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EFFECT OF NPK FERTILIZER AND GROWING MEDIA ON THE GROWTH AND GEL PRODUCTION OF TWO SPECIES OF ALOE PLANT (*ALOE VERA* AND *ALOE BUTTENERI*)

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ABSTRACT

This study was consummated during the period 1st Sep 2021 to 1st Jul 2022, in the Field of Horticulture Department/Agriculture Engineering Science College/ Duhok University/ Kurdistan region Iraq, aiming to study the effect of three levels of NPK fertilizer (urea, triphosphate, potassium sulfate) control (0,0,0), low (100,75,50), high (200,150,100) mgl-1 and five media (clay soil, loamy soil, clay soil+ loamy soil, peat moss + clay soil + loamy soil, peat moss + clay soil + loamy soil + compost) by volume, on the growth and Gel production of two species of Aloe (*Aloe vera*, *Aloe butteneri*) plant. The results can be summarized as follow. Increased NPK to high (200,150,100) mgl-1 increased significantly leaf size, Gel fresh weight, plant growth index, and leaf area for the two species. Also, the fourth media (peat moss + clay soil + loamy soil) and fifth media (peat moss + clay soil + loamy soil + local compost) were the best media for the most of studied parameters, whereas the third media (clay soil + loamy soil) was the least effect on most of the studied parameter. *Aloe vera* species a significantly superior to the *Aloe butteneri* species in all studied parameters.

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INTRODUCTION

Aloe (*Aloe vera*) and (*Aloe butteneri*) belong to the Liliaceae family which is also previously known as Asphodelaceae, Aloaceae, or Xanthorrhoeaceae family (Chen *et al*. 2012). The plant is in indigenous dry regions of eastern and southern Africa, Asia, Europe, America, and India (Mukesh *et al*., 2010). Aloe is a perennial plant, growing to the high of 45 – 75 cm. Its leaves are long and thick, and juicy, it is a wheel-like phyllotaxy. The two sides (edge) of the leaves and their leaf's tip have a thorny structure with a thorny tip. The inner substance of the leaves is jellylike, with a bad odor and bitter taste. The length of the leaf's ranges from 30-50 cm, while the breadth is 10 cm at the base it normally flowers from October to January and the long inflorescence has a large number of small pink flowers all around. (Balasubramanian and Narayanan, 2013) Aloe is highly sensitive to water, and all kinds of soils but well-drained soil with high organic matter nitrogen-rich and alkaline soil, Soil nitrogen should ideally be maintained. While most species of Aloe typically grow in sandy soils. The harvesting starts after (7-8) months of planting (Manvitha and Bidya

2014). Jat *et al*., (2015) observed that it is successfully grown on marginal to submarginal soils having low fertility. its growth is faster under medium fertile heavier soils, However, well-drained soil texture of loamy to coarse sandy loam soils with moderately fertile soils and pH up to 8.5 are most suitable for its commercial cultivation.

Organic products or fertilizers influence the soil structure, which leads to increasing the formation of aggregates that allow greater water retention and greater gas and nutrient exchange in the rhizosphere (Khan *et al*. 2009). Nematian, *et al*., (2012) found that vermicompost and planting density treatments had a significant effect on the rate of active substances and the highest amounts of Aloenin and Aloe-emodin were measured as 1193.3 µg/g and 536.3 µg/g in the fertilizer treatment of 15 ton/hec and density of 4 plants/m2 compared with 5 and 10 tons. Plants require suitable soil for higher yield, quality growth, and desired crop productivity that differ with soil characteristics, availability of nutrient elements, and overall soil fertility. Plants require suitable soil for higher yield, quality growth, and desired crop productivity that differ with soil characteristics, availability of the nutrient elements, and overall soil fertility. (Chowdhury 2018) found that the Growth and leaf biomass yield of A. vera was significantly influenced by different soil types. Also, Chowdhury (2020) study different combinations of IF (inorganic fertilizer consisting of urea, TSP, MoP, and gypsum at 150, 80, 120, and 30 kg ha-1) respectively and PM (poultry manure 5 t ha-1) were significantly influenced on the growth, yield attributes and leaf biomass yield of A. vera. The highest fresh leaf weight (4864 g. plant-1), fresh gel weight (2956 g. plant-1), and dry leaf weight (420.70 g. plant-1), were obtained from the plant treated with 25% IF and 75% PM. Whereas the tallest plant (57.14 cm) and highest number of leaves plant-1 (18.33) were found from the pot treated with 100% IF 0% PM, also About 153% yield increase over control was noticed from 25% IF 75% PM which was statistically identical with the yield increase of the treatment 100% IF 0 % PM.

Nitrogen (N), phosphorus (P), and potassium (K) are the key nutrients that manipulate plant growth by influencing all vital processes in plants viz., protein, energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and enzyme regulation. Nitrogen plays an important role in crop plants. It is involved in various critical processes, such as growth, leaf area-expansion and biomass-yield production. Excess NUE can support good plant performance and better crop out-put. Various plant molecules such as amino acids, chlorophyll, nucleic acids, ATP and phyto-hormones, that contains nitrogen as a structural part, are necessary to complete the biological processes, involving carbon and nitrogen metabolisms, photosynthesis and protein production (Frink *et al*., 1999, Crawford, *et al*.,2002). Phosphorus (P) is an essential element determining a plant's growth and productivity. Because of the soil fixation of P, its availability in soil is rarely sufficient for optimum growth and development. it's a structural component of nucleic acids, sugars, and lipids. Furthermore, the role of P in plant's developmental processes at both cellular and whole plant level, viz. photosynthesis, respiration, nitrogen fixation, seedling establishment, seed germination, root, shoot, flower, and seed development (Malhotra *et al*., 2018). Adenosine diphosphate (ADP) and adenosine triphosphate (ATP) are high-energy phosphate compounds that control

most processes in plants including photosynthesis, respiration, protein, and nucleic acid synthesis, and nutrient transport through the plant's cells potassium (K) is the primary osmolyte and ion involved in plant cell membrane dynamics, including the regulation of stomata and the maintenance of turgor and osmotic equilibrium (Sharpley *et al*., 1996). Saha *et al*., (2005) observed that the growth rate of leaf breadth in *Aloe vera* was highest with the treatments where more percentage of nitrogen fertilizer was used. Thus, leaf volume can be an important factor in the determination of leaf yield and leaf fresh weight (Hernandez -Cruz *et al*., 2002). nutrient minerals, such as N and K, increase leaf growth, and the number of leaves and lead to a substantial amount of gel in A. vera (Tawaraya *et al*., 2007). Barandozi (2011) study the effect of different amounts of fertilizers on the leaf and plant characteristics as well as the yield of *Aloe vera*. Observed that the plant produced the highest mature leaf length and a number of tillers plant -1 and maximum leaf weight, as well as the weight of largest leaves with the application of 50% P+ 50% K or as P2O5 and K2O.

Aloe vera uses for health (anti-inflammatory, antiviral, antioxidative actions, antibacterial, immunostimulant, antifungal, analgesic, antitumor, antidiabetic, and inhibition of tumor cells activation and proliferation), beauty, medicinal, and skin care properties. The Egyptians called Aloe "the plant of immortality." Today, the *Aloe vera* plant has been used for various purposes in dermatology (Marshall, 1990; Ray *et al*., 2013). The world trade worth the of *Aloe vera* plant is about 80 million US$ and is likely to increase by 35 - 40 % within 5 years. (Biswas, 2010).

Objectives and Aims of the Study:

Therefore, because of the high demand for this plant for its medicinal property and its use in the cosmetics industry and as an ornamental plant especially in Rocks gardens, this study will be done to achieve the following aims to Comparing two species of Aloe that are available in our region and obtained the best soil media for plant growth and the best NPK fertilizers levels to enhance the studied parameters.

MATERIALS AND METHODS

This investigation was consummated during the period 1st Sep 2021 to 1st Jul 2022, in the Field of Horticulture Department/Agriculture Engineering Science College/ Duhok University/Kurdistan region Iraq, aiming to study the effect of three levels of NPK fertilizer (urea, triphosphate, potassium sulfate) (0,0,0), (100, 75, 50), (200,150,100) mgl-1 and five media (clay soil, loamy soil, clay soil+ loamy soil, peat moss + clay soil + loamy soil, peat moss + clay soil + loamy soil + local compost) by volume, compost consist of (sheep manure: sawdust: hay: lawns clipping) by volume on the growth and Gel production of two species of Aloe (*Aloe vera*, *Aloe butteneri*). So, the experiment includes 3*5*2=30 treatment *3 replicates*3 plants for each replicate =270 plants. Transplants with 10-15 cm height obtained from local nursery cultivate in 30 cm pot size. The NPK Fertilizer treatments are performed by adding 100 ml of each level for each pot every 15 days, Irrigation of plants begins after planting, and when the plant needs it, daily services should be done. After 10-month the following data were recorded plant height, leaf size, Leaf area, tiller/plant, plant growth index, and Gel fresh weight. the experiment was performed according to the

RCBD design and the data were analyzed for each species and the comparation between the two species was made in another program by using the SAS program and the means for each species were compared by using DMRT at 0.05 level (SAS, 2013).

RESULTS AND DISCUSSION

Plant height (cm)

The data in table (1) clarified a significant superiority of plant height for the *Aloe vera* species (39.89) cm over the *Aloe buttener* species (24.91) cm. NPK fertilizer doesn't have any significant effect on the two species. on the other hand, the media effect significantly on the plant height of *Aloe butteneri* species, and the best media was (peat moss, clay soil, loam soil + compost) which gave the highest height (27.33) compared with the third media (clay soil + loamy soil) which gave the least height (22.39) cm. whereas the height of Aloe species didn't affect significantly with this factor. The interaction between NPK fertilizer and growing media caused a significant effect on *Aloe butteneri*, the highest means reaching 28.17 cm for the low fertilizer (100,75,50) and fifth media (peat moss + clay soil + loamy soil + compost) compared with the least height (22.00) cm for the same level of NPK and the third media (clay soil + loamy soil). Whereas the interaction between NPK fertilizer and growing media for *Aloe vera* hasn't any significant influence in this parameter and the height of plants ranged between 35.67 to 45.17 cm.

Table (1). Effect of NPK fertilizer and growing media on the plant height (cm) of *Aloe vera* and *Aloe butteneri* plant.

species	NPK fertilizer ($mg.l^{-1}$)	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss +Clay soil+	NPK effect	species effect
Aloe butteneri	control zero	25.33^{b-e}	24.50^{d-g}	22.83^{e-g}	24.33^{d-g}	27.67^{ab}	24.93^{a}	24.91^{b}
	low 100:75:50	25.17^{c-e}	26.17^{a-d}	22.00^{g}	24.83^{c-f}	28.17^{a}	25.27^{a}	
	high 200:150:100	24.00^{d-g}	25.00^{c-e}	22.33^{fg}	24.00^{d-g}	27.33^{a-c}	24.53^{a}	
	media effect	24.83^{b}	25.22^{b}	22.39^{c}	24.39^{b}	27.72^{a}		
Aloe vera	control zero	38.50^{a}	37.33^{a}	36.00^{a}	38.33^{a}	40.50^{a}	38.13^{a}	39.89^{a}
	low 100:75:50	44.50^{a}	42.50^{a}	37.50^{a}	40.50^{a}	44.17^{a}	41.83^{a}	
	high 200:150:100	45.17^{a}	37.83^{a}	41.00^{a}	35.67^{a}	38.83^{a}	39.70^{a}	
	media effect	42.72^{a}	39.22^{a}	38.17^{a}	38.17^{a}	41.17^{a}		

Means with same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Rang Test.

Leaf size (cm^3)

The data in the table (2) clarified a significant superiority of plant height for the *Aloe vera* species (72.49) cm^3 over the *Aloe butteneri* species (23.46) cm^3. The

two levels of NPK fertilizer low (100, 75, 50) mg.l-1 and high (200, 150, 100) mg.l-1 increased significantly the Leaf size of *Aloe butteneri* to 26.22 and 27.20 cm^3 respectively compared with the control which gave16.96 cm^3. Whereas increasing the level of NPK from control to low and high levels increased the Leaf size for *Aloe vera* species from 54.24 to 75,07 then to 88.16 cm^3 respectively.

The best-growing media for *Aloe butteneri* was the fifth media (peat moss + clay soil + loamy soil + compost) which gave (31.07) cm^3 whereas the least affected media was the third (clay soil + loamy soil) which gave the least Leaf size reached to (16.04) cm^3. Whereas for the *Aloe vera* species the least media effect occurs for the third media (clay soil + loamy soil) which gave the least mean (60.44) cm^3 compared with the other media which gave the highest means ranging between (66.22 to 79.41) cm^3.

The interaction between NPK fertilizer and growing media for *Aloe butteneri* species gave the highest significant value reached (35.00) cm^3 for low fertilizer (100, 75, 50) mg.l-1 and the fifth media (peat moss + clay soil + loamy soil + compost) when Compared with the little size of leaf 9.00 cm^3 for control (0,0,0) fertilizer and third (clay soil + loam soil).

Table (2). Effect of NPK fertilizer and growing media on the Leaf size of *Aloe vera* and *Aloe butteneri plant*.

Species	NPK fertilizer (mg. l^{-1})	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss + Clay soil+ Loamy soil+ compost	NPK effect	species effect
Aloe butteneri	control zero	13.56^{ef}	20.67^{b-e}	9.00^{f}	15.56^{d-f}	26.00^{a-d}	16.96^{b}	23.46^{b}
	low 100:75:50	24.33^{a-e}	28.56^{a-c}	18.89^{c-f}	24.33^{a-e}	35.00^{a}	26.22^{a}	
	high 200:150:100	27.56^{a-c}	29.33^{a-c}	20.22^{c-f}	26.67^{a-d}	32.22^{ab}	27.20^{a}	
	media effect	21.81^{bc}	26.19^{ab}	16.04^{c}	22.19^{bc}	31.07^{a}		
Aloe vera	control zero	51.11^{ef}	53.67^{d-f}	38.00^{f}	58.44^{c-f}	70.00^{b-f}	54.24^{c}	72.49^{a}
	low 100:75:50	95.67^{ab}	62.78^{b-f}	63.56^{b-f}	73.33^{a-e}	80.00^{a-e}	75.07^{b}	
	high 200:150:100	104.44^{a}	82.22^{a-e}	79.78^{a-e}	86.11^{a-d}	88.22^{a-c}	88.16^{a}	
	media effect	83.74^{a}	66.22^{ab}	60.44^{b}	72.63^{ab}	79.41^{a}		

Means with the same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Range Test.

The same interaction for *Aloe vera* species gave the highest Leaf size reaching 104.44 cm^3 for high fertilizer and clay soil interaction compared with the least size 51.11cm^3 for non-fertilized and third media (clay soil + loam soil).

Leaf area (cm^2)

The data in the table (3) showed a significant superiority of Leaf area for the *Aloe vera* species (367.19) cm^2 over the *Aloe butteneri* (168.92) cm^2. The two levels of NPK fertilizer low (100, 75, 50) mg. l-1 and high (200, 150, 100) mg. l-1 increased

significantly the Leaf area of *Aloe butteneri* to 188.90 and 179.17 cm^2 respectively compared with control (0, 0, 0) mg. l-1 which gave 138.97 cm^2. in the same way, the two levels of NPK increased this parameter for *Aloe vera* species to 425.92 and 420.41cm^2 respectively compared with control (255.23) cm^2.

The best-growing media for *Aloe butteneri* was the fifth media (peat moss + clay soil + loamy soil + compost) which gave (196.70) cm^2 whereas the least affected media was the third (clay soil + loamy soil) which gave Leaf area reached to (134.38) cm^2. Also, the best-growing media for *Aloe vera* species was the fifth media (peat moss + clay soil + loamy soil + compost) which gave (420.58) cm^2 whereas the least affected media was the third (clay soil + loamy soil) which gave Leaf area reached to (312.14) cm^2.

Table (3). Effect of NPK fertilizer and media on the Leaf area (cm^3) of *Aloe vera* and *Aloe butteneri* plant.

species	NPK fertilizer ($mg.l^{-1}$)	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss +Clay soil+ Loamy soil+ compost	NPK effect	species effect
Aloe butteneri	control zero	141.14^{ef}	141.68^{ef}	115.62^{f}	140.60^{ef}	154.43^{c-f}	138.69^{b}	168.92^{b}
	low 100:75:50	177.84^{a-e}	194.85^{a-d}	139.14^{ef}	172.65^{b-e}	211.38^{ab}	179.17^{a}	
	high 200:150:100	178.92^{a-e}	195.38^{a-d}	148.39^{d-f}	197.51^{a-c}	224.30^{a}	188.90^{a}	
	media effect	165.97^{b}	177.30^{ab}	134.38^{c}	170.25^{b}	196.70^{a}		
Aloe vera	control zero	272.14^{cd}	226.45^{d}	203.17^{d}	269.04^{cd}	305.33^{b-d}	255.23^{b}	367.19^{a}
	low 100:75:50	445.30^{a}	433.01^{ab}	359.64^{a-c}	418.86^{ab}	472.82^{a}	425.92^{a}	
	high 200:150:100	436.68^{ab}	393.30^{a-c}	373.60^{a-c}	414.87^{ab}	483.58^{a}	420.41^{a}	
	media effect	384.71^{a}	350.92^{ab}	312.14^{b}	367.59^{ab}	420.58^{a}		

Means with the same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Range Test.

The *Aloe butteneri* species were affected significantly by the interaction between the two factors and the best treatment was for the high fertilizer (200,150,100) and fifth media (peat moss + clay soil + loam soil + compost) which gave the highest Leaf area reached to 224.30 cm^2 compared with non-fertilized and third media (clay soil + loam soil) which gave the least area (115.62) cm^2. Whereas the interaction for the *Aloe vera* species gave the highest mean reached (483.82) cm^2 when grown in fifth media (peat moss + clay soil + loam soil + compost) and high fertilizer when compared to the least means 203.17 cm^2 for non-fertilized plants that grown in the third media.

Number of tiller/plants

Table (4) clarified significantly superior in this parameter for the *Aloe butteneri* (2.91) tiller/plant when compared with *Aloe vera* (2.43) tiller/plant. NPK fertilizer hasn't any significant effect on this parameter for the two species. The growing media also haven't any significant effect on this parameter. The interaction between the two factors also hasn't significantly affected this parameter and the number of tiller/plants ranged between 2.11 to 4.00 tiller/plant for *Aloe butteneri* species and between 2.00 to 3.37 tiller/plant for the other species.

Table (4). Effect of NPK fertilizer and growing media on the number of tiller/plants of *Aloe vera* and *Aloe butteneri* plant.

Species	NPK fertilizer ($mg.l^{-1}$)	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss + Clay soil+ Loamy soil+ compost	NPK effect	species effect
Aloe butteneri	control (zero)	3.33^{a}	2.83^{a}	2.11^{a}	3.33^{a}	2.83^{a}	2.89^{a}	2.91^{a}
	low 100:75:50	2.56^{a}	2.56^{a}	2.22^{a}	2.78^{a}	3.44^{a}	2.71^{a}	
	high 200:150:100	2.44^{a}	2.56^{a}	3.11^{a}	4.00^{a}	3.56^{a}	3.13^{a}	
	media effect	2.78^{a}	2.65^{a}	2.48^{a}	3.37^{a}	3.28^{a}		
Aloe vera	control zero	2.44^{a}	1.33^{a}	2.00^{a}	2.78^{a}	3.17^{a}	2.34^{a}	2.43^{b}
	low 100:75:50	2.33^{a}	2.67^{a}	2.33^{a}	2.83^{a}	2.72^{a}	2.58^{a}	
	high 200:150:100	2.00^{a}	2.22^{a}	2.44^{a}	2.11^{a}	3.11^{a}	2.38^{a}	
	media effect	2.26^{a}	2.07^{a}	2.26^{a}	2.57^{a}	3.00^{a}		

Means with the same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Range Test.

Plant growth index (cm^3)

The data in the table (5) showed significant superiority of plant growth index for the *Aloe vera* species (2402.18) cm^3 over the *Aloe butteneri* species (726.71) cm^3. NPK fertilizer hasn't a significant effect on *Aloe butteneri* growth index while it has a significant effect on the *Aloe vera* species, the low fertilizer level (100, 75, 50) mg.l-1 gave the highest mean reached 3069.32 cm^3 compared with the control which gave the least mean (1875.49) cm^3.

The fourth media (peat moss + clay soil + loamy soil) and fifth (peat moss + clay soil + loamy soil + compost) give the heights growth index of *Aloe butteneri* reached 877.03 and 840.19 cm^3 respectively compared with the second media (loamy soil) which gave the least mean 616.39 cm^3. Whereas for the *Aloe vera* species the least media effect occurs for the third media (clay soil + loamy soil) which gave the least mean (1766.51) cm^3 compared with the other media which gave the highest means ranging between (2221.75 to 3137.46) cm^3.

Table (5). Effect of NPK fertilizer and growing media on the plant growth index of *Aloe vera* and *Aloe butteneri* plant.

Species	NPK fertilizer ($mg.l^{-1}$)	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss +Clay soil+ Loamy soil+ compost	NPK effect	species effect
Aloe butteneri	control zero	577.76^{c}	620.15^{bc}	587.26^{c}	729.45^{a-c}	662.74^{bc}	635.47^{a}	726.71^{b}
	low 100:75:50	671.27^{bc}	622.01^{bc}	705.19^{a-c}	843.86^{a-c}	988.18^{ab}	766.10^{a}	
	high 200:150:100	682.07^{bc}	607.00^{bc}	676.28^{bc}	1057.79^{a}	869.65^{a-c}	778.56^{a}	
	media effect	643.70^{bc}	616.39^{c}	656.24^{bc}	877.03^{a}	840.19^{ab}		
Aloe vera	control zero	1398.87^{b}	2083.49^{b}	1597.02^{b}	1899.37^{b}	2398.70^{b}	1875.49^{b}	2402.18^{a}
	low 100:75:50	2939.66^{b}	2975.18^{b}	1807.95^{b}	5206.19^{a}	2417.60^{b}	3069.32^{a}	
	high 200:150:100	2732.29^{b}	1606.57^{b}	1894.56^{b}	2306.82^{b}	2768.44^{b}	2261.74^{a} ^{b}	
	media effect	2356.94^{a} ^{b}	2221.75^{ab}	1766.51^{b}	3137.46^{a}	2528.25^{ab}		

Means with same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Range Test.

The interaction between NPK fertilizer and media increased significantly the growth index of *Aloe butteneri* and the highest mean reached 1057.79 cm^3 for the fourth media (peat moss + clay soil + loamy soil) and high fertilizer (200, 150, 100) mg. l-1 compared with the least mean 577.76 cm^3 for clay soil and control treatment. On the other side, the interaction between NPK fertilizer and media increased significantly the growth index of *Aloe vera*, and the highest mean reached 5206.19 cm^3 for the fourth media (peat moss + clay soil + loamy soil) and low fertilizer (100, 75, 50) mg. l-1 compared with the least mean 1398.87 cm^3 for clay soil and control treatment.

Gel fresh weight (gm)

The data in the table (6) showed significant superiority of Gel fresh weight for the *Aloe vera* species (48.64) gm over the *Aloe butteneri* (10.62) gm. The two levels of NPK fertilizer low (100, 75, 50) mg. l-1 and high (200, 150, 100) mg. l-1 increased significantly the Gel fresh weight of *Aloe butteneri* to 10.71 and 12.37 gm respectively compared with control (0, 0, 0) mg.l-1 which gave 8.78 gm. in the same way the two levels of NPK increased this parameter for *Aloe vera* species to 53.06 and 60.07 gm respectively compared with control (32.79) gm.

The best-growing media for *Aloe butteneri* was the fifth media (peat moss + clay soil + loamy soil + compost) which gave the highest Gel weight (13.91) gm whereas the least affected media was the third (clay soil + loamy soil) which gave the least Gel weight (6.88) gm. Also, the best-growing media for *Aloe vera* species was the first media (clay soil) which gave (54.30) gm whereas the least affected media was the third (clay soil + loamy soil) which gave the least Gel weight reached (38.70) gm.

Table (6). Effect of NPK fertilizer and growing media on the Gel fresh weight (gm) of *Aloe vera* and *Aloe butteneri* plant.

Species	NPK fertilizer (mg l^{-1})	Clay Soil	Loamy Soil	Clay soil + Loamy Soil	Peat moss + Clay Soil + loamy soil	Peat moss +Clay soil+ Loamy soil+ compost	NPK effect	species effect
Aloe butteneri	control (zero)	6.50^{de}	10.94^{bc}	5.16^{e}	7.92^{c-e}	13.40^{ab}	8.78^{b}	10.62^{b}
	low 100:75:50	9.91^{d-b}	12.51^{ab}	7.55^{c-e}	10.92^{bc}	12.67^{ab}	10.71^{a}	
	high 200:150:100	13.20^{ab}	13.09^{ab}	7.93^{c-e}	11.96^{a-c}	15.67^{a}	12.37^{a}	
	media effect	9.87^{b}	12.18^{ab}	6.88^{c}	10.27^{b}	13.91^{a}		
Aloe vera	control (zero)	28.57^{ef}	32.63^{d-f}	23.22^{f}	38.07^{c-f}	41.47^{b-f}	32.79^{b}	48.64^{a}
	low 100:75:50	55.38^{bc}	49.15^{b-e}	41.78^{b-f}	60.92^{ab}	58.08^{a-c}	53.06^{a}	
	high 200:150:100	78.94^{a}	56.26^{bc}	51.09^{b-d}	60.53^{a-c}	53.51^{b-d}	60.07^{a}	
	media effect	54.30^{a}	46.01^{ab}	38.70^{b}	53.17^{a}	51.02^{a}		

Means with the same letter for each factor and interaction for each plant are not significantly different at 5% level based on Duncan's Multiple Range Test.

The *Aloe butteneri* species were affected significantly by the interaction between the two factors and the best treatment was the high fertilizer (200,150,100) and fifth media (peat moss + clay soil + loam soil + compost) which gave the highest Gel weight reached 15.67 gm compared with non-fertilized and third media (clay soil + loam soil) which gave the least weight (5.16) gm. Whereas the interaction for the *Aloe vera* species gave the highest mean reached (78.94) gm when grown in fifth media (peat moss + clay soil + loam soil + compost) and high fertilizer when compared to the least means 23.22 gm for non-fertilized plants that grown in the third media.

The significant effect of NPK fertilizer on height, leaf area, leaf size, tiller /plant, plant growth index, and Gel fresh weight may be related to the supply of nutrients, such as N, P, and K which played a significant role in the growth and primary metabolism performance and increase leaf growth, so As the availability of food for the plant increased, the amount of photosynthesis as well as it causes the increasing amount of carbon which can be used in the synthesis of primary and secondary compounds which resulted in higher gel weight in A. vera (Saha *et al*.,

2005). Or due to the positive effects of nitrogen on the activation of photosynthesis and metabolic processes of organic compounds in plants which, in turn, encourage plant vegetative growth. the significant effect of the growing media on leaf area, leaf size, plant growth index, and Gel fresh weight may be related to the application of organic matter increased cell division and elongation without hampering the nutrient uptake process which provided better results due to better nutrition. (Guerrero *et al*., 2001) or to the good environmental conditions and availability of nutrients, the physical structure which has allowed the roots system to better development then led to the absorption of larger amounts of elements, increased biological activities, soil aeration, and increasing water holding capacity then caused more biomass production. (Salem and Awad, 2005 and Abou El-Magd *et al*. 2006).

CONCLUSIONS

Increased NPK increased significantly leaf size, Gel fresh weight, plant growth index, and leaf area for the two species Also, the fourth media (peat moss + clay soil + loamy soil) and fifth media (peat moss + clay soil + loamy soil + local compost) were the best media for the most of studied parameters, whereas the third media (clay soil + loamy soil) was the least effect on most of the studied parameter. *Aloe vera* species a significantly superior to the *Aloe butteneri* species in all studied parameters.

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CONFLICT OF INTEREST

The researcher supports the idea that this work does not conflict with the interests of others.

تاثير السماد المركب NPK واوساط الزراعة على النمو وانتاج الجل لنبات الصبار نوعي *Aloe vera* و *Aloe butteneri*

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الخلاصة

اجريت هذه الدراسة خلال الفترة من 1 سبتمبر 2021 إلى 1 يوليو 2022، في حقول قسم البستنة/ كلية علوم الهندسة الزراعية/ جامعة دهوك/ إقليم كردستان العراق. بهدف دراسة تأثير ثلاثة مستويات من السماد المركب NPK (اليوريا، ثلاثي الفوسفات، كبريتات البوتاسيوم) هي المقارنة (0، 0، 0)، تسميد واطئ (50، 75 ، 100)، تسميد عالي (100، 150 ،200) ملغم. لتر$^{-1}$ وخمسة اوساط زراعية (تربة طينية، تربة مزيجيه، تربة طينية + تربة مزيجية ، بيتموس + تربة طينية + تربة مزيجية ، بيتموس + تربة الطينية + تربة مزيجية + كومبوست) على نمو وإنتاج الجل لنوعين من نبات الصبار (*Aloe vera*، *Aloe butteneri*). نفذت التجربة

باستخدام تصميم القطاعات العشوائية الكاملة (RCBD). وتلخصت النتائج بما يلي. أدت زيادة السماد المركب NPK إلى المستوى العالي (100،150،200) ملغم لتر −1 إلى زيادة كل من حجم الورقة والوزن الطازج للجل من ودليل النمو للنبات والمساحة الورقة. اظهر الوسط الرابع (بتموس + تربة طينية + تربة مزيجية) والوسائط الخامس (بتموس + تربة طينية + تربة مزيجية + كومبوست) تفوق معنوي على بقية اوساط الدراسة الاخرى ولمعظم الصفات المدروسة، بينما كان الوسط الثالث (تربة طينية + مزيجية). الأقل تاثيرا على معظم الصفات المدروسة. تفوق ألنوع *Aloe vera* وبشكل معنوي على ألنوع *Aloe butteneri* وفي جميع الصفات قيد الدراسة.

الكلمات المفتاحية: انتاج الجل، نبات الصبار، وسط الزراعة.

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