Effect Of Irrigation Systems And Agriculture Methods On The Productivity and Quality of Snap Bean Crop Under Sandy Soil Conditions

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ABSTRACT

This research aimed to study the effect of irrigation systems and agriculture methods on the productivity and quality of snap bean crop under sandy soil conditions. The study conducted in sandy soil in Al-Khatatba zone, Monofeya governorate, Egypt. In this study two types of irrigation systems were used namely drip irrigation and sprinkler irrigation and four different Snap bean cultivars namely, (Alfa, Giza 6, Karnak and Nebraska). The effect was studies within two seasons (winter growing seasons of 2019 and 2020). The results indicated that drip irrigation gave higher productivity than sprinkler irrigation regarding the productivity of snap beans (3.62 ton/ feddan) and (2.98 ton/ feddan) for drip and sprinkler irrigation systems respectively in the second season. Also, the results indicated that Nebraska and Alfa cultivars gave the best productivity (3.62 and 3.56 ton/ feddan) for Nebraska and Alfa cultivars respectively with the drip irrigation in the second seasons

Key words : beans, drip irrigation, sprinkler irrigation, productivity, quality, sand soil conditions.

الملخص

يهدف هذا البحث إلى دراسة تأثير أنظمة الري وطرق الزراعة على إنتاجية وجودة محصول الفاصوليا في ظروف التربة الرملية. أجريت الدراسة على تربة رملية بمنطقة الخطاطبة بمحافظة المنوفية بمصر. في هذه الدراسة تم استخدام نوعين من الري وهما الري بالتنقيط والري بالرش وأربعة أصناف مختلفة من الفاصوليا وهي ألفا وجيزة ٦ والكرنك ونبراسكا. تم دراسة التأثير خلال موسمين (الشتاء ٢٠١٩، ٢٠٢٠ على التوالى). أشارت أهم نتائج الدراسة إلى أن الري بالتنقيط أعطى إنتاجية أفضل من الري بالرش من حيث إنتاجية الفاصوليا حيث ان اعلى إنتاج كان (٣,٦٢ طن/فدان) للرى بالتنقيط فى حين كان (٢,٩٨ طن/فدان) للرى بالرش على التوالى. كما أشارت الدراسة إلى أن صنف نبراسكا وألفا أعطى أفضل إنتاجية مع الري بالتنقيط خلال الموسم الثانى (٣,٦٢ طن/ فدان) و (٣,٥٦طن/فدان) لكل من صنفى نبراسكا وألفا على التوالى .

الكلمات الدالة : الفاصوليا ، الري بالتنقيط ، الري بالرش ، الإنتاجية ، الجودة ، التربة الرملية

1. INTRODUCTION

The total worldwide cultivated area of green beans is 1,527,613 hectares, producing 21,720,588 tons, as reported by **(FAO, 2016).** China is the world's leading producer of green beans, with a total cultivated area of 635,385 hectares and a

production of 17,031,702 tons. In Egypt, green beans are a major cash crop, important not only for export but also for local markets, where it is an important protein source with high nutritional value for Egyptian families (Shalaby, et.al., 2017).

Snap bean *(Phaseolus vulgaris L.)* is widely used as protein source with highly nutritive value in human nutrition in Egypt. It is cultivated for its green pods as .well as dry seeds. Green bean is considered one of the most important vegetable crops grown in Egypt, which occupies a great figure in local consumption and export.

Therefore, expansion in cultivation of green beans is growing rapidly. Besides increasing the protein content of the meal, beans have contributed to improving the protein quality in diet because bean protein is rich in lysine.

The cultivated area of green bean in Egypt is 2.4% of total world cultivated area, producing about 3.5% of total world production of bean (FAO Statistics, 2004).

Water is the key factor of the agricultural production and development of different crops under arid and semi-arid conditions. Crop growth and yield are affected by the method of water delivery and the available water in the soil layers at the effective root zones. It is highly desirable to obtain higher yield using the least possible quality of water. Increasing irrigation level increased growth, green pods yield and water use efficiency (WUE) of beans (Amede et. al, 2004, Abdel-Mawgoud, et.al, 2005, and Abdel-Mawgoud, 2006).

This study aimed to evaluate irrigation systems (drip and sprinkler) on snap beans productivity, and the best cultivars in quality under field conditions.

2. MATERIALS AND METHODS

Two field experiments were carried out during the two winter growing seasons of 2019 and 2020 at the Private Farm in El-Khatatba located at latitude 30^{o} $52^{/}$ $66^{//}$ and Longitude 30^{o} $38^{/}$ $11^{//}$ to study the effect of irrigation systems (drip and micro sprinkler) and agriculture methods (Ordinary cultivation and cultivation of crow legs) on the productivity and quality of snap bean crop under sandy soil conditions. There were four snap bean cultivars (Nebraska, Giza6, Alfa and Elkarnak) as well as their interaction on vegetative growth characteristics, yield and its components under sandy soil conditions. Fertilizer requirements of beans crop were added according to recommendations of Vegetable Crop Research Institute, ARC, Ministry of Agriculture and Land Reclamation under the studied area. The recommendations are 200 kg/ fed. of calcium super phosphate (15.5 % P_2O_5), 50 kg/ fed. of ammonium sulphate (20.5 % N) and 25 kg/ fed. of potassium sulphate (48 % K_2O) during the seed bed preparation. While additional 50 kg/ fed. of ammonium sulphate and 25 kg/ fed. of potassium sulphate were added at the first irrigation (Mohaya).

Mechanical analysis of experimental soil was carried out by means of the pipette method (Page et al. 1982), the pH was measured in a, 1 M KCI solution, organic matter was determined according the method of Walkley-Black, cation exchange capacity (CEC) was done using ammonium acetate solution; $CaCO_3$ by means of the calcimeter, all of which methods cited by (Zhang et al. 2005). Contents of (N, P, K, Fe, Mn, Zn and Cu) were determined using the methods described by Clinton *et al*. (2004). The soil of the experimental field was sandy loam in texture. The physical and

chemical analysis of soil and water are presented in Table 1 and Table 2. The recommended agriculture practices for growing snap bean plants were applied whenever required. The experiment included 32 treatments (4 cultivars x two methods of agriculture x two methods of irrigation), which were the combination between two irrigation systems, two cultivation methods and four cultivars of snap bean. Spilt-spilt plots in a randomized complete blocks design with three replicates was used. The irrigation systems were situated in the main plots, while cultivation methods in subplots and cultivars in sub- sub plots. The sub-plot area was 20 m^2 which included 2 rows of 20 m long and 1m width. Seeds from each cvs. Nebraska, Giza 6, Alfa and Elkarnak were sown on 8th of February and harvested on 10th of May in the two investigated seasons of 2019 and 2020 in hills and spaced at 30 cm apart. Seeds were sown in hills on one side of ridge, then it thinned to leave on plant per hill. The total cultivated area is 20m X35m (700 m^2) divided according to the type of irrigation as shown in Fig. (1)

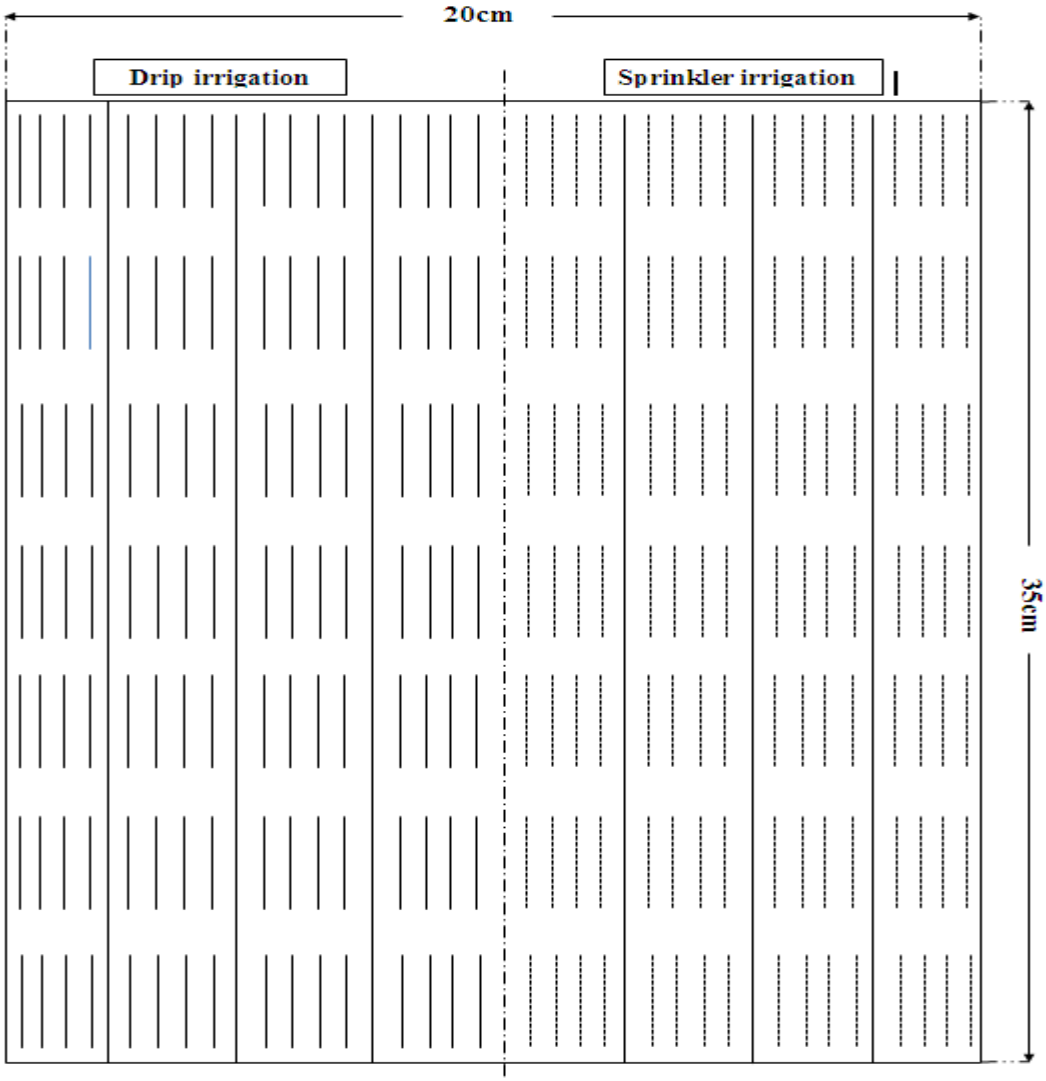

Figure 1: Schematic diagram for the cultivated area

Table 1: Some physical and chemical analyses of the soil

Location of Soils	PH(KCl)	EC ds. M^{-1}	OM %	$CaCo_3$	C.E.C cmolc. Kg^{-1}	Sand	Silt	Clay	Texture
El-Khatatba City	7.37	1.81	0.35	4.98	13.8	74.75	19.04	7.21	Sandy loam

Table 2: Mean composition of well water used for irrigation

Characteristics									
		Cation (meq/L)				**Anion (meq/L)**			
EC (well water)	pH	Na^+	K^+	Ca^{+2}	Mg^{+2}	HCO^-_3	Cl^-	SO_4^{--2}	SAR
(254 mg/l) (0.41 dS/m)	7.2	2.3	0.2	2.2	2.1	0.6	3.8	2.4	1.27

2.2. Irrigation water requirement

The FAO Penman–Monteith method **(Abdrabbo *et al.*, 2009 and 2013)** was used to calculate the reference evapotranspiration ET_o in the CROPWAT Program. Crop water requirements (ET_c) over the growing season were determined from ET_o according to the following equation using crop coefficient K_c:

$ET_c = K_c . ET_o$ where ET_c the crop water requirement, Kc is the crop coefficient and ET_o is the reference evapotranspiration. Since there was no rainfall during the experimental period, net irrigation requirement was taken to be equal to ET_c.

The total amounts of irrigation water applied (from sowing to harvest) in the irrigation levels in this study were (3782 and 4528m^3/fed for drip and micro sprinkler irrigation systems during studied seasons 2019 and 2020 respectively. The water requirement was determined for different months based on crop growth stages and climatic data.

2.3. Irrigation Methods

Two irrigation methods were selected to irrigate beans plants. The first is surface drip system (SDI) including GR, 4L/h emitters at 30 cm spacing. Polyethylene lateral with diameter of 16 mm were used at 100cm spacing.

The second method is micro sprinkler irrigation (MSI), the same practices were used for laterals but they were (8 L/h each with 2.5 m wet diameter).

All recorded data were subjected to ANOVA to identify significant treatments and/or interaction effects by ‘F test’ using the SPSS program (SPSS Systems for

Windows, version 20,. Mean separation between the significant treatments was calculated by L.S.D.

3. RESULTS AND DISCUSSION

According to the sprinkler irrigation, it is found that Karnak cultivar has the best results regarding the weight in the second season (2.98 ton/feddan) respectively. Then followed by Nebraska cultivar as the weights of pods for the first and second seasons are (2.8 ton/ feddan) respectively. The third rank was for the Giza 6 cultivar as the weights of pods were (2.73 ton/feddan) respectively. The last rank was for the Alfa cultivar as the weights for the first and second season were (2.61 ton/feddan) respectively. But the cultivar Giza 6 has higher weight of pods for the first season (2.34 ton/ feddan) as compared with other cultivars. Thus it can be concluded that the second season weights of pods were higher than the first season in general as shown in Fig. (2).

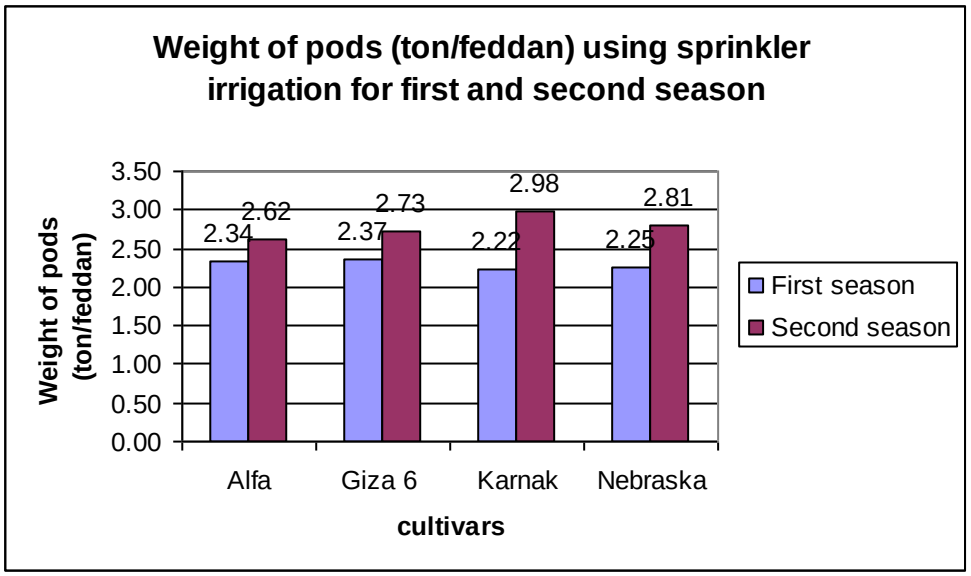

Figure 2: Average weight of pods (in grams) using Sprinkler irrigation

According to the drip irrigation, it is found that Nabraska cultivar has the best results regarding the weight in the first and second season (3.09 ton/feddan) and (3.62 ton/feddan) respectively. Then followed by Alfa cultivar as the weights of pods for the first and second seasons are (2.93 ton/feddan) and (3.56 ton/feddan) respectively. Karnak cultivar comes in the third rank with weights of pods for the first and second seasons (2.44 ton/feddan) and (3.21 ton/feddan) respectively. The last rank was for the Giza 6 cultivar as the weights of pods were (2.1 ton/feddan) and (3.03 ton/feddan) respectively. It is noticed that the second season weights of pods were higher than the first season in general as shown in Fig. (3).

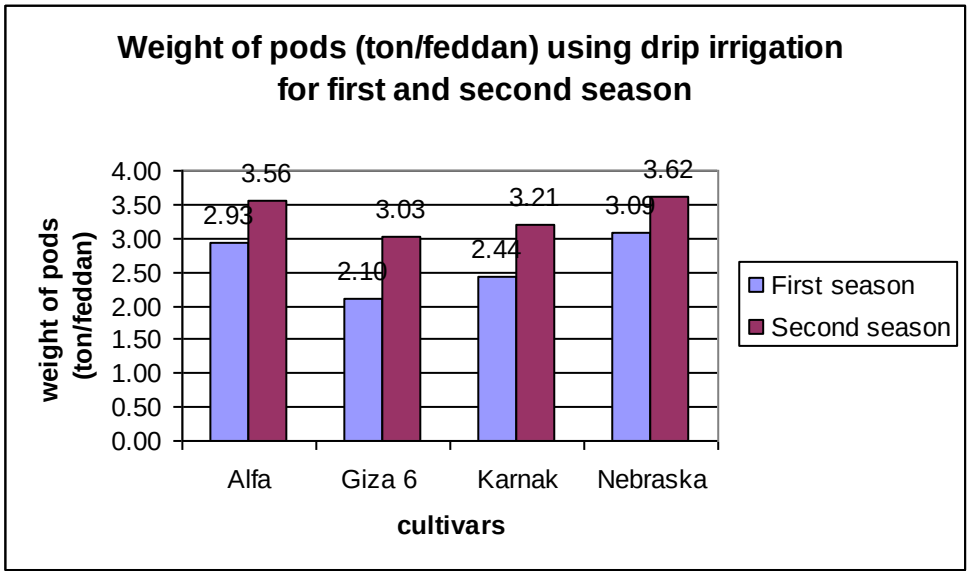

Figure 3: Average weight of pods (in grams) using Drip irrigation

The study indicated that drip irrigation is better than sprinkler irrigation regarding the productivity of all varieties of snap beans as showed in fig (4) . This result agreed with the result obtained by (Ramzan, et al., 2009 and El-Noemani et al., 2009, 2010) as they reported in their study that the drip irrigation resulted in higher than sprinkler irrigation regarding the productivity of snap beans.

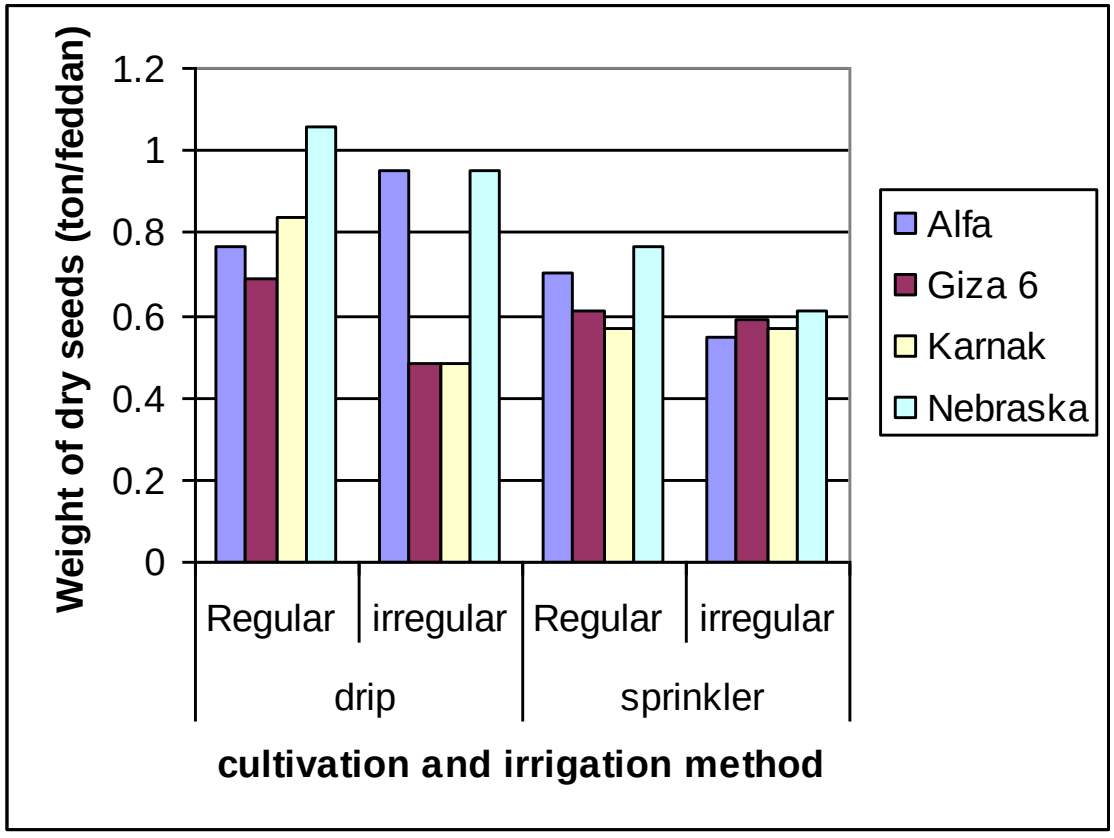

Figure 4: Comparison between average weights of dry seeds(ton/feddan) for regular and irregular cultivations using drip and sprinkler irrigation (second season).

4. CONCLUSION

Regarding to the drip irrigation, it is found that Nabraska cultivar has the best results regarding the weight in the first and second season (771.6 g) and (905 g) respectively. Then followed by Alfa cultivar as the weights of pods for the first and second seasons are (733.3 g) and (890.6g) respectively. Karnak cultivar comes in the third rank with weights of pods for the first and second seasons (610.8 g) and (803.3 g) respectively. The last rank was for the Giza 6 cultivar as the weights of pods were (525 g) and (758.3 g) respectively. It is noticed that the second season weights of pods are higher than the first season in general.

Regarding to the sprinkler irrigation, it is found that Karnak cultivar has the best results regarding the weight in the first and second season (555.8g) and (745 g) respectively. Then followed by Nabraska cultivar as the weights of pods for the first and second seasons are (561.6 g) and (701.6g) respectively. The third rank was for the Giza 6 cultivar as the weights of pods were (592.5 g) and (683.3 g) respectively. The last rank was for the Alfa cultivar as the weights for the first and second season are (585 g) and (654.1 g) respectively. But the cultivar Giza 6 has higher weight of pods for the first season.

1) Thus it can be concluded that the second season weights of pods are higher than the first season in general**.**

2) The study results also indicated that the values weights of the pods in regular cultivation were near to each other.

3) The results of the study also indicated that there are no significant differences between the means of weight of pods of snap beans.

4) Regarding the type of irrigation that gives high productivity of snap beans, the study indicated that the drip irrigation was better for all cultivars of snap beans than the sprinkler irrigation as there are significant differences between the means of weights of pods in the favor of drip irrigation.

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