Growth and Productivity of Red Globe Grapevines as Affected with Spraying of Fenugreek Seed Sprout, Nano-Boron and Moringa Extract

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Received: *23/12/2021*

Abstract: This study tested the effects of fenugreek sprout extract (0.025 - 0.1%), Nano boron (0.0025 - 0.01%), and Moringa extract (0.05 - 0.2%) on vegetative growth, nutritional status of the vine, percentage of berry colouration and sunburned berries, yield, and berry quality of Red Globe grapevines grown under Minia Governorate during 2019 and 2020 seasons. Applications of the extract of fenugreek seed sprouts either alone or in combination with Nano-boron from 0.0025 to 0.01% and Moringa extract from 0.05 to 0.2% significantly promoted all growth traits, yield, weight and dimensions of cluster (length and shoulders), berry weight and dimensions. Moreover, these treatments resulted in better chemical quality of the berries compared with the untreated (control). Percentage of sunburned in the berries materially tended to reduce with the present treatments. The best materials were Nano- boron, fenugreek seed sprout and Moringa extract, in ascending order. However, the best results were obtained when the three ingeredients were combined together. The promotion on these characteristics was related to increase the concentration of each material. Spraying Red Globe grapevines grown under Minia Governorate conditions three times (at the start of growth, immediately after setting, and after one month) with a mixture of fenugreek seed sprout at 0.05%, Nano- boron at 0.005% and Moringa extract at 0.1% was responsible for reducing sunburned % and improving berries colouration % as well as yield and quality of the berries.

Keywords*:* Red Globe grapevines, fenugreek seed sprout, Nano- boron, Moringa extract, yield and berries quality

INTRODUCTION

Poor yield and berries colouration of Red Globe grapevines grown in Mina Governorate conditions are serious problems for grape growers. The observed yield decline is mainly attributed to the unsuitable environmental conditions. Because of their environmental-friendly nature and the expected health benefits, scientific research continues for finding natural extracts and crop seed sprouts as substitutes for chemical amendments. These natural agents should be able to protect plants against tress, improve vigor, and give higher yield and quality of different crops, in addition to protecting our environment from pollution.

The beneficial effects of sprouts extracts from crop seeds, such as fenugreek, in combating the deleterious effects of improper environmental conditions, and improving trees ability to withstand different stresses that negatively affect the yield and quality of fruit crops is well-established. Application of seed sprouts extracts improves the fruit quality. They improve both the quality and quantity of fat and protein components, and promote essential amino acid biosynthesis, including tryptophan, glutamate, and arginine. Similar improvements were observed with vitamins B & C. These crop seed sprout extracts constitute a rich, bioavailable, and balanced natural formula of macro- and micronutrients essential for the growth and health of all fruit crops (Biommerson, 2007).

Previous studies supported the beneficial effects of using seed sprout extracts on growth, vine nutritional status, yield and fruit quality in different grapevines cvs. (Ebrahiem-Asmaa, 2017; Masoud and Ibrahim, 2017; Ahmed *et al.,* 2018a; Ahmed *et al.,* 2018b; Abdalla-Asmaa, 2018).

In recent years, modern science has tended to use Nano fertilizers as an alternative to traditional fertilizers that provide the plant with nutrient needs and enhance efficiency. Furthermore, applying nanotechnology-based products in agriculture is a growing research interest. Using nanotechnology can carring promotion fruit crops and safety to the reduction in agricultural input and improving processing and nutrition (Prasad *et al.,* 2014). The Nanomaterials has small size (1 to 100 nm) characterized by high surface area, conductivity reactivity and tunable pore size, due to their small sizes which leads to more effective delivery of nutrients in plant surface and transport channels (Rai and Ingle, 2012). Furthermore, using nano fertilizer can enhance uptake of more different nutrients for program fertilization (Manjunatha *et al.,* 2016).

Boron is a micronutrient essential to many plant metabolic processes. Notably, the productivity and growth of fruit trees depend on the availability of boron. Thus, the bioavailability of boron is crucial to the normal vegetative growth of the plant and to the development of new reproductive tissues. It can increase pollen grains germination, cell division and tube elongation which needed for enhancing fertilization and increase fruit set (%) (Mengel *et al.,* 2001). In grapevines cvs, boron deficiency results in increased shot berries appearance, dieback of the shoot tips, and the development of yellow parts in the vines (Marschner, 2012). In addition, boron-deficient vines poor quality produce clusters that set fewer berries, with large percentages of shot berries (Peacock and Christensen, 2005).

Foliar application of nano-boron caused a remarkable promotion of vine growth and yield of different grapevine cvs. Most importantly, this treatment improved the nutritional value and quality of the produced berries (Ahmed *et al.,* 2018c; Ebrahiem-Asmaa and Radwan, 2019a,b).

Plant extracts are used instead of synthetic chemicals for enhancing the vegetative growth, nutritional status, and the productivity of grapes. The high content of plant pigments, phenolic ingredients, essential oils, and other chemical constituents that might act synergistically provides a plausible explanation for the beneficial effects of using plant extracts on grapevine growth and yield parameters (Dhekney, 2016).

Previous studies on various grapevines cvs (Ahmed *et al*., 2014; Abdelaal *et al.,* 2017) highlighted the beneficial effects of spray application of plant extracts on growth, yield, and fruit quality.

The aim of this present study was evaluate the effect of application of spraying fenugreek seed sprout, Nano- boron and Moringa extract on vegetative growth characteristics, berry quality and overcoming the yield poor problems as well as irregular colouration of berries that facing Red Globe grapevines maintained under Minia region conditions.

MATERIALS AND METHODS

This study was carried out during two consecutive seasons of 2019 and 2020 on 117 uniforms in vigour 10-years old own-rooted Red Globe grapevines. The selected vines are grown in a private vineyards located at El-Kawady village, Matay district, Minia Governorate, where the texture of the soil is clay Table (1) and well drained and water table is not less than two meters deep. Vines were planted at 3.0 m between rows x 2.0 m between vines. The selected vines were pruned during the first week of January during both seasons. Spur pruning method and supported with Y modified shape methods was followed. In the both seasons leaving 66 buds per vine (on basis of 18 fruiting spurs x 3 buds plus six replacement spurs x 2 buds). Surface irrigation system was followed using Nile water. The experiment was carried out one the same vines for both seasons. The chosen vines (117 vines) received the recommended horticultural practices that are commonly applied in the vineyard.

Table (1): Analysis of the tested soil (Wilde *et al*., 1985)

Constituents	Values
Particle size distribution:	
Sand %	11.1
Silt %	16.9
Clay %	72.0
Texture	Clay
pH (1:2.5 extract)	7.59
EC (1:2.5 extract) (dsm^{-1}) 1 cm / 25°C.	0.81
O.M. %	2.10
$CaCO_3$ %	1.81
Total N %	0.15
Available P (Olsen, ppm)	4.11
Available K (ammonium acetate, ppm)	455.0

This experiment included the following thirteen treatments:

1- Control (vines sprayed with water only).
2- Fenugreek seed sprout extract at 0.025%.
3- Fenugreek seed sprout extract at 0.05%.
4- Fenugreek seed sprout extract at 0.1%.
5- Nano boron at 0.0025%.
6- Nano boron at 0.005%.
7- Nano boron at 0.01%.
8- Moringa extract at 0.05%.
9- Moringa extract at 0.1%.
10-Moringa extract at 0.2%.
11-Fenugreek seed sprout extract at 0.025% + Nano boron at 0.0025% + Moringa extract at 0.05%.
12-Fenugreek seed sprout extract at 0.05% + Nano boron at 0.005% + Moringa extract at 0.1%.
13-Fenugreek seed sprout extract at 0.1% + Nano boron at 0.01% + Moringa extract at 0.2%.

Each treatment was replicated three times with three vines per each replicate. Fenugreek seed sprout was prepared by sowing the seeds in dark places using glass jar method (Abdalla, 2008), then sprouts were harvested after 3-4 days from seed sowing. Sprouts were homogenized with distilled water at 1:10 using an electric blender for five minutes, then filtrated and kept under 4°C in refrigerator till use. Table (2) show the chemical analysis for fenugreek seed sprout. Moringa extract was prepared by blending 1 kg of young Moringa leaves with 1 liter 80% ethyl alcohol using a blender according to (Makkar and Becker, 1996).

The suspension homogenized and finally was filtrated twice through by filter paper. All concentrations were prepared from the crude extract. Table (3) show chemical composition of Moringa leaves (*Moringa oleifera*) extract. Table (4) show monthly average temperature and relative humidity percentages during the experimental seasons, calculated from the daily weathering report of the Mallawy Meteorological station.

Table (2): Chemical analysis for fenugreek seed sprout

Fenugreek seed sprout (mg 100 g F.W.)	
Constituents	**Values**
Asparatic acid	2.2
Arginine	2.1
Alanine	2.9
Isoleucin	2.1
Cysteine	1.9
Cystine	1.8
Glutamic acid	2.0
Methionene	6.0
Lysine	5.1
Vitamin A	1.0
Vitamin B1	0.32
Vitamin B2	0.30
Vitamin B6	1.00
Vitamin C	2.00
Ca	220
P	341
K	469
Mg	371
Fe	242
Phytic acid	0.9
Niacin	1.4

Table (3): Chemical composition of Moringa leaves (*Moringa oleifera*) extract

Constituents	**Values**
a) Vitamins (mg/ 100g D.W)	
Beta-carotene	149.2
E	50
A	90
B1	88.9
B2	1.1
C	19.0
K	25.6
b) Minerals (mg/ 100g D.W)	
Cu	88.7
K	49.9
N	89.9
P	12.9
Mg	20.2
c) Amino acids (mg/ 100g D.W)	
Lysine	8.3
Leucine	9.3
Threonine	6.6
Isoleucine	6.3
Cysteine	2.4
Methionine	3.6
Tryptophan	3.3
Zeatin	0.936
Gibberllins	0.802

Table (4): Monthly average temperature and relative humidity percentages during the experimental seasons, calculated from the daily weathering report of the Mallawy Meteorological station

Month	2019				2020			
	Temperature°C		RH. %		Temperature°C		RH. %	
	Max	Min	Max	Min	Max	Min	Max	Min
January	19.7	3.5	97	31	19.0	4.2	100	40
February	21.8	5.5	97	32	21.6	5.9	100	37
March	24.7	7.8	95	26	25.7	9.2	96	33
April	29.2	11.4	91	23	29.2	12.9	94	24
May	37.2	17.1	68	13	35.1	17.6	75	18
June	37.9	22.0	70	19	36.8	20.7	76	18
July	38.1	23.4	90	22	37.9	22.8	86	21
August	37.9	23.1	90	24	37.8	22.9	92	27
September	34.4	20.4	98	31	37.4	21.5	98	34
Mean	**31.2**	**14.9**	**88**	**25**	**31.1**	**15.3**	**91**	**28**

RH% = Relative humidity

Source: Mallawy Meteorological Station- Minia Governorate

Fenugreek seed sprout, Nano-boron and Moringa extract were sprayed three times at growth start (when shoots length reached about 15-20cm), just after berry setting (2nd week of April) and at one month later (2nd week of May). Triton B as a wetting agent was added to the thirteen treatments. Spraying was done till runoff.

A randomized complete block design (RCBD) was followed in the execution of the current experiment. In both seasons, the recorded parameters were as follows:

1- Vegetative growth parameters such as main shoot length (cm), number of leaves /shoot, leaf area (cm^2) (Ahmed and Morsy, 1999) leaf area (cm^2) = 0.45 ($0.79\times d^2$) +17.77

Where d is the maximum diameter of the leaf, then average leaf area was registered. Just before pruning date five canes for each vine were selected to measurement wood ripening, which calculated by dividing length of brownish part of the cane by the total length of can (Bouard, 1966). Pruning wood weight was determined by weighting the removal of 1-year old pruning wood during winter pruning period in both season study and the data were recorded as (kg/ vine). For each vine five basal internodes of ten canes were selected for measuring can thickness (cm) by using Vernier caliper.

2- Leaf photosynthesis pigments namely chlorophylls a & b and total carotenoids (mg/ 1g F.W) according to (Von- Wettstein, 1957; Hiscox and Israelstam, 1979).

3- Percentages of N, P, K and Mg were determined in the petioles from leaves opposite to basal cluster (Nijjar, 1985) (5-7 leaves from shoot top) on dry weight basis according to (Summer, 1985; Wilde *et al.,* 1985).

At the harvesting time (last week of July) when T. S. S reached about 16-19, according to (Badr and Ramming, 1994) number of clusters per vine was counted and yield (kg/vine) was calculated by multyplaying number of cluster × cluster weight. Five clusters were randomly selected from each vine for determining the following physical and chemical properties.

4-Weight (g.) and dimensions (length and shoulder, in cm) of cluster.

5-Percentages of the berries coloration.

6-Physical characteristics of the berries namely weight (g.) and dimensions (longitudinal and equatorial in cm).

7-Percentage of sunburned berries

8-The juice content of total soluble solids was determined by using a hand refractometer, percentage total sugars (Lane and Eynon, 1965), the percentage of total acidity was expressed as the content of tartaric acid/100 ml juice (AOAC, 2000) and TSS/acid ratio.

9-Total anthocyanins in the berries (mg/1g F.W) (Fulcki and Francis, 1968)

Statistical analysis of the present data was done and treatment means were compared using New L.S.D test at 5% level according to (Mead *et al*., 1993).

RESULTS

1- Some vegetative growth characteristics:

Data in Table (5) clearly show that spraying of the vines with fenugreek seed sprout, Nano-boron and Moringa extract applied either alone or in different combinations significantly stimulated the six growth characteristics determined in the current study. The length of the main shoot, the number of leaves per shoot, leaf area, wood ripening coefficient, pruning wood weight/ vine and can thickness were all higher than the control untreated vines. There was a progressive increasing on these growth characteristics with increase concentrations of fenugreek seed sprout, Nano-boron and Moringa extract. Using Moringa extract surpassed the applications of fenugreek seed sprout and Nano- boron when they applied in single phase. Combined application of fenugreek seed sprout, Nano- boron and Moringa extract was significantly favorable than using each alone in improving these growth aspects. Increasing concentrations of fenugreek seed sprout from 0.05 to 0.1%, Nano- boron from 0.005 to 0.01% and Moringa extract from 0.1 to 0.2% shown no significant promotion on these growth traits. The lowest values were recorded on the untreated vines. The maximum values were recorded on the vines that received three sprays of a mixture of fenugreek seed sprout at 0.1% and Nano-boron at 0.01% besides Moringa extract at 0.2%. These finding were consistent over both seasons.

2- Leaf chemical composition:

As shown in Table (6) that single or combined application of fenugreek seed sprout, Nano- boron and Moringa extract caused significant promotion on chlorophylls (a & b), total carotenoids, N, P, K and Mg compared to the control treatment. The promotion on leaf chemical composition was significantly related to increasing concentrations of each material. Increasing concentrations of fenugreek seed sprout from 0.05 to 0.1% and Nano-boron from 0.005 to 0.01% as well as Moringa extract from 0.1 to 0.2% had meaningless stimulation on these leaf chemical components. The best materials in improving these nutrients and leaf photosynthetic pigments were Nano-boron, fenugreek seed sprout and Moringa extract, in ascending order. Combined applications of fenugreek seed sprout from 0.025 to 0.1%, Nano-boron from 0.0025 to 0.01% and Moringa extract from 0.05 to 0.2% were significantly responsible for improving nutrients and plant pigments rather than using any one alone. The maximum values of chlorophyll a, chlorophyll b, total carotenoids, N, P, K and Mg were recorded on the vines that sprayed three times of a mixture of fenugreek seed sprout at 0.1%, Nano-boron at 0.01% and Moringa extract at 0.2% during 2019 & 2020 seasons, respectively. The untreated vines produced the lowes values. These results were true during both seasons.

3- Yield and cluster aspects:

It is noticed from the obtained data in Table (7) that subjecting Red Globe grapevines three times with fenugreek seed sprout, Nano-boron and Moringa extract significantly enhanced the yield expressed as the cluster weight and the total number of clusters/vine (especially in the second season) as well as weight, length and shoulder of cluster over the check treatment. The promotion of these characteristics was concentration-dependent. No significant promotion was observed among the medium to the high concentrations of each material.

Combined applications of fenugreek seed sprout, Nano-boron and Moringa extract were significantly superior than using each material alone in improving yield and cluster properties. Therefore, it is more economical to spray all materials together at the medium concentrations (0.05% for fenugreek seed sprout, 0.005% for Nano-boron and 0.1% for Moringa extract). Such treatment increased the yield/vine to 18.2 & 23.6 kg in the first and second seasons, respectively. On the other hand the untreated control vines, yielded only 14.6 & 14.8 kg in the same seasons, respectively. Thus, the increment on the yield after using the suggested combination was 24.6 & 59.4% higher than check treatment during both seasons, respectively. Number of clusters/vine was not affected by the present fenugreek seed sprout, Nano-boron and Moringa extract treatments in the first season of study. Similar trend was noticed during both seasons.

4- Percentage of berries colouration:

Percentage of berries colouration as shown in Table (8) significantly was enhanced in response to treating the vines with fenugreek seed sprout from 0.025 to 0.1%, Nano-boron from 0.0025 to 0.01% and Moringa extract from 0.05 to 0.2% relative to the control. The promotion on percentage of berries colouration was associated with increasing concentrations of each material. Spraying Moringa extract as well as fenugreek seed sprout and Nano-boron, in descending order was significantly responsible for enhancing percentage of berries colouration. Increasing concentration of fenugreek seed sprout from 0.05 to 0.1%, Nano-boron from 0.005 to 0.01% and Moringa extract from 0.01 to 0.2% failed to show significant effect on improving percentage of berries colouration. Combined application of these three components was significantly useful promotion on berries colouration (%) than using each material alone. The best results in this respect were recorded on the clusters harvested from vines treated three times with fenugreek seed sprout at 0.1%, Nano-boron at 0.01% and Moringa extract at 0.2%. Under such promised treatment, values of berries colouration (%) reached 84.5 and 85.3% during both seasons, respectively. The lowest values of berries colouration (%) (66.8 & 68.1%) on untreated vines. During both seasons, a similar pattern was seen.

Table (5): Effect of spraying fenugreek seed sprout, Nano-boron and Moringa extract on some vegetative growth characteristics of Red Globe grapevines during the two growing seasons 2019 and 2020

Treatments	Main shoot length (cm)		No. of leaves/shoot		Leaf area $(cm)^2$		Wood ripening coefficient		Pruning wood weight/vine (kg.)		Cane thickness (cm.)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	110.3	111.0	16.0	16.4	115.6	118.1	0.63	0.65	1.10	1.13	0.89	0.95
Fenugreek seed sprout at 0.025%	130.2	131.6	19.2	19.5	123.6	125.2	0.75	0.76	1.49	1.53	1.32	1.38
Fenugreek seed sprout at 0.05%	134.0	135.7	20.6	20.9	125.2	127.4	0.78	0.79	1.58	1.62	1.40	1.45
Fenugreek seed sprout at 0.1%	134.9	136.1	21.0	21.4	125.8	128.0	0.79	0.79	1.62	1.65	1.45	1.50
Nano-boron at 0.0025%	123.0	123.9	17.1	17.3	120.0	121.2	0.69	0.70	1.26	1.29	1.10	1.16
Nano-boron at 0.005%	126.1	127.0	18.4	18.6	121.3	123.1	0.73	0.74	1.36	1.38	1.17	1.21
Nano-boron at 0.01%	126.9	127.8	18.8	19.0	121.8	123.7	0.74	0.75	1.40	1.43	1.20	1.25
Moringa extract at 0.05%	136.0	137.2	22.3	22.7	127.0	129.2	0.80	0.82	1.70	1.73	1.52	1.57
Moringa extract at 0.1%	138.8	140.1	23.7	24.1	129.1	131.3	0.84	0.86	1.78	1.80	1.61	1.66
Moringa extract at 0.2%	139.4	140.9	24.2	24.7	129.8	131.9	0.85	0.87	1.81	1.84	1.64	1.70
Fenugreek seed sprout + Nano-boron + Moringa extract (at low concentration)	144.0	145.0	26.1	26.6	133.3	134.9	0.90	0.91	1.90	1.93	1.75	1.82
Fenugreek seed sprout + Nano-boron + Moringa extract (at Med. concentration)	147.1	148.0	27.8	28.1	135.1	137.0	0.94	0.95	1.99	2.01	1.84	1.90
Fenugreek seed sprout + Nano-boron + Moringa extract (at high concentration)	147.7	148.9	28.2	28.8	135.8	137.7	0.95	0.96	2.03	2.06	1.87	1.94
New L.S. D at 5%	**1.4**	**1.5**	**1.0**	**1.0**	**1.2**	**1.5**	**0.03**	**0.03**	**0.08**	**0.06**	**0.08**	**0.09**

Table (6): Effect of spraying fenugreek seed sprout, Nano-boron and Moringa extract on leaf pigments and percentages of N, P, K and Mg in the leaves of Red Globe grapevines during the two growing seasons 2019 and 2020.

Treatments	Chlorophyll a (mg/1 g F.W)		Chlorophyll b (mg/1 g F.W)		Total carotenoids (mg/1 g F.W)		N%		P%		K%		Mg%	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	3.04	3.08	1.06	1.10	1.02	1.03	1.58	1.61	0.134	0.136	1.12	1.14	0.50	0.53
Fenugreek seed sprout at 0.025%	3.40	3.44	1.33	1.37	1.30	1.32	1.78	1.80	0.171	0.174	1.29	1.32	0.68	0.71
Fenugreek seed sprout at 0.05%	3.49	3.55	1.39	1.44	1.36	1.38	1.85	1.87	0.180	0.182	1.34	1.37	0.73	0.74
Fenugreek seed sprout at 0.1%	3.53	3.58	1.42	1.47	1.38	1.39	1.88	1.90	0.183	0.186	1.35	1.36	0.74	0.75
Nano-boron at 0.0025%	3.22	3.26	1.23	1.28	1.20	1.22	1.65	1.68	0.150	0.153	1.17	1.19	0.55	0.58
Nano-boron at 0.005%	3.29	3.34	1.28	1.33	1.24	1.26	1.71	1.73	0.158	0.162	1.22	1.25	0.61	0.63
Nano-boron at 0.01%	3.32	3.37	1.30	1.35	1.26	1.27	1.74	1.76	0.160	0.165	1.24	1.27	0.62	0.63
Moringa extract at 0.05%	3.60	3.66	1.46	1.51	1.40	1.43	1.94	1.97	0.198	0.203	1.41	1.43	0.79	0.80
Moringa extract at 0.1%	3.69	3.76	1.52	1.58	1.46	1.48	1.99	2.02	0.210	0.212	1.47	1.49	0.83	0.84
Moringa extract at 0.2%	3.72	3.78	1.55	1.60	1.48	1.50	2.02	2.05	0.213	0.215	1.49	1.52	0.84	0.85
Fenugreek seed sprout + Nano-boron + Moringa extract (at low concentration)	3.80	3.85	1.60	1.65	1.52	1.54	2.08	2.11	0.237	0.241	1.56	1.58	0.88	0.90
Fenugreek seed sprout + Nano-boron + Moringa extract (at Med. concentration)	3.88	3.93	1.67	1.73	1.57	1.58	2.15	2.17	0.248	0.251	1.64	1.65	0.93	0.95
Fenugreek seed sprout + Nano-boron + Moringa extract (at high concentration)	3.90	3.93	1.69	1.75	1.58	1.59	2.18	2.20	0.251	0.252	1.67	1.68	0.94	0.96
New L.S. D at 5%	**0.05**	**0.06**	**0.04**	**0.04**	**0.03**	**0.03**	**0.05**	**0.04**	**0.05**	**0.06**	**0.04**	**0.04**	**0.3**	**0.3**

Table (7): Effect of spraying fenugreek seed sprout, Nano-boron and Moringa extract on yield as well as cluster weight and dimension of Red Globe grapevines during the two growing seasons 2019 and 2020.

Treatments	No. of clusters/vine		Yield/vine (kg)		Av. Cluster weight (g.)		Av. Cluster length (cm)		Av. Cluster shoulder (cm)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	23	23	14.6	14.8	639.0	645.0	20.0	21.1	10.1	10.3
Fenugreek seed sprout at 0.025%	23	26	15.6	17.8	680.0	686.0	24.8	25.0	13.0	13.4
Fenugreek seed sprout at 0.05%	23	27	15.9	18.8	691.0	697.0	26.0	26.2	13.9	14.3
Fenugreek seed sprout at 0.1%	23	27	16.0	18.9	696.0	699.0	26.8	27.0	14.1	14.5
Nano-boron at 0.0025%	23	24	14.9	15.7	651.0	655.0	22.0	23.3	11.2	11.5
Nano-boron at 0.005%	23	25	15.2	16.6	661.0	665.0	23.2	24.5	11.9	12.3
Nano-boron at 0.01%	23	25	15.3	16.7	666.0	669.0	24.0	25.2	12.2	12.5
Moringa extract at 0.05%	24	28	16.8	19.8	703.0	709.0	27.0	28.1	15.3	15.6
Moringa extract at 0.1%	24	29	17.1	20.8	716.0	720.0	28.7	29.4	16.2	16.6
Moringa extract at 0.2%	24	29	17.3	21.1	722.0	729.0	29.6	30.2	16.4	16.7
Fenugreek seed sprout + Nano-boron + Moringa extract (at low concentration)	24	30	17.8	22.5	745.0	750.0	31.0	31.9	17.1	17.5
Fenugreek seed sprout + Nano-boron + Moringa extract (at Med. concentration)	24	31	18.1	23.5	756.0	759.0	32.2	33.0	18.0	18.4
Fenugreek seed sprout + Nano-boron + Moringa extract (at high concentration)	24	31	18.2	23.6	760.0	764.0	32.9	33.9	18.2	18.6
New L.S. D at 5%	**NS**	**1.0**	**0.3**	**0.5**	**8.2**	**9.0**	**1.1**	**1.1**	**0.7**	**0.8**

5- Percentage of sunburned berries:

It is noticed from the data in Table (8) that percentage of sunburned berries was significantly declined with using fenugreek seed sprout from 0.025 to 0.1%, Nano-boron from 0.0025 to 0.01% and Moringa extract from 0.05 to 0.2% compared to the control treatment. The reduction on percentage of sunburned berries of Red Globe clusters significantly was correlated with increasing concentration of fenugreek seed sprout as well as Nano-boron and Moringa extract. Meaningless reduction on percentage of sunburned berries was observed among the higher concentration of fenugreek seed sprout, Nano-boron and Moringa extract. The best materials in reducing sunburned (%) were Nano-boron, fenugreek seed sprout and Moringa extract, in ascending order. Using three materials together three times significantly gave the lowest values of the application of each material alone. The lowest values of sunburned berries (%) reached (9.1 & 8.7%) were recorded on the vines that treated with all substances together at the higher concentrations during 2019 & 2020 seasons, respectively. The best results from economic standpoint of view, were recorded due to spraying the vines three times with a mixture of fenugreek seed sprout at 0.05% as well as Nano-boron at 0.005% and Moringa extract at 0.1%. The percentage of sunburned berries reached (33.4 & 32.7%) on the untreated vines during both season respectively. Similar results were announced during both seasons.

Table (8): Effect of spraying fenugreek seed sprout, Nano-boron and Moringa extract on berry colouration, percentage of sunburned and some physical of the berries of Red Globe grapevines during the two growing seasons 2019 and 2020.

Treatments	Berries colouration %		Sunburned berries %		Av. Berry weight (g.)		Av. Berry Longitudinal (cm)		Av. Berry Equatorial (cm)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	66.8	68.1	33.4	32.7	8.50	8.71	2.43	2.48	2.30	2.31
Fenugreek seed sprout at 0.025%	74.0	75.3	21.2	20.4	10.52	10.80	2.86	2.91	2.72	2.73
Fenugreek seed sprout at 0.05%	76.1	78.0	18.8	18.1	11.13	11.42	2.95	2.99	2.81	2.82
Fenugreek seed sprout at 0.1%	76.6	78.7	18.1	17.5	11.34	11.55	2.98	3.03	2.83	2.83
Nano-boron at 0.0025%	70.0	71.5	29.3	28.6	9.26	9.48	2.62	2.66	2.51	2.53
Nano-boron at 0.005%	71.9	73.8	26.9	26.2	9.87	9.90	2.72	2.77	2.60	2.62
Nano-boron at 0.01%	72.4	74.0	26.2	25.6	9.98	10.08	2.74	2.79	2.62	2.64
Moringa extract at 0.05%	77.2	78.7	16.0	15.3	11.67	11.80	3.07	3.11	2.91	2.94
Moringa extract at 0.1%	79.0	80.3	13.3	12.5	12.31	12.52	3.16	3.21	3.01	3.03
Moringa extract at 0.2%	79.7	80.8	13.0	12.0	12.43	12.74	3.20	3.25	3.03	3.04
Fenugreek seed sprout + Nano-boron + Moringa extract (at low concentration)	82.0	83.4	11.1	10.6	12.93	13.20	3.30	3.34	3.14	3.17
Fenugreek seed sprout + Nano-boron + Moringa extract (at Med. concentration)	83.8	84.9	9.5	8.9	13.50	13.72	3.39	3.44	3.24	3.30
Fenugreek seed sprout + Nano-boron + Moringa extract (at high concentration)	84.5	85.3	9.1	8.7	13.72	13.93	3.43	3.47	3.27	3.34
New L.S. D at 5%	**1.1**	**1.2**	**1.3**	**1.2**	**0.5**	**0.5**	**0.6**	**0.5**	**0.8**	**0.7**

6- Physical and chemical characteristics:

It is quite from the obtained data in Tables (8 & 9) that spraying Red Globe grapevines three times with fenugreek seed sprout, Nano-boron and Moringa extract either alone or all in combinations caused a significant promotion on quality of the berries in terms of increasing berry weight and dimensions (longitudinal and equatorial), T.S.S%, total sugars%, T.S.S/ acid ratio, total anthocyanins and reducing total acidity% relative to the control treatment. There was a gradual promotion on quality of the berries in both seasons with increasing concentration of three materials. Using morniga extract as well as fenugreek seed sprout and Nano-boron, in descending order was significantly responsible for enhancing quality of the berries. Significant differences on these characteristics were noticed among all concentrations of the three materials except among the higher two concentrations.

Combined application of these materials (fenugreek seed sprout, Nano-boron and Moringa extract) were significantly favorable than using each material alone in improving berries quality. Therefore, the best results of the present data with regard to berries quality from economic standpoint of view were recorded on the vines that treated with fenugreek seed sprout at 0.05% and Nano-boron at 0.005% as well as Moringa extract at 0.1%. Unpreferable effects on quality of the berries were obtained on untreated vines. These results were true during both seasons.

Table (9): Effect of spraying fenugreek seed sprout, Nano-boron and Moringa extract on some chemical characteristics of the berries of Red Globe grapevines during the two growing seasons 2019 and 2020.

Treatments	T.S.S%		Total acidity %		T.S.S/acid ratio		Total sugars %		Total anthocyanins (mg/1g F.W)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Control	16.6	16.7	0.667	0.665	24.9	25.1	14.8	14.9	22.0	22.7
Fenugreek seed sprout at 0.025%	17.7	17.8	0.599	0.596	29.5	29.9	15.9	16.0	25.7	26.5
Fenugreek seed sprout at 0.05%	18.0	18.2	0.580	0.578	31.0	31.5	16.2	16.3	26.7	27.4
Fenugreek seed sprout at 0.1%	18.1	18.3	0.576	0.575	31.4	31.8	16.3	16.4	27.0	27.8
Nano-boron at 0.0025%	16.9	17.0	0.634	0.632	26.7	26.9	15.2	15.3	23.1	23.9
Nano-boron at 0.005%	17.3	17.4	0.619	0.616	27.9	28.2	15.5	15.6	24.0	24.9
Nano-boron at 0.01%	17.4	17.5	0.616	0.614	28.2	28.5	15.6	15.7	24.4	25.1
Moringa extract at 0.05%	18.4	18.7	0.560	0.558	32.9	33.5	16.6	16.7	27.9	28.7
Moringa extract at 0.1%	18.8	19.0	0.554	0.552	33.9	34.4	16.9	17.0	29.0	29.7
Moringa extract at 0.2%	18.9	19.1	0.551	0.549	34.3	34.8	17.0	17.1	29.3	29.9
Fenugreek seed sprout + Nano-boron + Moringa extract (at low concentration)	19.2	19.4	0.531	0.529	36.2	36.7	17.3	17.4	30.8	31.6
Fenugreek seed sprout + Nano-boron + Moringa extract (at Med. concentration)	19.5	19.7	0.514	0.512	37.9	38.5	17.6	17.7	31.9	32.8
Fenugreek seed sprout + Nano-boron + Moringa extract (at high concentration)	19.6	19.8	0.518	0.508	38.4	39.0	17.7	17.8	32.3	33.1
New L.S. D at 5%	**0.3**	**0.3**	**0.015**	**0.014**	**0.6**	**0.8**	**0.3**	**0.3**	**0.6**	**0.7**

DISCUSSION

Germination process observed in sprouting of seeds may result in hydrolysis of complex polymeric constituents such as carbohydrates, protein precursors, and esterifed fats into simpler monomeric ones, such as soluble sugars, amino acids, and fatty acids. In addition, these enzymatic processes might induce the formation of growth stimulants and natural hormones (Abdalla, 2008; Anwar *et al.,* 2013).

The outstanding influence of fenugreek seed sprout on the growth and fruiting potential of Red Globe grapevines might be attributed to their high content of essential amino acids like glutamate, arginine, tryptophan, methionine, and Lysine (Cairney, 2005).

The current results showed that the promoting effects of fenugreek seed sprout on growth and productivity of Red Globe grapevines are in concordance with the results reported by Masoud and Ibrahiem (2017) on Red Globe grapevines, Allam (2017) on Superior grapevines, Ebrahiem- Asmaa (2017) on Flame seedless grapevines and Ahmed *et al.* (2018a & b) on Superior grapevines.

The nano-boron play a remarkable role in accelerating biological reaction due to the large surface area of that particle, which in turn lead to the production of indicators materials that reflected in surly vegetative indicators of the plant and surly reflected on yield Agrawal and Rathore (2014).

The positive impact of using nano-boron on the vegetative growth characteristics, yield and quality of Red Globe grapevines reported by the current study further supported by the results obtained by Allam (2017) on Superior grapevines, Ahmed *et al.* (2018c) on Superior grapevines; Ebrahiem–Asmaa and Radwan (2019a) on Early Sweet grapevines and Wassel *et al.* (2020) on Flame seedless grapevines.

The growth-stimulating effects of boron on some vegetative growth characteristics, plant pigments, nutrients, yield and quality of the berries in grapevines cv. Red Globe are in line with previous findings of Mengel *et al.* (2001) and Passingham (2004) who showed that Boron encourages cell division and the elongation of cells through controlling of polysaccharide synthesis. It is responsible for enhancing translocation and adsorption of sugars, Therefore, sugars maybe moved in the form of borate complex. Boron is a micronutrient vitsl to the formation of meristems and preventing the abortion of flowers. It is also preventing the accumulating of polyphenolic compounds. It is considered that using boron more effective for stimulating root development and uptake of water. On the other hand, boron can controlling the formation of starch and also preventing

the excessive conversion of sugars into starch. On addition, reducing at the lower extent the different disorders in the fruit crops (Nijjar, 1985; Fraguas and Silva, 1998).

The promoting effects of boron on vine growth, yield and quality, as observed in this study, corroborate the previous findings by Abdelaal *et al.* (2017); Ahmed *et al*. (2018c), Ebrahiem-Asmaa and Radwan (2019a, 2019b); Fawzi *et al*. (2019) and Mohamed and Qaoud (2019) on various grapevine cvs.

The promotion of vegetative growth characteristics, nutritional status, yield and quality of Red Globe berries by Moringa extract might be explained by its high content of essential nutrients such as N, P, K, Mg and Cu (Kasolo *et al.,* 2010) as well as vitamins namely beta-carotene, A, B like folic acids, pyridoxine, nicotinic acid, C, D and E (Mbikay, 2012). Moreover, Moringa extract have high content of amino acids Lysine, Leucine, Threonine, Isoleucine, Cysteine, Methionine and Tryptophan. The occurrence of vitamins and amino acids as important antioxidants protects plant cells against aging, cell death, and reactive oxygen species (ROS). In addition, Moringa extract have high zeatin concentrations "up to 200 mcg/g of leaves" and its enhances the antioxidant properties of many enzymes (Azra and Muhammad, 2013). It is rich in purine and adenine as derivatives of plant growth hormone group of cytokinin (Zhang and Ervin, 2004), plant growth regulators, phytochemicals, phenolics, and ascorbates (Aslam *et al.,* 2005).

The high essential nutrients, amino acids, antioxidants and vitamins of Moringa extract from surly reflected on improving cell division, biosynthesis, stimulating plant pigments formation and building of most organic foods and the tolerance of plant to biotic stresses (Nijjar, 1985; Samiullah *et al.,* 1988).

The promoting effect of Moringa extract on the physical and chemical characteristics of grapes are in agreement with those obtained by Abdelaal *et al.* (2017); Aly *et al.* (2020) and Kan *et al.* (2020) on various grapevines.

The results of Thanna *et al.* (2017) and Nasir *et al.* (2020) emphasized the great benefits of using Moringa extract on growth and fruiting of different horticultural crops.

CONCLUSION

On the light of the current results, it can be concluded that spraying Red Globe grapevines grown under Minia Governorate three times at growth start, just after berry setting and at one month later with a mixture of Fenugreek seed sprout at 0.05%, boron via nano- technology at 0.005% and Moringa extract at 0.1% was responsible for stimulating vegetative growth, nutritional status of the vines and improving yield and berries quality.

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نمو وإنتاجية كرمات العنب الرد جلوب وتأثرها برش نبت بذور الحلبة والنانو بورون ومستخلص المورينجا

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أجريت هذه الدراسة خلال موسمي ٢٠١٩ ، ٢٠٢٠ علي كرمات العنب الرد جلوب المنزرعة تحت ظروف محافظة المنيا وذلك لاختبار تأثير رش نبت بذور الحلبة بتركيز ما بين ٠,٠٢٥ إلي ٠,١% والنانو بورون بتركيز ما بين ٠,٠٠٢٥ الي٠,٠١% ومستخلص المورينجا بتركيز ما بين ٠,٠٥ إلي ٠,٢% علي النمو الخضري والحالة الغذائية للكرمة و النسبة المئوية لتلوين الحبات والنسبة المئوية للحبات المصابة بضربة الشمس وكذلك المحصول وجودة الحبات. أدت معاملة الكرمات بنبت بذور الحلبة بتركيز ما بين ٠,٠٢٥ إلي ٠,١% والنانو بورون بتركيز ما بين ٠,٠٠٢٥ الي٠,٠١% ومستخلص المورينجا بتركيز ما بين ٠,٠٥ إلي ٠,٢% سواء في الصورة الفردية أو المشتركة بينهما إلي تحسن واضح في جميع صفات النمو الخضري والمحصول ووزن وأبعاد العنقود ووزن الحبة وأبعادها وكذلك الخصائص الطبيعية والكيمائية للحبات وذلك مقارنة بمعاملة الكنترول ، كذلك أدي إلي حدوث نقص واضح في النسبة المئوية للحبات المصابة بضربة الشمس، كانت أفضل المواد هي النانو بورون ونبت بذور الحلبة و مستخلص المورينجا مرتبة ترتيبا تصاعديا. تفوق استخدام التوليفات المشتركة بينهما عن الاستخدام الفردي وكان التحسن مرتبطا مع زيادة التركيز المستخدم من كل منهما. أدت معاملة كرمات العنب الرد جلوب المنزرعة تحت ظروف محافظة المنيا ثلاثة مرات (في بداية النمو عند طول أفرع من ١٥-٢٠ سم وبعد العقد مباشرة وبعد العقد بشهر) بمخلوط من نبت بذور الحلبة بتركيز ٠,٠٥% والنانو بورون بتركيز ما بين ٠٠٥, % و مستخلص المورينجا بتركيز ٠,١% إلي تقليل النسبة المئوية للحبات المصابة بضربة الشمس وتحسين نسبة النسبة المئوية لتلوين الحبات وكمية المحصول وكذلك خصائص الجودة للحبات.

الكلمات الدالة: كرمات العنب الرد جلوب – نبت بذور الحلبة – النانو بورون – مستخلص المورينجا – كمية المحصول – خصائص الجودة للحبات.