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أثر كلا من طرق الزراعة ومستويات الري على إنتاجية البرسيم فى شمال دلتا النيل

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الملخص العربي

أقيمت تجربتان حقليتان فى المزرعة البحثية بمحطة البحوث الزراعية بسخا . محافظة كفرالشيخ بمنطقة شمال دلتا النيل خلال موسمي ٢٠٠٩/٢٠١٠ ، ٢٠١٠/٢٠١١ بهدف ترشيد مياه الري للبرسيم من خلال تحديد طريقة الزراعة المثلى وكذا تحديد مستويات الري الواجب الري عندها حيث خضعت ثلاث طرق زراعة لكميات مختلفة من ماء الري والتى حسبت على أساس الري حتى ٥ سم فوق سطح التربة (الكنترول او المعتاد فى المنطقة) و ١٠٠% . ٨٠% . ٦٠% من معادلة ابراهيم.

وقد أوضحت النتائج أن:

١- الزراعة الجافة (بذرة جافة في أرض جافة) ونصف جافة (بذرة مبتلة فى أرض جافة) حققتا الآتى: الوفر فى مياه الرى بقيمة متوسطة ١٦٠ م٣/فدان أو ٤٠١ مليون متر مكعب على المستوى القومى وذلك مقارنة بالزراعة التقليدية (المبتلة او ما يسمى باللمعة اى بذرة مبتلة فى أرض مبتلة).

٢- تقريبا نفس المحصول قد تحصل عليه تحت الزراعة الجافة ونصف جافة مثلما هو فى الزراعة المبتلة او التقليدية.

٣- العائد المحصولى من وحدة المياه المضافة (WUtE) كان ١٩.٣٣ ، ١٩.٩٨ كجم/م^3 لطريقتى الزراعة الجافة ونصف الجافة على الترتيب بينما العائد المحصولى من وحدة المياه المستهلكة (WUE) للطريقتين هما ٢٠.٠٦ ، ١٩.٧٤ كجم/م^3 على الترتيب. فى حين أن العائد المحصول من وحدة المياه المضافة والمستهلكة تحت الزراعة المبتلة هما ١٨.٦٨ ، ١٨.٤٧ كجم/م^3 على الترتيب.

EFFECT OF CULTIVATION METHOD AND IRRIGATION RATE ON PRODUCTIVITY AND WATER EFFECINCY OF BERSEEM CROP-GROWN IN NORTH NILE DELTA

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ABSTRACT: *Two field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, North Nile Delta region during the two growing seasons of 2009/10 and 2010/11. The main target of the study was to find out the proper cultivation method and the irrigation level as two ways towards effective management of berseem watering. The adopted treatments were assessed in factorial, split plot design with three replicates where the main plots were assigned to the cultivation methods as A- dry seed on dry soil B- soaked seed on dry soil and C- traditional (wet seed on wet soil) . The sub plots were occupied by four different irrigation regimes as follows :*

1. *Convenient irrigation (control) i.e. irrigation till the water level reaches 5.0 cm above soil surface.*
2. *Irrigation according to Ibrahim equation(1981) as follows*

ETp = 0.1642 + 0.8 EP …… where

ETp = Potential evapotranspiration, cm and
Ep = Pan evaporation,cmday^{-1}

3. *Irrigation with 0.8 of Ibrahim equation,*
4. *Irrigation with 0.6 of Ibrahim equation.*

The main findings could be summarized as follows:

1. *Saving irrigation water of an amount of about 169.2 m^3/fed. and 151.2 m^3/fed for dry and semi-dry cultivation methods or 423 and 378 million m^3 at the national level, respectively comparing with the wet or the traditional cultivation method.*
2. *Almost the same yield was produced under the three cultivation methods. The average values were 32.81, 34.01and 34.62 ton/fed for dry, semi-dry and the common cultivation, respectively.*
3. *Higher values of yield per unit applied water (WUtE) as well as consumed water (WUE) averaging 15.52, 15.68 kg/m^3 and 20.06, 19.74 kg/m^3 for dry and semi-dry cultivation, respectively comparing with 15.07 kg/m^3 applied and 18.47 kg/m^3 consumed, respectively under the wet or the common cultivation method.*

Key words : *Trifolium alexandrinum, water use efficiency, irrigation rate, cultivation method*

INTRODUCTION

Water is the most important factor in crop production in Egypt. The shortage of water in Egypt continuously increase 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 in Egypt. So, great 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 growing plants.

Water excessive as well as insufficient irrigation practice results in decreasing crop yield and water utilization efficiency. Egyptian clover (*Trifolium alexandrinum* L.) (berseem) is the main winter forage crops in Egypt due to its large occupied area is above 2.5 million feddan (1 feddan = 4200 m^2) or one third of the winter cropped land as well as it considered as the main animal feeder during the winter. The traditional method of cultivation berseem is the wet one which is namely "El-Lamaa" as to apply excess water before sowing then broadcast the seeds over the wet glistening surface of the soil.

The berseem irrigation parameters were studied widely in Egypt and worldwide. Mahrous *et al*. (1984) found that the average values of clover consumption use at Sakh, Egypt were 66.62, 59.13, 51.49 and 39.78 cm for wet, moist, medium and dry soil moisture levels, respectively. Abbas *et al*. (1995) studied the effect of the planting method and the irrigation management (one, two and three irrigations between cuttings) on fresh and dry yield of berseem. The results revealed that the optimum yield was obtained from the two methods of planting, i.e. the El-Lamaa method and the dry method with three irrigation between cuttings. In addition, El-Bably (2002) revealed that three irrigation events between cuttings significantly increased fresh and dry yields, however, it decreased water use efficiency. The author indicated that water consumed values were 59.62, 48.98 and 37.98 cm, over both seasons, for three, two and one irrigation between cuttings treatments, respectively. Moreover, Kassab (2006) found that dry cultivation is an effective method for irrigating Egyptian clover in North Middle Nile Delta region as a result of saving an amount of irrigation water.

The main target of the current study was to find out the effect of both cultivation methods and irrigation regimes on berseem clover production and water use efficiency in the North Middle Nile Delta. Specific goals were:

1. The impact of dry and semi- dry cultivation on water saving.
2. To find out the most proper method in computing irrigation water in north Nile Delta region where the study took place.
3. To get the proper method for berseem cultivation regarding water saving.
4. To determine some water relations such as applied irrigation water , crop water consumption use and water use efficiency.

MATERIALS AND METHODS

A field experiment was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during winter seasons 2009/2010 and 2010/2011 using Berseem (Egyptian clover). Table 1 shows some physical properties and water constants of the field where the experiments were executed. Dates of sowing (S) and cuttings (C) were as follows:

Season 1(2009/2010) :

S = 16/10/2009

C_1= 18/12/2009, C_2 = 4/2/2010,

C_3 = 19/3/2010, C_4 = 21/4/2010

Season 2(2010/2011) :

S = 20/10/2010

C_1= 22/12/2010, C_2 = 9/2/2011,

C_3 = 24/3/2011, C_4 = 30/4/2011

Cultural practices were implemented as done by the local farmers in the studied area except the two factors under investigation; methods of cultivation and amount of irrigation water (IW).

Table (1): Some of physical characteristics and water constants of the studied soils before cultivating the crop

Soil depth (cm)	Particle size distribution, %			Texture class	Bulk density, Mg/m^3	Total porosity %	Field capacity %	PWP %	AW %
	Sand	Silt	Clay						

0-15	12.3	33.3	54.4	Clayey	1.26	52.45	47.50	25.69	21.81
15-30	20.2	34.2	45.6	Clayey	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)

Experimental design and treatments:

The experimental design for the present work was a factorial, split plot design with three replicates, involving two factors i.e. cultivation methods and irrigation amount (regime).

Main plots were assigned to the cultivation methods as follows:

A. Dry seeds broadcasting over dry soil.
B. Wet seeds (presoaked seeds) broadcasting over dry soil.
C. Wet seeds (presoaked seeds) broadcasting over wet soil (or control).

The subplots were assigned to the irrigation amount as follows:

1. Convenient irrigation (control): Irrigation till the water reached 5.0 cm above the soil surface.
2. Irrigation according to Ibrahim equation (1981)

ETp=0.1642+0.8Ep

Where:

ETp=Potential evapotranspiration, $cmday^{-1}$.

Ep =Pan evaporation, $cmday^{-1}$

3. Irrigation with 0.8 of the Ibrahim equation
4. Irrigation with 0.6 of the Ibrahim equation.

Thus, the total number of experimental plots was 36 [3 "method" x 4 "water amounts" x 3 "replicates"]. Water applied under No. 2, 3 and 4 were equaled to ETc, which was computed as:

ETc= ETp x Kc

Where:

ETc= Crop evapotranspiration, $cmday^{-1}$

ETp= Potential evapotranspiration, $cmday^{-1}$

Kc= Crop coefficient

Values of Kc were quoted from FAO irrigation and drainage No. 56, 1998.

Therefore, such treatments of water applied were equated 100% ETc (No. 2), 80% ETc (No. 3) and 60% ETc (No. 4)

Data parameters:

1. Irrigation water (IW):

Application of irrigation water was controlled and measured by rectangular constructed weir fixed upstream with a discharge rate of 0.01654 m^3sec^{-1} at 10 cm as effective head over the crest.

2. Water consumptive use:

To compute the actual consumed water of the growing plants, soil moisture percentage was determined gravimetrically, on weight basis, before and 48 hours after each irrigation as well as at harvesting. Soil samples were taken from the successive layers of the effective root zone as 0-15, 15-30, 30-45 and 45- 60 cm. This method of computation is considered as one of the direct methods of consumptive use determination which is based on soil moisture depletion (SMD) or so called crop-water consumed (ETc) as stated by Hansen *et al*. (1979).

$$SMD = Cu = \frac{\theta_2 - \theta_1}{100} Db \text{ x } D$$

Where:

SMD, Etc = Soil moisture depletion in the effective root zone of 60 cm depth, cm.

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

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

D_b = Soil bulk density, $Mgm^{-3}$for the 60 cm soil depth.

D = Effective root zone, 60 cm depth.

3. Water consumptive use rate (mmday^{-1}).

It was estimated via dividing the seasonal Cu, mm by the length of growing season. The lengths of 2009/2010 and 2010/2011 seasons were 188 and 193 days, respectively.

4. Crop yield:

The obtained data of crop yield for each cut as well as the total yield was subjected to statistical analysis according to Snedecor and Cochran (1967).

5. Crop water efficiency:

Crop water efficiency is a parameter assess the efficiency exerted by crops in producing yields from water provided for plant. The water use efficiency (WUE) 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.

Crop water efficiencies were calculated as follows (Doorenbos and Pruit, 1975).

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

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

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

RESULTS AND DISCUSSION

Applied irrigation water

Data in Table 2 are concerning applied water (irrigation + rainfall) to berseem clover under the adopted treatments. Dry and Semi – dry cultivation methods resulted in lower values of applied water reached 9.14 and 6.48 % in 2009/2010 season and 8.78 and 9.53% in 2010/2011 one, comparable with wet cultivation method. On overall mean basis, applied irrigation water under dry and semi –dry cultivation were reduced by 8.93 and 8.00 % less than that under wet cultivation method. These findings are in agreement with those reported by Abbas *et al.* (1995) who stated that, on berseem clover production, the increase in applied irrigation water ranged 8.65 to 9.32% due to the traditional wet cultivation method (El-lamaa) as compared with the dry one. Furthermore, Kassab (2006) revealed that dry cultivation is an effective method for saving irrigation water applied for Egyptian clover grown in North Middle Nile Delta region.

Regardless cultivation methods, applied irrigation water at 100, 80 and 60% of that calculated according to Ibrahim equation exhibited lower values comprised 16.86, 34.62 and 48.69% in 2009/2010 season and in 2010/2011 season the reduction reached 20.26, 37.11 and 49.64% , as compared with convenient irrigation method. In connection, Abd el-fatah (2011) found that seasonal applied irrigation water for maize grown on North Nile Delta soil was lower by 2.79 - 3.19% as determined according to Ibrahim equation (1981), comparable with that applied under traditional irrigation.

Data in Table 2 revealed that the highest value of applied irrigation water was noticed due to convenient irrigation method as interacted under the wet cultivation method, and such trend was true in the two seasons of study and overall mean as well. On the contrary, the lowest value of applied irrigation water was recorded as the quantity of applied irrigation water was determined based on 60% of Ibrahim equation under dry cultivation method, and such findings were obtained in 2009/2010 and 2010/2011 seasons besides the overall mean.

Crop water consumptive use (Cu)

Berseem water consumptive use as affected by the adopted cultivation methods and irrigation regimes is present in Table 3. Data revealed that the highest Cu value was noticed under wet cultivation method and comprised 45.6 and 44.12 cm, respectively, in 2009/2010 and 2010/2011 seasons. Dry and semi – dry cultivation methods exhibited Cu values reached 10.81 and 8.84% lower than that recorded under wet cultivation method, respectively, in 2009/2010 season.

The same trend was obtained in 2010/2011 season with corresponding reduction values reached 13.35 and 6.82% lesser than that recorded with wet cultivation method. The lower Cu values under both dry and semi – dry cultivation methods are attributed to less applied water (summation of irrigation and rainfall) under such cultivation methods, comparable with wet cultivation one.

Irrespective of cultivation methods, data in Table 3 cleared out that irrigating at 100, 80 and 60% of that calculated based on Ibrahim equation exhibited lower Cu figures as compared with those reported under convenient irrigation, and such trend was true in the two seasons of study and overall mean as well. Values of Cu under irrigation at 100, 80 and 60% based on Ibrahim equation were 14.66, 27.03 and 43.68% lower than that for convenient irrigation in 2009/2010 season. The corresponding reduction in Cu values, in 2010/2011

Table 2

Table 3

season, reached 14.92, 29.14 and 38.67% in the same order. The overall mean followed the same trend where Cu values were lower by 14.78, 28.06 and 41.22% under irrigating at 100, 80 and 60% based on Ibrahim equation, respectively, comparable with convenient irrigation. In connection, Abd el-fatah (2011) found that seasonal consumptive use for maize grown on North Nile Delta soil was lower by3.97 - 7.32% as the applied water determined according to Ibrahim equation (1981), comparable with that applied under traditional irrigation. Furthermore, El-Bably (2002) indicated that water consumption values for berssem clover were increased to be 59.62 and 48.98 cm, respectively, under three and two irrigations between cuttings treatments as compared to 37.98 cm with one irrigation between cuttings treatment.

Higher Cu values (57.13 and 54.21 cm) were recoded as irrigation water was applied via the convenient method under the wet cultivation. Nevertheless, lower Cu values (29.19 and 28.34 cm) were obtained due to calculating the applied irrigation water according to 60% of Ibrahim equation under dry cultivation method.

Berseem clover fresh yield

Data in Table 4 and Fig 1 cleared out that total fresh yield of berseem clover seemed to reduce under both dry and semi – dry cultivation methods in 2009/2010 and 2010/2011 seasons and overall mean as well. The reduction in total fresh yield, due to dry and semi - dry cultivation methods, comprised 6.26 and 4.33% and 1.95 and 1.66% lesser than those recorded under wet cultivation method, respectively, in 2009/2010 and 2010/2011 seasons. Based on overall mean, the corresponding reduction values in fresh yield reached 5.28 and 1.82% in the same order.

Convenient irrigation (control) resulted in higher berseem fresh yield than those obtained as irrigation water quantities were applied based on 100, 80 and 60% of that determined via Ibrahim equation, and such findings were noticed in 2009/2010 and 2010/2011 seasons besides the overall mean. The reduction in berseem fresh yield due to calculating the applied irrigation water based on 100, 80 and 60% of Ibrahim equation reached (8.36 and 7.31%), (22.79 and 20.04%) and (34.96 and 34.81%), respectively, in 2009/2010 and 2010/2011 seasons as compared with convenient irrigation (control). Based on overall mean, the corresponding reduction values in fresh yield reached 7.99, 21.42 and 34.88% in the same order. The reductions in berseem fresh yield could be attributed to soil water stress resulted from less applied irrigation water under such irrigation regimes. In connection, El-Bably (2002), indicated that three irrigation events between cuttings significantly increased total cuttings of Egyptian clover fresh yields. Generally, Lovelli *et al.* (2007), stated that water supply significantly modified the growth of root in relation to the above ground plant part i.e. the amount of harvestable biomass of the forage in relation to total biomass.

On total yield basis, the highest value of berseem clover fresh yield (41.14 and41.54 tonfad^{-1}) were noticed with convenient irrigation regime under wet cultivation method. On the contrary, the lowest value of berseem clover fresh yield (25.12 and 25.86 tonfad^{-1}) were obtained due to applying

irrigation water based on 60% of Ibrahim equation under the dry cultivation method.

Berseem clover dry yield

Data in Table 4 illustrated that total dry yield of berseem clover tended to reduce under both dry and semi – dry cultivation methods in 2009/2010 and 2010/2011 seasons and overall mean as well. The reduction in total dry yield, due to dry and semi - dry cultivation methods, comprised 7.63 and 2.08% and 4.56 and 2.68% lesser than those recorded under wet cultivation method, respectively, in 2009/2010 and 2010/2011 seasons. Based on overall mean, the corresponding reduction values in dry yield reached 4.50 and 2.32% in the same order.

Convenient irrigation (control) resulted in higher berseem dry yield than those obtained as irrigation water quantities were applied based on 100, 80 and 60% of that determined via Ibrahim equation, and such

Table 4

Table 5

Fig1

findings were noticed in 2009/2010 and 2010/2011 seasons besides the overall mean. The reduction in berseem dry yield due to calculating the applied irrigation water based on 100, 80 and 60% of Ibrahim equation reached (3.31 and 5.60%), (19.39 and 20.24%) and (31.29 and 28.45%), respectively, in 2009/2010 and 2010/2011 seasons as compared with convenient irrigation (control). Based on overall mean, the corresponding reduction values in dry yield reached 4.59, 19.44 and 29.83% in the same order. The reductions in berseem dry yield could be attributed to soil water stress resulted from less applied irrigation water under such irrigation regimes. In connection, El-Bably (2002), indicated that three irrigation events between cuttings significantly increased total cuttings of Egyptian clover dry yields. Furthermore, Lazaridou, Martha and Koutroubas (2004), at Drama, Macedonia, Greece, stated that water stress resulted in a reduction of the above ground dry biomass to one third of irrigated berseem clover plants (2.3 vs 6.8 g/plant) .

Water Use Efficiency (WUE)

Data in Table 6 illustrated that WUE seemed to increase under both dry and semi – dry cultivation methods, comparable with the wet cultivation one, and such trend was true in the two seasons of study and on overall mean as well. The enhancement in WUE were 6.47 and 11.55% and 8.08 and 5.61% under dry and semi – dry cultivation methods more than wet cultivation method, respectively, in 2009/2010 and 2010/2011 seasons. The corresponding improvement in WUE , on overall mean, reached 6.76 and 5.06% under dry and semi – dry cultivation methods higher than wet cultivation one in 2009/2010 and 2010/2011 seasons, respectively. The improvement in WUE with dry and semi – dry cultivation methods may be attributed to lesser water applied (summation of irrigation and rainfall) under such cultivation methods, as compared with wet cultivation one. In this sense, El-Bably (2002), found that combined analysis proved that water use efficiency (WUE) values were 135.29,145.66 and 179.16 kg dry matter/fed/cm consumed water, over both seasons, for three, two, and one irrigation events between cuttings, respectively. In addition, Lazaridou, Martha and Koutroubas (2004), at Drama, Macedonia, Greece, stated that water stress resulted in increased water use efficiency for berseem clover plants.

Regardless the adopted cultivation methods, data in Table 6 exhibited higher WUE values as applied irrigation water were determined based on Ibrahim equation, under any circumstances of the studied regimes, in comparison with convenient irrigation and such findings were recorded in 2009/2010 and 2010/2011 seasons besides the overall mean. The increase percentage in WEU values comprised (7.09 and 9.30), (5.90 and 13.12) and (15.72 and 6.83), respectively, when applied water was calculated as 100, 80 and 60% based on Ibrahim equation, more than those obtained with convenient irrigation in 2009/2010 and 2010/2011 seasons. On the overall mean basis, the corresponding increases in WUE reached 8.23, 9.61 and 11.15% in the same above order. In this sense, Abd el-fatah (2011) found that water use efficiency for maize grown on North Nile Delta soil was higher by 16.0 – 16.53% as the applied water was determined according to Ibrahim

equation (1981), in comparison with that applied under traditional irrigation.

The highest mean WUE value (21.11kgm^{-3}) was noticed as irrigation water was 60% of water calculated based on Ibrahim equation and applied under dry cultivation method. On the contrary, the lowest mean WUE value (17.68 kgm^{-3}) was obtained due to convenient irrigation under the wet cultivation method.

Water Utilization Efficiency (WUtE)

Data in Table 7 illustrated that WUtE tended to increase under both dry and semi – dry cultivation methods, comparable with the wet cultivation one, and such findings were true in the two seasons of study and on overall mean as well. The improvement in WUtE were (2.63 and 5.00%) and (2.59 and 5.56%) under dry and semi – dry cultivation methods more than wet cultivation method, respectively, in 2009/2010 and 2010/2011

Table 6

Table 7

seasons. The corresponding improvement in WUtE , on overall mean, reached 2.97 and 4.05% under dry and semi – dry cultivation methods higher than wet cultivation one, respectively. The improvement in WUtE with dry and semi – dry cultivation methods may be due to the lesser water applied(summation of irrigation and rainfall) under such cultivation methods as compared with wet cultivation one. In this connection, Abbas *et al*. (1995) reported that irrigation efficiency (expressed as kg/cm depth of water applied) was increased under dry method more than the wet method. Furthermore, Ouda *et al.* (2010) stated that water productivity for berseem clover was gradually increased under all deficit irrigation treatments e.g. 95, 90, 85, and 80% of full irrigation.

Irrespective of the tested cultivation methods, data in Table 7 exhibited higher WUtE values as applied irrigation water were determined based on 100, 80 and 60% of Ibrahim equation in comparison with convenient irrigation, and such findings were recorded in 2009/2010 and 2010/2011 seasons besides the overall mean. The increase percentage in WUtE values comprised (8.45 and 9.78), (14.31 and 10.63) and (19.66 and 19.66), respectively, when applied water quantities were calculated as 100, 80 and 60% based on Ibrahim equation, more than those obtained with convenient irrigation in 2009/2010 and 2010/2011 seasons. On the overall mean basis, the corresponding increases in WUtE reached 9.15, 12.53 and 12.46% in the same above order.

The highest mean WUtE value (16.51kgm^{-3}) was noticed as irrigation water was 80% of water calculated based on Ibrahim equation and applied under the semi-dry cultivation method. On the contrary, the lowest mean WUtE value (14.03 kgm^{-3}) was obtained due to convenient irrigation under the wet cultivation method.

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أثر كلا من طرق الزراعة ومستويات الري على إنتاجية البرسيم فى شمال دلتا النيل

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الملخص العربي

أقيمت تجربتان حقليتان فى المزرعة البحثية بمحطة البحوث الزراعية بسخا . محافظة كفرالشيخ بمنطقة شمال دلتا النيل خلال موسمي ٢٠٠٩/٢٠١٠ ، ٢٠١٠/٢٠١١ بهدف ترشيد مياه الري للبرسيم من خلال تحديد طريقة الزراعة المثلى وكذا تحديد مستويات الري الواجب الري عندها حيث خضعت ثلاث طرق زراعة لكميات مختلفة من ماء الري والتى حسبت على أساس الري حتى ٥ سم فوق سطح التربة (الكنترول او المعتاد فى المنطقة) و ١٠٠% . ٨٠% . ٦٠% من معادلة ابراهيم.

وقد أوضحت النتائج أن:

١- الزراعة الجافة (بذرة جافة في أرض جافة) ونصف جافة (بذرة مبتلة فى أرض جافة) حققتا الآتى: الوفر فى مياه الرى بقيمة متوسطة ١٦٠ م٣/فدان أو ٤٠١ مليون متر مكعب على المستوى القومى وذلك مقارنة بالزراعة التقليدية (المبتلة او ما يسمى باللمعة اى بذرة مبتلة فى أرض مبتلة).

٢- تقريبا نفس المحصول قد تحصل عليه تحت الزراعة الجافة ونصف جافة مثلما هو فى الزراعة المبتلة او التقليدية.

٣- العائد المحصولى من وحدة المياه المضافة (WUtE) كان ١٩.٣٣ ، ١٩.٩٨ كجم/م^3 لطريقتى الزراعة الجافة ونصف الجافة على الترتيب بينما العائد المحصولى من وحدة المياه المستهلكة (WUE) للطريقتين هما ٢٠.٠٦ ، ١٩.٧٤ كجم/م^3 على الترتيب. فى حين أن العائد المحصول من وحدة المياه المضافة والمستهلكة تحت الزراعة المبتلة هما ١٨.٦٨ ، ١٨.٤٧ كجم/م^3 على الترتيب.

Table 2: Effect of cultivation method and irrigation regime on water applied (IW) for Egyptian berseem clover in 2009/2010 and 2010/2011 seasons

Parameter	Cultivation method*													
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method (C)				Mean
	Irrigation regime**					Irrigation regime**					Irrigation regime**				
	1	2	3	4		1	2	3	4		1	2	3	4	
2009/2010 season															
IW, m^3fad^{-1}	2342.11	1915.17	1512.11	1189.19	1739.65	2381.15	2010.19	1555.13	1216.11	1790.65	2540.60	2114.12	1682.22	1321.92	1914.72
IW, cm	55.76	45.60	36.00	28.31	41.42	56.96	47.86	37.03	28.96	42.70	60.49	50.34	40.05	31.47	45.59
Rainfall (m^3fad^{-1})	162.96														
Rainfall (mm)	38.8														
2010/2011 season															
IW, m^3fad^{-1}	2381.12	1866.15	1423.17	1166.10	1709.14	2311.15	1811.71	1465.11	1188.15	1694.03	2510.25	2065.18	1641.12	1273.19	1872.45
IW, cm	56.69	44.43	33.89	27.76	40.69	55.03	43.14	34.88	28.29	40.34	59.77	49.17	39.07	30.31	44.58
Rainfall (m^3fad^{-1})	722.82														
Rainfall(mm)	172.1														
Mean of two seasons															
IW, m^3fad^{-1}	2361.62	1890.66	1467.64	1177.65	1724.39	2346.15	1910.95	1510.11	1202.13	1742.34	2525.43	2089.65	1661.52	1297.55	1893.54
IW, cm	56.23	45.02	34.94	28.04	41.06	55.86	45.50	35.96	28.62	41.49	60.13	49.76	39.56	30.89	45.09
Rainfall (m^3fad^{-1})	442.89														
Rainfall(mm)	105.45														

**A, B and C are referred to cultivation methods i.e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*

***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*

Table 3: Effect of cultivation method and irrigation regime on water consumptive use(Cu) and its rate for Egyptian berseem clover in 2009/2010 and 2010/2011 seasons

Parameter	Cultivation method*														
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method (C)				Mean
	Irrigation regime**					Irrigation regime**					Irrigation regime**				
	1	2	3	4		1	2	3	4		1	2	3	4	
2009/2010 season															
CU, cm	52.22	44.11	37.15	29.19	40.67	53.16	44.81	39.11	29.18	41.57	57.13	49.78	42.33	33.15	45.60
CU rate, $mmday^{-1}$	2.7	2.3	1.9	1.5	2.1	2.8	2.3	2.0	1.5	2.15	3.0	2.6	2.2	1.7	2.38
2010/2011 season															
CU, cm	50.11	40.33	34.12	28.34	38.23	51.33	43.99	36.45	32.67	41.11	54.21	48.11	39.71	34.45	44.12
CU rate, $mmday^{-1}$	2.6	2.1	1.8	1.5	2.0	2.7	2.3	1.9	1.7	2.15	2.8	2.5	2.1	1.8	2.3
Mean of two seasons															
CU, cm	51.17	42.22	35.64	28.77	39.45	52.25	44.40	37.78	30.93	41.34	55.67	48.95	41.02	33.80	44.86
CU rate, $mmday^{-1}$	2.65	2.2	1.85	1.5	2.05	2.75	2.3	1.95	1.6	2.15	2.9	2.55	2.15	1.75	2.34

**A, B and C are referred to cultivation methods i.e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*

***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*

Table 4: Effect of cultivation method and irrigation regime on Egyptian berseem clover fresh yield in 2009/2010 and 2010/2011 seasons

Cutting and date	Cultivation method*																	
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method (C)				Mean	LSD		
	Irrigation regime**					Irrigation regime**					Irrigation regime**							
	1	2	3	4		1	2	3	4		1	2	3	4		05	01	SED
2009/2010 season																		
First 18/12/2009	7.07	5.87	5.53	4.93	5.85	7.40	6.07	5.67	5.20	6.09	7.53	6.20	5.73	5.27	6.18	0.49	0.67	0.23
Second 04/02/2010	9.40	9.13	7.07	6.13	7.93	10.20	9.27	7.27	6.20	8.24	10.47	9.40	7.47	6.27	8.40	0.55	0.75	0.26
Third 19/03/2010	11.20	10.60	9.07	6.73	9.40	11.73	11.20	9.87	7.13	9.98	11.87	11.40	10.00	7.33	10.15	0.65	0.90	0.31
Fourth 21/04/2010	10.93	9.93	7.93	7.33	9.03	11.13	10.13	8.47	7.80	9.38	11.27	10.63	8.73	7.87	9.63	0.56	0.77	0.27
Total yield	38.60	35.53	29.60	25.12	32.21	40.46	36.67	31.28	26.33	33.69	41.14	37.63	31.93	26.74	34.36			
2010/2011 season																		
First 22/12/2009	7.20	6.20	5.70	5.03	6.03	7.47	6.20	5.73	5.03	6.11	7.67	6.33	5.83	5.17	6.25	0.28	0.39	0.13
Second 09/02/2010	9.53	9.20	7.43	6.07	8.06	10.33	9.47	7.53	6.20	8.38	10.60	9.53	7.70	6.27	8.53	0.48	0.66	0.23
Third 24/03/2010	11.53	11.33	10.20	7.43	10.12	11.80	11.53	10.37	7.50	10.30	12.07	11.73	10.47	7.53	10.45	0.31	0.43	0.15
Fourth 30/04/2010	10.93	9.93	8.57	7.33	9.19	11.20	10.47	8.77	7.73	9.54	11.20	10.73	8.87	7.93	9.68	0.43	0.59	0.21
Total yield	39.19	36.66	31.90	25.86	33.40	40.80	37.67	32.40	26.46	34.33	41.54	38.32	32.87	26.90	34.91	Insignificant		
Average of total yield	38.90	36.10	30.75	25.49	32.81	40.63	37.17	31.84	26.40	34.01	41.34	37.93	32.40	26.82	34.64			

**A, B and C are referred to cultivation methods i. e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*

***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*

Table 5: Effect of cultivation method and irrigation regime on Egyptian berseem clover dry yield in 2009/2010 and 2010/2011 seasons

Cutting and date	Cultivation method*																	
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method (C)				Mean	LSD		
	Irrigation regime**					Irrigation regime**					Irrigation regime**							
	1	2	3	4		1	2	3	4		1	2	3	4		05	01	SED
2009/2010 season																		
First 18/12/2009	1.63	1.67	1.34	1.09	1.43	1.65	1.71	1.38	1.20	1.49	1.75	1.70	1.44	1.24	1.53	0.071	0.098	0.034
Second 04/02/2010	1.83	1.79	1.44	1.29	1.59	1.89	1.82	1.47	1.31	1.61	1.90	1.85	1.51	1.36	1.66	0.052	0.071	0025
Third 19/03/2010	2.55	2.30	1.91	1.64	2.10	2.62	2.36	1.96	1.64	2.15	2.65	2.44	1.92	1.72	2.18	0.073	0.100	0.035
Fourth 21/04/2010	1.88	1.99	1.75	1.41	1.76	2.00	2.03	1.78	1.42	1.81	2.09	1.97	1.82	1.47	1.84	0.165	0.226	0.079
Total yield	7.89	7.75	6.44	5.43	6.88	8.16	7.92	6.59	5.57	7.06	8.39	7.96	6.69	5.79	7.21			
2010/2011 season																		
First 22/12/2009	1.67	1.65	1.38	1.28	1.50	1.69	1.65	1.40	1.32	1.52	1.80	1.75	1.49	1.34	1.60	0.062	0.086	0.030
Second 09/02/2010	1.89	1.82	1.47	1.39	1.64	1.91	1.84	1.48	1.43	1.67	1.95	1.87	1.53	1.41	1.69	0.057	0.077	0.027
Third 24/03/2010	2.60	2.41	1.95	1.69	2.16	2.66	2.46	1.93	1.77	2.21	2.74	2.47	1.95	1.79	2.24	0.039	0.053	0.019
Fourth 30/04/2010	1.99	1.89	1.81	1.55	1.81	2.14	1.95	1.82	1.48	1.85	2.17	2.03	1.90	1.59	1.92	0.105	0.143	0.050
Total yield	8.15	7.77	6.61	5.91	7.11	8.40	7.90	6.63	6.00	7.25	8.66	8.12	6.87	6.13	7.45			
Average of total yield	8.02	7.76	6.63	5.67	7.00	8.28	7.91	6.61	5.79	7.16	8.53	8.04	6.78	5.96	7.33			

**A, B and C are referred to cultivation methods i.e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*

***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*

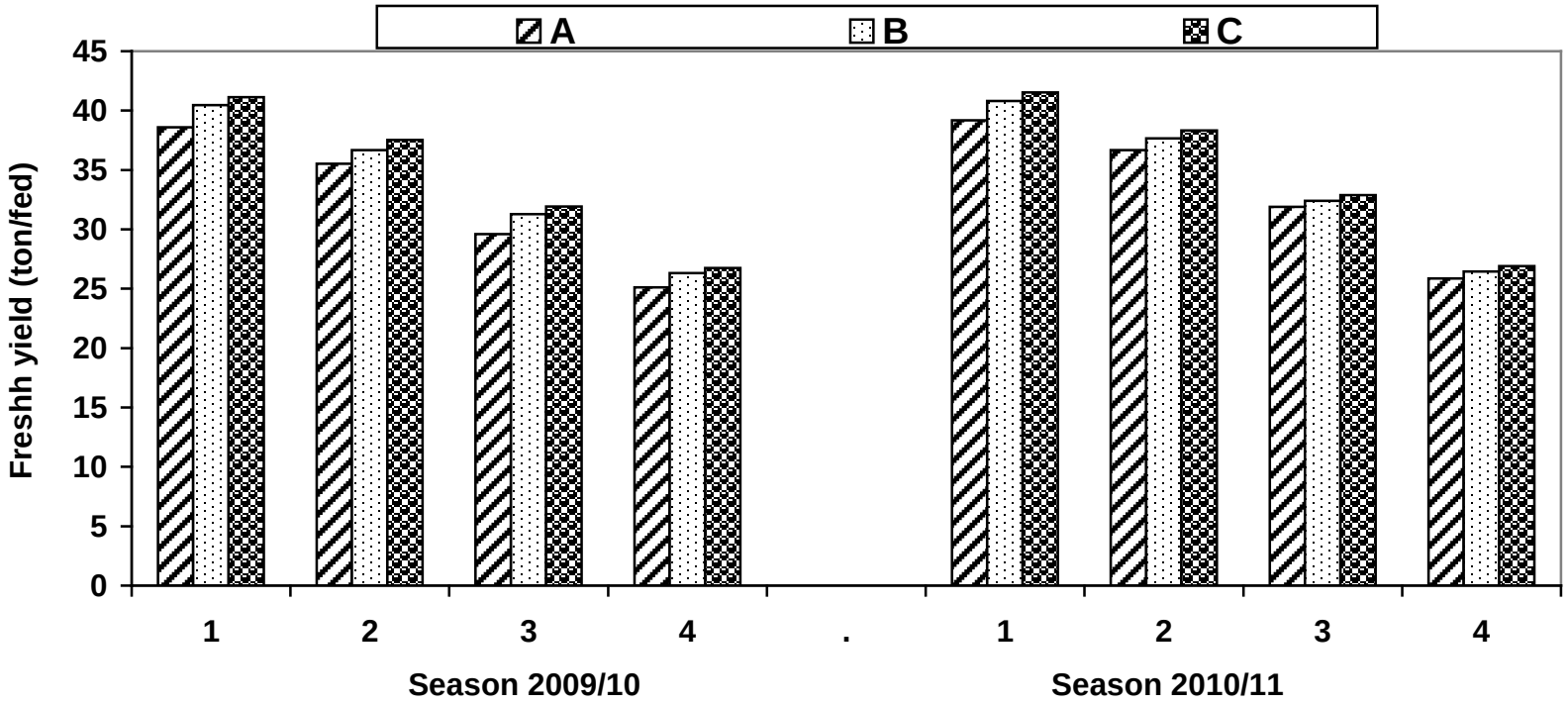

Fig. (1): Fresh yield (ton/fed) as affected by cultivation method and irrigation treatments In the two growing seasons.

Table 6 : Water Use Efficiency(WUE) for Egyptian clover as affected by cultivation method and irrigation regime in 2009/2010 and 2010/2011

Parameter	Cultivation method*													
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method ©				Mean
	Irrigation regime**					Irrigation regime**					Irrigation regime**				
	1	2	3	4		1	2	3	4		1	2	3	4	
2009/2010 season															
WUE (kgm^{-3})	17.60	19.18	18.97	20.49	19.06	18.12	19.48	19.04	21.48	19.53	17.15	17.95	17.96	19.21	18.07
2010/2011 season															
WUE, (kgm^{-3})	18.62	21.64	22.26	21.73	21.06	18.93	20.39	21.16	19.28	19.94	18.24	18.96	19.71	18.59	18.88
Mean of two seasons															
WUE, (kgm^{-3})	18.11	20.41	20.62	21.11	20.06	18.53	19.94	20.10	20.38	19.74	17.68	18.46	18.84	18.90	18.47

**A, B and C are referred to cultivation methods i.e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*
***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*

Table 7 : Water Utilization Efficiency (WUtE) for Egyptian clover as affected by cultivation method and irrigation regime in 2009/2010 and 2010/2011

Parameter	Cultivation method*														
	Dry method (A)				Mean	Semi – dry method (B)				Mean	Wet method (C)				Mean
	Irrigation regime**					Irrigation regime**					Irrigation regime**				
	1	2	3	4		1	2	3	4		1	2	3	4	
2009/2010 season															
WUtE (kgm^{-3})	15.41	17.10	17.67	18.58	17.19	15.90	16.87	18.21	19.09	17.52	15.22	16.48	17.30	18.01	16.75
2010/2011 season															
WUtE (kgm^{-3})	12.63	14.16	14.86	13.69	13.84	13.45	14.86	14.81	13.85	14.24	12.85	13.74	13.90	13.48	13.37
Mean of two seasons															
WUtE (kgm^{-3})	14.03	15.63	16.27	16.14	15.52	14.67	15.87	16.51	16.47	15.88	14.03	15.11	15.40	15.74	15.07

**A, B and C are referred to cultivation methods i.e. dry seed on dry soil, wet seed on dry soil and wet seed on wet soil, respectively.*
***1,2,3 and 4 are referred to convenient irrigation, 100, 80 and 60% of irrigation water based on Ibrahim equation, respectively.*