Influence of irrigation and cultivation methods on common bean (*Phaseolus vulgaris L.)* yield and quality under Sohag Governorate conditions

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Common bean, Cultivation methods, Fiber, Irrigation treatments, *Phaseolus vulgaris* L., Protein, and Yield components

Abstract

The present study was carried out during the autumn seasons 2014 and 2015 at Shandaweel Agriculture Research Station, Sohag Governorate, Egypt, to evaluate the effect of irrigation treatments and cultivation methods on vegetative growth, yield, yield components and quality of common bean (*Phaseolus vulgaris* L.) cultivar "Paulista" under Sohag conditions. A split plot design with three replications was used, where irrigation treatments (100%, 75% and 50% recommended irrigation), the three irrigations were randomly assigned in the main plots. The four cultivation methods (T1, T2, T3 and T4) were randomly distributed in sub-plots. The three irrigation treatments affected significantly on the most studied characters, in both seasons. The highest values of fresh pod yield were obtained at the 75% recommended irrigation treatment (4.084 and 4.114 ton/fed, in 2014 and 2015 seasons, respectively). It was affected significantly by cultivation methods on the most studied characters, in both seasons. The highest values of fresh pods yield were obtained at the sowing on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation (4.107 and 4.051 ton/fed, in the first and the second seasons, respectively) without significant differences with sowing on one side of 60 cm wide ridge or sowing on the two sides of 120 cm wide raised beds. The interactions of the 100% recommended irrigation treatment with some cultivation methods (T1, T2 and T3) or the interactions of the 75% recommended irrigation treatment with some cultivation methods (T1, T2, T3 and T4) gave the highest values of fresh pods yield than the other combinations, in both seasons without significant differences between them. Generally, we can be sowing common bean on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation or sowing on the two sides of 120 cm wide raised beds with irrigation by 75% the recommended irrigation.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is economically one of the major vegetable crops in Egypt for local consumption as well as for the exportation. Therefore, it is of interest to increase its yield's quality and quantity to fulfill the exportable and/or locality

demands. Egypt has a significant comparative advantage in the production of horticultural commodities including fresh bean for export, based on its geographic position and agro-climatic conditions. For these reasons expansion in fresh bean cultivation has exhibited impressive growth in Egypt during the past several years with a cultivated area of 2.4% of total world cultivated area of bean, producing about 3.5% of total world production of bean **(FAO Statistics, 2004)**.

Irrigation water is an important and could be as limiting factor for vegetable production. Now a day, water will be the most critical resource in the Middle East including Egypt and water deficit will be a very complicated problem. **Abdel-Mawgoud (2006),** investigated the interactive effects of different irrigation levels and compost applications on the growth, yield and quality of green bean crop cv. Pulista. Vegetative growth parameters as well as yield components responded positively to the individual effects of increasing the irrigation level. **El-Noemani *et al*., (2010),** mentioned that surface drip and/or subsurface drip systems exhibited the highest values of vegetative growth (plant height, No. of branches, No. of pods, leaves area and total plant); pods yield (Kg/fed.). Increasing irrigation treatment up to 100% Eto exhibited the highest values of vegetative growth. However, the highest values of pods yield/fed. were achieved by 80% Eto treatment. Proper understanding of the optimal water requirements of various crops is very important for judicious use of score water resources **(El-Shaikh, 1999)**. Therefore, it is important to study some farming systems for the maximum benefit of the unit area as well as the effect of these factors on the benefit of the amount of irrigation under the importance of irrigation water. **Worku and Astatkie (2011)**, investigated the effect of row spacing (50, 55, 60, 65 and 70 cm) and plant spacing (2.5, 5 and 10 cm) on yield and yield components. They found that the effect of plant spacing was more Variety-specific than that of row spacing. Yield and yield components per m^2 were significantly affected by both row spacing and plant spacing. Seed yield and yield components per m^2 were the highest for the highest plant density (50 cm Row spacing, 2.5 cm Plant spacing). **Getachew *et al.*, (2014)**, studied the effect of five level of spacing (50 cm x 7 cm, 40 cm x 15 cm, 40 cm x 10 cm, 40 cm x 7 cm, 30 cm x 15 cm) and two pipeline varieties. They found that analysis of variance has shown that most of the yield and yield components studied (pod length, pod diameter, number of pods, average pod weight and number of pods) were significantly affected by the interaction effects of variety. **Ricaurte *et al*., (2016)**, studied the effect of sowing

density on common bean leaf area development by using two sites of field experiments with sowing densities (5, 10, 15, 20, 25, and 35 plants m^2). In terms of leaf area development, analysis using a power function reflected large differences in the dynamics and final size of individual plant leaf area between the lower densities.

The objective of this study was effect of irrigation treatments and cultivation methods on growth, yield, yield components and quality of common bean plants under Sohag conditions.

MATERIALS AND METHODS

The present study was carried out during the autumn seasons 2014 and 2015 at Shandaweel Agriculture Research Station, Sohag Governorate, Egypt. The experimental soil was clay loam and its physical and chemical characteristics were determined before sowing. Ten random samples from soil at depth of 45 cm were taken for analysis Chemical and physical analysis of the soil are shown in Table (1).

Table (1): Soil characterization of the experimental location.

Season	Texture	$CaCO_3$%	Soil pH	Organic matter (O.M %)	Available nutrients in soil (ppm)		
					N	P	K
2014	Clay loam	7.55	7.90	1.20	18.5	18	38
2015	Clay loam	7.70	7.80	1.05	20	22	40

Two field experiments were conducted at the experimental farm during the autumn seasons of 2014 and 2015 at Shandaweel Agriculture Research Station. The area plot was 3.5 m long and 3 m wide (10.5 m^2) consisting of 6 ridges or 3 raised peds. Seed of common bean cultivar "Paulista" was sown at the first week of September in the two seasons, in hills 5-7 cm apart, sowing one seed per hill. The normal culture procedures for commercial common bean production over than the applied treatments were followed.

A split plot design with three replications was used, where irrigation treatments (100%, 75% and 50% recommended irrigation), the three irrigation treatments were randomly assigned in the main plots and four cultivation methods were randomly assigned in sub-plot.

The four cultivation methods was as follows:

T_1: Common bean was sown on one side of 60 cm wide ridge.

T_2: Common bean was sown on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation.

T_3: Common bean was sown on the two sides of 120 cm wide raised beds.

T_4: Common bean was sown on the two sides and the middle of 120 cm wide raised beds.

The measurement were taken on ten randomly selected plants.

A- Vegetative growth characters:

A1- Plant height (cm): the measurement was taken from cotyledonary node to the top of the main stem.

A2- Root length (cm): after 40 and 60 days from planting.

A3- Fresh root weight (g): (FRW) after 40 and 60 days from planting.

A4- Dry root weight (g): (DRW) after 40 and 60 days from planting.

A5- Leaf area (LA cm^2): It was measured at stages of 40 and 60 days from planting using Automic Leaf Area Meter (LI COR-3000).

B- Yield and its components characters:

C1- Pod length (cm), the measurements were taken on ten randomly sampled pods per plot at the marketable fresh-maturity stage.

C2- Pod diameter (cm), the measurements were taken on ten randomly sampled pods per plot at the marketable fresh-maturity stage.

C3- Number of pods/plant, average based on ten randomly sampled plants per plot in each fresh pods harvest.

C4- Pods weight/plant (g), the sum of pod weight/plant (g) in all fresh pods harvests in feddan.

C5- Fresh pods yield (kg/fed), the sum of weight of fresh pods in all fresh pods harvests in feddan.

C- Quality characters:

C1- Fiber content (%): The percentage of fiber content was determined according to **A.O.A.C (1995)**.

C2- Protein content (%): The percentage of protein content was determined according to **A.O.A.C (1995)**.

Statistical analysis:

The data statically analyzed according to **Gomez and Gomez (1984)**, using the computer MSTAT-C statistical analysis package **(Freed *et al.*, 1989)**. Mean values were compared by using Duncan's test used for comparing means **(Duncan, 1955)**.

Results and Dissection

Data during 2014 and 2015 including some vegetative characters, protein%, fiber%, yield and its components of common bean cultivar "Paulista" as affected by irrigation treatments and cultivation methods.

A- Vegetative characters:

Results presented in Table (2) show that the 100% recommended irrigation treatment was produced the highest values of plant height, dry root weight at 40 and 60 days from planting and leaf area at 40 and 60 days from planting, in 2014 and 2015 seasons, respectively. While, the 50% of recommended irrigation treatment was produced the highest values of root length at 40 and 60 days from planting and fresh root weight at 40 and 60 days from planting, in 2014 and 2015 seasons, respectively. These results were in agreement with those obtained by **Mohamed and Abd El-Hady (2009) and El-Noemani *et al*., (2010),** who found that increasing irrigation level up to 100% increased vegetative growth. The strong influence of increasing irrigation up to the maximum level on plant height could be explained as a result of enhancing cell division and enlargement which need more water supplies.

Data in Table (3) revealed that, cultivation methods were affected significantly on vegetative growth. It could be noticed that, sowing on one side of 60 cm wide ridge (T1) was the best method of cultivation at plant height and leaf area at 40 and 60 days from planting, in 2014 and 2015 seasons, respectively. While, sowing common bean on the two ridges and the middle of 120 cm wide raised beds was produced the highest values of root length and fresh and dry root weight at 40 and 60 days from planting, in both seasons, respectively. These results are in agreement with those reported by **Bitew *et al*., (2014),** who found that some vegetative growth increased linearly by increasing plant population (decreasing intra row spacing) due to competition of plants in higher densities on light resulting in taller plants.The interaction effect between irrigation treatments and cultivation methods on vegetative growth character reveal that, the highest values were found at the interaction between the 100% recommended irrigation treatment x sowing on one side of 60 cm wide ridge on plant height and leaf area at 40 and 60 days from planting, in both seasons. While, the interaction effect between the 50% recommended irrigation treatment and sowing on the two ridges and the middle of 120 cm wide raised beds produced the highest values on root length, fresh root weight at 40 and 60 days from planting in the two seasons. 100% recommended irrigation treatment and sowing on the two ridges and the middle of 120 cm wide raised beds produced the highest values on dry root weight at 40 and 60 days from planting (Table 4).

Table 2: Effect of irrigation treatments on vegetative growth of common bean in 2014 and 2015 seasons.

Traits / Irrigation treatments	Plant height (cm)	Root length at 40 days from planting (cm)	Root length at 60 days from planting (cm)	Fresh root weight at 40 days from planting (g)	Fresh root weight at 60 days from planting (g)	Dry root weight at 40 days from planting (g)	Dry root weight at 60 days from planting (g)	Leaf area at 40 days from planting (m^2)	Leaf area at 60 days from planting (m^2)
	2014 season								
100% Rec.	47.72^{A}	18.23^{C}	22.32^{C}	0.74^{C}	3.16^{C}	0.501^{A}	1.567^{A}	0.153^{A}	0.301^{A}
75% Rec.	46.67^{A}	20.04^{B}	26.09^{B}	1.01^{B}	3.53^{B}	0.408^{B}	1.220^{B}	0.119^{B}	0.190^{B}
50% Rec.	44.61^{B}	23.59^{A}	29.56^{A}	1.44^{A}	4.28^{A}	0.361^{C}	1.031^{C}	0.085^{C}	0.145^{C}
	2015 season								
100% Rec.	45.75^{A}	18.23^{C}	22.76^{C}	0.72^{C}	4.35^{C}	0.874^{A}	1.924^{A}	0.168^{A}	0.304^{A}
75% Rec.	44.96^{B}	20.75^{B}	27.16^{B}	0.97^{B}	3.02^{B}	0.764^{B}	1.503^{B}	0.126^{B}	0.191^{B}
50% Rec.	43.45^{C}	24.68^{A}	30.11^{A}	1.23^{A}	3.80^{A}	0.638^{C}	1.307^{B}	0.084^{C}	0.149^{C}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 3: Effect of cultivation methods on vegetative growth of common bean in 2014 and 2015 seasons.

Traits / Cultivation methods	Plant height (cm)	Root length at 40 days from planting (cm)	Root length at 60 days from planting (cm)	Fresh root weight at 40 days from planting (g)	Fresh root weight at 60 days from planting (g)	Dry root weight at 40 days from planting (g)	Dry root weight at 60 days from planting (g)	Leaf area at 40 days from planting (m^2)	Leaf area at 60 days from planting (m^2)
	2014 season								
Treatment 1 (T1)	50.30^{A}	17.81^{D}	18.86^{D}	0.68^{C}	2.10^{D}	0.260^{D}	0.813^{D}	0.144^{A}	0.253^{A}
Treatment 2 (T2)	47.19^{B}	19.75^{C}	25.04^{C}	0.95^{B}	3.22^{C}	0.308^{C}	1.028^{C}	0.121^{B}	0.248^{B}
Treatment 3 (T3)	45.67^{C}	21.39^{B}	28.41^{B}	1.07^{B}	4.28^{B}	0.458^{B}	1.543^{B}	0.116^{C}	0.180^{C}
Treatment 4 (T4)	42.17^{D}	23.53^{A}	31.66^{A}	1.55^{A}	5.03^{A}	0.596^{A}	1.714^{A}	0.097^{D}	0.167^{D}
	2015 season								
Treatment 1 (T1)	47.55^{A}	17.49^{D}	19.58^{D}	0.67^{D}	1.69^{D}	0.431^{D}	1.080^{D}	0.156^{A}	0.258^{A}
Treatment 2 (T2)	46.38^{B}	20.04^{C}	25.62^{C}	0.86^{C}	2.71^{C}	0.680^{C}	1.283^{C}	0.123^{B}	0.247^{B}
Treatment 3 (T3)	43.83^{C}	22.36^{B}	29.25^{B}	1.09^{B}	3.47^{B}	0.894^{B}	1.878^{B}	0.119^{B}	0.183^{C}
Treatment 4 (T4)	41.11^{D}	24.98^{A}	32.25^{A}	1.26^{A}	4.48^{A}	1.029^{A}	2.072^{A}	0.106^{C}	0.169^{D}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 4: Effect of irrigation treatments and cultivation methods on vegetative growth of common bean in 2014 and 2015 seasons.

Traits / Irrigation treatments	Cultivation methods	Plant height (cm)	Root length at 40 days from planting (cm)	Root length at 60 days from planting (cm)	Fresh root weight at 40 days from planting (g)	Fresh root weight at 60 days from planting (g)	Dry root weight at 40 days from planting (g)	Dry root weight at 60 days from planting (g)	Leaf area at 40 days from planting (m^2)	Leaf area at 60 days from planting (m^2)
		2014 season								
100% Rec.	**Treatment 1 (T1)**	52.40^{a}	15.08^{g}	15.33^{g}	0.44^{f}	1.82^{h}	0.317^{f}	0.927^{e}	0.182^{a}	0.390^{a}
	Treatment 2 (T2)	48.63^{bc}	17.59^{f}	21.55^{e}	0.73^{de}	2.59^{g}	0.433^{cd}	1.123^{d}	0.158^{b}	0.384^{a}
	Treatment 3 (T3)	46.33^{cde}	19.31^{e}	25.01^{d}	0.84^{de}	3.51^{ef}	0.537^{b}	2.027^{a}	0.147^{c}	0.226^{b}
	Treatment 4 (T4)	43.50^{fg}	20.96^{d}	27.41^{c}	0.94^{d}	4.70c	0.717^{a}	2.193^{a}	0.126^{d}	0.203^{c}
75% Rec.	**Treatment 1 (T1)**	50.50^{ab}	17.01^{f}	19.53^{f}	0.59^{ef}	2.01^{h}	0.247^{g}	0.823^{ef}	0.153^{bc}	0.205^{c}
	Treatment 2 (T2)	47.33^{cd}	19.20^{e}	25.28^{d}	0.83^{de}	3.22^{f}	0.380d^{e}	0.997d^{e}	0.115^{e}	0.202^{c}
	Treatment 3 (T3)	46.33^{cde}	20.61^{d}	27.36^{c}	0.95^{d}	4.16^{d}	0.433^{c}	1.463^{bc}	0.112^{e}	0.178^{d}
	Treatment 4 (T4)	42.50^{gh}	23.36b^{c}	32.20^{b}	1.69^{b}	4.74^{c}	0.563^{b}	1.620^{b}	0.097^{f}	0.176^{de}
50% Rec.	**Treatment 1 (T1)**	48.00^{cd}	21.35^{d}	21.72^{e}	1.01^{d}	2.46^{g}	0.217^{g}	0.690^{f}	0.098^{f}	0.164^{de}
	Treatment 2 (T2)	45.60^{def}	22.47^{c}	28.31^{c}	1.29^{c}	3.84^{de}	0.327^{ef}	0.963^{de}	0.089^{g}	0.157^{e}
	Treatment 3 (T3)	44.33^{efg}	24.27^{b}	32.86^{b}	1.44^{bc}	5.16^{b}	0.393^{cd}	1.140^{d}	0.088^{g}	0.135^{f}
	Treatment 4 (T4)	40.50^{h}	26.28^{a}	35.36^{a}	2.03^{a}	5.64^{a}	0.507^{b}	1.330^{c}	0.067^{h}	0.123^{f}
		2015 season								
100% Rec.	**Treatment 1 (T1)**	48.67^{a}	14.90^{i}	15.08^{g}	0.48^{f}	1.41^{e}	0.567^{e}	1.277^{de}	0.211^{a}	0.394^{a}
	Treatment 2 (T2)	47.50^{abc}	17.75^{gh}	21.34^{f}	0.65^{ef}	2.17^{d}	0.753^{cd}	1.397^{d}	0.166^{b}	0.384^{b}
	Treatment 3 (T3)	45.00^{d}	19.26^{fg}	25.33^{d}	0.80^{de}	2.58^{d}	1.030^{ab}	2.463^{a}	0.155b^{c}	0.230^{c}
	Treatment 4 (T4)	41.83^{e}	21.00^{def}	29.27^{c}	0.93^{de}	3.59^{c}	1.147^{a}	2.560^{a}	0.140^{c}	0.206^{de}
75% Rec.	**Treatment 1 (T1)**	47.67^{ab}	17.38^{h}	20.01^{f}	0.66^{ef}	1.49e	0.373^{f}	1.000^{f}	0.160^{b}	0.211^{d}
	Treatment 2 (T2)	46.50^{bc}	19.61^{f}	25.84^{d}	0.93^{de}	2.67^{d}	0.703^{de}	1.313^{de}	0.122^{d}	0.197^{e}
	Treatment 3 (T3)	44.00^{d}	21.74^{de}	30.69^{bc}	1.03^{cd}	3.48^{c}	0.897^{bc}	1.730^{c}	0.116^{de}	0.182^{f}
	Treatment 4 (T4)	41.67^{e}	24.27^{c}	32.11^{b}	1.26^{bc}	4.45^{b}	1.083^{a}	1.970^{b}	0.104^{ef}	0.172^{fg}
50% Rec.	**Treatment 1 (T1)**	46.33^{c}	20.19^{ef}	23.66^{e}	0.88^{de}	2.16^{d}	0.353^{f}	0.963^{f}	0.098^{fg}	0.170^{g}
	Treatment 2 (T2)	45.13^{d}	22.77^{cd}	29.67^{c}	1.00^{cd}	3.30^{c}	0.583^{e}	1.140^{ef}	0.082^{gh}	0.160^{h}
	Treatment 3 (T3)	42.50^{e}	26.07^{b}	31.72^{b}	1.45^{ab}	4.35^{b}	0.757^{cd}	1.440^{d}	0.085^{gh}	0.138^{i}
	Treatment 4 (T4)	39.83^{f}	29.68^{a}	35.37^{a}	1.60^{a}	5.40^{a}	0.857^{cd}	1.687^{c}	0.073^{h}	0.128^{j}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

B- Yield and its components characters:

Data presented in Table (5) show that the 100% of recommended irrigation treatment was produced the highest values at most yield and its components characters. While, there were no significant differences between the 100% recommended irrigation treatment and the 75% recommended irrigation treatment, in 2014 season. Also, there were no significant differences at the irrigation treatments on pod diameter charter, in the two seasons. These results were in agreement with those obtained by **Mohamed and Abd El-Hady (2009) and El-Noemani, *et al.*, (2010),** who found that increasing irrigation level up to 100% Eto increased vegetative growth. The strong influence of increasing irrigation up to the maximum level on plant height could be explained as a result of enhancing cell division and enlargement which need more water supplies.

Data in Table (6) revealed that, cultivation methods affected significantly on yield and its components. Sowing on one side of 60 cm wide ridge (T1) and sowing on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation (T2) were the best method of cultivation at most yield and its components characters, in 2014 and 2015 seasons. The highest values of fresh pod yield were obtained from the sowing on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation (4.107 and 4.051 ton/fed, in 2014 and 2015 season, respectively) without significant differences with sowing on one side of 60 cm wide ridge or sowing on the two sides of 120 cm wide raised beds. These results were in agreement with those obtained by **Worku and Astakie (2011)**. They found that, the higher per unit area and lower per plant yield and yield component responses to high plant density are in accordance with several previous research results.

Table 5: Effect of irrigation treatments on yield and its components of common bean in 2014 and 2015 seasons.

Traits / Irrigation treatments	Pod length (cm)	Pod diameter (cm)	Number of pods/plants	Pods weight/plant (g)	Fresh pods yield (ton/fed)
	2014 season				
100% Rec.	14.99^{A}	0.787^{A}	47.35^{A}	172.66^{A}	4.052^{A}
75% Rec.	14.82^{AB}	0.768^{A}	44.33^{B}	155.13^{B}	4.084^{A}
50% Rec.	14.53^{B}	0.757^{A}	39.88^{C}	145.94^{C}	3.743^{B}
	2015 season				
100% Rec.	14.80^{A}	0.814^{A}	51.80^{A}	169.46^{A}	4.007^{A}
75% Rec.	14.43^{B}	0.793^{A}	46.95^{B}	153.15^{B}	4.114^{A}
50% Rec.	14.15^{C}	0.783^{A}	44.40^{C}	143.51^{C}	3.652^{B}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 6: Effect of cultivation methods on yield and its components of common bean in 2014 and 2015 seasons.

Traits / Cultivation methods	Pod length (cm)	Plant diameter (cm)	Number of pods/plants	Pods weight/plant (g)	Fresh pods yield (ton/fed)
	2014 season				
Treatment 1 (T1)	15.58^{A}	0.817^{A}	51.23^{A}	176.71^{A}	4.024^{A}
Treatment 2 (T2)	14.84^{B}	0.780^{B}	46.67^{B}	168.28^{B}	4.107^{A}
Treatment 3 (T3)	14.54^{B}	0.756^{C}	42.74^{C}	161.59^{C}	4.001^{A}
Treatment 4 (T4)	14.16^{C}	0.730^{D}	34.78^{D}	125.07^{D}	3.705^{B}
	2015 season				
Treatment 1 (T1)	15.33^{A}	0.833^{A}	56.96^{A}	173.70^{A}	5.083^{A}
Treatment 2 (T2)	14.81^{B}	0.818^{A}	52.11^{B}	163.87^{B}	4.916^{AB}
Treatment 3 (T3)	14.31^{C}	0.793^{B}	44.99^{C}	157.81^{C}	4.734^{B}
Treatment 4 (T4)	13.39^{D}	0.741^{C}	36.81^{D}	126.11^{D}	4.792^{B}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 7: Effect of irrigation treatments and cultivation methods on yield and its components of common bean in 2014 and 2015 seasons.

Traits		Pod length (cm)	Plant diameter (cm)	Number of pods /plants	Pods weight /plant (g)	Fresh pods yield (ton/fed)
Irrigation treatments	Cultivation methods					
		2014 season				
100% Rec.	**Treatment 1 (T1)**	16.02^{a}	0.847^{a}	54.00^{a}	192.94^{a}	4.155^{ab}
	Treatment 2 (T2)	14.89^{bcd}	0.793^{bc}	48.51^{c}	186.09^{b}	4.193^{a}
	Treatment 3 (T3)	14.56^{cde}	0.770^{bcd}	46.17^{de}	176.84^{c}	4.152^{ab}
	Treatment 4 (T4)	14.47^{def}	0.740^{def}	40.74^{f}	134.78^{g}	3.707^{cd}
75% Rec.	**Treatment 1 (T1)**	15.50^{ab}	0.810^{ab}	51.00^{b}	174.16^{c}	4.169^{ab}
	Treatment 2 (T2)	14.99^{bcd}	0.780^{bcd}	47.51^{cd}	165.31^{d}	4.215^{a}
	Treatment 3 (T3)	14.68^{cde}	0.757^{c-f}	44.37^{e}	157.66^{e}	4.020^{abc}
	Treatment 4 (T4)	14.13^{ef}	0.723^{f}	34.44^{h}	123.37^{h}	3.931^{abc}
50% Rec.	**Treatment 1 (T1)**	15.21^{bc}	0.793^{bc}	48.67^{c}	163.04^{d}	3.749^{cd}
	Treatment 2 (T2)	14.66^{cde}	0.767^{cde}	44.00^{e}	153.44^{ef}	3.913^{abc}
	Treatment 3 (T3)	14.37^{def}	0.740^{def}	37.67^{g}	150.27^{f}	3.832^{bc}
	Treatment 4 (T4)	13.87^{f}	0.727^{ef}	29.17^{i}	117.01^{i}	3.478^{d}
		2015 season				
100% Rec.	**Treatment 1 (T1)**	15.62^{a}	0.843^{a}	63.11^{a}	192.31^{a}	4.172^{a}
	Treatment 2 (T2)	14.95^{bcd}	0.827^{ab}	56.21^{b}	179.52^{b}	4.153^{a}
	Treatment 3 (T3)	14.61^{de}	0.823^{ab}	48.07^{d}	172.44^{c}	4.142^{a}
	Treatment 4 (T4)	14.03^{f}	0.763^{cd}	39.80^{fg}	133.57^{g}	3.561^{cd}
75% Rec.	**Treatment 1 (T1)**	15.31^{ab}	0.833^{a}	55.02^{b}	168.56^{c}	4.128^{a}
	Treatment 2 (T2)	14.78^{cd}	0.813^{ab}	51.37^{cd}	163.04^{d}	4.200^{a}
	Treatment 3 (T3)	14.26^{ef}	0.790^{bc}	43.86^{e}	154.78^{e}	4.159^{a}
	Treatment 4 (T4)	13.38^{g}	0.733^{de}	37.56^{g}	126.21^{h}	3.969^{ab}
50% Rec.	**Treatment 1 (T1)**	15.07^{bc}	0.823^{ab}	52.74^{bc}	160.23^{d}	3.661^{cd}
	Treatment 2 (T2)	14.70^{cd}	0.813^{ab}	48.73^{d}	149.05^{f}	3.801^{bc}
	Treatment 3 (T3)	14.05^{f}	0.767^{cd}	43.05^{ef}	146.21^{f}	3.728^{bc}
	Treatment 4 (T4)	12.77^{h}	0.727^{e}	33.07^{h}	118.54^{i}	3.420^{d}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

The interaction effect between irrigation treatments x cultivation methods on yield and its components character was significantly in both seasons. Results reveal that, the highest values were found in the interaction between the 100% recommended irrigation treatment x sowing on one side of 60 cm wide ridge (T1) on most yield and its components characters. The interactions of the 100% recommended irrigation treatment with some cultivation methods (T1, T2 and T3) or the interactions of the 75% recommended irrigation treatment with some cultivation methods (T1, T2, T3 and T4) gave the highest values of fresh pods yield (ton/fed) than the other combinations, in both seasons without significant differences between them (Table 7).

C- Quality characters:

Results presented in Table (8) show that the 75% of recommended irrigation treatment was produced the highest values on protein content % without

significant effect with 50% recommended irrigation. While, the 100% recommended irrigation treatment was produced the best values on fiber content % (9.70%). These results are in agreement with those obtained by **Hegab, *et al*., (2014)**.

There were no significant differences between cultivation methods on protein content%, while, fiber contents% was significantly affected by cultivation methods. The best values of fiber content% were obtained at sowing on one side of 60 cm wide ridge with closing the end of every two ridges in the plot after the first irrigation. These results are in line with those reported by **Hughes and Swanson (1989),** who found that the cooking of common bean resulted in marked increases in insoluble dietary fiber and total dietary fiber, while soluble dietary fiber content decreased slightly. SEM revealed starch granules and protein bodies characteristic of the common bean while cooked contained amorphous material consisting of gelatinized starch and denatured proteins.

The combined effect of irrigation treatments and cultivation methods on quality characters (Table 10) indicate that, the interactions of the 75% recommended irrigation treatment with cultivation methods (T1, T2 and T3) or the interactions of the 50% the recommended irrigation treatment with cultivation methods (T1 and T2) gave the higher values of protein contents (%) than the other combinations. While, the interactions of the 100% recommended irrigation treatment with all cultivation methods or the interactions of the 75% recommended irrigation treatment with some cultivation methods (T2) gave the best values of fiber contents (%) than the other combinations

.

Table 8: Effect of irrigation treatments on quality characters of common bean in 2015 season.

Traits / Irrigation treatments	Protein content (%)	Fiber content (%)
100% Rec.	7.64^{B}	9.70^{C}
75% Rec.	9.43^{A}	11.41^{B}
50% Rec.	8.75^{A}	13.05^{A}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 9: Effect of cultivation methods on quality characters of common bean in 2015 season.

Traits / Cultivation methods	Protein content (%)	Fiber content (%)
Treatment 1 (T1)	8.86^{A}	11.15^{B}
Treatment 2 (T2)	8.84^{A}	10.84^{B}
Treatment 3 (T3)	8.68^{A}	11.59^{AB}
Treatment 4 (T4)	8.04^{A}	11.97^{A}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

Table 10: Effect of irrigation treatments and cultivation methods on quality characters of common bean in 2015 season.

Traits		Protein content (%)	Fiber content (%)
Irrigation treatments	**Cultivation methods**		
100% Rec.	**Treatment 1 (T1)**	7.87^{cd}	9.22^{d}
	Treatment 2 (T2)	7.34^{d}	9.59^{d}
	Treatment 3 (T3)	7.97^{cd}	9.82^{d}
	Treatment 4 (T4)	7.37^{d}	10.17^{cd}
75% Rec.	**Treatment 1 (T1)**	9.94^{ab}	10.44^{bc}
	Treatment 2 (T2)	9.07^{abc}	10.11^{cd}
	Treatment 3 (T3)	8.60^{bcd}	10.65^{b}
	Treatment 4 (T4)	7.37^{d}	12.44^{ab}
50% Rec.	**Treatment 1 (T1)**	9.94^{ab}	12.97^{ab}
	Treatment 2 (T2)	9.07^{abc}	12.51^{ab}
	Treatment 3 (T3)	8.60^{bcd}	13.31^{a}
	Treatment 4 (T4)	7.37^{d}	13.31^{a}

*Means followed by the same letter or letters are not significantly different of the 5% significance level.

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الملخص العربى

تأثير الري وطرق الزراعة علي محصول وجودة الفاصوليا تحت ظروف محافظة سوهاج

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أجريت هذه الدراسة فى محطة البحوث الزراعية بجزيرة شندويل بمحافظة سوهاج خلال مواسمى خريفى 2014 و 2015م لدراسة تأثير الري وطرق الزراعة على صفات النمو الخضرى والمحصول ومكوناته وبعض صفات الجودة فى محصول الفاصوليا الخضراء صنف بوليستا. حيث تم استخدام تصميم قطاعات كاملة العشوائية بتوزيع القطع المنشقة مرة واحدة حيث وزعت معاملات الري (100%، 75% و50% من المعدل الموصى به) من كمية مياه رى الفاصوليا فى القطع الرئيسة، بينما وزعت طرق الزراعة (زراعة الفاصوليا على خطوط بعرض 60سم ، زراعة الفاصوليا على خطوط بعرض 60سم مع غلق الخطوط بعد الرية الأولى، زراعة الفاصوليا على الجانبين على مصاطب بعرض 120سم وزراعة الفاصوليا على مصاطب بعرض 120 سم مع زراعة خط فى منتصف المصطبة) فى القطع الشقية وكانت مساحة القطعة التجريبية 10.5 م^2، وتمت الزراعة فى الأسبوع الأول من سبتمبر فى كلا الموسمين.

وكانت أهم النتائج على النحو التالى :
أظهرت النتائج أن معاملات الرى المستخدمة حققت فروقاً معنوية فى معظم صفات النمو الخضرى والمحصول ومكوناته وكذلك نسبة البروتين والألياف مع عدم وجود زيادة معنوية بين معاملاتى الري بالمعدل الموصى به و75% من معدل الرى الموصى به فى صفات إرتفاع النبات وطول القرن فى موسم 2014م. أعطت نتائج معاملة الرى بالكمية الموصى بها أعلى القيم لصفات الوزن الجاف لجذور النبات، مساحة سطح أوراق النبات، طول القرن وعدد قرون النبات ووزن القرون الخضراء للنبات ومحصول القرون الخضراء خلال موسمى الدراسة. بينما لم يكن هناك فروق معنوية بين معاملات الرى المختلفة لصفة عرض القرن خلال موسمى الدراسة.
أظهرت النتائج أن طرق الزراعة المدروسة حققت فروقاً معنوية فى معظم صفات النمو الخضرى والمحصول ومكوناته وكذلك نسبة البروتين والألياف، أعطت معاملة زراعة الفاصوليا على خطوط بعرض 60سم أعلى القيم لصفات إرتفاع النبات، مساحة سطح الورقة، طول القرن، عرض القرن، عدد قرون النبات، وزن القرون الخضراء للنبات وأفضل القيم لصفة نسبة الألياف خلال موسمى الدراسة ، بينما أعطت معاملة زراعة الفاصوليا على خطوط بعرض 60سم مع غلق الخطوط بعد الرية الأولى أعلى القيم لصفة محصول القرون الخضراء خلال موسمى الدراسة.
التفاعل بين معاملات الرى وطرق الزراعة المدروسة أظهر عدم وجود فروق معنوية بين الرى بكمية المياه الموصى بها وثلاث أرباع كمية المياه الموصى بها عند زراعة الفاصوليا على خطوط بعرض 60سم مع غلق الخطوط بعد الرية الأولى فى صفة محصول القرون الخضراء خلال موسمى الدراسة.
توصى الدراسة بزراعة الفاصوليا على مصطبة بعرض 120 سم مع زراعة خطين على جانبى المصطبة أو ضم كل خطين من الجانبين عند زراعة الفاصوليا على خطوط بعرض 60 سم بين الخطوط .. حيث يمكن الإستغناء عن ربع كمية المياه الموصى بها من مياه الرى.