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NUTRIENTS UPTAKE BY RICE PLANT AND GRAIN PROTEIN CONTENT AS AFFECTED BY IRRIGATION DEPTH AND RICE CULTIVARS GROWN IN NILE DELTA.

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ABSTRACT

Two field experiments were conducted at Sakha Agricultural Research Station, through the two growing seasons (1999 and 2000) in the Middle Delta region, to study the effect of three irrigation depths and some rice cultivars on protein content in rice grains , percentage and uptake of N, P and K in rice straw and grains.

The protein content in rice grains , the percentage and uptake of N, P and K in rice grains and straw were increased with increasing irrigation depth up to 7.5 cm., but this increase was not significant. The mean values of percentage and uptake of N, P and K in rice grains can be arranged as follows: N > P > K, while in rice straw can be arranged as follows: K > N > P.

Data also indicated that the mean values of N, P and K in rice straw were higher under rice cultivar Sakha 101 than those obtained under the other two rice cultivars, Giza 171 and Giza 177.

On basis of these mean values of the planted cultivars , they can be arranged as follows: Sakha 101 > Giza 171 > Giza 177 rice cultivars. While the mean value of N, P and K uptake in rice grains of studied cultivars can be arranged as follows: Sakha 101 > Giza 177 > Giza 171. Increasing the amount of irrigation water applied led to an increase in protein content in rice grains and N, P and K percentage and uptake of both rice grains and straw.

INTRODUCTION

Rice is the second important food crop in the world, and will become increasingly more valuable as the population of developing countries, many of them are depending on rice, continue to increase. One hope that every one would get food at present and future.

Rice yield can be increased with increasing irrigation water depth. The current study was designed to determinate the effects of three irrigation water depths and some rice cultivars on protein content of rice grains and N, P and K percentage and uptake in rice grains and straw. Obermueller and Mikkelesen (1974), reported that the concentration of nitrogen was not affected by water management. Nour (1989), studied the effect of irrigation interval (8 and 12 days) on rice. The results showed that increasing the irrigation interval up to 12 days decreased N, P and K content in rice shoots at all sampling dates. In grains N and P % decreased, while K % increased. Protein content was not affected by irrigation interval. Nour et al., (1994b) found that nitrogen was significantly decreased as irrigation interval increased from 6 to 12 days.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station in the Middle Delta region during the two growing seasons, 1999 and 2000. The soil of the experimental field is clayey texture. Sugar beet (*Beta vulgaris* L.) and Faba bean (*Vica faba*) were cultivated prior to the first growing season 1999. While the soil was left as follow prior to the second growing season 2000.

Disturbed soil samples were taken from the experiment site in the two growing seasons before conducting the experiment at different depths namely: 0-20, 20-40 and 40-60 cm. in the first growing season 1999.

While in the second growing season 2000, the depths were namely: 0-15, 15-30, 30-45 and 45-60 cm. Soil samples were air dried and grounded to pass through 2 mm sieve. Determinations of some soil chemical and physical properties were done as follows:

1- The soluble cations, anions and electrical conductivity were estimated in the soil paste described by Jackson (1967). Exchangeable Sodium percentage (ESP), Exchangeable Sodium ratio (ESR) and Sodium adsorption ratio (SAR) were estimated by using flame photometer and according to Jackson (1967).
2- Particle size distribution of the soil sample at different depths was determined according to the international method (Piper, 1950).

Soil physical and chemical properties of the two field experiments are presented in Tables (1 and 2).

A split plot design with four replicates was used in this current study. The main plots were randomly assigned to the rice cultivars, Giza 171 and Giza 177 in the first growing season 1999. While, in the second growing season 2000, three rice cultivars were used, Giza 171, Giza 177 and Sakha 101. The listed rice cultivars could be arranged in descending order in relation to the mean values of the elongation of growing period in the two growing seasons as following, Giza 171 (142 days) > Sakha 101 (137 days) > Giza 177 (117 days). The subplots were assigned to the irrigation treatments as follows:

I_1 : Watering every 6 days intervals, raising the submerged head to 2.5 cm. (1 inch) depth during irrigation.
I_2 : Watering every 6 days intervals, raising the submerged head to 5.0 cm (2 inches) depth during irrigation.
I_3 : Watering every 6 days intervals, raising the submerged head to 7.5 cm (3 inches) depth during irrigation.

The field of the experiment was dry leveled to allow irrigation water to spread uniformity on all plots. Field area was divided into 36 plots, each plot was 7x7.5 m^2 and isolated from the others to prevent the horizontal water movement.

Rice cultivars, Giza 171 and 177, were planted in 1999 growing season. While, in 2000 growing season, the cultivated rice cultivars were Giza 171, Giza 177 and Sakha 101. Field preparation and nursery practices performed according to the traditional local management. Date of sowing, transplanting, harvesting for different cultivars in the two growing seasons are presented in Table 3.

Table (1): Mean values of some soil chemical properties before transplanting in the two growing seasons (1999 and 2000).

Growing Seasons	Soil depth, cm.	SAR	ESP	ESR	E.C, mmhos/ cm / 25°c	Soluble cations, meq/L				Soluble anions, meq/L			
						Ca^{++}	Mg^{++}	Na^{++}	K^{+}	Co^{-}	Hco^{-}	Cl^{-}	So_4^{--}
1999	0-20	2-0	1.67	0.017	1.1	4.41	3.70	4.00	0.192	0.25	4.5	5.7	1.85
	20-40	3.73	4.02	0.042	1.45	5.10	3.08	7.35	0.174	0.25	3.0	10.45	1.99
	40-60	2.99	3.06	0.032	1.09	3.29	2.55	6.13	0.215	0.25	4.25	6.65	1.41
2000	0-15	2.47	2.34	0.024	1.4	5.10	4.87	5.50	0.216	0.25	5.0	9.0	1.33
	15-30	2.32	2.11	0.022	1.35	4.46	5.26	5.05	0.169	0.25	4.50	9.95	0.24
	30-45	4.26	5.38	0.050	2.05	7.16	4.33	10.28	0.140	0.50	2.75	11.4	7.25
	45-60	4.68	5.15	0.056	2.8	10.78	5.21	13.20	0.197	0.5	3.0	10.5	15.39

Table (2): Mean values of some soil physical properties of the permanent field before rice cultivation in the two Growing seasons (1999 and 2000).

Soil depth, Cm	Particle size distribution			Texture class	Bulk Density, kg/m^3	Field capacity %	Permanent wilting point %	Available water %
	Sand %	Silt %	Clay %					
0-15	12.30	33.30	54.40	Clay	1.26	47.50	25.81	21.69
15-30	20.20	34.20	45.60	Clay	1.31	39.87	21.66	18.21
30-45	20.40	41.40	38.20	Clay loam	1.29	38.40	20.86	17.54
45-60	21.10	41.50	37.40	Clay loam	1.38	36.39	19.78	16.61

Table (3): Date of some cultural practices in the two growing seasons.

The practices	1999		2000		
	Giza 171	Giza 177	Giza 171	Giza 177	Sakha 101
Sowing	June, 7	May, 8	May, 8	May, 8	May, 8
Transplanting	July, 12	July, 12	June, 9	June, 9	June, 9
Harvesting	October, 24	October, 4	October, 6	September, 9	September, 26

Seedlings were transplanted in hills (from four to five single plants per each hill) with spacing of 20x20 cm (hills x rows) according to rice cultivar Giza 171. Where, Giza 177 was transplanted on spacing of 15x15 cm (hills x rows) in the first growing season 1999. In the second growing season 2000, the three rice cultivars. were used, the two cultivars Giza 171 and 171 were transplanted as the former growing season 1999, in addition to Sakha 101 rice cultivar which was transplanted on spacing of 20 x 20 cm.

The amount of nitrogen fertilizer was applied to each cultivar according to the recommended doses reported by Crops Research Institute, Agricultural Research Center (A.R.C). Nitrogen fertilizer was splitted into two doses, the first dose which equaled to 2/3 of the total nitrogen amount was in urea form (46.5 % N), where the recommended nitrogen requirements for Sakha 101 and Giza 177 rice cultivars are 60 nitrogen unit per feddan. The second dose was added after 25 days from transplanting in the two growing seasons of study (Table 4).

Table (4): Dates and amounts of N and P fertilizers added in the two growing seasons (1999 and 2000).

Date and amount of fertilizer	1999		2000		
	Giza 171	Giza 177	Giza 171	Giza 177	Sakha 101
Date of phosphorus application	No - application	No - application	5/6/2000	5/6/2000	5/6/2000
Amount of phosphorus fertilizer	No – application	No – application	100kg P_2O_2/Fed	100kg P_2O_2/Fed	100kg P_2O_2/Fed
Date of nitrogen application	2/3 the amount of nitrogen was applied during land preparation and the second does was applied after transplanting with 25 days				
Amount of nitrogen fertilizer	40 N unit	60 N unit	40 N unit	60 N unit	60 N unit

The phosphatic fertilizer didn't apply in the first growing season, because the prior crop was faba bean (vica faba). But in the second growing season, the phosphatic fertilizer was applied during tillage implementation as the recommended dose of 100 kg single super phosphate (15.5 % $P_2 O_5$ / Fed). The irrigation treatments were initiated 21 days after transplanting in the first growing season 1999. In the second growing season 2000, irrigation treatments were practised after 14 days from transplanting.

All plots were treated in a similar manner for all agricultural process. Weeds and grasses were controlled, as necessary, manually. However, no herbicides or insecticides were used. The nursery requirements for fertilization were added according to the recommend doses reported by Crops Research Institute, agricultural Research Center (A.R.C).

Plant samples (shoots, leaves and grains) were collected from each plot at the end of the two growing seasons. Each plant sample was washed with distilled water thoroughly and was dried in an oven at 65°c for 24 hours. One gram of each sample was wet digested in $H_2 SO_4$ - $H_2 O_2$ mixture to determine the concentration and uptake of the three major elements (N,P, and K) according to Chapman and Pratt (1961). Total nitrogen concentration was determined by using Micro-Kejeldhal method. Phosphorus was determined by using ascorbic acid method according to Murphy and Riely (1962). Potassium was measured according to black (1965) by using flame photometer. Rice grain and straw yields were determined per plot and then converted to yield in ton/ fed. at harvesting date.

RESULTS AND DISCUSSION

1- Effect of water depth and some rice cultivars on:

a- Yield of rice grain and straw:

Data presented in Table (5) illustrated that the mean values of rice grain and straw yields were increased with increasing irrigation water depth up to 7.5 cm under studied rice cultivars, where the highest mean values were recorded for both rice grain and straw yields. On the contrary, the lowest mean values were recorded at 2.5cm, irrigation water depth. Data also showed that there is no significant difference in rice grain and straw yields among all irrigation depths (2.5, 5.0 and 7.5 cm). The values of rice grain yield for all rice cultivars and can be arranged as follows: Sakha 101 > Giza 177 > Giza 171, while for rice straw yield they can be arranged as follows: Sakha 101 > Giza 177 > Giza 171 rice cultivars.

Table (5): Effect of irrigation water depth and some rice cultivars on both grain and straw yields grown in the Nile Delta in the two growing seasons (1999 and 2000).

A- First growing season, 1999.

Irr. Depth, cm	Grain yield, tons/ Fed. Rice cultivars		Straw yield, tons / Fed. Rice cultivars	
	Giza 171	Giza 177	Giza 171	Giza 177
2.5	2.13	3.31	3.66	3.69
5.0	2.34	3.60	4.09	3.94
7.5	2.60	3.92	4.38	4.26

B- second growing season, 2000.

Irr. Depth, cm	Grain yield, tons/ Fed. Rice cultivars			Straw yield, tons / Fed. Rice cultivars		
	Giza 171	Giza 177	Sakha 101	Giza 171	Giza 177	Sakha 101
2.5	2.08	3.04	5.28	4.07	3.59	5.59
5.0	2.34	3.40	5.98	4.55	3.95	6.29
7.5	2.71	3.49	6.17	5.56	4.06	6.88

The slight increase in rice grain and straw yields with increasing water depth up to 7.5 cm might be due to increasing the availability of nutrients in soil and hence, increasing plant uptake of both water and absorbed nutrients which in turn were reflected on obtaining high yields. These findings are in agreement with those obtained by Mahrous *et al.*, (1984); Mahrous and Aly (1986); Nour (1989); Abo–Soliman *et al.*, (1990); Marazi *et al.*, (1993); Kreem (1994); Nour *et al.*, (1994C) and Ibrahim *et al.*, (1995).

Percentage and uptake of N, P and K in rice grains and straw and protein content in rice grains.

Clarified data presented in Tables (6 and 7) showed the effects of irrigation water depth and some rice cultivars on protein content in rice grains N, P and K percentage and uptake in both rice grains and straw in the two growing seasons, 1999 and 2000. It could be observed that protein content in rice grains and N, P and K percentage and uptake by both rice grains and straw were increased with increasing irrigation water depth up to 7.5 cm. But this increase wasn't significant.

Nitrogen percentage and uptake in rice grains and straw were increased with increasing irrigation water depth up to 7.5 cm., where the highest mean values for both percentage and uptake in rice grains and straw were recorded at 7.5 cm in comparison with those obtained at the other two depths, 2.5 and 5.0 cm. This may be due to the increase in soil nitrogen which is taken up through plant roots from soil solution as a result of absorbing huge amount of water within the growth stages. Similar results were obtained by Singandhupe and Rayupt (1990), where they reported that nitrogen percentage and uptake were higher with the continuous submergence conditions.

The mean values of protein content in rice grains were increased with increasing irrigation water depth up to 7.5 cm, under all the studied rice cultivars.

This may be due to the increment in total N% in grains which play an important role in synthesis of amino acids and also crude protein.

Phosphorus percentage and uptake in rice grain and straw were increased with increasing irrigation water depth up to 7.5 cm., where the highest mean values for both percentage and uptake for all studied rice cultivars were obtained under 7.5cm. This may be due to increasing the availability of phosphorus by reducing the ferric phosphate to the form of soulble ferrous phosphate and also the other forms of insoulble phosphate which will be changed to be more available. These results are in a great harmony with those obtained by Yadav (1972), Obremieller and Mikkelsen (1974) and Pandey *et al.*, (1992).

Potassium percentage and uptake in rice grain and straw were increased also with increasing irrigation water depth up to 7.5 cm, where the highest mean values were recorded at this depth for all studied rice cultivars in the two growing seasons. This increase in potassium percentage and uptake in rice grain and straw may be due to the water enhance of solvability

Table (6): Effect of irrigation water depth and some rice cultivars on N, P and K percentage and uptake and protein content in rice grains in the two growing seasons (1999 and 2000).

Growing Season		Giza 171							Giza 177							Sakha 101						
		N		protein	P		K		N		protein	P		K		N		protein	P		K	
		%	Uptake, kg/fed	Content	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	Content	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	Content	%	Uptake, kg/fed	%	Uptake, kg/fed
1999	2.5	0.63	13.36	3.73	0.37	7.82	0.22	4.73	0.73	24.26	4.36	0.33	12.19	0.19	6.45	-	-	-	-	-	-	-
	5.0	0.68	15.82	4.02	0.45	10.99	0.23	5.40	0.83	29.84	4.93	0.34	12.51	0.20	7.11	-	-	-	-	-	-	-
	7.5	0.95	24.60	5.63	0.46	12.62	0.23	6.08	0 95	37.32	5.67	0.37	14.62	0.20	7.97	-	-	-	-	-	-	-
2000	2.5	0.49	10.15	2.90	0.41	8.42	0.16	3.21	0.59	17.88	3.50	0.23	7.08	0.16	4.84	0.47	24.60	2.78	0.34	15.97	0.16	8.68
	5.0	0.54	12.59	3.20	0.45	10.53	0.17	3.99	0.66	22.44	3.93	0.34	11.49	0.18	5.96	0.50	30.02	2.98	0.36	21.33	0.20	11.75
	7.5	0.63	17.18	3.78	0.53	14.23	0.19	5.03	0.68	23.63	4.04	0.44	15.42	0.20	6.83	0.55	34.06	3.29	0.42	25.95	0.25	12.24

Rice cultivar Sakha 101 did not cultivate in 1999 season.

Table (7): Effect of irrigation water depth and some rice cultivars on N, P and K percentage and uptake by rice straw in the two growing seasons (1999 and 2000).

Growing Season	Irrigation depth (cm)	Giza 171						Giza 177						Sakha 101					
		N		P		K		N		P		K		N		P		K	
		%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed	%	Uptake, kg/fed
1999	2.5	0.37	13.62	0.15	5.07	1.72	61.97	0.35	12.84	0.08	3.14	1.84	68.08	-	-	-	-	-	-
	5.0	0.41	16.93	0.20	9.19	1.86	73.95	0.36	14.03	0.14	5.61	2.19	86.55	-	-	-	-	-	-
	7.5	0.44	19.27	0.24	11.93	2.02	86.60	0.54	21.57	0.14	5.66	2.21	88.42	-	-	-	-	-	-
2000	2.5	0.21	8.59	0.22	8.87	1.43	59.87	0.21	7.59	0.11	3.89	1.68	60.88	0.25	14.09	0.15	8.20	1.47	82.04
	5.0	0.25	11.15	0.24	10.92	1.47	67.30	0.21	8.37	0.20	7.70	1.69	66.21	0.29	18.05	0.19	11.70	1.67	104.67
	7.5	0.25	14.29	0.27	15.26	1.52	87.23	0.22	9.01	0.22	9.05	1.79	73.70	0.35	24.01	0.23	15.69	1.68	115.24

Rice cultivar Sakha 101 did not cultivate in 1999 season.

and subsequently the availability of nutrients particularly K in the soil solution besides increasing dry mater production. Similar results were obtained by Nour (1989).

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امتصاص العناصر بواسطة نبات الأرز ومحتوى البروتين في الحبوب وتأثرهم بعمق الري وأصناف الأرز النامية في دلتا النيل.

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أقيمت تجربتان حقليتان في المزرعة البحثية بسخا خلال موسمي النمو ١٩٩٩، ٢٠٠٠ في منطقة شمال الدلتا وذلك بهدف دراسة تأثير ثلاثة أعماق من مياه الري وبعض الأصناف من الأرز على محتوى البروتين في الحبوب وكذلك امتصاص النيتروجين، والفوسفور والبوتاسيوم في حبوب وقش الأرز.

زاد محتوى البروتين في الحبوب وكذلك النسبة المئوية وامتصاص عناصر النيتروجين والفوسفور والبوتاسيوم في حبوب وقش الأرز زيادة غير معنوية بزيادة عمق مياه الري حتى عمق ٧,٥سم. ويمكن ترتيب النسبة المئوية وكذلك امتصاص عناصر النيتروجين والفوسفور والبوتاسيوم في حبوب الأرز كالتالي: النيتروجين > الفوسفور > البوتاسيوم بينما في القش كانت كالتالي: البوتاسيوم > النيتروجين > الفوسفور.

أوضحت النتائج أيضا أن متوسط قيم امتصاص النيتروجين، والفوسفور، والبوتاسيوم بواسطة القش كانت أعلى للصنف سخا ١٠١ بالمقارنة بالصنفين الآخرين جيزة ١٧١، جيزة ١٧٧ والأصناف يمكن ترتيبها كالتالي من حيث امتصاص هذه العناصر: سخا ١٠١ > جيزة ١٧١ > جيزة ١٧٧بينما ترتيب الأصناف من حيث امتصاص الحبوب من هذه العناصر كالتالي: سخا ١٠١ > جيزة ١٧٧ > جيزة ١٧١.

أدت زيادة كمية مياه الري المضافة إلى زيادة المحتوى البروتيني في الحبوب وكذلك النسبة المئوية لعناصر النيتروجين، والفوسفور والبوتاسيوم في الحبوب والقش. دلت النتائج كذلك على زيادة محصول الحبوب والقش بزيادة عمق مياه الري حتى ٧,٥ سم تحت جميع الأصناف المدروسة ولكن هذه الزيادة كانت غير معنوية في موسمي الدراسة.