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Studies on Water Requirements for Wheat and Faba bean Crops under Different Cropping Systems

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A FIELD experiment was carried out during two growing winter seasons of 1999/2000 and 2000/2001 at the Agricultural Experimental Station, Faculty of Agriculture, Cairo University to study: a) the water requirements for two sole crops, *i.e.*, wheat and fababean and their intercropping, b) the effect of different water regimes on the irrigation water requirements and c) the crop yield, water use efficiency (WUE), land equivalent ratio (LER) and the economical return of the intercropping system of these field crops.

The obtained results indicated that calculated values of irrigation water requirements (IRc) for sole wheat or intercropping fababean/wheat and sole fababean, using Blaney-Criddle equation (BC) were more with 1.95 and 1.91 times than those calculated using Penman-Monteith (PM) and Pan-evaporation (PE) equations, respectively. The actual irrigation water requirements (IRa) for intercropping fababean/wheat recorded the highest amounts of irrigation water followed by sole wheat crop, while the fababean crop recorded the lowest values of IRa for the two growing seasons. In general, it is noticed that the previous values (IRa) were lower than the total amounts of calculated irrigation requirements (IRc).

The data indicated that the irrigation regimes had a significant influences on the grain and straw yield of wheat crop, seed yield of fababean and grain/seed yield of intercropping crops. Also, the results indicated that the values of water use efficiency (WUE) were affected by water depletion, where they decrease with increasing the water depletion except for the sole fababean where, the highest values of WUE was obtained at 35% water depletion. Meanwhile, the highest values of water use efficiency were obtained under intercropping system at the irrigation treatments 20% depletion from available water (ASMD). Economically, the LER indicated that intercropping resulted in greater productivity per unite of land than monocultures of the intercrop components. Data also, indicated that the application of intercropping system gave the highest net returns as compared with sole wheat or sole fababean.

Keywords: Intercropping system, Actual irrigation water requirements, Water use efficiency, Available soil moisture depletion, Wheat and fababean.

Irrigation requirements have a vital role in crop production and irrigation planning, but it is difficult to measure its accurately because it needs long time and hard work potentialities. So, prediction methods for crops water requirements are used to get over this difficulty. These methods often need to be applied under climatic and agronomic conditions very different from those under which they were originally developed. It is very important to evaluate these methods to be adapted if needed for application under different conditions (Amer, 1999).

Inercropping (planting of two or more crops simultaneously in the same field) is an attempt to increase the total yield of unit area, especially in the developing countries where it is not easy to bring more land into cultivation. Legume/cereal intercropping systems (soybean/maize, fababean/wheat) are generally more productive than reference sole crops (Borham, 2001). The biological basis for intercropping advantage involves the complementarily of resource use by crops grown in combination. Such resources include nutrients, water and light. This complementarily can be regarded as temporal when the timing of peak resource needs differ, or spatial when differences in resource use arise from canopy or root dispersion (Alain *et al.*, 1992).

In Egypt, it is very important to increase wheat and fababean production because the total local production is not sufficient to supply the annual demand of local requirements. Intercropping both crops would result in more yields of wheat grains and fababean seeds at practically no extra cost. Many attempts have been focused on intercropping fababean with wheat, because wheat and fababean are nearly identical in agronomic practices and climatic condition. (Eid *et al.*, 1988). Therefore, this work aims at: a) determining the actual irrigation water requirements of sole wheat, sole fababean and intercropping fababean/wheat, b) identifying the best empirical equation for predicting irrigation water requirements for these crops, and c) studying the impact of different irrigation regimes on the irrigation water requirements, crop yield, water use efficiency (WUE), land equivalent ratio (LER), and economical returns (income) of sole and intercropping cultivations.

Material and Methods

This study was carried out at the Experimental Farm, Faculty of Agriculture, Cairo University, during two successive winter seasons of 1999/2000 and 2000/2001. The studied area was divided into 36 equal plots (4X4.5 m) each one was separated by four proof tracks (1m width). A split plot design with four replicates was implemented whereas irrigation treatments were assigned to the main plots and the cropping systems were assigned to the sub-plots.

Treatments

Irrigation treatments

Three levels of irrigation water were tested in this study, *i.e.*, irrigation at 20, 35 and 50% depletion from available water, respectively. Gated pipe system was used for irrigation of each plot, gates were used with discharge reaching 1.85 L/sec. Irrigation water application was controlled through daily measurements of soil moisture content, using gravemetric method for the surface layer (0-20 cm), while the Neutron moisture meter was used for the following layers of 20-40 and 40-60 cm.

Cropping system

Includes sole wheat cultivation, sole fababean and intercropping fababean/wheat. Sole wheat (Sids 1) was sown in rows (15 cm between rows) at the rate of 72 kg/fed. Sole fababean (Cairo 1) was sown in the rows (30 cm between rows) as recommended by Ministry of Agriculture (2001). For intercropping fababean/wheat plants were sown in alternate rows (1:1), wheat was planted at 30 cm between rows with the rate of 72 kg/fed, this amount was planted in the half of the area of sole wheat. While fababean plants were sown in hills (20 cm between them) and leaving 4 plants in each hill, to achieve the same density of plants for sole crops and intercropping crops.

Fertilization regimes

Types, rates and dates of application for different utilized fertilizers under different crops were applied according to Eid *et al.* (1988) and the recommendations of the Ministry of Agriculture (2001).

Actual and calculated irrigation water requirements

The amounts of actual applied irrigation water requirements (IRa) under each irrigation treatment were determined according to James (1988); where irrigation system efficiency reach 65%, which was determined according to Merriam and Keller (1978) and leaching factor equal 10 % (Ayers and Wastcot, 1976).

Calculated Irrigation water requirements

The calculated irrigation water requirements (IRc) were calculated according to equation presented by FAO (1991) using the ETo of the different equations, *i.e.*, Blany-criddle (BC), pan-evaporation (PE) and Penman-Monteith (PM) using meteorological data of the area according to (CL, MOA) and the Kc values proposed by Doorenbos and Kassam, (1986), the same irrigation efficiency and leaching factor are used for calculating the actual water requirements.

Land equivalent ratio (LER)

It is calculated as the total land required by a sole crop to produce as much grain yield as from an intercropping system. It is calculated by determining the ratio of the yield of an individual crop in a mixture to its yield in a sole crop and adding the fraction (Mohta and De., 1980).

$$LER = LER_W + LER_F$$

Where: LER_W = Land equivalent ratio for a sole wheat.
LER_F = Land equivalent ratio for a sole fababean.

Water use efficiency (WUE)

Water use efficiency is calculated as grain yield produced per unit volume of water (Kg/m^3) as described by Giriappa (1983).

Soil sampling and determinations

Undisturbed and disturbed soil samples were collected from three successive soil depths (0-20, 20-40 and 40-60 cm) to determine some soil physical and chemical characteristics of the experimental site, according to methods described by Klute (1986); Shawky (1967); Vomocil (1965) and Page *et al.* (1982).

Results and Discussion

Data of soil physical and chemical characteristics of the experimental area are presented in Table 1.

TABLE 1. Soil physical and chemical characteristics of the experimental site.

Soil characteristics	**Soil depth (cm)**		
	0-20	**20-40**	**40-60**
Particle size distribution %			
C. sand	3.8	3.0	4.6
F. sand	38.0	48.2	75.0
Silt	36.2	23.4	9.2
Clay	22.0	25.4	11.2
Texture class	Loamy	Sandy clay loam	Sandy loam
Chemical properties			
$CaCO_3$ %	4.47	3.30	0.97
Organic matter %	2.49	1.40	0.77
pH (soil paste)	8.03	8.12	8.22
ECe (soil paste extract)	1.61	1.78	1.37
Physical properties			
Bulk density (g/cm^3)	1.20	1.27	1.35
Field capacity (v %)	40.13	38.53	32.37
Wilting point (v %)	20.57	19.66	11.39
Available water(v %)	19.56	18.77	20.98

The data obtained show that: a) the uppermost soil layer of the studied soil profile has a texture class of loamy underlain by sandy clay loam and sandy loam, b) an increase in bulk density values with depth, c) the volumetric soil moisture content at filed capacity and permanent wilting point decrease with depth, d) the available water content shows small increase in the third layer as compared with the other two layers and e) the studied soil layers are classified as non-saline soil.

Calculated irrigation water requirements (IRc)

Data presented in Table 2 show that the total irrigation water requirements calculated using the different equations is low for fababean as compared to wheat crop in the both studied seasons. Also, the mean values of the total calculated irrigation water requirements (IRc) for sole wheat or intercropping fababean/wheat and sole fababean calculated using BC equation are more with 1.95 and 1.91 times than those determined using PM and PE equations, respectively.

TABLE 2. Calculated irrigation water requirements (IRc, mm/month) of the studied wheat and fababean crops for the growing seasons of 1999/2000 and 2000/2001.

Growth seasons						
Growth months	1999/2000			2000/2001		
	BC*	PM*	PE*	PC*	PM*	PE*
Sole wheat and intercropping fababean/wheat						
Nov (3days)	7.3	5.1	4.9	14.2 (6days)	8.1	7.1
Dec.	85.1	55.7	54.7	78.0	42.3	73.8
Jan.	155.8	54.0	72.1	178.4	70.2	97.8
Fab.	200.2	96.6	74.0	204.8	108.0	115.9
Mar.	246.2	125.7	125.1	270.1	135.0	125.7
Apr.	152.3	93.8	83.4	143.2	97.8	79.5
May (5days)	12.2	8.6	5.3	7.4 (7days)	5.2	3.7
Total	859.1	439.5	419.5	896.1	466.6	503.5
Sole fababean						
Nov (3days)	7.3	5.1	4.9	14.2 (6days)	8.1	7.1
Dec.	85.1	55.7	54.7	78.0	42.3	73.8
Jan.	166.9	57.7	72.1	190.4	75.0	104.4
Fab.	200.2	96.6	74.0	204.8	108.0	115.9
Mar.	219.7	112.2	125.1	240.1	120.0	111.7
Apr.	152.3	93.8	83.4	136.4	93.2	75.6
Total	831.5	421.1	414.2	863.9	446.6	488.5

BC* = Blany-Criddle equation
PM* = Penman-Monteith equation
PE* = Pan evaporation equation

On the other hand, the data clearly indicate that the IRc peak of demand is found in March either during the first growing season, or during the second one, for sole wheat and sole fababean.

Actual irrigation water requirements (IRa)

Data illustrated in Fig. 1 show that the total actual irrigation water requirements (IRa) for intercropping fababean/wheat recorded the highest value followed by wheat crop, while the fababean crop recorded the lowest value of irrigation water requirements in the two growing seasons. These results may be due to the high consumptive use rate resulted from the high densities of intercropping fababean/wheat plants as compared to the sole wheat and sole fababean.

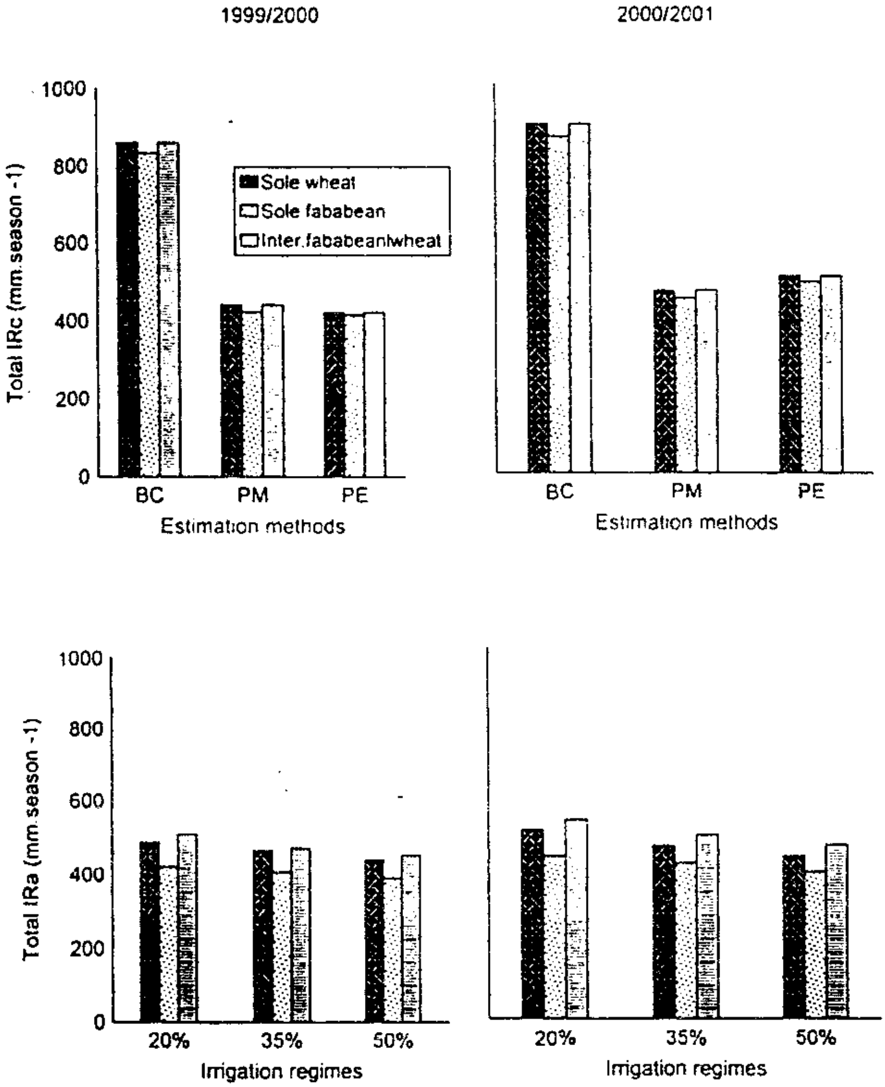

Fig. 1. Total calculated (IRc) and total actual (IRa) irrigation water requirements under different investigated equations and irrigation regimes.

The seasonal actual irrigation water requirements are influenced by moisture regime. The increase in consumptive use under the lowest available soil moisture depletion treatment (20 % ASMD) may be attributed to the increase in the direct evaporation resulting from the frequent wetting of the surface soil layer and the presence of relatively high amount of available water under this moisture regime. Therefore, the seasonal consumptive use is higher under 20 % ASMD regime followed by 35 % ASMD, while the lowest consumptive use was observed under 50 % ASMD regime for all crops and during the studied two growing seasons. Also, the data illustrated in Fig. 1 indicate that, the values of total actual irrigation water requirements in both seasons under all cropping systems are lower than the total calculated ones using the different investigated equations. Also, the highest difference between calculated and actual irrigation water requirements is obtained when using BC equation followed by PM and PE equations under all cropping systems.

Response of wheat grain yield to irrigation regimes and intercropping

Data in Table 3 indicate that the yield of sole wheat crop decreases with increasing the available soil moisture depletion (ASMD) in both studied seasons. This decrease may by rendered to water stress, which hinders the carbohydrate accumulation, and consequently, visible reduction in plant growth and grain yield (Azab, 1998). Therefore, the treatment of 20 % available soil moisture depletion gives the highest grain yield as compared to the other water treatments. The increase in grain yield reaches 11.7 & 29.8 % in the first season and 15.9 & 34.0 in the second one as compared to the treatments of 35 & 50 % ASMD, respectively.

TABLE 3. Impact of irrigation regimes and intercropping on the grain yield of wheat crop.

% of available soil moisture **depletion (ASMD)**	**1999/2000**		**2000/2001**	
	Grain yield of wheat* (ton/fed.) as mean value		**Grain yield of wheat (ton/fed.) as mean value**	
	Intercropping	**Sole**	**Intercropping**	**Sole**
50	1.96 a	2.28 a	1.71 a	2.12 a
35	2.25 b	2.65 b	1.98 b	2.45 b
20	2.59 c	2.96 c	2.36 c	2.84 c
L.S.D $_{(0.05)}$	0.054	0.041	0.059	0.060

*Means with the same letters are not significantly different.

Also, grain yield of intercropping wheat show a visible response to increasing availability of soil moisture, as the increase in the grain yield under 20 % ASMD reaches 15.1, 32.1 % in the first season and 19.2, 38.0 % in the second one compared to the treatments of 35 % & 50 % ASMD, respectively.

On the other hand, data reported in Table 4 show that straw yield of sole and intercroping wheat gave the highest values under 35 % ASMD treatment in both growing seasons. The differences between 35 % ASMD treatment and the other two treatments (50 and 20 % ASMD) are found to be significant.

TABLE 4. Impact of irrigation regimes and intercropping on straw yield of wheat crop.

% of available soil moisture depletion (ASMD).	1999/2000 Straw yield of wheat crop (ton/fed.) as mean value		2000/2001 Straw yield of wheat crop (ton/fed.) as mean value	
	Intercropping	Sole	Intercropping	Sole
50	3.52 c*	4.88 c	4.40 a	5.41 c
35	4.09 b	5.80 b	4.95 b	6.52 b
20	3.83 a	5.16 a	4.74 c	5.94 a
L.S.D $_{(0.05)}$	0.0309	0.0846	0.0697	0.0568

* Means with the same letters are not significantly different.

Statistical relationships (Table 5) show that there are a significant differences between grain yield of sole wheat and grain yield of intercropped wheat in both studied growing seasons and under the all irrigation regimes. The grain yield of the intercropped wheat is always less than the grain yield of the sole wheat.

TABLE 5. Statistical relationship between grain yield of sole and intercropping wheat under different irrigation regimes.

Crop	1999/2000 % water depletion			2000/2001 % water depletion		
	50	35	20	50	35	20
Sole wheat	2.28 a	2.65 a	2.96 a	2.12 a	2.45 a	2.84 a
Inter. Wheat	1.96 b	2.25 b	2.59 b	1.71 b	1.98 b	2.36 b
L.S.D. (0.05)	0.068	0.075	0.023	0.042	0.089	0.075

* Means with the same letters are not significantly different.

Response of fababean seed yield to irrigation regimes and intercropping

Data in Table 6 indicate that seed yield of sole and intercropping fababean gives the highest response under the medium conditions of the availability of soil water in both studied growing seasons. Therefore, the second irrigation level (35 % ASMD) of soil fababean over yielded the first and the third levels (20 and 50 % ASMD) by 12.6 & 17.5 % in the first season and 5.5 & 22.4 % in the second one, respectively.

TABLE 6. Impact of irrigation regimes and intercropping on the seed yield of fababean crop.

% of available soil moisture depletion (ASMD)	1999/2000 Seed yield of fababean (ton/fed.) as mean value		2000/2001 Seed yield of fababean (ton/fed.) as mean value	
	Intercropping	Sole	Intercropping	Sole
50	0.58 b*	1.04 b	0.64 b	1.28 b
35	0.64 a	1.26 a	0.80 a	1.65 a
20	0.62 ab	1.16 c	0.75 c	1.56 c
L.S.D $_{(0.05)}$	0.042	0.034	0.033	0.060

* Means with the same letters are not significantly different.

The reduction in seed yield with increasing soil moisture stress may be attributed to the decrease in water availability to the plants, which leads to visible retardation in cell division, cell elongation and carbohydrate accumulation (Azab, 1998). Meanwhile, the reduction in seed yield under the highest amounts of available water (20 % ASMD) may be refered to that conditions which push fababean plants to the vegetation growth on the account of flowering.

Data in Table 7 indicated that seed yield of intercropping fababean significantly differ than seed yield of sole fababean in the two growing seasons.

TABLE 7. Statistical relationship between seed yield of sole and intercropping fababean under different irrigation regimes.

Crop	1999/2000 % water depletion			2000/2001 % water depletion		
	50	35	20	50	35	20
Sole wheat	1.04	1.26	1.16	1.28	1.65	1.56
Inter. wheat	0.58	0.64	0.62	0.64	0.80	0.75
L.S.D. (0.05)	0.054	0.047	0.045	0.041	0.103	0.069

Water use efficiency (WUE)

Data presented in Fig. 2 clearly show that the values of water use efficiency (WUE) for sole wheat and intercropping fababean/wheat decrease with increasing soil water depletion. Meanwhile, WUE under sole fababean gives the highest value under 35 % ASMD treatment. On the other hand, the values of WUE for sole fababean are always lower than the values of WUE for sole wheat crop in both studied seasons. This is mainly due to the pronounced decrease in seed yield of fababean crop per unit area as compared to grain yield of sole wheat crop. Also, the values of WUE for intercropped fababean/wheat maize are higher than those of WUE of sole wheat and sole fababean crops in the two studied seasons and under all irrigation regimes. This may be explained by the efficient root distribution of intercropped fababean/wheat in the soil bulk, also to the high density of roots of intercropped fababean/wheat which consume more water and produce high dry matter as compared to a sole wheat or sole fababean.

Land equivalent ratio (LER)

LER is the total land required by a sole crop to produce as much grain yield as from an intercropping system. Data in Table 8 indicate that 30 to 40 % advantage of intercropping fababean with wheat as compared to its sole crops. Consequently, the LER indicates that intercropping resulted in greater productivity per unit of land than monocultures of the intercrop components.

Economical evaluation

Data in Tables 9a & b indicate that the net returns always increase with increasing the available soil water for all cropping systems. This may be due to the high yield productions which occur when soil water is easy to consume by plants. Meanwhile, when the plants consume a lot of energy to get water as the plants expose to water stress, the yield sharply decreases. These results also, clearly indicate that the cubic meter of irrigation water under the intercropping system gives the highest value of cash money as compared to sole crops. These results also illustrate the importance of applying the intercropping systems to get a maximum benefit from the unit-cultivated area.

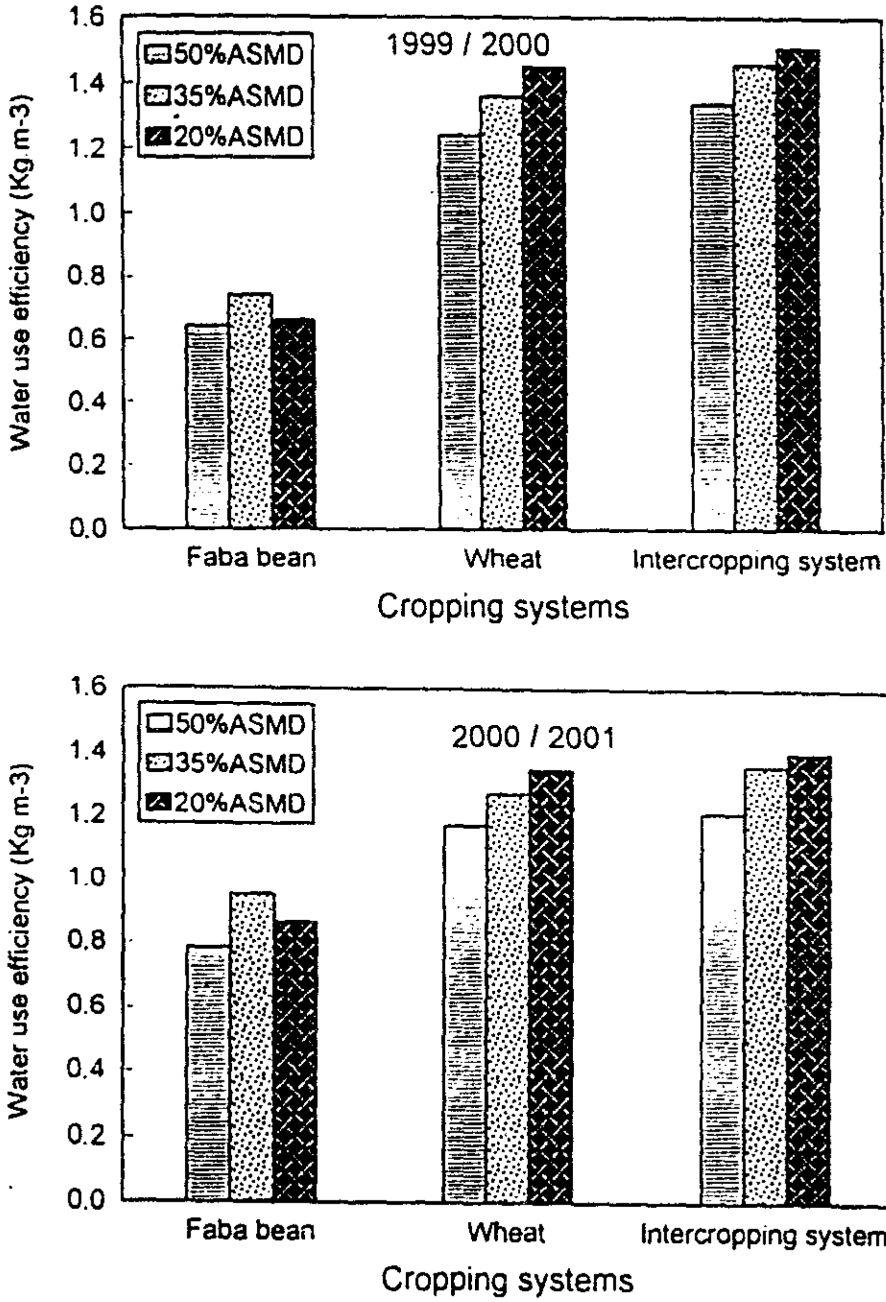

Fig.2. Water use efficiency as influenced by irrigation regimes under different cropping systems .

TABLE 8. Land equivalent ratio (LER) for intercropping fababean / wheat in the two growing seasons.

Irrigation regimes (ASMD)	Yield (ton fed^{-1})				Ratio (LER_w)		Yield (ton fed^{-1})				Ratio (LER_F)		Land equivalent ratio ($LER_w + LER_F$)	
	Intercropped wheat		Sole wheat				Intercropped fababean		Sole fababean					
	Growing season													
	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001	1999/ 2000	2000/ 2001
50 %	1.96	1.71	2.28	2.12	0.86	0.81	0.58	0.64	1.04	1.28	0.56	0.50	1.42	1.31
35 %	2.25	1.98	2.65	2.45	0.85	0.81	0.64	0.80	1.26	1.65	0.51	0.48	1.36	1.29
20 %	2.59	2.36	2.96	2.84	0.88	0.83	0.62	0.75	1.16	1.56	0.53	0.48	1.41	1.31

TABLE 9a. Economical evaluation for different irrigation regimes (growing season 1999-2000) .

Cropping systems and Irrigation regimes	Mean yield (Ton/fed)	Average Farmgate Price L.E.	Main crop Value (Income) L.E.	Straw yield value (ton/fed)	Cost			Total Costs (L.E.)	Net Returns (L.E)	Net returns/ m^3 water L.E.
					Total price of water L.E.	Agricultural operations L.E	Extra cost L.E			
Wheat 20 % ASMD	2.96	685.0	2027.6	825.6	100.1	778.6		878.7	1974.5	0.97
Wheat 35 % ASMD	2.65	685.0	1815.3	928.0	95.3	778.6		873.9	1869.4	0.96
Wheat 50 % ASMD	2.28	685.0	1561.8	780.8	90.3	778.6		868.9	1473.7	0.80
Fababean 20 % ASMD	1.16	1300	1508.0	-	72.4	689.8		762.2	745.8	0.42
Fababean 35 % ASMD	1.26	1300	1638.0	-	70.0	689.8		759.8	878.2	0.51
Fababean 50 % ASMD	1.04	1300	1352	-	67.1	689.8		756.9	662.2	0.40
Int. Wheat 20 % (ASMD)	2.59	685.0	1774.2	612.8			Fababean			
Int. Fababean 20 %	0.62	1300	806.0	-			Seeds			
* Total			2580.2	-	104.4	778.6	(133.2)	1135.9	2057.1	0.97
Int. Wheat 35 % (ASMD)	2.25	685.0	1541.3	654.4			Fertilizers			
Int. Fababean 35 %	0.64	1300	832.0	-			OF			
* Total			2373.3	-	96.8	778.6	Fababean	1128.3	1899.4	0.96
Int. Wheat 50 % (ASMD)	1.96	685.0	1342.6	563.2			119.7			
Int. Fababean 50 %	0.58	1300	754.0	-						
* Total			2096.6	-	92.9	778.6		1124.4	1535.4	0.81

TABLE 9b. Economical evaluation for different irrigation regimes (growing season 2000-2001).

Cropping systems and Irrigation regimes	Mean yield (Ton/fed)	Average Farmgate Price L.E.	Main crop Value (Income) L.E.	Straw yield value (ton/fed)	Cost			Total Costs (L.E.)	Net Returns (L.E)	Net returns/ m^3 water L.E.
					Total price of water L.E.	Agricultural operations L.E	Extra cost L.E			
Wheat 20 % ASMD	2.84	685.0	1945.4	950.4	103.0	778.6		881.6	2014.2	0.96
Wheat 35 % ASMD	2.45	685.0	1678.3	1043.2	94.7	778.6		873.3	1848.2	0.96
Wheat 50 % ASMD	2.12	685.0	1452.2	865.6	89.0	778.6		867.6	1450.2	0.80
Fababean 20 % ASMD	1.56	1300	2028	-	74.3	689.8		764.1	1263.9	0.70
Fababean 35 % ASMD	1.65	1300	2145	-	71.2	689.8		761.0	1384.0	0.80
Fababean 50 % ASMD	1.28	1300	1664	-	67.3	689.8		757.1	906.9	0.55
Int. Wheat 20 % (ASMD)	2.36	685.0	1616.6	758.4			Fababean Seeds (133.2) Fertilizers OF Fababean 119.7			
Int. Fababean 20 %	0.75	1300	975.0	-						
* Total			2591.6		108.9	778.6		1140.4	2209.6	0.99
Int. Wheat 35 % (ASMD)	1.98	685.0	1356.3	792						
Int. Fababean 35 %	0.80	1300	1040.0	-						
* Total			2396.3		100.5	778.6		1132.0	2056.3	1.00
Int. Wheat 50 % (ASMD)	1.71	685.0	1171.4	704						
Int. Fababean 50 %	0.64	1300	832.0	-						
* Total			2003.4		95.4	778.6		1126.9	1580.5	0.81

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دراسات عن الإحتياجات المائية لمحصولى القمح والفول البلدى تحت أنظمة زراعة مختلفة

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أجريت دراسة حقلية فى محطة التجارب الزراعية بكلية الزراعة – جامعة القاهرة خلال الموسم الصيفى لعامى ١٩٩٩/٢٠٠٠ ، ٢٠٠٠/٢٠٠١ بغـرض:-

أ . التعرف على الإحتياجات المائية لمحصولى القمح والفول البلدى منفردين أو فى حالة تحميل الفول البلدى على القمح.

ب. دراسة تأثير معدلات مختلفة من مياه الرى على كل من الإحتياجات المائية ، كمية المحصول ، كفاءة إستخدام المياه ، معامل إستخدام الأرض.

ج. تقييم العائد الإقتصادى لنظام تحميل الفول البلدى مع القمح.

ولتحقيق ذلك صممت تجربة حقلية بنظام القطع المنشقة ، تشتمل على أربع مكررات حيث وضعت معاملات الرى المختلفة (الرى بعد إستنفاذ ٢٠٪ ، ٣٥٪ ، ٥٠٪ من الماء الميسر فى التربة) فى القطع الرئيسية ، بينما وضعت أنظمة الزراعة المختلفة (قمح منفرد ، فول بلدى منفرد ، فول بلدى محمل على قمح) فى القطع تحت الرئيسية.

أضيفت مياه الرى إلى كل القطع التجريبية بإستخدام نظام Gated pipe ، وتم تتبع التغير فى نسبة الرطوبة فى الطبقة السطحية (٠ – ٢٠ سم) بإستخدام الطريقة الوزنية Gravimetric وبإستخدام جهاز تشتت النيوترونات Neutron scattering فى الطبقتين الثانية (٢٠ – ٤٠ سم) والثالثة (٤٠ – ٦٠ سم).

ويمكن تلخيص النتائج المتحصل عليها فيما يلـــى:-

١- أظهرت قيم الإحتياجات المائية (IRc) للقمح المنفرد أو الفول البلدى المحمل على القمح ، وكذلك الفول البلدى المنفرد والمحسوبة بإستخدام معادلة بلانى – كريدل زيادة تقدر بحوالى ١,٩٥ ، ١,٩١ مرة عن القيم المحسوبة بإستخدام معادلتى بينمان – مونتيث وإناء البخر على التوالى.

٢- أعلى قيم للإحتياجات المائية الفعلية (IRa) سجلت فى معاملة زراعة الفول البلدى المحمل على القمح يليه القمح المنفرد ثم الفول البلدى المنفرد وكذلك فى المعاملة التى تروى بعد إستنفاذ ٢٠٪ من الماء الميسر ، يليها معامل ٣٥٪ ثم معاملة ٥٠٪.

٣- إتضح أن قيم الإحتياجات المائية الفعلية (IRa) تحت كل نظم الزراعة وكذلك معاملات الرى المختلفة تحت الدراسة كانت أقل من قيم IRc بفروق متباينة ، ولقد سجل أعلى فرق بين الإحتياجات المائية الفعلية والمحسوبة فى حالة معادلة بلانى – كريدل ، يليها معامل بينمان – مونتيث ثم معادلة وعاء البخر والتى كانت قيمتها متقاربة إلى حد بعيد.

٤- أوضحت النتائج وجود فروق معنوية فى كمية المحصول تحت نظم الزراعة المدروسة مع زيادة النقص فى الماء الميسر للنبات.

٥- سجلت معامل الرى عند إستنفاذ ٢٠٪ من الماء الميسر أعلى كفاءة استخدام للمياه فى حالة القمح المنفرد والمحمل تليها معاملة الرى ٣٥٪ ثم ٥٠٪ أما فى حالة الفول البلدى المنفرد فكانت أعلى معاملة هى ٣٥٪ تليها ٢٠٪ ثم ٥٠٪ على الترتيب. أما بالنسبة لنظم الزراعة فكانت كفاءة استخدام مياه الرى على النحو التالى الفول البلدى محمل على قمح منفرد ، الفول البلدى منفرد.

٦- أثبتت النتائج أن المتر المكعب من المياه المستخدمة فى الزراعة تحت نظام التحميل (فول بلدى / قمح) أعطى أعلى عائد نقدى مقارنة بالزراعات المنفردة لكل من المحصولين خاصة فى الموسم الزراعى الثانى تحت معاملة رى ٣٥٪ يليها ٢٠٪ (ASMD) ثم ٥٠٪ التى أعطت أقل عائد نقدى لوحدة المياه.