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Enhancement of Cumin (*Cuminum cyminum* L.) Productivity Using Some Natural Plant Extracts

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IN THE present study, the effect of garlic (*Allium sativum*) and onion (*Allium cepa*) essential oils and water extracts at three concentrations (5, 10 and 15%) on yield and chemical composition of cumin (*Cuminum cyminum* L.) were investigated. All treatments improved growth parameters (plant height, shoot number and number of umbels /plant) and total seed yield with no effect on the chemical composition of cumin essential oil. Onion water extracts gave the highest total seed yield. Garlic water extracts gave the highest values of total carbohydrate, total protein and total free amino acids. The chemical composition of essential oils extracted from garlic cloves and onion bulbs were fractionated by GC/MS. Major compounds in garlic were allicin and diallyl disulfide followed by dimethyl-trisulfide while in onion were allium thiosulfinate, alkyl thiosulfnates and allyl propyl disulphide.

The use of natural products in horticultural practices instead of synthetic chemicals is becoming a main target for many fruit crop producers, where the world market has been growing rapidly in recent years for organic fruit production (Dimitri and Oberholtzer, 2006). Over the next few years, organic products will increase by 15-20% per year (Kortbech-Olesen, 2006), creating an opportunity to motivate agricultural producers to adopt organic concept to cultivate medicinal, aromatic plants and vegetables, thus obtaining the benefit of premium prices. Onion (*Allium cepa* L.) and garlic (*Allium sativum* L.),the most well-known species belonging to the allium family and commonly used in our daily diet, have been studied extensively for their therapeutic uses as antibiotic, antidiabetic, antiatherogenic and anticancer drugs (Augusti, 1996). Many of these biological effects are related to volatile sulphides, typical of the alliumplants, which are also responsible for their characteristic pungent aroma and taste (Lanzotti, 2006). Allicin (allyl 2-propene thiosulfinate or Diallylthiosulfinate was long thought to be the principal bioactive compound present in aqueous extract or raw garlic homogenate (Augusti, 1975).Important sulfur-containing compounds present in garlic homogenate are allyl methyl thiosulfonate, 1-propenyl allylthiosulfonate and -L-glutamyl-S-alkyl-L-cysteine (Block,1985). Sulfur compounds can induce bud breaking continues to be unknown. However, progress has been made in elucidating the implied routes in the regulation of sulfur in relation to the vegetative growth of plants (Hawkesford and De Kok, 2006). The sulfur demand of the genus allium is

related to the synthesis of thiosulfinates (Block *et al.,* 1992). In the case of onion, the content of thiosulfinates increased linearly with the sulfur supply which makes this species a good candidate for desulfurization of a sulfur enriched soil (Randle *et al.,* 1994).

Garlic bulb extract showed comparatively greater efficacy on promoting growth of two local varieties of groundnut. The fresh extracts of *Allium sativum* can be used to improve the vegetative growth of many plants (Block, 1985). Garlic extract contain antioxidant phytochemicals that prevent oxidant damage. These include unique water-soluble organosulfur compounds, lipid-soluble organosulfur components and flavonoids, notably allixin and selenium. Long-term extraction of garlic ages creating antioxidant properties by modifying unstable molecules with antioxidant activity, such as allicin, and increasing stable and highly bioavailable water-soluble organosulfur compounds, such as S-allylcysteine and S-allylmercaptocysteine (Borek, 2001). Onion and garlic are characterized by more polar compounds of phenolic and steroidal origin, often glycosilated, showing interesting pharmacological properties. These latter compounds, compared to the more studied thiosulfinates, (Lanzotti, 2006).

Cumin (*Cuminum cyminum* L.), a member of Apiaceae, is an annual plant which is originated from Egypt and East Mediterranean. The cumin fruits contain volatile oil (2–5 %) that imparts the characteristic aroma to the fruits. The yellow-coloured fresh oil contains cuminaldehyde and 2- p-menthadienals as its chief components (Behera *et al*., 2004). The fruits of *C. cyminum* L. are used as a traditional flavorings in a number of ethnic cuisines and food industries. Moreover, cumin oil shows a high antifungal activity against various pathogenic fungi, and effective high antibacterial activity. Therefore, it is also used as a fumigant or additive in the storage of foodstuffs. The medicinal component of the plant is oil which extracted from the ripe fruits. In folk medicine, cumin is used as a carminative for stomach disorders, diarrhea, and colic, as well as particularly in veterinary medicine (Li and Jiang, 2004). The purpose of the present study was to use natural extracts from garlic and onion as a growth promoter of cumin.

Materials and Methods

The present experiment was carried out at the Horticulture Research Station of South El-Tahrer during (2011/2012) seasons. The experiment contained 12 treatments in addition to the control (using water) with three replicates. The statistical analysis design of the experiment was randomized complete block design. Each experimental plot was (2× 6 m^2) with the spacing of 50 cm between rows and 25 cm between plants. Seeds were sown in the first week of November during both seasons. All treatments were sprayed three times at 30, 45 and 60 days after sowing. The garlic and onion extracts were prepared, hence, fresh mature were blended in distilled water 500 g/l, filtered then made up to three concentrations (5, 10 and 15%).The essential oil extracts were prepared with 5,

10 and 15% in water and tween 20 (Kubota and Miyamuki, 1992). Data of plant growth (plant height, number of branches, number of umbels/ plant) and total seed yield (g/ plant) were taken and statistically analyzed (Snedecor and Cochran 1972). Identification of garlic and onion oils was carried out by GC/MS according to the method of Vargas *et al.* (2008) as shown in Tables 1 and 2.

TABLE 1. Chemical composition of garlic oil by GC/MS

Components	**%**
2-Vinyl-4H-1,3-dithiin	2.65
3,3'-Thiobis-1-Propene	4.12
Methyl-trans-propenyl- disulfide	0.43
Unknown	1.54
3-Prop-2-ene-1-sulfinyl) sulfanyl]prop-1-ene (allicin)	23.53
Diallyl disulfide	21.98
Di-2-propenyl trisulfide	6.31
Dimethyl –trisulfide	17.43
Eugenol	6.76
Unknown	1.33
3-Vinyl-[4H]-1,2-dithiin	1.02
Diallyltetrasulphide	2.65
Diallylpentasulfide	0.32
Methyl allylpentasulfide	0.13
B-caryophyilene	3.93
Methyl allylhexasulfide	5.87

TABLE 2. Chemical composition of onion bulbs oil by GC/MS

Components	**%**
Disulfide, 1-methylethyl propyl	2.21
Methyl propyl disulfide	3.65
Isopropyldithioisopropane	13.12
S-benzyl phenylmethanethiosulfinate (allium thiosulfinate)	23.56
Methyl propyl trisulfide	11.54
Unknown	0.95
Alkyl thiosulfnates	21.34
2-Tridecanone	1.48
Allyl propyl disulphide	15.65
5-Methyl-2-octyl-(2H)-furan-3-one	3.87
3,5-Diethyl-1,2,4-Trithiolane	0.97
6,10,14-Trimethyl-2-Pentadecanone	1.66

Some chemical constituents of garlic cloves were Ca 1.363%, Mg 1.23%, Zn 66.5 ppm and Mn 94.4ppm (Nahed, 2009).

Essential oils were separated by water distillation according to the method of Guenther (1950). Fractionation and identification of cumin essential oil was executed by GC/MS schimadzu QP 5000 according to the method of Kan *et al.* (2007). The chemical composition of the treated cumin was performed. In this concern, protein (A.O.A.C., 1990), total carbohydrate, total soluble sugars (Dubois *et al.*, 1956), total free amino acids (Jayaraman, 1985), total phenols

content and total indoles (Daniel and George, 1972) and essential oil percentages were determined.

Results and Discussion

Effect of onion and garlic extracts on plant growth, production and chemical composition of cumin:

Plant growth

Data shown in Table 3 indicated that, all extracts (Onion and Garlic) had a significant effect in increasing all cumin growth parameters (plant height, branches number and umbels number) compared with the control. The highest plants (41.50 and 41.77cm) were produced with garlic water extract (at 15 %) in the first and second seasons, respectively, while the shortest plants (34.24 and 28.00 cm) were resulted in the control plants in the first and second seasons, respectively. On the other hand, the concentration of 10% onion water extract enhanced the other cumin growth parameters such as branches number and umbels number/plant compared with the other treatments and the control in both seasons.

TABLE 3. Effect of onion and garlic extracts on cumin growth parameters

Treatments		First season			Second season		
		Plant height(cm)	Number of branches/ plant	Number of umbels/ plant	Plant height (cm)	Number of branches/ plant	Number of umbels /plant
Control		34.24	8.00	18.67	28.00	6.67	17.07
Onion oil	5%	34.91	8.67	19.67	31.67	7.67	17.97
	10%	36.09	9.67	24.67	33.67	8.67	23.67
	15%	37.34	9.67	22.67	34.10	9.00	21.80
Garlic oil	5%	35.34	10.00	21.00	32.73	9.33	21.27
	10%	37.28	10.33	25.33	35.73	9.67	25.72
	15%	39.76	9.67	21.00	38.83	9.33	20.57
Onion water extract	5%	37.27	10.00	25.67	35.90	10.00	25.93
	10%	38.52	10.67	28.67	38.40	11.33	29.03
	15%	39.28	9.33	27.33	40.27	9.33	28.13
Garlic water extract	5%	36.57	9.00	24.33	33.13	8.33	23.30
	10%	37.67	10.00	23.33	36.73	9.67	22.57
	15%	41.50	8.67	19.33	41.77	7.33	17.70
LSD at (0.05)		0.63	0.45	0.98	0.54	0.73	0.75

Seed yield

It is clear from the results in Table 4 that, all of the treatments produced higher yield than control during the two seasons. The highest total seed yield (2.99 and 3.31 g / plant) was obtained by spraying onion water extract at 10% in the first and second seasons, respectively, while the lowest yield (1.10 and 1.55 g/plant) were resulted in the control plants in the first and second seasons, respectively.

TABLE 4. Seed yield of cumin as affected by spraying garlic and onion extracts

Treatments		First season	Second season
		Total seed yield (g/ plant)	Total seed yield (g/ plant)
Control		1.10	1.55
Onion Oil	5%	1.53	1.70
	10%	2.13	2.33
	15%	1.73	1.74
Garlic Oil	5%	1.67	1.62
	10%	2.20	2.28
	15%	1.63	1.60
Onion water extract	5%	2.33	2.71
	10%	2.99	3.31
	15%	2.63	2.90
Garlic water extract	5%	2.03	2.28
	10%	1.90	1.86
	15%	1.43	1.59
LSD at (0.05)		0.07	0.16

Chemical composition

The chemical composition of cumin seed as affected by spraying garlic and onion extracts are presented in Table 5. Generally, data revealed that garlic water extract at 10%resulted in the highest percentage of essential oil inboth seasons. Garlic water extract at 5% and 10% significantly increased the percentage of protein. In addition, the highest amino acid percentage in the first and second seasons was obtained by using 10% and 15% garlic water extract, respectively. Also, the concentration of garlic water extract at 5% gave the highest percentage of total carbohydrate in the first season, while, the same treatment at 10% resulted in the highest percentage of total carbohydrate in the second season.

The results also indicated that garlic water extract at 5% and 10% significantly increased the percentage of total sugars and total phenols in both seasons. On the other hand, garlic oil at 10% and 15% significantly increased the percentage of total indoles in both seasons whereas the onion water extract at15% significantly increased the percentage of total indoles in the second season only.

The obtained results are in agreement with those obtained by Chowdhury *et al.* (2007) and Botelho and Müller (2007). Also, Abd El-Rzek *et al.* (2011 and 2013) cleared that, spraying garlic extract had a positive effect on fruit physical and chemical characteristics, which improve the productivity and fruit quality. These effects were agreed with the results obtained by Ahmed *et al*. (2009) who reported that, fruits treated with garlic extract had the heaviest and largest fruits with the highest TSS.

TABLE 5. Chemical Composition % of cumin as affected by spraying garlic and onion extracts

Treatments		Essential oil	Protein	Amino acids	Carbohydrate	Total sugars	Total phenols	Total indoles
		First season						
Control		5.4	8.469	1.693	37.218	12.677	0.668	0.0076
Onion oil	**5%**	5.4	9.213	1.869	36.293	11.160	0.561	0.0070
	10%	5.7	8.708	1.534	41.772	7.915	0.605	0.0073
	15%	5.8	7.705	1.322	40.640	9.528	0.567	0.0073
Garlic oil	**5%**	5.4	8.31	1.726	39.367	10.627	0.640	0.0067
	10%	5.4	8.550	1.407	39.336	9.443	0.666	0.0080
	15%	5.7	10.882	1.756	37.436	11.240	0.610	0.0080
Onion water extract	**5%**	5.9	8.394	2.172	34.851	8.707	0.640	0.0078
	10%	5.8	9.408	2.097	34.296	10.706	0.582	0.0070
	15%	5.6	10.155	2.215	33.141	11.532	0.650	0.0079
Garlic water extract	**5%**	6	13.431	2.310	42.519	13.757	0.711	0.0076
	10%	6.2	13.219	2.464	41.035	14.103	0.706	0.0064
	15%	5.6	10.259	2.349	38.804	7.919	0.631	0.0070
LSD at (0.05)		---	**0.477**	**0.409**	**0.716**	**0.736**	**0.057**	**0.0007**
		Second season						
Control		5.2	8.084	1.659	37.701	12.020	0.659	0.0072
Onion oil	**5%**	5.8	8.889	1.737	36.858	11.921	0.524	0.0072
	10%	6	8.441	1.693	42.272	8.006	0.605	0.0075
	15%	5.8	8.230	1.411	40.452	9.538	0.552	0.0074
Garlic oil	**5%**	5.5	8.478	1.728	38.751	11.366	0.626	0.0065
	10%	5.5	8.159	1.378	38.966	9.511	0.700	0.0083
	15%	5.7	11.039	1.760	35.706	11.766	0.649	0.0082
Onion water extract	**5%**	5.8	8.746	2.398	34.696	8.780	0.632	0.0075
	10%	5.8	9.251	2.155	34.317	10.781	0.555	0.0070
	15%	5.7	10.237	2.148	33.672	11.246	0.634	0.0081
Garlic Water extract	**5%**	5.9	12.941	2.462	41.262	15.367	0.744	0.0073
	10%	6.3	13.082	2.477	43.404	15.558	0.712	0.0068
	15%	5.6	10.799	2.572	38.821	7.701	0.621	0.0070
LSD at (0.05)		---	**0.2848**	**0.3060**	**0.7232**	**0.5150**	**0.0461**	**0.0004**

The physiological mechanisms of sulfur compounds action in growth and morphogenetic processes remain unknown. Some works to be considered concerning the effects of sulfur compounds leading to an inhibition of catalase (Khan *et al*., 1987). Furthermore, Shulman *et al*. (1986) declared that when the activity of the catalase decrease, an oxidative stress will be induced in several systems due to an increment of the hydrogen peroxide content.

Volatile oil composition

Data of volatile oil contents as influenced by spraying with onion and garlic extracts are presented in Table 6. Data clearly revealed that, cumin contained mainly cumin aldehyde, p–terpinen, phellandrene and p-mentha-14-dien-7-ol which represent 27.09, 13.56, 8.41and 8.32% of the oil. These results are in agreement with those reported by Li and Jiang (2004) and Kan *et al.* (2007). Data showed that, no changes occurred in chemical composition between control and treated plants with onion or garlic extracts.

TABLE 6. Chemical constituents and concentrations of compounds present in the cumin essential oil as affected by spraying garlic and onion extracts

Concentration (%) / Compound	control	Garlic water 10%extract	Onion water extract 5%
alfa-Pinene	1.23	1.25	1.31
Phellandrene	8.41	8.26	8.55
Limonene	3.72	3.50	3.86
p-Terpinen	13.56	13.42	13.62
Terpinolene	2.24	2.28	2.37
Carvotanacetone	2.23	2.20	2.26
1,8-Cineole	1.5	1.50	1.48
Terpineol	3.65	3.62	3.55
Cumin aldehyde	27.09	27.01	26.97
p-Cymene	6.98	6.14	6.91
Coumarin	0.89	0.77	0.85
Caryophyllene oxide	1.41	1.32	1.42
p-Mentha-1,4-dien-7-ol	8.32	8.36	8.26
Thymol	4.01	3.81	4.17
Cumin alcohol	6.56	6.34	6.49
Hexadecanoic acid	2.47	2.28	2.46
Geraniol	3.08	3.17	3.02
Caryophyllene oxide	2.65	2.35	2.45

General Discussion

Garlic oil contains 3-[(Prop-2-ene-1-sulfinyl) sulfanyl prop-1-ene (allicin), diallyl disulfide and dimethyl–trisulfide (23.53, 21.98 and 17.43, respectively), these compounds had previously been reported on as derivatives of garlic (Kubota *et al*., 1999, 2000). On the other hand, onion oil contains S-benzyl phenyl methane thiosulfinate (allium thiosulfinate), alkyl thiosulfnates, and allyl propyl disulphide (23.56 , 21.34 and 15.65, respectively). The obtained results

are in partial agreement with those observed by Saleh *et al*. (2004) reported that, organosulfur compounds isolated from garlic by GC/MS are 3-vinyl-4H-1,2-dithiin, 2-vinyl-4H-1,3-dithiin and isomers co-elution, and di-2-propenyl trisulfide. Also, Vargas-Arispuro *et al*. (2008) isolated and identified allicin and S-methyl cysteine sulfoxide (SMCSO) from garlic. Goldan *et al*. (1988) mentioned that, volatile sulfur compounds in onion such as carbondisulfide (CS_2), carbonylsulfide (COS), hydrogen sulfide (H_2S), methylmercaptan (CH_3SH), and sulfur dioxide (SO_2) can be taken up by all onion parts

The chemistry of garlic is complex, with over 100 different compounds that contribute to its effects. The most important and unique feature is its high content of organosulfur substances (Block, 1985). Allicin is the main biologically active component of freshly crushed garlic (*Allium sativum*) cloves (Lawson *et al*., 1991). Members of the family Brassicaceae and of the taxon Allium (onion, garlic leek) are the most sulfur demanding plants and therefore excellent candidates for phyto-extraction (Ernst, 1998).

However, progress has been made in elucidating the implied routes in the regulation of sulphur in relation to the vegetative growth of plants (Hawkesford and De Kok, 2006). In the process of assimilation of sulphur by the plant, inorganic sulphur is fixed as cysteine after a process of reduction. Cysteine is the initial material for the production of reduced glutathione, which is responsible for detoxing cells through the elimination of free radicals and reactive species that accumulate during different types of stress. The sulphur molecules derived from garlic can be assimilated by the plant in the latent stage, it can favor the detoxification of the plant and promote bud breaking. At the same time, exogenous applications of reduced glutathione induced bud breaking when it was applied on buds of grapevines of (Vargas-Arispuro *et al*., 2008).

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تحسين انتاجية الكمون باستخدام بعض المستخلصات النباتية الطبيعية

همت سميح عبد السلام ، عبير علي دهب و محمد فريج محمد
قسم بحوث النباتات الطبية والعطرية - معهد بحوث البساتين - مركز البحوث الزراعية - القاهرة - مصر .

تمت دراسة تأثير الزيوت الطيارة والمستخلصات المائية للثوم والبصل فى ثلاث تركيزات (٥ و١٠ و١٥٪) على محصول الكمون والتركيب الكيميائى لنبات الكمون. جميع المعاملات ادت الى تحفيز قياسات النمو (طول النبات - عدد الافرع- عدد النورات) والمحصول الناتج من البذرة دون التأثير على التركيب الكيميائى للزيت الطيار.المستخلص المائى للبصل اعطى اعلى محصول للبذور.المستخلص المائى للثوم اعطى اعلى محتوى من الكربوهيدرات الكلية والبروتين الكلى والاحماض الامينية الكلية .التركيب الكيميائى للزيت الطيار لنبات الكمون المعامل بمستخلصات الثوم والبصل لم يتأثر. الزيت الطيار للثوم والبصل تم تفريده بواسطة جهاز التحليل الكروماتوجرافى بمطياف الكتلة وكانت المركبات الرئيسية فى الثوم هى
Allicin و diallyldisulfide وdimethyl -trisulfide .

اما فى البصل فكانت,allium thiosulfinat وalkyl thiosulfnates و allyl propyl disulphide .