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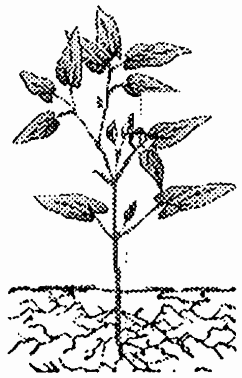

RESPONSE OF THREE RICE VARIETIES TO CONJUGATED APPLICATIONS OF *AZOLLA PINNATA* AND DIFFERENT RATES OF UREA

[25]

EL-Shahat[1] R.M.; M.G.Z. Girgis[2]; Al-Shaymaa[2]I. Ahmed[2]; E.A. Saleh[2]

1. Microbiology Department, Soils, Water & Environment Research Institute, Agriculture Research Center, (ARC), Giza, Egypt.
2. Unit of Biofertilizers, Microbiology Department, Faculty of Agriculture, Ain Shams University; Shoubra El-Kheima, Cairo, Egypt.

Key words: Rice varieties, *Azolla pinnata*, Urea, Soil characteristics, *Azospirilla*

ABSTRACT

A greenhouse pot experiment was carried out to study the possible use of *Azolla pinnata* as alternative nitrogen source for rice production. Three rice varieties, i.e., Giza 177, Sakha 101 and 102 were exposed for different treatments comprising the application of *Azolla*, urea or their different combinations to accomplish the recommended nitrogen dose of 60 kg N fed^{-1} for rice cultivation. Results revealed that the use of *Azolla* alone either as dry or fresh material enhanced most of rice yield components rates especially grain and straw yields. The combination of different rates of fresh *Azolla* with different levels of urea showed that 15 kg N fed^{-1} as fresh *Azolla* + 45 kg $Nfed^{-1}$ as urea gave grain and straw yields similar to those obtained from 60 kg $Nfed^{-1}$ as urea or 60 kg $Nfed^{-1}$ as fresh *Azolla*. Using fresh *Azolla* was generally superior to dry *Azolla*. Fresh *Azolla* applied at 60 kg N fed^{-1} also enhanced significantly the nitrogen contents of both grain and straw in comparison with other tested treatments except for the use of 60 kg $Nfed^{-1}$ as urea, which was similar to 60 kg $Nfed^{-1}$ as fresh *Azolla*. Using fresh *Azolla* also increased significantly both soil total microbial and azospirilla counts than those recorded by other tested treatments. *Azolla* applied either as dry or fresh materials increased significantly soil organic matter content compared to the application of urea alone. Fresh *Azolla* was superior to dry *Azolla* in increasing soil organic matter content. The latter treatment also decreased soil pH and increased WHC more than that of dry *Azolla* and/or urea treatments. However, no particular trend was detected due to *Azolla* application on soil electric conductivity. Therefore, the use of fresh *Azolla pinnata* in rice cultivation can be considered as a promising substitution for mineral nitrogen requirement plus its effect in reducing environmental pollution.

INTRODUCTION

The success of rice production in the tropics and subtropics depends on an efficient and economic supply of N, an element required in a large quantity in comparison with other essential ones. The efficient use of N from fertilizer sources in lowland rice is notoriously low, because of its loss from soils through various chemical and biochemical processes. Moreover, increasing the application of nitrogenous fertilizers is neither environmental friendly **(Conway and Pretty, 1988)** nor economically feasible **(Cassman and Pingali,**

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1994). Therefore, it becomes necessary to look for alternative renewable resources to meet at least a part of the N demands of rice crop. The nitrogen fixing blue-green algae (BGA) *Anabaena azollae* symbiotically associated with the water fern *Azolla* showed to be the most important in maintaining and improving the productivity of rice (**Roger *et al* 1993**). It can fix 30-60 kg N ha^{-1} in 30 days. *Azolla* is either incorporated as green manure at the beginning of the cropping season or grew as a dual crop along with rice, in the standing water of flooded fields. The fern is proved to be an important biological source to improve the N balance of rice fields (**Lumpkin and Plucknett 1982; Bharati & Mohanty 2000, Ladha *et al* 2000, Singh and Mahaparta 2000 and Giller, 2002**). **Madiama and Paul (2003)** reported that around 28% of N taken up by rice was derived from the biologically fixed nitrogen. *Azolla* also seems to help sustaining the soil N supply in quantities roughly equal to those extracted from soil to rice plant

The aim of the present work was to evaluate the effects of *Azolla* application alone and/or in different rate conjugated with different levels of urea on growth and yield of three rice varieties as well as some physicco-chemical and/or biological characteristics of the soil.

MATERIALS AND METHODS

Azolla pinnata 7001 was kindly provided with Agric. Microbial. Dept., Soils, Water and Environ. Res. Inst. Agric. Res. Center, Giza, Egypt, and used to examine its effect as fresh and/or dry either alone or combined at different rates with different nitrogen levels on growth and yield of three rice varieties namely, Giza 177, Sakha 101 and 102 under greenhouse conditions.

The experiment was carried out at Kalubia governorate during the summer season of 2003. Pots with 35 cm in diameter were filled with 10 kg of clay soil each. The soil was clay in texture according to the analysis of **Page *et al* (1982)**.

One week prior to rice transplantation, soil was supplemented with zinc sulphate and super phosphate (15.5% P_2O_5) at a rate of 24 and 100 kg fed^{-1}, respectively.

Azolla was incorporated into the upper 5 cm of the soil either as dry or fresh material conjugated with variable amounts of urea (46.5% N) to accomplish a final N dose of 60 kg N fed^{-1} one week before transplanting as fellows:

T_0 = 60 kg N fed^{-1} as urea

T_1 = 60 kg N fed^{-1} as dry *Azolla*

T_2 = 60 kg N fed^{-1} as fresh *Azolla*

T_3 = 45 kg N fed^{-1} as urea+15 kg N fed^{-1} as dry *Azolla*

T_4 = 45 kg N fed^{-1} as urea+15 kg N fed as fresh *Azolla*

T_5 =30 kg N fed^{-1} as urea+30 kg N fed^{-1} as dry *Azolla*

T_6 = 30 kg N fed^{-1} as urea+30 kg N fed^{-1} as fresh *Azolla*

T_7 = 15 kg N fed^{-1} as urea+45 kg N fed^{-1} as dry *Azolla*

T_8 = 15 kg N fed^{-1} as urea+45 kg N fed^{-1} as fresh *Azolla*

Five 30 days old rice seedlings of each rice variety were transplanted into each pot. One week later, the developed rice seedlings were thinned out to three healthy seedlings pot^{-1}.

The amount of added *Azolla* either dry or fresh was calculated on the basis that dry *Azolla* contains 4% N and fresh *Azolla* has 95% moisture content. The experiment was layed in randomized complete design (**Waller and Duncan, 1969**) with five replicates. At harvest (after 120 days from planting) rice plants were cut out just above soil surface, oven dried (70°C for 24 h) up to a constant dry weight and then exposed for determining the following parameters, a) plant height (cm/plant), b) plant weight (g/plant) c) number of panicles $plant^{-1}$, d) straw and grain yields (g pot^{-1}), e) 1000-grain weight (g) as well as nitrogen content of both grains and straw using Microkjldahl method as described by **Black *et al* (1965)**.

Some physicochemical properties of the soil, i.e., organic matter (OM) content, electrical conductivity (EC), soil reaction (pH), total nitrogen (TN) content and water holding capacity (W.H.C) were determined in the soil after rice harvesting according to the methods described by **Page *et al* (1982)**. At the same time, the soil was also sampled to determine total microbial densities using plate count technique on Buntt and Rovira medium (**Buntt and Rovira, 1955**) as well as azospirilla populations by MPN technique using semi-solid malate medium (**Döbereiner, 1978**) with the aid of statistical tables of **Cochran (1950)**. Data were subjected to statistical analyses according to **Gomez and Gomez (1984)**.

RESULTS AND DISCUSSION

Effect of different rates of *Azolla* and urea on growth of three rice varieties

Data in **Table (1)** show the effect of *Azolla* and/or urea on growth of three rice varieties

Table 1. Growth Yield of three rice varieties as affected by application of two forms of *Azolla pinnata* and different rates of urea under greenhouse conditions

Treatment \ Parameters		Plant height (cm plant^{-1})			Plant dry weight (g Pot^{-1})			Straw yield (g Pot^{-1})			No. of panicles plant^{-1}		
		Rice varieties											
		Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102
Urea (Kg N/fed)	*A pinnata*												
60	-	98.0	89.2	88.3	92.2	91.2	87.6	72.0	69.4	58.0	11	11	12
-	60 dry	91.0	90.2	88.2	99.0	95.4	103.2	69.0	70.0	75.0	11	11	12
-	60 fresh	90.1	91.3	95.0	111.8	96.6	98.0	69.0	74.0	69.4	11	11	12
15	45 dry	93.3	91.0	90.0	98.8	94.0	96.6	71.4	72.0	75.0	11	11	12
15	45 fresh	95.3	93.0	88.2	109.0	107.2	97.0	73.0	74.0	67.0	12	11	12
30	30 dry	91.0	88.2	91.0	116.0	106.0	101.4	79.0	64.0	74.4	11	11	12
30	30 fresh	98.0	87.1	95.0	110.4	100.0	95.0	80.0	71.0	80.2	11	10	12
45	15 dry	92.0	85.7	89.3	125.0	106.4	101.2	85.0	69.0	74.4	11	10	12
45	15 fresh	94.0	88.1	88.3	130.6	107.8	115.4	87.0	75.0	85.6	13	12	13
L.S.D. (0.05)	Treatment	N.S.			2.482			1.554			0.552		
	Varieties	1.305			1.600			1.097			0.285		
	Interaction	3.81			4.042			2.947			0.838		

namely, Giza 177, Sakha 101 and 102. All tested treatments exhibited in significant effect on plant height within the same variety. However, the three rice varieties showed significant differences towards plant height, since Giza 177 recorded the highest record of plant height being 98 cm plant^{-1} followed by 93 cm plant^{-1} for Sakha 101 and 95 cm plant^{-1} for Sakha 102.

On the other hand, plant dry weight was significantly affected by the tested treatments either for the same rice variety or among the three rice varieties. The greatest plant dry weight was 130.6, 107.8 and 115.4 g pot^{-1} for rice varieties Giza 177, Sakha 101 and 102, respectively. These values were significantly higher than those recorded due to the use of 60 kg N fed^{-1} as urea, being 92.2, 91.2, and 87.6 g pot^{-1}, in the same abovementioned respective order.

Effect of different rates of *Azolla* and urea on yield and yield components of three rice varieties

Data in **Table (1)** show that the highest straw yield was obtained from the addition of 45kg N fed^{-1} as urea + 15 kg N fed^{-1} as fresh *Azolla*. The corresponding straw yields were 75.0, 85.6 and 87.0 g pot^{-1} for rice varieties Sakha 101, 102 and Giza 177, respectively. With respect to the number of panicles plant^{-1}, the abovementioned treatment also significantly enhanced that parameter within each rice variety. The highest number of plant panicles were 13, 12 ad 13 for Giza 177, Sakha 101 and 102, respectively. However, each of these values was also significantly higher than those recorded in response to the other treatments.

Application of fresh *Azolla* at a rate of 60 kg N fed^{-1} gave insignificant effect on grain yield g pot^{-1} compared with the use of 60 kg Nfed^{-1} as urea. This trend was observed for all tested rice varieties **(Table 2)**. On the other hand, the use of dry *Azolla* at the same abovementioned rate gave significantly less grain yield g pot^{-1} compared to either the application of 60 kg N fed^{-1} as urea or as fresh *Azolla*. This observation was true for Giza 177 and Sakha 101 but was not for Sakha 102. However, the use of 15 kg N fed^{-1} as urea + 45 kg N fed^{-1} as fresh *Azolla* gave insignificantly different grain yield from those recorded by 60 Kg N fed^{-1} as urea and 60 Kg N fed^{-1} as fresh *Azolla* **(Table 2)**.

However, the highest grain yield (46.0 g pot^{-1}) was obtained from rice variety Giza 177 received

Table 2. Yield and yield components of three rice varieties as affected by application of two forms of *A. pinnata* and different rates of urea under greenhouse conditions

Treatment / Parameters		Grain weight (g Pot^{-1})			1000-grains weight(g)			N% of grain			N% of straw		
		Rice varieties											
		Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102	Giza 177	Sakha 101	Sakha 102
Urea (Kg N/fed)	*A. pinnata* (Kg N/fed)												
60	-	45	42.0	29.6	22	20	22	1.40	1.45	1.42	0.35	0.39	0.33
-	60 dry	33	32.0	28.2	23	23	23	1.70	1.69	1.64	0.53	0.43	0.43
-	60 fresh	46	43.0	30.0	28	26	27	1.78	1.80	1.70	0.60	0.48	0.52
15	45 dry	35	36.0	27.0	26	21	24	1.50	1.35.	1.35	0.48	0.35	0.40
15	45 fresh	37	35.0	29.0	25	23	25	1.62	1.44	1.44	0.50	0.36	0.41
30	30 dry	37	36.6	27.0	24	23	23	1.54	1.52	1.50	0.48	0.41	0.42
30	30 fresh	39	37.2	28.0	25	24	25	1.63	1.55	1.53	0.51	0.42	0.44
45	15 dry	41	37.4	27.0	26	24	25	1.59	1.61	1.59	0.52	0.43	0.45
45	15 fresh	45	43.4	30.0	27	25	26	1.68	1.75	1.65	0.56	0.46	0.49
L.S.D (0.05)	Treatment		3.042			1.112			0.018			0.013	
	Varieties		1.757			0.623			0.008			0.0073	
	Interaction		4.921			1.934			0.027			0.021	

60 kgNfed^{-1} as fresh *Azolla* compared to the other two rice varieties, which, gave their highest grain yields, i.e., 43.4 and 30.0 g pot^{-1} for Sakha 101 and Sakha 102 with the addition of the 45 kg Nfed^{-1} as urea plus 15 kg Nfed^{-1} as fresh *Azolla.* These records were significantly different from those recorded due to application of either 60 kg Nfed^{-1}as urea or fresh *Azolla*. Generally, the use of fresh *Azolla* alone or combined with different levels of urea was more effective than dry *Azolla*.

Regarding the weight of 1000-grain **(Table 2)**, results revealed that the highest weight of 1000-grain was recorded in all tested rice varieties when amended with 60 kgNfed^{-1} as fresh *Azolla*, being 26.0, 27.0 and 28.0 g for Sakha 101, Sakha 102 and Giza 177, respectively. Theses records were insignificantly different from those obtained from the application of 15 kg N fed^{-1} as urea + 45 kg N fed^{-1} as fresh *Azolla.*

All tested treatments increased significantly nitrogen contents for both rice grains and straw compared to the use of 60 kg N fed^{-1} as urea. However, the highest N contents of grain (1.8%) and straw (0.6%) were obtained from Sakha 101 and Giza 177 due to the application of 60 kg N fed^{-1} as fresh *Azolla* (T_2), respectively. These two records were significantly higher than those recorded by other tested treatments.

In this study, the use of *Azolla* as fresh or dry material either alone or at different combination with urea generally enhanced the growth of the tested rice varieties. However, the highest grain and straw yields were recorded due to the use of 45 kg N fed^{-1}as urea + 15 kg N fed^{-1}as fresh *Azolla.* This result was insignificantly different from those recorded due to the use of either 60 kg N fed^{-1} as urea or as fresh *Azolla*. In this respect, **EL-Zeky *et al* (2005)** reported that 40 kg N fed^{-1}as fresh *Azolla* +20 kg N fed^{-1}as urea gained rice yield insignificantly different from that obtained from the use of 60 kg N fed^{-1}as urea. They showed that *Azolla* incorporated into rice field at transplanting was quickly mineralized and 75% of its nitrogen became available for rice plants within one week. On the other hand, most of nitrogen applied as urea may be subjected to leaching, volatilization or denitrification. **Strik and Staden, (2003)** attributed the beneficial effect of *Azolla* to the production of cytokinins and auxins that enhance plant growth. **Mussa *et al* (2002)**, revealed that incorporation of *Azolla* into soil suddenly increased the C/N ratio of the soil, which favored the microbial proliferation and subsequent immobilization of available nitrogen. Mineralization is then gradually released available N in significant amount within 6-8 weeks due to the decay of added *Azolla*. Hence, *Azolla* application, decrease the loss of nitrogen by leaching, volatilization or denitrification.

Densities of total soil microbes and azospirillia

Data in (**Table 3**) show the effect of *Azolla* either applied alone or mixed with different levels of urea on densities of total microbes and azospirilla in soil remained after rice harvesting. Results revealed that the use of 60 kg $Nfed^{-1}$ as fresh *Azolla* resulted in the highest densities of total microbes and azospirilla compared to the other tested treatments. The recorded figures were 39, 40, 40 $\times 10^6$ and 65, 80, 58 $\times 10^5$ cfu g^{-1} soil for total microbes and azospirilla in soil used to grow rice varieties Giza 177, Sakha 101and Sakha 102, respectively. Mixing fresh *Azolla* with different levels of urea was more favorable in increasing the densities of total microbes and azospirilla than the dry *Azolla*.

Table 3. Effect of different rates of *Azolla* and/or urea on densities of total microbes and azospirilla of soil after rice harvesting

Treatment \ Parameters		Rice varieties					
		Giza 177		Sakha 101		Sakha 102	
		T.C*(cfux10^6)	*Azospirilla* (x10^5)	T.C. (cfux10^6)	*Azospirilla* (x10^5)	T.C. (cfux10^6)	*Azospirilla* (x10^5)
Urea (Kg N/fed)	*A. pinnata*						
60	-	11	20	18	16	17	25
-	60 dry	21	31	29	44	23	40
-	60 fresh	39	65	40	80	40	58
15	45 dry	20	32	12	22	15	18
15	45 fresh	23	40	19	33	22	30
30	30 dry	22	32	22	55	23	20
30	30 fresh	33	50	29	63	30	31
45	15 dry	28	47	30	55	32	37
45	15 fresh	30	60	37	69	35	52
L.S.D. (0.05)	Treatment	1.979		2.425		2.798	
	Varieties	1.086		1.346		1.713	
	Interaction	3.055		3.869		4.002	

*T.C = Total bacterial count
colony formed unit (cfu) = colony foming $unit^{-1}$ g soil

The use of fresh *Azolla* alone or combined with different levels of urea also increased the densities of total microbial flora and azospirilla more than urea application alone or combined with dry *Azolla*. This result is in accordance with that of **Mandal *et al* (1999)** who reported significant increases in biomass and counts of soil microorganisms due to *Azolla* incorporation. *Azolla* application either as fresh or dry material increased soil organic matter and, fresh *Azolla* was superior to dry *Azolla* in increasing the soil microbial, populations upon *Azolla* decomposition may the enhancement of soil microbial improve soil organic matter content (**Abd El-Rasoul *et al* 2004**).

Soil physicochemical properties

Data in **Table (4)** show the effect of *Azolla* applied either alone or at different combination with different levels of urea on some chemical and physical soil properties, i.e., organic matter (OM) content, electrical conductivity (EC), soil reaction (pH), total nitrogen (TN) content and water holding capacity (WHC). Results revealed that all *Azolla* treatments increased the soil organic matter (OM) content over those obtained by the application of 60 kg $Nfed^{-1}$ as urea. The highest OM contents were obtained from soils amended with 60 kg $Nfed^{-1}$ as fresh *Azolla* being 1.28, 1.25 and 1.24 for soils used to grow rice varieties Sakha 102, Sakha 101 and Giza 177, respectively. Regarding EC, no definite pattern was observed in response to the applied treatments, since; no marked changes were noticed in all examined soil samples. On the other hand, the application of fresh *Azolla* at different rates either alone or combined with different urea levels decreased soil pH under all tested rice verities. However, the use of 60 kg N fed^{-1} as fresh *Azolla* recorded the lowest pH values compared to the other tested treatments being 7.40, 7.41 and 7.32 for Sakha101, Sakha102 and Giza 177, respectively. All *Azolla* treatments also increased the TN contents of the three tested soil samples. The highest soil TN content was obtained from the use of 60 kg $Nfed^{-1}$ as fresh *Azolla*. The recorded percentages were 0.25, 0.32 and 0.35 in soils used to grow rice varieties Giza 177, Sakha101 and Sakha102, respectively. Generally, the use of fresh *Azolla* recorded higher soil nitrogen content than dry *Azolla*. This may be due to the finding that dry *Azolla* needs more time to become moistened and to promote the soil microbial activities activity to start mineralization (**Ghazal *et al* 1997**).

Table 4. Effect of different *Azolla* rates and/or nitrogen on some soil chemical properties after rice harvesting

Parameters / Treatment		Rice varieties														
		Giza 177					Sakha 101					Sakha 102				
		O.M.	E.C.	pH	T.N.	W.H.C	OM.	E.C.	pH	T.N.	W.H.C	O.M.	EC	pH	T.N.	W.H.C
Urea (Kg N / fed^{-1})	*A. pinnata* (Kg N / fed^{-1})															
*Control		0.20	0.20	7.80	0.11	55.00	0.20	0.20	7.80	0.13	55.00	0.20	0.20	7.80	0.11	55.00
60	-	0.20	0.23	7.81	0.15	55.80	0.20	0.20	7.82	0.16	55.72	0.20	0.20	7.83	0.17	55.90
-	60 dry	0.50	0.20	7.80	0.20	56.53	1.12	0.20	7.80	0.21	57.50	1.13	0.20	7.80	0.20	56.50
-	60 fresh	1.24	0.19	7.32	0.25	66.70	1.25	0.20	7.40	0.32	65.90	1.28	0.20	7.41	0.35	67.90
15	45 dry	1.00	0.20	7.85	0.19	60.00	1.14	0.20	7.81	0.23	61.70	1.10	0.20	7.82	0.27	62.70
15	45 fresh	1.03	0.20	7.74	0.20	61.11	1.16	0.20	7.76	0.26	62.11	1.13	0.20	7.75	0.28	63.11
30	30 dry	1.05	0.20	7.77	0.21	61.61	1.17	0.20	7.78	0.24	63.62	1.15	0.20	7.76	0.27	64.00
30	30 fresh	1.10	0.20	7.70	0.22	62.09	1.18	0.20	7.71	0.27	64.01	1.17	0.20	7.73	0.29	64.60
45	15 dry	1.12	0.20	7.71	0.22	62.71	1.19	0.20	7.73	0.28	64.71	1.20	0.20	7.72	0.30	65.70
45	15 fresh	1.16	0.20	7.43	0.23	63.82	1.20	0.20	7.41	0.30	64.95	1.22	0.20	7.42	0.32	66.55

*Control = Initial soil sample
E.C.: Electrical conductivity (dSm^{-1})
W.H.C: Water Holding Capacity %
O.M.: Organic matter %
T.N.: Total nitrogen (ppm)

Use of *Azolla* either as dry or fresh material increased the WHC over that recorded in the used soil before planting (initial soil) or the application of 60 kg Nfed^{-1} as urea. However, the highest W.H.C (65.90, 66.70 and 67.90%) were recorded in soils used to grow rice varieties Sakha 101, Giza 177 and Sakha 102 and amended with 60 kg Nfed^{-1} as fresh *Azolla*, respectively. Also, it is of worth to state that the use of fresh *Azolla* was superior to dry *Azolla* in increasing the soil WHC.

Azolla incorporation in fresh or dry form also decreased the soil pH. However, this finding was more detectable with fresh *Azolla* compared to dry *Azolla*, while the application of urea raised the soil pH. These results may be attributed to that urea fertilization stimulate alga growth (**Simpson *et al* 1994**). Hence, the dissolved CO_2 in the floodwater is reduced during the day time leading to a rise in pH (**Thind and Rowell, 1997**). The higher the flood-water pH, the higher potential for NH_3 volatilization. The lower flood water pH in the presence of *Azolla* cover is partly explained in terms of absorption of available light (**Vlek *et al* 2002**), and reducing light penetrating the floodwater (**Kröck *et al* 1988**). As shading is one of the most important factors limiting algal photosynthesis in rice fields (**Saito and Watanabe, 1978**), the reduced photosynthetic activity in the presence of *Azolla* cover prevents the rapid rise in flood water pH.

Nitrogen is the most essential element influencing rice productivity (**Macale and Vlek, 2004**). Mineral nitrogen is very costly and environmentally not safe. Therefore, many countries including China, India, Philippines and some African countries are currently utilizing *Azolla* for agricultural purposes as cheaper and eco-friendly alternative source of chemical nitrogen fertilizers (**Lejeune *et al* 1999**). Generally, it could be concluded that *Azolla* application in rice production could scure up to 75% of mineral nitrogen required due to decreasing nitrogen losses and increased N-use efficiency. Saving environment from pollution with the high concentration of chemical nitrogen and consequently producing satisfactory and good rice yield and maintaining soil fertility representing other beneficial aspects of *Azolla* application.

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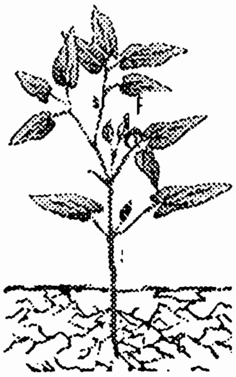

إستجابة ثلاثة أصناف من الأرز للتطبيقات المترابطة من الأزولا بنياتا ومستويات مختلفة من اليوريا

[٢٥]

رضا محمد الشحات[١]- مينا جورج زكى جرجس[٢]- الشيماء ابراهيم احمد[٢]- السيد احمد صالح[٢]

١- قسم الميكروبيولوجيا- معهد بحوث الأراضي والمياه والبيئة- مركز البحوث الزراعية- الجيزة- مصر

٢- وحدة التسميد الحيوي- قسم الميكروبيولوجيا- كلية الزراعة- جامعة عين شمس- شبرا الخيمة- القاهرة- مصر

أجريت تجربة أصص تحت ظروف الصوبة لدراسة تأثير إستخدام الأزولا بيناتا بصورتيها الطازجة والجافة كمصدر للنيتروجين. اما بصورة منفردة أو مختلطين باليوريا بمعدلات مختلفة للوصول إلى المعدل الموصى به ٦٠ كجم نيتروجين/ فدان لانتاج الأرز لدراسة أثر ذلك علي نمو وانتاجية المحصول لثلاثة أصناف من الأرز وهي جيزة ١٧٧، سخا ١٠١ وسخا ١٠٢) وكذا تأثير هذه المعاملات علي أعداد ميكروبات التربة الكلية والازوسبيريللم بالاضافة لتأثيرها علي بعض خواص التربة مثل محتواها من المادة العضوية ودرجة الحموضة والتوصيل الكهربي وكذا أعداد الميكروبات الكلية والأزوسبريللا بالتربة وقد أظهرت النتائج أن استخدام الأزولا سواء جافة أو طازجة شجع نمو أصناف الأرز المختلفة وأدى إلى زيادة محصول كل من الحبوب والقش. كما أوضحت النتائج ان استخدام ١٥ كجم نيتروجين أزولا طازجه مع ٤٥ كجم نيتروجين في صورة يوريا أعطى أفضل محصول لكل من الحبوب والقش والذي لم يختلف معنويا عن استخدام ٦٠ كجم نيتروجين أزولا طازجة أو٦٠ كجم نيتروجين في صورة يوريا. وقد أعطت الأزولا الطازجة تأثيرا أفضل من استخدام الأزولا الجافة سواء منفردة أو مخلوطة بمعدلات مختلفة من نيتروجين اليوريا. وأدى استخدام ٦٠ كجم نيتروجين في صورة أزولا طازجة إلي زيادة محتوى كل من الحبوب والقش من النيتروجين لأي من أصناف الأرز تحت الدراسة وذلك بالمقارنة مع باقي المعاملات تحت الدراسة. كما أدى استخدام كلاً من الازولا الطازجة بمعدلات مختلفة مع اليوريا بمستويات مختلفة إلى زيادة أعداد السيكروبات الكلية والأزوسبيريلا بالتربة. ومحتوى التربة من المادة العضوية بالمقارنة مع استخدام الأزولا الجافة أو اليوريا سواء منفردين أو مخلوطين بمعدلات مختلفة. كما أظهرت الدراسة أن استخدام الأزولا الطازجة أدي إلي انخفاض درجة حموضة التربة عنها في حالة استخدام الأزولا الجافة أو اليوريا و لم يكن هناك نمط معين واضح لتأثير اضافة الأزولا سواء جافة أو طازجة علي درجة التوصيل الكهربي للتربة.

تحكيم: ا.د مجدي إسماعيل محمد مصطفى
ا.د فكري محمد عبد العـال غزال