Yield and Fruit Quality of Washington Navel Oranges As Influenced By Foliar Application of Fenugreek and Rocket Seed Sprouts

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Abstract: This study was carried out during 2013 and 2014 seasons to investigate the effect of spraying fenugreek and/ or rocket seed sprouts each at 0.1% to 0.4% on growth, nutritional status, yield and fruit quality of Washington Navel orange trees. The two crop seed sprouts were applied four times at growth start, just after fruit setting and at one month intervals. Spraying fenugreek and/ or rocket seed sprouts four times at 0.1 to 0.4% was very effective in stimulating leaf area and shoot length N, P, K, Mg, Zn, Fe, Mn, fruit retention %, yield and fruit quality and reducing preharvest fruit drop % rather than non- application. Application of fenugreek seed sprout was materially favourable than using rocket seed sprout in this connection. Using both crop seed sprouts together was superior than using each crop seed sprout alone in this respect. The promotion on growth, leaf mineral content, yield and fruit quality was depended on increasing concentrations of each crop seed sprout from 0.1 to 0.4% without considerable effect among the higher two concentrations. Carrying out four sprays at growth start, just after setting and at one month intervals with a mixture of fenugreek and rocket seed sprouts at 0.2% was responsible for improving yield and fruit quality of Washington Navel orange trees.
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1. Introduction

Poor cropping as well as environmental pollution are suggested to be a major problems that faces Washington Naval orange growers in Middle Egypt. Poor cropping could be a result of poor setting and/ or high dropping of flowers and fruits due to unsuitable environmental factors and malnutrition. Pollution is one of the most problems affecting human health especially when the edible part of the plant is polluted with any of pollutants. Using synthetic chemicals cause the accumulation of harmful residual substances like NO_2, and NO_3 in the edible portions such as fruits as well as reduce exportation process. Therefore, it is essential for avoiding the use of chemicals and continuous application of crop seed sprout extracts which are promising in the long run of citrus.

Most studies clarified the beneficial effects of extracts of crops seed sprouts such as fenugreek, and rocket for alleviating the adverse effects of unsuitable environmental conditions and all stresses around trees on fruiting as well as solving different drawbacks facing production of fruit crops. Sprouting of seeds may alter the content and composition of proteins, fats and amino acids and enhance the biosynthesis of essential amino acids like glutamic acid, tryptophan and arginine, vitamins B & C and most essential macro and micro nutrients and makes them high available to fruit crops (**Cazoula *et al.*, 2004; Cairney, 2005 and Biommerson, 2007)** emphasized the beneficial effects of crop seed sprout on growth and fruiting of horticultural crops.

Camacho *et al.* (1992), Cairney (1995); Aballah *et al* (2000) and **Crews and Peoples (2004)** found that foliar application of crop seed sprouts such as barley, wheat, fenugreek and rocked had an obvious promotion on the yield through supplying the plants with their requirements from organic and mineral nutrients, natural hormones and antioxidants and they are responsible for reducing reactive oxygen species consequently protecting plan cells from death.

Previous studies emphasized the pronounced role of crop seed sprout on growth characters, nutritional status of plant, flowering, fruit setting, yield and both physical and chemical characteristics of the fruits in different horticultural corps (**Abdallah, 2008; Darwish, 2009; Anderson and Cedergreen 2010; Al- Shereif *et al.*, 2013; El- Sayed – Faten, 2014; El-Khawaga and Mansour, 2014; Ahmed and Habasy-Randa, 2014; Mohamed, 2014 and Refaai, 2014a and 2014b**).

The main target of this study was elucidating the effect of single and combined applications of two crop seed sprouts namely fenugreek and rocket on growth, yield and fruit quality of Washington Navel orange trees.

2. Material and Methods

This study was conducted during 2013 and 2014 seasons on thirty Uniform in vigour 22- years old Washington Navel orange trees onto sour orange

rootstock and grown in a private orchard located at Bany Mazar district, Minia Governorate, where the soil texture is silty clay and well drained and water Table depth not less than two meters. The selected trees are planted at 5x5 meters apart. Surface irrigation system using Nile water was followed. The chosen trees were subjected to the normal horticultural practices that are already applied in the orchard.

This study included the following ten treatments from fenugreek and rocket seed sprout:-

1- Control (treated with water trees).
2- Spraying fenugreek seed sprout at 0.1%.
3- Spraying fenugreek seed sprout at 0.2%.
4- Spraying fenugreek seed sprout at 0.4%.
5- Spraying rocket sprout at 0.1%.
6- Spraying rocket sprout at 0.2%.
7- Spraying rocket sprout at 0.4%.
8- Spraying both at 0.1%
9- Spraying both at 0.2%
10- Spraying both at 0.4%

Table (1): Analysis of the tested soil

Characters	Values
Sand %	6.1
Silt %	60.9
Clay %	33.0
Texture	Silty clay
O.M. %	2.11
CaCO3 %	1.95
pH (1: 2.5 extract)	7.64
EC (1: 2.5 extract) mmhos/ 2 cm/ 25^{o}C	0.96
Total N %	0.09
Available P (Olsen, ppm)	4.2
Available K (ammonium acetate, ppm)	400.9

Table (2): Chemical analysis for fenugreek and rocket seed sprouts.

Fenugreek (mg/ 100 g F.W.)		Rocket (mg/ 100 g F.W.)	
Constituent	Values	Constituent	Values
Asparatic acid	2.2	Cystine	4.1
Arginine	2.1	Cysteine	3.9
Alanine	2.9	Methionene	3.8
Isoleucin	2.1	Glutamic acid	3.5
cysteine	1.9	Thamine	0.16
Cystine	1.8	Riboflavine	0.15
Glutamic acid	2.0	Vitamin E	0.94
Methionene	6.0	Vitamin A	4.4
Lysine	5.1	Vitamin C	101
Vitamin A	1.0	K	496
Vitamin B_1	0.32	P	1410
Vitamin B_2	0.30	Mg	460
Vitamin B_6	1.00	Fe	267
Vitamin C	2.00	Mn	16
Ca	220	Zn	255
P	341		
K	469		
Mg	371		
Fe	242		
Phytic acid	0.9		
Niacin	1.4		

Each treatment was replicated three times, one tree per each. Rocket seeds were sown at a rate of 30 g seeds/ m^2. then they harvested at fully expanded green cotyledonny leaves stage (after eleven days from sowing). Fenugreek seeds were sown in dark place using glass jar method (**Abdallah, 2008**), then sprouts were harvested after three days from seed soaking. sprouts of rocket and fenugreek were homogenized with distilled water according to the investigated concentrations (1, 2 4 L/water respectively) using an electric blender for five minutes, then filterated and kept under 4^{o}C in refrigerator till use. Table (2) sows the chemical analysis of seeds sprouts of fenugreek and rocket. The two crop seed sprouts were sprayed four times during the two growing seasons at growth start (1st week of March), just after fruit setting (1st

week of May) and at one month intervals (1st week of June and July). Triton B as a wetting agent at 0.05% was added to all crop seed sprout solutions before application and spraying was done till runoff (50 L/ tree). The control trees were sprayed with water containing Triton B. Randomized complete block design (RCBD) was adopted.

Twenty mature leaves 7-months old were picked from non- Fruiting shoots of Spring growth cycle (**Summer, 1985**) for measuring the leaf area according to (**Ahmed and Morsy, 1999**). Four shoots from such cycle were taken from the four directions for measuring shoot length (cm.). The previous leaves were dried for determination of N, P, K & Mg as percentages and Zn, Fe and Mn as ppm (according to **Wilde *el al.*, 1985**. Also, fruit retention % and preharvest fruit dropping % were recorded.

Harvesting was carried at the middle of Dec. when T.S.S/ acid in the fruits of the untreated trees reached at least 8:1. Yield/ tree expressed in weight (kg.) and number of fruits/ tree was recorded. Twenty fruits were taken randomly from the yield of each tree for measuring fruit weight (g.), T.S.S %, total sugars %, total acidity % (as g citric acid/ 100 ml juice) and vitamin C content (as mg ascorbic acid/ 100 ml juice) (according to **Lane and Eynon volumetric method, 1965** and **A.O.A.C, 2000**).

Statistical analysis was done according to **Mead *et al.* (1993)**. The individual comparisons among the ten treatments were compared by using new L.S.D test at 0.05

3. Results

1- Leaf area and shoot length:

It is clear from the data in Table (3) that foliar application of fenugreek seed sprout and/ or rocket seed sprout each at 0.1 to 0.4% significantly enhanced the leaf area and shoot length relative to the check treatment. Spraying fenugreek seed sprout significantly surpassed the use of rocket seed sprout in this respect. Using both crop seed sproutd significantly enhanced such two growth characters comparing with using each crop seed sprout alone. Increasing concentrations of each crop seed sprout from 1: 0.4 % was followed by a gradual promotion on the followed by a gradual promotion on the leaf area and shoot length. A slight and unsignificant promotion on such two growth aspects was observed among the higher two concentrations of each crop seed sprout. The maximum values of leaf area (19.5 and 20.3 cm^2) and shoot length (15.7 and 16.1 cm) were recorded on the trees that received a mixture of fenugreek and rocket seed sprouts each at 0.4 %. The lowest values were observed on untreated trees. These results were true during both seasons.

2- Leaf chemical composition:

It is worth to mention from the data in Tables (3 &4) that supplying Washington Navel orange trees four times with fenugreek and / or rocket seed sprouts at 0.1 to 0.4% significantly was responsible for enhancing the seven nutrients namely N, P, K, Mg, Zn, Fe and Mn in the leaves over the check treatment. Using fenugreek seed sprout was significantly superior than using rocket seeds sprout in this respect. Combined application of fenugreek and rocket seed sprouts was significantly responsible for maximizing these nutrients rather than application of each crop seed sprout alone. No significant stimulation on these nutrients was observed when concentration of each crop seed extract was increased from 0.2 to 0.4%. The maximum N (2.32 & 2.41 %), P (0.39 & 0.41 %), K (1.82 & 1.84%), Mg (0.98 & 0.99 %), Zn (59 & 60 ppm), Fe (64.0 & 64.5 ppm) and Mn (60.5 & 64.3 ppm) in the leaves were recorded on the trees that foliar sprayed with both crop seed sprout each at 0.4. The untreated trees produced the minimum values. These results were true during both seasons.

3- Percentages of fruit retention and preharvest fruit drop and yield/ tree:

Data in Tables (4&5) clearly show that single and combined applications of fenugreek and rocket seed sprouts each at 0.1 to 0.4% four times significantly was accompanied with improving fruit retention%, yield and number of fruits/ tree and reducing preharvest fruit drop % over the check treatment. The effect either in increase or decrease was depended on increasing concentration of each crop seed sprout from 0.1 to 0.4 %. Increasing concentration of each seeds sprout from 0.2 to 0.4% failed significantly to show and any promotion on fruit retention, yield and number of fruits / tree and reduction on preharvest fruit drop. Using fenugreek seed sprout was significantly preferable in improving fruit setting and yield and reducing preharvest fruit drop % than using the other crop seed sprout namely rocket seed sprout. From economical point of view using fenugreek and rocket seed sprouts each at 0.2% is considered the best treatment. Under such promised treatment, yield/ tree reached 60.0 and 60.5%. The untreated trees produced 45.0 and 44.0 kg per tree during both seasons respectively. The percentage of increase on the yield due to application of the recommended treatment over the control treatment reached 33.3 and 37.5 % during 2013 and 2014 seasons respectively. These results were true during both the two experimental seasons.

4- Fruit quality:

It is evident from the data in Table (5) that treating Washington Navel orange trees four times with fenugreek and rocket seed sprouts each at 0.1 to 0.4% significantly was accompanied with enhancing

fruit quality in terms of increasing fruit weight, T.S.S. %, total sugars % and vitamin C content and decreasing total acidity % comparing with the check treatment. The promotion on fruit quality was significantly associated with increasing concentrations of each crop seed sprout from 0.1 to 0.4% in most cases. Using fenugreek seed sprout was significantly favourable than using rocket seed sprout in improving fruit quality. Combined applications of fenugreek and rocket seed sprouts was significantly superior than using each crop seed sprout alone in promoting quality of the fruits. Increasing concentrations from 0.2 to 0.4% failed significantly to show measurable promotion on fruit quality. The best results from economical point of view were obtained due to treating the trees four times with a mixture of fenugreek and rocket seed sprouts each at 0.2%. Unfavourable effects on fruit quality were recorded on untreated trees. These results were true during both seasons.

Table (3): Effect of spraying fenugreek and rocket seed sprouts on the leaf area and shoot length in the Spring growth cycle and percentages of N, P, K and Mg in the leaves of Washington Navel orange trees during 2013 and 2014 seasons.

Crop seed sprout treatments	Leaf area $(cm)^2$		Shoot length (cm.)		Leaf N %		Leaf P %		Leaf K %		Leaf Mg %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	14.2	15.0	11.1	11.5	1.71	1.80	0.16	0.15	1.39	1.40	0.51	0.49
Fenugreek at 0.1 %	16.1	16.9	13.6	14.0	2.00	2.09	0.27	0.28	1.60	1.61	0.75	0.76
Fenugreek at 0.2 %	16.7	17.5	14.1	14.5	2.11	2.19	0.30	0.31	1.66	1.66	0.83	0.84
Fenugreek at 0.4 %	16.8	17.6	14.2	14.6	2.10	2.20	0.31	0.32	1.67	1.68	0.84	0.85
Rocket at 0.1 %	14.7	15.5	11.6	12.0	1.81	1.90	0.19	0.20	1.45	1.46	0.59	0.60
Rocket at 0.2 %	15.5	16.3	12.8	13.2	1.90	1.99	0.22	0.22	1.50	1.50	0.66	0.66
Rocket at 0.4 %	15.6	16.4	13.0	13.4	1.91	2.00	0.23	0.23	1.51	1.51	0.67	0.66
Both at 0.1%	17.9	18.7	15.0	15.4	2.20	2.30	0.35	0.37	1.73	1.76	0.91	0.91
Both at 0.2 %	19.4	20.2	15.6	16.0	2.31	2.40	0.38	0.40	1.83	1.81	0.97	0.98
Both at 0.4 %	19.5	20.3	15.7	16.1	2.32	2.41	0.39	0.41	1.84	1.82	0.98	0.99
New L.S.D. at 5 %	0.4	0.5	0.4	0.5	0.06	2.05	0.02	0.02	0.05	0.05	0.06	0.05

Table (4): Effect of spraying fenugreek and rocket seed sprouts on the leaf content of Zn, Fe and Mn (as ppm) in the leaves, percentages of fruit retention and preharvest fruit drop and yield / tree of Washington Navel orange trees during 2013 and 2014 seasons.

Crop seed sprout treatments	Leaf Zn (ppm)		Leaf Fe (ppm)		Leaf Mn (ppm)		Fruit retention %		Preharvest fruit drop %		Yield/ tree (kg.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	40.0	40.9	41.1	41.3	33.3	32.9	0.90	0.89	31.3	32.0	45.0	44.0
Fenugreek at 0.1 %	50.0	51.0	52.0	52.5	45.0	44.9	1.11	1.12	19.1	19.0	53.3	54.0
Fenugreek at 0.2 %	53.0	53.7	55.0	55.5	48.9	48.8	1.20	1.21	16.0	15.8	56.0	57.0
Fenugreek at 0.4 %	53.3	54.0	55.6	56.0	49.0	49.0	1.21	1.22	15.8	15.7	56.3	57.5
Rocket at 0.1 %	43.1	43.7	44.1	44.4	37.9	37.7	0.96	0.97	27.0	26.9	47.5	48.0
Rocket at 0.2 %	46.4	46.6	48.0	48.3	41.0	41.6	1.03	1.04	24.3	24.1	50.0	50.5
Rocket at 0.4 %	47.0	46.7	48.3	48.7	41.3	41.7	1.04	1.05	24.0	23.9	50.5	51.0
Both at 0.1%	56.0	57.5	59.9	60.9	55.0	55.7	1.32	1.33	13.3	13.2	58.0	58.5
Both at 0.2 %	58.9	59.9	63.9	64.3	60.0	61.0	1.40	1.40	11.0	10.8	60.0	60.5
Both at 0.4 %	59.0	60.0	64.0	64.5	60.5	61.3	1.41	1.41	10.9	10.7	60.3	61.0
New L.S.D. at 5 %	2.2	2.1	2.9	2.8	3.0	3.0	0.05	0.06	1.9	1.7	1.2	1.4

Table (5): Effect of spraying fenugreek and rocket seed sprouts on the number of fruits / tree as well as some physical and chemical characteristics of the fruits of Washington Navel orange trees during 2013 and 2014 seasons.

Crop seed sprout treatments	Number of fruits / tree		Fruit weight (g)		T.S.S. %		Total sugars %		Total acidity %		Vitamin C content (mg/ 100 ml pulp)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Control	210.0	209.0	214.3	210.5	14.1	13.9	9.1	9.0	1.551	1.541	41.9	42.0
Fenugreek at 0.1 %	232.0	233.0	229.7	231.8	15.4	15.5	10.6	10.7	1.410	1.400	48.5	48.6
Fenugreek at 0.2 %	240.0	241.0	233.5	236.5	16.0	16.0	11.1	11.2	1.380	1.370	50.5	50.9
Fenugreek at 0.4 %	241.0	242.0	233.6	237.6	16.1	16.1	11.2	11.3	1.379	1.369	51.0	51.1
Rocket at 0.1 %	217.0	217.0	218.9	221.2	14.5	14.5	9.5	9.5	1.520	1.510	44.0	44.5
Rocket at 0.2 %	224.0	225.0	223.2	224.4	14.9	15.0	10.0	10.1	1.491	1.481	46.0	46.5
Rocket at 0.4 %	225.0	226.0	224.4	225.7	15.0	15.1	10.1	10.2	1.489	1.479	46.3	46.8
Both at 0.1%	248.0	250.0	233.9	234.0	16.6	16.9	11.7	11.8	1.310	1.309	53.9	46.8
Both at 0.2 %	255.0	257.0	235.3	235.4	17.3	17.6	12.2	12.3	1.292	1.290	58.0	59.0
Both at 0.4 %	256.0	258.0	235.5	236.4	17.5	17.7	12.3	12.4	1.290	1.288	58.3	59.1
New L.S.D. at 5 %	6.0	6.0	2.1	3.0	0.3	0.3	0.3	0.3	0.019	0.018	1.5	1.5

4. Discussion:

The outstanding effect of fenugreek and rocket seed sprouts on fruiting of Washington Navel orange trees might be attributed to their higher content of amino acids, vitamins and nutrients as previously mentioned in Table (2) **(Camacho *et al.*, 1992; Cairney, 1995; Abdallah *et al.*, 2000; Cazoula *et al.*, 2004; Crews and Peoples, 2004; Cairney, 2005; Blommerson, 2007 and Abdallah, 2008).**

Thee results are in agreement with those obtained by **Darwish (2009), Anderson and Cedergreen (2010), Al- Shereif *et al.* (2013); El-Sayed – Faten (2014); El- Khawaga and Mansour (2014); Ahmed and Habasy – Randa (2014); Mohamed (2014) and Refaai (2014a) and (2014b).**

Conclusion:

Under the present and resembling conditions, it is recommended to spray Washington Navel orange trees four times at first growth stage, just after fruit setting and at one month intervals with a mixture of fenugreek and rocket seed sprouts, each at 0.2 for promoting yield and fruit quality.

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