Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 52(4) (2014), 451–460 **http://annagricmoshj.com**

Effect of crop sequence and nitrogen levels on rice productivity

Ahmed M. Sheha, Nagwa R. Ahmed and Abdel-Aziz M. Abou-Elela
Crop Intensification Research Department, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt.

Corresponding author: dr.ahmedsheha67@yahoo.com, afmo67@yahoo.com

Abstract

Two field trials were conducted at the farm of El-Gemmiza Agriculture Research Station in 2011/2012 and 2012/2013 to study the effect of three nitrogen (N) levels and three crop sequences; CS1 (wheat / rice), CS2 (fahl berseem/sugar beet/rice) and CS3 (faba bean/rice) on the productivity of rice. Three levels of nitrogen used for rice crop were as follows: 75% kg N/fed. (N1), 100% kg N/fed. (N2) and 125% kg N/fed (N3) of the recommended N fertilizer rate for rice (70 kg N/fed). The experimental trial was based on a split plot design in a randomized complete block arrangement having three replications.

Results showed that crop sequence has significant increased grain yield/fed, plant height, straw yield/fed, panicle grains weight and no of filled grain/ panicle in both seasons, except, panicle length in the second season.

Straw yield and grain yield, 1000-grain weight and No of panicle/hill of rice were significantly affected by nitrogen levels in both seasons, and unfilled grains (%), plant height, No. of filled grains/panicle and panicle grains weight in the first season and panicale length in the second season.

The crop sequence of CS3 (faba been/rice) had great effect on the productivity of rice yield and yield components. Grain yield and most attributes were significantly affected by nitrogen fertilizer in both seasons. Increasing nitrogen fertilizer levels up to 125% kg N/fed of the recommended nitrogen rate of rice resulted in marked increases in grain yield (t/fed), straw yield, 1000-grain weight and No. of panicle/hill in both seasons.
The highest gross return was obtained with CS2.

Generally, it can be concluded that fertilizing with 125% kg N/fed of the recommended nitrogen rate of rice could improve the productivity of rice crop under the conditions of the present study. Higher rice yields were obtained after legume based sequence (CS3).

Keywords: crop sequence, nitrogen levels, rice, productivity

Introduction

Rice (Oryza sativa L.) is considered one of the most important cereal crops in Egypt but also all over the world. The total cultivated area of rice in Egypt was about 1,193,303 fed. in 2013 which produced 4,327,072 tons of paddy rice with an average of 3.96 t/fed. Improvement of rice production can be achieved through different agronomic practices. Nitrogen fertilizer levels and crop sequence are among these practices.

Nitrogen fertilization has a vital role in determining the percentage of nitrogen in the rice grains and nitrogen uptake by the rice plants (Ebaid and Ghanem, 2001). Kumar et al. (1995) reported that increasing nitrogen levels up to 120 kg N/ha significantly increased plant height, leaf area, yield components and grain yield. Rice growth characteristics as plant height, tillers /m^2, leaf area index, dry matter content, grain yield and its components (i.e., number of panicles/m^2, number of grains/panicle, percentage of filled grains and 1000-grains weight) were significantly increased when rice was fertilized with 144 kg N/ha (Mahrous et al., 1986 and Abd El-Wahab, 1998). Abou-Khalifa (2007) found that maximum tillering, panicale initiation, heading date, crop growth rate, leaf area index and grain yield were increased by increased nitrogen levels up to 165 kg N/ha. Increasing nitrogen efficiency through the use of optimum nitrogen fertilizer level is very important factor to obtain high yield of rice (Abd El-Hamed, 2002 and El-Rewainy, 2002). Panicle length, number of grains/panicle, sink capacity and grain yield (t/ha) were gradually increased with increasing nitrogen levels from zero to 164 kg/ha (Salem et al., 2011).

A well-planned cropping sequence can reduce insect, pest, disease, ameliorate soil structure, improve organic matter levels, prevent proliferation of weeds and consequently increase the crop yield. The general purpose of rotations is to improve soil fertility, reduce erosion, weather damage and reduce the reliance on agricultural chemicals and increase net profits (Bauman et al., 2000). Legumes are known to increase soil N and organic matter in addition to the improvement of soil physical and chemical properties (El-Sodany and Abou-Elela, 2010).

Among the plant nutrients, nitrogen plays a very important role in crop productivity (Ahmad, 2000) and its deficiency is one of the major yield limiting factor for cereal production (Shah et al., 2003). With continuous cereal cropping systems the N supplied from the decomposition of organic matter must be supplemented from other sources (McDonald, 1992). Generally, legumes in the rotation increase the available soil nitrogen because legumes are large, diverse and agriculturally important family in plant kingdom (Heywood, 1971). The benefits of the legumes in cropping systems are well established. Giller (2001) observed that legumes can fix substantial amount of atmospheric N2, which allows them to be grown in N-impoverished soils and without N fertilizer . In addition, Khalil et al. (2011) concluded that less N uptake by legume plants increased the N uptake by the following non-legume enhancing photosynthesis to increase photo-assimilates translocation to plant different sinks and, in turn, enhancing yield and yield attributes.

Incorporation of a legume in rotation with cereal prompts a marked increase in cereal yield compared with cereal monoculture (Buddenhagen, 1990). The increase in yield may be as much as 50%, due not only to biologically-fixed N2 but also to other factors, including improvement of the physical characteristics of the soil, reduced incidence of pests and diseases and of weed-related problems, elimination of phytotoxicity and the increased presence of growth-promoting substances (Ruselle et al., 1987 and Power et al., 1990).

Rice/wheat, rice/legume, rice/wheat/maize, rice/wheat/rice are some of the most common cropping systems in Egypt. Release of highly productive crop varieties, demanded improved cultural practices, high inputs especially high N fertilizer and plant protection measures (De Datta, 1981) .

Crop rotations have many benefits that can influence the success of crop production enterprises. Crop rotation is an essential practice in sustainable agriculture, because of its many positive effects like increasing soil fertility and reducing crop competition.

Crop rotation including legumes is one of the best alternatives for plant nutrient management which is environmentally safe and can efficiently reduce the fertilizer consumption in the developing countries. It is one of the effective tools for nutrient recycling and nitrogen fixation, which accelerate the microbial activity of the soil having the change in root physiology and interactions, better nutrient availability and higher crop yield (Pokhrel and Pokhrel, 2013).

Considerable amount of residue after harvesting legume crops with narrower C/N ratio is left in the soil which upon decomposition improves the physical condition and fertility of soil. Further supply of nitrogen by introducing legume crop in the cropping sequence involves no extra input and risk but may be a better substitute partly for chemical nitrogen. Apart from ability to fix the atmospheric nitrogen, legume crops do not need much of land preparation, irrigation, and fertilizer and have lower cost of cultivation than cereals. Rice-wheat is one of the most widely adopted crop sequence and further becoming more popular with the increasing area under high yielding varieties of rice and wheat. So the crop rotation has great production potential with less of risk. But continuous adoption of this rotation on same piece of land may have adverse impact on soil conditions (Pokhrel and Pokhrel, 2013).

This study addressed the effect of crop sequence (including legumes) and N fertilizer practice on rice yield, as part of a long-term experiment.

Materials and Methods

The present investigation was carried out at the farm of El-Gemmiza Agriculture Research Station, Agriculture Research Center, Egypt, during the two successive growing seasons (2011/2012 and 2012/2013). The experimental trial was a split-plot design in a RCB arrangement having three replications. Net sub-plot size was 3.5 x 5m. Treatments were three crop sequence CS1 (wheat / rice), CS2 (berseem cv. Fahl/sugar beet/rice) and CS3 (faba bean/rice) and three nitrogen levels .The varieties used were rice (Giza 178) ,wheat(Gemmiza 11),faba bean(Giza 716 cv.), Sugar beet (Beta vulgaris L.) and berseem (cv. fahl). The preceding crop was rice in the two seasnos. Pre-germinated seeds for rice were broadcast in the nursery on 15 and 20 May in 2012 and 2013 seasons, respectively with the rate of 30kg /fed. Three to four seedlings,27-days old, were transplanted at 20x20 cm distance between hills and rows.

Three levels of nitrogen were used for rice were as follows (N1) 75% kg N/fed., (N2)100% kg N/fed and (N3) 125% kg N/fed of the recommended nitrogen fertilizer of rice (70 kg N/fed). Nitrogen fertilizer was applied in form of ammonium sulfate (20.5 % N unit) in two equal doses. All of the other cultural practices for all crops production were undertaken as recommended. At the end of winter cropping season after harvesting wheat,sugar beet and faba bean plants, soil samples(0-30 and30-60 cm) were collected from each sub- plot. The collected soil samples were air-dried, ground in a ceramic mortar and passed through 2 mm sieve and stored to determine soil mechanical and chemical properties. Soil sample of the experimental site were determined before soil preparation according to Black (1965) in the two seasons, as shown as in Table (1) and Planting and harvesting dates of crops in Table (2).

Table 1. Mechanical and chemical analysis of experimental site of the two seasons (2012 and 2013).

Mechanical	Depth of soil sample (cm)			
	Season 2012		Season 2013	
	0-30	30-60	0-30	30-60
Clay %	56.14	55.21	56.67	54.80
Silt %	23.29	21.94	22.48	22.00
Sand %	20.57	22.85	20.85	23.20
Texture	Clay			
Chemical analysis:				
Available N (ppm)	22.9	21.8	24.0	22.0
Available P2O5 (ppm)	9.3	8.7	9.5	10.0
Available K2O (ppm)	522	531	510	490
Ec (mmhos/cm3)	0.8	0.8	0.9	0.9
pH	7.40	7.3	7.3	7.2
CaCo3 %	2.71	3.10	3.0	3.0
Organic matter %	1.0	1.1	1.1	1.2
Cations(meq/100 g. soil)				
Na+	0.36	0.37	0.37	0.37
K+	0.01	0.01	0.03	0.04
Ca++	0.25	0.27	0.24	0.24
Mg++	0.26	0.28	0.22	0.22
Anions (meq/100 g. soil)				
HCO3	0.32	0.48	0.36	0.40
Cl-	0.38	0.39	0.28	0.30
SO4	0.20	0.06	0.22	0.12

Table 2. Planting and harvesting dates of rice, wheat, faba bean, berseem cv. fahl and sugar beet in two seasons (2012 and 2013).

Crop sequence		Planting date	Harvesting date	Planting date	Harvesting date	Planting date	Harvesting date
Wheat/rice(CS1)	Seasons 2011/2012	23/11/2011	8/5/2012	_	_	15/5/2012	2/9/2012
Fahl berseem/sugar beet/rice(CS2)		11/9/2011	10/11/2011	17/11/2011	10/5/2012	15/5/2012	2/9/2012
Faba bean/rice(CS3)		12/11/2011	22/4/2012	_	_	15/5/2012	2/9/2012
Wheat/rice(CS1)	Seasons 2012/2013	20/11/2012	10/5/2013	_	_	20/5/2013	10/9/2013
Fahl berseem/sugar beet/rice(CS2)		15/9/2012	15/11/2012	20/11/2012	15/5/2013	20/5/2013	10/9/2013
Faba bean/rice(CS3)		10/11/2012	20/4/2013	_	_	20/5/2013	10/9/2013

The following data were recorded for rice characters:

At harvest the studied characters for rice were recorded as follows: -
Ten random main panicles were collected from each plot to estimate:

1-Plant height (cm) was estimated (from ten randomly selection hill).
2-Panical length (cm).
3-no. of panicles/hill
4-no. of filled grains/panicle
5-unfilled grain % calculated as follows:

$$\text{Unfilled grain} = \frac{\text{No. of unfilled grains / panicle}}{\text{No. of Total grains / panicle}} \times 100$$

6-Panical grains weight (g).
7-1000-grain weight (g).
8-Grain and straw yields (ardab and ton/fad were measured from an area of 4 m^2 in the center of each sub- plot). Grain yield was adjusted to 14% moisture content.

Cereal unit

The yield of all crops were changed to units of cereal according by Brockaus (1962) for judicious comparison between 100kg for each crops as follow: wheat=1 unit, faba been=1.2 units, sugar beet=0.25unit, rice=1unit , fahl berseem=0.14 unit, straw yield for wheat or rice =0.25unit,faba been=0.25unit and straw yield Top for sugar beet=0.10unit. (The average yield of crop sequence in both seasons, as shown as in Table 3 and cereal unit in Table 6).

Economic evaluations:
Gross return from each treatment was calculated in Egyptian pounds (LE)
Ton of sugar beet roots = 263
Ton of sugar beet tops = 41
Ardab of wheat grains = 385
Ton of wheat straw = 668
Ardab of faba been seeds = 745
Ton of faba been straw = 617
Ton of rice grains = 2120
Ton of rice straw = 132
Ton of fahl berseem = 150
In 2012/2013, Price of the yield were cost dared to the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Agricultural Statistics (2012/2013), Economic Affairs Sector; Ministry of Agriculture; Egypt (in Arabic).

Statistical analysis:

Data were statistically analyzed as mentioned by Gomez and Gomez (1984). Treatment means were compared using the least significant difference (LSD at 5%) test as outlined by Waller and Duncan (1969).

Results and Discussion

Effect of crop sequence of rice production:
Results in Table 4 showed a significant increase in plant height, panicle grains weight, No. of filled grain/panicale and grain and straw yields/fed in both seasons, except panicale length in the second season. The highest rice yield was obtained from the faba bean/rice cropping system (CS3) followed by (CS2) fahl berseem/sugar beet/rice and (CS1) wheat/rice cropping system. Furthermore, when faba been was the preceding crop to rice, rice produced taller plants, either significantly or insignificantly compared to rice followed wheat. Higher rice yields were obtained from legume based rotation due to nodular bacteria on the root system of legumes that can fix nitrogen (N) from the atmosphere and concentrate and activate phosphorus (P) and potassium (K) in the sub-soil. Chen (1993) reported that legumes can incorporate 1000 kg of fresh biomass in the soil containing 200 kg dry matter, 5 kg N, 0.4 kg P and 3.3 kg K. Legume can provide 15 T/ha biomass and quick decomposition of which is possible with easy releasing of the available nutrients responsible to produce additional 570 - 1200 kg grain yield of rice in the next season. El-Sodany and Abou-Elela (2010) reported that legumes are known to increase soil N and organic matter in addition to the improvement of soil physical properties .The sweet clover in rotation to wheat can increase yield by 50% with first, 24% in second and 10% in third crop (Chen, 1993). These results were attributed to the good residual effect of faba bean on soil fertility, greater N uptake and conversion into photo- assimilates, resulting the increase of grain yield attributes and grain yield (Khalil et al., 2011).

Effect of N fertilization levels on studied traits of rice:
Grain yield and most attributes were significantly affected by nitrogen fertilizer in both seasons (Table 4). Increasing nitrogen fertilizer levels up to 125% kg N/fed of the recommended nitrogen fertilizer rate of rice resulted in marked increases in grain yield (t/fed), straw yield,1000-grain weight and No. of panicle/hill in both seasons, wherever, plant height, number of filled grains per panicle and unfilled grains% in the first season and panicle length in the second season. Similar conclusions were reported by Asano et al. (1999) and Abd El-Hamed (2002).
The highest values of grain yield and most attributes were obtained by N3, followed by N2, while the lowest values were obtained from N1.Grain yields were 3.413, 3.738 and 4.152 t/fed in 2012 season, while they were 3.575, 4.017 and 4.279 t/fed in 2013 season.

Table 3. Average yield of crop sequence in the two seasons (2012 and 2013).

Crops	Season 2011/2012 Root (ton/fed)	Top (ton/fed)	Grain yield (ardab/fed)	Straw yield (ton/fed)	Yield (ton/fed)	Season 2012/2013 Root (ton/fed)	Top (ton/fed)	Grain yield (ardab/fed)	Straw yield (ton/fed)	Yield (ton/fed
Sugar beet	27.83	10.636	-	-	-	28.73	14.546	-	-	-
Wheat	-	-	20.97	1.41	-	-	-	21.01	1.55	-
Faba bean (seed yield)	-	-	8.03	1.32	-	-	-	9.19	1.28	-
berseem cv. Fahl	-	-	-	-	11	-	-	-	-	10.20

Table 4. Effect of preceding crop (CS), nitrogen level (N) and interaction on yield and yield components of rice in the two seasons (2012 and 2013).

Characters / Treatments	Plant height (cm)		Panicle length (cm)		No. of Panicles/hill		No..of filled grains/ panicale		Unfilled grains//%		Panicle grains weight (g)		1000-grain weight (g)		Straw yield (t//fed)		Grain yield (t/fed)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Preceding crops																		
CS1	71.38	79.04	17.67	18.57	17.53	17.87	110.35	109.38	5.49	5.02	2.83	2.786	20.7	20.43	3.25	2.94	3.55	3.65
CS2	80.74	84.20	18.34	19.86	17.89	17.93	118.67	123.63	5.69	5.28	3.04	2.929	21.03	20.42	3.44	3.35	3.66	3.97
CS3	96.88	91.70	19.83	21.06	18.18	18.71	126.30	127.3	6.14	6.24	3.67	3.553	21.99	22.65	3.95	4.03	4.04	4.24
LSDat0.05	2. 24	13.80	NS	1.58	NS	NS	9.19	15.4	NS	NS	.87	.56	.N S	NS	1.86	1.24	.28	0.59
Nitrogen level																		
N1	78.18	80.84	17.16	18.89	17.57	17.79	112.13	109.4	6.14	5.84	2.88	2.792	20.21	20.29	4.21	4.11	3.41	3.57
N2	84.53	86.74	19.01	19.78	17.99	18.15	117.61	117.92	5.80	5.44	3.21	3.157	21.27	20.98	4.81	4.42	3.73	4.01
N3	86.29	87.36	19.68	20.81	18.25	18.58	122.41	119.90	5.44	5.26	3.45	3.431	22.25	22.67	4.98	4.77	4.15	4.27
LSD at0.05	3.5	NS	NS	1.38	.22	.34	6.22	NS	.34	NS	.49	NS	.97	1.69	.84	.49	.37	.43
CSXN	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Effect of the interaction between crop sequence and nitrogen fertilizer on plant height (cm) of rice in the first season (2012).

Crop sequence	Nitrogen level		
	N1	N2	N3
Wheat/rice (CS1)	69.8	76.15	75.47
Fahl berseem/sugar beet/rice (CS2)	79.72	79.65	84.64
Faba bean/rice (CS3)	93.3	97.77	98.07
LSD at 0.05	2.5		

Table 6. Cereal units for solid and intercrops in the two seasons (2012 and 2013).

Traits / Crop sequence		Winter crops		Summer crops		Total CU
		Main product	By product	Main product	By product	
Wheat/rice (CS1)	Seasons 2011/2012	31.45	2.85	35.60	8.15	78.05
Fahl berseem/sugar beet/rice (CS2)*		84.97	10.64	36.50	8.60	140.71
Faba bean/rice (CS3)		14.93	3.30	40.43	9.87	68.53
Wheat/rice (CS1)	Seasons 2012/2013	31.51	3.88	36.50	7.35	79.24
Fahl berseem/sugar beet/rice (CS2)*		86.10	14.55	39.70	8.37	148.72
Faba bean/rice (CS3)		17.09	3.20	42.45	10.07	72.81

* Cereal unit of fahl berseem and sugar beet

Income :-

Highest total income (L.E. 17597.61 and L.E. 18541.14 in the first and second seasons, respectively) was obtained with CS2 'sugar beet/fahl berseem/rice' Table7

Table 7. Total income of crop sequence (CS1, CS2 and CS3) in 2012 and 2013 Seasons .

Cropping sequence		Wheat/Rice (CS1)				Berseem/Sugar beet/Rice (CS2)					Faba bean/Rice (CS3)			
		Wheat		Rice		Fahl berseem	Sugar beet		Rice		Faba bean		Rice	
Character		Grain yield (ardab/fed)	Straw yield (ton/fed)	Grain yield (ton/fed)	Straw yield (ton/fed)	Gross fresh (ton/fed)	Sugar beet (ton/fed)	Top fresh weight (ton/fed)	Grain yield (ton/fed)	Straw yield (ton/fed)	Seed yield (ardab/fed)	Straw yield (ton/fed)	Grain yield (ton/fed)	Straw yield (ton/fed)
Yield	Season 2012	20.97	1.14	3.56	3.26	11.00	27.83	10.64	3.65	3.44	8.03	1.32	4.04	3.95
Income L.E.		8073.45	761.52	7547.20	430.32	1650.00	7319.29	436.24	7738.00	454.08	5982.35	814.44	8564.80	521.40
Total income L.E.		16812.49				17597.61					15882.99			
Yield	Season 2013	21.01	1.55	3.65	2.94	10.20	28.73	14.55	3.97	3.35	9.19	1.28	4.25	4.03
Income L.E.		8088.85	1035.40	7738.00	388.08	1530.00	7555.99	596.55	8416.40	442.20	6846.55	789.76	9010.00	531.96
Total income L.E.		17250.33				18541.14					17178.27			

Nitrogen encourages plants biomass development. It is an essential element that plays prominent role in building new meristematic cells, enhancing cell elongation and increasing photosynthetic activities of the plant. These results are in harmony with those obtained by Abd El-Wahab (1998), Ebaid and Ghanem (2001) and Abou-Khalifa (2007).

In addition, Khalil et al. (2011) concluded that less N uptake by legume plants increased the N uptake by the following non-legume enhancing photosynthesis to increase photo-assimilates translocation to plant different sinks and, in turn, enhancing yield and yield attributes. Chaturvedi (2005) report that nitrogen fertilizer application increased significantly tillers/m2 in rice at harvest. The numbers of panicale are associated with the tiller production which is most important yield attributing character. Maximum panicle number under nitrogen fertilizer treatment was 18.25 and 18.85 in the respective two seasons which observed for 125% kg N/fed of the recommended nitrogen fertilizer rate of rice and minimum was 17.57and 17.79 in for respective seasons which obtained for 75% kg N/fed of the recommended nitrogen fertilizer rate of rice (Table 4). The N application can be increasingly affected some traits such as panicle length, panicle number per square meter which are correlated with grain yield (Bahmanyar and Ranjbar, 2007). Nitrogen can increase rice grain yield by increasing the total dry matter production, number of panicles, and panicle length of rice (Wei et al., 2011).

Nitrogen level played an important role in increasing plant height (Table 4). The plant height increased gradually due to successive increasing level of nitrogen fertilizer application during each of the two seasons. The tallest plant height highs were 86.29 and 87.36 cm which recorded in crop receiving N3 compared to N1 and N2 level. Increase in plant height was due to various physiological processes including cell division and cell elongation of the plant. Zhilin et al. (1997) stated that plant height increased significantly due to nitrogen application.

The interaction between crop sequence and nitrogen fertilizer on plant height of rice:

The results in Table (5) showed that plant height was significantly affected by the interactions between crop sequence and nitrogen rates only in the first seasons such plant height recorded its maximum value (98.07 cm) of CS3 (faba been/rice) using N3. However the lowest value (69.8) was given by CS1 (wheat/rice) with N1 applications.

Conclusions

The overall results of the present investigation concluded that nitrogen fertilizer is our essential nutrient for achieving satisfactory crop yields. Generally, it can be concluded that fertilizing with 125% kg N/fed. (N3) of the recommended nitrogen fertilizer rate of rice may improve the productivity of rice crop under the circumstances of the present study. Higher rice yields and income were obtained from legume based sequence.

References

Abd El-Wahab, A.E. 1998. Physiological behaviour of some Egyptian rice cultivars under different nitrogen levels. Egypt. J. Appl. Sci., 13(4): 119-129.

Abd El-Hamed, M.I. 2002. Agricultural studies on rice. M.Sc. Thesis, Dept. Agron. Faculty of Agriculture, Kafr El- Sheikh, Tanta University, Egypt.

Abou-Khalifa, A.A. 2007. Performance of two hybrid rice and Sakha 101 rice cultivars to three nitrogen levels and three sowing dates. Egypt. J. Plant Breed., 11(2): 681-691.

Ahmad, N. 2000. Fertilizer scenario in Pakistan policies and development. Proceedings of Conference Agricultural and Fertilizer Use. 2000 NFDC, P and D Division, Government of Pakistan, February 15-16.

Agricultural Statistics. 2012/2013. Summer and Nili Crops (Part II). Economic Affairs Sector, Ministry of Agriculture, Egypt.

Asano, H.; K. Isobe and Y. Tsuboki, 1999. Effect of harvesting date on the quality and palatability of paddy rice cultivated by Aig Amo Duck Farming System. Japanese J. of Crop Sci., 68: 375-378.

Bahmanyar, M.A. and G.A. Ranjbar, 2007. Response of rice cultivar to rates of nitrogen and potassium application in field and pot conditions. Pakistan j. of Biol. Sci., 10 (9):1430-1437

Bauman, D.T., M.J. Kroff and L. Bastiaans, 2000. Inter cropping leeks to suppress weeds. Weed Research, 40: 359-374.

Black, C.A. 1965. Methods of Soil Analysis. Amer., Soc., of Agron. Inc., Madison,Wisconsin, USA

Brockhaus,V.L.1962.ABCderLandwirtschaftipartr1,2nded.VEB,BrockhausVeriag,Leipzig,Germany,P: 488-489.

Buddenhagen, I.W. 1990. Legumes in farming systems in mediterranean climates, in: Osman A.E., I M.H.brahim, M.A. Jones.(Eds.), The Role of Legumes in the Farming Systems of the Mediterranean Areas, Kluwer Academic Publishers, ICARDA, The Netherlands, pp. 3-29.

Chaturvedi I, 2005. Effect of nitrogen fertilizers on growth,yield and quality of hybrid rice (oryza sativa L.). Journal of central european agricultural.volume6.No.4(611-618).

Chen, L. 1993. Crop sequences for sustaining soil resources in China. In International Crop Science-I. Crop Science Society of America, USA 895 p.

De Datta, S.K. 1981.Principles and Practices of Rice Production. New York, USA, Wiley, pp: 618

Ebaid, R.A. and S.A. Ghanem, 2001. Effect of nitrogenous and potash fertilizers on the productivity of Sakha 101 rice cultivar. J. Agric. Sci. Mansoura Univ., 26(4): 1833-1840.

El-Rewainy, I.M.O. 2002. The effect of different nitrogen fertilizer sources on yield and some agricultural characters in rice. Ph.D. Thesis, Dept. of Crop Sci., Fac. of Agric., Shebin El-Kom, El-Menofiya University, Egypt

El-Sodany, M.E. and A.M. Abou-Elela, 2010. Effect of preceding winter crops relay cropping, intercropping system and nitrogen fertilizer on soil physical and chemical properties. J. of soil Sci. & Agric. Engneering.1(3):237-298.

Giller, K.E. 2001. Nitrogen fixation in tropical cropping systems. CAB International, Wallingford, UK, pp. 423 .

Gomez, K.A. and, A.A. Gomez,1984. Statistical Procedures for Agricultural Research. 2nd, (ed). John Wiley and Sons, New York, U.S.A.

Heywood, V.H. 1971. The leguminosae: A systematic purview. Pp.1-29. In: Chemotaxonomy of the Leguminosae. (Eds.): J.B. Harborne, D. Boulter and B.L. Turner. Academic Press, London.

Khalil, H.E., A.I. Nawar, A.M Abou Elela, Abdel, I.E. Mohammadein and M.E. El-Sodany, 2011. Response of maize to N fertilization following sunflower and winter preceding crops.Alex.J.Agric.Res.,56(2):11-19.

Kumar, G.S., S.N. Reddy and M. Ikramullah, 1995. Effect of seedling age and nitrogen level on performance of rice (Oryza sativa) under late planting. Indian J. Agri. Sci., 65(5): 354-355.

Mahrous, F.N., A.T. Badawi and M.S. Balal, 1986. IR 1626 long grain rice variety as influenced with sowing dates, seeding spacing and nitrogen levels. Proc.2 Conf. Agron., Alex. Egypt : 115-127.

McDonald, G.K. 1992. Effects of nitrogenous fertilizer on the growth, grain yield and grain protein concentration of wheat, Aust. J. Agric. Res., 43: 949-967.

Pokhrel S. and S. Pokhrel, 2013. Legumes crop rotation can improve food and nutrition security in Nepal. Agron. J. of Nepal (Agron JN) Vol. 3.123-127.

Power J.F., 1990.Legumes and crop rotations, in: Francis Ch.A., Flora C.B., King L.D. (Eds.) Sustainable Agriculture in Temperate Zones, John Willey & Sons, New York,pp. 178–204.

Ruselle M.D.,O.B. Hesterman ,C.C. Haeffer and G.H. Heichel, 1987. Estimating nitrogen and rotation effects in legume-corn rotation, in: Power J.F. (Ed.), The Role of Legumes in Conservation Tillage Systems, Soil Conserv. Soc. A. Iowa, pp. 41–42.

Salem A.K.M., W.M. ElKhoby, A.B. Abou-Khalifa and M. Ceesay, 2011. Effect of Nitrogen Fertilizer and Seedling Age on Inbred and Hybrid Rice Varieties. American-Eurasian J. Agric. & Environ. Sci., 11 (5): 640-646.

Shah, Z.H., S.H. Shah, M.B. Peoples, G.D. Schwenke and D.F. Herriedge, 2003. Crop residue and fertilizer N effects on nitrogen fixation and yields of legume–cereal rotations and soil organic fertility. Field Crops Res., 83: 1-11.

Waller,R.A. and D.B.Duncan 1969. Abays rule for symmetric multiple comparison proplem.Amer.Stat.Assoc.J.,1485-1503.

Wei F, H.Tao, SH Lin , BAM Bouman and K. Dittert , 2011. Rate and their influence on grain yield under different growing conditions. Science Asia,37:98-104.

Zhilin, L, R.S.Sarker ,SK Nayak ,I Ravi and JL. Li , 1997. Physiological effect of nitrogen application on aromatic rice. Journal of South China Agricultural University. 18:13–17

تأثير التعاقب المحصولى ومعدلات التسميد النيتروجينى على انتاجية الأرز

أحمد محمد شيحه ونجوى رفعت أحمد و عبد العزيز محمود أبو العلا

قسم بحوث التكثيف المحصولى – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية – الجيزة – مصر

أقيمت تجربتان حقليتان بالمزرعة البحثية بمحطة بحوث الجميزة – محافظة الغربية خلال موسمى2012و2013 لدراسة تأثير ثلاث تعاقبات محصولية تسبق الأرز (قمح ثم أرز– برسيم فحل ثم بنجر سكر ثم أرز– فول بلدى ثم أرز) وثلاث مستويات من التسميد النيتروجينى (75% ، 100% ، 125% من التسميد النيتروجينى الموصى به للأرز "70 كجم نيتروجين/فدان") ، وكان التصميم المستخدم القطع المنشقة مرة واحدة في ثلاث مكررات حيث تمثل القطع الرئيسية التعاقبات المحصولية ومستويات النيتروجين فى القطع الثانوية.

أشارت أهم النتائج إلى الآتى:–

1- تأثرت معظم صفات الأرز تحت الدراسة معنويا بالتعاقب المحصولى فى كلا الموسمين حيث وجد أن نظام التعاقب المحصولى الثالث (فول بلدى/أرز) أعطى أعلى إنتاجية لمحصول الحبوب/فدان ومحصول القش/فدان وإرتفاع النبات ووزن حبوب الدالية وعدد الحبوب الناضجة فى كلا الموسمين بينما كانت أقل القيم لجميع صفات الأرز تحت الدراسة فى نظام زراعة الأرز عقب قمح .

2- تأثرت جميع صفات الأرز تحت الدراسة معنويا بالتسميد النيتروجينى فى كلا الموسمين حيث أدى التسميد زيادة معنوية لصفات محصول الحبوب للفدان ، محصول القش/ فدان ، محصول الالف حبة وعدد السنابل فى الجورة فى كلا الموسمين وارتفاع النبات ، طول الدالية ، عدد حبوب الدالية ، وزن حبوب الدالية وعدد الحبوب الناضجة فى موسم واحد فقط .

3- التفاعل بين التعاقب المحصولى والتسميد النيتروجينى لم يكن معنويا على جميع صفات الأرز تحت الدراسة عدا صفة ارتفاع النبات فى الموسم الاول فقط .

4- أعلى عائد نقدى تم الحصول عليه كان من التعاقب المحصولى الثانى (برسيم فحل/بنجر سكر/أرز) وكان 17597,61 و18541,14 جنيها فى الموسم الاول والثانى على الترتيب .

5- بصفة عامة يمكن التوصية ان افضل تعاقب اعطى اعلى قيمة لمحصول الأرز كان عند زراعة الأرز عقب محصول بقولى (فول بلدى) مع اعلى معدل تسميد نيتروجينى (125%كجم نيتروجين من التسميد النيتروجينى الموصى به للأرز) تحت الدراسة . وأعلى عائد نقدى كان عند زراعة الأرز عقب بنجر سكر و برسيم فحل .