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# EFFECTIVE MANAGEMENT OF FABA BEEN WATERING UNDER DIFFERENT IRRIGATION LEVELS.

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## ABSTRACT

A field trial was carried out at Sakha Agriculutural Research Station, Kafr El-Sheikh Governorate during the two successive winter growing seasons 2009/2010 and 2010/2011. Treatments were: A traditional irrigation (control), B irrigation based on Ibrahim equation (no -deficit) , C irrigation with 85% from Ibrahim equation (deficit ) , D irrigation with 70%from Ibrahim equation (deficit) and R: Rainfall i.e. left for rainfall following cultivation.

The main target of the current study was to investigate the influence of irrigation levels on faba bean yield, its components as well some water relations. The main finding of this study could be concluded as follows:

The highest values of water applied [irrigation water (IW) +rainfall (Rf) were recorded under treatment A (control) and the mean seasonal value was 2874.64m³/fed. (68.44cm). On the contrary, the lowest value was recorded under the conditions of rainfall (treatment R) where the seasonal value was 906.49m³/fed. (21.58 cm).

Regarding crop consumptive use (CU), the seasonal values can be arranged in descending order as; 29.95 > 29.55 > 27.19> 26.56 > 9.81 cm for B, A, C, D and R treatments, respectively.

Concerning seed yield (kg/fed.), the highest mean values were recorded under irrigation treatment A and the value was 1102.71 kg/fed. On the other hand, the lowest value was recorded under the conditions of rainfall with treatment R and the seasonal value was 503.86 kg/fed.

Regarding all studied parameters, the treatment B which irrigated based on Ibrahim equation gave the highest number of pods 16.1/plant. While the treatment A of traditional irrigation gave the highest plant height 101.1 cm, number of branches 6.7and 100-seed weight 74.9 g. On the other hand , the lowest mean values were recorded under irrigation treatment R which left for rainfall during the growing season after planting irrigation.

## INTRODUCTION

In Egypt, the limited water supply is becoming more serious. This is due to the irrigated agriculture is the dominant type of farming . Irrigation is the main sector in water consumption, since it consumes about 85% of the total water supply. Irrigation should be aimed with restoring the soil water in the root zone to a level at which the crop can fully meet its evapotranspiration needs.

Reported that water consumptive use for faba bean (1980) El-Maghraby decreased by reducing the number of irrigations (i.e. by prolonging irrigation intervals).

Krogman et al., (1980) reported that seed yield (but not the 100-seed weight) was significantly increased with the increase in number of irrigations through irrigation upon depletion of 40%, 60% or 75% of available water.

Mínguez et al., (1993) found that water stress has a determinant effect on faba bean vegetative growth, as well as reproductive growth.

Yasseen et al., (1999) showed that plant characteristics (plant height, No. branches/plant , No. pods/ plant) highly significantly increased as soil moisture depletion level decreased.

Abd El Aziz (2008) found that the first treatment of supplementary irrigation significantly increased plant height, number of branches, leaf area, leaf area index, number of flowers, number of pods/plant, number of seeds/pods, and weight of 100 seeds.

Alderfasi and Alghamdi (2010) found that the shortage of water decreased most growth characters. So, the main target of this study was to find out the role of water deficit on faba bean yield, its components, protein content as well some water relations.

## MATERIALS AND METHODS

A field experiment was conducted at Sakha Agricultural Research Station ،Kafr El-Sheikh Governorate, North Nile Delta region during the two growing seasons 2009/2010 and 2010/2011 to study the impact of irrigation levels on faba bean yield and some of its water relations. Soil of the experimental field was clayey in texture (Table 1).

The faba bean crop (*Vicia faba*. c.v. Giza 843) as winter crop was grown during the seasons of 2009/2010 and 2010/2011. Dates of sowing (S) and harvesting (H) were as follows for faba bean crop: Season 1: S = 15/11/2009, H = 10/5/2010 and Season 2: S = 08/11/2010, H = 05/5/2011. All agricultural practices were done as recommended by Agricultural Research Center (ARC) except the irrigation treatments which were as follows:

A:Traditional irrigation (control).

B:Irrigation based on Ibrahim equation (no- deficit) ( ETp = 0.1642 +0.8 Ep). (Ibrahim, 1981) .

C: Irrigation with 85%from Ibrahim equation (deficit).

D: Irrigation with 70%from Ibrahim equation (deficit).

R: Rainfall i.e. left for rainfall following cultivation.

A randomised block design with four replicates was conducted in this study.

**Table (1): Some physical characteristics of the studied site.**

| Soil depth (cm) | Physical properties | | | | | | Soil water relation (%, w/w) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Particle size distribution | | | Texture class | Bulk density ($kg/m^3$) | Total porosity % ** | Field capacity (%) | P.W.P. % | A.W. % * |
| | Sand% | Silt% | Clay% | | | | | | |
| 0-15 | 12.30 | 33.3 | 54.40 | Clay | 1.08 | 59.25 | 46.90 | 25.49 | 21.41 |
| 15-30 | 20.20 | 34.2 | 45.60 | Clay | 1.12 | 57.74 | 39.72 | 21.59 | 18.13 |
| 30-45 | 20.40 | 41.40 | 38.20 | Clay loam | 1.17 | 55.85 | 38.00 | 20.65 | 17.35 |
| 45-60 | 21.10 | 41.50 | 37.40 | Clay loam | 1.22 | 53.96 | 35.48 | 19.28 | 16.20 |
| Mean | 18.50 | 37.60 | 43.92 | Clay | 1.15 | 56.60 | 40.03 | 21.76 | 18.27 |

**PWP: Permanent wilting point; AW: Available water * A.W = Fic – Pww ** Total prosity = (1- $\frac{Bulk\ density}{real\ density}$ ) x 100**

**Execution and data collected:**

**1-Irrigation control**

Application of irrigation water was controlled and measured by rectangular constructed fixed weir upstream with a discharge of 0.01654 $m^3$/sec at 10 cm as effective head over the crest.

**2-Crop-water consumptive use (CU):**

To compute the actual water consumed by the growing plants. Soil moisture percentage was determined gravimetrically before and after each watering as well as harvesting. Samples were taken for the effective root zone of 60 cm, with 15 cm for each successive soil layers. The method of computation is considered as the direct method of calculating water consumptive use based on soil moisture depletion (S.M.D.) or So-called crop water consumed (ETC) as stated by Hansen *et al.,* 1979:

$$SMD = CU = \frac{\theta 2 - \theta 1}{100} \times D_b \times d \times A = m^3/fed$$

**Where:**

SMD = Soil moisture depletion in the effective root zoon = 60 cm

CU = Actual water consumptive use of the growing plants.

$\theta 2$ = Soil moisture percentage (W/W) for the 60 cm soil depth, 48 hrs. after irrigation.

$\theta 1$ = Soil moisture percentage (W/W), before the next irrigation for the 60 cm soil depth.

$D_b$ = Soil bulk density, $kg/m^3$ for the 60 cm soil depth.

d = Soil wetting depth i.e. effective root zone of 60 cm.

A = Irrigated area, $m^2$ (4200 $m^2$ i.e. area of 1.0 feddan).

**3-Crop and irrigation efficiencies:**

a. **Applied irrigation water use efficiency (crop water productivity):**

It was calculated according to Doorenbos and Pruitt (1975) as:

$$I.W.U.E. = \frac{Yield\left(\frac{kg}{fed}.\right)}{Amount\ of\ water\ applied\ to\ crop\left(\frac{m^3}{fed}.\right)}$$

b. **Water use efficiency:**

It was calculated according to Doorenbos and Pruitt (1975) as:

$$W.U.E. = \frac{Yield\left(\frac{kg}{fed}.\right)}{Amount\ of\ water\ consumed\ by\ crop}$$

**4-Crop attributes:**

-Plant height

-Number of branches per plant

-Number of pods per plant

-100 seed weight

Data collected were subjected to statistical analysis according to Snedecor and Cochran (1967).

## RESULTS AND DISCUSSION

**Amount of water applied (Wa):**

As shown in Table(2) water applied (Wa) to faba bean crop consists of two items ; irrigation water (I.W) and rainfall (RF). Seasonal amount of rainfall was 3.88 cm and 17.21 cm in the first and second growing seasons, respectively. Seasonal water applied (WA) showed that treatment A received the highest applied water of 2874.64 m³/fed. On the contrary, the treatment R received the lowest average of applied water 906.49 m³/fed, as 463.6 m³/fed as IW for cultivation and 442.89 m³/fed as RF. The values of applied water for all irrigation treatments can be arranged in descending order as: 2874.64 > 2732.85 > 2458.49 > 2184.5 > 906.49 m³/fed. For A, B, C, D, and R treatments, respectively. Comparing traditional irrigation (Trt.A) with other irrigation treatments The corresponding percentages of water saving are ; 4.9, 14.5, 24.0 and 68.5% for treatments B, C, D and R, respectively.

**Table (2): Seasonal water applied (Wa , m³/fed and cm) ;irrigation water (IW) and rainfall (RF) as affected by irrigation treatments for faba bean.**

| Treat / Parame | A | B | C | D | R |
|---|---|---|---|---|---|
| | Season 1 (2009/2010) | | | | |
| I.W., m³/fed. | 2598.38 | 2442.56 | 2147.52 | 1852.49 | 475.68 |
| I.W., cm. | 61.86 | 58.15 | 51.13 | 44.10 | 11.32 |
| RF, m³/fed | 162.96 | | | | |
| RF, (cm). | 3.88 | | | | |
| | Season 2 (2010/2011) | | | | |
| I.W., m³/fed. | 2265.12 | 2137.36 | 1883.69 | 1630.74 | 451.52 |
| I.W., cm. | 53.93 | 50.88 | 44.84 | 38.82 | 10.75 |
| RF, m³/fed. | 722.82 | | | | |
| RF, (cm). | 17.210 | | | | |
| | Mean of 2 seasons | | | | |
| I.W., m³/fed. | 2431.75 | 2289.96 | 2015.6 | 1741.61 | 463.60 |
| I.W., cm. | 57.89 | 54.51 | 47.98 | 41.46 | 11.03 |
| RF, m³/fed. | 442.89 | | | | |
| RF, (cm). | 10.545 | | | | |
| | Total water applied( Means of 2 seasons) | | | | |
| Total water applied ., m³/fed | 2874.64 | 2732.85 | 2458.49 | 2184.50 | 906.49 |
| Total water applied ., cm | 68.44 | 65.06 | 58.53 | 52.01 | 21.58 |

**Crop water consumptive use (CU):**

Data of seasonal crop water consumptive use (CU) for faba bean plants as tabulated in Table (3) cleared that mean seasonal values of water consumptive use were 29.55, 29.95, 27.19, 26.56 and 9.81 cm for irrigation treatments A, B, C, D and R, respectively.

Increasing value of consumptive use for treatment B which received 2732.85 m³/fed. as Wa . comparison with other treatments was due to increasing amount of applied water which resulted in increasing soil moisture content. These results are in a great harmony with those obtained by El-

Maghraby (1980) who reported that water consumptive use for faba bean decreased by reducing the number of irrigations (i.e. by prolonging irrigation intervals).

**Table (3): Seasonal water consumptive use (CU, cm) for faba bean as affected by irrigation treatments.**

| Season<br>Trt | ٢٠١٠/٢٠٠٩ | ٢٠١١/٢٠١٠ | Mean |
|---|---|---|---|
| A | ٣٠.٤٦ | ٢٨.٦٥ | ٢٩.٥٥ |
| B | ٣٠.٨٧ | ٢٩.٠٤ | ٢٩.٩٥ |
| C | ٢٨.٩٠ | ٢٥.٤٨ | ٢٧.١٩ |
| D | ٢٧.٥٣ | ٢٥.٥٩ | ٢٦.٥٦ |
| R | ٨.٩١ | ١٠.٧١ | ٩.٨١ |
| Mean | ٢٥.٣٣ | ٢٣.٨٩ | ٢٤.٦١ |

**Water use and water utilization efficiency (W.U.E.)& (W.Ut.E., kg/m³):**

These parameters assess the efficiency exerted by crops in producing yield from water provided for plant. The water use efficiency (W.U.E.) indicates the amount of yield produced by a unit volume of water consumed to plants, while the water utilization efficiency (W.Ut.E) indicates the amount of yield given by a unit volume of water applied by plants. Results of W.U.E. show that treatment R have the highest overall value of 1.21 kg/m³ (Table 4). The values of W.U.E. could be arranged in the descending order as: 1.21 > 0.88 > 0.85 > 0.68 > 0.60 kg/m³ for treatments R, A, B, C and D, respectively.

**Table (4): Water use efficiency (W .U. E. Kg/m³) of faba bean as affected by different irrigation treatments.**

| Trt | A | B | C | D | R |
|---|---|---|---|---|---|
| Season 1 (2009/2010) | | | | | |
| W. U. E. (Kg/m³) | 0.90 | 0.88 | 0.68 | 0.59 | 1.26 |
| Season 2 (2010/2011) | | | | | |
| W. U. E. (Kg/m³) | 0.86 | 0.82 | 0.69 | 0.62 | 1.17 |
| Mean of 2 seasons | | | | | |
| W.U. E. (Kg/m³) | 0.88 | 0.85 | 0.68 | 0.60 | 1.21 |

Concerning water utilization efficiency (W.Ut.E) results of the effect of irrigation levels on faba bean water utilization efficiency show the same trend like that the water use efficiency. Table (5) show that treatment R has the highest overall value of 0.59 kg/m³. Values of W.Ut.E .could be arranged in descending order as: 0.59 > 0.39> 0.38> 0.32> 0.31 kg/m³ for treatments R, B, A, C and D, respectively.

**Table (5):Water utilization efficiency (W Ut E. Kg/m³) of faba bean as affected by different irrigation treatments.**

| Trt | A | B | C | D | R |
|---|---|---|---|---|---|
| Season 1 (2009/2010) | | | | | |
| W Ut E.( Kg/m³) | 0.42 | 0.44 | 0.36 | 0.34 | 0.74 |
| Season 2 (2010/2011) | | | | | |
| W Ut E. (Kg/m³) | 0.34 | 0.35 | 0.28 | 0.28 | 0.45 |
| Mean of 2 seasons | | | | | |
| W Ut E.( Kg/m³) | 0.38 | 0.39 | 0.32 | 0.31 | 0.59 |

**Seed yield (kg/fed.):**

Data in Table (6) revealed that irrigation treatments had a significant effect on seed yield in both growing seasons. The height mean values of yield were recorded under treatment A which received the height amount of water applied and the values were 1163.35 and 1042.07 kg/fed for the first and second seasons, respectively. On the other hand, the lowest values were recorded under rainfed treatment R which received the less amount of irrigation water and the valus were 478.04 and 529.69 kg/fed in the first and second seasons, respectively. Treatment B gave 97.91% from treatment A seed yield while treatment C,D and R gave 71.91, 61.59 and 45.69%, respectively. Generally, it could be concluded that decreasing the irrigation water amount led to decreasing in faba bean seed yield. These results are agreement with those obtained by Krogman et al. (1980) and Kassab, (2010).

**Table (6):Seed yield (kg/fed) of faba bean as affected by irrigation treatments.**

| Season / Trt | 2009/2010 | 2010/2011 | Mean |
|---|---|---|---|
| A | 1163.35 | 1042.07 | 1102.71 |
| B | 1150.25 | 1009.21 | 1079.73 |
| C | 837.38 | 748.36 | 792.87 |
| D | 691.01 | 667.40 | 679.20 |
| R | 478.04 | 529.69 | 503.86 |

**Crop attributes:**

**Plant height (cm):**

Data in Table (7) show that mean values of faba bean plant height was high significantly affected with irrigation treatments. The highest value 102.0 and 100.2 cm was recorded under traditional irrigation (Trt. A). On the other hand, the lowest value 69 and 72.1 was found under rainfall (Trt.R) in the first and second growing seasons, respectively. These results are in a great agreement with those obtained by Yasseen et al. (1999) , Abd El Aziz (2008), Alderfasi and Alghamdi (2010)

**100 seed weight(g), number of pods/ plant and number of branches/plant:**

Data presented in Table (7) also illustrate that there is a highly significant effect due to different irrigation treatments on weight of 100 seed

and number of branches /plant in the two growing seasons and results show that number of pods/plant was significantly affected by irrigation treatments at first season ,while it was not significant affected in the second season. The lowest values was recorded under treatment R. These results are in a great harmony with those obtained by Abd El Aziz, (2008) and Ouda (2010)

**Table (7): Plant height (cm), 100 seed weight(g), number of pods/ plant and number of branches/plant as affected by irrigation treatments.**

| Trt | Season 2009/2010 | | | | | | |
|---|---|---|---|---|---|---|---|
| | **A** | **B** | **C** | **D** | **R** | **F-test** | **LSD 5%** |
| Plant height (cm) | 102.0 | 98.5 | 84.8 | 81.6 | 69 | ** | 8.17 |
| No. of branches / plant | 6.35 | 6.3 | 5.8 | 5.6 | 4.5 | ** | 0.839 |
| No. of pods/ plant | 16.2 | 17.1 | 14.7 | 14.0 | 13.8 | ** | 1.839 |
| 100 seed weiht (g) | 74.4 | 64.8 | 62.5 | 59.0 | 36.9 | ** | 5.279 |
| | **Season 2010/2011** | | | | | | |
| Plant height (cm) | 100.2 | 98.9 | 86.0 | 82.7 | 72.1 | ** | 2.163 |
| No. of branches / plant | 7.0 | 6.45 | 5.85 | 5.75 | 4.6 | ** | 0.739 |
| No. of pods/ plant | 14.4 | 15.1 | 14.3 | 13.7 | 13.5 | <1 | |
| 100 seed weiht (g) | 75.4 | 65.9 | 63.5 | 59.1 | 40.3 | ** | 7.482 |

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## الاداره المائية الفعالة للفول البلدي تحت مستويات ري مختلفة.

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**** مركز البحوث الزراعية – سخا – كفر الشيخ**

أجريت تجربتان حقليتان بمحطة بحوث سخا – بمحافظه كفر الشيخ خلال موسمي النمو ٢٠٠٩/ ٢٠١٠ و٢٠١٠/ ٢٠١١ وذلك بهدف دراسة تأثير مستويات الري علي محصول الفول البلدي ومكوناته وكذلك بعض العلاقات المائية. وكانت معاملات الري هي:

الري التقليديA: .

١٠٠% من معادله إبراهيم. الري بـB:

الري ب ٨٥% من معادله إبراهيم.C:.

٧٠% من معادله إبراهيم. الري بـD:.

متروكة للمطر بعد ريه الزراعة. R:

**يمكن تلخيص أهم النتائج فيما يلي:**

- سجلت اعلي القيم للماء المضاف تحت المعاملة A حيث كانت ٢٨٧٤,٦٤م٣/ فدان وعلي العكس من ذلك سجلت المعامله R اقل القيم وكانت القيمة ٩٠٦,٤٩م٣/فدان. وقد تحصل علي وفر في مياه الري من المعاملة B (١٠٠% من معادله إبراهيم) بما قيمته ١٤١,٧٩ م٣/فدان.
- بالنسبة لقيم الاستهلاك المائي الموسمي دلت النتائج علي زيادة القيم تحت ظروف المعاملة B مقارنه بباقي المعاملات ويمكن ترتيب القيم تنازليا كالأتي ٢٩,٩٥> ٢٩,٥٥> ٢٧,١٩> ٢٦,٥٦> ٩,٨١ بالنسبة للمعاملات B,A,C,D,R علي الترتيب.
- بالنسبة لمحصول الحبوب كجم/فدان سجلت اعلي القيم تحت معامله الري A وكانت القيمة ١١٠٢,٧١ كجم/ فدان وعلي العكس سجلت اقل القيم تحت المعاملةR حيث كانت ٥٠٣,٨٦ كجم/ فدان.
- بالنسبة لمكونات المحصول مثل وزن ال١٠٠ حبه (جرام) وعدد الفروع /نبات وطول النبات سجلت اعلي القيم تحت المعاملة A وسجلت اعلي القيم لعدد القرون /نبات تحت المعاملة B في حين سجلت اقل القيم تحت المعاملة R والتي تركت للأمطار بعد ريه الزراعة.

**توصيه:**

تحت خطر النقص المائي الذي يواجه مصر وجب ايجاد الحلول والطرق التي تساعد علي مواجهه هذا الخطر وفي هذه الدراسه وجد ان استخدام ١٠٠% من معادله ابراهيم يعمل علي توفير ٥% من كميه الماء مقارنه بالري التقليدي بما يعادل ١٤٢ م٣ /فدان وحوالي ٥٠ مليون م٣ علي المستوي القومي في حين ينخفض انتاج المحصول بنسبه ٢% فقط.

**قام بتحكيم البحث**

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