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Productivity of Thyme (*Thymus vulgaris* L.) as Influenced by Organic and Biological Fertilizers

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ABSTRACT

The aerial part of the thyme plant is the most widely used herbal medication and spice. Nutrition plays a key role on producing high quality of thyme as soil nutrients show important role in growth and quality of medicinal plants. Field trials were established during 2020-2021 and 2021-2022 seasons in Agricultural Research Station at Tag El-Ezz Experimental Farm, to study the impact of organic, mineral and bio fertilization on vegetative growth, biochemical content and essential oil of thyme Experiment were conducted in split plot design with 3 riplicats, bio fertilization was the main plot as (without and with Azotobacter), while mineral and organic fertilization as the sub plot with (100% NPK, 100% organic, 25% Org+75% NPK, 75% Org+25% NPK and 50% Org+50% NPK). Results indicated that precence of Azotobacted imp0roved vegetative growth. chemical content and quality of leaves as well as essential oil content of thyme plant, Addition of 25% virmecompost+75% NPK recorded the highest values of various parameters. So, the application of 25% virmecompost+75% NPK in precence of Azotobacter was the recommended treatment used for improving thym vegetative and quality as well as essential oil content of thym plant.

Keywords: Thyme, organic, mineral, Bio- fertilization, growth and essential oil.

1. Introduction

For centuries, herbs have been extremely popular between consumers. They are a rich source of natural products (Nurzyńska-Wierdak *et al.,* 2012). They have a wide range of primary and secondary compounds, which has led to their use as a medicinal and spice raw resource. They're excellent disinfectants and antitussives (Hałubowicz-Kliza 2007, Kazimierczak *et al.,* 2011). Thyme (*Thymus vulgaris* L.) is an aromatic, plant and member in *Lamiaceae* family Thyme essential oil can be used in pharmaceutical, drug and food industries (Khazaie *et al.,* 2008; Chizzola *et al.,* 2008; Bassolé and Rodolfo-Juliani 2012). The essential oil content, vitamins, phenolics, flavonoids, tannins, minerals, vitamins, and triterpene components define the usefulness and abundance of thyme (Dauqan and Abdullah, 2017).

Chemical fertilization is a quick approach to giving plants but abundant utilization has perilous ecological impacts like leaching, emission, and runoff, polluting aquatic environments and salt accumulation in soil. Chemical replenishes NPK but depletes key soil nutrients found in fertile soil, resulting in a loss of soil fertility. In this approach, it is necessary to avoid environmental pollution by administering the recommended dosages of NPK required by the crop and replacing mineral fertilizers with organic and biological fertilizers (Sakr, 2017).

Improvements in agronomic approaches utilized in the cultivation of this famous species are being made, particularly in terms of using organic and ecologically friendly methods (e.g., looking for fertilization options rather than the standard mineral NPK fertilization method) that are able to do positively influencing the yield and quality of herbal material (Kwiatkowski *et al.,* 2020; Kwiatkowski and Harasim 2021). Researchers have begun to focus on the detrimental consequences of using NPK as mineral fertilizers in agriculture, both in terms of agriculture and on humans. As a result, the development of suitable alternatives for giving nutrients to crops (so-called "green agriculture"), such as organic and bio fertilizers, could reduce the difficulties associated with traditional NPK mineral

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fertilizers and thereby protecting both human health and the environment (Nejatzadeh-Barandozi and Pourmaleknejad, 2014; Skubij and Dzida, 2016; Kwiatkowski and Harasim, 2021).

Utilization of biofertilizers an alternative for chemical fertilizers should not be considered as a simple objective and short term benefits; however as a mean to improve environmental conditions then human health (Khorrami *et al.,* 2016). Biological fertilization uses soil amendments containing various forms of organic matter and/or rhizosphere microorganisms that interact favorably with the plant (Sakr, 2017). As far as sustainability, organic and bio-fertilizer are becoming more popular as alternatives to mineral fertilization for growing healthy and natural food. Organic fertilization is the use of decomposed organic matter to fertilize soil. It improves the soil's mechanical and physical properties, as well as water retention (Sakr, 2017). It slowly releases mineral nutrients throughout the growing season, giving the plant enough time to build strong roots, strong stems, and a disease- and pest-resistant immune system (Nejatzadeh-Barandozi and Pourmaleknejad, 2014). Organic matter stimulates root and leaf growth, resulting in an increase in yield (Kwiatkowski *et al.,* 2020). While, *Azotobacter* assumes a vital part in organic matter decomposition, elements cycling and they produce phytohormones like auxins, gibberellins and cytokinins (Sakr, 2017). Auxins promote cell elongation, root development, and root surface area, allowing the plant to absorb more nutrients, resulting in increased growth and yield (Tanimoto, 2005; Sakr, 2017). *Azotobacter* can fix atmospheric nitrogen, make and release some biological and active material such as nicotinic acid, biotin, vitamin B and pentoterik acid (Roshanpour *et al.,* 2014).

The aim of this study was to evaluate the effect of organic and bio fertilization or supplemented with different rates of NPK, as an alternative organic fertilization method, on the growth and chemical content of thyme plant. This was then compared with standard mineral NPK fertilization and organic fertilization.

2. Material and Methods

Field trials were established during 2020-2021 and 2021-2022 at Agricultural Research Station at Tag El-Ezz Experimental Farm, Temi El-Amdid District, El-Dakahlia Governorate, Egypt to study the effect of organic, mineral and bio fertilization on vegetative growth, chemical content and essential oil of thyme (*Thymus vulgaris* L.).

The experiment was conducted in a split plot design with 3 replicates. Bio fertilization was the main plot as (without and with *Azotobacter*), while mineral and organic fertilization as the sub plot with (100% NPK, 100% organic, 25% Org+75% NPK, 75% Org+25% NPKand 50% Org+50% NPK).Table 1 shows physic-chemical properties of the soil. Mechanical analysis determined according to the methods of Haluschak (2006). Available N, P and K were determined according to Reeuwijk (2002).

Table 1: Physical and chemical analyses of soil used in this study

	Particle size distribution (%)						
	Coarse sand	**Fine sand**	**Silt**	**Clay**	**Texture**		
Soil sample (0-30 cm)	6.18	8.96	37.11	47.75	Clay		
	Chemical properties and available nutrients						
	pH	**EC dSm^{-1}**	**OM (%)**	**SP (%)**	**N m ($mg\ kg^{-1}$)**	**P ($mg\ kg^{-1}$)**	**K ($mg\ kg^{-1}$)**
	7.86	5.84	1.28	88.52	39.81	7.68	210.4

pH was determined in soil suspension (1: 5), Soil Electrical Conductivity (EC) was determined in saturated soil paste extract

N-fixing bacteria as *Azotobacter chroococcum*was obtained from Bio-fertilizer production unit of Soil, Water and Environment Research Institute, Giza, Egypt. Seedling of Thymus were dipped in a solution for 5 min using a liquid culture from *Azotobacter* at a rate of 5 $ml.L^{-1}$ before planting (1ml contain 10^8 cells of bacteria) as recommended by (Omar and El-Katan, 2003).

Organic fertilizer in form of vermicompost was obtained from Central Laboratory for Agricultural Climate, Agricultural Research Center, Giza, Egypt and added during the preparation of soil in the two seasons at the rate of 10 ton.fed^{-1} as recommended dose. Chemical analysis of vermicompost in two seasons are showed in Table (2).

Table 2: Chemical analysis of the vermicompost used in the experimental.

Vermicompost	Chemical properties								
	pH (1:2.5)	EC, dSm^{-1} (1:5)	OM (%)	N (%)	P (%)	K (%)	Fe (ppm)	Zn (ppm)	Mn (ppm)
	7.86	6.78	45.16	1.81	1.09	0.65	1568	118	95

Chemical fertilizer (NPK): The recommended rate of nitrogen for thyme was applied at a rate of 50 kg N fed^{-1}using urea (46% N) and potassium was applied at a rate of 40 kg K_2O fed^{-1} using potassium sulphate (48% K_2O), N and K were added at two doses. Phosphorus was applied at a rate of 25 kg P_2O_5 fed^{-1}using calcium super phosphate (15.5% P_2O_5) added with soil preparation.

Seedlings of Thyme (*T. vulgaris* L.) were obtained from well-known commercial orchard at Cairo. Uniform seedlings were transplanted at the 1st of November in the experimental plots. The distance between seedlings was 30 cm and between lines was 50 cm.

After 120 days from planting 3 plants were cut at a 5 cm from the soil level from all treatments and the vegetative growth parameters were measured as (plant high cm, fresh and dry weight g/plant as well as stem diameter cm).

Chemical content such as chlorophyll content was determined by spectrophotometric method of Gavrilenko and Zigalova (2003).

Chemical constituents of leaves expressed as N was obtained using the Kjeldahl method. P and K were measured using spectrophotometers and flame photometer, respectively as descripted by Rukun (1999).

Crude protein content was calculated by using the following formula: Crude protein % = Nitrogen (N) × 5.75. N content of thyme leaves as described by (Anonymous, 1990). For estimation of total carbohydrates in fresh leaves; the ethanol extract was used for the determination of total carbohydrates was estimated as descripted by Sadasivam and Manickam, (1996). Dry matter (%) was determined in fresh mater by the gravimetric method (after drying samples at 105°C to constant weight) as mentioned by (Skubij and Dzida, 2016).

The essential oil was extracted from air-dried leaves (30 g) in a glass Clevenger-type distillation apparatus following European Pharmacopoeia (2004) and subjecting the material to hydrodistillation for 3 h and oil was calculated as %.

Variance of data was analyzed with the ANOVA procedure of CoStat program according to Gomez and Gomez, (1984).

3. Results

3.1. Vegetative growth parameters

Data in Table 3 showed the effect of vermicompost *Azotobacter* on vegetative parameters as (plant high (cm), fresh & dry weights (g/plant) and stem diameter (cm)) of thyme during both seasons. The presented data in Table 3 indicated that in presence of *Azotobacter,* the plant high, fresh, dry weight and stem diameter were increased compared with the absence of *Azotobacter* in the two seasons. The stimulative effect of *Azotobacter* may be related to its benefited impact on vital enzymes and hormonal which gave stimulating effects on plant growth. As for the effect of NPK and vermicompost individually at recommended dose or mixed together on the vegetative growth parameters, data in Table 3 indicated that all treatments significantly affected on the mentioned traits. The treatment of full dose of NPK recorded the highest mean values with no significant effect with the treatment of 25% virmecompost+75% NPK in the two seasons of the experiments.

The interaction effects between treatments under investigation are presented in the same Table. All treatments significantly affected plant high (cm), fresh & dry weights (g/plant) and stem diameter (cm). All treatment of NPK and/or vermicompost recorded high values comparing with the untreated plants and the highest mean values scored with the treatment of25% virmecompost+75% NPK followed by full dose of NPK in presence of *Azotobacter*. The same trend was true during both seasons.

Table 3: Vegetative growth parameters of thyme as affected by vermicompost, NPK and *Azotobater* during 2020-2021 and 2021-2022.

Treatments		Plant height (cm)		Fresh weight (g/plant)		Dry weight (g/plant)		Steam diameter (cm)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
A: bio-fertilization									
Without		35.12b	37.14b	62.84b	64.74b	19.81b	20.94b	0.54b	0.59b
Azotobacter		37.27a	39.51a	65.14a	67.43a	22.06a	23.39a	0.58a	0.64a
B: Mineral and/or organic fertilization									
100% NPK		41.06a	43.30a	68.93a	71.23a	25.78a	27.18a	0.61a	0.67b
100% Org.		29.66d	31.56d	57.38d	59.33d	14.29d	15.22d	0.47c	0.53e
25% Org+75% NPK		41.03a	43.36a	68.85a	70.97a	25.79a	27.25a	0.63a	0.69a
75% Org.+25% NPK		36.28b	38.50b	63.99b	66.13b	21.05b	22.34b	0.55b	0.61c
50% Org+50% NPK		32.96c	34.91c	60.80c	62.76c	17.76c	18.83c	0.53b	0.58d
C: Interaction treatments									
Without	**100% NPK**	40.49c	42.64c	68.16c	70.31c	24.94c	26.25c	0.57bc	0.63d
	100% Org.	28.75j	30.59j	56.64h	58.27i	13.42j	14.30j	0.46f	0.52g
	25% Org+75% NPK.	38.71d	40.78d	66.34d	68.31d	23.46d	24.72d	0.59b	0.65c
	75% Org.+25% NPK	35.54f	37.64f	63.21f	65.20f	20.26f	21.45f	0.54cd	0.59e
	50% Org+50% NPK	32.14h	34.07h	59.85g	61.59h	16.97h	18.00h	0.52de	0.58e
Azotobacter	**100% NPK**	41.64b	43.96b	69.70b	72.15b	26.62b	28.12b	0.65a	0.71b
	100% Org.	30.57i	32.53i	58.11h	60.38h	15.16i	16.15i	0.48ef	0.53f
	25% Org+75% NPK	43.34a	45.93a	71.37a	73.63a	28.13a	29.78a	0.66a	0.73a
	75% Org.+25% NPK	37.01e	39.36e	64.76e	67.05e	21.84e	23.23g	0.57bc	0.63d
	50% Org+50% NPK	33.77g	35.74g	61.74f	63.93g	18.55g	19.66g	0.53cd	0.58e

3.2. Chemical content

Presented data in Table 4 declared the effect of vermicompost, NPK and *Azotobater* on chemical content of thyme as (chlorophyll content mg g^{-1}, N, P and K (%)) during both seasons.
Result indicated that in presence of *Azotobacter* the chemical content increased significantly and recorded the highest values comparing to the absence of *Azotobacter*. The same trend was true during both seasons.

It is obvious from the same data in Table 3 that chlorophyll content (a and b mg.g^{-1}), N, P and K% are significantly affected by the application NPK and organic fertilization in individual way or supplemented together. In general, plants received full dose of NPK fertilization recorded the highest values of chemical content in the two seasons, but application of 25% vermicompost+75% NPK recorded nearly values with no significant effect followed by 75% vermicompost +25% NPK.

The statistical analysis of variance in the same Table, revealed that there were highly significant differences for chlorophyll (a and b mg.g^{-1}), N, P and K (%) in thyme leaves owing to the interaction effect among all treatments. In this respect, the highest values recorded with using 25% vermicompost+75% NPK followed by NPK at 100% in presence of *Azotobacter* comparing to the other treatments especially with absence of *Azotobacter*.

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Table 4: Chemical content of thyme as affected by vermicompost, NPK and *Azotobater* during 2020-2021 and 2021-2022.

Treatments		Chlorophyll a (mg g^{-1})		Chlorophyll b (mg g^{-1})		N (%)		P %)		K (%)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A: bio-fertilization											
Without		0.743^{b}	0.769^{b}	0.486^{b}	0.501^{b}	2.24^{b}	2.36^{b}	0.517^{b}	0.534^{b}	2.62^{b}	2.77^{b}
Azotobacter		0.765^{a}	0.789^{a}	0.506^{a}	0.524^{e}	2.40^{a}	2.54^{a}	0.539^{a}	0.556^{a}	2.71^{a}	2.87^{a}
B: Mineral and/or organic fertilization											
100% NPK		0.800^{a}	0.826^{a}	0.541^{a}	0.558^{a}	2.68^{a}	2.82^{a}	0.581^{a}	0.601^{a}	2.86^{a}	3.02^{a}
100% Org.		0.696^{d}	0.719^{d}	0.438^{d}	0.453^{d}	1.84^{d}	1.96^{d}	0.460^{d}	0.475^{d}	2.39^{d}	2.55^{d}
25% Org+75% NPK.		0.798^{a}	0.825^{a}	0.542^{a}	0.559^{a}	2.67^{a}	2.82^{a}	0.580^{a}	0.599^{a}	2.85^{a}	3.01^{a}
75% Org.+25% NPK		0.753^{b}	0.779^{b}	0.495^{b}	0.511^{b}	2.31^{b}	2.45^{b}	0.525^{b}	0.542^{b}	2.67^{b}	2.83^{b}
50% Org+50% NPK		0.724^{c}	0.746^{c}	0.466^{c}	0.482^{c}	2.09^{c}	2.22^{c}	0.492^{c}	0.507^{c}	2.55^{c}	2.70^{c}
C: Interaction treatments											
Without	**100% NPK**	0.794^{c}	0.823^{c}	0.535^{c}	0.551^{c}	2.63^{c}	2.77^{c}	0.574^{c}	0.594^{b}	2.84^{b}	2.99^{b}
	100% Org.	0.688^{j}	0.712^{j}	0.431^{j}	0.444^{h}	1.78^{j}	1.90^{j}	0.452^{j}	0.468^{h}	2.36^{g}	2.51^{h}
	25% Org+75% NPK.	0.775^{d}	0.802^{d}	0.521^{d}	0.536^{d}	2.49^{d}	2.63^{d}	0.555^{d}	0.573^{c}	2.75^{c}	2.90^{c}
	75% Org.+25% NPK	0.744^{f}	0.769^{f}	0.486^{f}	0.501^{f}	2.25^{f}	2.38^{f}	0.518^{f}	0.534^{e}	2.64^{de}	2.80^{de}
	50% Org+50% NPK	0.715^{h}	0.737^{h}	0.459^{h}	0.473^{g}	2.03^{h}	2.15^{h}	0.484^{h}	0.499^{g}	2.51^{f}	2.66^{f}
Azotobacter	**100% NPK**	0.805^{b}	0.830^{b}	0.547^{b}	0.566^{b}	2.72^{b}	2.88^{b}	0.589^{b}	0.608^{b}	2.89^{b}	3.05^{b}
	100% Org.	0.703^{i}	0.726^{i}	0.444^{i}	0.461^{g}	1.89^{i}	2.01^{i}	0.467^{i}	0.481^{h}	2.42^{g}	2.58^{g}
	25% Org+75% NPK.	0.821^{a}	0.847^{a}	0.564^{a}	0.581^{a}	2.84^{a}	3.01^{a}	0.606^{a}	0.625^{a}	2.96^{a}	3.13^{a}
	75% Org.+25% NPK	0.762^{e}	0.788^{e}	0.505^{e}	0.521^{e}	2.38^{e}	2.53^{e}	0.532^{e}	0.550^{d}	2.69^{cd}	2.86^{cd}
	50% Org+50% NPK	0.732^{g}	0.754^{g}	0.472^{g}	0.490^{f}	2.15^{g}	2.29^{g}	0.499^{g}	0.514^{f}	2.59^{e}	2.74^{e}

3.3. Quality parameters of thyme

Data obtained in Table 5 for total carbohydrates, protein and dry matter indicated that, with addition of bio-fertilization in form of *Azotobacter* increased significantly the values of total carbohydrates, protein and dry matters (%) comparing the untreated plants in absence of *Azotobacter* in the two seasons of the experiment.

The same Table showed the total carbohydrates, protein and dry matter as affected by NPK and / or vermicompost individually or supplemented together. The data were significantly affected with all application, but the highest values recorded with addition of full dose NPK fertilization followed by 25% vermicompost+75% NPK which recorded near values with the full dose with no significant effect in the both seasons.

The statistical analysis of variance in Table 5, revealed that there were highly significant differences for the total carbohydrates, protein and dry matter according to the interaction between all treatments under investigation during two seasons of the experiment. In this respect, the highest values recorded with using 25% vermicompost+75% NPK followed by NPK fertilization at 100% in pretense of *Azotobacter* during both seasons.

Table 5: Quality parameters of thyme as affected by vermicompost, NPK and *Azotobater* during 2020-2021 and 2021-2022.

Treatments		**Carbohydrate (%)**		**Protein (%)**		**Dry matter (%)**	
		1st	**2nd**	**1st**	**2nd**	**1st**	**2nd**
		A: bio-fertilization					
Without		16.41b	17.45b	12.86b	13.59b	26.50b	28.04b
Azotobacter		16.88a	17.99a	13.78a	14.62a	28.32a	30.03a
LSD at 5%		**0.24**	**0.37**	**0.14**	**0.34**	**0.59**	**0.43**
		B: Mineral and/or organic fertilization					
100% NPK		17.63a	18.74a	15.38a	16.23a	31.27a	33.00a
100% Org.		15.24d	16.26d	10.55d	11.25d	22.32d	23.76d
25% Org+75% NPK.		17.69a	18.75a	15.33a	16.20a	31.34a	33.15a
75% Org.+25% NPK		16.67b	17.77b	13.30b	14.10b	27.35b	29.02b
50% Org+50% NPK		16.01c	17.09c	12.04c	12.77c	24.76c	26.25c
LSD at 5%		**0.32**	**0.33**	**0.20**	**0.23**	**0.36**	**0.50**
		C: Interaction treatments					
Without	**100% NPK**	17.45bc	18.43cb	15.12c	15.91c	30.60c	32.27c
	100% Org.	15.03i	16.07f	10.24j	10.93j	21.64j	23.03j
	25% Org+75% NPK.	17.21cd	18.23b	14.34d	15.10d	29.50d	31.11d
	75% Org.+25% NPK	16.53ef	17.58cd	12.94f	13.67f	26.68f	28.24f
	50% Org+50% NPK	15.83gh	16.95e	11.69h	12.36h	24.06h	25.54h
Azotobacter	**100% NPK**	17.81ab	19.04a	15.64b	16.56b	31.94b	33.72b
	100% Org.	15.45hi	16.46f	10.87i	11.58i	22.99i	24.48i
	25% Org+75% NPK.	18.16a	19.27a	16.33a	17.29a	33.18a	35.18a
	75% Org.+25% NPK	16.80de	17.96bc	13.67e	14.53e	28.02e	29.80e
	50% Org+50% NPK	16.19fg	17.22de	12.38g	13.17g	25.46g	26.97g
LSD at 5%		**0.45**	**0.47**	**0.28**	**0.33**	**0.51**	**0.71**

Data presented in Fig. 1 revealed that addition of *Azotobacter* sp. increased values of essential oil % comparing with the un-inoculated plants during both seasons. It can be found that, addition of NPK and/or vermicompost increased the average value of essential oil%. In general, plants fertilized with 25% vermicompost+75% NPK followed by NPK fertilization at 100% with no significant effect especially during the second seasons and in presence of *Azotobacter* sp. attained the highest values of essential oil during both seasons.

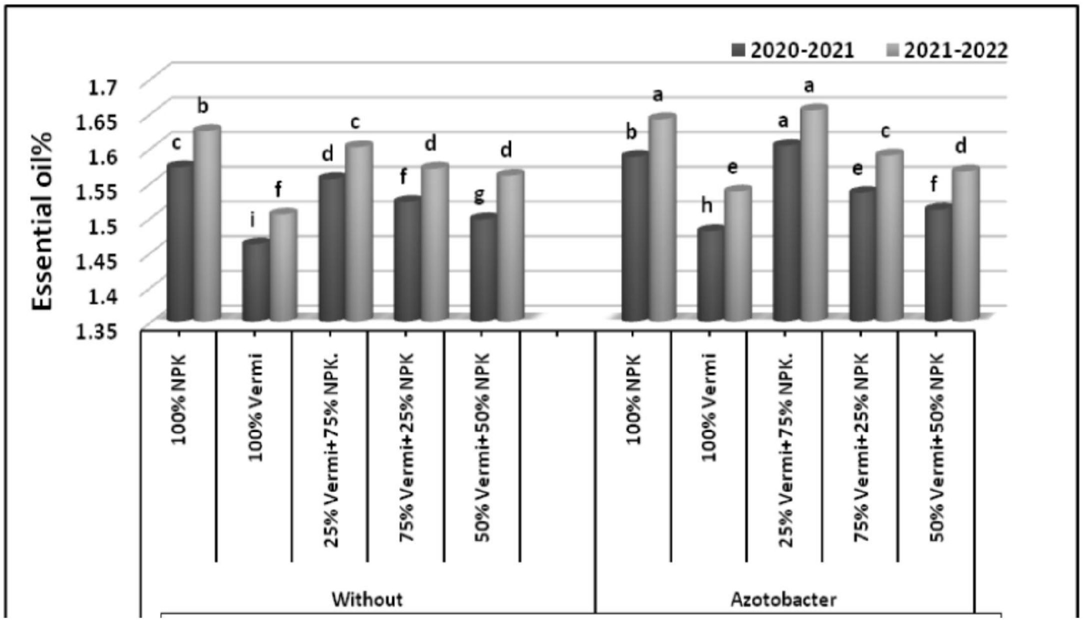

Fig. 1: Essential oil % of thyme plant as affected by vermicompost, NPK and Azotobater during 2020-2021 and 2021

4. Discussion

In the present study, *Azotobacter sp*. bacterium, as a growth bio-stimulant has a wide range of favorable features that promote plant growth, including the ability to stabilize nitrogen and then raise the nitrogen content in the plant. Furthermore, the ability of the components of the local bio-fertilizer to increase soil element uptake is linked to their ability to secrete some plant hormones such as cytokines, auxins, and gibberellins, which have an essential effect in increasing the surface area of the roots by increasing the lengths of the main roots and their branches, which increases nutrient absorption. The results of this study have good consistency with previous studies (Yadegariand Mosadeghzad. 2012; Nejatzadeh-Barandozi and Pourmaleknejad, 2014; Nadjafi *et al.,* 2014; Khorrami *et al.,* 2016; Ngerebara and Amadi, 2020). In this respect, it's possible that Azotobacter's stimulatory effect on boosting essential oil percentage is due to their enhancement of vegetative development characteristics and plant chemical composition. Furthermore, this beneficial effect could be linked to an increase in the number of glands. However, in this regard, the physiological activity of the glands had a greater effect on essential oil levels than simply their number (Nejatzadeh-Barandozi and Pourmaleknejad, 2014).

The improvement in thyme vegetative growth (plant high, fresh, dry weight and stem diameter), chemical content (chlorophyll content, N, P and K) and it is quality (total carbohydrates, protein, dry matter and essential oil) in this investigation due to the physiological and biological aspects of organic fertilization were reflected in the use of vermicompost as an organic fertilizer, which explained the role of organic matter as a source of nutrients such as N, P, K, and micronutrients such as Fe, Zn, and Mn, as well as a source of energy for the growth of microbial communities. Vermicompost are rich in nutrients, active of microbiological as mentioned by Domingues (2004), It is a stabilized finely divided peat-like substance with a low C: N ratio, good water holding capacity, and high porosity, gradual nutrient release, and most components suitable for absorption by plant roots. Darzi *et al.,* (2012) studied the impact of vermicompost of anise and found a positive effect in plant height, biological and seed yield because of the utilization of vermicompost at 10 $ton.h^{-1}$. Ibrahim (2020) showed that addition of vermicompost increased plant height, branch number, herb fresh and dry weights as well as fixed and volatile oil percentage and N, P, K % content in black cumin.

In addition, results of this research in relation to some mixed fertilizer treatments indicated that application of vermicompost as a source of organic fertilizer either alone or in combination with NPK, were positivelyaffected on vegetative growth (plant high, fresh, dry weight and stem diameter), chemical content (chlorophyll content, N, P and K) and it is quality (total carbohydrates, protein, dry

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matter and essential oil) of thyme plant. The beneficial effect of low organic and mineral levels may be due to nitrogen's important role in metabolic activities such as glucose synthesis and photosynthesis. as for K, despite being the only required plant element that is not found in any plant part, potassium is an important mineral for plant growth. Many enzymatic processes use it as a catalyst. It also regulates the opening and shutting of stomata, which influences transpirational cooling and photosynthetic carbon dioxide uptake (Mikkelsen, 2008). Moreover, Phosphorus is a significant dietary component of energy molecules, nucleic acids, phospholipids, and co-enzymes, as well as a main part of metabolic activities (Hafez and Mahmoud, 2009). This could be explained the superiority of treatment (25% vermicompost+75% NPK) which represented both organic fertilizers types affected growth parameters and chemical content of thyme plants. Similar results have been reported by (Jabbari *et al.,* 2011; Nejatzadeh-Barandozi and Pourmaleknejad, 2014and Sakr, 2017)

5. Conclusion

It may be cocluded that application of organic manure improved yield and other determined criteria. It also appears that vermicompost combined with Azotobacter as bio-fertilizer reduced the use of mineral fertilization. So, it can be concluded that the addition of 25% virmecompost+75% NPK followed by full dose of NPK in presence of Azotobacter significantly improved quality yield of thyme (*Thymus vulgaris* L.) and produced high quality product for human health.

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