N + 200kg K₂O./fed
- 3- 200kg N + 300kg K₂O/fed (control).

b- Spray treatments.

- 1- Foliar spray with yeast extract at 100 ml/l
- 2- Foliar spray with salicylic acid (SA) at 1g/l.

3- Foliar spray with distilled water(control).

Ammonium nitrate (33% N) and potassium sulphate (50%K₂O) were used as a source of nitrogen and potassium. All treatments received 80 kg/fed.of P₂O₅ phosphorus. The amounts of mineral fertilizers were divided into equal portions and were added through the irrigation water (fertigation) two times per week starting 21 days after transplanting and ended 15 days before the end of harvesting season. Foliar spray treatments were started after 20 days from transplanting and every 15 days four times throughout the growing season.

Data recorded:

Vegetative growth characteristics.

Five plants were taken from each experimental plot as a representative sample on February after 130 days from transplanting and the following data were recorded.

- 1- Plant length, fresh and dry weight per plant, number of crowns/plant, number of leaves/plant, leaf area (cm²) and crown diameter
- 2- **Total nitrogen, phosphorus and potassium:** were determined in the digested dry matter of plant foliage according to the methods described

by **Kock and Mc Meeekin (1924)**, **Trough and Meyer (1939)** and **Brown and Lilliland (1946)**, respectively

- 3- **Total protein:** Protein content was calculated by using the conversion factor ($N \times 6.25$) as described by **Pregl (1945)**.
- 4- **Total carbohydrates:** It was determined colorimetrically according to method described by **James (1995)**.
- 5- **Fruit yield and its components:**
 - A. **Early fruit yield:** It was determined as weight of all harvested fruits at the ripe stage during November, December and January.
 - B. **Total fruit yield:** It was calculated using total fruit yield per plot.
 - C. **Fruit yield (per plant):** It was calculated from fruit yield/plot and number of plants/plot.
 - D- **Marketable yield:** it was calculated after discarding the infected fruits.
 - E- **Un-marketable yield (kg/fed):** It was calculated as weight of infected fruits during the harvesting season.
 - F- **Exportable yield (t/fed):** it was calculated as weight of harvested fruits at the 3/4 color stage during November, December and January, after discarding the misshaped fruits.

6- Fruit quality

Physical and chemical fruit quality: A random sample of 10 fruits at marketable stage from each experimental plot was taken to determine the following properties. Average fruit weight, fruit firmness. Total soluble solids (T.S.S.), total titratable acidity, ascorbic acid and anthocyanin as the method described in **A. O. A.C. (1990)**. Total sugars were determined as the method described by **Nelson (1974)**. Nitrate content was determined as the method described by **Cafado et al. (1975)**.

Statistical analysis:

All collected data were subjected to statistical analysis according to **Snedcor and Cochran (1991)** where the least significant difference was considered when even possible.

Results and Discussion

1. Vegetative growth characteristics:-

Data presented in Tables 1 and 2 show that using the highest rate of fertilizer i.e. 200kg N + 300 kg K₂O/fed significantly reflected the highest values in all studied growth traits i.e., plant height, number of leaves and crown per plant, crown diameter, average leaf area as well as fresh and dry weight per plant during both seasons. Such increment in all studied growth parameters as a result of increasing the amounts of mineral fertilizers to 200 kg N + 300 kg K₂O may be attributed to the main role of macro – nutrients (N and K) on formation of protoplasmic

material, cell division and cell elongation as well as increase the bio- chemicals reactions which affect the rate of plant growth. as found by, **Abd El- Aziz (2007)**, **Abo Sedera et al. (2009)**, and **Mosalem (2010)**

In Tables 1 and 2 obtained data show clearly that spraying strawberry plants with salicylic acid at 1 g/ Liter and yeast extract at 100 ml/ Liter gave the highest values of all vegetative growth characters during both seasons. The increase in growth due to the application of the tested stimulants may be attributed to the role of such materials as antioxidants which contract the free radicals which affect the activity and viability of plant cells. Also it affects the physiological processes of plants and promotes plant growth.

Obtained results are in accordance with those reported by **Saleh (2004)**, **Abo Sedera et al. (2009)**, **Shafshak et al. (2010)** and **Ahmed (2011)**

Data recorded in Tables 1 and 2 show clearly that application of mineral fertilizers at the highest used levels 150 kg N + 200 kg K₂O and 200 kg N + 300kg K₂O combined with spraying the plants with salicylic acid at 1g/L or yeast extract at 100 mL/L exhibited the highest values in all measured growth parameters during both seasons of study.

2- Chemical constituents of plant foliage

Data recorded in Table 3 indicate that the highest level of mineral (N and K) fertilizers (200 kg N + 300 kg K₂O/ fed) recorded the highest values in all assayed chemical constituents except total nitrogen and total crud protein which recorded the highest values in case of moderate mineral fertilizer level (150 kg N + 200kg fed) during both seasons. Such increments in N, P and K content as a result of increasing fertilization level may be due to the increase of such nutrients in roots biosphere and consequently increases its uptake and accumulation of such macro nutrients in plant foliage. Also the increase in total carbohydrate contents might be attributed to the main role of used macro–nutrients (NPK) as constituents of photo synthetic pigment molecules and increase assimilation rate for precursors of carbohydrates in leaves.

Results show also that foliar application of salicylic acid at 1g liter exhibited the highest values of N, P, K, protein and carbohydrates in plant foliage compared with the control and other used growth stimulant. during two seasons. In this connection, promoting effect of growth stimulants on the concentration of macro- elements was connected with its positive effect on vegetative growth parameters (Tables, 1 and 2). Moreover, such increasing tendency of N, P, K, protein and carbohydrates as a result of studied growth stimulants may be attributed to its main role on the enzymes which may control the active absorption of nutrients and water from the soil. Obtained results are in the same line with those reported by

Mohamed (2008), Shafshak et al. (2010) and Jamail et al. (2013).

As for the effect of the interaction, the same data in Table 3 indicate that fertilizing strawberry plants with the highest used level of macro-nutrients (N and K) combined with spraying the plants with either salicylic acid at 1g/L or yeast extract at 100 m/L exerted the highest values of phosphorus, potassium and total carbohydrates during both seasons of study. In addition, using the medium level of mineral fertilizer (150 kg N plus 200 kg K₂O / fed) combined with foliar spray of salicylic acid at g/L reflected the highest values of both total nitrogen and crude protein in the two seasons of study.

Abd El-All (2009) and Karlidag et al (2009) reported similar results.

3- Fruit yield and its components:

Data recorded in Tables 4 and 5 show that application of mineral fertilizers (N and K) at (200 Kg N + 300 Kg K₂O fed) exhibited the highest values for total produced yield and its components. Such increments in total produced yield and its components were connected with the increase in vegetative growth rate Tables (1 and 2) and fruit physical parameters (Table 6) which in turn affect the total fruit yield. In this connection, **El Shal et al. (2003), Ulvi et al. (2009) and Mosalem (2010)** on strawberry indicated that total fruit yield and its components were enhanced as a result of mineral fertilizers (NPK). Data in Tables 4 and 5 reveal that spraying plants with salicylic acid at 1g / liter exhibited the highest values in all determined yield parameters compared with other studied spray treatments during both seasons. Such increments in total produced yield and its components were connected with the increase in vegetative growth parameters Tables (1 and 2). Obtained results are in parallel to those reported by **Shafshak et al. (2010)**. Also, data in Tables 4 and 5 reveal also that using the highest rate of (N, K) fertilizers (200 kg N+ 300 kg K₂O) and spraying the plants with salicylic acid (1g / liter) reflected the highest produced yield and its components compared during with the other tested treatments both seasons of study.

4-Fruit quality:-

Data in Table 6 show that application of mineral fertilizers (N, K) at (200 kg N+ 300kg K₂O/fed) exhibited the highest values for all measured fruit quality traits. Increasing the rate of N, K fertilizer up to (200kg N +300kg K₂O). Such results may be attributed to such macro-nutrients are necessary to cells formation and division as well as increasing

rates of photosynthetic assimilates and migration of it to storage organs (fruit) and in turn increase its parameters. In this regard, **Abo-El Hamed et al. (2006)** reported that application of nitrogen and potassium fertilizers increased physical fruit quality expressed as fruit length, diameter and size. However, **Abd El- Aziz (2007)** indicated that application of mineral fertilizer did not affect physical fruit quality. Obtained results are similar to those reported by **Ghoneim et al. (2003), El- Sayed (2004), Abo El Hamd et al. (2006) and Abd El-Aziz (2007)**. In Table 6 data reveal also that spraying plants with salicylic acid at 1g /Liter and yeast at 100ml /Liter significantly increased average fruit length, diameter, weight and fruit firmness compared with the control treatment. Such increment in fruit parameters due to salicylic acid treatment may be attributed to the role of salicylic acid on increasing the uptake of NPK (Table 6) and the absorption of water by roots which in turn increased fruit size. Similar observation were recorded by **Saleh (2004), Babalar et al. (2007) and Shafshak et al. (2010)** on strawberry. As for the interaction, data in Table 6 reveal that supplying the plant with mineral fertilizer at rate (200 kg N + 300 Kg K₂O/fed) combined with spraying the plants with salicylic acid at 1/Liter reflected the highest values of all determined physical fruit quality characters (average fruit length, diameter, weight and fruit firmness) during both seasons.

Data recorded in Tables 7 and 8 indicate that fertilizing the plant with mineral fertilizer (N and K) at 100 kg N + 100 kg K₂O, 150 Kg N + 200 kg K₂O or 200kg N + 300 kg K₂O /fed significantly affected TSS, V.C and total sugars content during the first season and TSS, total sugars and nitrate content during the second season. However it did not affect total acidity, anthocyanine and nitrate content during the first season and V.C, total acidity and anthocyanine pigment contents during the second season. In this respect, the highest level of mineral (N and K) fertilizers (200 kg N + 300 kg K₂O/fed) recorded the highest values in all assayed chemical constituents during both seasons.

Spraying the plants with salicylic acid increased all assayed organic constituents (TSS, Vitamin C, acidity, total sugars and Anthocyanine content compared with yeast extract and control treatment (Table 7 and 8). Finally, using the highest rate of N and K (200 kg N + 300 kg K₂O / fed) fertilizers and spraying the plants with salicylic acid (1g/Liter) increased all determined constituents (TSS, Vitamin C, acidity, total sugars and anthocyanine) compared with the other interaction treatments.

Table1. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on vegetative growth characteristics of strawberry plants cv. Florida during 2011/2012 season.

Treatments		2011/2012						
N,K(kg/fed)	Spray	Plant height (cm)	Fresh weight(g)	Dry weight(g)	Number of Leaves	Number of crowns	Crown diameter (cm)	Leaf area(cm ²)
100kgN+100kg K ₂ O		19.13	31.92	9.86	13.83	2.04	1.82	792.6
150kgN+200kg K ₂ O		20.78	51.38	12.95	17.29	2.77	2.15	884.7
200kgN+300kg K ₂ O		20.94	62.93	15.77	18.05	3.02	2.39	984.6
LSD at 0.5%		1.07	15.22	3.20	2.85	0.61	0.06	NS
	Control	18.21	37.22	10.26	14.63	2.09	1.94	736.7
	Salicylic acid (1g/l)	21.73	55.53	14.44	17.81	3.08	2.41	989.6
	yeast extract (100ml/l)	20.90	53.50	13.88	16.74	2.65	2.02	935.6
LSD at 0.5%		1.11	13.78	1.75	2.53	0.48	0.22	150.4
	Control	17.44	24.95	7.72	11.83	1.65	1.67	584.7
100kgN+100kg K ₂ O	Salicylic acid (1g/l)	19.91	35.33	11.86	15.00	2.63	2.10	875.0
	yeast extract (100ml/l)	20.02	35.49	9.99	14.67	1.83	1.70	918.1
	Control	18.39	36.97	8.80	16.78	2.00	1.95	793.9
150kgN+200kg K ₂ O	Salicylic acid (1g/l)	22.44	60.33	14.58	17.89	3.13	2.40	914.8
	yeast extract (100ml/l)	21.50	56.84	15.48	17.22	3.19	2.10	945.2
	Control	18.80	49.73	14.25	15.28	2.63	2.20	831.3
200kgN+300kg K ₂ O	Salicylic acid (1g/l)	22.83	70.93	16.88	20.55	3.50	2.72	1179.0
	yeast extract (100ml/l)	21.18	68.15	16.18	18.33	2.94	2.27	943.5
LSD at 0.5%		1.9190	23.87	3.03	4.54	0.76	0.38	260.6

Table2. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on vegetative growth characteristics of strawberry plants cv. Florida during 20012/2013 season.

Treatments		2012/2013						
N,K(kg/fed)	Spray	Plant height (cm)	Fresh weight (g)	Dry weight (g)	Number of Leaves	Number of crowns	Crown diameter (cm)	Leaf area (cm ²)
100kgN+100kg K₂O		24.26	65.99	17.28	28.24	3.875	2.52	1374.2
150kgN+200kg K₂O		25.29	78.03	18.82	32.15	3.92	2.68	1462.4
200kgN+300kg K₂O		25.57	82.24	20.17	32.45	3.89	2.87	1496.7
LSD at 0.5%		0.86	5.77	1.89	2.73	NS	0.24	NS
	Control	24.46	65.53	16.60	25.90	3.25	2.48	1312.2
	Salicylic acid (1g/l)	25.78	83.67	20.44	33.87	4.48	2.77	1559.3
	yeast extract (100ml/l)	24.88	77.06	19.22	33.07	3.96	2.82	1461.8
LSD at 0.5%		1.08	5.54	1.30	2.59	0.66	0.23	127.3
	Control	23.30	59.63	15.90	24.33	3.38	2.38	1261.8
100kgN+100kg K₂O	Salicylic acid (1g/l)	25.05	70.09	18.45	31.28	4.50	2.56	1504.6
	yeast extract (100ml/l)	24.42	68.27	17.48	29.10	3.75	2.63	1356.3
	Control	25.10	67.18	16.20	26.67	3.25	2.38	1298.0
150kgN+200kg K₂O	Salicylic acid (1g/l)	25.88	89.52	21.20	34.83	4.25	2.78	1585.9
	yeast extract (100ml/l)	24.89	77.40	19.09	34.94	4.26	2.90	1503.4
	Control	24.99	69.79	17.71	26.70	3.13	2.70	1376.8
200kgN+300kg K₂O	Salicylic acid (1g/l)	26.41	91.41	21.68	35.50	4.68	3.13	1587.4
	yeast extract (100ml/l)	25.32	85.51	21.13	35.16	3.88	2.79	1525.8
LSD at 0.5%		1.87	13.18	2.25	6.16	1.14	0.40	220.5

Table 3. Effect of fertigation using N,K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on chemical constituents of plant foliage of strawberry plants cv. Florida during 2011/2012 and 2012/2013 seasons.

Treatments		2011/2012			2012/2013						
N,K(kg/fed)	Spray	N%	P%	K%	Total crude protein	Carbohydrates (g/ 100 g d.w.)	N%	P%	K%	Total crude protein	Carbohydrates (g/ 100 g d.w.)
100kgN+100kg K₂O		1.58	0.45	1.45	9.84	14.93	1.58	0.45	1.44	9.89	14.52
150kgN+200kg K₂O		1.81	0.47	1.49	11.34	15.4	1.75	0.48	1.48	11.03	14.52
200kgN+300kg K₂O		1.69	0.48	1.53	10.55	15.64	1.68	0.49	1.52	10.48	14.62
LSD at 0.5%		NS	0.03	0.03	NS	NS	NS	0.02	0.04	NS	NS
	Control	1.64	0.45	1.44	10.24	14.49	1.59	0.45	1.43	9.93	14.33
	Salicylic acid (1g/l)	1.73	0.48	1.53	10.84	15.92	1.73	0.48	1.52	10.79	14.79
	yeast extract (100ml/l)	1.71	0.48	1.5	10.66	15.56	1.71	0.48	1.49	10.68	14.64
LSD at 0.5%		NS	0.02	0.03	NS	0.96	NS	0.02	0.03	NS	NS
	Control	1.66	0.4	1.42	10.36	14.71	1.46	0.41	1.42	9.14	14.90
100kgN+100kg K₂O	Salicylic acid (1g/l)	1.57	0.48	1.48	9.78	15.13	1.80	0.48	1.47	11.27	14.54
	yeast extract (100ml/l)	1.5	0.47	1.45	9.39	14.96	1.48	0.47	1.43	9.26	14.12
	Control	1.8	0.47	1.44	11.26	14.37	1.71	0.48	1.43	10.67	14.47
150kgN+200kg K₂O	Salicylic acid (1g/l)	1.82	0.47	1.53	11.39	15.94	1.76	0.48	1.51	11.02	14.56
	yeast extract (100ml/l)	1.82	0.48	1.51	11.37	15.88	1.82	0.48	1.51	11.39	14.86
	Control	1.45	0.47	1.47	9.09	14.38	1.59	0.47	1.46	9.97	13.61
200kgN+300kg K₂O	Salicylic acid (1g/l)	1.81	0.48	1.58	11.34	16.68	1.61	0.48	1.57	10.08	15.27
	yeast extract (100ml/l)	1.80	0.48	1.55	11.22	15.85	1.82	0.48	1.53	11.39	14.98
LSD at 0.5%		NS	0.03	0.05	NS	1.67	NS	0.04	0.06	NS	1.06

Table 4. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on total fruit yield and its components of strawberry plants of cv. Florida during 2011/2012 season.

Treatments		2011/2012					
N,K (kg/fed)	Spray	Early yield (ton/fed)	Exportable yield (ton/fed)	Marketable yield (ton/fed)	Total yield (g/plant)	Total Yield (t/fed)	Unmarketable yield (kg/fed)
100kgN+100kg K ₂ O		6.706	2.562	16.427	424.39	16.976	548.20
150kgN+200kg K ₂ O		7.839	3.266	18.787	485.99	19.440	652.53
200kgN+300kg K ₂ O		8.593	3.637	19.898	514.24	20.570	671.78
LSD at 0.5%		1.333	0.524	1.9450	49.818	1.993	77.699
	Control	6.891	2.737	16.201	422.80	16.912	710.49
	Salicylic acid (1g/l)	8.256	3.408	20.040	514.82	20.593	552.60
	yeast extract (100ml/l)	7.990	3.321	18.871	487.00	19.480	609.42
LSD at 0.5%		1.121	0.376	2.752	68.452	2.738	79.49
	Control	6.120	2.120	14.857	386.05	15.442	585.20
100kgN+100kg K ₂ O	Salicylic acid (1g/l)	7.447	2.867	17.995	462.21	18.844	493.80
	yeast extract (100ml/l)	6.552	2.700	16.431	424.91	16.996	565.60
	Control	6.286	2.878	15.803	413.01	16.520	717.60
150kgN+200kg K ₂ O	Salicylic acid (1g/l)	8.505	2.394	20.930	538.34	21.534	604.00
	yeast extract (100ml/l)	8.725	3.525	19.629	506.62	20.265	636.00
	Control	8.267	3.213	17.945	469.33	18.773	828.67
200kgN+300kg K ₂ O	Salicylic acid (1g/l)	8.817	3.963	21.196	543.91	21.756	560.00
	yeast extract (100ml/l)	8.695	3.737	20.552	529.48	21.179	626.67
LSD at 0.5%		1.942	0.652	4.767	118.56	4.743	137.67

Table 5. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on total fruit yield and its components of strawberry plants cv. Florida during 2012/2013 season.

Treatments		2012/2013					
N,K (kg/fed)	Spray	Early yield (ton/fed)	Exportable yield (ton/fed)	Marketable yield (ton/fed)	Total yield (g/plant)	Total Yield (t/fed)	Unmarketable yield(kg/fed)
100kgN+100kg K₂O		6.730	2.618	14.474	367.15	14.686	211.37
150kgN+200kg K₂O		7.245	2.872	18.294	468.48	18.739	444.70
200kgN+300kg K₂O		7.847	3.176	18.709	481.34	19.254	545.72
LSD at 0.5%		0.9178	0.492	1.118	25.937	1.038	236.47
	Control	6.290	2.476	15.797	407.65	16.306	509.23
	Salicylic acid (1g/l)	7.992	3.195	18.119	460.83	18.433	313.05
	yeast extract (100ml/l)	7.540	2.995	17.560	448.49	17.940	379.51
LSD at 0.5%		1.055	0.380	1.547	38.244	1.530	123.02
	Control	6.232	2.145	13.688	349.58	13.983	296.47
100kgN+100kg K₂O	Salicylic acid (1g/l)	6.734	2.931	14.991	379.52	15.181	187.35
	yeast extract (100ml/l)	7.225	2.777	14.743	372.34	14.894	150.29
	Control	6.146	2.561	16.949	438.93	17.557	607.35
150kgN+200kg K₂O	Salicylic acid (1g/l)	7.986	2.986	19.163	486.85	19.474	310.88
	yeast extract (100ml/l)	7.602	3.070	18.769	479.65	19.186	415.88
	Control	6.493	2.721	16.754	434.43	17.377	623.88
200kgN+300kg K₂O	Salicylic acid (1g/l)	9.255	3.668	20.203	516.11	20.644	440.92
	yeast extract (100ml/l)	7.794	3.138	19.169	493.48	19.739	572.35
LSD at 0.5%		1.827	0.658	2.679	66.241	2.650	213.08

Table 6. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on physical fruit quality of strawberry plants cv. Florida during 2011/2012 and 2012/2013 seasons.

Treatments		2011/2012				2012/2013			
N,K(kg/fed)	Spray	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit firmness (g/cm ²)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit firmness (g/cm ²)
100kgN+100kg K ₂ O		15.83	4.14	2.98	142.38	19.88	4.19	3.12	98.78
150kgN+200kg K ₂ O		17.56	4.29	3.19	155.63	21.03	4.28	3.32	100.25
200kgN+300kg K ₂ O		17.85	4.33	3.27	162.01	21.04	4.31	3.26	107.59
LSD at 0.5%		1.31	0.19	0.15	11.31	0.96	0.08	0.12	1.49
	Control	14.84	4.01	2.99	147.70	19.16	4.19	3.12	100.29
	Salicylic acid (1g/l)	18.80	4.42	3.24	157.99	22.07	4.33	3.32	105.43
	yeast extract (100ml/l)	17.59	4.33	3.20	154.33	20.71	4.26	3.26	100.90
LSD at 0.5%		0.89	0.12	0.12	7.21	0.85	0.09	0.12	3.39
100kgN+100kg K ₂ O	Control	13.40	3.99	2.89	130.00	18.19	4.11	3.01	97.55
	SA 1g/l	17.25	3.21	3.04	147.50	21.31	4.32	3.22	102.50
	yeast 100ml/l	16.84	3.21	3.01	149.64	20.85	4.15	3.09	96.28
150kgN+200kg K ₂ O	Control	15.67	4.04	3.07	155.84	19.99	4.22	3.28	100.33
	SA 1g/l	19.28	4.51	3.29	158.97	22.23	4.30	3.35	100.67
	yeast 100ml/l	17.73	4.32	3.21	152.08	20.85	4.32	3.37	99.75
200kgN+300kg K ₂ O	Control	15.47	4.00	3.04	157.25	19.30	4.24	3.08	102.97
	SA 1g/l	19.88	4.54	3.40	167.50	22.66	4.37	3.39	113.13
	yeast 100ml/l	18.20	4.46	3.37	161.28	21.14	4.33	3.32	106.67
LSD at 0.5%		1.54	0.20	0.21	12.49	1.48	0.17	0.21	5.89

Table7. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on on chemical constituents in fruits of strawberry plants cv. Florida during 2011/2012 season.

Treatments		2011/2012					
N,K (kg/fed)	spray	TSS%	Vit.C (mg/100g f.w)	Acidity (mg/100g f.w)	Total sugars%	Anthocyanin (mg/100g f.w)	Nitrate (ppm)
100kgN+100kg K ₂ O		10.35	42.26	1.655	6.19	81.54	155.56
150kgN+200kg K ₂ O		10.54	43.33	1.69	6.28	83.51	198.89
200kgN+300kg K ₂ O		10.73	46.75	1.72	6.62	87.57	286.67
LSD at 0.5%		0.17	0.94	NS	0.30	NS	NS
	control	10.32	42.28	1.62	6.16	79.18	247.78
	Salicylic acid (1g/l)	10.73	45.07	1.82	6.18	88.13	208.33
	yeast extract (100ml/l)	10.57	44.99	1.62	6.75	85.30	185.00
LSD at 0.5%		0.37	1.12	0.079	0.41	6.53	NS
100kgN+100kg K ₂ O	control	10.07	41.33	1.66	5.61	75.62	228.33
	Salicylic acid (1g/l)	10.47	42.47	1.70	6.40	86.15	116.67
	yeast extract (100ml/l)	10.51	42.99	1.60	6.57	82.84	121.67
150kgN+200kg K ₂ O	control	10.34	41.50	1.59	6.26	80.80	186.67
	Salicylic acid (1g/l)	10.76	44.50	1.87	5.83	87.43	235.00
	yeast extract (100ml/l)	10.53	44.00	1.60	6.75	82.30	175.00
200kgN+300kg K ₂ O	control	10.56	43.99	1.60	6.62	81.14	328.33
	Salicylic acid (1g/l)	10.96	48.25	1.89	6.29	90.82	273.33
	yeast extract (100ml/l)	10.67	48.00	1.67	6.94	90.77	258.33
LSD at 0.5%		0.64	1.93	0.14	0.71	11.31	161.32

Table 8. Effect of fertigation using N K mineral fertilizers and foliar spray with growth stimulants as well as their interaction on on chemical constituents in fruits of strawberry plants cv. Florida during 2012/2013 season.

Treatments		2012/2013					
N,K (kg/fed)	spray	TSS%	Vit.C (mg/100g f.w)	Acidity (mg/100g f.w)	Total sugars%	Anthocyanin (mg/100g f.w)	Nitrate (ppm)
100kgN+100kg K ₂ O		8.98	51.44	1.44	6.08	82.03	131.67
150kgN+200kg K ₂ O		9.34	51.67	1.53	6.17	86.00	238.89
200kgN+300kg K ₂ O		9.74	53.22	1.56	6.48	87.31	267.78
LSD at 0.5%		0.69	NS	NS	0.38	NS	97.737
	control	8.80	50.00	1.48	5.82	80.13	253.89
	Salicylic acid (1g/l)	9.63	53.78	1.61	6.19	88.79	211.11
	yeast extract (100ml/l)	9.62	52.56	1.44	6.72	86.42	173.33
LSD at 0.5%		0.40	1.97	NS	0.85	7.43	NS
	control	8.54	48.33	1.37	5.66	75.48	203.33
100kgN+100kg K ₂ O	Salicylic acid (1g/l)	9.18	53.33	1.50	6.30	86.10	135.00
	yeast extract (100ml/l)	9.20	52.66	1.47	6.28	84.52	56.67
	control	8.89	51.33	1.57	5.75	82.13	273.33
150kgN+200kg K ₂ O	Salicylic acid (1g/l)	9.45	53.00	1.57	6.05	88.64	213.33
	yeast extract (100ml/l)	9.69	50.67	1.47	6.72	87.24	230.00
	Control	8.98	50.34	1.50	6.04	82.77	285.00
200kgN+300kg K ₂ O	Salicylic acid (1g/l)	10.26	55.00	1.77	6.22	91.64	285.00
	yeast extract (100ml/l)	9.97	54.34	1.40	7.16	87.52	233.33
LSD at 0.5%		0.70	3.42	0.37	1.48	12.87	183.89

References

- A. O.A. C. (1990).** Official and tentative methods of analysis. Association of Official Analytical Chemists. Washington, D.C,U.S.A.
- Abd El-All, M. M. (2009).**Improvement of tomato productivity by using certain natural materials. Ph.D. Thesis. Fac. of Agric., Benha univ.
- Abd El-Aziz, M.G. (2007).** Studies on fruiting regulation of some strawberry cultivars grown under new reclaimed soils conditions. Ph.D. Thesis, Fac. Agric., Ain Shams Univ., Egypt.
- Abo-El-Hamd, A. S. A., A. A. Abdou, S. A. A. Mansour and A. A. A. El-Sayed. (2006).** Effect of some biofertilizers on the yield and fruit quality of strawberry. Ann .of Agric. Sci., Moshtohor, 44(1): 251-264.
- Abo Sedera, F. A., Nadia S. Shafsha, S. M. Eid and M. H. M. Mohamed. (2009):** Improving productivity and quality of strawberry via organic fertilization and application of some natural growth stimulants 3rd IRT international scientific Conference Intergrated Relational Tourism. territories and developmet in the Mediterranean area, Helwan Univ , Egypt, 24 - 27th October 2009 .
- Ahmed, W.M.S. (2011).** Some factors affecting runner formation and transplants production in strawberry nursery. M.Sc. Thesis, Fac. Agric., Ain Shams Univ., 52pp .
- Ali. T. G. A. (2010).** Physiological studies on growth, seeds yield and its quality of common bean. Ph. D Thesis. Fac. of Agric., Benha univ
- Babalar, M., M. Asghari, A. Talaei and A. Khosroshahi .(2007).** Effect of pre and post harvest salicylic acid treatment on ethylene production, fungal decay and overall quality of Selva strawberry fruit. Food chemistry J., 105:449-453.
- Brown, J. and O. Lilliland. (1946).** Rapid determination of potassium and sodium in plant material and soil extracts by flame photometric. Proc. Amer. Soc. Hort. Sci, 48: 341- 346.
- Cafado, D. A.,M. Haroon, L. E. Sharderand and V. L. Youn.(1975).** Rapid colorimetric determination of nitrate in plant tissues by nitrification of salicylic acid comm. Soil and plant Anal., 6:71-80.
- El-Sayed, A. A. A. (2004).** Effect of some nutrients on growth and yield of strawberry. M.Sc. Thesis. Fac. Of Agric., Al- Azhar Univ., Egypt.
- El-Shal, M.A., S.M.El-Araby, I.M.Ghoneim and H. Anter. (2003).** Effects of biofertilization under varying NPK levels on growth, yield and fruit quality of strawberry plants. J. Agric. & Env. Sci., Alex. Univ., Egypt.2:106-129
- Ghoneim, I.M., S.M. El-Araby, A.I. Shehata and R.A. Mohamed. (2003).** Effects of nitrogen, organic manure and biofertilizer application on strawberry plants.II.yield and fruit quality. J. Agric. & Env. Sci., Alex. Univ., Egypt. 2:63-87.
- Jamali, B. Eshghi, S and Taffazoli, E. (2013).** Vegetative growth, yield, fruit quality and fruit and leaf composition of strawberry cv. 'pajaro' as influenced by salicylic acid and nickel sprays. Journal of Plant Nutrition . 36: 7, 1043-1055.
- James, C. S. (1995).** Analytical chemistry of foods Blokie Academic, proffessional, London.
- Kaponski, K. and Z. Kawecki. (1994).** Nitrogen fertilization and growth and cropping of strawberries in the conditions of zulawy. 11. plant morphology and leaf chemical composition. Acta Academia Agric. 58.125-134. (C.F. Hort. Abstr. 66(6): 4890, 1996).
- Karlidag, H. Yildirim, E. and Turan, M.(2009)** Salicylic acid ameliorates the adverse effect of salt stress on strawberry. Scientia Agricola66: 2, 180-187.
- Koch, F. C. and T. L. McMeekin .(1924)** A new direct nasalization micro keldahl method and ammonium. J. Amer. Soc. Chem., 46: 521.
- Moasalem, S. M. R. (2010)** Physiological studies on growth, yield and quality of some strawberry cultivars M.Sc. Thesis, Fac. of Agric.Moshtohor, Benha Uniiv.
- Mohamed, M. H. M. (2008).** Effect of some agricultural treatments on growth and productivity of strawberry M.Sc Thesis. Fac, of Agric., Benha univ.
- Nelson, N. (1974).** A photometric adaptation of the somogyi methods for determination of glucose. J. Biology. Chem. 195: 19-23.
- Pregl, E. (1945).** Quantitative organic micro analysis 4th ed. J. Chundrill, London.
- Saleh,E. H. A . (2004).** Studies on strawberry nutriton in sandy soil under drip irrigation system. M.Sc. Thesis, Fac. of Agric.Moshtohor, Benha Uniiv.
- Shafshak, Nadia, S., S.M. Eid, F.A. Abo-Sedera and M.H.M. Mohamed (2010).** Effect of nitrogen fertilization sources and foliar application of garlic extract, plant gured or salicylic acid on strawberry productivity and storability. The Fifth International Conference for Development and Environment in the Arab world. March 21-23, 2010. Assiut, Egypt. 357-375.
- Snedecor, G. W. and W.G. Cocharn. (1991).** Statistical methods. 8th E.d., Iowa state univ. press, Iowa. USA.
- Trough, E. and Meyer. (1939)** Improvement in denies calorimetric method for phosphorus and arsenic. Indian English Chemistry Analysis edition. 1:136- 139.
- Ulvi M, Priit. P., T. Thutare, K. Karp and Strast El - Vool. (2009).** Effect of phosphite fertilization on growth, yield and fruit composition of strawberries. Scientia Hort. 199: 264-269.

إستجابة الفراولة لمعاملات حمض السلسليك ومستخلص الخميرة تحت تراكيب مختلفة من

النيتروجين والبوتاسيوم

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الملخص العربي

إجريت هذه الدراسة خلال موسمي 2011/2012 و2012/2013 في مزرعة خاصة بقرية الدير مركز طوخ بمحافظة القليوبية لبحث إستجابة نباتات الفراولة للمعامله بحمض السلسليك ومستخلص الخميره تحت تراكيب مختلفه من النيتروجين والبوتاسيوم وسجلت البيا رأت علي النمو الخضري والمكونات الكيماوية والمحصول ومكوناته .
تظهر النتائج أن اعلي المستويات من الاسمدة المعدنية (150كجم نيتروجين + 200كجم بوتاسيوم وكذلك 200كجم نيتروجين + 300كجم بوتاسيوم) للقدان مع الرش بحمض السلسليك بمعدل 1جم /لتر او مستخلص الخميرة بمعدل 100مل/لتر اعطي اعلي القيم لصفات النمو الخضري وهي ارتفاع النبات وعدد الاوراق والتيجان الثانويه للنبات وقطر التاج ومساحه سطح الورقة والوزن الطازج والجاف للنبات وكذلك الحصول علي اعلي قيم الفوسفور والبوتاسيوم والبروتين في الاوراق خلال موسمي الدراسه .
وتظهر النتائج أيضا ان التركيبه ذات المعدل العالي من النيتروجين والبوتاسيوم (200كجم نيتروجين + 300كجم بو 12) مع الرش بحمض السلسليك (1جم /لتر) أعطت اعلي قيم المحصول ومكوناته خاصه المحصول المبكر والمحصول الصالح للتصدير واعطت اعلي القيم لخصائص الثمار الطبيعيه والكيماويه مثل طول ووزن الثمار والصلابة بالاضافه الي المواد الصلبه الذائبه وحمض الاسكوريك والحموضة والسكريات الكلية والانثوسيانين خلال الموسمين .
توصي الدراسة انه يفضل إضافة التركيبه السماديه المعدنيه المكونه من 200كجم نيتروجين + 300كجم بوتاسيوم ورش النباتات بمعدل 1جم/لتر حمض السلسليك للحصول علي افضل نمو خضري ومحصول مبكر وكلي وصالح للتصدير وتحسين الخصائص الطبيعيه والكيماويه لثمار الفراوله في مزارع التصدير تحت ظروف محافظه القليوبيه .