Tikrit Journal for Agricultural Sciences (2024) 24 (1): 34-44
DOI: https://doi.org/10.25130/tjas.24.1.4

IRAQI Academic Scientific Journals
العراقية المجلات الأكاديمية العلمية

ISSN:1813-1646 (Print); 2664-0597 (Online)
Tikrit Journal for Agricultural Sciences
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

Influence of Shading, GA_3 and NPK fertilizer on the growth and development of Myrtle *Myrtus communis* plants

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KEY WORDS:
shade, GA_3, NPK, Myrtle growth

Received: 15/10/2022
Accepted: 06/11/2023
Available online: 31/03/2024

ABSTRACT

This study was conducted during the period between 23th September 2021 to 1st July 2022, in the nursery of Duhok University, Kurdistan region, Iraq. Aiming to evaluate effect of the Shade (0 and 50) %, Gibberellic acid (0, 250, and 500) $mg.l^{-1}$ and three levels of NPK fertilizer control (0, 0, 0), low (150, 100, 75), and high (300,200,150) $mg.l^{-1}$ on the growth and development for Myrtle (*Myrtus communis*) plants. This experiment was performed by use randomized complete block design (RCBD). The best results include the following: 50% shade significantly increased the plant height (36.21) cm, leaf area (4.41) cm^2, total chlorophyll (57.41) spad, vegetative dry weight (14.62) gm, plant growth index (9230) cm^3 and number of premier tricussate shoots (14.37) branch/plant compared with 0%. spray with 500 $mg.l^{-1}$ GA_3 significantly increased plant height (35.58) cm, number of branches, leaf area (2.84) cm^2, total chlorophyll (57.28) spad, dry weight (13.67) gm, plant growth index (8098) cm^3, number of premier tricussate shoots (14.37) branch/plant. Also used NPK fertilizer caused significantly increase in all these traits, the best interaction treatment among the three factors include 50% shade with 500 $mg.l^{-1}$ GA_3 and (300,200,150) $mg.l^{-1}$ NPK that gave the highest significant values for the plant height (43.53) cm, leaf area (4.53) cm^2, total chlorophyll (64.57) spad, vegetative dry weight (20.27) gm, plant growth index (15580) cm^3 and number of premier tricussate shoots (20.67) branch/plant compared with control (0 shade, 0 GA^3, (0,0, 0) $mg.l^{-1}$).

تاثير التظليل والرش بحامض الجبرلين والتسميد بالسماد المركب (NPK) على النمو والتطور لنبات الاس

هزرت محمد قاسم و يوسف حسين حمو

قسم البستنة / كلية التقنية عقرة / جامعة دهوك التقنية - قسم البستنة / كلية علوم الهندسة الزراعية / جامعة دهوك

الخلاصة

اجريت هذه الدراسة في الفترة من 23 ايلول 2021 الى 1 تموز 2022 في مشتل جامعة دهوك /جامعة دهوك/كردستان/ العراق. بهدف تقييم تاثير التظليل باستخدام شبكة الساران (صفر و 50) % والرش بحامض الجبرلين بتركيز (0 , 250 , 500) ملغم.لتر$^{-1}$ والتسميد بثلاث مستويات من السماد المركب NPK المقارنة (0 , 0 , 0) واطئ (150 , 100 , 75) عالي (300 , 200 , 150) ملغم.لتر$^{-1}$ في النمو والتطور لنبات الأس (*Myrtus communis*). نفذت التجربة باستخدام تصميم القطاعات العشوائية الكاملة (RCBD) وتضمنت افضل النتائج مايلي. ادى التظليل بنسبة 50% الى احداث زيادة معنوية لصفات ارتفاع النبات (36.21) سم ومساحة الورقة (4.41) سم والكلوروفيل الكلي (57.41) (spad) والوزن الجاف للمجموع الخضري (14.62) غم ودليل النمو للنبات (9230) سم^2 وعدد الافرع الممكن استخدامها في تنسيق باقات الورد (طولها اكثر من 30 سم) (14.37) فرع / نبات مقارنة بمعاملة المقارنة 0 % تظليل. كما ادى الرش بحامض الجبرلين الى حصول زيادة معنوية في كل من ارتفاع النبات (35.58) سم وعدد الافرع (19.14) فرع لكل نبات ومساحة الورقة (2.84) سم^2 والكلوروفيل الكلي (57.28) (spad) والوزن الخضري الجاف (13.67) غم ودليل النمو للنبات (8098) سم^3 اضافة الى عدد الافرع الممكن استخدامها في تنسيق باقات الورد (13.17) فرع / نبات . كما ادى التسميد بالسماد المركب الى احداث زيادة معنوية في جميع الصفات المدروسة. وكانت افضل معاملة تداخل بين العوامل الثلاثة قيد الدراسة هي التظليل 50% والرش بـالجبرلين بتركيز 500 ملغم.لتر$^{-1}$ والتسميد بالمستوى العالي (300 , 200 , 150) ملغم.لتر$^{-1}$ والتي اعطت اعلى القيم المعنوية لصفات ارتفاع النبات (43.531) سم ومساحة الورقة (4.53) سم والكلوروفيل الكلي (64.57) (spad) والوزن الجاف للمجموع الخضري (20.27) غم ودليل النمو للنبات (15580) سم^2 وعدد الافرع الممكن استخدامها في تنسيق باقات الورد (20.67) فرع / نبات مقارنة بمعاملة المقارنة (صفر% تظليل , 0 ملغم.لتر$^{-1}$جبرلين , (0 , 0 ,0) ملغم.لتر$^{-1}$ سماد مركب.

الكلمات المفتاحية: التظليل , السماد المركب , حامض الجبرلين , نبات الآس

INTRODUCTION

Myrtle (*Myrtus communis* L.) commonly named Myrtle, Sweet Myrtle, True Myrtle, belong to *Myrtaceae* family, is aromatic rounded shape shrub, widespread all around the Mediterranean basin, which include approximately 145 genera and over 5500 species **(Snow,** 2011; Bouzabata *et al*., 2015). An evergreen sclerophyll shrub that grows naturally in the Mediterranean region under various lighting circumstances, such as wide clearings with direct sunshine and understory (canopy shading) (Mendes *et al*., 2001 and Dessena *et al*., 2015). it is very important plant for its ornamental uses in revegetation projects in semi-arid degraded land and in landscaping (Romani *et al*., 2004). Myrtle is a strong fragrant plant that has been utilized historically because to the high essential oil concentration in its leaves, flowers, and fruits. It has also played a significant part among the herbs used in alternative medicine. Due to its bioactive components, such polyphenol, and application in pharmaceutics, cosmetics, and liqueur, it also has a medicinal and preventative impact against a variety of ailments (Laurentis., (2005); Velasco *et al.*, (2019) and Medda *et al*., (2021). In Sardinia (Italy), myrtle berries are extensively utilized in the culinary business, particularly by the liqueur sector, and are highly important in landscape architectural works. It may also be used as cut frond with both its flowers and berries. (Mulas, 2000; Franco, 2002; Arslan and Ekren, 2018).

Light is one of the most critical environmental for plant growth and development (Hatamian and Roozban, 2015). Different light levels have an impact on how well plants use water, exchange gases in their leaves, and develop. It has been shown to change the

composition and amount of essential oils in aromatic crops. But when plants are cultivated in shadow, their stomatal conductance, photosynthetic rate, ATP synthesis, carbon absorption, and growth are all inhibited (Kumar *et al.*, 2013; Rezai *et al.*, 2018). Different crops responded to shade differently, according to research on changing microclimate using various green shade nets (Shao *et al.*, 2014). These microclimate fluctuations alter the rate of CO_2 uptake and photosynthesis, which has an impact on crop growth and yield (Mamta *et al.*, 2015). The leaf shape and anatomy of *Myrtus communis* were significantly altered by the light environment. Compared to plants growing in sunlight, low-light plants produced more leaves per unit dry mass in vested. The growth of thicker leaves under high light was what caused differences in specific leaf area (SLA) between leaves in the sun and those in the shade (Mendes *et al*., 2001). Fadil, *et al*., (2016) found that the morphological parameters of Moroccan *Myrtus communis* grew in a shady area ranged in height from 146 to 200 cm, leaf length from 3.25 to 4.5 cm, leaf width from 1.01 to 1.58 cm, and leaf thickness from 189 to 215 mm. Compared to the location that was exposed to light, which produced leaves that ranged in height from 67 to 130 cm, were 0.65 to 1.08 cm wide, and measured 375 to 412 mm thick.

Gibberellic acid is a plant hormone that promotes growth through cell enlargement, controls the permeability of cell membranes, and aids in the transition of plants from the vegetative to blooming stages. And control the synthesis, distribution, or transmission of the signal from these hormones to control how the plant grows and develops in response to its environment. So Bioactive is naturally present in all plant kingdoms with growing peaks, fresh leaves, fruit, and newly grown seed embryos serving as the main sources of these compounds. It is known to promote a variety of processes, including seed germination, leaf expansion, shoot/stem elongation, floral initiation, floral organ development, and fruit development, as well as the vegetative growth of a wide range of ornamental or medicinal plants (Hooley, 1994; Ebtsam *et al*., 2005; Taiz and Zager, 2010; Colebrook *et al*., 2014). Al-Layla (2006) Shown that spraying the plant *Ficus elastica* with 300 $mg.l^{-1}$ of GA_3 caused a rise in the plant's height and diameter as well as an increase in the amount of chlorophyll.

Nitrogen plays a significant role in the synthesis of plant components through the action of various enzymes. It also increases the production of volatile oils in annual herbs, As a growth inhibitor and a source of more nutrients for plants than elemental phosphorus and potassium (Ting, 1981; Jones *et al*., (1991)). Using too much nitrogen fertilizers may raise the danger of nitrate buildup (Powlson *et al*., 2008). Phosphorus is one of the basic elements necessary for the growth and production of plant. It plays an important role in carbohydrate transformations, as it participates in the oxidative phosphorylation that releases energy for plant cells. A deficiency causes an imbalance in its metabolic processes, and a plant cannot complete its life cycle without it (Yagodin, 1982). Potassium has a crucial role in controlling both plant physiology and stomatal behavior Potassium is frequently ranked second to nitrogen in plant tissue levels by plant physiologists. As a fun fact, the only important nutrient for plants that isn't a component of any plant parts is potassium (Sringarm *et al*., 2009). Steinmetz *et al*., (2013) Mention that myrtle development requires fertilization with 50–100 kg/ha of N and K and 25–50 kg/ha of P, whereas Fe should be treated based on the degree of leaf greening. Abbaszadeh *et al*., (2019) The maximum leaf yield (356 kg ha^{-1}), shoot yield (773 kg ha^{-1}), essential oil percent (1.86%), and essential oil yield (14 kg ha^{-1}) were obtained in treatments of 45 tons per hectare of vermicompost, which contain 8300 mg.kg, phosphor 59900 mg.kg, and 18700 mg.kg potassium on *Myrtus communis*. Mostafa, (2019) Found that fertilized dragonhead (*Dracocephalum moldavica*) plants with NPK (100% recommended rate (RR), 75 % RR and 50% RR), The recommended rate of NPK was 200 kg ammonium sulphate (20.5 % N), 200 kg calcium super phosphate (15.5 % P_2O_5) and 100 kg potassium sulphate (48 % k_2O) per feddan

that 100% RR measurements were taken for the maximum dragonhead plant heights, branch counts, fresh and dried plant weights, feddan productions, volatile oil outputs, and plant colors. This study aimed to obtained the best level of shading, NPK and GA_3 for best growth and development of myrtle plant.

MATERIALS AND METHODS

The experiment was carried out at the nursery of Duhok University- Kurdistan region, Iraq. during the period between 23th September 2021 to 1st July 2022 in Iron frame (6×6 ×2)m covered with green mesh for 50% shade treatment to study the effect of shade, GA_3 and NPK fertilizer on the growth and development of myrtle (*Myrtus communis*). rooted cuttings three-month old (12 ± 2) cm were taken from the nursery of Duhok University were used in this experiment then transplanted on 23th Sep in to 17 cm pot filled with mixture of (3 river soil:1compost which consist of (sheep manure: hay: lawns clipping: plant leaf)), which its chemical characteristics were pH (7.2), Ec (0.3) ds.m^{-1},$CaCo_3$ (12.5)%, K (73) mg.l^{-1}, P (56.5) mg.l^{-1}, N (1610) mg.l^{-1}, C/N ratio (45.5), Organic matter (2.98)%. After two weeks from transplanting plants divided in two group the first was Shaded 50% by covered with green mesh (saran network) whereas the second group under 100% sunlight, the second factor spray with GA_3 (0, 250, 500) two time the first on at 23th October and the second one month later, the third factor was three level of NPK (0, 0, 0), (150, 100, 75), and (300,200,150) mg.l^{-1} (urea 46% N, triple super phosphate 46% p_2o_5, potassium sulfate k_2o 48-52%) gave with irrigation each month.

So The experiment was included three factors 2 shaded levels, 3 GA_3 concentration and 3 NPK fertilizer (2×3×3=18) × 3 replicate × 5 plant so the experiment include (270) plants .The studied measurements included: plant height, leave area, total chlorophyll measured by use SPAD-502 meter, Vegetative dry Weight, Plant growth index (cm^3) which calculated according to Hidalgo (2001) by the formula: **Plant growth index (cm^3) = 3.14 [1/2 ×(less width + large width)/2]2 ×plant height**. and premier tricussate shoots. This experiment was performed by use randomized complete block design (RCBD), the data were analyses by use SAS program the difference between various treatments means are tested with Duncan Multiple range test at 5% level.

RESULTS AND DISSCATION

Table (1) clarified that shading the Myrtus plant with 50% shade caused significantly increased in plant height reached 36.21cm compared with without shade which gave 30.81cm. Sprayed with 500 mg.l^{-1} GA_3 caused a significantly increased in this trait reached 35.58 cm compared with without GA_3 (31.93) cm. In addition, fertilization with high level of NPK (300, 200, 150) mg.l^{-1}caused a significantly increased reached 36.01 cm when compared with the control (31.15) cm.

The triple interaction among shade, GA_3 and NPK fertilizer factors indicated that the plants with 50% shade, GA_3 500 mg.l^{-1} and high level of NPK (300,200,150) mg.l^{-1} best value for plant height Reach 43.53cm in compared with least value 27.30 cm for the control plants (0 shade, 0 GA_3 and 0 NPK fertilizer) with increasing percentage reached 37.28% .

Table (1). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the plant height of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading effect	GA_3 effect
		0	Low	High		
0	0	27.30^{h}	29.77^{gh}	31.97^{e-g}	30.81^{b}	**0**
	250	29.10^{gh}	30.63^{f-h}	32.63^{d-g}		31.93^{b}
	500	29.73^{gh}	32.07^{e-g}	34.10^{c-f}		**250**
50	0	31.93^{e-g}	34.30^{c-e}	36.30^{b-d}	36.21^{a}	33.02^{b}
	250	33.07^{d-g}	35.20^{b-e}	37.50^{bc}		**500**
	500	35.77^{b-e}	38.30^{b}	43.53^{a}		35.58^{a}
NPK fertilizer effect		31.15^{c}	33.38^{b}	36.01^{a}		

* low (150, 100, 75), high (300, 200, 150) mg.l^{-1}. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

The data in table (2) shows that shaded Myrtle plants with 50% shade caused a significantly increased leaf area reached 3.41cm^2 compared with those without shade that gave only 1.86 cm^2. GA_3 caused a significantly increased leaf area (2.84) cm^2 when sprayed with 500 mg.l^{-1} compared with those without GA_3 (2.42) cm^2. In addition, leaf area increased significantly with a high level of NPK fertilizer reached 3.23 cm^2 when compared with the control which gave 2.06 cm^2. The triple interaction among the three factors indicated that the plants grew under 50% shade sprayed with 500 mg.l^{-1} GA_3 and fertilized with high level of NPK (300,200,150) mg.l^{-1} gave 4.53cm^2 in compared with the least value 1.14 cm^2 control.

Table (2). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the leaf aria (cm^2) of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading × GA_3	Shading effect	GA_3 effect
		0	Low	High			
0	0	1.14^{k}	1.61^{j}	2.19^{gh}	1.65^{f}	1.86^{b}	**0**
	250	1.43^{j}	1.87^{i}	2.38^{fg}	1.89^{e}		2.42^{c}
	500	1.59^{j}	2.05^{hi}	2.46^{f}	2.03^{d}		**250**
50	0	2.43^{f}	3.47^{c}	3.67^{c}	3.19^{c}	3.41^{a}	2.63^{b}
	250	2.80^{e}	3.17^{d}	4.16^{b}	3.37^{b}		**500**
	500	2.95^{e}	3.48^{c}	4.53^{a}	3.65^{a}		2.84^{a}
NPK fertilizer effect		2.06^{c}	2.61^{b}	3.23^{a}			

* low (150, 100, 75), high (300, 200, 150) mg.l^{-1}. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

From the data in Table (3) we show that 50% shade increased a significantly the total chlorophyll to 57.41 (SPAD) compared with 54.67 (SPAD) for unshaded plants. Sprayed this plant with 250 GA_3 cannot effect significantly on this trait whereas 500 mg.l^{-1} GA_3 increased this trait significantly to 57.28 (SPAD) compared with 0 mg.l^{-1} GA_3 that gave 54.98 (SPAD). In addition, high level of NPK fertilizer significantly increased the total chlorophyll to 60.88 (SPAD) when compared with the control which gave 50.32 (SPAD). The interaction among the three factors indicated that the plants which sprayed with 500 mg.l^{-1} GA_3 and (300,200,150) mg.l^{-1} of NPK and grew under 50% shade increased the total chlorophyll to 64.57 (SPAD) compared with the least value 47.00 (SPAD) for the control plants.

The data in Table (4) showed that Myrtle plants grew under 50% shade gave the more significant vegetative dry weight reaching 14.62 gm compared with 8.17gm for unshaded plants. 500 mg.l^{-1} GA_3 increased significantly this trait to 13.67 gm compared with 10.66 gm

for 250 mg.l^{-1} and 9.85gm for 0 mg.l^{-1} GA_3. Increased NPK fertilizer from (0, 0, 0) to (150, 100,75) to (300, 200, 150) mg.l^{-1} caused significantly increased in vegetative dry weight to 9.59, 11.82, 12.77 gm respectively. The triple interaction among shade, GA_3 and NPK fertilizer factors indicated that the plants which sprayed with 500 mg.l^{-1} GA_3 and fertilized with (300,200,150) mg.l^{-1} NPK and grew under 50% shade gave the highest value of vegetative dry weight reach 20.27 gm in compared with the least value 4.97gm for the control plants.

Table (3). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the total chlorophyll (spad) of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading effect	GA_3 effect
		0	Low	High		
0	0	47.00^{j}	55.07^{fg}	58.77^{c-e}	54.67^{b}	**0**
	250	48.20^{ij}	56.47^{e-g}	59.63^{b-d}		54.98^{b}
	500	49.77^{hi}	57.23^{d-f}	59.93^{b-d}		**250**
50	0	50.93^{h}	57.30^{d-f}	60.80^{bc}	57.41^{a}	55.87^{b}
	250	51.67^{h}	57.63^{d-f}	61.60^{b}		**500**
	500	54.33^{g}	57.87^{de}	64.57^{a}		57.28^{a}
NPK fertilizer effect		50.32^{c}	56.93^{b}	60.88^{a}		

* low (150, 100, 75), high (300, 200, 150) mg.l^{-1}. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Table (4). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the vegetative dry weight (gm) of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading effect	GA_3 effect
		0	Low	High		
0	0	4.97^{h}	8.29^{g}	9.09^{fg}	8.17^{b}	**0**
	250	5.69^{h}	8.50^{fg}	8.81^{fg}		9.85^{c}
	500	7.83^{g}	10.11^{ef}	10.22^{ef}		**250**
50	0	11.83^{de}	12.71^{d}	12.22^{d}	14.62^{a}	10.66^{b}
	250	11.66^{de}	13.27^{d}	16.01^{c}		**500**
	500	15.57^{c}	18.04^{b}	20.27^{a}		13.67^{a}
NPK fertilizer effect		9.59^{c}	11.82^{b}	12.77^{a}		

* low (150, 100, 75), high (300, 200, 150) mg.l^{-1}. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

The data in Table (5) showed that shaded Myrtle plants with 50% shade caused significantly increased in plant growth index reached to 9230 cm^3 compared with unshaded that gave 4700 cm^3, Also 500 mg.l^{-1} of GA_3 significantly increased this trait to 8098 cm^3 compared with 6040 cm^3 for 0 mg.l^{-1}, In addition, Increased NPK fertilizer from (0, 0, 0) to (150, 100,75) to (300, 200, 150) mg.l^{-1} caused significantly increased in this trait to 5010, 6739, 9055 cm^3 respectively. The greatest result for this feature was 15580 cm^3 for 50% shade and 500 mg.l^{-1} GA_3 (300,200,150) mg.l^{-1} NPK, compared to 2720 cm^3 for control, due to the triple interaction between the three components.

From the data in table (6) 50% shade for Myrtle plants significantly increased the number of premier tricussate shoots reaching 14.37 branch/plant compared with 6.07 branch/plant for unshaded plants. Also, GA_3 significantly increased this trait to reached 13.17 branch/plant compared with 7.50 branch/plant for 0 mg.l^{-1} GA_3. In addition, low and high NPK fertilizer significantly increased this trait to 10.50 and 11.50 branch/plant respectively compared with

the control which gave 8.67 branch/plant. The triple interaction among shade, GA_3 and NPK fertilizer factors indicated that the plants that shaded with 50% and sprayed with 500 $mg.l^{-1}$ GA_3 and fertilized with high level of NPK gave the highest value of this trait reached 20.67 branch/plant in compared with the least value 3.67 branch/plant for the plants which without shade, GA_3 and NPK fertilizer.

Table (5). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the growth index (cm^3) of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading effect	GA_3 effect
		0	150	300		
0	0	2720^{j}	4307^{h-j}	5367^{f-i}	4700^{b}	**0**
	250	3647^{ij}	4767^{g-i}	5579^{f-i}		6040^{b}
	500	4124^{ij}	5352^{f-i}	6438^{e-g}		**250**
50	0	6153^{e-h}	7714^{de}	9980^{bc}	9230^{a}	6756^{b}
	250	6627^{e-g}	8533^{cd}	11384^{b}		**500**
	500	7336^{d-f}	9759^{bc}	15580^{a}		8098^{a}
NPK fertilizer effect		5101^{c}	6739^{b}	9055^{a}		

* low (150, 100, 75), high (300, 200, 150) $mg.l^{-1}$. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Table (6). Influence of shading, Gibberellic acid (GA_3) and NPK fertilizer on the Number of premier tricussate shoots/plant of *Myrtus communis* plant.

Shading	GA_3	NPK Fertilizer			Shading effect	GA_3 effect
		0	150	300		
0	0	3.67^{j}	5.33^{h-j}	6.33^{g-i}	6.07^{b}	**0**
	250	5.00^{i}	6.33^{g-i}	7.00^{f-h}		7.50^{c}
	500	6.00^{g-i}	7.33^{fg}	7.67^{fg}		**250**
50	0	8.67^{ef}	9.67^{de}	11.33^{d}	14.37^{a}	10.00^{b}
	250	11.00^{d}	14.67^{c}	16.00^{c}		**500**
	500	17.67^{b}	19.67^{a}	20.67^{a}		13.17^{a}
NPK fertilizer effect		8.67^{c}	10.50^{b}	11.50^{a}		

* low (150, 100, 75), high (300, 200, 150) $mg.l^{-1}$. Means with same letter for each factor and interaction are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Significantly increased in plant high, leaf area, total chlorophyll, vegetative dry weight, plant growth index, and a number of premier tricussate shoots of Myrtle plants' may be refer to as light effect which has a positive effect on growth by easing thermal stress, lowering evapotranspiration, and preventing wind damage, making it likely to be the resource that is most frequently limiting growth, survival, and reproduction (Chazdon *et al*., (1988) and Callaway, 2007). this result was in agreement with Sedigheh *et al*., (2018) It discovered that Sage (*Salvia officinalis*) leaves grew the largest under 50% shade and the lowest under full sunlight. Both 50% and 70% shadow levels produced yellowish-green leaves. Chlorophyll and

carotenoid concentration decreased as light intensity decreas. An ideal light irradiance for the growing of sage is said to be 30% shadow. Additionally, the significant increase in chlorophyll and plant growth index with an increase in shading up to 50% may be due to chlorophyll molecules that are susceptible to photo oxidation, where equilibrium is reached in lower radiation levels, and an increase in vegetative growth to capture more light, likely as a result of a shading avoidance mechanism Alvarenga *et al*., 2003 and Ballare, (1999). The significant increase in all studied traits when increasing GA_3 from 0 to 250 to 500 $mg.l^{-1}$ may be attributed to the growth promotion effect of GA_3 in stimulating and accelerating cell division, increasing cell elongation and enlargement or both Al-Khassawneh (2006), Jaleel (2007). Or refer to role of this hormone to stimulation and speed of division and elongation of the cells and thus increase the fresh and dry weight vegetative group in the plant Kumar *et al*., (2008). One of the most crucial elements that boosts plant output is plant nutrition. Increasing NPK fertilizer from (0, 0, 0) to (150, 100, 75) to (300, 200, 150) $mg.l^{-1}$ led to a significant increase in plants height, Leaf area, total chlorophyll, vegetative dry weight and other trait might due to nitrogen fertilizer which is increased carbohydrate auxin activity and other organic compounds, then enhancing protein synthesis which allows the plants to grow faster, increase metabolism, cell division and elongation and thereby stimulated apical growth as well as formation of leaves (Verma *et al*., 1996; Kiruthikadevi, (2002).

CONCLUSIONS

According to the results, the most important conclusion was: (1) used 50% shade was more effective in enhancing plants height, Leaf area, total chlorophyll, vegetative dry weight, plant growth index and the number of premier tricussate shoots compared with unshaded.

(2) Spray with GA_3 at 500 mg l^{-1} was more effective in improving all studied traits compared with 250 $mg.l^{-1}$ and 0 $mg.l^{-1}$ GA_3. (3) Increased NPK level from (0, 0, 0) to (150, 100, 75) to (300,200,150) $mg.l^{-1}$ was more effective in improving most of studied traits significantly.

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