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IMPACT OF IRRIGATION SCHEME AND P-FERTILIZATION RATE ON GROWTH, YIELD, YIELD QUALITY, P- USE EFFICIENCY AND WATER PRODUCTIVITY FOR BERSEEM CLOVER GROWN ON MIDDLE DELTA SOIL

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ABSTRACT

A field trial was carried out in the experimental farm of Gemmeiza Agricultural Research Station (Middle Nile Delta) during two successive 2007/2008 and 2008/2009 growing seasons. The objective of such trials is to find out the extent to which irrigation scheme(Farmer and bed- furrow irrigation schemes) and P-fertilization rate(15, 30 and 45 kg P_2O_5/fed.) influenced growth, yield, yield quality, P-use efficiency and water productivity for berseem clover var. Gemmeiza1.The treatments were arranged in split – plot experimental design with three replicates.

The most important findings could be as follows:-

1- Plant height values, at the different cuttings and total, in the two seasons of study, significantly reduced under bed-furrow irrigation, as compared with the farmer one. In general, leaves number/stem averages were higher, up to the third cutting in 1st season and up to second cutting in 2nd season, under bed- furrow irrigation, more than the farmer irrigation practice. N^{o} of leaves/stem criterion tended to increase with bed –furrow irrigation practice. Plant height and N^{o} of leaves/stem traits tended to increase as P- rate increased.

2- Fresh and dry berseem clover yields(at different cuttings and total) seemed to increase due to farmer irrigation scheme as compared with bed –furrow irrigation one, in both seasons of study. In addition, increasing P-rate resulted in increased values of both total fresh and dry berseem clover yields.

3- leaves/stem ratio(L/S) under bed-furrow irrigation scheme surpassed that under the farmer irrigation one, on dry weight basis. Data also revealed that increasing P-rate tended to improve L/S ratio either on fresh or dry weight basis. Crude protein and crud fiber yields tended to reduce under bed- furrow irrigation ,while increasing P-rate resulted in higher crude protein and crud fiber yields.

4-The seasonal applied water under bed-furrow irrigation scheme were reduced by 19.78 and 21.14%, in 1st and 2nd seasons, comparable with farmer one, respectively. Moreover, bed-furrow irrigation scheme resulted in higher water productivity values on total fresh and dry berseem clover yields basis. The calculated P- Use Efficiency values were reduced under bed-furrow irrigation as compared with the farmer irrigation one. Such reduction is mainly attributed to the reduction in total fresh and dry yields under the former irrigation practice. Increasing P rate tended to enhance water productivity for berseem clover on total fresh and dry yields basis.

Keywords: Bed- furrow irrigation, Berseem clover yield, Yield quality, P-use efficiency, Water productivity

INTRODUCTION

Berseem clover (*Trifolium alexandrinum* L.) is an annual forage crop widely grown in Mediterranean environments. In Egypt, forage crops, which approximately represented 18 percent of the total value of field crops, are grown on about 1.11 million ha since catch or long season berseem clover (Mesqawi) on 0.71 million ha equals about 1.7 million feddans, (FAO 2005). Egyptian clover, *Trifolium alexandrinium*, is the traditional forage crop in Egypt which planted since at least the time of the Pharaohs. It is grown as an annual crop in the winter and spring and it is part of a mandated crop rotation in most the Nile delta.

Irrigation is the detrimental factor in agricultural production under the Egyptian conditions. On accomplishing sustainable agriculture concept, the limited available water resources must be efficiently used in order to conserve such resources and to improve its productivity as well. El-Babbly (2002), stated that, the combined analysis indicated that three irrigation events between cuttings significantly increased total cuttings of Egyptian clover fresh and dry yields to be 104.14 and 19.48 t ha^{-1}, respectively. Furthermore, 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. 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)and simultaneously increased water use efficiency.

Phosphatic fertilization, in general, is essential for good performance of leguminous crops due to its role with several enzymatic reactions depending on phosphorylation and synthesis of various organic compounds in the plant. Haque(1998), in Ethiopia, evaluated the effectiveness of Egyptian phosphate rock (EPR) relative to triple superphosphate (TSP) applied at 0, 15, 30, 45, and 60 kg P ha^{-1} to annual *Trifolium* species grown on a P-deficient Vertisol. The fertilizers were applied once and their effects were followed on seven consecutive annual clover crops. The author found that the clover responded to P at all the rates used and significant ($P<0.05$) P effects on clover P content and DM yields were observed up to the fourth crop. In Egypt, Nassar et al.(2001) found that fresh and dry yields of berseem, at different cuts as well as seed and straw yields, were significantly increased due to raising P application up to 45 kg P_2O_5/fed.

The present trial aiming to find out the extent to which growing berseem clover on bed-furrow, comparable with the traditional irrigation practice, and different phosphatic fertilization rates affected growth, yield, yield quality, P- use efficiency and water productivity for berseem clover grown on Middle Delta soil.

MATERIALS AND METHODS

A field trial was executed in the experimental farm of Gemmeiza Agricultural Research Station (Middle Nile Delta) during two successive 2007/2008 and 2008/2009 growing seasons. Particle size distribution , some soil – water relations and bulk density are shown in Table(1). The available soil P levels in the surface soil layer(0 - 40 cm depth) were 3.75 and 4.00 mg/kg soil, respectively, in 1st and 2nd seasons as determined according to Olsen *et al.* 1954. The objective of such the present trial is to find out the extent to which irrigation scheme and P-fertilization rate and their interaction influenced water productivity, growth and yield quality of berseem clover (*Trifolium alexandrium* L.,var. Gemmeiza 1).The adopted treatments were arranged in split – plot experimental design and each treatment was replicated three times. The adopted treatments were allocated as follows :-

1- Main plots (irrigation scheme) :-
1a – Traditional farmer practice.
1b – Bed – furrow irrigation scheme (the beds were120 cm in width).

2- Split plots (P- fertilization rates) :-
2a - 15 kg P_2O_5/fed. 2b - 30 kg P_2O_5/fed. 2c - 45 kg P_2O_5/fed.

Table(1): Particle size distribution, soil field capacity, soil wilting point and bulk density of the experimental site, 2007/2008 and 2008/2009 seasons

Soil depth (cm)	Clay %	Silt %	Fine sand %	Coarse sand %	Texture class	F.C.* %,wt/wt	W.P.** %,wt/wt	Bulk density ($gmcm^{-3}$)
2007/2008 season								
00-15	40.19	44.84	14.14	0.83	Clay	43.20	23.40	1.11
15.-30	46-10	40.11	12.68	1.11	Clay	41.10	22.34	1.26
30-45	48.90	39.73	10.12	1.22	Clay	39.60	21.52	1.31
45-60	49.00	39.95	10.00	1.05	Clay	36.00	19.57	1.35
2008/2009 season								
00-15	45.25	22.63	30.80	1.50	Clay	45.60	24.30	0.82
15.-30	45.48	29.35	24.40	0.50	Clay	42.30	22.10	1.20
30-45	37.73	27.57	31.90	2.50	Clay loam	39.50	21.00	1.29
45-60	33.03	29.70	36.00	1.00	Clay loam	36.90	18.60	1.38

***Soil field capacity. ** Soil wilting point.**

The area of each split – plot equals $36m^2$ i.e. 3.6 m in width by 10 m in length. The assessed P- fertilizer rates were incorporated into the top soil before planting irrigation. An initial N dose, equals to 20kg N per feddan, was added before Mohayah watering. The sowing dates were on 15/11/2007 in 1st season and on 18/11/2008 in 2nd one. The applied irrigation water was determined according to James (1988) using the following formula for submerged orifice:-

$$Q = 0.61 \times 0.443 \times A \sqrt{h} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$ where

Q = Opening discharge, L/sec
A = Opening area , cm^2 and
h = Effective water head over the opening center, m

At each cutting, fresh berseem clover yield was determined on 12 m^2 area from each subplot, under the three replicates, and expressed as ton/feddan. Then, sample equals one kilogram each, was taken and the following traits were recorded:-

1- Plant length, cm 2- Number of leaves/stem

3-Leaves/Stem ratio (fresh and dry basis) was determined according to Ranjbar(2008).

4- Dry matter, nitrogen and crude fiber % were determined as described in AOAC (1980). Protein(N% x 6.25), and fiber yields were expressed as Kgs/fed, on dry weight basis. Data of plant height, N^o of leaves/stem, leaves / stem ratio and both fresh and dry yields were subjected to the statistical analyses according to Snedecor and Cochran (1980) and the means were compared by LSD test at 5% level.

RESULTS AND DISCUSSION

Plant height and leaves number/stem

Data in Table (2) revealed that plant height values, at the different cuttings in the two seasons of study, significantly reduced under bed-furrow irrigation, as compared with the farmer one. Moreover, the plant height was significantly influenced due to the adopted P- rates. The interaction seemed mostly to be insignificant to alter such growth trait.

On 4 cuttings average basis, the plant length values were significantly reduced under bed-furrow irrigation by 4.91 and 3.07%,in 1^{st} and 2^{nd} seasons, respectively, comparable with farmer practice. Regardless irrigation practices, berseem plant height values were significantly increased by 2.37 and 8.39% in 1^{st} season and by 3.84 and 6.75% in 2^{nd} one due to P2 and P3 rates, respectively, as compared with P1 rate.

As shown in Table(2) , at the different cuttings, leaves N^o/stem improved significantly in 1^{st} and 2^{nd} seasons under bed-furrow irrigation, comparable with farmer irrigation. The P-rate exhibited positive significant effect to influence such trait in the 1st and 2^{nd} seasons too. Interaction effect was significant to alter such trait at second and fourth cuttings only, and such trend was similar in the 1st and 2^{nd} seasons.

On 4 cutting average basis, number per stem tended to increase significantly under bed- furrow irrigation as compared with the farmer practice, where the increase % comprised 4.41 and 013 in1^{st} and 2^{nd} seasons, respectively. Irrespective of irrigation scheme, as P- rate increased leaves N^o/stem increased, where the increase values reached 10.19 and 15.69% in 1^{st} season and by 7.49 and 12.25% in 2^{nd} season under P2 and P3 rates, respectively, more than those under P1 rate. Regarding the importance of leaves number/stem trait, Ranjbar (2008) reported that berseem cultivars producing more leaves are preferred in the breeding program due to its improved nutritive value.

Table (2): Berseem clover plant height and Leaves N°/stem at different cuttings as influenced by irrigation scheme, P- rate and their interaction

Irrigation scheme	P- rate*	plant height(cm)				Mean	Leaves N°/stem				Mean
		Cutting number					Cutting number				
		I	II	III	IV		I	II	III	IV	
		The first season(2007/2008)									
Farmer scheme	P1	44.15	58.50	78.70	56.50	59.46	5.7	5.6	7.4	6.1	6.2
	P2	47.00	60.60	78.38	56.93	60.72	6.4	6.2	7.9	7.2	6.9
	P3	47.23	64.55	81.95	68.15	65.47	6.5	6.4	8.2	8.0	7.3
	Mean	46.13	61.22	79.68	60.41	61.86	6.2	6.1	7.8	7.1	6.8
Bed-furrow irrigation	P1	40.55	56.48	72.28	59.20	57.12	6.1	6.2	7.6	6.3	6.6
	P2	43.43	57.35	73.63	60.05	58.61	7.0	7.2	8.2	6.5	7.2
	P3	46.10	59.10	75.05	62.53	60.69	7.3	7.7	8.4	6.6	7.5
Mean		43.36	57.64	73.65	60.63	58.82	6.8	7.0	8.1	6.5	7.1
LSD,05	Irrigation	1.31	0.89	2.47	NS		0.11	0.06	NS	0.09	
	P - rate	1.22	1.50	1.30	5.75		0.21	0.11	0.17	0.16	
	Interaction	NS	NS	NS	NS		NS	0.16	NS	0.22	
		The second season(2008/2009)									
Farmer scheme	P1	47.13	60.33	60.28	63.18	57.73	6.8	6.7	8.5	7.3	7.3
	P2	48.85	61.80	61.73	63.33	58.92	7.3	7.2	8.6	8.4	7.9
	P3	52.15	63.18	63.80	65.35	61.12	7.5	7.6	8.9	8.7	8.2
	Mean	49.38	61.77	61.93	63.95	59.25	7.2	7.2	8.6	8.1	7.8
Bed-furrow irrigation	P1	44.33	55.75	55.85	64.43	55.09	7.4	7.2	7.5	7.3	7.4
	P2	45.25	60.23	59.75	66.50	58.18	8.0	8.3	7.7	7.4	7.9
	P3	48.00	60.73	61.13	67.33	59.29	8.4	8.8	8.1	8.0	8.3
Mean		45.86	58.90	58.91	66.08	57.43	8.0	8.1	7.8	7.5	7.9
LSD,05	Irrigation	1.64	1.21	1.45	1.20		0.08	0.23	0.16	0.27	
	P - rate	0.72	0.86	0.74	1.24		0.22	0.15	0.21	0.29	
	Interaction	NS	1.21	1.04	NS		NS	0.21	NS	0.41	

*** P1, P2 and P3 are referred to 15, 30 and 45 kg P_2O_5/fed rates, respectively.**

Fresh and dry berseem clover yields

Data in Table (3) revealed that, at different cuttings, fresh yield seemed to reduce significantly under bed furrow irrigation up the third cuttings, then increased significantly at the fourth one, and such trend was observed in 1st and 2nd seasons. Regarding dry yield, the reduction was continuous up to the fourth cutting with mostly significant differences, in 1st and 2nd seasons. Significant increases were observed for fresh and dry yields at different cuttings due to increasing P-rate, and such findings were true in 1st and 2nd seasons. The interaction effect was mostly significant to alter such traits in the two seasons of study.

Total fresh and dry yields of berseem clover, on 4 cuttings basis, were reduced under bed-furrow irrigation scheme by 14.44 and 9.89% in 1st season and by 15.76 and 14.22% in 2nd season, respectively, comparable with the farmer practice. Such reduction is due less applied irrigation water under bed-furrow irrigation practice. In connection, Iannucci (2001) reported a yield reduction of berseem clover subjected to drought. In Egypt**,** El-Babbly (2002), stated that, the combined analysis indicated that fresh and dry yields

of clover tended to reduce under one irrigation between the two cuts treatment, as compared with two and three irrigations between the two cuts ones. 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. In this respect, lovelli et al.(2007), stated that water supply significantly modified the growth of root in relation to above ground plant part i.e. the amount of harvestable biomass of the forage in relation to total biomass.

Table (3) : Fresh and dry yields for berseem clover, at different cuttings and total, as influenced by irrigation scheme, P- rate and their interaction

Irrigation scheme	P- rate*	Fresh yield(ton/fed) Cutting number				Total yield (ton/fed)	Dry yield(ton/fed) Cutting number				Total Yield (ton/fed)
		I	II	III	IV		I	II	III	IV	
		The first season(2007/2008)									
Farmer scheme	P1	7.775	11.650	12.475	10.950	42.850	0.743	1.203	1.918	1.723	5.587
	P2	8.750	11.750	13.450	11.575	45.525	0.848	1.250	2.013	1.780	5.891
	P3	8.900	12.580	14.100	12.375	47.955	0.855	1.315	2.035	1.845	6.050
	Mean	8.480	11.992	13.342	11.633	45.443	0.815	1.257	1.988	1.783	5.843
Bed-furrow irrigation	P1	6.880	9.950	10.350	8.300	35.480	0.715	1.035	1.638	1.265	5.038
	P2	7.850	11.425	11.025	9.825	40.125	0.770	1.295	1.690	1.553	5.308
	P3	7.900	11.775	11.225	10.125	41.025	0.785	1.315	1.725	1.628	5.453
Mean		7.543	11.050	10.867	9.417	38.877	0.757	1.215	1.684	1.482	5.265
LSD,05	Irrigation	0.49	0.32	0.21	0.13	1.38	0.05	NS	0.03	0.10	0.11
	P - rate	0.58	0.33	0.41	0.23	0.64	0.05	0.03	0.06	0.10	0.11
	Interaction	NS	0.46	NS	0.34	1.14	NS	0.04	NS	NS	0.16
		The second season(2008/2009)									
Farmer scheme	P1	8.203	12.223	11.460	9.673	41.559	0.853	1.470	1.855	1.788	5.966
	P2	8.488	12.560	11.760	10.523	43.331	0.878	1.528	1.898	1.865	6.169
	P3	8.973	12.630	12.880	11.130	45.613	1.008	1.480	2.013	1.908	6.409
	Mean	8.554	12.471	12.033	10.442	43.501	0.913	1.493	1.922	1.853	6.181
Bed-furrow irrigation	P1	6.818	10.443	9.963	8.733	35.957	0.728	1.115	1.648	1.530	5.021
	P2	7.358	10.943	11.538	8.750	38.589	0.740	1.220	1.808	1.493	5.261
	P3	7.568	11.818	11.818	9.243	40.447	0.750	1.438	1.803	1.633	5.624
Mean		7.248	11.068	11.106	8.910	38.331	0.739	1.258	1.753	1.552	5.302
LSD,05	Irrigation	0.10	0.16	0.25	0.19	0.45	0.01	NS	0.01	0.02	0.12
	P - rate	0.11	0.12	0.28	0.13	0.58	0.01	NS	0.06	0.02	0.12
	Interaction	NS	0.18	0.40	0.18	0.82	0.02	NS	NS	0.03	0.16

*** P1, P2 and P3 are referred to 15, 30 and 45 kg P_2O_5/fed rates, respectively.**

Data in Table(3) indicated that the total fresh and dry berseem yields seemed to increase as P-fertilizer rates increased. The increases, in total fresh yield were 9.37 and 13.61%, in 1st season, under P2 and P3,as compared with P1, respectively.. The corresponding total fresh yield increases, in 2nd season, comprised 5.68 and 11.13%, in the same order, respectively. With respect to dry berseem yield the increases reached 5.46 and 8.29% in 1st season and 4.29 and 7.05% in the second one, respectively, under P2 and P3 rates, as compared with P1 rate. These results are in full agreement with those reported by Nassar *et al*. (2001). Moreover, Haque (1998), on an Ethiopian P-deficient Vertisol, evaluated the effectiveness of Egyptian Phosphate Rock (EPR) relative to Triple Super Phosphate (TSP),

applied as one dose, at0, 15, 30, 45, and 60 kg P ha^{-1} rates, and their effects were followed on seven consecutive annual clover crops. The author found that clover responded to P at all the rates used. Significant ($P<0.05$) P effects on clover DM yields were observed up to the fourth crop. On justifying such findings, Kabesh *et al*.,1989 and EL – Koumy *et al*.,1993, stated that one of the fundamental roles of P, in plant nutrition, is increasing the meristemic tissues in the plants which uptake much of P in the early growth stages resulting in enhanced root development and macro and micronutrients uptake which reflected on higher crop fresh and dry yields.

Yield quality characters

Leaves/ stem ratio(L/S Ratio)

Data in Table(4) clear out that , under bed-furrow irrigation scheme, leaves/stem ratio (on fresh weight basis) was reduced at the different cuttings, except the first one, comparable with those under farmer irrigation scheme. Nevertheless, on dry weight basis the trend was completely differed, where higher L/S values were recorded under bed-furrow irrigation practice and such findings were true in the two seasons of study. The differences were mostly significant in 1st season, while in 2nd season were mostly insignificant. Furthermore, irrespective of irrigation practices, P-rate exhibited significant effect to increase such trait in most cuttings either on fresh or dry weight basis in 1st and 2nd seasons. The interaction revealed different trends to influence leaves/stem ratio on fresh and dry weight basis.

On 4 cuttings average, L/S ratio(on fresh weight basis), under farmer irrigation practice increased by 4.44 and 6.67% in 1st and 2nd seasons, respectively, more than that under bed-furrow irrigation practice. Nevertheless, on dry weight basis, bed-furrow irrigation practice seemed to surpass the farmer one in this respect, since 4 cuttings L/S ratio average was increased by 5.71 and 4.23 % in 1st and 2nd seasons, as compared with the farmer practice, respectively. So, berseem clover production under bed-furrow irrigation scheme may be preferable due to higher L/S ratio(on dry weight basis). In this respect, Brink and Fairbrother (1992), stated that the softer tissues of berseem clover e.g. leaves are characterized with higher nutritive value owing to its content of photosynthetic assimilates which is including carbohydrates, vitamins, more digestible proteins and other macro and micro nutrients compared with stem .

Data also revealed that increasing P-rate tended to improve L/S ratio either on fresh weight or on dry weight basis. The increases, as 4 cuttings average, in L/S ratio (on fresh weight basis) comprised 7.32 and 17.07% in 1st season and 7.32 and 17.07% in 2nd season under P2 and P3 rates, comparable with P1 rate, respectively. The L/S ratio (on dry weight basis) exhibited the same trend, since the increases were 9.90 and18.18% in 1st season and 7.46 and 19.40% in 2nd season under P2 and P3 rates, compared with P1 rate, respectively. In connection, Iannucci *et al*., (1996), reported that high leaf/stem ratio produce higher quality forages or hays and thus are preferred for cultivation by the farmers.

Table (4): Leaves / stem ratio (wt/wt) on fresh and dry weight basis for berseem clover, at different cuttings as influenced by irrigation scheme, P- rate and their interaction

Irrigation scheme	P- rate*	Fresh weight				Mean	Dry weight				Mean
		Cutting number					Cutting number				
		I	II	III	IV		I	II	III	IV	
		The first season(2007/2008)									
Farmer scheme	P1	0.36	0.42	0.39	0.49	0.42	0.63	0.72	0.61	0.63	0.65
	P2	0.40	0.47	0.47	0.50	0.46	0.65	0.77	0.72	0.70	0.71
	P3	0.40	0.48	0.47	0.53	0.47	0.66	0.79	0.77	0.73	0.74
	Mean	0.39	0.46	0.44	0.51	045	0.65	0.76	0.70	0.69	0.70
Bed-furrow irrigation	P1	0.43	0.34	0.37	0.43	0.39	0.68	0.66	0.66	0.69	0.67
	P2	0.44	0.38	0.39	0.45	0.42	0.72	0.75	0.74	0.70	0.73
	P3	0.46	0.49	0.48	0.48	0.48	0.80	0.95	0.76	0.78	0.82
Mean		0.44	0.40	0.41	0.45	0.43	0.73	0.79	0.72	0.72	0.74
LSD,05	Irrigation	0.02	0.01	NS	0.02		0.03	NS	0.01	0.02	
	P - rate	0.01	0.02	0.17	0.02		0.04	0.03	0.02	0.03	
	Interaction	NS	0.03	NS	NS		NS	0.04	0.02	0.04	
		The second season(2008/2009)									
Farmer scheme	P1	0.36	0.41	0.41	0.50	0.42	0.62	0.72	0.61	0.67	0.66
	P2	0.38	0.46	0.43	0.54	0.45	0.65	0.82	0.72	0.68	0.72
	P3	0.40	0.48	0.47	0.56	0.49	0.66	0.84	0.81	0.73	0.76
	Mean	0.38	0.46	0.44	0.53	0.45	0.64	0.79	0.71	0.69	0.71
Bed-furrow irrigation	P1	0.43	0.34	0.36	0.43	0.39	0.67	0.65	0.67	0.68	0.67
	P2	0.45	0.39	0.39	0.44	0.42	0.70	0.75	0.72	0.69	0.72
	P3	0.47	0.40	0.46	0.49	0.46	0.80	0.97	0.75	0.78	0.83
Mean		0.45	0.38	0.40	0.45	0.42	0.72	0.79	0.71	0.71	0.74
LSD,05	Irrigation	0.04	0.03	NS	0.01		0.02	NS	NS	NS	
	P - rate	NS	0.02	NS	0.02		0.02	0.04	0.02	0.02	
	Interaction	NS	NS	NS	NS		0.02	0.05	0.02	NS	

*** P1, P2 and P3 are referred to 15, 30 and 45 kg P_2O_5/fed rates, respectively.**

Crude protein and crude fiber yields

Data in Table(5) clear out that, irrespective of irrigation scheme and P-rates, protein yield gradually increased up 3rd cutting and then tended to decrease at 4th one, in 1st and 2nd seasons. Protein yields were significantly affected due to the adopted irrigation scheme, in 1st season, at 3rd and 4th cuttings and total as well, meanwhile, in 2nd season, a significant effect was observed up to 4th cutting besides the total yield. Furthermore, P- rates significantly altered protein yields up to 4th cuttings and total as well, in the two seasons of study. Interaction effect was mostly significant (1st season) and significantly influenced protein yields at different cuttings.

Data in Table (5) revealed that , under bed-furrow irrigation practice, total crude protein yields were reduced by 21.54 and 16.59%, in 1st and 2nd seasons, comparable with the farmer practice, and such reductions are due to the reductions in total dry yields. Regardless the effect of irrigation practices and P- rates, protein yield was mostly tended to increase up to the third cutting and then decreased in the fourth one which could be attributed to the reduction in growth rate. In connection, Lazaridou, Martha and Koutroubas (2004), found that growth rate (GR) of irrigated berseem clover increased progressively, being lower at early vegetative stage and higher at the beginning of flower stage. Total crude protein yield seemed to enhance

due to increasing P- rate, where the increases comprised 14.48 and 31.47% in 1st season and 13.02 and 29.25% in 2nd season, under P2 and P3 rates, respectively, as compared with P1 rate. Nassar *et al.(*2001) stated that , irrespective of P-source, N- uptake by different organs of clover plants was significantly increased du to increasing P- rate up to 45 Kg P_2O_5/fed.

Data in Table (5) revealed that, crude fiber yields gradually increased up to 4th cutting, regardless irrigation practices and P-rates under study. Such findings were true in 1st and 2nd seasons. Moreover, both irrigation practices and P-rates treatments and interaction as well significantly affected fiber yield at different cuttings and such results were true in 1st and 2nd seasons.

Table (5): Crude protein and crude fiber yields on dry weight basis for berseem clover, at different cuttings and total, as influenced by irrigation scheme, P- rate and their interaction

Irrigation scheme	P- rate*	Crude protein yield(ton/fed)				Total	Crude fiber yield(ton/fed)				Total
		Cutting number					Cutting number				
		I	II	III	IV		I	II	III	IV	
		The first season(2007/2008)									
Farmer scheme	P1	120	212	375	298	1005	150	254	360	420	1184
	P2	148	221	406	330	1105	162	355	433	491	1441
	P3	150	268	485	385	1288	176	378	520	574	1648
	Mean	139	234	422	338	1133	163	329	438	495	1425
Bed-furrow irrigation	P1	128	177	208	235	748	108	221	406	444	1179
	P2	135	247	268	253	903	181	294	431	480	1386
	P3	153	253	345	266	1017	238	400	450	520	1608
	Mean	139	226	274	251	889	176	305	429	481	1391
LSD, 05	Irrigation	NS	NS	0.62	0.39	1.59	0.64	1.73	1.79	1.03	2.27
	P - rate	1.34	1.02	1.56	1.10	3..06	1.44	0.99	2.12	1.74	4.24
	Interaction	NS	1.45	2.21	1.56	4.33	2.03	1.39	3.00	2.46	NS
		The second season(2008/2009)									
Farmer scheme	P1	173	311	248	240	972	147	251	320	413	1131
	P2	182	337	333	315	1167	200	353	354	430	1337
	P3	184	382	345	332	1243	240	371	500	520	1631
	Mean	180	343	309	296	1127	196	325	391	454	1366
Bed-furrow irrigation	P1	95	258	252	236	841	142	244	315	366	1077
	P2	122	230	293	236	881	152	248	350	384	1134
	P3	143	364	315	277	1099	230	260	431	450	1371
	Mean	120	284	787	250	940	175	251	365	400	1194
LSD, 05	Irrigation	0.14	0.93	0.16	0.36	2.04	0.36	1.04	3.25	0.39	3.28
	P - rate	0.04	0.78	1.37	0.47	3.10	0.81	0.85	3.42	0.74	5.18
	Interaction	0.57	1.11	1.94	0.66	4.39	1.14	1.21	4.84	1.04	7.33

*** P1, P2 and P3 are referred to 15, 30 and 45 kg P_2O_5/fed rates, respectively.**

Total crude fiber yield was decreased by 2.38 and 12.59% in 1st and 2nd seasons under bed- furrow irrigation scheme, respectively, comparable with farmer irrigation one. Crud fiber yield seemed to enhance due to increasing P- rate, where the increases comprised 19.63 and 37.73% in 1st season and 11.96 and 35.96% in 2nd season, under P2 and P3 rates, respectively, as compared with P1 rate. Such increases in crude protein and crude fiber yields may be attributed to the role of P, in plant nutrition, which help increasing the

meristemic tissues in the plants which up take much of P in the early growth stages resulting in enhanced root development and macro and micronutrients uptake which consequently reflected on higher crop fresh and dry yields as previously reported by Kabesh *et al*.,1989 and EL- Koumy *et al*.,1993.

Seasonal applied water, water productivity and P- Use efficiency

Data in Table (6) illustrated that the seasonal applied water under bed-furrow scheme were reduced by 19.78 and 21.14%, in 1st and 2nd seasons, comparable with farmer practice, respectively. These results are in accordance with those reported by Aboulenien *et al*.(2010), who stated that growing berseem on raised seed bed saved 18% of applied irrigation water, as compared with the farmer practice(flat method).In connection, Aboulenien *et al*.(2009), found that wide- furrows irrigation (on old lands) was effective to reduce the applied water quantity for wheat and corn crops by 23.0 and 22.0%, respectively, as compared with the farmer practices.

Table (6): Seasonal water applied , water productivity and P- Use Efficiency for total berseem clover yield as influenced by irrigation scheme , P- rate and their interaction.

Irrigation scheme	P- rate*	Water applied (mm)	Water productivity (kg/fed/mm)		P- Use Efficiency (kg/kg P_2O_5)	
			Total fresh yield basis	Total dry yield basis	Total fresh yield basis	Total dry yield basis
	The first season (2007/2008)					
Farmer scheme	P1	910	47.088	6.140	2856	372
	P2		50.137	6.474	1521	196
	P3		52.698	6.648	1066	134
	Mean		50.238	6.421	1814	234
Bed-furrow irrigation	P1	730	48.603	6.421	2365	336
	P2		54.966	7.260	1337	177
	P3		56.199	7.470	917	121
	Mean		53.256	7.050	1540	203
Farmer scheme	**The second season (2008/2009)**					
	P1	880	47.226	6.235	2770	398
	P2		49.240	7.581	1444	206
	P3		51.833	7.283	1014	142
	Mean		49.433	7.033	1743	249
Bed-furrow irrigation	P1	694	51.811	7.278	2397	335
	P2		55.604	7.581	1286	175
	P3		58.281	8.104	899	125
	Mean		55.232	7.656	1527	212

*** P1, P2 and P3 referred to 15, 30 and 45 kg P_2O_5/fed rates, respectively**

Water productivity is an efficiency term quantified as a ratio of product output (goods and services) over water input. The output could be biological goods such as crop grain, fodder….etc. So, The estimated water productivity, in the present study, is expressed as kgs of total berseem yield(fresh or dry) obtained due to applying one mm depth of irrigation water per feddan.

Accordingly, data in Table(6) revealed that bed-furrow irrigation practice resulted in higher water productivity values (on total fresh yield basis) reached 6.01 and 29.84.75% in 1st and 2nd seasons, respectively, as compared with farmer irrigation scheme. Similar trend for water productivity values (on total dry yield basis) was noticed where the increase values comprised 9.80 and 8.86% in1st and 2nd seasons, respectively. El-Babbly (2002), stated that reducing number of irrigation events, between each two cuttings, to be one or two irrigation(s) tended to increase water use efficiency (kg dry matter/fed/cm consumed water) for Egyptian clover by 32.43 and 7.66 %, respectively, more than that with three irrigation events between each two cuttings. Furthermore, Lazaridou, Martha and Koutroubas (2004), stated that water stress resulted in an increased water use efficiency for irrigated berseem clover and the highest value was obtained at the beginning of the flower stage. In addition, Lovelli *et al*.(2007), reported that, generally, it is accepted for forages and other crops that water deficiency determines a more efficient water use. Aboulenien *et al*.(2010), found that, on Egyptian old lands, growing berseem on raised seed bed, increased water productivity value (as m^3/kg fresh yield) to be 39.14% more than that under the farmer practice(flat method).In this sense, 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.

Data in Table(6) revealed that, irrespective of irrigation practices, increasing P rate seemed to increase water productivity value. In 1st season water productivity value, on total fresh yield basis, was increased by 9.55 and 13.79% under P2 and P3 rates, respectively, comparable with P1 rate. The corresponding increase values in 2nd season reached 5.86 and 11.18% in the same order. On the total dry yield basis, similar trends were recorded since the increase values comprised 9.33 and 12.38% in 1st season and 12.19 and 13.87% in 2nd one under P2 and P3 rates, respectively, as compared with P1 rate. In connection, Mechergui *et al.(*1989) stated that P-fertilization enhanced water use efficiency for barley and bread wheat grown under rainfed conditions. In addition, Othman, Sanaa and EL-Sharkawy, Amal (2006) found that increasing P rate, over the recommended rate, exhibited higher water utilization efficiency for faba bean crop.

The P- Use Efficiency parameter quantifies, in the present study, the total resultant berseem yield (on fresh or dry basis) due to applying the unit of P_2O_5, in single super phosphate fertilizer form . Data in Table (6) cleared out that the calculated P- Use Efficiency values, on total fresh yield basis, were reduced under bed-furrow irrigation by 15.10 and12.39% in 1st and 2nd seasons, respectively, as compared with the farmer irrigation practice. The same trend was observed, as P - Use Efficiency was determined on total dry yield basis, since the corresponding reduction values reached13.25 and 24.83% in 1st and 2nd , respectively. This could be attributed to less applied irrigation water under bed-furrow irrigation practice which in turn reduced both total fresh and dry yields. In general, P- Use Efficiency value, on total fresh or dry yield basis, tended to reduce as P- rate increased. The reductions in P-Use Efficiency values, on total fresh yield basis, were 45.27 and 62.05% in 1st season and 47.29 and 64.86% in 2nd one under P2 and P3 rates,

respectively, comparable with P1 rate. In addition, the reductions in PUE values, on total dry yield basis, comprised 47.32 and 63.98% in 1st season and 59.14 and 71.38% in 2nd season under P2 and P3 rates, respectively, compared with P1 rate. Although fresh and dry berseem yields seemed to increase as P-rate increased (Table 3), the reduction in P- Use Efficiency value could be justified as those increases in both total fresh and dry yields of berseem were not proportioned with the increase in P- rate. These results previously reported by Othman, Sanaa and EL-Sharkawy, Amal (2006) with faba bean .

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تأثير اسلوب الري و معدل التسميد الفوسفاتي علي النمو و المحصول وجودة و انتاجية مياة الري للبرسيم المصري (المسقاوي) في أراضي وسط دلتا نهرالنيل

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1. اقيمت تجربة حقلية بمزرعة محطة البحوث الزراعية بالجميزة (وسط دلتا النيل) في موسمي 2008/2007، 2009/2008 بغرض معرفة تأثير اسلوب الري و معدل التسميد الفوسفاتي و تفاعلهما علي النمو و المحصول وجودتة و انتاجية مياة الري للبرسيم (المسقاوي – صنف جميزة 1). صممت التجربة في قطع منشقة في ثلاثة مكررات حيث احتلت معاملتي الري بالمصاطب و ري المزارع (التقليدي) القطع الرئيسة بينما وضعت معدلات التسميد الفوسفاتي 15 ، 30 ، 45 كجم فو$_2$ا$_5$ للفدان بالقطع التحت رئيسة. أهم النتائج يمكن ايجازها في الآتي :-
2. انخفضت صفة ارتفاع النبات معنويا (في كل الحشات) مع الري بالمصاطب مقارنة بري المزارع في موسمي الزراعة. متوسط عدد أوراق الساق تحسن مع الري بالمصاطب. كلا من صفتي ارتفاع النبات و متوسط عدد الأوراق بالساق زادتا بزيادة معدل التسميد الفوسفاتي .
3. المحصول الكلي للبرسيم(طازج و جاف) ازداد مع استخدام ري المزارع وكدلك مع زيادة معدل التسميد الفوسفاتي وذلك في موسمي الزراعة.
4. نسبة الأوراق الي الساق كانت أفضل مع الري بالمصاطب ، علي أساس الوزن الجاف، . زيادة معدل التسميد الفوسفاتي أدي أيضا الي تحسن هذة الصفة. انخفض محصول البروتين مع الري بالمصاطب و لكن زيادة معدل التسميد الفوسفاتي أدي الي زيادته ونفس الاتجاة كان مع محصول الألياف.
5. كميه مياه الري المضافه تحت الري بالمصاطب كانت أقل ب 19.78 و 21.14% مقارنة بري المزارع في موسمي الزراعة ، علي التوالي وكذا تحسنت انتاجية مياة الري تحت الري بالمصاطب. أدت زياده معدل التسميد الفوسفاتي الي تحسن انتاجية مياه الري. انخفضت كفاءه استخدام السماد الفوسفاتي مع الري بالمصاطب ، ويرجع ذلك أساسا الي انخفاض كلا من المحصول الكلي الطازج و الجاف تحت هذا النظام من الري. بصفة عامة انخفضت كفاءة استخدام السماد الفوسفاتي بزيادة معدل التسميد .

قام بتحكيم البحث

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