Response of Three Sweet Basil Cultivars to Inoculation with *Bacillus subtilis* and Arbuscular Mycorrhizal Fungi under Salt Stress Conditions

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Abstract: A pot experiment was conducted to investigate the effect of inoculation with *Bacillus subtilis* and/or Arbuscular Mycorrhizal Fungus (AMF) or maintained as uninoculated controls on the growth, essential oil %, oil yield and nutrient uptake of three sweet basil cultivars (Local cultivar, Nano Compatt and Red Bordaux) under different salt stress levels (0, 1000, 2000 and 4000 ppm). Results indicated that the high salinity level (4000 ppm) caused significantly reduction in plant height, fresh and dry weights of the herb, number of branches/plant, essential oil % and oil yield as well as contents of N, P and K in leaves of all studied sweet basil cultivars. Meanwhile, sodium Na^+ content in leaves were high, especially at high NaCl concentration. Red Bordaux cultivar was more sensitive to salinity stress than Local and Nano Compatt cultivars. Inoculation with *Bacillus subtilis* and/or mycorrhizal fungi showed positive effects on growth, oil %, oil yield and nutrient uptake either with or without the salinization treatment. Mycorrhizal colonization showed generally more pronounced effects than *B. subtilis*. Dual inoculation with *B. subtilis* and mycorrhizae provided higher tolerance to salinity compared with the individual treatment. It could be concluded that inoculation of sweet basil cultivars with *B. subtilis* and mycorrhizal fungi may induce increases in tolerance to salinity of the three tested sweet basil cultivars.

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1. Introduction

Salinity is the main environmental factor accountable for restricting plant growth and decreasing crop productivity in many areas of the world, especially in arid and semi-arid regions (Apse *et al.*, 1999). About one billion hectares of the world's land area is not in use due to salinity stress (Jain *et al.*, 1989). Additionally, one-third of the world's Arab land resources are affected by salinity (Qadir *et al.*, 2000). Soil salinity is mainly attributed to the soluble salts in irrigation water, fertilizers used in agriculture, high evaporation rate and insufficient leaching of ions especially in arid lands (Copeman *et al*., 1996; and El-Saidi, 1997). Excessive salts in soil lower the availability of water, inhibit metabolic processes and affect nutrient composition, osmotic balance and hydraulic conductivity, resulting in stunted growth and productivity of plants (Hopkins, 1999; and Al-Karaki *et al.*, 2001). The development of salt-tolerant crops or desalination of soil by leaching excessive salts, though successful is not economical for sustainable agriculture (Hamdy, 1990; and Cantrell and Linderman, 2001). In this respect, the use of a non-hazardous biological method, such as Plant Growth-Promoting Rhizobacteria (PGPR) and mycorrhizal applications to alleviate salt stress and use of moderately salt-tolerant plants are better options (Dixon *et al.*, 1993; and Mayak *et al.*, 2004). Many studies have demonstrated that inoculation with plant growth-promoting rhizobacteria (e.g., *Bacillus subtilis*) and arbuscular mycorrhizal fungi improve plant growth, yield and nutrient uptake under a variety of salinity stress conditions (Al-Karaki *et al.*, 2001 and Mayak *et al.*, 2004).

Plant Growth-Promoting Rhizobacteria (PGPR) have been reported to be key elements for plant establishment under nutrient-imbalance conditions (Egamberdiyeva and HÖflich, 2004). PGPR may improve plant growth and yield by direct and indirect mechanisms (Noel *et al.*, 1996). Indirect mechanisms of plant growth stimulation include a variety of mechanisms by which the bacteria prevent phytopathogens from inhibiting plant growth and development (Glick and Bashan, 1997). Direct mechanisms may act on the plant itself and affect growth by providing plants with fixed nitrogen, phytohormones, iron and soluble phosphate (Kloepper and Schroth, 1978). PGPR can also protect plants from the deleterious effects of some environmental stresses including flooding (Grichko and Glick, 2001), drought (Mayak *et al.*, 2004a), salt (Mayak *et al.*, 2004b) and phytopathogens (Harman and BjÖrkman, 1998). *Bacillus subtilis* can induce plant resistance to stress and produces various plant hormones for growth improvement (Han and Lee, 2005). Many workers have showed that inoculation of plants with *B. subtilis* increased plant growth, yield and nutrient uptake, especially under salt stress conditions (Bochow *et al*., 2001; Ashraf *et al*., 2004; Saleh *et al*., 2005), by influencing phytohormone production (e.g. auxin, cytokinin, or giberallin), and/or by enzymatic lowering of plant ethylene levels (BjÖrkman *et al.*, 1998; Grichko and Glick, 2001).

Arbuscular Mycorrhizal Fungi (AMF) form symbiotic associations with the roots of most plant species (Al-Karaki and Al-Raddad, 1997). These symbiotic associations can enhance plant growth and nutrient uptake under various environmental stress conditions such as salinity, drought and low fertility (Al-Karaki and Al-Raddad, 1997; and Zuccarini and Okurowska, 2008). Also under conditions of low nutrient availability the hyphae of AMF can absorb nutrient from soil beyond the zone depleted by roots so they increase the effectiveness with which the soil volume is exploded (Smith and Read, 1997). The beneficial effect of mycorrhizal fungi on plant growth was attributed to enhanced phosphorus uptake (Al-Karaki *et al*., 2001). Some authors also point out how AM fungi can increase plant resistance to salt stress by influencing the hormonal balance of the host plant (Danneberg *et al*., 1992) or by increasing water uptake (Ruiz-Lozano and Azcon, 1995).

Little available information in the literature about the interaction between plant growth-promoting rhizobacteria and arbuscular mycorrhizal fungi to alleviate salt stress. Thus, the present study was conducted to evaluate the response of three sweet basil cultivars to inoculation with *Bacillus subtilis* and / or arbuscular mycorrhizal fungi under salt stress.

2. Material and Methods

The present experiment was carried out twice at the Experimental Farm of Floriculture, Faculty of Agriculture, Assiut University, Assiut, Egypt during the two successive seasons of 2007 and 2008 to investigate the effect of inoculation with *Bacillus subtilis* and/or Arbuscular Mycorrhizal Fungus (AMF) on the growth, volatile oil %, yield and nutrient uptake of three sweet basil cultivars under salt stress conditions. The three basil cultivars were obtained from the Agriculture Research Center, Giza, Cairo, Egypt. Uniform rooted cuttings (ca. 3 weeks old) of three sweet basil cultivars (Local cultivar, Nano Compatt and Red Bordaux) were transplanted in earthenware pots 30 cm diameter and 40 cm height with perforated bottoms. All pots were filled with 10 Kg of clay loam soil, physical and chemical properties of the soil used were done according to the methods described by Jackson (1973) as shown in Table (1).

At the beginning of May one plantlet was planted in each pot in both seasons. One week after transplanting, plantlets were inoculated with either of *B. subtilis* and/or mycorrhizal fungi or maintained as uninoculated controls. Active strain of *Bacillus subtilis* (10^8 CFU/ml) and arbuscular mycorrhizal fungi (*Glomus irradicans*) provided by the Unit of Biofertilizers, Faculty of Agriculture, Ain Shams University, Shobra El-Kheima, Egypt. The soil was inoculated with *B. subtilis* and/or AMF at three times (one week after transplanting, one month later and one week after the 1^{st} cut). *B. subtilis* inoculation was applied at a rate of 10 ml/pot. The inoculation with AMF was placed in the pots at 25 spores/pot before the seeds were sown (Demir and Onogur, 1999). The combined treatment of both microorganisms was applied at 10 ml/pot broth culture of *B. subtilis* + 25 spores/pot of AMF. Also, uninoculated plants are involved as a control.

Table (1): Some physical and chemical analysis of the soil used in the experiment before planting.

Properties		Value	Properties		Value
Texture analysis:	Clay %	44.2	Soluble cations	meq/L. (soil paste), Ca^{++}	2.03
	Silt %	22.3		Mg^{++}	0.31
	Sand %	33.5		Na^{+}	3.06
Texture grade		Clay loam		K^{+}	1.83
Total Ca CO_3 (%)		1.60	Soluble anions	meq/L. (soil paste), Cl^{-}	2.01
E.C. dS/m (1:5) soil extract		0.72		$CO^{=}_3$	-
				HCO^{-}_3	3.79
				$SO^{=}_4$	1.48
pH (1:2.5 soil suspension)		8.5	Total nitrogen (%)		0.28
Organic matter (%)		1.27	Total phosphorus (%)		0.164
			Total potassium (%)		0.221

Plantlets were irrigated regularly with tap water for two weeks after transplanting, and then seedlings were subjected to different salinity levels of different NaCl concentrations (0 "tap water", 1000, 2000 and 4000 ppm). The irrigation whether with tap water or saline water must reach the level of 65% of total Water Holding Capacity (W.H.C.) of the soil by weighing every pot daily and the needed amount of water was added. The general principal stated by Boutraa and Sanders (2001) was used for the water treatment application.

The experiment including 48 treatments which were the combination between three sweet basil cultivars (Local cultivar, Nano Compatt and Red Bordaux), four salinity levels (0 "tap water", 1000, 2000 and 4000 ppm NaCl) and three inoculation with beneficial microorganisms plus uninoculated control (control, *B. subtilis*, AMF and *B. subtilis* + AMF). The treatments arranged in a split-split-plot design, with three replicates. The three basil cultivars represented the main plots, while the four salinity levels and the four microorganisms inoculation represented in sub-plots and sub-sub plots, respectively.

Plant samples were collected for two cuts, the 1st at the beginning of August and the 2nd at the end of October to estimate different growth and yield parameters. For each cut three plants were selected randomly from three separated pots and the following growth parameters were recorded: plant height (cm), number of the branches per plant, fresh and dry weights of herbs per plant (g), essential oil percentage in fresh herb and oil yield per plant. The essential oil was extracted by water distillation according to the method described by Guenther (1961).

Samples were collected and dried for 48 h at 70 °C to determine the chemical constituents of leaves which taken at full blooming stage. Total nitrogen was determined by using semi-micro Kjeldahl method described by Black *et al*. (1965). Total phosphorus was determined using Spectrophotometer according to Jackson (1973). Leaf content of K was determined photometrically using a flame photometer according to the method of Jackson (1958). Na content was determined according to the method described by A.O.A.C method (A.O.A.C., 1990).

The collected data were subjected to statistical analysis of variance using the normal (F) test and the means separation were compared by using Least Significant Difference (LSD) at 5% level according to Snedecor and Cochran (1980).

3. Results

3.1. Plant height and number of branches:

Obtained results in Table 2 presented a clear comparison between the three chosen cultivars irrespective to salinity and inoculation with microorganisms in both cuts and both seasons. Nano Compatt cultivar surpassed those of Red Bordaux and Local cultivars in plant height and number of branches and with significant difference, followed by Local cultivar.

High salinity badly affected studied growth parameters of basil plant during the two growing seasons and in both cuts (Table 2). It was clear also that low salinity levels of 1000 ppm significantly increased plant height and number of branches of the first cut compared with control plants, while in second cut different salinity levels induced a marked significant reduction in plant height and number of branches compared with control plants in both growing seasons.

Inoculation basil plants with beneficial microorganisms revealed that all treatments caused significant increase in plant height and number of branches compared with control plants. The presented data also showed that the highest significant increase in plant height and number of branches obtained when plants inoculated with *B. subtilis* + AMF treatment compared with control plants. Followed by single inoculation with AMF, while the lowest means obtained for inoculation with *B. subtilis* compared with control plants.

The interaction between tested cultivars and different salinity levels showed that the maximum significant increase in plant height and number of branches in the first cut was observed in Nano compatt cultivar grown under 1000 ppm in both growing seasons, and in control plants (without salinity) of Nano compatt cultivar in the second cut for both growing seasons compared with the other treatments.

Also, the interaction between tested cultivars and different beneficial microorganisms inoculation illustrated that pronounced results were obtained in Nano Compatt cultivar as a response to *B. subtilis* + AMF inoculation in both cuts and both seasons compared with the other treatments.

For the combined effect of different salinity levels and different beneficial microorganism treatments the highest records of the studied growth parameters observed under the combined effect of 1000 ppm and *B. subtilis* + AMF treatment in the first cut in both seasons, and control treatment (without salinity) combined with *B. subtilis* + AMF inoculation in the second cut of both growing seasons compared with the other treatments.

The tri-interaction between cultivars, salinity and different beneficial microorganisms treatments on plant height and number of branches of the first cut illustrated that the highest records were observed under the combined effect between Nano Compatt cultivar and 1000 ppm as response to inoculation with *B. subtilis* + AMF compared with the other treatments. While, for the second cut the highest means observed under the combined effect of control treatment (without salinity) of Nano Compatt cultivar and *B. subtilis* + AMF inoculation in both growing seasons.

Table (2): Effect of inoculation with *Bacillus subtilis* and arbuscular mycorrhizal fungi (AMF) on plant height and number of branches of the three sweet basil cultivars under salt stress condition during 2007and 2008 seasons.

Charact. / Treat.		First season				Second season			
		Plant height		No of branches/plant		Plant height		No of branches/plant	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Basil cultivars									
Local cultivar		39.0	43.8	6.5	8.0	43.2	49.0	7.8	9.0
Nano Compatt		43.3	50.8	7.4	8.6	48.8	53.9	8.9	10.2
Red Bordaux		34.3	28.2	5.7	3.7	38.0	31.2	6.6	5.2
$LSD_{0.05}$		1.37	1.31	0.09	0.09	1.74	1.78	0.23	0.19
Salinity levels									
Control		41.8	49.0	7.4	8.4	47.0	53.4	9.2	10.3
1000		44.3	47.0	7.8	7.9	49.0	51.4	9.7	10.0
2000		39.1	40.3	6.1	6.6	42.7	45.5	7.3	7.8
4000		30.3	27.4	4.9	4.2	34.6	28.4	5.0	4.4
$LSD_{0.05}$		1.09	0.91	0.16	0.14	0.60	1.39	0.29	0.11
Beneficial microorganisms									
control		35.5	38.4	5.6	6.0	37.8	39.8	5.6	6.9
B. subtilis		38.6	41.0	6.5	6.7	43.2	44.7	6.6	8.1
AMF		39.8	41.7	6.9	7.0	45.4	46.4	7.1	8.5
B.+ AMF		41.6	42.7	7.1	7.3	47.0	47.8	7.3	9.0
$LSD_{0.05}$		0.80	0.81	0.16	0.14	0.85	1.01	0.49	0.10
Basil cultivars X Salinity levels									
Local cultivar	Cont.	40.8	48.5	7.2	9.4	45.6	53.5	8.9	11.1
	1000	43.2	47.1	7.8	9.1	46.7	50.8	9.6	10.5
	2000	40.5	43.1	6.2	7.6	44.2	50.6	7.4	8.5
	4000	31.7	36.7	6.9	6.0	36.4	41.3	5.4	6.1
Nano Compatt	Cont.	47.2	56.3	8.5	10.0	53.9	60.1	10.5	12.3
	1000	48.7	53.8	8.8	9.6	55.1	57.8	11.2	11.9
	2000	43.9	47.7	6.7	8.2	47.9	53.8	8.5	9.5
	4000	33.4	45.3	5.7	6.6	38.4	43.8	5.5	7.0
Red Bordaux	Cont.	37.5	42.4	6.5	5.7	42.5	46.7	6.2	7.7
	1000	41.0	40.2	6.9	4.9	45.3	45.7	6.5	7.5
	2000	32.9	30.2	5.3	4.0	35.2	32.2	4.5	5.5
	4000	25.6	00.0	4.1	0.0	29.0	00.0	0.0	0.0
$LSD_{0.05}$		1.90	1.58	0.27	0.24	1.04	2.41	N.S	0.20
Basil cultivars X Beneficial microorganisms									
Local cultivar	Cont.	42.2	40.7	5.7	7.1	35.1	43.4	6.8	7.5
	B.sub.	40.1	44.0	6.5	8.0	38.8	49.1	7.8	9.1
	AMF	38.8	44.8	6.9	8.3	40.1	51.1	8.2	9.6
	B.+ AMF	35.1	45.9	7.0	8.6	42.2	52.4	8.5	9.9
Nano Compatt	Cont.	39.0	47.7	6.3	7.6	39.0	49.3	7.5	8.8
	B.Sub	44.4	50.8	7.4	8.4	43.1	53.4	9.0	10.0
	AMF	43.1	51.7	7.8	9.1	44.4	55.4	9.5	10.6
	B.+ AMF	46.7	52.9	8.2	9.3	46.7	57.3	9.7	11.3
Red Bordaux	Cont.	34.9	26.8	5.0	3.4	32.4	26.7	5.6	4.3
	B.Sub	34.9	28.1	5.7	3.7	33.9	31.7	6.6	5.2
	AMF	33.9	28.8	6.0	3.7	34.9	32.7	7.1	5.5
	B.+ AMF	32.4	29.3	6.2	3.9	35.9	33.7	7.3	5.7
$LSD_{0.05}$		1.39	N.S	0.29	0.24	1.48	N.S	N.S	0.17

Continuous Table (2)

Treat. / Charact.			First season				Second season			
			Plant height		No of branches/plant		Plant height		No of branches/plant	
			1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Salinity levels X Beneficial microorganisms										
Cont.	Cont.		40.2	46.6	6.6	7.5	46.6	48.0	7.9	8.7
	B.sub.		41.8	49.0	7.3	8.4	48.9	53.6	9.2	10.4
	AMF		42.1	49.8	7.7	8.7	49.8	54.3	9.6	10.9
	B.+AMF		43.2	50.8	7.9	8.9	49.0	56.8	9.9	11.3
1000	Cont.		40.9	45.0	6.8	5.5	45.0	46.6	8.2	8.3
	B.sub.		43.6	46.6	7.6	7.1	46.6	51.1	9.7	10.0
	AMF		44.9	47.6	8.4	7.7	47.6	53.3	10.2	10.5
	B.+AMF		47.8	48.9	8.5	8.3	50.8	55.6	10.7	11.0
2000	Cont.		35.1	37.4	5.2	5.9	37.4	38.8	6.3	6.6
	B.sub.		39.2	40.7	6.1	6.6	40.7	45.9	7.2	7.7
	AMF		40.6	41.2	6.3	6.8	41.2	47.6	7.8	8.1
	B.+AMF		41.4	42.0	6.7	7.2	42.0	49.7	8.1	8.7
4000	Cont.		25.7	24.6	4.0	3.7	24.6	25.7	4.0	3.7
	B.sub.		29.8	27.7	5.0	4.1	27.7	28.3	5.1	4.3
	AMF		31.9	28.2	5.1	4.4	28.2	29.5	5.7	4.6
	B.+AMF		33.8	29.0	5.4	4.5	29.0	30.1	5.1	4.9
$LSD_{0.05}$			1.61	N.S	N.S	0.28	1.71	2.02	N.S	0.20
Basil cultivars X Salinity levels X Beneficial microorganisms										
Local cultivar	Cont.	Cont.	38.4	46.0	6.7	8.2	40.4	47.3	7.8	9.0
		B.sub.	41.1	48.4	7.1	9.5	46.1	53.8	9.1	11.3
		AMF	41.1	49.0	7.3	9.7	47.5	56.5	9.3	11.9
		B.+AMF	42.5	50.4	7.5	10.0	48.3	56.2	9.5	12.0
	1000	Cont.	40.1	44.3	6.9	8.1	42.1	46.3	8.2	8.5
		B.sub.	43.1	46.7	7.5	9.3	46.8	50.7	9.7	10.7
		AMF	43.4	48.4	8.6	9.5	48.2	52.8	9.9	11.0
		B.+AMF	46.0	49.0	8.4	9.7	49.8	53.2	10.5	11.6
	2000	Cont.	35.5	39.3	5.3	6.7	38.2	44.0	6.5	6.9
		B.sub.	40.1	43.7	6.2	7.5	44.7	50.5	7.3	8.4
		AMF	42.4	43.9	6.4	7.9	46.1	52.2	7.8	9.0
		B.+AMF	44.1	45.5	6.2	8.3	47.6	55.5	8.0	9.5
	4000	Cont.	26.3	33.4	4.0	5.3	26.6	36.0	4.5	5.5
		B.sub.	30.9	37.2	5.0	5.8	36.1	41.5	5.3	6.1
		AMF	33.7	37.7	5.2	6.2	40.6	43.2	5.8	6.3
		B.+AMF	36.1	38.5	5.2	6.5	42.2	44.5	6.0	6.5
Nano Compatt	Cont.	Cont.	45.3	53.4	7.3	9.0	48.5	54.7	9.0	10.7
		B.sub.	46.8	56.1	8.4	9.9	53.5	59.3	10.5	12.2
		AMF	48.0	57.5	9.1	10.5	56.3	62.2	11.0	12.7
		B.+AMF	48.7	58.2	9.3	10.7	57.3	64.3	11.5	13.4
	1000	Cont.	44.0	51.8	7.5	8.6	49.5	52.0	9.3	10.2
		B.sub.	47.4	53.7	8.7	9.0	54.7	56.3	11.0	11.8
		AMF	49.0	54.1	9.3	10.3	57.0	60.0	12.0	12.6
		B.+AMF	54.4	55.7	9.5	10.5	59.0	62.7	12.6	13.0
	2000	Cont.	39.2	45.3	5.9	7.2	42.0	49.5	7.2	8.5
		B.sub.	45.1	47.9	6.7	8.2	48.0	54.8	8.5	9.3
		AMF	45.5	48.1	7.0	8.5	50.1	54.3	9.0	9.5
		B.+AMF	45.7	49.4	7.2	8.9	51.3	56.5	9.3	10.6
	4000	Cont.	27.4	40.2	4.3	5.7	30.5	40.9	4.5	5.7
		B.sub.	33.2	45.7	5.7	6.5	38.2	43.3	6.0	6.8
		AMF	35.2	46.9	5.8	7.0	42.1	54.8	6.8	7.5
		B.+AMF	37.8	48.4	6.8	7.0	42.7	54.3	4.7	8.1
Red Bordaux	Cont.	Cont.	37.1	40.3	5.8	5.2	39.2	42.1	7.0	6.5
		B.sub.	37.4	42.4	6.5	5.8	42.0	47.8	8.0	7.7
		AMF	37.3	43.0	6.7	5.8	43.4	47.2	8.5	8.2
		B.+AMF	38.4	43.9	7.0	6.0	54.3	49.8	9.6	8.5
	1000	Cont.	38.7	39.1	6.0	4.5	40.5	41.5	7.2	6.2
		B.sub.	40.3	37.4	6.7	4.8	45.5	46.2	8.5	7.5
		AMF	42.2	40.4	7.3	5.0	47.0	47.0	8.7	8.0
		B.+AMF	43.1	42.0	7.5	5.3	48.2	48.0	9.0	8.3
	2000	Cont.	30.5	27.7	4.4	3.7	31.5	23.0	5.1	4.5
		B.sub.	32.5	30.5	5.3	4.0	34.5	32.5	5.9	5.5
		AMF	34.0	31.7	5.5	4.0	36.6	36.3	6.5	5.8
		B.+AMF	34.5	31.0	6.0	4.3	38.1	37.0	6.9	6.0
	4000	Cont.	23.5	00.0	3.6	0.0	24.1	00.0	3.0	0.0
		B.sub.	25.4	00.0	4.2	0.0	28.2	00.0	4.0	0.0
		AMF	26.2	00.0	4.3	0.0	30.2	00.0	4.5	0.0
		B.+AMF	27.5	00.0	4.3	0.0	33.5	00.0	4.7	0.0
$LSD_{0.05}$			N.S	N.S	N.S	N.S	N.S	3.49	N.S	0.34

3.2. Fresh and Dry weights:

The data present in Table 3 proved that there was a significant difference observed between the three tested basil cultivars in the mean values of their fresh and dry weights during the two growing seasons and in both cuts, where Nano Compatt cultivar recorded higher values compared with that recorded by Red Bordaux and Local cultivars and with significant differences, followed by Local cultivar.

It was noticed also from the obtained data in the same table that 1000 ppm salinity level showed the highest significant increase in fresh and dry weights of the first cut in both seasons compared with control plants, followed by significant decrease with further increase in salinity levels. While, the data of the second cut revealed that there was an inverse proportional relationship between increasing the severity of salinity on one hand and fresh and dry weights on the other hand in both growing seasons. The results also revealed that the highest salinity level (4000 ppm) revealed the lowest significant means in fresh and dry weights of the two cuts and in both growing seasons.

The use of different types of beneficial microorganisms proved significant increase in fresh and dry weights of basil plant compared with control one, where the highest significant means obtained in *B. subtilis* + AMF inoculation compared with control treatment, followed by single inoculation with AMF.

The interactive effect between the three chosen basil cultivars and different salinity levels deduced that during the two growing seasons and for the three tested cultivars of the first cut**,** the fresh and dry weights attained their highest values and with significant difference under 1000 ppm compared with the other treatments, moreover Nano Compatt cultivar suppressed that of Red Bordaux and Local cultivar. While, in the second cut the highest means obtained in control plants (without salinity) of Nano Compatt cultivar.

The combined effect of the three basil cultivars and beneficial microorganisms inoculation revealed that the highest means for both cuts and both seasons were recorded by the interaction between Nano Compatt cultivar and *B. subtilis* + AMF inoculation compared with the other treatments.

The combined effect of salinity and beneficial microorganisms indicated that the highest means of the first cut obtained under 1000 ppm salinity level combined with *B. subtilis* + AMF inoculation compared with the other treatments. While in the second cut, the highest means obtained when control treatment (without salinity) inoculated with *B. subtilis* + AMF. These results were true in both growing season

The effect of the tri-interaction between tested cultivars, salinity levels and different microorganisms inoculation indicated that the highest values of fresh and dry weights for the first cut in both seasons obtained when Nano Compatt cultivar grown under 1000 ppm and inoculated with *B. subtilis* + AMF. While, in the second cut the highest means obtained in control plants (without salinity) of Nano Compatt cultivar as response to *B. subtilis* + AMF inoculation compared with the other treatments.

3.3. Oil percent and yield:

Examination of the collected data in Table 4 revealed the superiority of Local cultivar in oil % and oil yield compared with the other two cultivars and with significant difference, followed by Nano compatt cultivar while the lowest means obtained by Red bordaux cultivar.

Oil % showed progressive significant increase with increasing NaCl salinity level up to 2000 ppm while further increase in salinity up to 4000 ppm revealed significant decrease in both cuts and in both growing seasons compared with control plants. For oil yield, the data of the first cut showed that increasing salinity up to 1000 ppm revealed significant increase in oil yield, while further increase in salinity caused significant decrease in oil yield compared with control plants in both growing seasons. Furthermore, the data of the second cut revealed that different salinity level caused significant decrease in oil yield compared with control treatment in both growing seasons.

Pots treated with microorganisms showed greater oil % and oil yield than untreated pots and with significant difference compared with control treatment. The greatest significant oil % and oil yield means were obtained as a response to *B. subtilis* + AMF inoculation, followed by single inoculation with AMF.

The interaction effect between tested cultivars and different salinity levels showed that during the two growing seasons and for both cuts, the highest significant oil % values recorded under the combined effect between Local cultivar and 2000 ppm salinity level compared with the other treatments. Moreover, the collected data for oil yield indicated in the first cut that the highest significant means obtained under the combined effect between Local cultivar and 1000 ppm salinity level compared with the other treatments in both seasons. While, for the second cut the highest records obtained in control plant of Local cultivar in both growing season.

Table (3): Effect of inoculation with *Bacillus subtilis* and arbuscular mycorrhizal fungi (AMF) on plant fresh and dry weights of the three sweet basil cultivars under salt stress condition during 2007 and 2008 seasons

Charact / Treat.		First season				Second season			
		Fresh weight		Dry weight		Fresh weight		Dry weight	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Basil cultivars									
Local cultivar		108.1	140.6	21.7	30.2	114.9	170.7	25.6	36.6
Nano Compatt		120.6	150.3	24.2	31.3	126.8	187.6	27.9	38.7
Red Bordaux		66.2 1.48	48.3 8.2	18.8	13.6	106.2	61.6	17.8	13.3
$LSD_{0.05}$				0.31	1.07	3.0	4.4	0.60	0.60
Salinity levels									
Control		133.4	152.4	28.9	33.6	151.4	205.2	33.0	42.4
1000		142.8	148.2	31.6	31.9	156.3	183.0	34.1	39.4
2000		88.3	104.5	19.1	23.6	87.6	119.5	20.4	24.2
4000		28.8 1.61	47.2 8.2	06.6	10.8	29.4	52.1	07.5	12.1
$LSD_{0.05}$				0.68	0.70	1.6	4.4	0.46	0.68
Beneficial microorganisms									
control		77.9	93.8	17.7	20.9	81.6	115.7	18.8	24.8
B. subtilis		95.6	112.3	21.0	25.1	105.3	136.3	23.8	28.6
AMF		106.3	116.8	23.1	26.4	112.7	149.6	25.4	31.4
B.+ AMF		113.4	129.5 7.4	24.4	27.5	125.1	158.1	27.0	33.3
$LSD_{0.05}$		1.56		0.47	0.56	1.1	3.9	0.64	0.47
Basil cultivars X Salinity levels									
Local cultivar	Cont.	142.3	183.4	28.0	37.6	157.4	237.2	33.9	49.1
	1000	151.3	177.9	30.1	37.0	162.9	214.4	35.1	48.4
	2000	106.8	135.9	21.7	30.7	103.5	156.6	24.0	31.4
	4000	32.1	65.3	06.9	15.7	35.9	74.5	09.3	17.3
Nano Compatt	Cont.	153.5	192.9	29.7	39.0	170.7	265.1	36.6	52.5
	1000	166.6	184.0	32.4	37.6	176.4	236.8	37.7	51.0
	2000	117.3	148.2	24.8	31.3	120.3	166.7	27.5	32.5
	4000	45.1	76.3	09.8	16.8	39.9	81.7	09.8	18.9
Red Bordaux	Cont.	104.5	89.7	28.9	24.2	126.2	113.3	28.6	25.5
	1000	110.4	73.9	32.3	21.2	129.5	97.7	29.6	18.9
	2000	40.7	29.6	10.9	08.9	39.1	35.1	09.6	08.8
	4000	09.2	00.0	03.2	00.0	12.4	00.0	03.3	00.0
$LSD_{0.05}$		2.78	14.2	1.18	1.21	2.8	7.6	0.79	1.18
Basil cultivars X Beneficial microorganisms									
Local cultivar	Cont.	85.7	115.0	17.7	25.6	89.3	135.2	20.0	29.7
	B.sub.	104.1	135.8	20.8	30.3	112.0	166.4	25.6	35.2
	AMF	116.0	151.5	23.2	32.0	120.0	182.6	27.6	39.7
	B.+ AMF	126.8	160.5	24.9	33.1	138.4	198.5	29.1	41.7
Nano Compatt	Cont.	97.3	130.9	20.1	26.9	101.4	163.2	23.0	33.5
	B.sub.	118.2	152.6	23.8	31.1	125.1	182.4	27.6	37.6
	AMF	130.8	145.7	25.9	32.5	133.8	199.8	29.4	40.4
	B.+ AMF	136.2	172.2	27.0	34.2	146.9	204.9	31.5	43.5
Red Bordaux	Cont.	50.7	35.4	15.2	20.9	54.1	48.7	13.3	11.2
	B.sub.	64.5	48.6	18.6	25.1	78.8	60.2	18.2	13.0
	AMF	72.2	53.1	20.3	26.4	84.3	66.4	19.3	14.2
	B.+ AMF	77.4	56.2	21.3	27.5	90.0	71.0	20.3	14.9
$LSD_{0.05}$		2.70	12.8	N.S	0.97	1.8	6.8	N.S	0.82

Continuous Table (3)

Treat. \ Charact.			First season				Second season			
			Fresh weight		Dry weight		Fresh weight		Dry weight	
			1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Salinity levels X Beneficial microorganisms										
Cont.	Cont.		107.6	134.7	24.2	29.4	123.5	175.7	26.8	37.7
	B.sub.		127.3	153.3	27.7	33.6	148.3	197.3	32.6	41.3
	AMF		146.1	143.8	31.1	34.5	159.2	217.7	35.1	44.2
	B.+ AMF		152.7	177.6	32.6	36.8	174.7	230.0	37.6	46.3
1000	Cont.		120.4	124.9	27.4	27.6	124.8	159.7	27.3	33.2
	B.sub.		139.0	147.0	30.7	31.9	154.8	185.3	34.3	38.4
	AMF		151.3	157.4	33.5	33.7	165.0	194.7	36.5	42.1
	B.+ AM		160.4	163.6	34.7	34.4	180.3	192.4	38.5	44.0
2000	Cont.		62.8	84.7	14.3	19.2	54.8	94.0	15.4	20.0
	B.sub.		87.9	104.7	19.2	24.5	89.3	115.4	20.9	23.7
	AMF		96.1	111.5	20.7	25.3	94.7	125.4	21.9	25.5
	B.+ AM		106.2	117.3	22.3	25.5	111.7	143.0	23.3	27.7
4000	Cont.		20.8	30.8	04.8	07.3	23.2	33.4	05.7	08.2
	B.sub.		28.1	44.3	06.5	10.5	28.7	47.3	07.4	11.0
	AMF		31.8	54.3	07.3	12.2	32.0	60.6	08.2	13.9
	B.+ AM		34.4	59.5	07.9	13.3	33.7	67.1	08.6	15.3
$LSD_{0.05}$			3.11	N.S	0.93	N.S	2.1	7.8	1.28	0.95
Basil cultivars X Salinity levels X Beneficial microorganisms										
Local cultivar	Cont.	Cont.	118.4	158.5	24.2	34.0	132.0	200.7	26.7	43.5
		B.sub.	134.6	155.6	26.1	37.4	148.0	227.5	32.8	47.8
		AMF	150.0	173.0	29.5	38.2	164.0	250.0	36.8	51.0
		B.+AMF	166.0	184.6	32.3	40.7	185.5	270.5	39.4	54.1
	1000	Cont.	127.6	155.6	25.8	34.0	136.5	183.8	38.1	41.1
		B.sub.	145.1	173.0	29.0	36.8	156.0	216.3	34.9	46.4
		AMF	158.0	184.6	31.6	38.0	170.0	223.8	37.6	52.3
		B.+AMF	174.6	198.3	33.9	39.2	189.0	233.8	39.8	53.9
	2000	Cont.	75.1	108.2	16.1	23.9	59.0	118.3	18.1	25.4
		B.sub.	106.4	135.2	21.5	31.7	108.0	155.0	25.2	31.0
		AMF	120.0	147.2	24.1	33.5	109.0	165.0	26.1	33.7
		B.+AMF	125.8	153.0	25.0	33.6	138.0	188.0	26.5	35.4
	4000	Cont.	21.6	37.8	4.8	10.5	36.0	38.0	7.1	8.9
		B.sub.	30.1	61.0	6.5	15.1	36.0	66.7	9.3	15.5
		AMF	35.9	79.3	7.7	18.3	37.0	91.7	10.1	21.7
		B.+AMF	40.6	83.2	8.6	19.0	41.0	101.5	10.8	23.2
Nano Compatt	Cont.	Cont.	126.8	176.1	25.6	34.7	145.0	239.0	31.8	47.1
		B.sub.	143.9	198.6	27.4	38.5	165.0	252.5	35.4	50.9
		AMF	169.8	141.6	32.3	39.9	175.2	279.8	37.6	54.7
		B.+AMF	173.4	219.8	33.6	42.7	197.5	289.0	41.4	57.4
	1000	Cont.	144.5	167.3	29.2	33.7	152.5	214.2	31.7	43.0
		B.sub.	161.5	192.0	31.1	37.2	168.0	243.0	36.9	50.7
		AMF	177.3	204.0	34.0	39.4	180.0	255.2	39.4	53.4
		B.+AMF	183.2	208.3	35.2	40.1	205.0	235.0	42.8	56.8
	2000	Cont.	84.6	125.6	18.5	27.5	77.0	137.5	20.9	28.2
		B.sub.	121.8	148.0	26.4	32.3	129.0	159.2	28.5	31.2
		AMF	127.2	153.7	26.9	32.5	135.0	174.2	29.7	33.5
		B.+AMF	135.5	165.3	27.3	33.0	140.0	196.0	30.9	37.0
	4000	Cont.	33.2	54.6	7.0	11.5	31.0	62.0	7.8	15.7
		B.sub.	45.5	71.8	10.1	16.3	38.5	75.0	9.6	17.4
		AMF	49.0	83.6	10.5	18.2	45.0	90.0	10.8	20.0
		B.+AMF	52.6	95.2	11.7	21.0	45.0	99.8	11.0	22.0
Red Bordaux	Cont.	Cont.	77.5	69.5	22.7	19.5	93.5	87.5	21.9	22.5
		B.sub.	103.5	87.2	29.6	24.9	132.0	112.0	29.6	25.2
		AMF	118.5	95.1	31.5	25.4	138.3	123.3	30.0	26.8
		B.+AMF	118.6	106.9	32.0	27.0	141.0	130.5	30.9	27.4
	1000	Cont.	89.1	51.8	27.2	15.2	85.5	81.0	22.1	15.6
		B.sub.	110.3	76.0	32.0	21.7	140.5	96.5	30.0	18.0
		AMF	118.7	83.7	34.8	23.8	145.0	105.0	32.5	20.5
		B.+AMF	123.4	84.1	35.1	24.0	147.0	108.4	32.8	21.4
	2000	Cont.	28.6	20.2	8.4	6.2	28.5	26.3	7.1	6.5
		B.sub.	35.6	31.0	9.7	9.4	31.0	32.1	8.9	8.8
		AMF	41.1	33.5	11.0	9.8	40.0	37.0	10.0	9.4
		B.+AMF	57.4	33.6	14.5	10.0	57.0	45.0	12.4	10.6
	4000	Cont.	7.5	00.0	2.5	00.0	09.0	00.0	2.2	00.0
		B.sub.	8.7	00.0	3.0	00.0	11.5	00.0	3.3	00.0
		AMF	10.5	00.0	3.8	00.0	14.0	00.0	3.7	00.0
		B.+AMF	10.0	00.0	3.5	00.0	15.0	00.0	3.9	00.0
$LSD_{0.05}$			5.39	N.S	1.62	N.S	3.7	13.5	2.22	1.64

Table (4): Effect of inoculation with *Bacillus subtilis* and arbuscular mycorrhizal fungi (AMF) on oil percentage and oil yield in fresh herb of the three sweet basil cultivars under salt stress condition during 2007 and 2008 seasons.

Charact. / Treat.		First season				Second season			
		Oil percentage		Oil yield		Oil percentage		Oil yield	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Basil cultivars									
Local cultivar		0.19	0.22	0.214	0.317	0.21	0.30	0.242	0.517
Nano Compatt		0.13	0.14	0.170	0.225	0.12	0.14	0.156	0.269
Red Bordaux		0.12	0.11	0.079	0.070	0.12	0.12	0.087	0.099
$LSD_{0.05}$		0.009	0.015	0.005	0.004	0.005	0.010	0.002	0.005
Salinity levels									
Cont.		0.14	0.17	0.191	0.274	0.13	0.19	0.206	0.405
1000		0.15	0.18	0.220	0.270	0.15	0.20	0.234	0.392
2000		0.16	0.18	0.153	0.201	0.17	0.21	0.158	0.275
4000		0.12	0.10	0.036	0.071	0.16	0.14	0.047	0.108
$LSD_{0.05}$		0.003	0.004	0.002	0.001	0.002	0.004	0.002	0.002
Beneficial microorganisms									
control		0.12	0.13	0.100	0.138	0.13	0.16	0.106	0.213
B. subtilis		0.14	0.15	0.141	0.195	0.15	0.18	0.153	0.274
AMF		0.15	0.17	0.169	0.230	0.15	0.19	0.171	0.319
B.+ AMF		0.16	0.17	0.190	0.253	0.17	0.21	0.216	0.374
$LSD_{0.05}$		0.003	0.004	0.002	0.002	0.004	0.004	0.001	0.002
Basil cultivars X Salinity levels									
Local cultivar	Cont.	0.19	0.22	0.267	0.409	0.19	0.29	0.300	0.692
	1000	0.20	0.23	0.307	0.405	0.20	0.30	0.335	0.651
	2000	0.22	0.25	0.235	0.333	0.23	0.32	0.250	0.507
	4000	0.15	0.18	0.047	0.120	0.23	0.28	0.082	0.218
Nano Compatt	Cont.	0.12	0.15	0.185	0.291	0.11	0.13	0.193	0.364
	1000	0.13	0.15	0.218	0.286	0.12	0.15	0.213	0.347
	2000	0.15	0.16	0.172	0.231	0.14	0.15	0.170	0.258
	4000	0.11	0.12	0.051	0.092	0.12	0.13	0.048	0.106
Red Bordaux	Cont.	0.11	0.14	0.119	0.125	0.10	0.15	0.124	0.167
	1000	0.12	0.15	0.136	0.114	0.12	0.16	0.155	0.161
	2000	0.13	0.13	0.052	0.039	0.14	0.16	0.056	0.059
	4000	0.10	0.00	0.009	0.000	0.12	0.00	0.013	0.000
$LSD_{0.05}$		0.005	0.007	0.004	0.003	0.004	0.007	0.004	0.003
Basil cultivars X Beneficial microorganisms									
Local cultivar	Cont.	0.16	0.17	0.136	0.201	0.18	0.27	0.155	0.372
	B.sub.	0.18	0.22	0.197	0.307	0.20	0.30	0.220	0.490
	AMF	0.20	0.23	0.241	0.361	0.21	0.31	0.246	0.566
	B.+ AMF	0.21	0.24	0.282	0.399	0.25	0.32	0.345	0.640
Nano Compatt	Cont.	0.11	0.13	0.110	0.170	0.11	0.12	0.111	0.303
	B.sub.	0.13	0.14	0.151	0.214	0.12	0.13	0.153	0.243
	AMF	0.13	0.15	0.176	0.247	0.13	0.14	0.167	0.281
	B.+ AMF	0.14	0.15	0.190	0.270	0.13	0.16	0.193	0.348
Red Bordaux	Cont.	0.10	0.10	0.053	0.043	0.11	0.10	0.052	0.065
	B.sub.	0.11	0.10	0.074	0.065	0.12	0.11	0.086	0.089
	AMF	0.12	0.12	0.092	0.081	0.13	0.13	0.100	0.110
	B.+ AMF	0.13	0.12	0.097	0.090	0.13	0.14	0.110	0.133
$LSD_{0.05}$		0.005	0.007	0.003	0.003	0.007	0.007	0.003	0.003

Continuous Table (4):

Treat. / Charact.			First season				Second season			
			Oil percentage		Oil yield		Oil percentage		Oil yield	
			1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Salinity levels X Beneficial microorganisms										
Cont.	Cont.		0.12	0.14	0.132	0.188	0.12	0.17	0.147	0.314
	B.sub.		0.14	0.16	0.176	0.258	0.13	0.18	0.193	0.366
	AMF		0.15	0.18	0.215	0.305	0.13	0.20	0.215	0.437
	B.+ AMF		0.15	0.19	0.239	0.343	0.15	0.21	0.268	0.503
1000	Cont.		0.13	0.15	0.154	0.188	0.13	0.18	0.162	0.302
	B.sub.		0.15	0.17	0.210	0.258	0.14	0.20	0.218	0.378
	AMF		0.16	0.19	0.245	0.301	0.15	0.21	0.247	0.419
	B.+ AMF		0.17	0.19	0.273	0.333	0.17	0.23	0.310	0.470
2000	Cont.		0.14	0.16	0.092	0.138	0.15	0.18	0.085	0.185
	B.sub.		0.15	0.18	0.142	0.200	0.17	0.21	0.154	0.257
	AMF		0.17	0.19	0.175	0.225	0.17	0.22	0.171	0.290
	B.+ AMF		0.18	0.20	0.202	0.242	0.19	0.24	0.223	0.367
4000	Cont.		0.11	0.08	0.023	0.038	0.14	0.11	0.030	0.052
	B.sub.		0.12	0.10	0.034	0.066	0.15	0.14	0.046	0.095
	AMF		0.12	0.11	0.043	0.087	0.16	0.14	0.051	0.131
	B.+ AMF		0.13	0.11	0.045	0.094	0.17	0.15	0.062	0.155
$LSD_{0.05}$			0.006	0.008	0.004	0.003	N.S	0.008	0.003	0.003
Basil cultivars X Salinity levels X Beneficial microorganisms										
Local cultivar	Cont.	Cont.	0.15	0.16	0.178	0.254	0.16	0.27	0.211	0.542
		B.sub.	0.18	0.22	0.242	0.383	0.18	0.28	0.266	0.637
		AMF	0.20	0.24	0.300	0.468	0.18	0.30	0.295	0.750
		B.+AMF	0.21	0.25	0.249	0.516	0.23	0.31	0.427	0.843
	1000	Cont.	0.16	0.18	0.204	0.280	0.17	0.28	0.230	0.515
		B.sub.	0.20	0.23	0.290	0.398	0.19	0.30	0.296	0.649
		AMF	0.21	0.24	0.332	0.443	0.20	0.31	0.340	0.694
		B.+AMF	0.23	0.26	0.402	0.516	0.25	0.32	0.473	0.748
	2000	Cont.	0.18	0.22	0.135	0.215	0.20	0.29	0.118	0.839
		B.sub.	0.20	0.25	0.213	0.338	0.22	0.31	0.238	0.481
		AMF	0.23	0.26	0.276	0.383	0.24	0.33	0.269	0.545
		B.+AMF	0.25	0.26	0.315	0.398	0.27	0.35	0.273	0.658
	4000	Cont.	0.13	0.14	0.028	0.053	0.20	0.23	0.059	0.087
		B.sub.	0.14	0.18	0.042	0.110	0.22	0.29	0.079	0.193
		AMF	0.16	0.19	0.057	0.151	0.22	0.30	0.081	0.275
		B.+AMF	0.15	0.20	0.061	0.166	0.26	0.31	0.107	0.315
Nano Compatt	Cont.	Cont.	0.11	0.13	0.139	0.229	0.10	0.12	0.145	0.287
		B.sub.	0.12	0.14	0.173	0.278	0.11	0.12	0.182	0.303
		AMF	0.12	0.15	0.204	0.305	0.12	0.13	0.210	0.364
		B.+AMF	0.13	0.16	0.225	0.352	0.12	0.15	0.237	0.434
	1000	Cont.	0.11	0.13	0.159	0.217	0.11	0.13	0.168	0.278
		B.sub.	0.13	0.14	0.209	0.269	0.12	0.14	0.202	0.340
		AMF	0.14	0.16	0.248	0.326	0.12	0.15	0.216	0.383
		B.+AMF	0.14	0.16	0.256	0.333	0.13	0.17	0.267	0.456
	2000	Cont.	0.13	0.14	0.110	0.176	0.13	0.13	0.100	0.179
		B.sub.	0.14	0.15	0.171	0.222	0.14	0.15	0.181	0.239
		AMF	0.15	0.16	0.191	0.246	0.14	0.15	0.189	0.261
		B.+AMF	0.16	0.17	0.217	0.281	0.15	0.18	0.210	0.353
	4000	Cont.	0.10	0.10	0.033	0.060	0.10	0.11	0.031	0.068
		B.sub.	0.11	0.12	0.050	0.086	0.12	0.12	0.046	0.090
		AMF	0.12	0.13	0.059	0.109	0.12	0.13	0.054	0.117
		B.+AMF	0.12	0.12	0.063	0.114	0.13	0.15	0.059	0.150
Red Bordaux	Cont.	Cont.	0.10	0.12	0.078	0.082	0.09	0.13	0.084	0.114
		B.sub.	0.11	0.13	0.114	0.113	0.10	0.14	0.132	0.157
		AMF	0.12	0.15	0.142	0.143	0.10	0.16	0.139	0.197
		B.+AMF	0.12	0.15	0.142	0.160	0.10	0.18	0.141	0.235
	1000	Cont.	0.11	0.13	0.098	0.067	0.10	0.14	0.086	0.113
		B.sub.	0.12	0.14	0.132	0.106	0.11	0.15	0.155	0.145
		AMF	0.13	0.16	0.154	0.134	0.13	0.17	0.186	0.179
		B.+AMF	0.13	0.18	0.160	0.151	0.13	0.19	0.191	0.206
	2000	Cont.	0.11	0.12	0.031	0.024	0.13	0.12	0.037	0.032
		B.sub.	0.12	0.13	0.043	0.040	0.14	0.16	0.043	0.051
		B.+AMF	0.14	0.14	0.058	0.047	0.14	0.17	.056	0.063
			0.13	0.14	0.075	0.047	0.15	0.20	0.086	0.090
	4000	Cont.	0.09	0.00	0.007	0.00	0.11	0.00	0.001	0.00
		B.sub.	0.10	0.00	0.009	0.00	0.12	0.00	0.014	0.00
		AMF	0.11	0.00	0.012	0.00	0.13	0.00	0.018	0.00
		B.+AMF	0.10	0.00	0.010	0.00	0.13	0.00	0.020	0.00
$LSD_{0.05}$			0.011	0.014	0.007	0.006	N.S	0.013	0.005	0.006

Regarding the interaction between the three chosen basil cultivars and different microorganisms inoculation in both cuts and in the two growing seasons the data showed that the highest significant means in both oil % and oil yield obtained in Local cultivar as response to inoculation with *B. subtilis* + AMF compared with the other treatments, followed by single inoculation with AMF in the same cultivar.

Oil % revealed mostly significant increase under the combined effect of *B. subtilis* + AMF treatment and 2000 ppm in the both cuts and in both seasons compared with the other treatments. For the oil yield the data showed that *B. subtilis* + AMF inoculation revealed the highest significant means in both seasons and both cuts combined with 1000 ppm in the first cut and with control plants (without salinity) in the second cut compared with the other treatments.

The tri-interaction between the three studied factors showed that inoculated Local cultivar with *B. subtilis* + AMF under 2000 ppm salinity level revealed mostly the highest significant means of oil % in both cuts and seasons. Furthermore, inoculated Local cultivar with *B. subtilis* + AMF under 1000 ppm showed the highest significant records for oil yield in the first cut of both seasons, and *B. subtilis* + AMF combined with control plants (without salinity) of Local cultivar in the second cut of both growing

3.4. Minerals content:

The obtained results pointed out in both growing seasons that there was a significant difference observed between the three tested basil cultivars in the mean values of their leaf mineral content where the highest values for N, P and K % were observed in Nano Compatt cultivar in the two cuts, followed by Local cultivar, while the lowest means obtained in Red Bordaux cultivar (Tables 5&6). For Na % the data revealed that the highest Na % obtained in Red Bordaux cultivar, while the lowest values obtained in Nano Compatt cultivar in both cuts for both growing seasons (Table 6).

Leaf N, P and K % revealed an increase in their contents in the first cut of both growing seasons with increasing salinity concentration up to 1000 ppm followed by significant decrease with further increase in salinity levels compared with control plants. The data of the second cut showed that increasing salinity badly affected minerals content compared with control plants during the two growing seasons (Tables 5 & 6). Na^+ content showed in the first cut of both growing seasons significant increase with increasing salinity level compared with control plants, similar trend was obtained in the second cut but with decrease in Na% under the highest salinity level (4000 ppm), this result were true for both seasons (Table 6). All biological inoculations increased N, P and K % significantly compared to control treatment in absence of salinity and cultivars in both cuts and both seasons. Minerals content showed that the highest significant increases in their content obtained as a response to *B. subtilis* + AMF treatment compared with control plants, followed by single inoculation with AMF in both P and K % and followed by *B. subtilis* in case of N %, similar results obtained in the second cut and second season (Tables 5 & 6). While, reversed trend obtained in Na % where different inoculations with microorganisms revealed gradual significant decrease in Na % compared with control plants in both cuts of both seasons, the lowest significant means obtained in *B. subtilis* + AMF treatment followed by AMF treatment (Table 6).

Nano Compatt cultivar grown under 1000 ppm showed the highest values in N, P and K % compared with the other treatments of both cuts and both seasons. Salt stress increased the concentration of Na+ in leaves of the three basil cultivars where the highest values for Na % obtained under the highest salinity levels 2000 & 4000 ppm in the three basil cultivars, also it was clear from the results that Red Bordaux cultivar was more sensitive to salinity than the other two basil cultivars.

Nano Compatt cultivar inoculated with *B. subtilis* + AMF treatment revealed generally the highest values of N, P and K % in both cuts and during the two growing seasons. Different inoculations revealed decrease in Na % in both seasons and both cuts, where the lowest means obtained as a response to *B. subtilis* + AMF treatment for the three basil cultivars.

Different microorganisms inoculation showed marked increase in N, P and K concentrations under different salinity levels compared with control plants, where the highest concentrations of N, P and K in the first cut found under 1000 ppm combined with *B. subtilis* + AMF inoculation in both growing seasons. While, in the second cut the highest concentrations obtained in control treatment (without salinity) as a response to *B. subtilis* + AMF inoculation. For Na % the present data revealed that different microorganisms inoculation caused decrease in Na concentration under different salinity levels compared with control plants, where the highest Na concentration of the first cut found in uninoculated treatment under 4000 ppm and in uninoculated treatment under 2000 ppm in the second cut, these results were true for both growing seasons.

The interactions between the three studied factors indicated in the first cut of the two growing seasons that the highest records of N, P and K % obtained in Nano Compatt cultivar grown under 1000 ppm as a response to *B. subtilis* + AMF inoculation. While, the data of the second cut showed that the highest records obtained in control plants (without salinity) of Nano Compatt cultivar as a response to *B. subtilis* + AMF inoculation in both seasons. Furthermore, the means of Na % showed that Red Bordaux cultivar was highly sensitive for the high concentrations of Na content (4000 ppm) than the other two cultivars even with different inoculations with microorganisms.

Table (5): Effect of inoculation with *Bacillus subtilis* and arbuscular mycorrhizal fungi (AMF) on Nitrogen and Phosphorus % in dry leaves of the three sweet basil cultivars under salt stress condition during 2007 and 2008 seasons.

Treat. \ Charact.		First season				Second season			
		N %		P %		N %		P %	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Basil cultivars									
Local cultivar		1.93	1.96	0.206	0.200	2.09	2.17	0.211	0.219
Nano Compatt		1.97	1.99	0.211	0.213	2.11	2.20	0.217	0.226
Red Bordaux		1.85	1.45	0.194	0.147	2.07	1.65	0.207	0.160
$LSD_{0.05}$		0.05	0.03	0.004	0.008	0.02	0.04	0.001	0.001
Salinity levels									
Cont.		1.96	2.01	0.212	0.216	2.23	2.32	0.223	0.237
1000		2.00	2.01	0.226	0.215	2.27	2.29	0.231	0.234
2000		1.89	1.92	0.196	0.193	1.99	2.13	0.205	0.208
4000		1.83	1.26	0.180	0.121	1.86	1.30	0.187	0.128
$LSD_{0.05}$		0.03	0.03	0.003	0.005	0.02	0.02	0.002	0.002
Beneficial microorganisms									
control		1.80	1.69	0.187	0.170	1.91	1.83	0.192	0.183
B. subtilis		1.96	1.84	0.200	0.183	2.16	2.07	0.207	0.212
AMF		1.92	1.80	0.211	0.195	2.11	2.03	0.224	0.237
B.+ AMF		1.99	1.86	0.216	0.197	2.17	2.11	0.224	0.237
$LSD_{0.05}$		0.02	0.02	0.002	0.002	0.01	0.02	0.002	0.002
Basil cultivars X Salinity levels									
Local cultivar	Cont.	1.97	2.02	0.211	0.217	2.23	2.32	0.222	0.237
	1000	2.01	2.03	0.229	0.217	2.25	2.26	0.230	0.237
	2000	1.88	1.90	0.198	0.190	2.01	2.18	0.206	0.212
	4000	1.85	1.88	0.184	0.174	1.88	1.94	0.185	0.190
Nano Compatt	Cont.	2.02	2.05	0.222	0.228	2.24	2.33	0.231	0.242
	1000	2.06	2.06	0.232	0.229	2.31	2.33	0.238	0.247
	2000	1.95	1.96	0.204	0.207	1.99	2.19	0.209	0.219
	4000	1.87	1.89	0.186	0.188	1.88	1.96	0.190	0.193
Red Bordaux	Cont.	1.89	1.97	0.203	0.204	2.23	2.30	0.217	0.227
	1000	1.91	1.94	0.217	0.200	2.24	2.27	0.225	0.221
	2000	1.82	1.89	0.186	0.181	1.98	2.04	0.200	0.192
	4000	1.76	0.00	0.170	0.000	1.82	0.00	0.187	0.000
$LSD_{0.05}$		N.S	N.S	N.S	0.008	0.03	0.03	0.004	0.004
Basil cultivars X Beneficial microorganisms									
Local cultivar	Cont.	1.83	1.87	0.187	0.181	1.91	1.98	0.190	0.198
	B.sub.	1.95	2.00	0.203	0.193	2.18	2.25	0.204	0.212
	AMF	1.94	1.96	0.215	0.209	2.12	2.19	0.226	0.234
	B.+ AMF	1.98	2.01	0.217	0.215	2.16	2.28	0.222	0.232
Nano Compatt	Cont.	1.86	1.88	0.196	0.197	1.97	2.03	0.197	0.204
	B.sub.	2.02	2.04	0.207	0.212	2.17	2.25	0.215	0.222
	AMF	1.97	1.98	0.217	0.220	2.12	2.22	0.227	0.238
	B.+ AMF	2.05	2.07	0.225	0.224	2.17	2.32	0.229	0.238
Red Bordaux	Cont.	1.71	1.33	0.179	0.133	1.86	1.48	0.189	0.148
	B.sub.	1.90	1.50	0.190	0.143	2.15	1.71	0.202	0.159
	AMF	1.85	1.47	0.203	0.153	2.11	1.68	0.219	0.168
	B.+ AMF	1.93	1.52	0.204	0.156	2.15	1.74	0.219	0.166
$LSD_{0.05}$		N.S	N.S	0.003	0.004	0.02	N.S	0.003	0.003

Continuous Table (5):

Treat.		Charact.	First season				Second season			
			N %		P %		N %		P %	
			1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Salinity levels X Beneficial microorganisms										
Cont.	Cont.		1.76	1.86	0.197	0.202	1.93	2.10	0.204	0.216
	B.sub.		2.04	2.06	0.206	0.211	2.33	2.38	0.216	0.236
	AMF		1.98	2.02	0.218	0.223	2.32	2.33	0.234	0.246
	B.+ AMF		2.05	2.11	0.227	0.229	2.35	2.45	0.239	0.250
1000	Cont.		1.85	1.86	0.204	0.196	2.03	2.05	0.210	0.214
	B.sub.		2.04	2.06	0.221	0.211	2.35	2.37	0.227	0.227
	AMF		2.00	2.02	0.234	0.227	2.31	2.33	0.242	0.243
	B.+ AMF		2.09	2.09	0.246	0.227	2.37	2.40	0.245	0.249
2000	Cont.		1.82	1.83	0.183	0.173	1.90	1.93	0.183	0.183
	B.sub.		1.91	1.96	0.195	0.191	2.08	2.19	0.199	0.204
	AMF		1.86	1.91	0.205	0.205	1.97	2.15	0.220	0.224
	B.+ AMF		1.95	1.96	0.202	0.202	2.02	2.60	0.218	0.221
4000	Cont.		1.76	1.22	0.166	0.111	1.78	1.23	0.172	0.120
	B.sub.		1.86	1.28	0.179	0.118	1.91	1.34	0.185	0.125
	AMF		1.82	1.25	0.188	0.127	1.85	1.30	0.197	0.134
	B.+ AMF		1.86	1.29	0.188	0.129	1.90	1.34	0.195	0.134
$LSD_{0.05}$			N.S	N.S	0.004	0.004	0.03	0.03	0.003	0.004
Basil cultivars X Salinity levels X Beneficial microorganisms										
Local cultivar	Cont.	Cont.	1.77	1.89	0.197	0.207	1.92	2.16	0.204	0.216
		B.sub.	2.04	2.06	0.204	0.214	2.32	2.36	0.211	0.234
		AMF	2.00	2.02	0.217	0.221	2.32	2.32	0.238	0.248
		B.+AMF	2.06	2.11	0.227	0.227	2.34	2.44	0.234	0.248
	1000	Cont.	1.89	1.90	0.204	0.200	1.98	1.98	0.207	0.217
		B.sub.	2.06	2.08	0.227	0.207	2.34	2.36	0.227	0.227
		AMF	2.02	2.04	0.238	0.227	2.32	2.30	0.248	0.256
		B.+AMF	2.08	2.09	0.248	0.234	2.36	2.40	0.238	0.248
	2000	Cont.	1.84	1.86	0.183	0.166	1.90	1.94	0.180	0.183
		B.sub.	1.90	1.94	0.197	0.186	2.16	2.26	0.197	0.204
		AMF	1.87	1.89	0.208	0.200	1.96	2.20 2.30	0.221	0.234
		B.+AMF	1.92	1.90	0.204	0.207	2.02		0.227	0.227
	4000	Cont.	1.80	1.82	0.165	0.152	1.82	1.82	0.170	0.176
		B.sub.	1.87	1.90	0.183	0.166	1.90	2.00	0.183	0.183
		AMF	1.85	1.87	0.197	0.186	1.87	1.94	0.197	0.197
		B.+AMF	1.87	1.92	0.190	0.193	1.92	1.98	0.190	0.204
Nano Compatt	Cont.	Cont.	1.80	1.89	0.207	0.214	1.96	2.13	0.211	0.226
		B.sub.	2.11	2.11	0.217	0.227	2.34	2.38	0.227	0.248
		AMF	2.04	2.05	0.227	0.234	2.31	2.34	0.238	0.255
		B.+AMF	2.11	2.17	0.238	0.248	2.36	2.48	0.248	0.261
	1000	Cont.	1.92	1.92	0.211	0.207	2.18	2.19	0.216	0.217
		B.sub.	2.11	2.09	0.224	0.227	2.36	2.36	0.238	0.237
		AMF	2.06	2.07	0.238	0.238	2.30	2.34	0.248	0.261
		B.+AMF	2.16	2.16	0.255	0.234	2.38	2.44	0.251	0.254
	2000	Cont.	1.89	1.89	0.190	0.186	1.92	1.96	0.186	0.190
		B.sub.	1.96	2.00	0.204	0.207	2.02	2.24	0.204	0.214
		AMF	1.92	1.94	0.211	0.221	2.00	2.24	0.225	0.234
		B.+AMF	2.04	2.01	0.211	0.214	2.02	2.32	0.221	0.238
	4000	Cont.	1.82	1.82	0.176	0.180	1.80	1.87	0.176	0.183
		B.sub.	1.90	1.94	0.183	0.186	1.96	2.02	0.190	0.190
		AMF	1.84	1.87	0.190	0.193	1.87	1.94	0.197	0.204
		B.+AMF	1.90	1.94	0.197	0.193	1.90	2.02	0.197	0.197
Red Bordaux	Cont.	Cont.	1.72	1.80	0.186	0.186	1.90	2.02	0.197	0.207
		B.sub.	1.96	2.02	0.197	0.193	2.34	2.40	0.211	0.227
		AMF	1.89	1.99	0.211	0.213	2.32	2.34	0.227	0.234
		B.+AMF	1.99	2.07	0.217	0.222	2.34	2.42	0.234	0.238
	1000	Cont.	1.75	1.77	0.197	0.180	1.94	1.99	0.207	0.207
		B.sub.	1.94	2.01	0.211	0.200	2.34	2.38	0.217	0.217
		AMF	1.91	1.96	0.227	0.207	2.32	2.34	0.238	0.234
		B.+AMF	2.04	2.02	0.234	0.214	2.36	2.36	0.238	0.227
	2000	Cont.	1.72	1.73	0.176	0.166	1.87	1.90	0.183	0.176
		B.sub.	1.87	1.95	0.183	0.180	2.06	2.06	0.197	0.193
		AMF	1.80	1.91	0.197	0.193	1.96	2.02	0.214	0.204
		B.+AMF	1.89	1.97	0.190	0.186	2.02	2.16	0.207	0.197
	4000	Cont.	1.65	0.00	0.156	0.00	1.72	0.00	0.170	0.00
		B.sub.	1.82	0.00	0.170	0.00	1.87	0.00	0.183	0.00
		AMF	1.78	0.00	0.176	0.00	1.82	0.00	0.197	0.00
		B.+AMF	1.80	0.00	0.176	0.00	1.87	0.00	0.197	0.00
$LSD_{0.05}$			N.S	N.S	N.S	0.007	0.05	0.06	0.006	0.006

Table (6): Effect of inoculation with *Bacillus subtilis* and arbuscular mycorrhizal fungi (AMF) on potassium and sodium % in dry leaves of the three sweet basil cultivars under salt stress condition during 2007 and 2008 seasons.

Charact. / Treat.		First season				Second season			
		K %		Na %		K %		Na %	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Basil varieties									
Local cultivar		1.14	1.27	1.03	1.01	1.20	1.32	1.04	1.03
Nano Compatt		1.15	1.27	1.00	0.75	1.21	1.32	1.03	0.75
Red Bordaux		1.02	0.90	1.04	1.05	1.09	1.20	1.04	1.04
$LSD_{0.05}$		0.001	0.005	0.004	0.002	0.003	0.003	0.003	0.005
Salinity levels									
Cont.		1.14	1.28	0.96	0.95	1.22	1.36	0.96	0.96
1000		1.14	1.27	0.99	0.99	1.23	1.33	1.00	1.00
2000		1.08	1.23	1.06	1.06	1.16	1.29	1.06	1.07
4000		1.03	0.81	1.09	0.74	1.07	0.84	1.11	0.73
$LSD_{0.05}$		0.001	0.003	0.002	0.004	0.002	0.003	0.004	0.003
Beneficial microorganisms									
control		1.05	1.10	1.07	0.98	1.11	1.13	1.09	0.98
B. subtilis		1.10	1.14	1.03	0.94	1.17	1.19	1.07	0.95
AMF		1.12	1.17	1.00	0.92	1.19	1.24	1.00	0.92
B.+ AMF		1.13	1.17	0.99	0.90	1.21	1.25	1.00	0.91
$LSD_{0.05}$		0.001	0.001	0.002	0.003	0.003	0.003	0.003	0.001
Basil cultivars X Salinity levels									
Local cultivar	Cont.	1.15	1.29	0.95	0.94	1.23	1.40	0.96	0.94
	1000	1.18	1.29	0.99	0.99	1.25	1.35	1.00	1.01
	2000	1.13	1.26	1.06	1.06	1.19	1.30	1.06	1.06
	4000	1.09	1.23	1.10	1.10	1.15	1.23	1.12	1.11
Nano Compatt	Cont.	1.19	1.31	0.93	0.93	1.25	1.35	0.96	0.96
	1000	1.20	1.33	0.97	0.96	1.27	1.37	0.99	0.96
	2000	1.11	1.25	1.04	1.04	1.18	1.30	1.05	1.05
	4000	1.08	1.20	1.08	1.09	1.14	1.28	1.10	1.09
Red Bordaux	Cont.	1.09	1.23	1.00	0.99	1.18	1.31	0.97	0.98
	1000	1.06	1.20	1.00	1.03	1.15	1.28	1.01	1.02
	2000	1.01	1.16	1.07	1.08	1.11	1.27	1.07	1.10
	4000	0.92	0.00	1.10	1.12	0.92	0.00	1.12	0.00
$LSD_{0.05}$		0.002	0.005	0.003	0.007	0.004	0.005	0.006	0.005
Basil cultivars X Beneficial microorganisms									
Local cultivar	Cont.	1.08	1.21	1.07	1.07	1.15	1.24	1.10	1.06
	B.sub.	1.12	1.25	1.04	1.02	1.22	1.31	1.05	1.04
	AMF	1.18	1.31	1.01	0.98	1.22	1.36	1.01	1.00
	B.+ AMF	1.18	1.29	0.99	0.96	1.25	1.36	1.01	1.00
Nano Compatt	Cont.	1.11	1.24	1.05	0.79	1.17	1.24	1.10	0.78
	B.sub.	1.16	1.28	1.01	0.76	1.22	1.32	1.04	0.75
	AMF	1.15	1.29	0.98	0.73	1.22	1.36	0.98	0.74
	B.+ AMF	1.18	1.31	0.98	0.72	1.25	1.37	0.98	0.73
Red Bordaux	Cont.	0.95	1.10	1.10	1.09	1.02	0.92	1.09	1.09
	B.sub.	1.03	1.14	1.05	1.05	1.10	0.94	1.05	1.06
	AMF	1.04	1.17	1.02	1.04	1.12	1.00	1.01	1.03
	B.+ AMF	1.05	1.17	1.00	1.02	1.12	1.00	1.01	0.99
$LSD_{0.05}$		0.002	0.002	0.004	0.005	0.005	0.006	0.006	0.003

Continuous Table (6):

Treat. / Charact.			First season K % 1st cut	First season K % 2nd cut	First season Na % 1st cut	First season Na % 2nd cut	Second season K % 1st cut	Second season K % 2nd cut	Second season Na % 1st cut	Second season Na % 2nd cut
Salinity levels X Beneficial microorganisms										
Cont.	Cont.		1.10	1.25	1.03	1.02	1.17	1.27	1.04	1.01
	B.sub.		1.13	1.27	0.97	0.96	1.21	1.35	0.99	0.98
	AMF		1.16	1.30	0.93	0.92	1.24	1.40	0.93	0.94
	B.+ AMF		1.16	1.32	0.91	0.91	1.26	1.41	0.90	0.91
1000	Cont.		1.10	1.21	1.04	1.04	1.17	1.24	1.08	1.04
	B.sub.		1.14	1.27	1.00	1.00	1.22	1.32	1.02	1.00
	AMF		1.17	1.30	0.96	0.98	1.25	1.36	0.95	0.98
	B.+ AMF		1.17	1.29	0.96	0.96	1.27	1.39	0.97	0.97
2000	Cont.		1.03	1.18	1.10	1.11	1.11	1.22	1.12	1.11
	B.sub.		1.09	1.24	1.07	1.07	1.15	1.27	1.07	1.07
	AMF		1.10	1.24	1.04	1.04	1.18	1.34	1.02	1.05
	B.+ AMF		1.11	1.25	1.02	1.01	1.19	1.33	1.05	1.04
4000	Cont.		0.95	0.78	1.12	0.76	0.99	0.80	1.14	0.76
	B.sub.		1.05	0.80	1.10	0.74	1.09	0.82	1.12	0.74
	AMF		1.06	0.82	1.07	0.73	1.10	0.86	1.10	0.72
	B.+ AMF		1.06	0.83	1.08	0.72	1.11	0.86	1.09	0.71
$LSD_{0.05}$			0.002	0.002	0.005	0.006	0.005	0.006	0.007	0.003
Basil cultivars X Salinity levels X Beneficial microorganisms										
Local cultivar	Cont.	Cont.	1.09	1.24	1.01	1.04	1.18	1.31	1.01	1.04
		B.sub.	1.13	1.27	0.97	1.01	1.20	1.39	0.97	1.01
		AMF	1.20	1.33	0.93	0.97	1.25	1.43	0.95	0.95
		B.+AMF	1.20	1.33	0.91	0.93	1.27	1.47	0.91	0.91
	1000	Cont.	1.11	1.22	1.04	1.06	1.20	1.24	1.10	1.06
		B.sub.	1.15	1.27	1.01	1.01	1.22	1.33	1.01	1.04
		AMF	1.22	1.35	0.95	1.04	1.29	1.43	0.97	1.01
		B.+AMF	1.22	1.33	0.97	1.01	1.31	1.41	0.97	0.97
	2000	Cont.	1.07	1.20	1.10	1.10	1.13	1.22	1.12	1.12
		B.sub.	1.11	1.25	1.08	1.06	1.18	1.31	1.10	1.06
		AMF	1.15	1.29	1.06	1.06	1.20	1.34	1.01	1.04
		B.+AMF	1.17	1.31	1.01	1.04	1.24	1.33	1.06	1.01
	4000	Cont.	1.05	1.18	1.12	1.15	1.09	1.20	1.15	1.15
		B.sub.	1.07	1.22	1.10	1.12	1.15	1.22	1.12	1.12
		AMF	1.13	1.25	1.10	1.10	1.18	1.24	1.12	1.10
		B.+AMF	1.11	1.27	1.08	1.10	1.18	1.25	1.10	1.08
Nano Compatt	Cont.	Cont.	1.15	1.31	0.97	1.01	1.20	1.27	1.04	1.01
		B.sub.	1.20	1.33	0.93	0.95	1.26	1.39	1.01	0.97
		AMF	1.20	1.33	0.91	0.91	1.25	1.41	0.91	0.95
		B.+AMF	1.22	1.35	0.91	0.91	1.29	1.43	0.88	0.91
	1000	Cont.	1.18	1.25	1.01	1.04	1.22	1.25	1.08	1.04
		B.sub.	1.20	1.31	0.97	0.94	1.27	1.37	1.01	1.01
		AMF	1.22	1.35	0.95	0.93	1.29	1.35	0.91	0.97
		B.+AMF	1.22	1.33	0.93	0.91	1.31	1.41	0.97	1.01
	2000	Cont.	1.07	1.22	1.10	1.10	1.13	1.24	1.12	1.08
		B.sub.	1.13	1.27	1.04	1.06	1.18	1.26	1.04	1.06
		AMF	1.11	1.25	1.01	1.01	1.20	1.35	1.02	1.04
		B.+AMF	1.13	1.27	1.01	0.97	1.22	1.35	1.04	1.04
	4000	Cont.	1.03	1.18	1.12	1.12	1.11	1.22	1.15	1.12
		B.sub.	1.11	1.19	1.10	1.10	1.15	1.25	1.10	1.10
		AMF	1.07	1.22	1.04	1.08	1.13	1.33	1.08	1.06
		B.+AMF	1.11	1.22	1.06	1.05	1.18	1.31	1.06	1.06
Red Bordaux	Cont.	Cont.	1.05	1.20	1.10	1.01	1.13	1.24	1.06	0.97
		B.sub.	1.07	1.22	1.01	0.93	1.17	1.27	0.97	0.95
		AMF	1.09	1.24	0.97	0.88	1.20	1.37	0.95	0.93
		B.+AMF	1.13	1.27	0.91	0.91	1.22	1.35	0.91	0.91
	1000	Cont.	1.03	1.16	1.06	1.01	1.11	1.22	1.06	1.01
		B.sub.	1.07	1.22	1.01	1.01	1.15	1.25	1.02	0.95
		AMF	1.07	1.20	0.97	0.97	1.18	1.31	0.97	0.95
		B.+AMF	1.07	1.22	0.97	0.95	1.18	1.35	0.96	0.93
	2000	Cont.	0.96	1.12	1.10	1.12	1.07	1.22	1.10	1.12
		B.sub.	1.03	1.18	1.08	1.10	1.11	1.24	1.08	1.10
		AMF	1.03	1.18	1.06	1.06	1.13	1.33	1.01	1.08
		B.+AMF	1.03	1.18	1.04	1.04	1.20	1.31	1.06	1.08
	4000	Cont.	0.77	0.00	1.12	0.00	0.77	0.00	1.14	0.00
		B.sub.	0.96	0.00	1.10	0.00	0.96	0.00	1.12	0.00
		AMF	0.99	0.00	1.08	0.00	0.99	0.00	1.10	0.00
		B.+AMF	0.96	0.00	1.10	0.00	0.96	0.00	1.10	0.00
$LSD_{0.05}$			0.003	0.004	0.008	0.011	0.009	1.131	0.012	0.005

4. Discussion

It was clearly seen from the results that Nano Compatt cultivar surpassed those of Red Bordaux and Local cultivars in plant height, number of branches, fresh and dry weights, N, P and K % and showed lower Na %. While, Local cultivar surpassed the other two cultivars in oil % and oil yield. Moreover, Red Bordaux cultivar was more sensitive to salinity stress than the other two basil cultivars. These variations in the response of the three cultivars to water deficit was attributed to the genetic ability of the resistant cultivar to undergo certain modifications in their metabolic pathway which causes increase in osmotic potential thus increasing cell turgor and eventually growth (Abdalla and Khoshiban, 2007).

Saline soils and saline irrigations constitute a serious production problem for most crops as saline conditions are known to suppress plant growth. The present study demonstrates that high salinity level (4000 ppm) adversely affected the growth attributes of the three sweet basil cultivars. These results are in agreement with those obtained by Shannon and Grieve (1999); Han and Lee (2005); Al-Karaki (2006); Khalil (2006); Yildirim *et al.* (2006) and Turkmen *et al*. (2008). The observed reduction in growth criteria in basil plants under high salinity levels may be attributed to that salinity reduced cell size and the number of cells per unit area (Storganov; 1962 and Greenway and Munns; 1980), also high salt concentration adversely affects enzymatic processes through some interaction of salt and some organic substances of the cell **(**Oertil, 1966). In addition**,** Waisel (1969) suggested that the decrease in dry matter production of plants under stress conditions was due to reduction in photosynthesis and increased respiration. Ghazi (1976) added that growth depression under salinity conditions might be due to decrease of root growth and shortage of water absorption. Moreover, the increase in external ion concentration may lead also to reduction of both cell development and cell turgor as well as inhibition of enzyme activity and photosynthesis. In addition, the suppressive effect of salinity may be caused by the disturbance in mineral uptake (Khadr *et al.*, 1980), protein synthesis (Tseniv *et al.,* 1983) or photosynthetic and carbohydrates metabolism **(**Patil *et al.*, 1983). Salinity also affects soil ions such as Na and Cl, decreasing water potential and disturbing ion balance concentration; therefore the uptake, transportation and usage of plant nutrients are negatively affected by salinity, for example an increase in soil Na concentration reduces the K uptake of plants (Turkmen *et al.,* 2008). The stimulatory effect of low salinity levels on growth of some plants in this study were recorded by several authors as Maraim (1990) who recorded growth stimulation at intermediate salinity, associated with ions accumulation and increased shoot succulence occurred in *Sporobolus virginicus*. Naidoo *et al.* (1995) recorded stimulatory effect of moderate salinity on growth of some plants; these may be due to improve shoot osmotic status as a result of increasing ions uptake. Similar results were reported by Ashraf and Sharif (1998) whom recorded good growth with slightly increase in shoot dry weight under moderate saline conditions, due to their lower accumulation of Na, Cl and Ca in their leaves.

To alleviate the negative effect of soil salinity on basil physiological responses we co-inoculated the three studied cultivars with two beneficial microorganisms, Arbuscular Mycorrhizal Fungus (AMF) and/or *B. substilis*. Results of the measurement of growth response, oil %, oil yield and minerals uptake are given in Tables 2, 3, 4, 5 & 6 which showed that all previously mentioned characters with or without salinization treatments were significantly increased by all beneficial microorganisms treatments, and these biological treatments ameliorated the deleterious effect of salinity. These results are in greet accordance with those obtained by Glick *et al*. (1997); Mayak *et al.* (2004b); Yildirim and Taylor (2005); Barassi *et al*.(2006); and Wei Liu *et al*.(2010). Mycorrhizal colonization showed generally more pronounced effects than *B. subtilis*, dual inoculation with *B. subtilis* and mycorrhizae provided higher tolerance to salinity compared with the individual treatment and untreated ones, where pots treated with *B. substilis*+ AMF showed greater plant height, number of branches, fresh and dry weight, essential oil % and yield as well as N, P, K % and lower Na % compared to the other treatments under saline conditions. This result was in great accordance with those obtained by Al-Karaki *et al*., 2001; Mayak *et al*., 2004; Saleh *et al*., 2005; Al-Karaki, 2006; and Zuccarini and Okurowska, 2008. These results may be due to mycorrhizal symbiosis is an important factor in helping plants to cope with adverse environmental conditions, the major reason for increasing growth can be attributed to the ability of plants in associations with AMF to uptake some nutrients efficiently (Smith *et al*., 1992), AMF in saline conditions could have partly to increase the uptake of P, N, K, Ca, Zn, Cu, this may be due to the soil pores that can be penetrated by AMF hyphae are perhaps an order of magnitude smaller than those available to roots (Smith and Read, 1997), the effect of AMF on plant Na content was clearly observed that AMF decreased the Na uptake of plants, AMF could protect plants from Na toxicity either by regulating Na uptake from the soil or by accumulating it in root (Rabie and Almadini, 2006), this is important because the lower the Na uptake the higher the salinity tolerance. The increase in nutrient uptake proposed to be due to increasing affinity to a particular ion and lowering the threshold concentration for absorption (Bolan *et al*., 1987) and by exploring greater soil volume and increasing root surface area (Rhodas and Gerdemann, 1980). The induction of plant resistance to salt stress is provided through a discriminated absorption of the ions present in the circulating solution, so that sodium Na^+ and chloride Cl^- uptake is kept at tolerable levels (Al-Karaki and Hammad, 2001), and through better balance of mineral nutrient uptake (Graham, 1986). Also *B. subtilis* enhanced the stability of the cell membrane, raised the root vigour of plant under salt stress, improved photosynthesis under salt stress by increasing the net photosynthetic rate and the stomatic conductance. PGPR strains such as *B. subtilis* can produce bacterial exopolysaccharides (EPSs) that bind cations, including Na^+ (Geddie and Sutherland, 1993), it may be envisaged that increasing the population density of EPS-producing bacteria in the root zone would decrease the content of Na^+ available for plant uptake and thus help alleviating salt stress in plants growing in saline environments (Ashraf *et al*., 2004). So the application of *Bacillus subtilis* is a safe and promising way to relieve salt stress in crop production (Bochow *et al*., 2001; Ashraf *et al*., 2004; Saleh *et al*., 2005 and Wei Liu *et al*., 2010).

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