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# Effect of Spraying with Potassium, Organic Fertilization and Plants Densities in Growth and Yield of Onion

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**Abstract.** A field experiment was carried out in the city of Amiriya Al-Fallujah / Anbar Governorate, to know the response of the local grown red onions to spraying with potassium and organic fertilization under different plant densities during the season 2020-2021. The seeds were sown on 10/1/2020 and transferred to the field on 12/1/2020. The experiment included two factors, the first is a combination of organic fertilization (20 Mg.ha<sup>-1</sup>) and spraying with potassium sulfate (0, 5) g.l<sup>-1</sup> as follows: (T0: recommended fertilizer dose and T1: Cow's manure and T2: recommended fertilizer amount + spraying with potassium and T3: cow's manure + half of the number of fertilizers + potassium spray and T4: Double the recommended amount of cow's manure + half the amount of fertilizer recommended dose + spraying potassium. The second factor is Planting distances(S1: 10 × 10, S2: 10 × 15 and S3: 10 × 20) (cm). The distance between the plants was fixed to 10 cm was and the dimensions changed between plants' lines. The study was carried out as a factorial experiment within the randomized complete Block Design. The results of the study indicated the clear effect of the study factors on the characteristics of vegetative growth, yield and onions' content of total soluble solids(TSS), as the treatment T4S3 excelled by giving it the highest content of dry matter and the highest leaf area, the highest percentage of potassium in the leaves and this was positively reflected done by giving the plants of this treatment the highest yield of the plant and reached (5.83 gm, 15.26 dm<sup>2</sup>, 1.57% and 108.50 gm) in sequence. Hence, reducing the cultivation distances between plants and their interaction with fertilization levels had a positive effect in improving the yield traits , as the T4S1 treatment achieved the highest yield for the experimental unit and the highest marketable yield reached (10.03 kg and 77.06 Mg.ha<sup>-1</sup>), compared to T1S3-treated plants, which achieved the lowest yield for the experimental unit and the lowest marketable yield amounted to (4.733 kg and 35.73 Mg.ha<sup>-1</sup>) respectively.

## 1. Introduction

Onion, (*Allium cepa* L.), belongs to the Alliaceae family [1], is one of the most important strategic vegetable crops in Iraq and the world. It is consumed in large quantities and is characterized by its high nutritional value, as it contains large proportions of vitamins C and K, proteins, iron and calcium elements, as well as about its medical importance because it contains Quercetin, which is of great importance as an antioxidant and a cure for cancer [2]. Onions are among the vegetable crops that are absorbable for fertilizers and major elements in particular. It needs twice as much as the rest of the vegetable crops. Because it is one of the plants of the heavy roots group and its long-growing season. Onions need nitrogen, phosphorous and potassium (N, P, K) in large quantities, and a deficiency of any of them causes a decrease in the growth of the plant [3]. Potassium K is one of the major elements



needed by the plant for growth and development during the life cycle of the plant. It is one of the basic elements that participate in some of the vital interactions and physiological activities that occur inside the plant cells, such as the formation of proteins, respiration, photosynthesis, absorption and transfer of ions and resistance to pollution and its resistance to diseases as well as its role in increasing the characteristics of vegetative growth and yield and improving its quality [4]. The excessive use of chemical fertilizers, in addition to the increase in their high economic cost, has paved the way for the use of alternative organic sources that reduce pollution, reduce the percentage of harmful nitrates in the crop, and reduce the harmful environmental effects of non-decomposing materials by transforming them into a useful form as well as increasing the nutritional capacity of the soil to achieve its nutritional needs. From these sources, the waste of cattle, sheep and poultry [5]. Agricultural plant densities are one of the important factors in managing the crop for its role in growth and production. It achieves the best size of the onion and the highest yield if the plants grow at an ideal density. The relative increase in plant densities per unit area should increase the number of plants per square meter without causing damage to field competition, which is reflected positively in plant yield and quality [6].

From the above, the study aimed to:

1. Knowing the effect of best potassium concentration, organic fertilization and plant density on growth and yield of onions.
2. Determine the best interaction achieving the highest growth and yield with the best quality (total soluble solids and high dry matter).

## 2. Materials and methods

The field study was carried out in Anbar Governorate, Amiriya Fallujah district (33.164 latitudes and 43.864 longitudes) southwest of Baghdad for the agricultural season 2020-2021 to study the response of local red onions to spraying with potassium and organic fertilization under different plant densities. The study was implemented as a factorial experiment in a randomized complete block design (RCBD) with three replications. The field was divided into 3 sectors, each sector containing 15 experimental units with an area (1.5 m long x 0.8 m wide). Samples were taken from the soil of the field before planting at a depth of (15-20 cm) in order to characterize the soil of the field physically and chemically (Table 1). Cultivation of onion seeds, a local red variety, on 10/1/2020, in rectangular plates with an area of (1.5 m x 1 m) in sandy soil, in lines with a depth of 0.5 cm and a distance of 5 cm between one line and another. After the transplants reach the appropriate size 3-4 real leaves were transferred to the permanent field on (1/12/2020). After we performed all the service operations recommended by [2].

The study included two factors:

The first factor: fertilization and the following combinations

T0: The complete fertilizer recommendation (NPK) 120-100-100 was considered as the comparison treatment

T1: Cows' manure (20 Mg.ha<sup>-1</sup>) [14] + half of the fertilizer recommendation

T2: Fertilizer recommendation + potassium spray 5 g/l in two phases, the first after (90) days and the second after (15) days from the first spray

T3: Cows' manure (20 Mg.ha<sup>-1</sup>) + half of the fertilizer recommendation + potassium spray 5 g / liter in two stages, the first after (90) and the second after (15) days from the first spray.

T4: Double the recommendation of cow manure + half of the fertilizer recommendation + potassium spray 5 g/liter in two phases, the first after (90) days and the second after (15) days from the first spray.

The second factor: planting distances

S1: (10 x 10) cm. The distance between plants is 10 cm, and between one line and another is 10 cm.

S2: (10) x (15 cm). The distance between plants is 10 cm, and between one plant and another is 15 cm.

10): S3 x 20 cm The distance between the plants is 10 cm and between one line and another 20 cm.

The results were statistically analyzed according to the (Genstat) program and the averages were compared according to the LSD test at the probability level of 0.05 [7].

Table 1. The Physical and chemical properties of field soil at a depth of 20 cm.

E.C ds.m <sup>-1</sup>	pH	Ready Nitrogen mg.kg <sup>-1</sup>	ready-made phosphorous mg.kg <sup>-1</sup>	ready- made potassium g.kg <sup>-1</sup> m	Silt g.kg <sup>-1</sup>	Clay g.kg <sup>-1</sup>	Sand g.kg <sup>-1</sup>	soil texture
3.08	7.93	42.61	26.73	152.42	457	245	193	clay loam

The studied traits:

A- traits of vegetative growth: A sample of five randomly selected plants was taken and the following characteristics were estimated.

1- The dry weight of the total vegetation (gm).

2- The leaf area of the plant (dm<sup>2</sup>): The leaf area of the capillary was measured from the equation:

$$\text{Leaf area} = (-93.1) + (1.83 \times \text{leaf length}) + (38.6 \times \text{leaf circumference at a distance of 25\% from its base}) [8].$$

The area of one leaf (cm<sup>2</sup>) was extracted, then the leaf area of one plant was extracted according to the following equation:

$$\text{The leaf area of a plant (dm}^2\text{)} = (\text{one leaf area cm}^2\text{)} / 100 \times \text{the number of leaves per plant.}$$

3- Determination of potassium concentration in the leaves:

The proportion of this element was determined by a flame photometer according to the method mentioned in [9].

B- The characteristics of the yield

1 - *Yield per plant (g)*: Ten onions were taken from each experimental unit at random to calculate the average weight of one onion in grams.

2- *Experimental unit yield (kg)*: It is calculated by multiplying the number of plants in the experimental unit by the yield of one plant.

3- *Marketable yield (Mg.ha<sup>-1</sup>)*: According to the total yield in hectares after excluding the non-varietal, damaged, double and flowering onion.

4- *Percentage of total dissolved solids (TSS) in onions*: Using the handrefractometer, drops of fruit juice were placed on the manual handrefractometer, where the percentage of total dissolved solids in these onions was measured and the reading was taken [10].

### 3. Results and discussion:

Table 2. Effect of spraying with potassium , organic fertilization and plants densities in growth and yield of onion on shoot dry matter (gm) and Leaf area (dm<sup>2</sup>).

Fertilization T	shoot dry matter (gm)				Leaf area (dm <sup>2</sup> )			
	Planting distances S			Means	Planting distances S			Means
S1	S2	S3	S1		S2	S3		
T0	3.80	4.30	4.90	4.33	10.80	12.63	12.80	12.07
T1	3.56	4.43	4.50	4.16	9.83	10.53	13.63	11.33
T2	4.23	4.73	5.23	4.73	11.13	11.23	14.66	12.34
T3	4.60	4.66	4.96	4.74	11.93	12.20	13.26	12.46
T4	4.96	5.46	5.83	5.42	13.13	13.53	15.26	13.97
Means	4.23	4.72	5.08		11.36	12.02	13.92	
LSD S		0.40				0.92		
LSD T		0.51		0.05		1.20		0.05
LSD S×T		N.S				N.S		

The results of Table (2) showed that treatment T4 was significantly superior by giving it the highest rate in the amount of dry matter, the vegetative total and leaf area, which amounted to (5.422 gm and 13.978 dm<sup>2</sup>), respectively, compared to treatment T1, which gave (4.167 gm and 11.333 dm<sup>2</sup>), respectively. Treatment S3 gave significant differences in the amount of dry matter in the vegetative total and leaf area of the plant, which amounted to (5.087 gm and 13.927 dm<sup>2</sup>), respectively, compared to treatment S1, which gave (4.233 gm and 11.367 dm<sup>2</sup>), respectively. The reason for the superiority of T4 treatment is due to the role of organic fertilization, which works It helps to increase the availability of nutrients and improve the physical and chemical properties of the soil [11], as well as the role of potassium in activating some vital processes inside the plant such as photosynthesis, enzyme formation, protein synthesis, cation and anion balance, stress resistance, stomata movement and disease resistance [12]. The reason for the superiority of treatment S3 is to increase the number of plants per unit area without overcrowding and competition for nutrients, light and water, which makes the plants grow well to give a large shoot system as a result of the increased absorption of the elements and their accumulation in the storage tissues of the plant that improve the quantitative and qualitative characteristics of the product [13].

Table 3. Effect of spraying with potassium, organic fertilization and plants densities in growth and yield of onion on potassium concentration.

Fertilization T	% of potassium K in leaves			
	Planting distances S			Means
S1	S2	S3		
T0	1.08	1.21	1.36	1.22
T1	1.06	1.08	1.10	1.08
T2	1.30	1.35	1.33	1.33
T3	1.22	1.36	1.48	1.36
T4	1.24	1.39	1.57	1.40
Means	1.18	1.28	1.37	
LSD S		0.06		
LSD T		0.08		0.05
LSD S×T		N.S		

The results as seen in Table (3) that the T4 fertilization treatment achieved a significant increase in the potassium percentage in the vegetative total, amounting to (1.40%) compared to the T1 treatment that gave (1.08%), and the S3 treatment achieved the highest potassium percentage in the vegetative

total, reaching (1.37%), compared with treatment S1, which amounted to (1.18%). The reason for the increase in the percentage of potassium in vegetative growth is attributed to the effect of spraying with potassium fertilizer in the advanced stages of the plant's life, which caused an increase in the vital activities of the plant and the reason for the transfer of metabolic products to the vegetative parts and then to the stored parts, which is the reason for an increase in the characteristics of the quotient (Tables 2 and 3). These results are all aligned with [14] results.

Table 4. Effect of spraying with potassium, organic fertilization and plants densities in growth and yield of onion on plant yield (gm) and Experimental unit yield (kg).

Fertilization T	yield per plant (gm)				Experimental unit yield (kg)			
	Planting distances S			Means	Planting distances S			Means
	S1	S2	S3		S1	S2	S3	
T0	71.26	76.46	83.20	76.97	8.76	6.96	4.86	6.86
T1	70.26	76.20	79.56	75.34	8.26	6.83	4.73	6.61
T2	75.86	76.36	92.90	81.71	9.13	6.86	5.53	7.17
T3	77.93	79.06	94.96	83.98	9.07	7.16	5.66	7.30
T4	81.06	85.967	108.50	91.84	10.03	8.06	7.10	8.40
Means	75.28	78.81	91.82		9.055	7.18	5.58	
LSD S			1.31			0.80		
LSD T			1.70	0.05		1.03		0.05
LSD S×T			2.94			N.S		

The results of Table 4 showed the clear effect of the two study factors, as the T4S3 treatment achieved the highest yield per plant, which amounted to 108.80 gm, compared to the T1S1-treated plants, which gave the lowest yield of 70.26 gm. Treatment T4 was significantly superior by giving the highest yield of the experimental unit amounted to 8.40g compared to the lowest yield given by the treatment plants T1 which was 6.61gm, while treatment plants S1 gave the highest yield of 9.05kg with a significant difference from the lowest yield given by the plants of treatment S3 which was 5.58kg.

Table 5. Effect of spraying with potassium, organic fertilization and plants densities in growth and yield of onion on Marketable yield (Mg.ha<sup>-1</sup>) and total soluble solids (TSS) in onions.

Fertilization T	Marketable yield (Mg.ha <sup>-1</sup> )				% of total dissolved solids (TSS) in onions			
	Planting distances S			Means	Planting distances S			Means
	S1	S2	S3		S1	S2	S3	
T0	69.06	53.43	37.40	53.30	9.80	10.16	11.56	10.51
T1	65.43	52.90	35.73	51.35	8.43	9.80	10.56	9.60
T2	72.10	53.23	42.10	55.81	10.20	11.80	11.66	11.22
T3	73.96	55.10	42.63	57.23	11.43	11.53	12.13	11.70
T4	77.06	59.83	48.63	61.84	12.23	12.33	12.50	12.35
Means	71.52	54.90	41.30		10.42	11.12	11.68	
LSD S			0.97			0.83		
LSD T			1.25	0.05		1.07		0.05
LSD ST			2.17			N.S		

The results of Table 5 indicated the significant effect of the factors of fertilization and planting distances, and this was evident in the T4S1 treatment, which achieved the highest marketable yield of 77.06 tons. hectares-1 compared to the lowest yield given by T1S3 plants, which amounted to 35.73 tons/ hectares-1. The reason for the superiority may be due in the characteristics of the yield, the role of organic fertilization in improving the properties of the soil and increasing the availability of nutrients. Moreover, the role of potassium in activating the vital processes of plants and increasing the formation of enzymes and protein synthesis, which caused an increase in the indicators of vegetative growth, which was positively reflected on the characteristics of the crop, as the accumulation of dry

matter in stages the advanced age of the plant will make the onions sink to polarize and store the products of photosynthesis, which increases the yield of onions. These results are in line with [14]. It is indicated here that the reason for the superiority of S3 plants in the yield of one plant is due to the large distance between the planting lines gave a good opportunity for plant growth and it reflected positively on the yield of one plant. On the contrary, the treatment plants S1 outperformed in the marketable yield due to the increase in the number of plants grown per unit area. These results are also in agreement with the findings of [15]. The results of Table (5) showed the superiority of T4-treated plants significantly by giving them the highest percentage of TSS which amounted to 12.35% compared to the lowest percentage it gave, on the other hand, treatment plants T1 which amounted to 9.60%. Alternatively, it achieved the lowest percentage of Total Soluble Solids (TSS) by S3 plants, which amounted to 11.68% compared to the lowest percentage achieved by treatment plants S1. This is due to the role of potassium spraying in the advanced stages of plant life, which helped in the accumulation of waste products. Photosynthesis in onions and transformed into a sink for total soluble solids (TSS). Increasing planting distances gave an appropriate opportunity for plants to absorb the largest amount of elements and accumulate them in the onions, which increased the percentage of TSS in plants treated with S3, which is consistent with these results with [16].

#### 4. Conclusion

From this study we can conclude: the best concentration of Potassium fertilizer is (5 gm.L<sup>-1</sup>) , fertilizing onion plants with (20 ton.hac<sup>-1</sup>) with organic fertilizer and the distance (10\*10) cm between plants and rows are the best treatments achieves high growth and yield with best quality.

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