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Effect of Dry Yeast and Compost Tea on Growth and Oil Content of *Borago Officinalis* Plant

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Abstract: The effect of various concentration of dry yeast and compost tea on growth, yield and oil composition (sap.and unsap. matter) of borage plants was studied in field experiments during two successive seasons. In both seasons, the results pointed out that 20L./ fed. (feddan=4200 m2) of compost tea significantly increased plant height, fresh and dry weight of aerial parts and flowers and number of branches and suckers, Adding dry yeast at the rate of 6 g/L. was the most effective on growth parameters and oil%. In the scale of interaction, the maximum mean values of most characters have been recorded with 4g/L. of dry yeast + 20 L./ fed. of compost tea. The quantitative and qualitative analysis of the unsap (hydrocarbons and sterols) were done. Campersterol was found to be the major sterol followed by stigmasterol (cholesterol inhibitors). Highly record of Gamma Linolenic acid (the precursor of prostaglandin E1) was in plants treated with 20L./fed. of compost tea.

Key words: Borage, dry yeast, compost tea, fixed oil, sap. and unsap., medicinal and aromatic plants.

INTRODUCTION

Borage is a fairly common domestic herbal remedy that has been used since ancient time. It has a particularly good reputation for its beneficial effect on the mind, being used to dispel melancholy and induce euphoria. It is also used as diuretic herb that soothes damage for irritated tissue. It's therapeutic actions are as adrenal gland restorative, galactogogue, demulcent, emollient, mild relaxing and vulnerary[1] anti-inflammatory and diaphoretic[2].

Oil content of the seed is 30-40% by weight of which 23-24% is Gamma Linolenic Acid (GLA) "18: 3Δ, 6, 9, 12"[3].

It is a fatty acid that the body convents to a hormone – like substance called prostaglandin E1 (PGE1). As a medicine, GLA is commonly used as nutritional supplement and prescription pharmaceutical to combat heart diseases, diabetes, atopic eczema, arthritis, multiple sclerosis and cyclical mastalgia[3,4,5]. The compost tea is a highly concentrated microbial solution produced by extracting beneficial microbes from vermi-compost and /or compost. It is a source of foliar and organic nutrients, contains chelated micronutrients for easy plant absorption and the nutrients for both plant and microbial uptake. Compost used to improve soil physical and biological properties i.e, water retention capacity, drainage, pH, better availability of soil micro-organism and reducing the negative impact of chemical based pesticides and fertilizers in the ecosystems[6].

Adding various organic compost to the soil resulted increase growth characters, yield and chemical constituents of rosemary Khalil[7] and *Tagetes erecta* plant Khalil*l*[8].

Compost tea also produced plant hormones, mineralize plant available nutrients, fixes nitrogen and providing usefull microorganisms that colonize leaf surfaces. Many investigators reported similar promotion effect for compost fertilizer on different plants, Edris et al[9] on *origanum majorana*, El-Sherbeny et al[10] on *Ruta graveolens* and Hendawy[11] on *Plantago arenaria*.

Active dry yeast is a natural safety biofertilizers causes various promotive effect on plants. It is considered as a natural source of cytokinins which simulates cell division and enlargement as well as the synthesis of protein, nucleic acid and B-vitamin[12]. It also releases CO_2 which reflected in improving net photosynthesis[13].

Heikal[14] reported that active dry yeast as foliar fertilizer enhanced growth, plant nutritional and essential oil yield of thyme plants. Roselle (*Hibiscus sabdariffa*) plants sprayed with dry yeast at a rate of $2gL^{-1}$, showed the highest yield of calyxes as revealed by[15]. Khedr and Farid[16] demonstrated that the effect of dry yeast is due to its capability in induction of endogenous hormones like GA3 and IAA. Moreover, several investigators studied the response of other

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plants to application of dry yeast i.e. El-Sayed *et al*[17] on coriander, Naguib and Khalil[18] on black cumin and Wahba[19] on Oenothera plants. Recently, dry yeast is used as an alternative source of growth substances in bio/organic fertilization system.

The main aim of this work is to study the effect of dry yeast and compost tea on growth and chemical components of Borage plants.

MATERIALS AND METHODS

Two field experiments were carried our at Saft El-Laban farm, Giza, Egypt during two successive growing seasons 2007 and 2008 to study the effect of compost tea and active dry yeast (*Saccharomycess cerevisiae*) on growth parameters, chemical constituents and oil of *B.officinalis* plant. Seeds of Borage were obtained from Horticulture Department Station, Faculty of Agriculture, Moshtohor, Zagazig Univeristy, Egypt.

Materials: Seeds were sown directly in soil on 12th of October 2006, and on the second of October 2007, in plots of 2x2 m arranged in completely randomized design, with three replicates for each treatments. Each plot contains 3 rows 60 cm apart, and the distance between plants was (40cm). Calcium super phosphate (15.5% P_2O_5), at 100kg/feddan and ammonium suplhate (20.5%N) at 100kg/feddan and potassium fertilizer (potassium sulphate 48% K_2O) at 50kg/feddan were applied. Phosphorus fertilizer was added at the time of soil preparation while nitrogen fertilizer was added at two separate side dressings, the first one at 15th of February and the second at 15th of March through the two seasons.

Compost tea was the organic fertilizer obtained from (Soil Fertility Lab., Sekem Academy for Science) and were added after two months of sowing at two levels 10 L./fed. and 20L./fed. The physico-chemical properties of organic compost tea are shown in Table (2).

The powder form of the active dry yeast purchased from the local market. Yeast activation done overnight by sucrose before spraying on the plants.

The individual and combination effect of the treatments were applied to the plants:

Treat.1: Control (sprayed with water).
Treat.2: Sprayed with compost tea at 10 L./fed.
Treat.3: Sprayed with compost tea at 20 L./fed.
Treat.4: Sprayed with compost tea at 2 g./L.
Treat.5: Sprayed with compost tea at 4 g./L.
Treat.6: Sprayed with dry yeast at 6 g / L.
Treat.7: Sprayed with dry yeast at 2 g / L. + compost tea at 10 L./fed.
Treat.8: Sprayed with dry yeast at 2 g / L. + compost tea at 20 L./fed.
Treat.9: Sprayed with dry yeast at 4 g / L. + compost tea at 10 L./fed.
Treat.10: Sprayed with dry yeast at 4 g / L. + compost tea at 20 L./fed.
Treat.11: Sprayed with dry yeast at 6 g / L. + compost tea at 10 L./fed.
Treat.12: Sprayed with dry yeast at 6 g / L. + compost tea at 20 L./fed.

The plants were sprayed with dry yeast and compost tea twice, the first at 15th February and second at 15th March, early in the morning. Control plants received distilled water.

Sampling: The following agronomic characters were measured during both two growth seasons:

Plant height (cm), plant fresh weight (g/plant) of aerial parts, plant dry weight (g/plant) of aerial parts, plant dry weight (g/plant) of aerial parts, flowers (fresh and dry weight), no. of suckers, seed weight per plot area and percentage of fixed oil in seeds. Seeds of borage plants were scattered when matured and to avoid the loss of seeds during maturation, the seeds were collected when begin to ripe and left to dry, then weighed.

Chemical Analysis: Fixed oil was determined according to *A.O.A.C.*[21].

The seed oil was fractionated to saponifiable and unsaponifibale matter, where the saponified matter was methylated to form methyl ester then the fractions were injected to GLC to determine their constituents, using standards of fatty acids and adopting the method of Vogle[22].

GLC fractionation of sap. and unsap. matter of borage oil was determined for the control treatment (spraying with water) and three other treatments which recorded the highest values of growth characters at the scale of individual factors and interaction. They were as follow:

Treat 1: control.
Treat 3: 20L./ fed. of compost tea.
Treat 6: 4g/L. of active dry yeast.
Treat 10: 4g/L. of active dry yeast + 20 L./fed. of compost tea.

Statistical Analysis: The results of all the parameters were statistically analysed adopted the method of Snedecor and Cochran[23].

RESULTS AND DISCUSSION

The response of *B.officinalis* plants to application of dry yeast and/or compost tea is shown in Tables (3&4) during 2006/2007 and 2007/2008 seasons. It is clear that spraying borage plants with dry yeast and/or

Table 1: The mechanical and chemical analysis of the soil were carried out according to the methods of Chapman and Pratt[20].

Physical properties		Chemical parameters		
Soil type	loamy	pH	7.8	
Course sand	4.9%	Available N	13.8	mg/100g
Fine sand	30.7%	Available P_2O_5	0.482	mg/100g
Silt	27.5%	Available K_2O	3.01	mg/100g
Clay	27.5%			
Organic matter	2.1%	Fe	1.1	ppm
		Mn	0.53	ppm
		Zn	2.1	ppm
		Cu	2.1	ppm
		Na	2.9	ppm
		Mg	2.4	ppm

Table 2: The physico-chemical properties and microbial population of organic compost tea:

Bacterial Plate count (CFU/ml)	7.1 x 107	EC ds/m	0.923
Bacterial Direct count (Cell/ml)	6.4 x 10^8	pH	6.56
Spore forming bacteria (CFU/ml)	7 x 10^4	Mineral Nitrogen (ppm)	249
Total fungi (CFU/ml)	1.1 x 10^4	Available Phoshorus (ppm)	7.3
Total fungi (CFU/ml)	2.8 x 10^5	Available Potassium (ppm)	201
	Ca (ppm)	88	
		Mg (ppm)	115
		Fe (ppm)	66
		Zn (ppm)	7.33

compost tea increased vegetative, flowering and yield parameters compared with control (spraying with water)

Effect of Compost Tea: Raising compost tea doses from 10 to 20 L./fed. significantly increased plant height (cm), fresh and dry weight of aerial parts and flowers (g/plant) and number of suckers and branches, this was true in both seasons. Seed weight (g.) per plot area progressed from 16.3 to 18.3 g. by adding the higher rate of compost tea but failed to reach the level of significancy. Oil percentage was equal for both treatments.

Regarding to the effect of compost tea in the second season, it was found that spraying with 20L./ fed. of compost tea significantly improved plant growth characters expressed as plant height, fresh and dry weight of aerial parts, number of suckers and seed weight. The other studied parameters were not statistically responded to this factor.

These results were coinciding with those of Khalid *et al*[24] and Gharib *et al*[25]. They all showed that compost tea increased vegetative growth and essential oil content of *Ocimum basilicum* and marjoram plants, respectively.

The beneficial effect of compost tea on herb dry matter may be due to both supply nutrients and microbial functions (as usefull microorganisms increase the time stomata stay open, then reducing loss from the leaf surface). It can provide chelated microelements and make them easier for plants to absorb and increasing soil aeration and acidity[9,10,26].

Effect of Dry Yeast: Adding dry yeast at the rates of (2, 4 and 6g/L.) increased growth parameters and oil percentage of borage plants compared with control treatment. In 2006/2007 season, increasing the dose of dry yeast from 2g/L. to 4g/L. showed significant differences in the mean values of fresh weight of aerial parts, number of suckers, seed weight and oil%.

Table 3: Effect of sprayed dry yeast and/or compost tea on growth characters, yield, oil percentage of *Borago officinalis* plants during 2006-2007 season

Treatment	Plant height (cm)	Fresh weight (g/ plant) of Aerial parts	Dry weight (g/ plant) of Aerial parts	Flowers Fresh weight (g) plant	Flowers Dry weight (g) plant	Number of suckers / plant	Number of branches/ plant	Seed weight/ (g) plot area (4m2)	%of oil
Control	78	815	185.23	212	76.33	8	15.60	83.0	26
Compost tea 10 L./fed	82	921	204.67	222	79.93	9	16.30	91.0	28
Compost tea 20 L./fed	89	1033	219.79	238	85.69	10	18.30	93.4	28
Dry yeast 2g/L.	85	980	208.51	218	74.14	9	17.00	97.5	28
Dry yeast 4g/L.	92	1040	241.86	225	76.50	10	17.30	105.0	27
Dry yeast 6g/L.	97	1095	238.04	237	80.60	11	18.50	110.0	28
Compost tea 10 + dry yeast 2	100	1082	245.91	242	82.28	11	17.30	116.0	28
Compost tea 20 + dry yeast 2	102	1100	244.44	255	86.70	12	18.30	122.0	28
Compost tea 10 + dry yeast 4	105	1120	260.47	250	86.21	13	19.00	130.0	28
Compost tea 20 + dry yeast 4	112	1175	286.59	278	99.29	15	21.30	138.0	30
Compost tea 10 + dry yeast 6	108	1060	252.38	266	95.00	13	20.00	132.0	29
Compost tea 20 + dry yeast 6	108	1095	254.65	262	89.06	12	19.00	134.0	29
L.S.D. (5%)	2.90	42.10	10.80	17.93	5.84	0.85	1.11	3.14	–

Table 4: Effect of sprayed dry yeast and/or compost tea on growth characters, yield, oil percentage of *Borago officinalis* plants during 2007-2008 season

Treatment	Plant height (cm)	Fresh weight (g/ plant) of Aerial parts	Dry weight (g/ plant) of Aerial parts	Flowers Fresh weight (g) plant	Flowers Dry weight (g) plant	Number of suckers / plant	Number of branches/ plant	Seed weight/ (g) plot area (4m2)	%of oil
Control	77	832	193.49	214	85.68	7	15.00	85.0	25
Compost tea 10 L./fed	84	910	211.63	221	89.21	9	17.50	93.0	27
Compost tea 20 L./fed	88	1020	237.21	235	94.86	10	18.50	97.5	27
Dry yeast 2g/L.	89	1010	234.88	222	84.08	9	18.00	98.5	27
Dry yeast 4g/L.	92	1060	246.51	228	86.33	11	18.50	107.0	28
Dry yeast 6g/L.	100	1105	256.98	240	90.89	12	19.50	110.0	28
Compost tea 10 + dry yeast 2	100	1095	254.65	245	92.76	12	18.50	114.0	27
Compost tea 20 + dry yeast 2	103	1135	263.95	260	98.44	13	20.00	121.0	28
Compost tea 10 + dry yeast 4	106	1140	265.12	266	98.52	13	20.00	132.0	28
Compost tea 20 + dry yeast 4	114	1190	276.74	275	105.77	16	23.00	136.0	30
Compost tea 10 + dry yeast 6	110	1075	250.00	265	101.92	13	20.00	134.0	28
Compost tea 20 + dry yeast 6	109	1110	258.14	260	98.42	14	21.00	131.0	28
L.S.D. (5%)	3.56	40.06	11.02	16.54	6.03	0.87	1.05	3.32	–

The same trend was observed when applying the highest rate (6g/L.) of dry yeast. In the second season, only the fresh weight of aerial parts, number of suckers and oil% had statistically responded to application of 2,4 and 6g/L. Obviously the level of 6g/L. of dry yeast gave the highest record of studied parameters.

Stimulating vegetative growth by using dry yeast may be due to its influence on the nutritional signal transduction producing growth regulators and suppressing pathogen[27]. It is also a natural source of cytokinins that stimulates cell proliferation and differentiation, controlling shoot and root morphogenesis and chloroplast maturation[12]. El-Tohamy and El-Greadly[28] revealed that dry yeast treatments (5 and 10 g/L.) result in improving pods quality of snap beans plants (*Phaseouls vulgaris*) in terms of chlorophyll, protein, carbohydrates and decreased fiber content.

Effect of Interaction: Taking into consideration the effect of both studied factors, results showed that interaction treatments between compost tea and active dry yeast had augmented growth and yield parameters compared with control (spraying with water). The maximum mean values of most characters under study have been recorded with applying 4g/L. of dry yeast + 20 L./fed. of compost tea in both seasons. Gomaa and Mohamed[29] studied the combined effect of organic and biotreatments on guar plants. They found that the greatest forage yield per feddan (4200m2) produced from 20 ton FYM (Farm Yard Manure) + Rhizobium + yeast (40 L./fed.).

Table 5: GLC fractionation of unsap. matter of borage oil

Borago Unsaponifiable matter Component	Treatment 1	3	6	10
C8				
C9	0.190	0.310	0.268	0.436
C10	0.204	0.404	0.286	0.437
C12 n-dodecane	0.150	0.293	0.201	0.275
C13 Tridecane	0.911	1.091	1.008	1.047
C14 Tetadecane	0.654	0.797	0.720	0.783
C15 Pentadecane	0.482	0.602	0.558	0.615
C16 Hexadecane	0.439	0.619	0.536	0.563
C17 Heptadecane	1.749	1.899	1.782	1.874
C18 Octadecane	0.666	0.846	0.763	0.953
C19 Nanodecane	2.476	2.596	2.570	2.601
C20 Eicosane	4.440	4.110	4.491	3.760
C21 Heneicosane	3.100	3.280	3.197	3.264
C22 Docosane	5.327	4.440	5.392	5.492
C23 Tricosane	3.641	2.800	3.792	4.018
C24 Tetradecosane	2.766	3.236	2.841	2.891
C26 Hexacosane	3.643	3.833	3.694	1.020
C27 Heptacosane	4.220	2.400	4.317	4.344
C28 Octacosane	1.654	1.774	1.705	1.779
C30 Triacontane	5.250	8.710	5.370	5.378
Squalene $C_{30}H_{50}$	6.050	6.362	6.115	6.174
Cholesterol	2.523	3.443	2.985	3.216
βSitosterol	6.322	7.062	6.784	7.000
Compesterol	7.550	7.190	8.124	8.238
Stigmasterol	6.324	6.864	6.865	7.002
β-amyrine	5.569	6.349	5.903	6.257
Total	76.30	81.31	80.27	79.42

Table 6: GLC fractionation of sap. matter of borage oil.

Treatment	Myrestic	Palmatic	α Stearic	Oleic	Linoleic	α -Linolenic	γ-Linolenic	Stearodinic	Saturated	Unsaturated	Total
	C 14:0	C 16:0	C 18:0	C 18:1	C 18:2	C 18:3	C 18:3	C 18:4			
1	0.85	21.4	16.5	11.3	21.1	11.2	12.3	2.4	38.85	58.30	97.05
3	0.05	22.4	11.3	12.7	22.75	12.2	16.8	0	33.75	64.45	98.20
6	0.12	12.6	14.5	12.3	21.9	13.31	12.4	8.3	27.22	68.21	95.43
10	0.48	11.3	8.88	15.02	17	14.9	10.2	9.6	20.66	66.12	89.38

Where : Treat. 1 : Control Treat. 3 : 20L./fed. of compost tea Treat. 6 : 4g/L. of active dry yeast
Treat. 10 : 4 g/L. of active dry yeast + 20L./ fed. of compost tea

Sap. And Unsap. Matter: The quantitative and qualitative analysis of the unsaponifibale matter (hydrocarbons and sterols) are shown in Table (5).

Nineteen hydrocarbonic compounds were detected in borage oil of these treatments started from C_9 to C_{30} along with four phyto-sterols. Squalene (the metabolic precursor of sterols and steroids) was also detected in all samples. Campesterol was found to be the major sterol in all determined treatments and ranged from 7.19 to 8.24 % followed by stigmasterol which ranged from 6.32 to 7.0 %.

From human health point of view, these plant sterols or phytosterols are minor constituents of oil present in the unsap. fraction. Large doses of those compounds inhibit cholesterol absorption in the small intestine cause a modest decrease in serum cholesterol concentration[30]. Increasing the side chain substitution of cholesterol decreases its absorbability in human body. β-sitosterol (in borage oil) for example has a side chain substitution of an ethyl group compared with cholesterol and is absorbed less than cholesterol.

The cholesterol- lowering effect of β-sitosterol and sitostanol (the hydrogenated form of β-sitosterol) has been well established by[31,32]. Mitova *et al*[33] determined saturated straight chain hydrocarbons with 21-31 carbon atoms in *Carthamus lanatus* using GC/MS. Their findings confirmed our results. Triacontane (C_{30}) was found to be the major hydrocarbonic compound and ranged from 5.25 (control) to 8.79% (compost tea at 20 L./fed.).

The main fatty acids of the fixed oil of borage as determined with GLC are shown in Table(6). The data proved that palmatic, β-stearic, oleic, Linoleic, α-Linolenic and α-Linolenic acids are the dominant acids. El-Gengaihi *et al*[34] and Refaat *et al*[35] found the same distribution of fatty acids in the seeds of borage which were in a harmony with our results.

In general, the unsaturated fatty acids are higher than saturated one in all treatments. The unsaturated fatty acids ranged from 58.3% for control (spraying with water) to 68.2% for spraying with dry yeast at 6g/L. Linoleic acid (C_{18}:2) was the dominant fatty acid and ranged from 17% for combined application of dry yeast at 4g./L. + compost tea at 20L./ fed. to 22.75% for spraying compost tea at 20L./ fed.

Palmatic acid (C_{16} : 0) was found to be the major saturated fatty acids of borage fixed oil. Plant received compost tea at 20L./fed. gave the maximum percentage (22.4%) of this acid. These results were in agreement with Özcan[36] on borage oil.

An inverse relation between α-Linolenic acid (C_{18}:3) and Linoleic acid (C_{18}:2) was observed. Similar results were obtained by El-Gengaihi *et al*[34]. Highly record of α-Linolenic acid (the precursor of prostaglandin E1) which is usefull to human health was in plants treated with 20L./fed. of compost tea.

We may recommended the application of 4g/L. of active dry yeast + 20 L./fed. of compost tea for maximizing the production of *B.officinalis* plants in all growth characters, fixed oil% and Campesterol (the major phyto-sterol). It could be also recommended that to obtain the highest value of α-Linolenic acid, borage plants fertilized with 20L./fed. of compost tea.

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