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IMPACT OF NUMBER OF IRRIGATIONS AND AMOUNT OF WATER APPLIED ON PRODUCTIVITY AND WATER USE OF EGYPTIAN CLOVER.

Kassab, M. M.; I. A. El-Saiad and M. A. M. Ibraim
Soils, Water & Environment Res. Inst., Agric. Res. Center, Egypt

ABSTRACT

A field trial was carried out at Sakha Agricultural Research Station, Kafr el-Sheikh Governorate during the two successive winter seasons 2008/2009 and 2009/2010. The main targets for this present work were to study the influence of number of irrigations during each crop cut and amount of applied water on productivity of Egyptian clover (Berseem) as well as some water relations. Number of irrigations were; A- one irrigation during each cut, B- two irrigations through each cut. While, applied irrigation water was based on:

1. Irrigation according to soil moisture depletion (S.M.D) method.
2. Irrigation by using Ibrahim equation (ETp = 0.1642 + 0.8 EP)
3. Irrigation till 5.0 cm as water depth above soil surface (control).

The obtained data can be summarized as follows:

Both fresh and dry yields were increased by increasing number of irrigations during each two successive seasons. The mean values of the two seasons were 34.13 and 38.47 under one and two irrigations between cuts, respectively. Regarding applied water, the highest fresh yield was recorded under irrigation till 5.0 cm above soil surface more over dry yield has the same trend as the fresh yield but with less values.

Regarding water- utilization and use efficiencies, the high values were obtained under giving one irrigation through each cut. The highest values were 22.10 and 23.83 kg/m^3 at giving one irrigation for water utilization and use efficiencies, respectively.. Concerning the effect of applied water, the highest mean values for both efficiencies were recorded under irrigation after using Ibrahim's equation.

The highest mean values of amount of applied water were recorded under giving two irrigations through each cut comparing with giving one irrigation in the two growing seasons. Irrigation till water depth 5.0 cm above the soil surface (control) gave the highest values for amount of applied water. The same trend was recorded regarding consumptive use in the two growing seasons.

INTRODUCTION

The shortage of water in Egypt continuously increases as a result of the fixed water share of Egypt and the rapid increase in water demand. Irrigation uses more than 85% of the total renewable water supply in Egypt. So, tremendous efforts should be implemented in this sector to rationalize water at the national level. One of the most effective ways for irrigation management at the farm level is to determine precisely the actual irrigation water which should be applied to meet the needs of the growing plants Water excessives as well as insufficient irrigation results in decreasing crop yield. Egyptian clover (*Trifolium alexandrinum* L.) is one of the main forage crops in Egypt. The national cultivated area of berseem is above 2.5 million feddan. Increasing its production is important to meet the nutritional

requirements of animal in winter and summer season as fresh forage and hay or silage, respectively.

The impact of irrigation on berseem as seasonal crop and alfalfa as perennial one was investigated by several researchers either in Egypt or worldwide. Mahrous *et al.* (1984) indicated that to obtain optimum yield of clover, available soil moisture should be maintained between 40-60% depletion of available soil moisture. Also, they found that water consumptive use values at Sakha were 66.62, 59.13, 51.49 and 39.78 cm, respectively for wet, moist, medium and dry soil moisture levels, respectively. Water use efficiency had decreased as the soil moisture was maintained at high level by the frequent irrigations. In Kafr El-Sheikh Governorate, North Nile Delta, Ibrahim *et al.* (1988) found that the percentages of water shortage varies between 3.61% in September to 39.51% in June. Abbas *et al.* (1995) and Abd El-Hafez *et al.* (1997) concluded that the optimum yield of clover significantly increased when three irrigations between cuttings were applied. El-Bably (2002) found that three irrigation events between cuttings significantly increased fresh and dry yields. On the other hand, it decreased water use efficiency. He also indicated that water consumed values were 59.52, 48.98 and 37.98 cm, over both seasons, for three, two and one irrigation between cuttings, respectively. Kassab (2006) found that dry cultivation is an effective method of irrigation for Egyptian clover in North Middle Nile Delta region due to saving amount of irrigation water applied. In addition, increasing water utilization efficiency under the conditions of dry cultivation in comparison with wet cultivation method.

The main objective of this investigation was to assess the effect of number of irrigations and amount of applied irrigation water on yield of Egyptian clover (berseem) and some water relations.

MATERIALS AND METHODS

A field trial was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during the two successive winter seasons 2008/09 and 2009/10. This trial aimed to study the effect of number of irrigations between each two cuts and amount of water applied on yield of Egyptian clover (Berseem) in the soil North Middle Nile Delta region as well some water relations. Some physical characteristics of the experimental site are shown in Table(1).

Table (1): Some physical characteristics of the studied soils before cultivating the crop.

Soil depth (cm)	Physical characteristics								
	Particle size distribution %			Texture class	Bulk density Mg/m^3	Total porosity %	Field capacity %	PWP %	A.W %
	Sand	Silt	Clay						
0-15	12.3	33.3	54.4	Clay	1.26	52.45	47.50	25.69	21.81
15-30	20.2	34.2	45.6	Clay	1.30	50.94	39.87	21.66	18.21
30-45	20.4	41.4	38.2	Clay loam	1.29	51.32	38.40	20.86	17.54
45-60	21.1	41.5	37.4	Clay loam	1.38	47.92	36.39	19.78	16.61
Mean	18.5	37.6	43.92		1.31	50.66	40.54	22.00	18.51

PWP = Permanent wilting point, AW = Available water, Mg = Mega gram (10^6 g)

Dates of sowing and cuttings in the two seasons are presented in Table (2).

Table (2): Dates of sowing and cuttings of Egyptian clover (berseem) in the two growing seasons.

Parameter	First season (2008/09)	Second season (2009/10)
Sowing	15/10/2008	21/10/2009
First cut	3/1/2009	6/1/2010
Second cut	17/2/2009	20/2/2010
Third cut	3/4/2009	7/4/2010
Fourth cut	4/5/2009	12/5/2010

Experimental Design and Treatments:

The experimental design was a split plot with three replicates involving two factors i.e. number of irrigations and amounts of irrigation water applied. Main plots (plot area = 52.5 m^2)were assigned to number of irrigations as; (A) "one irrigation" for each cut and (B) "two irrigations" between cuts. The subplots were assigned to the amount of applied irrigation which based on three methods for calculating water applied as follows:

1. Soil moisture depletion (SMD) method:

Amount of irrigation water was determined as amount of water needed to raise the moisture content before each irrigation to field capacity (FC). This method is defined as the direct method in computing applied irrigation water (Hansen, et al., 1979), SMD was determined from the following equation:

$$SMD = \frac{FC - \theta}{100} \times Db \times d \times A$$

Where:

SMD = Soil moisture depletion in the effective root zone

θ = Soil moisture percentage before irrigation on weight basis.

Db = Soil bulk density, Mg/m^3.

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

A = Irrigated area, m^2

Fc = Field capacity

2. Ibrahim equation (1981)

Irrigation water applied was calculated using Ibrahim's equation:

$$ETp = 0.1642 + 0.8\ EP$$

Where:

ETp = Potential evapotranspiration, cm/day

Ep = Evaporation Pan, cm/day

Therefore, irrigation water was equaled the crop evapotranspiration (ETc) which was computed as follows:

$$ETa = ETp \times Kc$$

Where:

ETa = Actual evapotranspiration (cm/day)

Kc = Crop coefficient

Values of Kc were taken from FAO irrigation and Drainage No. 56, 1998.

It is useful to mentioned here that irrigation water (I.W) was equaled, the water consumed by the growing plants (S.M.D. sub treatment) and ET_a.

The reason that I.W equaled ET_a that the field trial was conducted at crops water requirements research field which designed specifically to carry on such studies i.e. minimizing the water leaching requirement was negligible due to the high quality of irrigation water.

3. Convenient irrigation (control)

Irrigation till the water reaches 5.0 cm above the soil surface

Data collections:

1. Irrigation water (IW)

The feeder canal received the water from a branch where a measuring weir was fixed upstream with a discharge rate of 0.01654 m^3/sec. at 10 cm as effective head over the fixed rectangular weir crest.

2. Consumptive use (CU)

To compute the actual consumed water of the growing plants, soil moisture percentage was determined gravimetrically on weight basis before and after each irrigation as well at harvesting. Soil samples were taken from the successive layers of the effective root zone; 0-15, 15-30, 30-45 and 45-60 cm, respectively. This method of computation is considered as one of the direct methods of water consumptive use determination which is based on soil moisture depletion (SMD) or so-called crop water consumed (CU) as stated by Hansen, et al., (1979).

$$SMD \cong CU = \frac{\theta_2 - \theta_1}{100} \text{ x Db x d x A } (m^3 / \text{fed.})$$

Where:

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

CU = Consumptive use of the growing plants, m^3/fed.

θ_1 = Soil moisture percentage (w/w) before irrigation for the 60 cm soil depth.

θ_2 = Soil moisture percentage (w/w) for the 60 cm soil depth, 48 hrs after the preceding irrigation.

Db = Mean soil bulk density, Mg/m^3 for the 60 cm soil depth.

d = Effective root zone of 60 cm.

A = Irrigation area, m^2.

Crop yield

Fresh and dry crop yields were determined for each treatment. The obtained data of crop yield for each cut as well as the seasonal yield was subjected to statistical analysis according to Snedecor and Cochran (1967).

Crop water efficiency

Crop water efficiencies is a parameter to assess the efficiency exerted by crops in producing yields from water provided for plant. The crop water use efficiency (CWUE) indicates the amount of yield given by a unit volume of water consumed by plant. The water utilization efficiency (WUtE) or crop water productivity indicates the amount of yield given by a unit volume of water applied for plant in field.

Crop water efficiency was calculated as follows (Doorenbos and Pruit, 1975).

$$WUtE = \frac{Yield\,(kg/fed)}{Water\ applied\,(m^3/fed)}$$

$$WUE = \frac{Yield\ (kg/fed)}{Water\ consumed\ by\ crop\ (m^3/fed)}$$

Where:
WUtE = Water utilization efficiency (kg/m^3) and
CWUE = Crop water use efficiency (kg/m^3)

Normal cultural practices implemented by the local farmers in the studied region were performed apart from the two investigated factors.

RESULTS AND DISCUSSION

Fresh and dry yield of Egyptian clover:

Data presented in Tables (3 & 4) clearly show that number of irrigations between cuts and amount of water applied have a significant effect on fresh and dry yield of Egyptian clover. Data illustrated that giving two irrigations for each cut gave the highest fresh yield in the two growing seasons comparing with giving one irrigation between cuts. The highest mean seasonal values are 33.8, 34.46 and 38.07 and 38.87 ton/fed. under one irrigation and two irrigations during each cut in the first and second growing seasons, respectively.

Table (3): Fresh yield of Egyptian clover (ton / fed.)as affected by irrigation treatments in the two growing seasons.

Cut No.	Date of cut	One irrigation (A)			Two irrigations (B)		
		A_1	A_2	A_3	B_1	B_2	B_3
First season (2008/09)							
1	3/1/2009	6.87 c	6.53 c	7.07 d	7.40 d	7.47 d	7.47 d
2	17/2/2009	8.20 b	7.73 b	8.33 b	9.13 b	9.00 b	9.27 b
3	3/4/2009	10.73 a	10.13 a	10.67 a	12.33 a	12.13 a	12.60 a
4	4/5/2009	7.87 b	7.67 b	7.73 c	8.67 c	8.73 b	8.73 c
Seasonal yield		33.67	32.06	33.80	37.53	37.33	38.07
Comparison			SED		LSD 5%		LSD 1%
2-B means at each c * s			0.23		0.51		0.72
2-C means at each b * s			0.20		0.43		0.60
2-S means at each c * B			0.18		0.36		0.48
Second season (2009/10)							
1	6/1/2010	6.53 c	6.27 c	7.13 d	7.60 c	7.53 c	7.27 d
2	20/2/2010	8.33 b	7.87 b	8.67 b	9.20 b	9.13 b	9.60 b
3	7/4/2010	10.93 a	10.80 a	10.73 a	12.73 a	12.67 a	12.93 a
4	12/5/2010	7.93 b	7.80 b	7.93 c	8.87 b	8.87 b	9.07 c
Seasonal yield		33.72	32.74	34.46	38.4	38.2	38.87
Comparison			SED		LSD 5%		LSD 1%
2-B means at each c * s			0.20		0.42		0.59
2-C means at each b * s			0.19		0.41		0.58
2-S means at each c * B			0.19		0.38		0.52
Average		33.69	32.40	34.13	37.96	37.76	38.47

Irrigation treatments are as follows:
1: SMD (soil moisture depletion method)
2: Ibrahim (ETp = 0.1642 + 0.8 Ep)
3: Control (irrigation till 5.0 cm water above soil surface)

Also data in the same tables clearly indicated that amount of irrigation water applied has a high significant effect on fresh and dry yields of Egyptian clover. The highest mean values for fresh yield are recorded under irrigation till 5.0 cm water above soil surface in the two growing seasons. The same trend was observed regarding dry yield. Meaningfully, the highest mean values were recorded under giving two irrigations in each cut and irrigation with depth till 5.0 cm above soil surface. This finding might be due to such moisture content obtained from the referred treatment (B_3) is suitable for good and healthy plant growth which resulting in high yield. These results are in a great harmony with those obtained by Abbas *et al.* (1995) who indicated that the low yield of Egyptian clover was associated with low levels of soil moisture.

Table (4): Dry forage yield of Egyptian clover (ton/fed.) as affected by irrigation treatments in the two growing seasons.

Cut	Date of cut	One irrigation			Two irrigations		
		A_1	A_2	A_3	B_1	B_2	B_3
First season							
1	3/1/2009	1.04 d	1.03 d	1.05 d	1.14 c	1.23 d	1.32 c
2	17/2/2009	1.28 c	1.31 c	1.36 c	1.74 b	1.81 c	1.88 b
3	3/4/2009	1.66 a	1.69 a	1.81 a	1.94 a	1.98 a	2.14 a
4	4/5/2009	1.55 b	1.60 b	1.65 b	1.87 a	1.90 b	1.96 b
Seasonal yield		5.53	5.63	5.87	6.69	6.92	7.30
Comparison			SED		LSD 5%		LSD 1%
2-B means at each c * s			0.04		0.08		0.11
2-C means at each b * s			0.04		0.08		0.11
2-S means at each c * b			0.03		0.07		0.09
Second season							
1	6/1/2010	1.09 d	1.08 d	1.10 d	1.22 c	1.28 d	1.35 c
2	20/2/2010	1.31 c	1.33 c	1.39 c	1.79 b	1.84 c	1.90 b
3	7/4/2010	1.70 a	1.73 a	1.76 a	1.98 a	2.03 a	2.15 a
4	12/5/2010	1.58 b	1.63 b	1.66 b	1.92 a	1.94 b	1.97 b
Seasonal yield		5.68	5.77	5.91	6.91	7.09	7.37
Comparison			SED		LSD 5%		LSD 1%
2-B means at each c * s			0.03		0.07		0.10
2-C means at each b * s			0.03		0.07		0.10
2-S means at each c * b			0.03		0.06		0.07
Average		5.60	5.70	5.89	6.80	7.00	7.33

Irrigation treatments are as follows:
1: SMD (soil moisture depletion method)
2: Ibrahim (ETp = 0.1642 + 0.8 Ep)
3: Control (irrigation till 5.0 cm water above soil surface)

Water applied (WA)

Water received by the Egyptian clover (Berseem) constitutes of two sources; irrigation water (IW) and rainfall (RF) as shown in Table (5) and illustrated in Fig. (1) . The average values of IW over both seasons are 1561.89, 1480.12 and 1602.05 m^3/fed. obtained from treatments; A_1, A_2 and A_3, respectively. The results in the same Table clearly showed that A_2 treatment received the lowest value (1480.12 m^3/fed). and the highest value

(1602.05 m^3/fed) was recorded under A_3 treatment. The corresponding lowest and highest values under two irrigations are 2365.51 and 2476.19 m^3/fed. for B_2 and B_3, respectively. Therefore, giving one irrigation through each cut is associated with the lower amounts of applied irrigation water and vice versa regarding the two irrigations in each cut. It is preferable to notify that number of irrigations (IW) is nine and five under two and one irrigation between cuts, respectively. These numbers are including the cultivation one.

Table (5): Seasonal water applied irrigation water (IW) and rainfall (RF) for different irrigation treatments

Treatment	One irrigation (A)			Two irrigations (B)		
	A_1	A_2	A_3	B_1	B_2	B_3
First season (2008/09)						
IW; m^3/fed	1590.15	1499.05	1581.18	2481.18	2315.91	2440.62
IW, cm	37.86	35.69	37.65	59.07	55.14	58.11
RF, m^3/fed	142.8					
(mm)	34.0					
Second season (2009/10)						
IW; m^3/fed	1533.64	1461.19	1622.91	2366.73	2415.11	2511.76
IW, cm	36.52	34.79	39.64	56.35	57.50	59.80
RF, m^3/fed	162.96					
(mm)	38.8					
Means of the two seasons						
IW; m^3/fed	1561.89	1480.12	1602.05	2423.96	2365.51	2476.19
IW, cm	37.19	35.24	38.14	57.71	56.32	58.96
RF, m^3/fed	152.9					
(mm)	36.4					

Irrigation treatments are as follows:
1: SMD (soil moisture depletion method)
2: Ibrahim (ETp = 0.1642 + 0.8 Ep)
3: Control (irrigation till 5.0 cm water above soil surface)

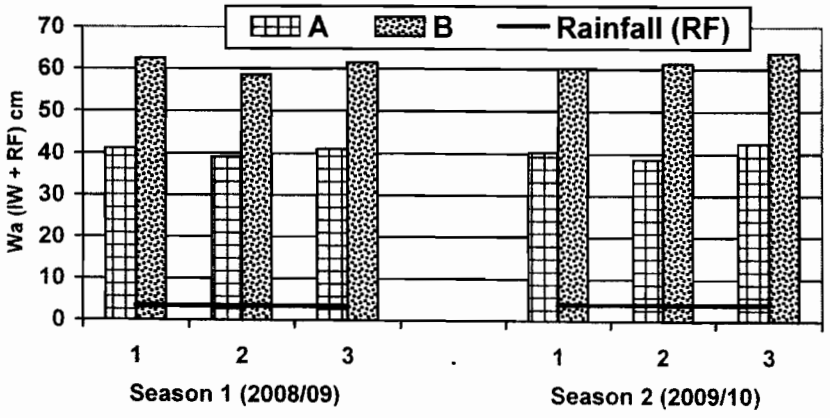

Fig. 1: Water applied (IW + RF) as affected by different number of irrigations (A & B) and irrigation treatment (1, 2, 3).

The values of seasonal rainfall was 34.00 and 38.8 mm during the first and the second growing seasons, respectively. Therefore, the mean seasonal water applied equal 1714.79, 1633.00 and 1754.95 m^3/fed. for giving one irrigation in each cut of A_1, A_2 and A_3, treatments, respectively and 2576.86, 2518.41 and 2629.09 m^3/fed for giving two irrigations in each cut of B_1, B_2 and B_3 treatments, respectively. In general, as illustrated in Fig. (2), under one irrigation between each cut, water applied consists of 91.01% as irrigation and 8.99% as rainfall. While, the corresponding percentages under two waterings between cuts are 94.06% and 5.94%.

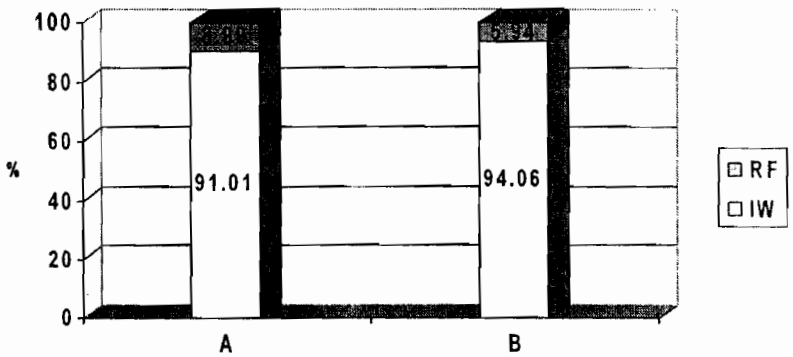

Fig. (2): Percentage of water applied (WA), irrigation water (IW) and rainfall (RF) under different waterings of each cut.

Crop water consumptive use (CU):

Seasonal crop water consumptive use (CU) or ETc was computed on the basis of water depletion from the effective root zone of the upper 60 cm soil depth. Values of seasonal (CU) and their rates for Egyptian clover (Berseem) resulted from different irrigation treatments are presented in Table (6). It is obvious that the consumptive use increased in the same line with increasing the applied water or increasing the number of irrigations in each cut. The mean value of CU for the two growing seasons under one irrigation/cut are 34.01, 32.69 and 35.46 cm for A_1, A_2 and A_3, treatments, respectively. The corresponding values for giving two irrigations in each cut are 53.69, 52.99 and 55.53cm for B_1, B_2 and B_3, treatments, respectively.

Table (6): Seasonal consumptive use (CU, cm) and its rates (mm/day) as affected by the different irrigation treatments

Treatment	One irrigation (A)			Two irrigations (B)		
	A_1	A_2	A_3	B_1	B_2	B_3
First season (2008/09)						
CU, cm	34.81	32.10	36.77	55.23	53.27	54.15
CU rate (mm/day)	1.9	1.7	2.0	3.0	2.9	2.9
Second season (2009/10)						
CU, cm	33.20	33.27	34.15	52.15	52.71	56.91
CU rate (mm/day)	1.7	1.7	1.8	2.7	2.7	3.0
Means of the two seasons						
CU, cm	34.01	32.69	35.46	53.69	52.99	55.53
CU rate (mm/day)	1.8	1.7	1.9	2.8	2.8	2.9

Regarding rate of CU, it is obvious from the same Table (6) that the seasonal rate of CU under giving one irrigation in each cut are 1.8, 1.7 and 1.9 mm/day for A_1, A_2 and A_3, treatments, respectively. The corresponding values under giving two irrigations in each cut are 2.8, 2.8 and 2.9 mm/day for B_1, B_2 and B_3, treatments, respectively.

Crop water efficiency:

Water utilization efficiency (WUtE)

Water utilization efficiency (WUtE) determines the capability of the plants to convert the water applied into marketable yield. Data presented in Table (7) illustrated that the mean values of (WUtE) have clearly affected by the studied parameters i.e. number of irrigations between cuttings and amount of water applied. As shown in Table (7), the mean values of WUtE are higher under giving one irrigation for each cut comparing with giving two irrigations. The highest mean value was 22.10 kg/m^3 and the lowest mean value was 15.53 kg/m^3 obtained under giving one and two irrigations in each cut, respectively. Data also indicated that the values of WUtE are affected by amount of applied irrigation water. The highest mean values resulted under giving one or two irrigations are obtained when water applied was calculated by using Ibrahim's equation which represents the conditions of the studied region. Increasing mean values of WUtE under giving one irrigation in each cut comparing with giving two irrigations might be due to the high amount of applied water for the two irrigations. The amount of applied water is the dominator in computing WUtE. These results are in a great harmony with those obtained by Osman *et al.* (1999).

Table (7): Water utilization efficiency (WUtE) or crop-water productivity for Egyptian clover as affected by different irrigation treatments in the two growing seasons

	WUtE (kg/m^3)					
	One/each cut			Twice/each cut		
	A_1	A_2	A_3	B_1	B_2	B_3
Season 1 (2008/09)	21.17	21.79	21.38	15.13	16.12	15.60
Season 2 (2009/10)	21.99	22.41	21.23	16.22	15.82	15.47
Mean	21.58	22.10	21.30	15.67	15.97	15.53

Crop water use efficiency (WUE)

As clearly shown in Table (8), data illustrated that the two studied parameters of number of irrigations and amount of water applied have affected the crop water use efficiency (CWUE). The highest seasonal mean values in the two growing seasons are recorded under giving one irrigation in each cut. The highest mean value was 23.83 kg/m^3 and the lowest one was 16.50 kg/m^3, for one and two irrigations, respectively. Concerning with the amount of water applied, the highest mean value under giving one and two irrigations in each cut were recorded under using Ibrahim"s formula and the mean values are 23.83 and 16.97 kg/m^3, respectively.

This trend could be attributed to the direct effect of the less consumed water. This conclusion is more closely with that obtained by several researchers such as; Joy and Dobrenz. (1971) and Delaney *et al.* (1978), they reported that (CWUE) was greater under low than under high water regimes

Table (8): Crop water use efficiency (CWUE) for Egyptian clover as affected by the different irrigation treatments in the two growing seasons

	WUE (kg/m^3)					
	One/each cut			Twice/each cut		
	A_1	A_2	A_3	B_1	B_2	B_3
Season 1 (2008/09)	23.03	24.22	21.89	16.18	16.68	16.73
Season 2 (2009/10)	24.18	23.43	24.03	17.53	17.26	16.26
Mean of two seasons	23.60	23.83	22.96	16.86	16.97	16.50

COCLUSSION

It could be concluded that by giving two irrigations between berseem cuts and irrigation based on Ibrahim's equation gave nearly the highest yield as well as crop water productivity i.e. crop yield per unit of applied water and consumed water.

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تأثير عدد الريات وكمية المياه المضافة علـــى إنتاجيـــة البرســـيم وكـــذا العائـــد المحصولى من وحدة المياه المضافة

ماهر محمد كساب ، إبراهيم عباس الصياد و محمد عبد الفتاح محمد ابراهيم
معهد بحوث الاراضى والمياه والبيئة ، مركز البحوث الزراعية

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا ــ محافظة كفرالشيخ خلال موسمى الدراسة ٢٠٠٨/٢٠٠٩م و ٢٠٠٩/٢٠١٠م. هذه الدراسة تهدف إلى دراسة تأثير عدد الريات وكمية الماء المضاف على إنتاجية البرسيم المصرى وبعض العلاقات المائية. وكانت معاملات الرى:

أ- اعطاء رية كل حشة.
ب- اعطاء ريتين كل حشة أما بالنسبه لكميات المياه المضافة فكانت:
١- رى حسب الاستنفاذ الرطوبي(إضافة المياه حتي السعة الحقلية).
٢- الري حسب كمية المياه المضافة حسب معادلة إبراهيم.
٣ - الرى بعمق ٥سم (المقارنة).

أهم النتائج يمكن تلخيصها كما يلى:

بالنسبه للمحصول الطازج والجاف زادت القيم بزيادة عدد الريات لكل حشة حيث سجلت **أعلى القيم** عند اعطاء ريتين لكل حشة والقيم كانت بالنسبه للمحصول الطازج ٣٣.٨ ، ٣٤.٤٦ ، ٣٨.٠٧ ، ٣٨.٨٧ طن/فدان تحت اعطاء رية وريتين بكل حشة فى الموسم الأول والثانى على الترتيب. **بالنسبه لتأثير كمية** المياه المضافة سجلت أعلى القيم تحت الرى لعمق ٥سم نفس الاتجاه تم ملاحظته بالنسبه للمحصول الجاف ولكن القيم أقل.

بالنسبة لكفاءات استخدام مياه الري (مستوي الحقل والمحصول) **قد** زادت **قيمهم** تحت اعطاء رية لكل حشة مقارنة باعطاء ريتين وأعلى القيم كانت: ٢٢.١٠ ، ٢٣.٨٣ كجم/م^{٣} فى حالة اعطاء رية كل حشة بالنسبه لمستوي الحقل والمحصول على الترتيب. أما بالنسبه لتأثير كميات المياه المضافة على الكفاءات سجلت أعلى القيم تحت معاملة الرى باستخدام معادلة إبراهيم والتي تناسب ظروف المنطقة.

بالنسبه لكمية المياه المضافة سجلت أعلى القيم تحت اعطاء ريتين لكل حشة بالمقارنة باعطاء رية واحدة فى كلا موسمى الدراسة ٢ الرى حتى عمق ٥سم فوق سطح التربة أعطى أعلى القيم بالنسبه لكمية المياه المضافة. نفس الاتجاه تم ملاحظته بالنسبه لقيم الاستهلاك المائى فى كلا موسمى الدراسة.

قام بتحكيم البحث

أ.د / السيد محمود الحديدى — **كلية الزراعة – جامعة المنصورة**
أ.د / محمد ابراهيم مليحه — **مركز بحوث الصحراء**