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EFFECT OF DIFFERENT IRRIGATION LEVELS ON SOME WATER RELATIONS AND YIELD OF FABA BEAN

BY

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ABSTRACT

Two field experiments were carried out at Sakha Agricultural Research Station during the two successive season 1999/2000 and 2000/2001 growing seasons in the North Middle Nile Delta region to study the effect of amount of applied water on some water relations and yield of faba bean. The main treatments were irrigation depths which were D_1 = irrigation till water depth reached 2.5 cm above soil surface, D_2 = irrigation till water depth 5.0 cm and D_3 = irrigation till water depth 7.5 cm, while the sub treatments were furrow width, which were F_1 = furrow 60 cm wide and planting on one side, F_2 = furrow 120 cm wide and planting on both sides and F_3 = furrow 120 cm wide and planting on both sides plus the middle.

Increasing depth of irrigation water increased the amount of applied water in the growing seasons. The highest mean values occurred with 7.5 cm giving 2022.3 and 2041.9 m^3/fed. in the two season respectively. Lowest values occurred with 2.5 cm giving 1400.4 and 1453.5 m^3/fed. in the two growing seasons, respectively. The highest mean values for water applied were with F_1 giving 1527.8, 1767.3 and 2233.3 m^3/fed. under D_1, D_2 and D_3, respectively. The highest mean consumptive use (CU) was 1819.3 and 1695.7 m^3/fed. in the first and second seasons, respectively. Water consumptive use was higher under F_1 treatment the highest CU values for D treatments were 1633.5, 1822.5 and 1924.5 m^3/fed. under D_1, D_2, and D_3 respectively. Bean yield was highest with D_2 giving 1490.0 and 1449.7 kg/fed. in the first and second seasons, respectively. F_3 gave highest yield among F treatments.

Water use efficiency (WUsE) and water utilization efficiency (WUtE) were highest with D_2 giving 0.91 and 1.02 kg/m^3 for the first and second seasons respectively, and were highest for F_3 among F treatments.

INTRODUCTION

Faba beans (*Vicia faba*) is one of the main legumes used for human and animal consumption. Egypt leads in per-hectare yield among bean producing countries. Bean cultivated area in Egypt is about 300, 000 to 350,000 feddans. It is a winter crop and is sensitive for irrigation. The main target of the present work

is to maximize crop yield per unit of applied irrigation water through controlling both irrigation depth and furrow width. The effect of irrigation regime on faba bean has bean studied by various workers including Tawadros *et al.* (1993a).

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station in the North Middle Nile Delta region during the two successive seasons 1999 and 2000. A split plot design with four replicates was used in this study. The main plots were assigned to irrigation depths which were:

1- D_1 : irrigation till the water reaches 2.5 cm, above soil surface.
2- D_2: irrigation till the water reaches 5.0 cm, above soil surface.
3- D_3 : irrigation till the water reaches 7.5 cm, above soil surface.

Each of these depths represents the depth of water accumulated above soil surface (water head) before stopping irrigation. Such depths were achieved with each irrigation. There were 4 irrigations for the faba bean crops (in each of growing season). Farmers of the region use D_3.

The sub plots were assigned to furrow spacing which is also spacing between ridge tops; there were 3 treatments as follows:

1- F_1 = 60 cm furrow spacing with 1 plant row/furrow (the traditional spacing and planting used by farmers of the region).
2- F_2 = 120 cm furrow spacing with 2 plant rows/furrow.
3- F_3 = 120 cm furrow spacing with 3 plant rows/furrow.

Irrigation number, dates, and intervals were the same for all treatments.

Execution and data collected:

1. Irrigation water:

Irrigation water was controlled by a steel gate for each field plot as well as those fixed at the side of each header canal. A measuring weir was fixed upstream with a discharge rate of 16.54 L/sec. at 10 cm as effective head. Irrigation water was applied till the designated water depth on soil surface was achieved.

2. Consumptive use:

To compute the actual consumed water by the growing plants, soil moisture percentage was determined gravimetrically on oven dry basis before and after each irrigation as well as at harvesting. Soil samples were taken from four equal successive layers of the effective 60 cm root zone, i.e. 0-15, 15-30, 30-45 and 45-60 cm.

This method of computation is considered as the direct method of consumptive use calculation based on soil moisture depletion (SMD) or so-called crop-water consumed (ETc) as stated by Hansen *et al.*, 1979.

$$SMD = CU = \frac{\Theta_2 - \Theta_1}{100} \times Db \times d \times A$$

Where:

SMD= soil moisture depletion in the effective 60-cm root zone.

CU= consumptive use of the growing plants.

Θ_1 = mean soil moisture percentage (w/w), before irrigation for the root zone.

Θ_2 = mean soil moisture percentage (w/w), for the root zone, 48 hrs. after irrigation (field capacity).

Db= mean soil bulk density, gm/cm^3 for the 60 cm root zone.

D= soil wetting depth of root zone (i.e. 60 cm).

A= Irrigation area in m^2 of one feddan (i.e. 4200)

3. Crop yield:

Crop yield in each plot was recorded (in terms of kg/fed.) at harvest.

4. Parameters of irrigation water efficiency for yield production:

Efficiency of irrigation water was measured in terms of weight of bean grains (kg) produced by unit volume of water (m^3). Water utilization efficiency (WUtE) and water use efficiency (WUsE) expressed as (kg plant production/m^3 of water) were calculated according to Doorenbos and Pruitt (1975) as follows:

$$(A)\ WUtE = \frac{Yield\,(kg)}{Amount\ of\ water\ applied\ to\ crop\ (m^3)}$$

$$(B)\ WUsE = \frac{Yield\,(kg)}{Amount\ of\ water\ consumed\ by\ crop\ (m^3)}$$

RESULTS AND DISCUSSION

1. Water applied:

Data in Table 1 show that among D treatments amount of water applied was increased with increasing irrigation depth up to 7.5 cm; and the highest mean values were recorded under the highest depth 7.5 cm in the two growing seasons, being 1805.4 m^3/fed. or 42.98 cm for 1st and 2nd seasons, respectively. The lowest was under 2.5 cm being 1200.2 m^3/fed. or 28.58 cm respectively. The highest mean values among F treatments was with F_1 with planting in one side with giving an average of 1547.2 m^3/fed. or 36.84 cm for seasons 1 and 2, respectively. These results are in a good harmony with those obtained by Tawadrows *et al.* (1993).

2. Water consumptive use (CU):

Data in Table 1 show that by increasing irrigation water amount increased the CU. The highest among the D treatments occurred at 7.5 cm irrigation with an average of 1757.5 m^3/fed. (i.e. 41.85 cm) for the 2 seasons; whereas the lowest occurred at 2.5 cm irrigation depth with an average of 1480.4 m^3/fed (i.e. 35.25 cm). comparing F treatments show that the highest CU was under F_1 with an overall average 1793.59 m^3/fed. (i.e. 42.70 cm). These findings are in agreement with those obtained by Serry *et al.*, 1980. From the analysis of CU data, it cleared that there is a contribution from water table to crop-water needs. This might be due to both shallow water table and clayey texture soils.

3. Faba bean yield:

Data show that among the D treatments the highest mean values of yield occurred under 5.0 cm irrigation depth giving means of 1490 and 1449.7 kg/fed. in the first and second seasons, respectively. Regarding the F treatments, F_3 treatment recorded the highest value of marketable yield 18060 kg/fed. These results are in agreement with those obtained by El-Waraky and Wahba 1998.

Table (1): Water relation and yield faba bean as affected by different irrigation.

Parameters	Treatments											
	D_1 = 2.5 cm				D_2 = 5.0 cm				D_3 = 7.5 cm			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
	1st season (1999-2000)											
I.W m^3/fed.	1523.4	1343.4	1334.4	1400.4	1740	1576.4	1609.4	1642.1	2178.4	1890.4	1998.4	2022.3
I.W cm	36.27	31.99	31.77	33.34	41.43	37.53	38.32	39.09	51.87	45.01	42.95	46.61
CU. m^3/fed.	1646	1410	1486	1514	1863	1558	1627	1682.7	1956	1717	1785	1819.3
CU. cm	39.2	33.57	35.38	36.05	44.35	37.1	38.73	4006	46.56	40.89	42.49	43.31
Cu. Cm/day	0.22	0.19	0.20	0.20	0.25	0.21	0.2	0.23	0.26	0.23	0.24	0.24
Yield kg/fed.	1070	1027	1365	1154	1305	1345	1820	1490	1062	1050	1400	1170.7
WUsE kg/m^3	0.65	0.73	0.92	0.77	0.70	0.86	1.13	0.89	0.54	0.61	0.78	0.64
WUtE kg/m^3	0.70	0.76	1.02	0.99	0.75	0.85	1.13	1.05	0.49	0.56	0.70	0.65
	2nd season (2000-2001)											
I.W m^3/fed.	1532.2	1391.2	1437.2	1453.5	1794.2	1622.2	1704.2	1706.9	2288.2	1871.2	1966.2	2041.9
I.W cm	36.48	33.12	34.22	34.61	42.72	38.62	40.58	40.64	54.48	44.55	43.02	47.35
CU. m^3/fed.	1621	1330	1389	1446.7	1782	1489	1509	15693.3	1893	1566	1628	1695.7
CU. cm	38.60	31.77	33.08	34.48	42.44	35.45	35.93	37.94	45.08	37.28	38.76	40.37
Cu. Cm/day	0.22	0.18	0.19	0.20	0.24	0.20	0.21	0.22	0.26	0.21	0.22	0.23
Yield kg/fed.	1045	1020	1362	1142.3	1265	1292	1792	1449.7	1007	995	1367	11.23
WUsE kg/m^3	0.65	0.76	0.98	0.80	0.71	0.87	1.19	0.92	0.53	0.64	0.84	0.38
WUtE kg/m^3	0.68	0.73	0.95	0.94	0.71	0.80	1.05	0.99	0.44	0.53	0.70	0.63

4. Water use (WUsE) and water utilization (WUtE) efficiencies:

Data in Table 1 show that by increasing irrigation depth leads to decrease WUsE as well as WUtE. The D_2 treatment gave means of 0.89 and 1.05 (kg/m^3) in season 1, respectively. The second growing season the same trend was clearly found for the two efficiencies, where the mean values were 1.16 WUsE and 0.99 WUtE for season 2. Regarding comparison among F treatments, the highest were recorded under F_3 treatment. These findings are in agreement with those obtained by Ashoub *et al.* (2000).

CONCLUSION

The main results for this study can be summarized as follows:

- Irrigation till water reached 5.0 cm above soil surface (D_2) was most effective; its use instead of 7.5 cm (D_3) gave water saving of 358 m^3/fed. (19.8% saving). Increasing the spacing between furrows from 60 to 120 cm involved irrigation water saving of 183 m^3/fed. saving of 11.3%.
- Treatment 5.0 cm water depth with 120 cm furrow planting 3-rows gave the highest yield (1806 kg/fed.) using an application rate of 1430 m^3/fed (i.e. 34.05 cm), saving 326 m^3/fed.; treatment of 7.5 cm water depth with plant rows, gave the second highest yield. Increase in applied water was associated with an

increase in CU., seasonal and daily rate of CU decreased with the increase in the spacing between furrows.

- The highest yield was obtained by 5.0 cm water depth with 120 cm furrow with 3 rows, with seasonal CU of 37.3 cm and CU rate of 0.22 cm/day.
- Treatment D_2F_3 gave the highest WUtE (1.27 kg/m^3) as well as WUsE (1.16 kg/m^3).
- Therefore, it might be concluded that by irrigation till water reaches 5.0 cm above soil surface with cultivation 3 plant rows using a 120 cm wide furrow may be the most efficient regime for faba bean in middle north Nile Delta region.

REFERENCES

Ashoub, M.A.; Abdel-Aziz, I.M.A.; Shahin, M.M. and Gohar, M.N. (2000): Influence of irrigation intervals and magnesium fertilization on yield and water relation of sunflower. Annals Agric. Soc, Ain Shams Univ., Cairo, 45(23): 453-476.

Doornbos, J. and Pruit, W.O. (1975): Crop Water requirements. Irrigation and Drainage Paper, No. 24, FAO, Rome.

El-Waraky, M.K. and Wahba, M.F. (1998): Influence of irrigation frequency before and after canal closure on the productivity of faba bean. food legume crops program, Field Crops Research Institute, Agriculture Res. Center, Egypt.

Serry, A.; Tawadros, H.W.; El-Serougy, S.; Badawi, A.Y.; Metwally, M.A.; Seif El-Yazal, M.W.; Mahrous, F.N. and Miseha, W.I. (1980): Consumptive use of water by major field crops in Egypt. Agric. Res. J. 58(5): 197-200.

Snedecor, W.G. and Cochran, W.G. (1967): Statistical Methods 6th ed. Iowa State Univ., USA.

Tawadros, H.W.; Gad El-Rab, Miseha, W.I. (1999): Effect of irrigation frequency and wetting depth on faba bean production. J. Agric. Sci. Mansoura Univ. 18(12): 3752-3764.

تأثير مستويات الرى المختلفة وعرض الخط على بعض العلاقات المائية ومحصول الفول البلدى

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** قسم الأراضى ــ كلية الزراعة بمشتهر ــ جامعة بنهـــــا.

أقيمت تجربتين حقليتين فى حقل بحوث المقننات المائية والرى الحقلى بسخا ــ محافظة كفرالشيخ بشمال وسط دلتا النيل خلال موسمى النمو ١٩٩٩/٢٠٠٠م ، ٢٠٠٠/٢٠٠١م وذلك لدراسة تأثير كمية المياه المضافة وعرض الخط على بعض العلاقات المائية ومحصول الفول البلدى حيث قد تم دراسة ثلاث مستويات رى وهى:

- D_1: الرى حتى عمق ٢,٥سم فوق سطح التربة (١ بوصة).

- D_2: الرى حتى عمق ٥,٠٠سم فوق سطح التربة (٢ بوصة).
- D_3: الرى حتى عمق ٧,٥سم فوق سطح التربة (٣ بوصة) وهو الرى التقليدى.

والمعاملات تحت الرئيسية كان عرض الخط وهو:

- F_1: الزراعة على خط بعرض ٦٠سم والزراعة على ريشة واحدة (كما هو متبع بالمنطقة).
- F_2: الزراعة على خط بعرض ١٢٠سم والزراعة على ريشتين.
- F_3: الزراعة على خط بعرض ١٢٠سم والزراعة على ثلاث ريش.

وقد أوضحت النتائج التى تم التوصل إليها ما يلى:

أعلى كمية مياه رى نتجت من المعاملة D_3 أى الرى إلى عمق ٧,٥سم فوق سطح التربة وهو الرى التقليدى وكانت: ٢٠٢٢,١٠ ، ٢٠٤١,٩م^3/فدان = ٤٨,١٥ ، ٤٨,٦٠سم فى كلا موسمى النمو على الترتيب. بينما أقل قيم لمياه الرى سجلت تحت العمق ٢,٥سم D_1 وكانت: ١٤٠٠,٤ ، ١٤٣٥,٥م^3/فدان فى كلا موسمى النمو على الترتيب.

وأوضحت النتائج أيضا أن كمية المياه المضافة للمعاملة F_1 وهى الزراعة على الخطوط العادية بعرض ٦٠سم قد سجلت أعلى الكميات تحت جميع مستويات الرى (D_3, D_2, D_1) حيث كانت متوسطات القيم فى الموسمين ١٥٢٧,٨، ١٧٦٧,٣، ٢٢٣٣,٣م^3/فدان.