Response of *Achillea millefolium*, L. to Bio-Organic Fertilization under Clay Soil Condition

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ABSTRACT

Two field experiments were carried out at Sakha Agricultural Research Station during the 2008/2009 and 2009/2010 seasons to investigate the effect of inoculated rice straw compost (IRC) with plant growth promoting rhizobacteria (PGPR) and its compost tea compared with N.P. K fertilization on the growth, yield and essential oil of *Achillea millefium,L.* The obtained results showed that all compost application significantly increased plant height ,number of branches, number of inflorescences, fresh and dry weight, dry yield/fed and essential oil% and yield/fed. Supplying plants with foliar spray of compost tea every 10 days intervals (F4) increased all studied parameters. Oil %, oil yield /fed and Total oil yield/fed/season increased in all treatment in the second and third cut as compared with the first one. Most treatments of IRC with PGPR and its tea earlier the flowering which reached to 20-30 day in the third cut for that the number of cuts were increased to three cuts for season. Concerning to the essential oil constituents, chamazolene was the major compound, followed by β–pinene, limonene, αpinene, Sabinene, 1-8 cineol, Camphor, Bornyl acetate and β–caryophyllene. The highest chamazolene percentage occurred by F6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days. Compost and its tea plays an important role in controlling several plant disease by increasing beneficial microorganism's number in rhizosphere *Achillea millefium,L* plants like Bacteria and Actinomycetes and decrease the other harmful like Fungi .Meanwhile it would be used safety products (Inoculated Rice Straw Compost (IRC) with PGPR) to alternative the mineral fertilization

Keywords: Achillea millefium,L (yarrow), Inoculated Rice Straw Compost (IRC), plant growth promoting rhizobacteria (PGPR), Compost tea, Essential oil , Oil component.

INTRODUCTION

Numbers of herbs have been traditionally regarded as natural remedies for common ailments of human population. Motivation of people towards herbs are increasing due to their concern about the side effects of drugs, those are prepared form synthetic materials.

Achillea millefolium, L. family Astraceae (Compositae), commonly known as yarrow, a native to Europe and western Asia, and is widely naturalized in North America, Australia and New Zealand. It grows wild in temperate regions throughout the world, in meadows and a long road sides, (Keville, 1999).

Achillea essential oil contains several physiologically active substance that reduce inflammation, help cold and flu, increase perspiration, relive digestion antiseptic, provide local anesthesia, relaxing spasms (antispasmodic) and arresting hemorrhage, beside its effectiveness in lowering blood pressure and is also used as an aromatic bitter and a stringent herb (Chiej, 1984). Chamazulene was major constituent of the oil followed by β-pinene, thujone, lemonene, 1-8 cineol, bisabolol, camphor, α-pinene, broneol, terpeinol and caryophyllene. (Ibrahim, 2004).

Organic farming was recommended by (EU regulations, 1991) as it ensures safety products for human health as well as environment (Abd El-Gawad, 1999). Compost has been used extensively in reclamation of marginal and law quality soils. Not only improves the structure of fine textured soils but creates the structure coarse-textured as well. The chemical and physical properties of the soils were affected directly by the compost application. Increasing in organic matter content and reduction in calcium carbonate content were due to the compost which is rich in humic acid. Macro and micro soil morphology were improved (Wahba, 2007).

There has been a recent surge of popular interest in potential for improving plant health through the use of water-based compost sprays, typically called compost teas. Compost and its tea most promising bio-products recently responsible for developing different management programs as plant pest, disease and fertility (Sheuerell and Mahafee, 2002).Compost application, as growing media, can improve their physical and chemical properties as well as increasing the availability of macro and micro nutrients needed for seedling to be grown (Badran *et al*,2007).

Root-colonizing are commonly referred as "Rhizobacteria" remain confined to the root surface (rhizoplant) but some enter the root interior and behave as entophytes. Several rhizobacterial strains have been found to increase plant growth after

inoculation onto seeds and therefore called "plant growth-promoting rhizobacteria" (PGPR) (Kloepper and Schroth, 1981). The compost tea is a highly concentrated microbial solution produced by extracting beneficial microbes from vermicompost and\or compost .It is a source of foliar and soil organic nutrients, contain chelated micronutrients for easy plant absorption and the nutrients is in a biologically available form for both plant and microbial uptake. Hendawy, (2008).

Thus, this investigation was conducted to study the optimum applied dose of Inoculated Rice straw Compost (IRC) with PGPR and its tea compared with N.P.K fertilization to obtain the highest production of vegetative growth, oil yield as well as chemical constituents of *Achillea millefolium*, L.

MATERIALS AND METHODS

A field experiment was carried out at the two successive seasons of 2008/2009 and 2009/2010, in Sakha Experimental Farms Station of Agricultural Research Center, at Kafr El Sheikh Governorate, Egypt, aiming to study the effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on the growth, chemical composition and oil yield of *Achillea millefium, L.*

Plants of yarrow, obtained from Medicinal and Aromatic Plants Department, Agricultural Research Centre, Egypt, were cultivated using plant divisions on 2nd and 15th October in the first and second seasons, respectively. Directly in rows, the distance 50*60cm in completely randomized block design containing 9 treatments with three replicates, Every replicate contain 10 plants for each treatment in the replicate (as a plot). The physical and chemical properties of the experimental soil were determined before cultivation, according to Jackson, 1967, as showed in Table (a)

Table a: physical and chemical analysis of experimental soil before cultivation.

Physical analysis:	
Sand%	19.31
Silt%	30.42
Clay%	50.27
Soil texture	Clay
Chemical analysis:	
Ec (m mhos/cm)	1.74
pH	7.95
Soluble cations(meq/L)	
Na+	13.94
K+	1.45
Ca++	5.33
Mg++	1.45
Soluble anions (meq/L)	
Co3-	-
Hco3-	6.96
Cl-	2.35
SO4++	12.86
Available N(ppm)	39.40
Available P(ppm)	8.37
Available K(ppm)	209.3
Organic matter%	1.6

Inoculated rice straw compost (IRC):

Two groups of microorganisms were successfully used for preparing the rice straw compost as the first application was done by *Trichoderma virdi* as cellulose decomposer which cultivated on Potato Dextrose Agar (PDA) media and added to compost as liquid culture rate. Selective plant growth promoting rhizobacteria (PGPR) strains comprised of *Azotobacter chrococcum, Azosperillum barasilense and Paenibacillus polymxa* were also added to enrich compost with available nutrients, growth promoting substances and provide compost with bio-promoting potency against the phytopathogens. These rhizobacteria were grown on nutrients broth media and mixed with solid carrier (Vermiculite+beat moss at ratio of 75:25 W.N). Bacterial inoculants were added to compost at maturity stage at rate of 400g ton-1 from each bacterial inoculants .Selected strains (PGPR) were kindly obtained from the stock culture collection of Biological Nitrogen Fixation Unit. Dept. of Soil Microbiology at Sakha. Agric. Res, Station. The chemical and biological properties of the used compost were found to be in the Table (b).

A- technique for producing compost tea:

Compost extract is a centuries old technique in which compost is suspended in a barrel of water for 7 to 14 days, usually soaking in sake (Diver, 2002). The primary benefit of the extract is to provide a supply of soluble nutrients that can be used as liquid fertilizer. Compost tea is a compost extract that is brewed with a microbial food source (such as molasses, kelp, rock dust, humic- valvic acids and others) Scheuerell and Mahafee, 2002)

Table b: Chemical and biological characters of Inoculated Rice Straw Compost (IRC).

Characters	Value
Ph	7.31
Ec (ds m-1 at 25 c)	4.87
C/N ration	14.12
Organic matter (%)	38.71
Total nitrogen (%)	1.59
Total soluble nitrogen (%)	674
Available P (ppm)	134
Cross seed germination test (%) *	91.66
Total count of bacteria (cfu/ml)**	34×10^8
Total count of fungi (cfu/ml)**	19×10^4
Total count of actinomycetes (cfu/ml)**	$27*10^6$
Dehydrogenase activity ***	787
Co2 evaluation rate ****	18.7

* Cross germination test was carried out using Eruca sativum seeds after 72h.
** Colony formed unit *** Mg TpF/100g dry soil.
**** Mg Co2/100g soil/24h.

The used fertilization treatments were as the following:

F1: control (recommended N, P and K)
F2: IRC (4 ton/feddan)
F3: IRC (6 ton/feddan)
F4: foliar spray of its compost tea every 10 days intervals.
F5: foliar spray of its compost tea every 20 days intervals.
F6: IRC (2 ton / feddan) + foliar spray of its compost tea every 10 days intervals.
F7: IRC (2 ton / feddan) + foliar spray of its compost tea every 20 days intervals.
F8: IRC (3 ton / feddan) + foliar spray of its compost tea every 10 days intervals.
F9: IRC (3 ton / feddan) + foliar spray of its compost tea every 20 days intervals.

IRC: Inoculated rice straw compost with selected strains of plant growth promoting rhizobacteria (PGPR)

N.P.K: the recommended dose (Abozeid, 1988) was added at the rate of 150 kg ammonium sulphate (20.5% N), 200kg calcium super phosphate (15.5% P2O5) and 50kg potassium sulphate (48% K2O) per feddan.

The microbial compost was applied in the soil before cultivation at four rates of 2, 3, 4,6 ton/fed. At the flowering stage (when 70% of the plants were flowering), the plants were harvested three times in each season. at 15th of each January, April and June for three cuts in the first season 2008-2009, respectively and 21th January, 18th April and 3th June for three cuts in the second season 2009-2010, respectively.

The following data were recorded:

A-Vegetative growth characters
1. Plant height (cm).
2. Number of branches.
3. Number of inflorescences
4. Time to flowering(day)(when the first plant flowering/treatment)
5. fresh weight of herb (g /plant)
6. Dry weight of herb (g /plant)
7. Dry yield of herb/cut/ feddan(kg)
8. Total dry yield/season / feddan (ton)

B-Essential oil: oil percentage of the dry herb (vegetative growth and flowers) was conducted according to British pharmacopoeia, 1963.Then calculated the oil yield /fed (litter) and total oil yield /fed/season. GC/Mass analysis of volatile oil of each treatment for the third cut was performed with specification of the apparatus used according to Robert Adams, 1995.

C- Chemical Analysis. Nitrogen % was determined by modified micro kjeldahl method as described by A.O.A.C, 1970.As for phosphorus% was determined, according to Murphy and Riley, 1962. Potassium% was estimated using to Cottenie *et al*, 1982.

D- Effect of different combinations of Inoculated rice straw compost and its compost tea on some groups of micro- organisms in rhizosphere of plants: Total accounts of Bacteria, Fungi and Actinomycetes in plant rhizosphere were determined using soil extract agar medium (Page *et al*., (1982), Rosebengal, Sterptomyium agar (Martin, 1950) and Jensen's medium, respectively.

Statistical Analysis: The statistical analysis was carried out according to Sendecor and cochran, 1990. The mean values of the treatments were compared by Duncan's Multiple Range Test .

RESULTS AND DISCUSSION

A. Vegetative growth characters:

1-Plant height and Number of branches:

Data in Table (3) indicated that all compost and its tea treatments in general significantly increased plant height and Number of branches as compared with control (recommended N.P.K). The highest significant values of plant height and number of branches were obtained from the application of F4 (foliar spray of its compost tea every 10 days intervals). The number of branches gradually increased with increasing harvested number for the two seasons. It means that the extraction of compost tea as foliar spray every 10 days and Inoculated Rice straw Compost (IRC) with PGPR is necessary to produce the active ingredients and nutritional substances required to enhance the plant growth in comparison with NPK fertilization. This could be attributed to an increase of nitrogen content of plants as a result of symbiotic N2-fixation activity beside the role of the bio- organic fertilization. Kloepper (1993) stated that application of plant growth-promoting rhizobacteria (PGPR) is often associated with increased rates of plant growth. The postulated mechanisms of plant growth stimulation by associative bacteria are stimulation of root growth by production of phytohormones .These results were supported by El-Ghadban *et al*, 2008.

Table 1: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on Plant height and Number of branches on *Achillea millefolium*, L plants.

Treatments	Plant height (cm)			Number of branches		
	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut
	First Season					
F_1: control	88.33b	71.33e	83.33ab	50.00abc	58.67bcd	83.00b
F_2: IRC (4 ton/feddan)	65.67d	79.00cd	83.00ab	51.33ab	66.33abc	83.00b
F_3 :IRC (6 ton/feddan)	90.33ab	85.00b	81.67ab	44.00bcd	57.67cd	73.00cd
F_4:foliar spray of compost tea every 10 days	96.00a	92.33a	84.00a	54.67 a	70.67a	92.33a
F_5: foliar spray of compost tea every 20 days	80.67c	75.67de	75.67c	43.00cd	50.33d	86.33b
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	63.67d	82.67bc	75.00c	49.67abc	69.67ab	76.67c
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	87.67b	84.00bc	76.00c	46.33bcd	61.33abc	69.67d
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	78.67c	89.00ab	74.33c	41.00c	59.67abc	71.33d
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	75.00c	86.00b	78.00bc	44.67bcd	64.33abc	70.67d
	Second Season					
F_1: control	66.67cd	59.00c	73.67ab	42.67b	52.67cd	71.33b
F_2: IRC (4 ton/feddan)	55.67d	67.33b	76.33a	42.67b	56.00abc	70.33bc
F_3 IRC (6 ton/feddan)	77.67abc	76.33a	74.00ab	39.67bc	53.67bcd	61.00def
F_4 foliar spray of compost tea every 10 days	86.67a	81.67a	76.33a	47.33a	56.67ab	85.00a
F_5: foliar spray of compost tea every 20 days	65.67cd	58.00c	66.00b	36.67cd	44.67g	65.67cd
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	63.33cd	77.33a	67.67ab	43.33b	59.33a	63.00de
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	86.00ab	74.33ab	69.67ab	40.33b	50.33de	56.33f
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	68.33bcd	73.67ab	67.00b	35.67de	48.67ef	65.67cd
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	62.33cd	75.67ab	70.33ab	32.67e	46.33fg	59.33ef

Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

2- Number of inflorescences and Time to flowering:

Data presented in Table (2) illustrated the effect of Inoculated Rice straw Compost (IRC) with PGPR and its tea on increasing Number of inflorescences and earlier the flowering as compared with the control (recommended NPK fertilization) which recorded the least significant values of Time to flowering were recorded in the three cuts of the two seasons. F4 (foliar spray of compost tea every 10 days) increased gradually number of inflorescences with plant age which recorded 171.33 and 129.00 flower in the third cut for the two seasons, respectively. F4 treatment were be ready to be flower within significantly shorter time than the control which needed 52.67,52.00and20.33 days in the first season and 71.67,60.00and24.33days in the second one for the three cuts ,respectively. These results may be due to addition of the extraction of compost tea as foliar spray every 10 days and inoculated rice straw compost (IRC) with PGPR which contains microorganisms ,nutrients were rapidly benefit to plant growth and flowering earlier through direct contribution of plant nutrition. These results are in agreement with those obtained by shalaby *et al,* 2009.

Table 2: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on Number of inflorescences and Time to flowering (day)on *Achillea millefolium*, L plants.

Treatments	Number of inflorescences			Time to flowering(day)		
	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut
	First Season					
F_1: control	20.67g	57.33e	171.33a	94.00a	79.33a	30.33a
F_2: IRC (4 ton/feddan)	36.00e	64.33d	106.33d	63.67b	64.00bc	20.33c
F_3: IRC (6 ton/feddan)	57.67c	85.33b	160.00ab	61.67b	55.00de	25.33b
F_4: foliar spray of compost tea every 10 days	75.67a	92.67a	180.33a	52.67c	52.00e	20.33c
F_5: foliar spray of compost tea every 20 days	39.33d	81.67bc	154.33abc	102.00a	79.00a	20.00c
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	36.67d	76.67c	127.67bcd	50.33c	61.67bcd	20.33c
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	58.33b	82.33b	115.33cd	51.00c	55.00de	25.33b
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	29.67ef	56.33e	145.00abcd	96.00a	52.33cde	25.00b
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	27.67f	60.33de	123.33bcd	100.33a	68.00b	30.33a
	Second Season					
F_1: control	16.33g	38.33d	136.00a	105.00a	90.00a	33.33a
F_2: IRC (4 ton/feddan)	21.67f	42.67cd	91.67c	72.33d	72.33c	30.33ab
F_3: IRC (6 ton/feddan)	55.67b	77.33ab	184.33ab	96.00b	62.00d	32.67a
F_4: foliar spray of compost tea every 10 days	66.67a	84.33a	129.00a	71.67d	60.00d	24.33c
F_5: foliar spray of compost tea every 20 days	32.00d	71.00b	112.00b	110.00a	90.00a	22.67c
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	26.33e	50.67c	93.33c	71.67d	77.00b	23.67c
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	38.33c	72.00b	83.33c	84.67c	77.00b	29.00b
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	22.67ef	44.00cd	84.33c	108.33a	77.00b	25.00c
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	22.67ef	51.00c	87.67c	110.00a	77.00b	24.00c

Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

3- Fresh and Dry weight of herb:

Data presented in Table (3) evident that all applied treatments in general significantly promoted effect on the accumulation of the fresh and dry herb weight .Meanwhile the F1 (recommended N.P.K fertilization), F4 (foliar spray of compost tea every 10 days) and F6 IRC (2 ton / feddan) + foliar spray of compost tea every 10 days without significant difference in most cases as gave the highest increment and more favorable effect on mass production in the three cuts of the two seasons . The beneficial effect of compost tea on herb yield may be due to its direct nutrition and\or its microbial functions. For its direct nutrition, the compost tea provides chelated micronutrients for easy plant absorption as well as nutrients in biological available from both plant and microbial uptake Hendawy,(2008).In addition, its microbial functions, compost tea produced plant growth hormones, mineralize plant available nutrients and fixes nitrogen. Several investigators reported similar promotion effect for compost fertilizer on different plants such as Edris, *et al* (2003) on *Organium majorana*, Hussein *et al* (2006) on *Dracocephalum moldavica* and El-sherbeny *et al* (2007) on *Ruta graveolens*. In this connection, Khalil (2006) recorded that mucilage content in *Plantago afra* herb was not affected by organic manures, while adding the biofertilizers with organic manures producing the largest content of mucilage.

Table 3: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on Fresh and Dry weight of herb on *Achillea millefolium*, L plants.

Treatments	Fresh weight of herb (g /plant)			Dry weight of herb (g /plant)		
	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut
	First Season					
F_1 control	616.89a	1913.43a	1463.50a	161.30a	198.90a	249.54a
F_2: IRC (4 ton/feddan)	417.03d	1128.06bc	1004.75abc	98.50bcd	138.67c	223.99b
F_3 IRC (6 ton/feddan)	500.36c	1283.06bc	858.34bc	113.74bc	189.52ab	197.41cd
F_4 foliar spray of compost tea every10 days	600.36a	1672.98ab	1314.97ab	132.07ab	163.71bc	220.55bc
F_5 foliar spray of compost tea every 20days	516.94bc	1040.21c	867.68bc	103.62bcd	135.60c	220.87bc
F_6 IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	616.93a	1661.30ab	784.37c	93.10bcd	142.06c	236.54ab
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	450.50cd	1229.68bc	901.61bc	62.10d	137.17c	191.40d
F_8 IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	450.47cd	931.19c	744.10c	85.81cd	140.01c	144.63e
F_9 IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	583.58ab	1419.98abc	653.03c	76.68cd	149.07c	183.39d
	Second Season					
F_1 control	300.30cd	1209.63ab	1117.93a	67.14b	90.29ab	177.54a
F_2: IRC (4 ton/feddan)	150.38e	685.97c	903.92b	39.27d	85.65abc	155.52ab
F_3 IRC (6 ton/feddan)	283.61d	1132.75ab	493.48d	55.56c	87.32ab	120.80cd
F_4 foliar spray of compost tea every10 days	500.49a	852.46bc	535.67cd	92.00a	82.94abc	152.19ab
F_5 foliar spray of compost tea every20 days	400.47b	945.85abc	550.77cd	40.24d	85.54abc	166.32ab
F_6 IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	367.18bc	1323.27a	925.49b	41.56d	81.02abc	141.02bc
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	283.60d	987.09abc	635.19c	35.94d	93.11a	118.68cd
F_8 IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	300.59cd	1168.55ab	501.75d	85.35a	83.55abc	157.26ab
F_9 IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	267.28d	1174.17ab	487.86d	83.58a	74.70c	105.02b

Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test

4- Dry yield/cut /fed and Total dry yield/season / feddan

Table (4) shows that inoculated rice straw compost (IRC) with PGPR and its tea increased Dry yield/cut /fed and Total dry yield/season /feddan. The highest significant values of Dry yield/cut /fed were obtained from the application of F1 (recommended N.P.K fertilization) and F4 (foliar spray of compost tea every 10 days) without significant difference in most cases in the three cuts of the two seasons. Concerning to Total dry yield/season / feddan data resulted in most compost treatments equal with the NPK fertilizer in the two seasons except for the F2 (4ton/feddan)which gave the least value of total dry yield/season / feddan. This results means that Compost and its tea bio-products can be used instead of the mineral product. These results are in agreement with those obtained by Shaala, 2007

Table 4: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on Dry yield/cut /fed (kg) and Total dry yield /season /feddan (ton) on *Achillea millefolium*, L. plants.

Treatments	Dry yield/cut /fed (kg)			Total dry yield /season /feddan (ton)
	1st Cut	2nd Cut	3rd Cut	Total cut
			First Season	
F_1 control	1317.02a	1873.03a	2291.92a	5.48a
F_2: IRC (4 ton/feddan)	819.38b	1305.85bc	2107.96a	2.94c
F_3 IRC (6 ton/feddan)	882.18b	1450.59bc	1857.82a	4.191a
F_4 foliar spray of compost tea every 10 days	1255.01a	1540.59b	2075.61a	4.87a
F_5 foliar spray of compost tea every 20 days	975.19b	1150.61c	1382.94a	3.51b
F_6 IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	876.13b	1458.85bc	1574.07a	3.91ab
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	584.42b	1286.84bc	1744.96a	3.62b
F_8 IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	721.67b	1341.12bc	1361.10a	3.42b
F_9 IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	1581.71a	1318.13bc	1719.70a	4.62a
			Second Season	
F_1: control	631.19b	868.41ab	1669.02a	3.17b
F_2: IRC (4 ton/feddan)	369.34d	774.93bcd	1463.34abc	2.61c
F_3:IRC (6 ton/feddan)	523.34c	853.10abc	1136.81de	2.51c
F_4 :foliar spray of compost tea every 10 days	865.80a	780.92abcd	1432.25abc	3.08b
F_5: foliar spray of compost tea every 20 days	378.72d	805.01abc	1566.30ab	2.75c
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	391.11d	762.44cd	1327.10bcd	4.88a
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	338.22d	876.25a	1116.86de	2.33c
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	808.46a	786.31abcd	1260.18cd	2.85bc
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	781.67a	702.99d	970.37e	2.46c

Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

B-Essential oil:

1- Essential oil %, oil yield / feddan and Total oil yield/fed/season:

Oil %, oil yield / fed and Total oil yield/ fed/ season increased by applied various levels of IRC and its foliar tea compost without variance of control treatment in some cases (Table, 5). However the highest increment were recorded with application of F4 (foliar spray of compost tea every 10 days). Oil %, oil yield /fed and Total oil yield/fed/season increased in all treatment in the second and third cut as compared with the first one. Total oil yield/ fed /season reached to 34.36 and 15.13 L for the treatment of F4 for the two seasons ,respectively .These results agree with Khalil *et al,* 2008, El-sherbeny *et al.* (2005) on *Siderities montana* L.,who mentioned that compost addition markedly improved oil %,productivity and oil yield as compared to the control.

Table 5: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on means oil %, oil yield / feddan and Total oil yield/fed/season on *Achillea millefolium*,L plants.

Treatments	Oil%			Oil yield/feddan(L)			Total oil yield/fed/season (L)
	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut	Total cut
				First Season			
F_1 control	0.30	0.32	0.80	3.95	3.12	18.33	25.40
F_2: IRC (4 ton/feddan)	0.30	0.42	0.76	2.46	5.48	16.02	23.96
F_3: IRC (6 ton/feddan)	0.26	0.28	0.64	2.29	4.06	11.89	18.24
F_4: foliar spray of compost tea every 10 days	0.36	0.52	1.20	4.52	4.93	24.91	34.36
F_5: foliar spray of compost tea every 20 days	0.32	0.34	0.72	3.12	3.91	9.96	16.99
F_6 :IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	0.28	0.30	0.54	2.45	4.38	8.50	15.33
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	0.30	0.36	0.76	1.75	4.63	13.26	19.64
F_8:IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	0.34	0.44	0.82	2.45	5.90	11.16	19.51
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	0.30	0.28	0.44	4.75	3.69	7.57	16.01
				Second Season			
F_1: control	0.26	0.28	0.54	1.64	2.43	9.01	13.08
F_2: IRC (4 ton/feddan)	0.28	0.24	0.60	1.03	1.86	8.78	11.67
F_3: IRC (6 ton/feddan)	0.28	0.24	0.66	1.47	2.05	7.50	11.02
F_4 :foliar spray of compost tea every 10 days	0.30	0.32	0.70	2.60	2.50	10.03	15.13
F_5 :foliar spray of compost tea every 20 days	0.28	0.42	0.50	1.06	3.38	7.83	12.27
F_6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	0.24	0.28	0.44	0.94	2.13	5.84	8.91
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	0.24	0.26	0.68	0.81	2.28	7.59	10.68
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	0.28	0.28	0.42	2.26	2.20	5.54	10.00
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	0.26	0.26	0.42	2.03	1.83	4.08	7.94

2- Composition of the Essential oil

Data in Table (6) appears that nine compounds were identified in yarrow oil comprising between 27.65 and 95.69% of the oil for F7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days and F6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days, respectively, It is evident that total identified compounds were affected by foliar spray of compost tea every 10 days. The major components in yarrow herb oil are chamazolene, forming from 10.12 to 92.37%, followed by β–pinene from 1.04 to 13.52% and limonene from 0.55 to 8.88%. The other six compound were α-pinene, Sabinene, 1-8 cineol, Camphor, Bornyl acetate, β –caryophyllene .This result are inaccordance with previous reports , since chamazolene (azulene)or proazulenes were reported as a main constituent of *Achillea millefolium* essential oil (Svoboda and Hampson,2001).The percentage of chamazolene was slightly affected by different treatments ,whereas the lowest chamazolene percentage resulted from F7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days, but the highest percentage occurred by F6: IRC (2 ton / feddan) + foliar spray of compost tea every 10 days. These results are in agreement with Banchio *et al*, 2008 on *Origanum majorana* who found that increased synthesis, relative percentages of oil constituents were changed significantly by inoculation the treated plants with Bradyrhizobium and *P. fluorescens*, rose terpinen-4-ol trans-sabinene hydrate in the leaves as compared to the control.

Table 6: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on oil component on *Achillea millefolium*, L plants in the third cut.

Treatment	α-pinene	Sabinene	β-pinene	Limonene	1-8 cineol	Camphor	Bornyl acetate	Chamazolene	β-caryophyllene	Total	U.K
F_1	1.50	5.82	10.17	8.88	0.71	2.64	2.89	18.59	3.27	54.48	45.52
F2	1.89	3.26	5.43	3.78	0.63	0.24	3.04	12.71	1.50	32.48	67.52
F3	0.72	0.91	13.52	13.08	5.81	5.20	2.72	26.69	3.35	72.00	28.00
F4	1.48	0.58	7.00	5.93	1.16	2.17	0.55	11.82	1.59	32.28	67.72
F5	2.50	0.81	7.42	5.44	2.47	1.01	2.75	12.69	1.63	36.72	63.28
F6	0.44	0.08	1.04	0.55	0.36	0.41	0.32	92.37	0.12	95.69	4.31
F7	0.41	0.71	7.27	4.24	1.94	0.18	0.73	10.12	2.05	27.65	72.35
F8	0.48	1.25	3.70	2.14	1.39	0.31	1.48	69.62	2.28	82.65	17.35
F9	1.92	0.38	10.79	8.68	0.62	1.47	3.29	23.63	2.93	53.71	46.29

C- Chemical Analysis:

1- N, P, K%

From the data in Table(7) it can be noticed that the NPK % in *Achillea millefolium* herb significantly increased with applying recommended N.P.K fertilization (F1) and F4 (foliar spray of compost tea every 10 days) in most cases in the three cuts of the two seasons. These results may be due to that IRC with PGPR stimulate the plant growth by facilitating the uptake of minerals N, P and K or secretes of phytohormons resulting in increase of NPK uptake. Similar results were obtained with Herrera *et al,* (1997) who indicated that N, P, K, Ca and Mg of thyme seedlings increased with increasing compost ratio in growth media. Also, El-Sherbeny et al (2007), indicated that to produce *Rota graveolens* plants contained highest nutrients content, when treated with compost at 238kg N\hec. Moreover, Kumawat *et al* ,(2002) on *Plantago ovata Fork*, revealed that the maximum NPK uptake by crop, were recorded under 60kgN\ha.).

Table 7: Effect of inoculated rice straw compost (IRC) with PGPR and its tea compared with N.P.K fertilization on N,P and K% of *Achillea millefolium*,L plants.

Treatments	N%			P%			K%		
	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut	1st Cut	2nd Cut	3rd Cut
First Season									
F_1	1.94a	2.84b	3.80a	0.30c	0.31abc	0.38a	2.51b	2.67a	2.57d
F_2	1.53g	2.42f	2.65b	0.32ab	0.29cd	030d	2.53ab	2.55c	2.73b
F_3	1.92ab	2.84b	3.22d	0.30c	0.29d	0.34c	2.33d	2.44ef	2.26f
F_4	1.90b	2.27a	3.88a	0.32a	0.31abcd	0.36b	2.55a	2.62b	2.82a
F_5	1.53g	2.51e	3.50c	0.30c	0.30bcd	0.31d	2.51b	2.42f	2.46e
F_6	1.86c	2.72c	3.23d	0.33a	0.32a	0.36b	2.52ab	2.51d	2.75b
F_7	1.72e	2.64d	3.52c	0.32ab	0.32ab	0.30d	2.35d	2.31g	2.82a
F_8	1.82d	2.75c	3.88a	0.30c	0.32a	0.36b	2.52ab	2.56c	2.74b
F_9	1.70f	2.66d	3.82a	0.30bc	0.30bcd	0.33c	2.41c	2.46e	2.62c
Second Season									
F_1	1.85a	2.79a	3.723ab	0.27e	0.27ab	0.35a	2.56a	2.56a	2.51cd
F_2	1.35e	2.26f	3.306d	0.28cde	0.27ab	0.28c	2.53ab	2.31c	2.60bc
F_3	1.83ab	2.74b	3.273d	0.29bcd	0.24c	0.30bc	2.32d	2.21d	2.21e
F_4	1.87a	2.81a	3.816a	0.30b	0.28ab	0.31b	2.54ab	2.54ab	2.82a
F_5	1.33e	2.18g	3.410cd	0.32a	0.26bc	0.28c	2.42c	2.33c	2.39d
F_6	1.73bc	2.62c	3.46bcd	0.29bcd	0.29a	0.32b	2.52b	2.42b	2.67b
F_7	1.60d	2.51d	3.32d	0.28de	0.27abc	0.27c	2.34d	2.24d	2.60bc
F_8	1.71c	2.62c	3.87a	0.28bc	0.29a	0.32b	2.51b	2.42b	2.67b
F_9	1.51d	2.41e	3.66abc	0.27e	0.29ab	0.35a	2.56a	2.56a	2.51cd

,Means having the same letter in the column are not significantly different at 5% level according to Duncan's Multiple Range Test.

D. Effect of different combinations of Compost and Compost tea on some groups of microorganisms:

Data presented in Table (8) clearly indicated that microbial accounts is greatly affected by growth media of rhizosphere. All compost and its tea don't stimulate the growth of all microorganism's number in rhizosphere plants which the treatment of F4 and F9 increased Bacteria growth to $12.6*10^6$ c.f.u/ gram and F2 increased Actinomycetes account to $3.8 * 10^5$ c.f.u/ gram while Fungi account increased with applied NPK fertilizer as reached to $6.6 *10^4$ c.f.u/ gram of rhizosphere mixture. Such results indicated that incorporation of compost in growth medium enhance the growth of Bacteria, this could be observed from the striking differences between treatments as the number of bacterial cells raised from 8.9×10^6 to 12.6×10^6 c.f.u. on another hand fungal densities decreased progressively with increasing levels of compost indicating the inhibitive effect of compost and compost tea towards fungi. This could be observed in plant rhizosphere of all treatments. Changes in actinomycetes in rhizosphere is not greatly affected by growth medium of rhizosphere except followed by the treatment that contain IRC (4 ton / feddan) F_2. Substantially more microorganisms are present near plant root surfaces than in bulk soil. This "rhizosphere effect" is caused by the release of exudates from growing root tissues and the lyses of cells of older root parts. This results may be due to enriched compost devised better environmental conditions in plant rhizosphere beside its role in increasing the level of supply in available from of nutritional elements required at trace levels both by the plant and by microorganisms. Similar results were obtained with (Dazzo and Yanni 2006) who indicated that Foliar fertilization with compost tea with its remarkable nutritional values that are present in soluble chemical components into an aqueous sphere, play an important role in controlling several plant diseases and it contains beneficial biotic.

From the above results it would be recommended to use inoculated rice straw compost (IRC) with PGPR and its compost tea as foliar spray every 10 days intervals for *Achillea millefium, L.* as it ensures safety products alternative to mineral fertilization that is plays an important role in controlling several plant disease by increasing beneficial microorganism's number in rhizosphere plants like Bacteria and Actinomycetes and decrease the other harmful like Fungi and obtained the best growth , oil yield and nearly equal with the mineral on the total yield of *Achillea millefium, L.*

Table 8: Effect of compost and compost tea on microorganism's number in rhizosphere of plants.

Treatment	Mean No. of cells (c.f.u)		
	Bacteria (10^6)	Actinomycetes (10^5)	Fungi (10^4)
F_1 (control)	8.9	1.4	6.6
F_2: IRC (4 ton/feddan)	9.2	3.8	4.6
F_3: IRC (6 ton/feddan)	8.0	1.4	4.7
F_4: foliar spray of compost tea every 10 days	12.60	1.9	3.6
F_5: foliar spray of compost tea every 20 days	12.50	2.2	4.3
F_6 :IRC (2 ton / feddan) + foliar spray of compost tea every 10 days	11.60	2.3	3.7
F_7: IRC (2 ton / feddan) + foliar spray of compost tea every 20 days	11.20	2.4	3.6
F_8: IRC (3 ton / feddan) + foliar spray of compost tea every 10 days	12.50	2.3	4.4
F_9: IRC (3 ton / feddan) + foliar spray of compost tea every 20 days	12.60	2.0	4.3

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الملخص العربى

استجابة نبات الاشيليا للتسميد العضوي الحيوي تحت ظروف الأراضى الطينية

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أجريت تجربتان حقليتان في محطة البحوث الزراعية بسخا خلال موسمي النمو٢٠٠٨/ ٢٠٠٩و٢٠٠٩/٢٠١٠ لدراسة تأثير التسميد بكمبوست قش الأرز الملقح بالبكتيريا المنشطة لنمو النبات ومستخلص شاي الكمبوست له ومقارنته بالتسميد النيتروجيني والفوسفوري والبوتاسي على النمو والمحصول والزيت العطري لنبات الاشيليا. وقد أوضحت النتائج أن كل معاملات الكمبوست زادت معنويا من ارتفاع النبات وعدد الأفرع وعدد النورات الزهرية والوزن الطازج والجاف للنبات والمحصول الجاف للفدان ومحصول الزيت العطرى للفدان. أدى رش النبات بشاى الكمبوست كل عشرة أيام على التوالي إلى زيادة كل القياسات المستخدمة.اتضح زيادة نسبة الزيت ومحصول الزيت للفدان والمحصول الكلى للزيت فى الموسم فى كل المعاملات فى الحشة الثانية والثالثة عند مقارناتها بالحشة الاولى . معظم معاملات الكمبوست وشاى الكمبوست تدفع النبات مبكرا للتزهير حيث بدأ النبات في التزهير بعد ٢٠-٣٠ يوم في الحشة الثالثة لذلك زادت عدد الحشات إلى ثلاثة حشات في الموسم ، بالنسبة للمكونات الكيماوية للزيت وجد أن الكامازيولين هو المكون الاساسى للزيت العطري يتبعه البيتابينين واليمونين والالفابينين والبيتابينين و١-٨ سينيول والكامفور والبورنيل اسيتات والبيتاكاريوفلين. إضافة ٢طن للفدان كمبوست مع الرش بشاى الكمبوست كل عشرة أيام أعطى أعلى نسبة للكمازيولين. ووجد أن الكمبوست وشاي الكمبوست يلعبا دورا مهما في التحكم في عديد من الأمراض للنبات وذلك عن طريق زيادة أعداد الميكروبات النافعة في محيط نمو نبات الاشيليا مثل البكتيريا والاكتينوميسات ويقلل الأخرى الضارة مثل الفطريات. لذلك يمكن التسميد بكمبوست قش الأرز الملقح بالبكتريا المنشطة لنمو النبات ومستخلص شاي الكمبوست له كتسميد امن بديل للتسميد المعدني.