



RESPONSE OF YARROW PLANTS TO SOME AGRICULTURAL TREATMENTS

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ABSTRACT

A field experiment was carried out during two successive seasons, 2013/2014 and 2014/2015 at the experimental Farm, Fac. of Agric., Minia Univ., aiming to study the effect of compost (0, 5, 7.5 and 10 ton/fed.) and mineral NPK and/or biofertilizers on the yield of herb and oil productivity of yarrow plants. Results revealed that compost at the three used levels increased herb yield and oil % and oil yield per cut and/plant. Compost at 10 ton/fed. was the most effective in raising the productivity of plant. Treating plants by mineral NPK (100 %) or 75 % NPK + biofertilizers was the most effective in this concern comparing with other used treatments. The interaction treatment of compost (10 ton/fed.) with mineral NPK (100 %) or combined with 75 % NPK + biofertilizers (E.M. + M.A.) gave the best result in this concern without significant differences between such superior two interaction treatments.

INTRODUCTION

Achillea millefolium, L. (yarrow) is one of the important medicinal and essential oil, containing azulene plants.

Achillea leaves and flowers could be successfully used as stimulant, aromatic and tonic, valuable for treating wounds, Bleeding, treating colds, fevers, kidney disease and

menstrual pain (Duke, 1985 and Moerman, 1998).

Organic fertilizers are very important in plant fertilization in many countries due to their beneficial effects on the soil, growth and increase the productivity, as well as, improving the quality of plant production (Harb and Mahmoud, 2009 and Ferraz *et al.*, 2014 on yarrow; Mahboobeh *et al.*, 2014 on *Mentha piperita*, L., Sirousmehr *et al.*, 2014 on sweet basil and El-Nady, 2015 on *Cymbopogon citratus*).

Mineral NPK fertilizers had positive effect on vegetative growth traits and essential oil production of medicinal and aromatic plants (Kandil *et al.*, 2009 on Genovese basil, Giorgi *et al.*, 2009 on *Achillea collina*, Abtahi *et al.*, 2013 on *Pelargonium graveolens*, El-Mekawy, 2013 on *Achillea santolina* and Jadhav *et al.*, 2014 on *Tagetes erecta*).

Biofertilizers are very important in medicinal and aromatic plants production for drugs extraction and manufacturing as a main substance for human disease healing and health care. The effect of biofertilization on the growth and productivity of medicinal plants were studied by Abd El-Raaf (2009) on borage, Ali (2013) on *Calendula officinalis* and Roshanpour *et al.* (2014) and Saburi *et al.* (2014) on basil plant.

Therefore, the present study was carried out to investigate the response of yarrow plants to compost and bio/mineral fertilization.

MATERIALS AND METHODS

This research was carried out at the experimental farm of Fac. of Agric., Minia Univ., during two consecutive seasons of 2013/2014 and 2014/2015. The experimental treatments were arranged in a randomized complete blocks in a split-plot design with three replicates. The main plots (A) included four levels of compost (control, 5, 7.5 and 10 ton/fed.). While, seven treatments of mineral NPK and/or biofertilization occupied the sub-plots (B) (100 % NPK, 75 % NPK + E.M., 50 % NPK + E.M., 75 % NPK + M.A., 50 % NPK + M.A., 75 % NPK + E.M. + M.A. and 50 % NPK + E.M. + M.A.).

The experimental unit (plot) was 3.0 × 2.4 m and contained 5 rows, 60 cm apart. The seedlings were transplanted as individual plants in hills, 40 cm apart, therefore, each plot contained 30 plants. Mechanical and chemical analysis of the used soil were performed according to Jackson, (1973) as shown in Table (a).

Compost was added during preparing the soil to cultivation in both seasons. Chemical characteristics of compost (Table, b), which obtained from the Egyptian Co. for Solid Waste Utilization, New Minia City.

The recommended mineral NPK fertilization (full dose) was 300 kg/fed. ammonium nitrate (33.5 % N), 100 kg/fed. calcium superphosphate (15.5 % P₂O₅) and 50 kg/fed. potassium sulphate (48 % K₂O) according to El-Sayed (1986). While, 75 % NPK were 225 + 75 + 37.5 kg/fed. and 50 % NPK

were 150+50+25 kg/fed., respectively. All of P fertilizer was added during soil preparation, while the amounts of mineral NK fertilizers were divided

Table (a) : Soil analysis :

Soil character	Values	Soil character	Values
Sand %	28.30	Available P %	15.12
Silt %	30.70	Exchangeable K ⁺ mg/100 g soil	2.11
Clay %	41.0	Exch. Ca ⁺⁺ mg/100 g soil	31.74
Soil type	Clay loam	Exch. Na ⁺ mg/100 g soil	2.41
Organic matter %	1.62		
CaCO ₃ %	2.09		Fe 8.54
pH 1:2.5	7.83	DTPA	Cu 2.06
E.C. m mhose/cm	1.04	Ext. ppm	Zn 2.75
Total N %	0.08		Mn 8.26

Table (b) : Physical and chemical properties of the used compost :

Properties	Value	Properties	Value
Dry weight of 1 m ³	450 kg	C/N ratio	14.1-18.5
Fresh weight of 1 m ³	650-700 kg	NaCl %	1.1-1.75
Moisture (%)	25-30	Total P %	0.5-0.75
pH (1:10)	7.5-8	Total K %	0.8-1.0
E.C. (m mhose/cm)	2-4	Fe ppm	150-200
Total N %	1-1.4	Mn ppm	25.56
Org. matter %	32-34	Cu ppm	75-150
Org. carbon %	18.5-19.7	Zn ppm	150-225

Fresh and active two biofertilizers, Effective microorganisms (E.M.) and Minia Azotein (M.A.) applied either separately or in a mixture three times at one month interval starting December 18th for both seasons. Biofertilizers were added to the soil around each plant (50 ml/plant, 1 ml=10⁷ cells) and then plants were irrigated immediately. All other agricultural practices were carried out as usual in the region.

into three equal batches and added at one month interval, starting December 25th of both seasons.

The plants were harvested three times every two months starting 1st March, also flowers were collected before harvesting the plants. Data were recorded for dry weight of herb/plant per cut and total herb yield/plant/season, dry weigh of flowering heads /plant/cut and total flower yield/plant/season. Also, total yield of essential oil/plant was calculated (oil yield/herb/plant + oil yield/plant/ flowering head). Essential oil was determined according to British Pharmacopoeia, 1963.

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

RESULTS AND DISCUSSION

1- Herb and flowering head dry weights :

Data presented in Tables (1, 2, 3 and 4) indicated that both herb dry weight and flowering head dry weight regardless of compost levels or mineral NPK and/or biofertilization were heavier in the third flowering cut following by the second cut and then first cut. Herb dry weight and flowered head dry weight were significantly increased in the two seasons during the three cuts due to the application of all studied compost treatments i.e. 5, 7.5 and 10 ton/fed., over that of untreated control plants. Among the three compost levels, herb and flowering head dry weights became gradually heavier parallel to the gradual increase in the level of compost fertilization with significant differences being detected in all cuts in the two seasons. The heaviest weights were obtained with the highest level of compost (10 ton/fed.).

The obtained data indicated that application of compost increased weight of herb and flowering head compared to the control. This could be attributed to the role of organic fertilization in enhancing plant growth which reflected in flowering yield. These results are in agreement with those reported by Harb and Mahmoud

(2009) and Ferraz *et al.* (2014) on yarrow plants.

Concerning mineral NPK and/or biofertilization treatments the seven tested treatments significantly affected both herb dry weight and flowering head dry weight in the three cuts during both seasons. The mineral NPK (full dose) followed by 75 % NPK + E.M. + M.A. treatments seems to be the most effective treatments with no significant differences being existed, in the three cuts during both seasons. The mineral NPK (full dose) followed by 75 % NPK + E.M. + M.A. treatments seem to be the most effective treatments with no significant differences being existed, in the three cuts during both seasons, between such two treatments as clearly shown in Tables (1, 2, 3 and 4). The treatments of 50 % NPK + M.A. gave the least values. The superiority of mineral NPK and bio-fertilizers application alone or together for stimulating herb and flowering dry weights exhibited the same trend owing to the favorable effect of 100 % NPK and 75 % NPK + biofertilizers on dry yield might be attributed to the improved nutrition (Dhillon *et al.*, 1980). Similar results were obtained by Giorgi *et al.* (2009) on *Achillea collina* and El-Mekawy (2013) on *Achillea santolina* regarding the effect of mineral NPK fertilization. While, Abd El-Raaf (2009) on borage and Ali (2013) on *Calendula officinalis* regarding the effect of biofertilizers.

The interaction between compost and mineral NPK and/or biofertilization treatments was

significant for herb and head flowering dry weights in the three cuts in both seasons. The highest values were obtained with compost (10 ton/fed.) combined with full dose of NPK followed by the treatments (10 ton/fed. compost) combined with 75 % NPK plus the mixture of E.M.+M.A (Tables, 1 to 4).

2- Essential oil percentage and oil yield in herb and in flower heads :

2-A- Essential oil % and yield/plant/cut and /plant/season in the herb :

Data presented in Tables (5 to 14) indicated that oil percentage in Tables (5 and 6) and yield/cut (ml/cut) in Tables (7 and 8) and total oil yield/plant/season in the dry herb (Table 9) were significantly increased as a result of compost fertilization in the three cuts during the first and the second seasons, the maximum oil % and yield (ml/plant/cut or ml/plant/season) were obtained with compost at 10 ton/fed.

Data in Tables (10 to 14) showed that oil % (per plant/cut), oil yield (per cut) and total oil yield/plant/season were significantly increased with compost as an organic fertilization. The highest values were obtained in the plants that received (10 ton/fed.) compost.

These results are in agreement with those reported by Harb and Mahmoud (2009) and Ferraz *et al.* (2014) on yarrow, Mahboobeh *et al.* (2014) on peppermint and El-Nady (2015) on *Cymbopogon citratus*.

Concerning the effect of mineral NPK and/or biofertilization treatments on oil % in herb (Tables, 5 and 6) and in flower heads (Tables, 10 and 11), as well as, oil yield (ml/plant) in herb (Tables, 7 to 9), in flower head (Tables 12 to 14), it can be noticed that application treatment mineral NPK significantly increased oil % and oil yield in both dry herb and flower heads in all cuts in both seasons than all other used treatments, except, the treatment of 75 % NPK + E.M. + M.A. Many investigators studied the effect of mineral NPK on oil plant production, Kandil *et al.* (2009) on Genoverse basil, Abtahi *et al.* (2013) on geranium, El-Mekawy (2013) on *Achillea santolina* and Jadhav *et al.* (2014) on *Tagetes erecta* they concluded that mineral NPK were effective in enhancing oil production. While, application of bio-fertilizers had favorable effect on oil productivity as reported by Roshanpour *et al.* (2014) and Saburi *et al.* (2014) on basil plants. Also, Abdou *et al.* (2014) on lavender found that the reduced dose of mineral NPK plus biofertilizers resulted in the best values of percentage and oil yield/plant.

The interaction between main and sub plots treatments was significant for all above mentioned parameters. The maximum values were obtained as a result of the combination treatments between compost at 10 ton/fed. and mineral NPK (full dose) or 75 % NPK + biofertilizers (E.M. + M.A.) as indicated in Tables (5 to 14).

2-B- Total essential oil yield/plant :

From Table (15), it was clear that organic fertilizer such as compost had a significant effect on oil yield of yarrow plants in the two seasons. The highest oil yield (oil yield/plant in herb + oil yield/plant in flower heads) was obtained from compost at 10 ton/fed.

Data in Table (15) revealed that mineral NPK (100 %) followed by 75 % NPK + biofertilizers had a considerable effect on this parameter compared with other used treatments.

It is noticed that the combined treatment between compost and mineral NPK and/or biofertilization significantly increased oil yield production in comparison to control plants. The treatments of compost at 10 ton/fed. with 100 % NPK or with 75 % NPK + biofertilizers gave the maximum values of oil yield/plant as shown in Table (15).

Table (1): Effect of compost and bio-mineral NPK fertilization on herb dry weight of yarrow (*Achillea millefolium*, L.) plants during the first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	6.62	6.91	7.25	8.24	7.25
75 % NPK + E.M.	5.62	5.85	6.87	6.88	6.31
50 % NPK + E.M.	4.71	4.94	5.33	5.62	5.15
75 % NPK + M.A.	5.19	5.29	5.98	6.62	5.77
50 % NPK + M.A.	3.75	4.61	5.13	5.47	4.74
75 % NPK + E.M.+ M.A.	6.31	6.76	7.30	7.60	6.99
50 % NPK + E.M.+ M.A.	4.95	5.10	5.57	6.13	5.44
Mean (A)	5.31	5.64	6.20	6.65	5.95
L.S.D. at 5 %	A : 0.31		B : 0.28		AB : 0.56
2 nd Cut					
100 % NPK	11.48	12.61	12.77	13.51	12.59
75 % NPK + E.M.	10.56	10.88	11.42	12.49	11.34
50 % NPK + E.M.	9.10	9.34	9.71	11.03	9.80
75 % NPK + M.A.	10.23	10.58	11.15	12.18	11.03
50 % NPK + M.A.	7.98	8.11	8.85	10.27	8.80
75 % NPK + E.M.+ M.A.	11.21	12.13	12.17	13.18	12.18
50 % NPK + E.M.+ M.A.	9.66	9.94	10.39	11.36	10.34
Mean (A)	10.03	10.51	10.92	12.01	10.87
L.S.D. at 5 %	A : 0.40		B : 0.43		AB : 0.86
3 rd Cut					
100 % NPK	13.52	14.55	15.05	16.18	14.82
75 % NPK + E.M.	12.51	13.27	13.52	13.99	13.32
50 % NPK + E.M.	10.56	10.94	11.42	11.59	11.12
75 % NPK + M.A.	12.10	12.35	12.88	13.08	12.60
50 % NPK + M.A.	9.15	9.41	10.04	10.07	9.67
75 % NPK + E.M.+ M.A.	13.13	14.36	14.95	15.48	14.48
50 % NPK + E.M.+ M.A.	11.71	11.94	12.16	12.31	12.02
Mean (A)	11.81	12.39	12.86	13.25	12.58
L.S.D. at 5 %	A : 0.46		B : 0.51		AB : 1.02

Table (2): Effect of compost and bio-mineral NPK fertilization on herb dry weight of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	7.17	7.29	7.76	8.27	7.62
75 % NPK + E.M.	6.29	6.56	7.04	7.08	6.74
50 % NPK + E.M.	5.30	5.33	5.56	5.82	5.50
75 % NPK + M.A.	5.78	5.99	6.36	6.36	6.13
50 % NPK + M.A.	4.02	4.91	5.35	5.83	5.03
75 % NPK + E.M.+ M.A.	7.05	7.19	7.49	7.62	7.34
50 % NPK + E.M.+ M.A.	5.59	5.61	5.82	6.01	5.75
Mean (A)	5.88	6.13	6.48	6.71	6.30
L.S.D. at 5 %	A : 0.21		B : 0.29		AB : 0.58
2 nd Cut					
100 % NPK	11.15	11.61	12.19	12.46	11.86
75 % NPK + E.M.	10.20	10.67	11.50	11.52	10.98
50 % NPK + E.M.	8.62	9.11	9.82	10.34	9.47
75 % NPK + M.A.	9.78	10.36	10.70	11.46	10.58
50 % NPK + M.A.	7.68	8.36	8.42	9.05	8.38
75 % NPK + E.M.+ M.A.	10.64	11.10	12.02	12.22	11.50
50 % NPK + E.M.+ M.A.	9.36	10.14	10.29	10.61	10.10
Mean (A)	9.63	10.19	10.70	11.09	10.41
L.S.D. at 5 %	A : 0.33		B : 0.38		AB : 0.76
3 rd Cut					
100 % NPK	14.67	15.52	16.31	17.06	15.89
75 % NPK + E.M.	12.47	13.42	13.90	14.67	13.62
50 % NPK + E.M.	9.66	10.71	11.21	12.12	10.93
75 % NPK + M.A.	11.38	11.83	12.65	13.38	12.31
50 % NPK + M.A.	8.66	9.62	10.32	11.38	9.99
75 % NPK + E.M.+ M.A.	13.55	14.55	16.49	17.84	15.61
50 % NPK + E.M.+ M.A.	10.89	10.97	11.96	12.39	11.55
Mean (A)	11.61	12.38	13.27	14.12	12.85
L.S.D. at 5 %	A : 0.45		B : 0.32		AB : 0.64

Table (3): Effect of compost and bio-mineral NPK fertilization on flowering heads dry weight (g/plant) of yarrow (*Achillea millefolium*, L.) plants during the first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	9.45	9.87	10.35	11.77	10.36
75 % NPK + E.M.	8.03	8.36	9.82	9.83	9.01
50 % NPK + E.M.	6.73	7.06	7.61	8.03	7.36
75 % NPK + M.A.	7.42	7.55	8.54	9.46	8.24
50 % NPK + M.A.	5.36	6.59	7.33	7.82	6.77
75 % NPK + E.M.+ M.A.	9.02	9.65	10.43	10.86	9.99
50 % NPK + E.M.+ M.A.	7.07	7.29	7.96	8.76	7.77
Mean (A)	7.58	8.05	8.86	9.50	8.50
L.S.D. at 5 %	A : 0.45		B : 0.38		AB : 0.76
2 nd Cut					
100 % NPK	14.35	15.76	15.96	16.89	15.74
75 % NPK + E.M.	13.20	13.60	14.28	15.61	14.18
50 % NPK + E.M.	11.37	11.68	12.14	13.79	12.25
75 % NPK + M.A.	12.79	13.22	13.94	15.23	13.79
50 % NPK + M.A.	9.98	10.14	11.06	12.84	11.00
75 % NPK + E.M.+ M.A.	14.01	15.16	15.21	16.48	15.22
50 % NPK + E.M.+ M.A.	12.08	12.42	12.99	14.20	12.92
Mean (A)	12.54	13.14	13.65	15.01	13.59
L.S.D. at 5 %	A : 0.60		B : 0.54		AB : 1.64
3 rd Cut					
100 % NPK	30.95	33.30	34.45	37.04	33.93
75 % NPK + E.M.	28.63	30.37	30.95	32.02	30.49
50 % NPK + E.M.	24.16	25.03	26.15	26.54	25.46
75 % NPK + M.A.	27.68	28.26	29.48	29.93	28.84
50 % NPK + M.A.	20.95	21.53	22.97	23.05	22.12
75 % NPK + E.M.+ M.A.	30.05	32.86	34.21	35.43	33.14
50 % NPK + E.M.+ M.A.	26.80	27.34	27.82	28.18	27.53
Mean (A)	27.03	28.38	29.44	30.31	28.79
L.S.D. at 5 %	A : 0.75		B : 0.78		AB : 1.56

Table (4): Effect of compost and bio-mineral NPK fertilization on flowering heads dry weight (g/plant) of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	10.24	10.42	11.09	11.82	10.89
75 % NPK + E.M.	8.98	9.37	10.05	10.11	9.63
50 % NPK + E.M.	7.57	7.61	7.94	8.31	7.86
75 % NPK + M.A.	8.26	8.56	9.08	9.08	8.75
50 % NPK + M.A.	5.74	7.01	7.64	8.33	7.18
75 % NPK + E.M.+ M.A.	10.07	10.27	10.70	10.89	10.48
50 % NPK + E.M.+ M.A.	7.99	8.01	8.31	8.58	8.22
Mean (A)	8.40	8.75	9.26	9.59	9.00
L.S.D. at 5 %	A : 0.25		B : 0.42		AB : 0.84
2 nd Cut					
100 % NPK	13.94	14.51	15.24	15.58	14.82
75 % NPK + E.M.	12.75	13.34	14.37	14.40	13.72
50 % NPK + E.M.	10.78	11.39	12.27	12.93	11.84
75 % NPK + M.A.	12.22	12.95	13.38	14.33	13.22
50 % NPK + M.A.	9.60	10.45	10.52	11.31	10.47
75 % NPK + E.M.+ M.A.	13.30	13.87	15.03	15.27	14.37
50 % NPK + E.M.+ M.A.	11.70	12.68	12.86	13.26	12.62
Mean (A)	12.04	12.74	13.38	13.86	13.01
L.S.D. at 5 %	A : 0.32		B : 0.45		AB : 0.90
3 rd Cut					
100 % NPK	33.41	35.35	37.15	38.87	36.20
75 % NPK + E.M.	28.39	30.57	31.66	33.42	31.02
50 % NPK + E.M.	21.99	24.39	25.52	27.61	24.88
75 % NPK + M.A.	25.91	26.94	28.80	30.49	28.04
50 % NPK + M.A.	19.72	21.91	23.52	25.91	22.76
75 % NPK + E.M.+ M.A.	32.15	33.15	37.15	40.50	35.74
50 % NPK + E.M.+ M.A.	23.61	24.38	26.58	27.54	25.53
Mean (A)	22.17	28.10	30.06	32.04	28.09
L.S.D. at 5 %	A : 0.85		B : 0.48		AB : 0.96

Table (5): Effect of compost and bio-mineral NPK fertilization on oil percentage (in herb) of yarrow (*Achillea millefolium*, L.) plants during the first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.308	0.325	0.354	0.383	0.343
75 % NPK + E.M.	0.257	0.286	0.297	0.319	0.290
50 % NPK + E.M.	0.234	0.240	0.251	0.274	0.250
75 % NPK + M.A.	0.251	0.268	0.291	0.314	0.281
50 % NPK + M.A.	0.223	0.229	0.228	0.234	0.229
75 % NPK + E.M.+ M.A.	0.298	0.302	0.320	0.325	0.311
50 % NPK + E.M.+ M.A.	0.245	0.257	0.274	0.308	0.271
Mean (A)	0.259	0.272	0.288	0.308	0.282
L.S.D. at 5 %	A : 0.012		B : 0.032		AB : 0.064
2 nd Cut					
100 % NPK	0.434	0.480	0.514	0.526	0.488
75 % NPK + E.M.	0.349	0.349	0.365	0.365	0.357
50 % NPK + E.M.	0.268	0.292	0.308	0.331	0.300
75 % NPK + M.A.	0.275	0.343	0.343	0.360	0.330
50 % NPK + M.A.	0.211	0.240	0.273	0.280	0.251
75 % NPK + E.M.+ M.A.	0.388	0.394	0.406	0.411	0.400
50 % NPK + E.M.+ M.A.	0.274	0.308	0.331	0.337	0.313
Mean (A)	0.314	0.344	0.363	0.373	0.349
L.S.D. at 5 %	A : 0.010		B : 0.088		AB : 0.176
3 rd Cut					
100 % NPK	0.468	0.520	0.526	0.531	0.511
75 % NPK + E.M.	0.371	0.383	0.406	0.411	0.393
50 % NPK + E.M.	0.308	0.331	0.360	0.371	0.343
75 % NPK + M.A.	0.331	0.377	0.377	0.406	0.373
50 % NPK + M.A.	0.257	0.302	0.302	0.331	0.298
75 % NPK + E.M.+ M.A.	0.406	0.428	0.445	0.446	0.431
50 % NPK + E.M.+ M.A.	0.314	0.343	0.371	0.377	0.351
Mean (A)	0.351	0.383	0.398	0.410	0.386
L.S.D. at 5 %	A : 0.011		B : 0.080		AB : 0.160

Table (6): Effect of compost and bio-mineral NPK fertilization on oil percentage (in herb) of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.308	0.337	0.377	0.377	0.350
75 % NPK + E.M.	0.245	0.287	0.291	0.297	0.280
50 % NPK + E.M.	0.239	0.245	0.245	0.257	0.247
75 % NPK + M.A.	0.241	0.247	0.286	0.291	0.266
50 % NPK + M.A.	0.211	0.234	0.239	0.240	0.231
75 % NPK + E.M.+ M.A.	0.286	0.302	0.314	0.326	0.307
50 % NPK + E.M.+ M.A.	0.240	0.246	0.263	0.286	0.259
Mean (A)	0.253	0.271	0.288	0.296	0.277
L.S.D. at 5 %	A : 0.008		B : 0.043		AB : 0.086
2 nd Cut					
100 % NPK	0.417	0.485	0.508	0.508	0.480
75 % NPK + E.M.	0.354	0.359	0.360	0.377	0.362
50 % NPK + E.M.	0.253	0.296	0.314	0.343	0.302
75 % NPK + M.A.	0.302	0.348	0.354	0.371	0.344
50 % NPK + M.A.	0.217	0.262	0.285	0.302	0.266
75 % NPK + E.M.+ M.A.	0.388	0.394	0.400	0.401	0.395
50 % NPK + E.M.+ M.A.	0.280	0.302	0.325	0.343	0.313
Mean (A)	0.316	0.350	0.364	0.378	0.352
L.S.D. at 5 %	A : 0.014		B : 0.086		AB : 0.172
3 rd Cut					
100 % NPK	0.485	0.514	0.542	0.548	0.523
75 % NPK + E.M.	0.383	0.383	0.394	0.417	0.394
50 % NPK + E.M.	0.308	0.314	0.348	0.360	0.332
75 % NPK + M.A.	0.315	0.377	0.383	0.391	0.367
50 % NPK + M.A.	0.268	0.268	0.308	0.325	0.293
75 % NPK + E.M.+ M.A.	0.422	0.428	0.434	0.434	0.430
50 % NPK + E.M.+ M.A.	0.314	0.360	0.377	0.377	0.357
Mean (A)	0.356	0.378	0.398	0.407	0.385
L.S.D. at 5 %	A : 0.009		B : 0.094		AB : 0.188

Table (7): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/cut (in herb) of yarrow (*Achillea millefolium*, L.) plants during the first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1st Cut					
100 % NPK	0.020	0.022	0.026	0.032	0.025
75 % NPK + E.M.	0.014	0.017	0.020	0.022	0.018
50 % NPK + E.M.	0.011	0.012	0.013	0.015	0.013
75 % NPK + M.A.	0.013	0.014	0.017	0.021	0.016
50 % NPK + M.A.	0.008	0.011	0.012	0.013	0.011
75 % NPK + E.M.+ M.A.	0.019	0.020	0.023	0.025	0.022
50 % NPK + E.M.+ M.A.	0.012	0.013	0.015	0.019	0.015
Mean (A)	0.014	0.015	0.018	0.020	0.017
L.S.D. at 5 %	A : 0.001		B : 0.003		AB : 0.006
2nd Cut					
100 % NPK	0.050	0.061	0.066	0.071	0.061
75 % NPK + E.M.	0.037	0.038	0.042	0.046	0.040
50 % NPK + E.M.	0.024	0.027	0.030	0.037	0.029
75 % NPK + M.A.	0.028	0.036	0.038	0.044	0.036
50 % NPK + M.A.	0.017	0.019	0.024	0.029	0.022
75 % NPK + E.M.+ M.A.	0.043	0.048	0.049	0.054	0.049
50 % NPK + E.M.+ M.A.	0.026	0.031	0.034	0.038	0.032
Mean (A)	0.031	0.036	0.040	0.045	0.038
L.S.D. at 5 %	A : 0.003		B : 0.012		AB : 0.024
3rd Cut					
100 % NPK	0.063	0.076	0.079	0.086	0.076
75 % NPK + E.M.	0.046	0.051	0.055	0.057	0.052
50 % NPK + E.M.	0.033	0.036	0.041	0.043	0.038
75 % NPK + M.A.	0.040	0.047	0.049	0.053	0.047
50 % NPK + M.A.	0.024	0.028	0.030	0.033	0.029
75 % NPK + E.M.+ M.A.	0.053	0.061	0.067	0.069	0.062
50 % NPK + E.M.+ M.A.	0.037	0.041	0.045	0.046	0.042
Mean (A)	0.041	0.047	0.051	0.054	0.049
L.S.D. at 5 %	A : 0.005		B : 0.015		AB : 0.030

Table (8): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/cut (in herb) of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1st Cut					
100 % NPK	0.022	0.025	0.029	0.031	0.027
75 % NPK + E.M.	0.015	0.019	0.020	0.021	0.019
50 % NPK + E.M.	0.013	0.013	0.014	0.015	0.014
75 % NPK + M.A.	0.014	0.015	0.018	0.019	0.016
50 % NPK + M.A.	0.008	0.011	0.013	0.014	0.012
75 % NPK + E.M.+ M.A.	0.020	0.022	0.024	0.025	0.023
50 % NPK + E.M.+ M.A.	0.013	0.014	0.015	0.017	0.015
Mean (A)	0.015	0.017	0.019	0.020	0.017
L.S.D. at 5 %	A : 0.002		B : 0.004		AB : 0.008
2nd Cut					
100 % NPK	0.046	0.056	0.062	0.063	0.057
75 % NPK + E.M.	0.036	0.038	0.041	0.043	0.040
50 % NPK + E.M.	0.022	0.027	0.031	0.035	0.029
75 % NPK + M.A.	0.030	0.036	0.038	0.043	0.036
50 % NPK + M.A.	0.017	0.022	0.024	0.027	0.022
75 % NPK + E.M.+ M.A.	0.041	0.044	0.048	0.049	0.045
50 % NPK + E.M.+ M.A.	0.026	0.031	0.033	0.036	0.032
Mean (A)	0.030	0.036	0.039	0.042	0.037
L.S.D. at 5 %	A : 0.005		B : 0.013		AB : 0.026
3rd Cut					
100 % NPK	0.071	0.080	0.088	0.093	0.083
75 % NPK + E.M.	0.048	0.051	0.055	0.061	0.054
50 % NPK + E.M.	0.030	0.034	0.039	0.044	0.036
75 % NPK + M.A.	0.036	0.045	0.048	0.052	0.045
50 % NPK + M.A.	0.023	0.026	0.032	0.037	0.029
75 % NPK + E.M.+ M.A.	0.057	0.062	0.072	0.077	0.067
50 % NPK + E.M.+ M.A.	0.034	0.039	0.045	0.047	0.041
Mean (A)	0.041	0.047	0.053	0.057	0.049
L.S.D. at 5 %	A : 0.003		B : 0.016		AB : 0.032

Table (9): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/season (in herb) of yarrow (*Achillea millefolium*, L.) plants during the first and second seasons (2013/2014 and 2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
First season (2013/2014)					
100 % NPK	0.133	0.159	0.170	0.189	0.162
75 % NPK + E.M.	0.098	0.106	0.117	0.125	0.111
50 % NPK + E.M.	0.068	0.075	0.084	0.095	0.080
75 % NPK + M.A.	0.081	0.097	0.104	0.118	0.100
50 % NPK + M.A.	0.049	0.058	0.066	0.075	0.062
75 % NPK + E.M.+ M.A.	0.116	0.130	0.139	0.148	0.133
50 % NPK + E.M.+ M.A.	0.075	0.085	0.095	0.104	0.089
Mean (A)	0.087	0.099	0.109	0.120	0.103
L.S.D. at 5 %	A : 0.010		B : 0.030		AB : 0.060
Second season (2014/2015)					
100 % NPK	0.140	0.161	0.180	0.188	0.167
75 % NPK + E.M.	0.099	0.109	0.117	0.126	0.112
50 % NPK + E.M.	0.064	0.074	0.083	0.094	0.078
75 % NPK + M.A.	0.079	0.095	0.105	0.113	0.098
50 % NPK + M.A.	0.048	0.059	0.069	0.078	0.063
75 % NPK + E.M.+ M.A.	0.119	0.128	0.143	0.151	0.135
50 % NPK + E.M.+ M.A.	0.074	0.084	0.094	0.100	0.088
Mean (A)	0.087	0.099	0.110	0.119	0.104
L.S.D. at 5 %	A : 0.008		B : 0.032		AB : 0.064

Table (10): Effect of compost and bio-mineral NPK fertilization on oil percentage (in flower head) of yarrow (*Achillea millefolium*, L.) plants during first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.514	0.542	0.590	0.638	0.571
75 % NPK + E.M.	0.428	0.476	0.495	0.532	0.483
50 % NPK + E.M.	0.390	0.400	0.418	0.457	0.416
75 % NPK + M.A.	0.419	0.447	0.485	0.523	0.469
50 % NPK + M.A.	0.371	0.381	0.380	0.390	0.381
75 % NPK + E.M.+ M.A.	0.496	0.504	0.533	0.542	0.519
50 % NPK + E.M.+ M.A.	0.409	0.428	0.456	0.514	0.452
Mean (A)	0.432	0.454	0.480	0.514	0.470
L.S.D. at 5 %	A : 0.066		B : 0.067		AB : 0.135
2 nd Cut					
100 % NPK	0.723	0.800	0.857	0.876	0.814
75 % NPK + E.M.	0.581	0.581	0.608	0.609	0.595
50 % NPK + E.M.	0.447	0.486	0.514	0.552	0.500
75 % NPK + M.A.	0.458	0.571	0.571	0.600	0.550
50 % NPK + M.A.	0.352	0.400	0.455	0.466	0.418
75 % NPK + E.M.+ M.A.	0.647	0.657	0.676	0.685	0.666
50 % NPK + E.M.+ M.A.	0.457	0.514	0.552	0.562	0.521
Mean (A)	0.524	0.573	0.605	0.621	0.581
L.S.D. at 5 %	A : 0.131		B : 0.086		AB : 0.171
3 rd Cut					
100 % NPK	0.780	0.866	0.876	0.885	0.852
75 % NPK + E.M.	0.619	0.638	0.676	0.685	0.655
50 % NPK + E.M.	0.514	0.552	0.600	0.618	0.571
75 % NPK + M.A.	0.552	0.628	0.629	0.676	0.621
50 % NPK + M.A.	0.428	0.504	0.504	0.552	0.497
75 % NPK + E.M.+ M.A.	0.676	0.714	0.742	0.744	0.719
50 % NPK + E.M.+ M.A.	0.523	0.571	0.619	0.628	0.585
Mean (A)	0.585	0.639	0.664	0.684	0.643
L.S.D. at 5 %	A : 0.053		B : 0.051		AB : 0.102

Table (11): Effect of compost and bio-mineral NPK fertilization on oil percentage (in flower head) of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.514	0.562	0.628	0.628	0.583
75 % NPK + E.M.	0.409	0.478	0.485	0.495	0.467
50 % NPK + E.M.	0.399	0.409	0.409	0.428	0.411
75 % NPK + M.A.	0.401	0.411	0.476	0.485	0.443
50 % NPK + M.A.	0.352	0.390	0.399	0.400	0.385
75 % NPK + E.M.+ M.A.	0.476	0.504	0.524	0.543	0.512
50 % NPK + E.M.+ M.A.	0.400	0.410	0.438	0.476	0.431
Mean (A)	0.422	0.452	0.480	0.494	0.462
L.S.D. at 5 %	A : 0.062		B : 0.067		AB : 0.135
2 nd Cut					
100 % NPK	0.695	0.809	0.847	0.847	0.800
75 % NPK + E.M.	0.590	0.599	0.600	0.628	0.604
50 % NPK + E.M.	0.422	0.494	0.523	0.571	0.503
75 % NPK + M.A.	0.504	0.580	0.590	0.618	0.573
50 % NPK + M.A.	0.361	0.437	0.475	0.504	0.444
75 % NPK + E.M.+ M.A.	0.647	0.656	0.666	0.668	0.659
50 % NPK + E.M.+ M.A.	0.466	0.504	0.542	0.572	0.521
Mean (A)	0.526	0.583	0.606	0.630	0.586
L.S.D. at 5 %	A : 0.056		B : 0.066		AB : 0.132
3 rd Cut					
100 % NPK	0.809	0.856	0.904	0.914	0.871
75 % NPK + E.M.	0.638	0.638	0.657	0.695	0.657
50 % NPK + E.M.	0.514	0.523	0.580	0.600	0.554
75 % NPK + M.A.	0.525	0.629	0.638	0.651	0.611
50 % NPK + M.A.	0.447	0.447	0.514	0.542	0.488
75 % NPK + E.M.+ M.A.	0.704	0.714	0.723	0.723	0.716
50 % NPK + E.M.+ M.A.	0.524	0.600	0.628	0.628	0.595
Mean (A)	0.594	0.630	0.663	0.679	0.642
L.S.D. at 5 %	A : 0.090		B : 0.087		AB : 0.173

Table (12): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/cut (in flower head) of yarrow (*Achillea millefolium*, L.) plants during the first season (2013/2014).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.049	0.053	0.061	0.075	0.059
75 % NPK + E.M.	0.034	0.040	0.049	0.052	0.044
50 % NPK + E.M.	0.026	0.028	0.032	0.037	0.031
75 % NPK + M.A.	0.031	0.034	0.041	0.049	0.039
50 % NPK + M.A.	0.020	0.025	0.028	0.030	0.026
75 % NPK + E.M.+ M.A.	0.045	0.049	0.056	0.059	0.052
50 % NPK + E.M.+ M.A.	0.029	0.031	0.036	0.045	0.035
Mean (A)	0.033	0.037	0.043	0.049	0.040
L.S.D. at 5 %	A : 0.004		B : 0.008		AB : 0.016
2 nd Cut					
100 % NPK	0.104	0.126	0.137	0.148	0.128
75 % NPK + E.M.	0.077	0.079	0.087	0.095	0.084
50 % NPK + E.M.	0.051	0.057	0.062	0.076	0.061
75 % NPK + M.A.	0.059	0.075	0.080	0.091	0.076
50 % NPK + M.A.	0.035	0.041	0.050	0.060	0.046
75 % NPK + E.M.+ M.A.	0.091	0.100	0.103	0.113	0.101
50 % NPK + E.M.+ M.A.	0.055	0.064	0.072	0.080	0.067
Mean (A)	0.066	0.075	0.083	0.093	0.079
L.S.D. at 5 %	A : 0.007		B : 0.009		AB : 0.018
3 rd Cut					
100 % NPK	0.241	0.288	0.302	0.328	0.289
75 % NPK + E.M.	0.177	0.194	0.209	0.219	0.200
50 % NPK + E.M.	0.124	0.138	0.157	0.164	0.145
75 % NPK + M.A.	0.153	0.177	0.185	0.202	0.179
50 % NPK + M.A.	0.090	0.109	0.116	0.127	0.110
75 % NPK + E.M.+ M.A.	0.203	0.235	0.254	0.264	0.238
50 % NPK + E.M.+ M.A.	0.140	0.156	0.172	0.177	0.161
Mean (A)	0.158	0.181	0.195	0.207	0.185
L.S.D. at 5 %	A : 0.021		B : 0.052		AB : 0.104

Table (13): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/cut (in flower head) of yarrow (*Achillea millefolium*, L.) plants during the second season (2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
1 st Cut					
100 % NPK	0.053	0.059	0.070	0.074	0.063
75 % NPK + E.M.	0.037	0.045	0.049	0.050	0.045
50 % NPK + E.M.	0.030	0.031	0.032	0.036	0.032
75 % NPK + M.A.	0.033	0.035	0.043	0.044	0.039
50 % NPK + M.A.	0.020	0.027	0.030	0.033	0.028
75 % NPK + E.M.+ M.A.	0.048	0.052	0.056	0.059	0.054
50 % NPK + E.M.+ M.A.	0.032	0.033	0.036	0.041	0.035
Mean (A)	0.035	0.040	0.044	0.047	0.042
L.S.D. at 5 %	A : 0.004		B : 0.010		AB : 0.020
2 nd Cut					
100 % NPK	0.097	0.117	0.129	0.132	0.119
75 % NPK + E.M.	0.075	0.080	0.086	0.090	0.083
50 % NPK + E.M.	0.045	0.056	0.064	0.074	0.060
75 % NPK + M.A.	0.062	0.075	0.079	0.089	0.076
50 % NPK + M.A.	0.035	0.046	0.050	0.057	0.046
75 % NPK + E.M.+ M.A.	0.086	0.091	0.100	0.102	0.095
50 % NPK + E.M.+ M.A.	0.055	0.064	0.070	0.076	0.066
Mean (A)	0.063	0.074	0.081	0.087	0.076
L.S.D. at 5 %	A : 0.006		B : 0.026		AB : 0.052
3 rd Cut					
100 % NPK	0.270	0.303	0.336	0.355	0.315
75 % NPK + E.M.	0.181	0.195	0.208	0.232	0.204
50 % NPK + E.M.	0.113	0.128	0.148	0.166	0.138
75 % NPK + M.A.	0.136	0.169	0.184	0.198	0.171
50 % NPK + M.A.	0.088	0.098	0.121	0.140	0.111
75 % NPK + E.M.+ M.A.	0.226	0.237	0.269	0.293	0.256
50 % NPK + E.M.+ M.A.	0.124	0.146	0.167	0.173	0.152
Mean (A)	0.132	0.177	0.199	0.218	0.180
L.S.D. at 5 %	A : 0.040		B : 0.060		AB : 0.120

Table (14): Effect of compost and bio-mineral NPK fertilization on oil yield/plant/season (in flower head) of yarrow (*Achillea millefolium*, L.) plants during the first and second seasons (2013/2014 and 2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
First season (2013/2014)					
100 % NPK	0.394	0.468	0.500	0.551	0.476
75 % NPK + E.M.	0.288	0.313	0.345	0.367	0.328
50 % NPK + E.M.	0.201	0.223	0.251	0.277	0.237
75 % NPK + M.A.	0.242	0.287	0.306	0.343	0.294
50 % NPK + M.A.	0.145	0.174	0.194	0.218	0.182
75 % NPK + E.M.+ M.A.	0.339	0.383	0.412	0.435	0.391
50 % NPK + E.M.+ M.A.	0.224	0.251	0.280	0.302	0.263
Mean (A)	0.257	0.293	0.321	0.349	0.304
L.S.D. at 5 %	A : 0.021		B : 0.088		AB : 0.176
Second season (2014/2015)					
100 % NPK	0.420	0.479	0.535	0.561	0.497
75 % NPK + E.M.	0.293	0.320	0.343	0.373	0.332
50 % NPK + E.M.	0.189	0.215	0.245	0.275	0.230
75 % NPK + M.A.	0.231	0.280	0.306	0.331	0.286
50 % NPK + M.A.	0.143	0.171	0.201	0.231	0.185
75 % NPK + E.M.+ M.A.	0.360	0.379	0.425	0.454	0.404
50 % NPK + E.M.+ M.A.	0.210	0.243	0.273	0.290	0.253
Mean (A)	0.230	0.291	0.325	0.352	0.298
L.S.D. at 5 %	A : 0.026		B : 0.095		AB : 0.190

Table (15): Effect of compost and bio-mineral NPK fertilization on total oil yield/plant/season (in herb + in flower head) of yarrow (*Achillea millefolium*, L.) plants during the first and second seasons (2013/2014 and 2014/2015).

Bio-mineral NPK fertilization treatments (B)	Compost levels (ton/fed.) (A)				Mean (B)
	0.0	5.0	7.5	10.0	
First season (2013/2014)					
100 % NPK	0.527	0.627	0.670	0.740	0.638
75 % NPK + E.M.	0.386	0.419	0.462	0.492	0.439
50 % NPK + E.M.	0.269	0.298	0.335	0.372	0.317
75 % NPK + M.A.	0.323	0.384	0.410	0.461	0.394
50 % NPK + M.A.	0.194	0.232	0.260	0.293	0.244
75 % NPK + E.M.+ M.A.	0.455	0.513	0.551	0.583	0.524
50 % NPK + E.M.+ M.A.	0.299	0.336	0.375	0.406	0.352
Mean (A)	0.344	0.392	0.430	0.469	0.407
L.S.D. at 5 %	A : 0.037		B : 0.116		AB : 0.232
Second season (2014/2015)					
100 % NPK	0.560	0.640	0.715	0.749	0.664
75 % NPK + E.M.	0.392	0.429	0.460	0.499	0.444
50 % NPK + E.M.	0.253	0.289	0.328	0.369	0.308
75 % NPK + M.A.	0.310	0.375	0.411	0.444	0.384
50 % NPK + M.A.	0.191	0.230	0.270	0.309	0.248
75 % NPK + E.M.+ M.A.	0.479	0.507	0.568	0.605	0.539
50 % NPK + E.M.+ M.A.	0.284	0.327	0.367	0.390	0.341
Mean (A)	0.317	0.390	0.435	0.471	0.402
L.S.D. at 5 %	A : 0.035		B : 0.127		AB : 0.254

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الملخص العربي

استجابة نباتات الأشيليا لبعض المعاملات الزراعية

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تم إجراء تجربة حقلية في موسمي 2013/2014 و 2014/2015 بمزرعة كلية الزراعة جامعة المنيا بهدف دراسة تأثير الكمبوست (صفر ، 5 ، 7.5 و 10 طن/فدان) والتسميد المعدني ن فو بو و/أو التسميد الحيوي على محصول العشب وإنتاجية الزيت لنباتات الأشيليا.

أظهرت النتائج أن:

- المستويات الثلاثة للكمبوست أدت إلى زيادة معنوية في محصول العشب والنسبة المئوية للزيت ومحصول الزيت للنبات/الحشة وللنبات/موسم. الكمبوست عند مستوى 10 طن/فدان كان أكثر فاعلية في زيادة الإنتاجية للنبات.
 - معاملة النباتات بالسماط المعدني ن فو بو (100 %) أو 75 % ن فو بو + تسميد حيوي كان أكثر فاعلية في هذا الصدد مقارنة بالمعاملات المستعملة الأخرى.
- معاملة التفاعل بين الكمبوست (10 طن/فدان) مع التسميد المعدني ن فو بو (100 %) أو 75 % ن فو بو + الحيوي (الميكروبات الدقيقة النشطة + المنيا أزوتين) أعطت أفضل النتائج في هذا الشأن بدون فرق معنوي بين هاتين المعاملتين المتفوقتين للتفاعل.