The Journal of Research on the Lepidoptera
The Lepidoptera Research Foundation. June 2020
ISSN 0022-4324 (print) ISSN 2156-5457 (online)
Volume 51 (2): 1021-1033

Comparing the Performance of the Exudation Irrigation System and Surface Drip Irrigation with Two Levels of Phosphate Fertilizer in Some Growth Characteristics and Productivity of the Pea Plant (Vicia fabaL.)

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Abstract.
A field experiment was conducted to study the effect of exudation irrigation and surface drip irrigation with two levels of phosphate fertilizer (60 and 120 kg ha^{-1}) in some of growth and productivity characteristics of the leguminous plant Vicia faba L. Spain's Luz De Otono cultivar. the plant height, number of branches, pods and seeds in the pod and number of leaves were studied, in addition to the weight of 1000 seeds, and the productivity of dry seeds and green pods, and the differences were significant in the weight of 1000 seeds and in the productivity of green pods. It was found that the combination 60 kg ha^{-1} with exudation irrigation (I_2P_1) gave these best **characteristics.**

Keywords. Exudation, Phosphorous, Pods, Productivity.

Received: 16 April 2020
Accepted: 15 May 2020
DOI: 10.36872/LEPI/V51I2/301155

INTRODUCTION

The increase in demand for food calls for increased food production. To achieve this, it is necessary to adopt techniques that increase the efficiency of irrigation, including drip irrigation, as water is added without a major loss, whether by deep percolation or runoff (Stryker,2001). The American Society of Agricultural Engineers (2000) ASAE indicated that a portion of irrigation water goes into the air by evaporation from the surface of the wet soil, so it was thought to pump water directly to the root zone of the plant, the idea of Sub drip Irrigation was born, but this reduced the size of the irrigated root zone and this reflects negatively on the growth and spread of the roots. to escape from the loss caused by deep percolation, the method of exudation Irrigation was invented, which is one of the old ways in its concept and modern in its development and application, This is because irrigation continues to flowing inside the root zone from the beginning to the end of the season, and the drainage rate is changed by changing the pressure applied with the beginning of each stage of plant growth (Al-Hadithi et al, 2006). Its original habitat is Central Asia, and one of the materials used in this method of irrigation is pottery pipes (Ismail, 2000). the use of the exudation irrigation method reduced the apparent density values, and increased porosity compared to surface and subsurface drip irrigation treatments in a PRD method (Al-abaied and Harfoush, 2011). Followers of exudation irrigation led to reduced water consumption compared to drip irrigation (Saleh and Alabaied, 2015). Peas (Vicia faba L.) are an economically important legume crop whose seeds have a high protein content 25-40% (Natalia et al, 2008). and 56% carbohydrates and on mineral elements, fibers, oils and vitamins, especially vitamin B, and a high percentage of phytic acid (Mahmoud, 2010), in addition to its importance in improve soil properties by stabilizing atmospheric nitrogen (Attiya, 1985). Faba bean (Vicia faba L.) is a carboxylate-exuding legume that enhances the phosphorus (P) nutrition of subsequently grown cereals and the use of phosphorus (P)-efficient legumes is a prerequisite for sustainable intensification of low-input agro-ecosystems (Nebiyu et al, 2016). (Vicia faba L.; Family: Fabaceae), is one of the important legume crop of the world cultivated under both irrigated and rainfed conditions (Singh et al, 2012). Worldwide, legumes are grown on approximately 250 M ha and fix about 90 Tg of N_2 per year (Divito et al, 2014). It is have nutritional and medicinal properties, thereby incrementing its future aspects in potential utilization in medicine and agriculture (Sathya et al, 2018). the plant V. faba was originated from the East and it is widely consumed in South America and interestingly it has capability to grow in all climatic conditions (Marcello and Elena, 2017). the fruit is prevalent protein-affluent diet for humans as well it is widely utilized as animal feed (Hendawey and Younes, 2013). the V. faba plant was resistant to human cytomegalovirus (HCMV), the HCMV is a pathogen that causes infections in people and its astringency in those who are immune deficient and withal causes birth defects **(** Yan et al, 2010). The molecular mechanisms, antioxidant, anti-inflammatory and anti-diabetic properties by which Faba bean polyphenols could be involved in the protection against the development of human diseases are described(Turco et al, 2016). The average global production of beans is 1700 kg / ha (Akibode and Maredia, 2011).

Phosphorous fertilization

Phosphorus is one of the major nutrients that plants need in large quantities (Salimpour et al, 2010). It is highly responsive plant to phosphorus fertilization, which increases the yield (Khalifa, 2015). and that phosphate fertilization increases the result by an increase in biological processes such as photosynthesis and the transfer of carbohydrates from the places of their formation to the places of their storage (Iesa, 2009). Phosphorus fertilizers could improve the growth characteristics, nodulation, and nutrient uptake of faba bean in acid soil(Fekadu et al,2019). Add phosphate fertilizer will improve the performance of plant roots and increase the absorption of nutrients, and this will lead to an increase in the characteristics of plant growth (Giller et al,2015). Results indicated that highly significant positive responses of number of pods per plant, total biomass and seed yields of faba bean to phosphorus fertilizer and weeding treatments were noted (Getachew et al, 2006).

Materials and methods of work

A field experiment was conducted during the winter season in silty loam soil to study the effect of exudation irrigation and surface drip irrigation with two levels of phosphorous fertilizer (60 and 120 kg Ha^{-1}) on some growth characteristics and yield of the Spanish cultivar Luz De Otono. Treatments were distributed with a factorial experiment according to the randomized complete block design (RCBD) with three replicates (Sahuki and Waheeb, 1990). Soil samples were taken prior to planting and at depths 0-30 cm by Soil auger to perform measurements of some physical and chemical properties. Shown in Table 1:

Table 1. Some physical and chemical properties of the field soil before planting. (depth: 0 -30 cm)

The property		The Unit	the value
Bulk density		Mg^{-1}	1.46
Particle density		Mg^{-1}	2.62
Porosity		%	44.27
Mean weight diameter		mm	0.315
Saturated hydraulic conductivity		$Cm\ h^{-1}$	5.88
Volumetric distribution of soil particles	sand	$g\ kg^{-1}$	389
	silt		536
	clay		75
texture		-	Silty loam(SL)
Weighted moisture at tension(bar)	0	%	42
	1/3		25
	15		9
Available water		%	16
PH		-	
EC		$Ds\ m^{-1}$	
OM		$G\ kg^{-1}$	

The soil moisture characteristic curve was determined by calculating the corresponding tension for each level of soil moisture depletion (Black, 1965) shown in the following figure:

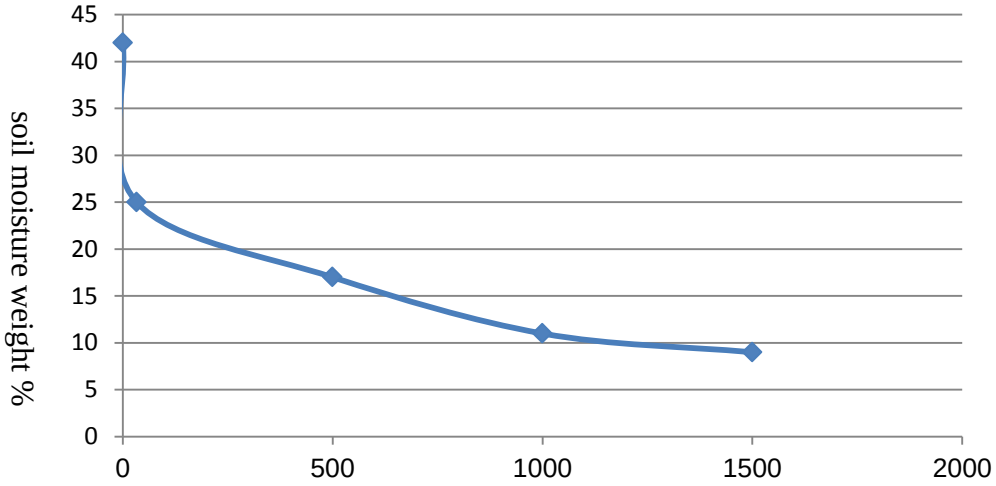


Figure 1 : S0il Moisture characteristic Curve

The components of the exudation irrigation system

1) A 1000-liter water tank on which a transparent plastic tube with a metallic tape is installed to calculate the amount of water consumed daily from the tank to the exudation utensils.
2) The main Transfer tube is 16mm plastic tube.
3) The triple divisions and the plastic rings with silicon to prevent water leakage from the sewers.
4) The distance between one to another exudation Container is 50 cm.
5) The distance between a line and another is 80 cm.

Figures 2 and 3 show the exudation utensils before and after their burial in the root zone.

Figure 2. Exudation utensils before burial Figure 3: The exudation irrigation in the case of exudation irrigation system after burying the exudation utensils

As for the components of the surface drip irrigation system, it is similar to the irrigation system with exudation and the distance between one emitter to another was 50 cm, and the distance between line to another 80 cm also.

As for cultivation: The seeds of the Spanish variety Lue De Otono were cultivated at a rate of 100 kg Ha^{-1} according to Ali et al (1990) on both sides of the emitters line and the exudation utensils line with a distance of 12 cm, alternately, between one hole and another 35 cm, where length of each line was 20 m,The distance between a line to another is 80 cm, where a plant density of 71375 plant Ha^{-1}.

The irrigation scheduling: it was according to the stages of growth and deepening of the roots determined by Iesa (1990) as follows:

Germination stage: 35 days, roots depth 10 cm.

The vegetative growth stage: 40 days, roots depth 15 cm.

Proliferative growth stage: 30 days, roots depth 20 cm.

Maturity stage: 40 days, roots 25 cm.

The scheduling was carried out according to the evaporation from the American evaporation basin Class A, which was installed in the middle of the field (FAO, 1993) in order to estimate the date of the following irrigation for drip irrigation treatments.

The drainage of exudation utensils was calibrated accordingly, so that water consumption was one of the two irrigation methods. which reached considering the reducing factor to 340 mm. Season -1

Study factors:

First: Irrigation:

1 - Surface drip irrigation. Symbolized: I_1

2 - Exudation irrigation. Symbolized: I_2

Second: Fertilization

1 - Phosphate fertilization 50% of the fertilizer recommendation. Symbolized: P_1 (60 kg Ha^{-1}).

2- Phosphate fertilization100% of the fertilizer recommendation. Symbolized: P_2 (120 kg Ha^{-1}).

Irrigation was carried out at the Exhaustion of 50% of the available water, while phosphate fertilizer (46% triple superphosphate) was added at the two mentioned levels of fertilizer recommendation (Ali et al, 2014) all once per experimental unit under the cultivation line.

RESULTS AND DISCUSSION

All discussions will be for the same class only.

First: plant Height

The highest height for treatment I_2P_1 was 133.7 cm, and the lowest height for treatment I_1P_2 was 113 cm. however, the statistical analysis did not show significant differences between the four treatments and this increase achieved by exudation irrigation came as a result of securing the moisture content in the root zone continuously with less evaporation and deep percolation at its lower limits compared to surface drip irrigation where part of the irrigation water is lost by evaporation, and this is consistent with what was reached by (Alabaied and Harfoush, 2011, and Saleh and Al-abaied, 2015), while the height at Abdel-Aziz (2018) was only 67.5 cm, perhaps due to the clay textures, but at Al-Anbari (2011) the height was 85.80 cm when he was irrigate with salty water (7.8 dS M^{-1}), while Al-Hayali et al (2018) obtained a height of 104.9 cm when spraying with chelated iron at a concentration of 1g L^{-1}. Figure 4 shows these results:

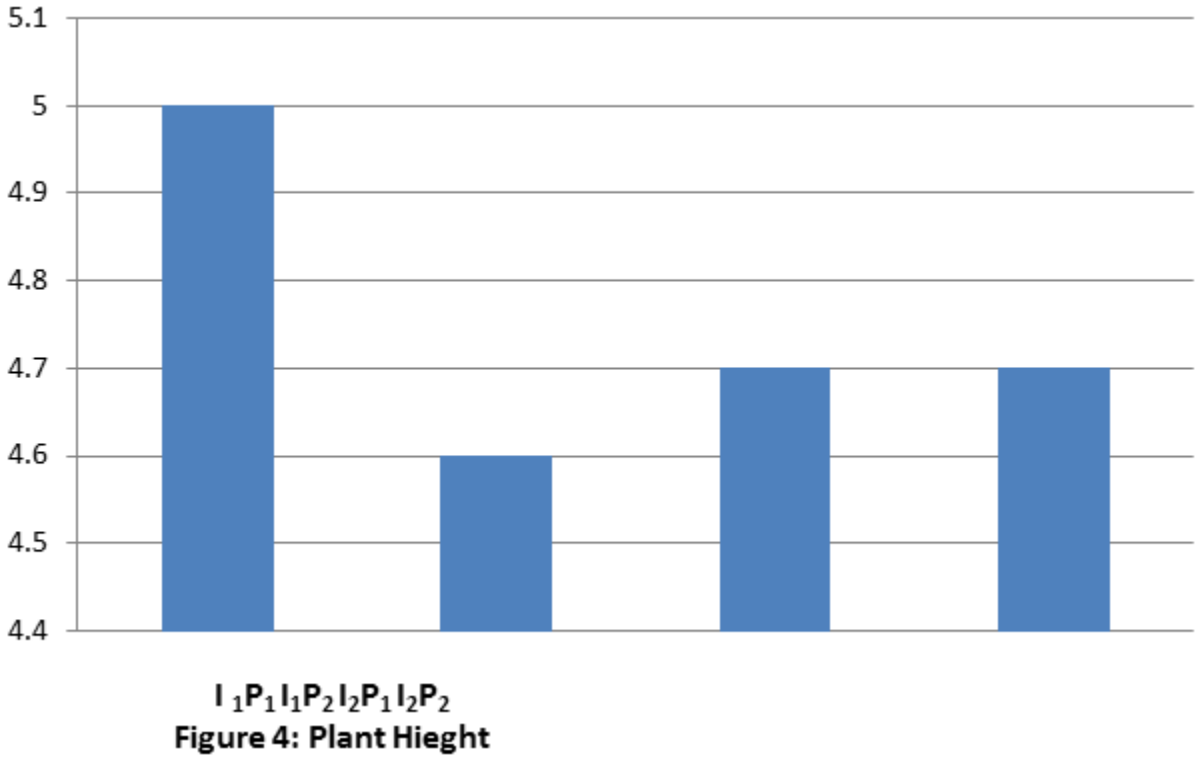


Figure 4: Plant Hieght

Second: the number of branches in the plant

The largest number of branches occurred in the two treatments, I_1P_1 and I_2P_1, which is 12 branches, while 11 branches were for the remaining two treatments. Statistical analysis did not show the significance of these differences. while Abdel-Aziz(2018) obtained 8 branches when spraying the activator Supower at a concentration of 0.5 g L^{-1} on the leaves, and Al-Hayali et al (2018) when spraying with chelated iron at a concentration of 1g L^{-1} got a number of branches of 10.20 $plant^{-1}$. and Figure 5 shows these results:

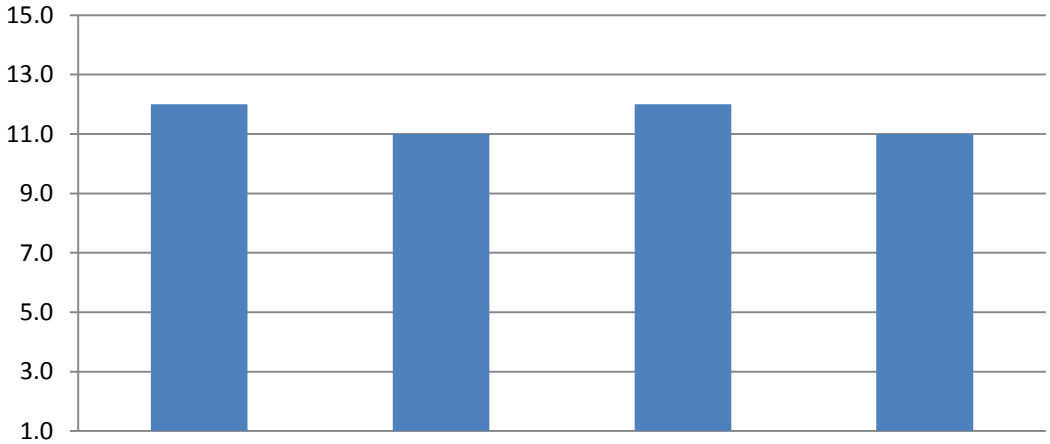


Figure5: Number of branches in the plant

Third: The number of pods in the plant

Although the treatment I_2P_1 achieved the highest average number of pods in a single plant was 12.3 and the lowest number was for the treatments I_1P_2 and I_2P_2 which is 10 pods plant^{-1}, the differences were not significant according to the statistical analysis. This is corresponds to

what Selawy et al (2018) got, as they reached 13.22 pods Plant^{-1} when spraying the plant with 20 mg zinc Liters^{-1} also Corresponds to Darwish(2019) who got 13.2 pods Plant $^{-1}$ when spraying the amino acid 8% Green Up Amino NH3 at a concentration of 10 g L^{-1} on the leaves, as for Al-Anbari (2011) he got 14.86 pods Plant^{-1} when irrigated with salt water, Al-Dulaimi and AL Fahdawi (2015) obtained 19.09 pods per plant when they added 150 kg k ha^{-1} with a spray of 30 mg CU L^{-1}, as for Yousof et al (2017) they got 16 pods per plant, and a moderate temperature of 25 degrees Celsius might have caused this increase. figure 6 shows the number of pods for the four treatments:

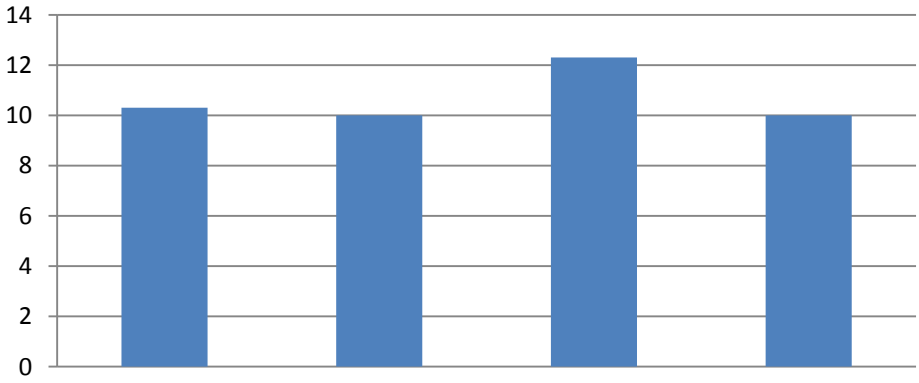
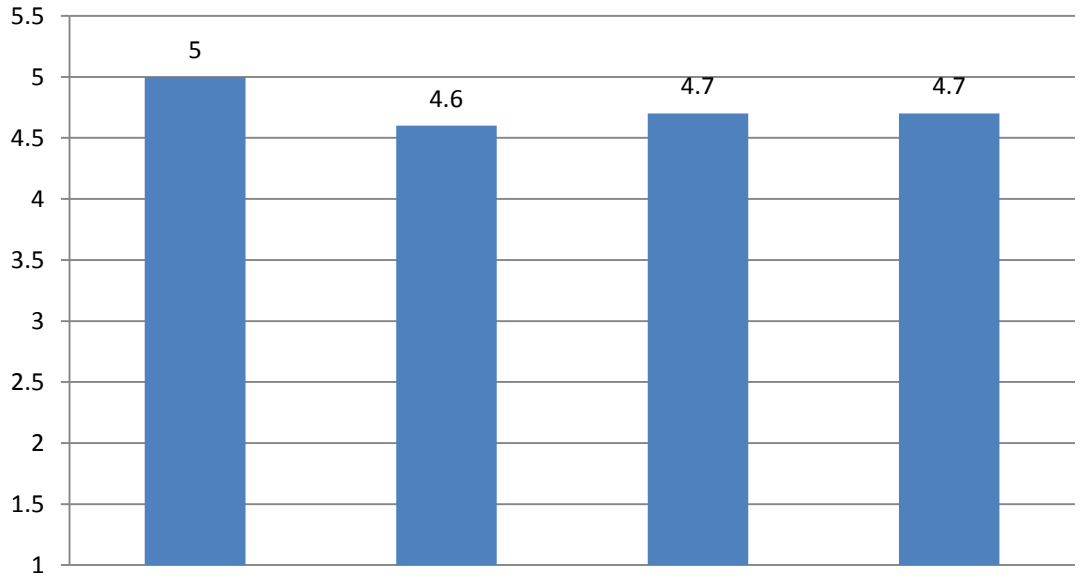


Figure 6:The nomber of Pods in a Plant

Fourth: The number of seeds per pod

The differences in this characteristic were also not significant between the four treatments, and the largest value for treatment I_1P_1 was 5 seeds. the lowest was 4.6 pods pod^{-1} for I_1P_2, this corresponds to Al-Selawy et al (2018) which has a rate of 4.86 seeds pod^{-1}, And with Darwish (2019) he got the same number (5) when he sprayed the amino acid 8% Green Up Amino NH3 at a concentration of 10 g liter^{-1} on the leaves, as for Al-Anbari (2011) he obtained a rate of 6.53 seeds pod^{-1}, and stated that this may be due to saline water irrigation, as for Yousof et al(2017), they obtained 4.6 seeds pod^{-1}, when they studied the relationship between temperature and aphid injury. Figure 7 shows these results:



I_1P_1 I_1P_2 I_2P_1 I_2P_2 Figure 7: nomber of seeds in the pod

Fifth: The number of leaves

Statistical analysis did not show significant differences between the number of leaf values between the four treatments, although the highest value was for treatment I_2P_2 as it reached 174 leaves. Plant^{-1}, and the lowest was for treatment I_1P_1 of 108 leaves-plant^{-1}, also in the treatment I_1P_2, a large value reached 170 leaves plant^{-1}, which indicates that the second level of phosphate addition (120) kg Ha^{-1} was the reason for the increase in the number of leaves, but this did not reflect positively on increasing the weight of the seeds in these treatments, perhaps due to the small size of the plant leaf, with its large number. Abdel-Aziz (2018) got less than this number which is 80.1 leaves plant^{-1}, and as for Al-Hayali (2018) obtained close numbers of the highest value, amounting to 175.6 leaves plant^{-1}, figure 8 shows the number of these leaves for the four treatments:

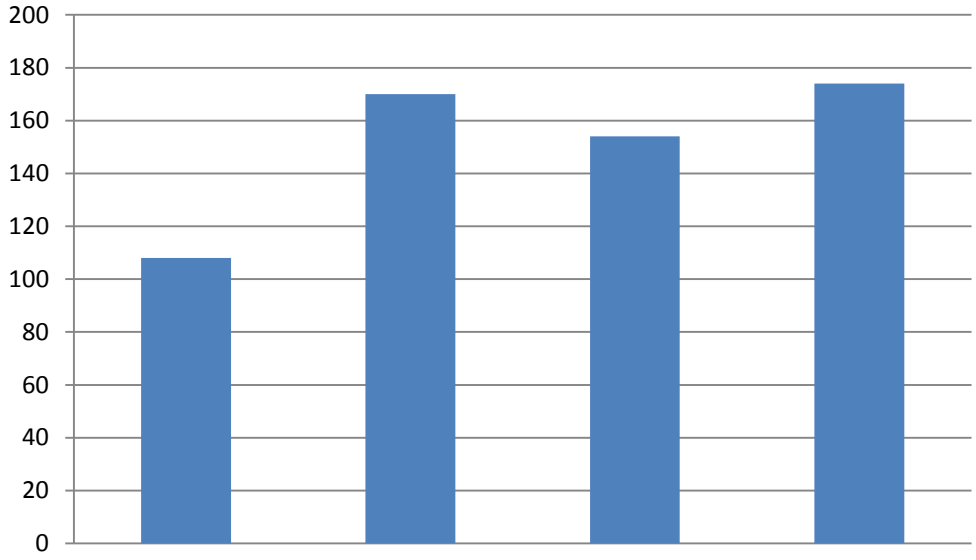


Figure 8 : The number of leaves per plant

Sixth: Weight of 1000 seeds

The exudation irrigation treatment was superior to the drip irrigation treatment at the first fertilization level (60 kg Ha^{-1}) with significant differences, however, these differences were not significant at the second fertilization level (120 kg ha^{-1}), the results shown in table 2 indicate that the second fertilization level in the case of drip irrigation increased the seed weight with a significant difference compared to the first level, however, the opposite happened in the case of exudation irrigation, as the first level gave a significant increase to the second level, the highest weight for treatment I_2P_1 was 1586.7 g, and the lowest weight for treatment I_1P_1 was 1173.3 g, table 2 also shows the superior weight of the exudation irrigation method more than drip irrigation method and with a significant difference as well, the reason for this may be due to the continuous availability of moisture in the root zone from the beginning to end of the season without interruption compared to what happens when the irrigation is repeated in the case of drip irrigation, this is corresponds to the findings of Al-abaied and Harfoush(2011) and Saleh and Al-abaied (2015), Al-selawy et al (2018) obtained almost the same result for treatment I_1P_1 as they had a weight of 1000 seeds equal to 1177.9 g, and close to this result obtained by Darwish(2019) as the weight was equal to 1007.5 g, as for Al-Anbari (2011) got a weight of 996.7 g only, and this weight was probably small due to irrigation with salty water (7.8) dS M^{-1}, as for Abdel-Aziz (2018) when he used the activator Supower at 0.5 g L^{-1} to spray on leaves, he got the highest value of 2769.16 g weight 1000 green seeds.

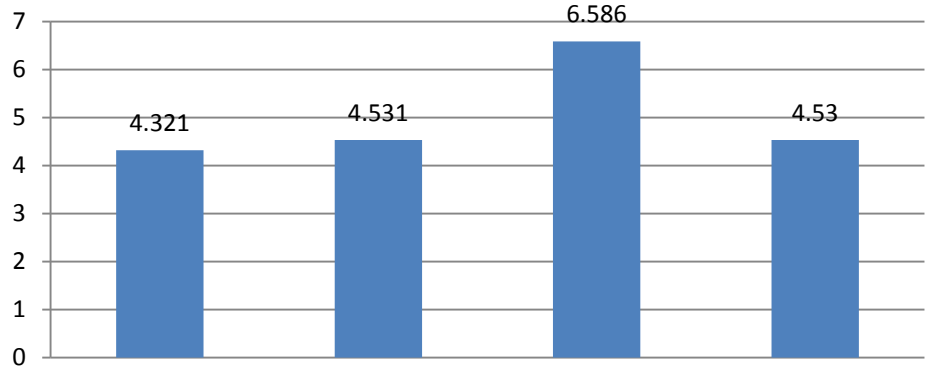
Table 2. Weight of 1000 seeds (g) for the treatments and the average of the two irrigation methods

treatment	I_1P_1	I_1P_2	I_2P_1	I_2P_2
Weight of 1000 seeds	1173.3	1360	1586.7	1360
average	1266.65		1473.35	
$LSD_{0.05}$	111.03			

Seventh: productivity

1- Dry Seed Productivity

Statistical analysis did not show significant differences between treatments although the I_2P_1 treatment gave a high yield of 6.586 ton ha^{-1}, compared to the lowest value of the I_2P_2 treatment was 4.530 tons ha^{-1}, this is correspondent to what Al-Anbari (2011) obtained when he had a production per hectare of 5942 tons, when he increased the plant density to 148.146 ha^{-1}, compared to the density in our research of 71375 plants, this productivity, despite the small number of plants per unit area, but this result came higher than that obtained by Selawy et al (2018) as it did not get from seed production except at 2431 kg ha^{-1} when zinc was used as a spray on the leaves at a rate of 10 mg L^{-1}, likewise, Yousof (2017) only received 2.619 kg seed ha^{-1}. Figure 9 shows the productivity of the search treatments:



I1P1 I1P2 I2P1 I2P2 Figure 9 :Dry seed Productivity (ton ha^{-1})

2- Green pods Productivity

Table 3 shows that the highest Productivity for treatment I_2P_1 was 26.044 ton ha^{-1} while the lowest for treatment I_1P_1 was 18.144 ton ha^{-1}. Statistical analysis showed significant differences in these differences,when Mahmood et al (2019) used the activated Ascophyllum nod sum extracted from seaweed sprayed on leaves, at a concentration of 4.5 ml L^{-1}, they obtained a similar result of 28.592 ton ha^{-1}, and when comparing the results of

our research with what Abdel-Aziz (2018) obtained was 23.778 ton ha^{-1} when the activator used Supower at 0.5 g L^{-1}, we find that the productivity of treatment I_2P_1 gave higher than this result while other treatments were less.

Table 3. Productivity of green pods (ton ha^{-1})

treatment	I_1P_1	I_1P_2	I_2P_1	I_2P_2
Productivity (ton ha^{-1})	16848	18120	26044	18573
average	17484		22308.5	
$LSD_{0.O5}$	329.54			

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