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RESPONSE OF CUMIN PLANT TO SOME ORGANIC, BIOFERTILIZATION AND ANTIOXIDANT TREATMENTS

II. ESSENTIAL OIL PRODUCTION AND CHEMICAL CONSTITUENTS

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ABSTRACT: The effect of farmyard manure (FYM) at 10, 15 and 20 m^3/fed. Effective microorganisms (E.M.) and/or vitamin E or vit. B_1 treatments on oil production (essential oil % and essential oil yield/plant and /fed) and chemical components (photosynthetic pigments content and NPK %) were investigated during 2015/2016 and 2016/2017 at Samalot region (El-Byaho village) - Minia Governorate and Laboratory of ornamental plants, Fac. of Agric., Minia Univ. All treatments of FYM statistically increased oil production as well as chemical components as compared with control. The high level of FYM was more effective in this concern. The treatments of E.M. + vit. B_1 followed by E.M. + vit. E, then mineral NPK (full dose) gave the best results in increasing all previous traits. Supplying cumin plants with FYM at 20 m^3/fed. in combination with E.M. + vitamins (B_1 or E) or FYM at 15 m^3/fed. plus E.M. + vit. B_1 resulted overall the highest values of the previous traits.

Key words: *Cuminum cyminum*, Effective microorganisms, vit. E, vit. B_1, essential oil, chemical components.

INTRODUCTION

Cumin (*Cuminum cyminum*, L.) is aromatic plant within the Apiaceae Family that is used use in foods, fragrances and medicinal preparation. Cumin is regularly used as a favoring agent in a number of ethnic cuisines. Cumin seeds have been found to possess significant biological activities, such as, antibacterial (Morton, 1976), antifungal, anti-carcinogenic (Gagandeep *et al.*, 2003), anti-diabetic, anti-thrombotic (Ferrie *et al.*, 2011) and antioxidant properties (Ferrie *et al.*, 2011 and Thippeswamy and Akhilender, 2005). Cumin seeds contain 7% essential oil and have therapeutic properties such as, antiseptic, anti-spasmodic, antitoxic, bactericidal, carminative, digestive, diuretic, emmenagogue, nervine, stimulant and tonic (Willatgamuwa *et al.*, 1998).

Farmyard manure is very important due to its beneficial effects on the soil, growth and increase the productivity, as well as, improving the quality of plant production (Safwat and Badran, 2002 and Patel *et al.*, 2013 on cumin).

Mineral fertilizers especially N, P and K are very important for plant growth and productivity (Safwat and Badran, 2002 on cumin, Rekaby, 2013 on coriander, Abdou *et al.*, 2013 on caraway).

Effective microorganisms (E.M.) increase crop growth and productivity (Abdou *et al*., 2009a on borage and Abdou *et al*., 2009b on guar; Muthaura *et al*., 2010 on pigweed; Abdou *et al*., 2012 on fennel and Ibrahim, 2014 on khilla).

Vitamins as antioxidants have positive effect on plant growth and its production (Ismail, 2008 on black cumin; Ayad *et al*., 2009 on geranium; Abdou *et al*., 2013 on caraway; Abd El-Salam, 2014 and Abdou *et al*., 2014 on sweet basil).

Therefore, the purposes of this research were to investigate the effect of FYM, E.M., mineral NPK and/or vitamins (vit. E or vit. B_1) treatments on essential oil production and chemical constituents of cumin plants.

MATERIALS AND METHODS

This research was carried out at Samalot region (El-Byaho village) - Minia Governorate and Laboratory of ornamental plants, Faculty of Agriculture, Minia University during two consecutive seasons (2015/2016 and 2016/2017). Mechanical and chemical analysis of the experimental soil were performed according to Jackson (1973) as shown in (Table, a). Also, chemical characteristics of FYM are shown in (Table, b) which obtained from a private farm.

Effective microorganisms (E.M., containing photosynthetic bacteria + lactic acid + yeasts) was obtained from the Laboratory of Biofertilizers, Dept. of Genetics, Fac. of Agric., Minia Univ.

Alpha-tocopherol (vit. E) was supplied by Sigma chemical Company, U.S.A. and Thiamine (vit. B_1) was obtained from El-Gomhoria Company for chemicals, cairo, Egypt.

The experiment was arranged in a randomized complete blocks design in a split-plot with three replicates. The main plots (A) included four treatments of FYM (control, 10, 15 and 20 m^3/fed.). While six treatments of mineral NPK (full dose), E.M., vit. E at 50 ppm, vit. B_1 at 50 ppm, E.M. + vit. E and E.M.+vit. B_1.

The experimental unit (plot) was 3.0×3.0 m and containing 4 rows, 60 cm apart and seeds were cultivated in hills, 25 cm apart, therefore, each plot contained 48 hills and

Table a. Physical and chemical properties of the experimental soil.

Soil character	Values	Soil character		Values
Sand %	29.20	**Available P %**		15.16
Silt %	30.70	**Exchangeable K^+ mg/100 g soil**		2.09
Clay %	40.10	**Exch. Ca^{++} mg/100 g soil**		31.76
Soil texture	Clay loam	**Exch. Na^+ mg/100 g soil**		2.38
Organic matter %	1.64			
$CaCO_3$ %	2.10		**Fe**	8.20
pH 1:2.5	7.86	**DTPA**	**Cu**	2.10
E.C. m mhose/cm	1.03	**Ext. ppm**	**Zn**	2.61
Total N %	0.08		**Mn**	8.11

Table b. Chemical analysis of FYM applied in the present study.

Properties	1st season	2nd season	Properties	1st season	2nd season
Organic matter %	28.0	27.5	**K %**	1.18	1.22
Carbon %	15.80	16.65	**Fe ppm**	239.0	237.5
Total N %	0.92	0.95	**Zn ppm**	271.2	273.1
C/N ratio	17.17	17.53	**Mn ppm**	233.5	235.8
Humidity %	8.00	7.91	**pH**	7.31	7.21
P %	0.23	0.25	**E.C. (mhose/cm)**	1.07	1.08

plants were thinned to two plants/hill after 5 weeks from sowing date (October, 10th for both seasons). Farmyard manure was added during preparing the soil to cultivation in both seasons.

The recommended mineral NPK fertilization (full dose) was 200 kg ammonium nitrate (33.5 % N) + 300 kg calcium superphosphate (15.5 % P_2O_5) and 100 kg potassium sulphate (48 % K_2O)/fed. according to Helmy (2015). All amounts of P fertilizer were added during the preparing the soil, while, the amounts of NK fertilizers were divided into 3 equal doses and added at one month interval, starting December, 5th in both seasons.

Fresh and active Effective microorganisms (E.M.), applied three times to the soil beside the plants at 50 ml/hill (1 ml=10^7 cells). The first dose was added after 7 days from the first dose of NK (starting December, 12th) and one month thereafter and then plants were irrigated immediately.

Vitamins (E or B_1) were applied by hand sprayer, 3 times on the same schedule of E.M. The plants were sprayed till run off. All other agricultural practices were carried out as usual in the region.

At the end of experiment, the following data were recorded : oil production (oil %, oil yield/plant and /fed.) and chemical constituents (chlorophyll a, b and carotenoids, as well as, the percentages of N, P and K %.) in the leaves. Pigments (Fadle and Sari El-Deen, 1978 in fresh leaves) and N, P and K% in the dry herb according to Wilde *et al.* (1985), Chapman and Pratt (1975) and Cottenie *et al.* (1982) respectively.

The obtained data were Tabulated and statistically analyzed according to MSTAT-C (1986) and L.S.D. test at 5 % was followed to compare between the means.

RESULTS AND DISCUSSION

Essential oil yield production:

Data presented in Table (1) revealed that essential oil % and essential oil yield/plant and /fed in fruits of cumin were significantly increased by used FYM at 10, 15 and 20 m^3/fed comparing with control. The significant greatest effect was occurred due to applying FYM at 20 m^3/fed. In agreement with those results concerning organic fertilizer were the findings of Asl and Moosavi (2012); Asgharipour (2012); Patel *et al.* (2013) and Forouzandeh *et al.* (2014) on cumin.

Data presented in Table (1) revealed that the parameters of essential oil production were significantly affected by different used treatments in two seasons. The highest essential oil %, essential oil yield/plant and /fed. resulted from the treatments of E.M. + vit. B_1 followed by E.M. + vit. E then mineral NPK.

The stimulatory effect of NPK on essential oil % and essential oil yield were stated by Moraghebi *et al*. (2008); Valadabadi *et al.* (2010) and Sedigh *et al*. (2014) on cumin. Meanwhile, the efficiency of biofertilizer was reported by Sedigh *et al.* (2014) on cumin, Hellal *et al.* (2011) on dill and Zand *et al.* (2013) on anise. Also, Abdou *et al*. (2013) on caraway found that essential oil % and yield were increased due to the treatment of vit. E. Moreover, Abdou *et al.* (2014) on sweat basil mentioned that vit. B_1 significantly increased essential oil % and yield as compared to control treatment.

The effect of interaction treatments was significant for essential oil %, essential oil yield/plant and /fed. in both seasons. The greatest values were obtained by adding FYM (20 m^3/fed.) plus E.M. + vit. E or vit. B_1, followed by FYM at 15 ton/fed. in combination with E.M. + vit. B_1.

Chemical composition:

Photosynthetic pigments:

It is clear from data presented in Table (2) that the highest chlorophyll a, b and carotenoids content resulted from plants treated with high level of FYM (20 m^3/fed). Similar results were obtained by Shalatet (2006) and Helmy (2015) on cumin .

Table 1. Effect of farmyard manure (FYM), mineral NPK fertilization, E.M. biofertilizer and some vitamins (vitamin E and vitamin B_1), as well as, their combination treatments on essential oil percentage, oil yield/plant and /fed of *Cuminum cyminum*, L. plants during 2015/2016 and 2016/2017 seasons.

NPK, E.M. and some vitamins (vitamin E and vitamin B_1) (B)	FYM levels (m^3/fed) (A) 1st season (2015/2016) 0	10	15	20	Mean (B)	2nd season (2016/2017) 0	10	15	20	Mean (B)
Essential oil percentage										
NPK	3.10	3.51	3.88	4.81	3.82	3.34	3.79	4.19	5.19	4.13
E.M. at 50 ml/plant	2.46	2.95	3.38	4.03	3.21	2.65	3.19	3.65	4.35	3.46
Vit. E at 50 ppm	2.74	3.17	3.55	4.17	3.40	2.95	3.42	3.83	4.50	3.68
Vit. B_1 at 50 ppm	2.84	3.48	3.79	4.55	3.66	3.06	3.76	4.09	4.91	3.96
E.M.+Vit. E	3.38	3.79	4.49	4.98	4.16	3.65	4.09	4.85	5.38	4.49
E.M.+Vit. B_1	4.49	4.71	5.14	5.26	4.90	4.85	5.08	5.55	5.68	5.29
Mean (A)	3.17	3.60	4.04	4.63		3.42	3.89	4.36	5.00	
L.S.D. at 5 %	A : 0.37		B : 0.14		AB : 0.28	A : 0.41		B : 0.18		AB : 0.36
Essential oil yield /plant (ml/plant)										
NPK	0.28	0.35	0.42	0.57	0.40	0.31	0.40	0.47	0.64	0.45
E.M. at 50 ml/plant	0.18	0.26	0.32	0.44	0.30	0.20	0.29	0.36	0.49	0.34
Vit. E at 50 ppm	0.22	0.29	0.36	0.46	0.33	0.25	0.32	0.41	0.51	0.37
Vit. B_1 at 50 ppm	0.25	0.34	0.39	0.52	0.37	0.28	0.38	0.44	0.59	0.42
E.M.+Vit. E	0.32	0.39	0.51	0.61	0.46	0.36	0.44	0.57	0.69	0.51
E.M.+Vit. B_1	0.51	0.54	0.70	0.73	0.62	0.57	0.61	0.78	0.82	0.70
Mean (A)	0.29	0.36	0.45	0.55		0.33	0.41	0.50	0.62	
L.S.D. at 5 %	A : 0.03		B : 0.07		AB : 0.14	A : 0.04		B : 0.07		AB : 0.14
Essential oil yield /fed (liter/fed)										
NPK	11.90	15.07	17.79	24.18	17.23	13.37	16.92	19.98	27.15	19.36
E.M. at 50 ml/plant	7.67	11.17	13.75	18.61	12.80	8.62	12.55	15.44	20.91	14.38
Vit. E at 50 ppm	9.48	12.31	15.45	19.50	14.19	10.64	13.83	17.35	21.91	15.93
Vit. B_1 at 50 ppm	10.49	14.33	16.72	22.34	15.97	11.78	16.09	18.78	25.09	17.93
E.M.+Vit. E	13.75	16.72	21.61	26.10	19.54	15.44	18.78	24.28	29.31	21.95
E.M.+Vit. B_1	21.61	23.20	29.74	31.22	26.44	24.28	26.05	33.41	35.06	29.70
Mean (A)	12.48	15.47	19.18	23.66		14.02	17.37	21.54	26.57	
L.S.D. at 5 %	A : 2.71		B : 2.61		AB : 5.22	A : 2.85		B : 2.92		AB : 5.84

Regarding the effect of sub-plot treatments, the highest values of pigments resulted from plants treated with E.M. + vit. B_1 or vit. E as compared with mineral NPK. In agreement with these results were those findings of Abd El-Naeem (2008) on caraway and Hellal *et al*. (2011) on dill concerning the effect of mineral NPK. Also, Muthaura *et al*. (2010) on pigweed plants and Ibrahim (2014) on Khilla mentioned that E.M. biofertilizer increased pigments content. Moreover, Botros (2013) on caraway concluded that vitamins treatment increased chl. a, b and carotenoids content.

The effect of interaction treatments was significant. The high contents of chlorophyll a, b and carotenoids were obtained with

Table 2. Effect of farmyard manure (FYM), mineral NPK fertilization, E.M. biofertilizer and some vitamins (vitamin E and vitamin B_1), as well as, their combination treatments on photosynthetic pigments (chlorophyll a, b and carotenoids content) of *Cuminum cyminum*, L. plants during 2015/2016 and 2016/2017 seasons.

NPK, E.M. and some vitamins (vitamin E and vitamin B_1) (B)	FYM levels (m^3/fed) (A) 1st season (2015/2016) 0	10	15	20	Mean (B)	2nd season (2016/2017) 0	10	15	20	Mean (B)
Chlorophyll a (mg/g f.w.)										
NPK	3.104	3.186	3.267	3.359	3.229	3.290	3.377	3.463	3.561	3.423
E.M. at 50 ml/plant	2.858	2.929	3.002	3.077	2.967	3.029	3.105	3.182	3.262	3.144
Vit. E at 50 ppm	2.788	2.858	2.928	3.000	2.894	2.955	3.029	3.104	3.180	3.067
Vit. B_1 at 50 ppm	2.893	2.912	2.955	3.048	2.952	3.067	3.087	3.132	3.231	3.129
E.M.+Vit. E	3.115	3.194	3.275	3.369	3.238	3.302	3.386	3.472	3.571	3.433
E.M.+Vit. B_1	3.120	3.205	3.372	3.394	3.273	3.307	3.397	3.574	3.598	3.469
Mean (A)	2.980	3.047	3.133	3.208		3.158	3.230	3.321	3.400	
L.S.D. at 5 %	A : 0.015		B : 0.013		AB : 0.026	A : 0.021		B : 0.038		AB : 0.076
Chlorophyll b (mg/g f.w.)										
NPK	1.015	1.042	1.069	1.100	1.057	1.076	1.105	1.133	1.166	1.120
E.M. at 50 ml/plant	0.933	0.956	0.981	1.001	0.968	0.989	1.013	1.040	1.061	1.026
Vit. E at 50 ppm	0.909	0.933	0.956	0.980	0.945	0.964	0.989	1.013	1.039	1.001
Vit. B_1 at 50 ppm	0.944	0.951	0.965	0.996	0.964	1.001	1.008	1.023	1.056	1.022
E.M.+Vit. E	1.018	1.045	1.072	1.103	1.060	1.079	1.108	1.136	1.169	1.123
E.M.+Vit. B_1	1.020	1.048	1.104	1.111	1.071	1.081	1.111	1.170	1.178	1.135
Mean (A)	0.973	0.996	1.025	1.049		1.032	1.056	1.086	1.111	
L.S.D. at 5 %	A : 0.011		B : 0.004		AB : 0.008	A : 0.012		B : 0.005		AB : 0.010
Carotenoids (mg/g f.w.)										
NPK	1.035	1.062	1.089	1.120	1.077	1.097	1.126	1.154	1.187	1.141
E.M. at 50 ml/plant	0.953	0.976	1.001	1.026	0.989	1.010	1.035	1.061	1.088	1.048
Vit. E at 50 ppm	0.929	0.953	0.976	1.000	0.965	0.985	1.010	1.035	1.060	1.022
Vit. B_1 at 50 ppm	0.964	0.970	0.985	1.016	0.984	1.022	1.028	1.044	1.077	1.043
E.M.+Vit. E	1.038	1.065	1.092	1.123	1.080	1.100	1.129	1.158	1.190	1.144
E.M.+Vit. B_1	1.040	1.068	1.124	1.131	1.091	1.102	1.132	1.191	1.199	1.156
Mean (A)	0.993	1.016	1.045	1.069		1.053	1.077	1.107	1.133	
L.S.D. at 5 %	A : 0.014		B : 0.004		AB : 0.008	A : 0.017		B : 0.006		AB : 0.012

FYM (20 m^3/fed) in combination with E.M. + any of used vitamin or FYM at 15 m^3/fed. + vit. B_1.

N, P and K %:

It is obvious from data presented in Table (3) that the high percentages of N, P and K were recorded with adding FYM at 20 m^3/fed in both seasons.

These results are in close conformity to those of Hemdan (2008) on anise and Hellal *et al*. (2011) on dill plants.

Data presented in Table (3) indicated that the treatments of E.M. + vit. B_1 followed

Table 3. Effect of farmyard manure (FYM), mineral NPK fertilization, E.M. biofertilizer and some vitamins (vitamin E and vitamin B_1), as well as, their combination treatments on nitrogen, phosphorus and potassium percentages of *Cuminum cyminum*, L. plants during 2015/2016 and 2016/2017 seasons.

NPK, E.M. and some vitamins (vitamin E and vitamin B_1) (B)	FYM levels (m^3/fed) (A)									
	1st season (2015/2016)					2nd season (2016/2017)				
	0	10	15	20	Mean (B)	0	10	15	20	Mean (B)
N %										
NPK	1.90	1.99	2.04	2.16	2.02	1.95	2.04	2.08	2.21	2.07
E.M. at 50 ml/plant	1.90	1.96	2.03	2.13	2.01	1.93	2.03	2.06	2.18	2.05
Vit. E at 50 ppm	1.88	1.93	2.01	2.13	1.99	1.93	2.04	2.03	2.15	2.04
Vit. B_1 at 50 ppm	1.89	1.94	2.01	2.14	2.00	1.90	2.05	2.05	2.20	2.05
E.M.+Vit. E	1.96	2.06	2.12	2.25	2.10	2.02	2.12	2.17	2.31	2.16
E.M.+Vit. B_1	2.00	2.11	2.18	2.32	2.15	2.07	2.18	2.26	2.39	2.23
Mean (A)	1.92	2.00	2.07	2.19		1.97	2.08	2.11	2.24	
L.S.D. at 5 %	A : 0.05		B : 0.07		AB : 0.14	A : 0.03		B : 0.08		AB : 0.16
P %										
NPK	0.200	0.220	0.245	0.249	0.229	0.203	0.225	0.244	0.259	0.233
E.M. at 50 ml/plant	0.199	0.219	0.244	0.248	0.228	0.201	0.224	0.243	0.256	0.231
Vit. E at 50 ppm	0.196	0.215	0.240	0.241	0.223	0.199	0.221	0.239	0.251	0.228
Vit. B_1 at 50 ppm	0.200	0.218	0.243	0.248	0.227	0.201	0.225	0.241	0.259	0.232
E.M.+Vit. E	0.207	0.228	0.254	0.259	0.237	0.210	0.231	0.252	0.265	0.240
E.M.+Vit. B_1	0.210	0.231	0.257	0.262	0.240	0.211	0.234	0.254	0.270	0.242
Mean (A)	0.202	0.222	0.247	0.251		0.204	0.227	0.246	0.260	
L.S.D. at 5 %	A : 0.004		B : 0.005		AB : 0.010	A : 0.009		B : 0.008		AB : 0.016
K %										
NPK	1.60	1.69	1.74	1.86	1.72	1.66	1.75	1.79	1.92	1.78
E.M. at 50 ml/plant	1.60	1.68	1.72	1.83	1.71	1.63	1.75	1.78	1.94	1.78
Vit. E at 50 ppm	1.58	1.66	1.70	1.83	1.69	1.60	1.74	1.76	1.92	1.76
Vit. B_1 at 50 ppm	1.59	1.67	1.71	1.84	1.70	1.61	1.75	1.77	1.93	1.77
E.M.+Vit. E	1.62	1.72	1.78	1.91	1.76	1.69	1.79	1.84	1.98	1.83
E.M.+Vit. B_1	1.64	1.75	1.82	1.97	1.80	1.72	1.83	1.89	2.04	1.87
Mean (A)	1.61	1.70	1.75	1.87		1.65	1.77	1.81	1.96	
L.S.D. at 5 %	A : 0.04		B : 0.03		AB : 0.06	A : 0.04		B : 0.02		AB : N.S.

by E.M. + vit. E then mineral NPK produced the high percentages of N, P and K % in the dry leaves.

In accordance with these results regarding mineral NPK were the findings of Hemdan (2008) on anise and Tanious (2008) on fennel and Ibrahim (2014) on khilla concerning E.M. treatment. Moreover, Ismail (2008) on black cumin and Ibrahim (2014) on khilla plants concluded that each of N, P and K % were increased due to the use of vitamins.

The effect of interaction treatments was significant in both seasons, except K % in

the second season. The best interaction treatment was FYM at 20 m^3/fed in combination with E.M. + vit. B_1.

Applying organic manure not only relived material inhibition an autotoxic substance in the root exudates by cinnamic acid but also promoted growth, increased the content and composition of plant secondary metabolites. The stimulatory effect of NPK full dose may be due to that mineral NPK has an important role in essential oil biosynthesis, influence on photosynthesis and respiration for carbon skeleton production.

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إستجابة نبات الكمون لبعض معاملات التسميد العضوي والحيوي ومضادات الأكسدة
٢- انتاجية الزيت الطيار والتركيب الكيماوي

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تم دراسة تأثير السماد البلدي (١٠ – ١٥ – ٢٠ م٣/فدان) والسماد المعدني والميكروبات الدقيقة النشطة و/أو الفيتامينات (ب١ أو ه)على انتاجية الزيت الطيار (النسبة المئوية ومحصول الزيت للنبات وللفدان) والمحتوى الكيماوي (المحتوى للصبغات والنسبة المئوية للنتروجين والفوسفور والبوتاسيوم) لنبات الكمون في موسمي النمو ٢٠١٥/٢٠١٦ و ٢٠١٦/٢٠١٧ في قرية البيهو والتابعة لمركز سمالوط بمحافظة المنيا ومعمل كلية الزراعة - جامعة المنيا. كل معاملات السماد البلدي أدت إلى زيادة معنوية في كل الصفات السابقة والمستوى العالي من السماد العضوي كان الأفضل. معاملات الميكروبات الدقيقة النشطة + فيتامين ب١ تليها الميكروبات الدقيقة النشطة + فيتامين ه ثم ن فو بو (جرعة كاملة) كانت الأحسن في زيادة كل الصفات السابقة. إمداد نباتات الكمون بالسماد البلدي ٢٠ م٣/فدان مع الميكروبات الدقيقة النشطة + فيتامين ب١ أو فيتامين ه أو استعمال ١٥ م٣/فدان سماد بلدي + الميكروبات الدقيقة النشطة + فيتامين ب١ تحقق أفضل النتائج متفوقة على كل معاملات التداخل.