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Effect of nitrogen fertilizer sources and foliar spray of humic and/or fulvic acids on yield and quality of rice plants

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ABSTRACT

To study the effect of nitrogen fertilizer sources and foliar spray of organic acids on rice crop, In this regard, this test was performed in 2010 and 2011 years at El- Gemmeiza Agricultural Research Station, El-Gharbia Governorate located at lat. 30.47, long 31.00 and 14.80 m above the mean sea; the used design was split plot randomized complete block with 3replications. Main plots, two nitrogen fertilizer sources: anhydrous ammonia & urea while subplots, were treated with foliar application of humic and / or fulvic acid resulting 4 treatments including: controls (without foliar spray), humic, fulvic and humic +fulvic acids were considered.

Keywords: rice, humic and fulvic acids, ammonia, urea, qualitative and quantitative yield

INTRODUCTION

Rice (Oryza sativa L.,) is considered one of the most important summer crops in Egypt. The productivity of rice is affected by many factors such as seed germination, N fertilization, and quality of the fertilizer techniques. Rice is one of the most important cereal crops of the world, grown in wide range of climatic zones, to nourish the mankind. Earlier studies reveal that judicious and proper use of fertilizers can markedly increase the yield and improve the quality of rice [1].Panicles with a low percentage of sterile flowers permit the application of higher doses of nitrogen and produce better yields [2]. Modern production agriculture requires efficient, sustainable, and environmentally sound management practices. Nitrogen is normally a key factor in achieving optimum lowland rice grain yields [3]. Nitrogen (N) is essential for rice, and usually it is the most yield-limiting nutrient in irrigated rice production around the world [4]. [5] and [6] concluded that in cereals crop such as rice, N accumulation is associated with dry matter production and yield of shoot and grain. The nitrogen fertilizer rates were affected linearly the number of grain per panicle and the grain yield. The yields always increase with the addition of nitrogen fertilizer. This implies that nitrogen is very important in the rice system [7].

The type of nitrogenous fertilizer may also affect the yield and quality of the grain [8]. Some of these fertilizers, are anhydrous ammonia (82%N) and urea (46 %N).Anhydrous ammonia (82%N) is a liquid under high pressure and must be injected at least six inches deep into a moist soil because it becomes a gas once it is released from the tank. In soil, ammonia reacts with water to form the ammonium (NH4`) ion, which is held on clay and organic matter. Anhydrous ammonia is generally the cheapest source of N; however, the method of application is less convenient and requires more power to apply than most other liquid or dry materials. Another form urea, are substantially cheaper than others, and their use may be justified on economic grounds provided they do not adversely affect the yield or quality of the grain. [9] reported that calcium ammonium nitrate gave a greater yield and was a more efficient nitrogen source than urea and the grain N content was higher.

Addition of humic and fulvic acids has numerous profit and agriculturists all over the world are accepting humic and fulvic acids as a vital part of their fertilizer program. It can be applied directly to the plant foliage in liquid form or to the soil in the form of granules alone or as fertilizer mix. Humic acid is one of the major components of humus. Humates are natural organic substances, high in humic acid and containing most of known trace minerals essential to the growth of plant life [10]. Humic substances are an important soil component because they constitute a stable fraction of carbon and improve water holding capacity, pH buffering and thermal insulation [11]. Studies of the positive effects of humic substances on plant growth have demonstrated the importance of optimum mineral supply, independent of nutrition [12]. HA is a suspension, based on potassium-humates, which can be applied successfully in many areas of plant production as a plant growth stimulant or soil conditioner for enhancing natural resistance against plant diseases and pests [13 and 14], stimulation plant growth through increased cell division, as well as optimized uptake of nutrients and water, moreover, HA stimulated the soil microorganisms [15 and 16].

The present investigation was undertaken during the summer seasons of 2010 and 2011 to have a detailed account of the effect of two commercially-available nitrogenous (N) fertilizers and foliar spray of humic and or fulvic acids on the yield, its components and nutritional states of rice grainand straw yield (Oryza sativa L.) as well as nitrogen fraction of drainage water at 60days from transplanting and soil after harvesting.

MATERIALS AND METHODS

The present study was carried out during two successive summer seasons of 2010 and 2011 at the experimental farm of Gemmeiza Agriculture Research Station (Middle Delta, Egypt). The experimental site located at lat. 30.47, long 31.00 and 14.80 m above the mean sea level, to investigate the effect of nitrogen fertilizer sources as well as humic and fulvic acids together or individually on some yield components, grain and straw yield as well as grain quality and nitrogen loss as nitrite and nitrate by leaching through drainage water at 60 days from transplanting. Some physical and chemical properties were determined according to [17] and tabulated in Table (1a and b).
A split plot design with four replicates was used with two nitrogen sources i. e anhydrous ammonia and urea as main plots as well as humic and fulvic acids at rate of 5 g/L., individually or mixed and non addition of spray (control treatment) served check which were allocated at random in sub-plots.

Rice seedlings varieties, Giza 101, was sown on 15th and 19th May at the first and second season, respectively and transplanted after one month from growing seed in the nursery bed in the two seasons.

Table (1a) Some physical and chemical properties of the studied soils

Seasons	pH	EC	OM	$CaCO_3$	C. sand	F. sand	Silt	Clay	Soil texture
			%						
2010	7.88	7.75	1.81	3.44	0.84	20.15	32.88	46.13	Clay
2011	7.95	7.84	1.85	3.56	0.88	21.14	34.96	43.02	Clay

Table (1 b) Cations, anionsand nutrients concentration in a paste extract of the studied soil.

Seasons	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	N	P	K
	meq/L								Avail. (ppm)		
2010	2.85	2.15	2.14	0.55	0.00	1.64	4.25	1.80	39.12	9.12	375
2011	3.01	2.05	2.35	0.41	0.00	1.55	4.12	2.15	35.84	8.15	366

Plot size was 21 m^2 (5x4.2) and contained 20 rows 5 cm long and 15 cm apart. Phosphorus and potassium fertilizers were applied at rates of 15.0 kg P_2O_5 and 24 kg K_2O_5 in the form of superphosphate (15.0% P_2O_5) and potassium sulphate (48% K_2O), respectively. Both phosphorus and potassium were added during soil tillage. While, nitrogen fertilizer in the form of anhydrous ammonia with full dose was injected in the soil before planting about 7 days. While, the other one in the form of urea as well as humic and fulvic acids were divided into equal split portion to be added at basal dressing and at panicle initiation (20 and 35 days from transplanting, respectively). Humic and fulvic acids were also added as a foliar spray on rice plant at rates of 5 g / l (300 L/fed.) fed., = faddan 4200 m^{2}. The recommended dose of zinc fertilizer was applied to nursery bed at a rate of 2kg zinc sulphate ($ZnSO_4$)/kerate (two kerate nursery transplanted on fed.). A Pisometer was established in each experimental plot for analyzing nitrite and nitrate in the drainage water at 60 days from transplanting

At harvest time, the following parameters were recorded: plant height (cm), numbers of tillers/m^2, 1000-grain weight, grain and straw yields. Grains and straw samples were taken and oven dried at 70^{o}C, crushed, digested and chemically analyzed to determine N, P and K% in grains and straw, then calculate their contents. Nitrogen was determined using micro Kjeldahl, while phosphorous was determined colorimetrically using ammonium molybdate and ammonium metavanadate according to the procedure outlined by [17]. Potassium was determined using the flame spectrophotometry method [18]. Nitrite and Nitrate in rice grain and straw as well as drainage water samples after 60 days from transplanting, in addition to nitrite, nitrate and ammonium of soil after harvesting were determined according to the procedure outlined by [19].

The results were statistically analyzed using M stat computer package to calculate F ratio according to [20]. Least significant difference method (L.S.D) was used to differentiate means at the 0.05 level [21].

RESULTS AND DISCUSSION

Yield and some yield components of rice plant

Data presented in Table 2 reveal that the highest significant values of tillers No. /m^2, 1000grains weight (g) and straw yield (t/fed.,) were obtained when anhydrous ammonia was applied in first season only. Meanwhile, the same trend was observed on grain and straw yield of rice plant in second one. Conversely, the lowest significant values of such parameters were recorded by urea fertilizer form in both seasons. On the other hand, plant height wasn't affected by nitrogen form in both seasons, the same trend were obtained on grain yield in first season as well as tillers No. /m^2 and1000 grains weight (g) in second one. The increases of such parameters in response to application of N fertilizers is probably due to enhancing availability of nitrogen which enhanced leaf area resulting in higher photo assimilates and thereby resulted in more dry matter accumulation. These results are supported by the findings of [22] who concluded that, the urea fertilizer gave significant reductions in growth and yields in most of the experiments compared with ammonium nitrogen fertilizer form. [23], concluded that the grain and straw of rice yield were increased significantly by adding nitrogen fertilizer. Rice grain yield was increased significantly when N fertilizer at 220 kg/ha was added, while the lowest value was recorded by control treatment (without addition of N fertilizer) [24]. Also, [25] found that the differences in the number of tillers among the different N sources were mainly due to their variations in the availability of N and other nutrients. Adequacy of nitrogen probably favored the cellular activities during panicle formation and development that led to increased number of tillers $hill^{-1}$.

Regarding the effect of organic acids as foliar spray on rice yield and its components, results show that the foliar application of humic and fulvic together increased significantly such parameters. Meanwhile, the foliar spray of humic acid alone gave the highest significant values of all parameters in second season only with no significant differences between them. On the other hand, the lowest ones were recorded by control treatment (without foliar any organic acids) in both seasons. Plant growth is influenced indirectly and directly by humic and fulvic substances. The indirect effects, are those factors which provide energy for the beneficial organisms within the soil, influence the soil's water holding capacity, influence the soil's structure, release of plant nutrients from soft minerals, increased availability of trace minerals, and in general improved soil fertility. The direct effects include those changes in plant metabolism that occur following the uptake of organic macromolecules, such as humic acids, fulvic acids. Once these compounds enter plant cells, several biochemical changes occur in membranes and various cytoplasmic components of plant cells. Similar finding was achieved by [26] who reported that humic acid contains cytokinins and their application resulted in increasing endogenous cytokinin and auxin levels which possibly leading to improve yield. This may explain the increment in the filled grains weight/panicle and grain yield observed in this study. [27] found that the growth parameters, morphological characteristics and chemical contents' of faba bean plants records significant increases especially when (HA at 2000 ppm) was added.

Concerning the interaction effect between nitrogen fertilizer sources and organic acids as foliar spray on rice yield and its components, data presented in Table 2 reveal that, the foliar application of humic + fulvic as mixture with anhydrous ammonia gave a highest significant values of all parameters in both seasons. Conversely, in most cases, the lowest ones were obtained by control treatment under tow forms of nitrogen fertilizer in both seasons.

Table 2 Effect of nitrogen fertilizer sources and foliar application of organic acids on yield and some yield components of rice plant

Treatments	Plant height (cm)	Tillers No. /m²	1000 grains weight(g)	Grain yield t/fed.	Straw yield t/fed.	Plant height (cm)	Tillers No. /m²	1000 grains weight(g)	Grain yield t/fed.	Straw yield t/fed
	1st season					2nd season				
Nitrogen sources										
Anhydrous ammonia (AA)	90.175	545.92 *	28.885 *	3.677	3.326*	96.025	570.50	29.815	3.928*	3.558*
Urea	88.425	535.083	26.393	3.377	3.057	93.150	550.00	28.173	3.655	3.235
LSD at 5%	NS			NS		NS	NS	NS		
Foliar spray of organic acids										
Without foliar	85.95	501.5	25.62	3.052	2.756	90.45	515.3	27.06	3.451	3.005
Humic acid	91.45	552.5	28.58	3.825	3.426	96.40	577.5	29.34	3.963	3.536
Fulvic Acid	87.60	545.2	26.43	3.224	2.933	92.05	558.2	28.55	3.624	3.263
Humic+ Fulvic	92.20	562.8	29.93	4.008	3.650	99.45	590.0	31.03	4.129	3.783
LSD at 5%	4.160	21.01	0.2639	0.1125	0.1258	5.065	48.53	2.756	0.2484	0.3182
Interaction between nitrogen sources and foliar spray of organic acids										
(AA) + Without	87.10	505.0	26.55	3.139	2.838	92.40	528.0	27.22	3.507	3.110
(AA) + Humic	92.30	558.3	29.97	3.981	3.600	98.00	587.0	30.41	4.148	3.752
(AA) + Fulvic	88.20	552.0	27.74	3.433	3.070	93.50	568.3	29.73	3.785	3.407
(AA) + Humic+Fulvic	93.10	568.3	31.28	4.156	3.795	100.2	598.7	31.90	4.273	3.965
Urea + Without	84.80	498.0	24.69	2.964	2.674	88.50	502.7	26.89	3.395	2.900
Urea + Humic	90.60	546.7	27.18	3.668	3.253	94.80	568.0	28.26	3.777	3.320
Urea + Fulvic	87.00	538.3	25.12	3.016	2.796	90.60	548.0	27.37	3.463	3.118
Urea + Humic+ Fulvic	91.30	557.3	28.58	3.860	3.505	98.70	581.3	30.17	3.985	3.600
LSD at 5%	5.883	29.72	0.3732	0.1591	0.1779	7.163	68.63	3.898	0.3513	0.4501

Macronutrients content of grain rice yield

Results illustrate in Table 3 for N, P and K content of rice grain yield took the same manner of yield and its components. The anhydrous ammonia increased significantly values of N, P and K content of grain rice compared to urea fertilizer form in both seasons. It is well known that nitrogen fertilizers influence the content of photosynthetic pigments, the synthesis of the enzymes taking part in the carbon reduction, the formation of the membrane system of chloroplasts, etc. Thus the increase in growth and yield owing to the application of N-fertilizers may be attributed to the fact that these nutrients being important constituents of nucleotides, proteins, chlorophyll and enzymes, involve in various metabolic processes which have direct impact on vegetative and reproductive phases of plants. These findings confirm those of [22] who concluded that, the urea fertilizer gave the lowest grain N content in experiments. Thus in this series of experiments, urea had little effect on the quality of the grain. It may be concluded that nitrogen fertilizers, ammonium sulphate nitrate were found to be optimum for rice production.

Table 3 Effect of nitrogen fertilizer sources and foliar application of organic acids on N, P and K contents of rice grain yield

Treatments	N content of grain (kg/fed.)	P content of grain (kg/fed.)	K content of grain (kg/fed.)	N content of grain (kg/fed.)	P content of grain (kg/fed.)	K content of grain (kg/fed.)
	1st season			2nd season		
Nitrogen sources						
Anhydrous ammonia (AA)	53.547 *	14.230 *	65.707 *	56.670 *	16.050 *	68.607 *
Urea	49.277	13.057	58.746	52.237	14.253	62.810
LSD at 5%						
Foliar spray of organic acids						
Without foliar	43.19	12.19	56.76	48.43	13.44	59.22
Humic acid	54.88	13.64	64.61	57.89	15.95	68.67
Fulvic Acid	50.18	12.54	58.36	52.19	14.27	62.12
Humic+ Fulvic	57.39	16.21	69.17	59.31	16.94	72.83
LSD at 5%	0.4210	0.3753	0.7116	0.3558	0.4724	1.525
Interaction between nitrogen sources and foliar spray of organic acids						
(AA) + Without	44.64	12.91	58.13	49.13	14.00	60.83
(AA) + Humic	57.38	14.22	70.50	60.90	16.97	72.41
(AA) + Fulvic	53.22	13.08	61.92	55.15	15.50	65.50
(AA) + Humic+ Fulvic	58.95	16.71	72.28	61.50	17.73	75.69
Urea + Without	41.75	11.47	55.40	47.73	12.87	57.60
Urea + Humic	52.38	13.05	58.73	54.87	14.93	64.92
Urea + Fulvic	47.15	12.00	54.80	49.22	13.05	58.74
Urea + Humic+ Fulvic	55.83	15.71	66.05	57.13	16.16	69.98
LSD at 5%	0.5954	0.5307	1.006	0.5032	0.6680	2.157

For the foliar spray of organic acids on N, P and K content of rice grain yield, The mixture of humic and fulvic acids increased significantly values of N, P and K content of grain rice in both seasons. Vice versa, the lowest ones were observed by control treatment (without foliar any organic acids) in both seasons. Humic acid enhances cell permeability, which in turn made for a more rapid entry of minerals into root cells and so resulted in higher uptake of plant nutrients. This effect was associated with the function of hydroxyls and carboxyls in these compounds. These results agrees with those obtained by [28] who concluded that the uptake of N, P and K by both of straw and grain of wheat plant increased due to foliar application of humic acid as compared to control treatment. [29] indicated that the nitrogen, phosphorus and potassium in wheat grain has been significantly increased due to application at 50ppm humic acid individually or combined with 30ppmindolacitic acid.

With respect to the interacted factors under this studyon N, P and K content of rice grain yield, data tabulated in Table 3 show that when rice plants were foliar sprayed by mixture of humic and fulvic acids under the applied anhydrous ammonia fertilizer, the values of N, P and K content of rice grain yield were increased significantly in both seasons. On the other hand, the lowest significant ones were obtained by control treatment with urea fertilizer form in both ones. Also, sole foliar spray of fulvic acids under urea gave the lowest significant values of P and K content in both seasons.

Macronutrients content of straw rice yield

Results in Table 4reveal that the same trend of N, P and K content of strawrice yield were obtained form macronutrients content of straw yield. The highest significantly values of N, P and K content of grain rice were recorded by anhydrous ammonia compared with urea fertilizer form in both seasons. These findings confirm those of obtained by [22] who suggested that, nitrogen content in plant is markedly influenced by the application of different N fertilizers. The higher N content of nitrogen treated plants could be connected with the positive affect of nitrogen in some important physiological processes. These differences were statistically significant. Significantly lowest N content was obtained from the plots where urea was added.

Table 4 Effect of nitrogen fertilizer sources and foliar application of organic acids on N, P and K contents of rice straw yield

Treatments	N content of straw (kg/fed.)	P content of straw (kg/fed.)	K content of straw (kg/fed.)	N content of straw (kg/fed.)	P content of straw (kg/fed.)	K content of straw (kg/fed.)
	1st season			2nd season		
Nitrogen sources						
Anhydrous ammonia (AA)	25.855*	8.088 *	30.982*	27.058 *	9.087 *	32.285*
Urea	24.160	7.548	29.080	25.782	8.155	29.240
LSD at 5%						
Foliar spray of organic acids						
Without foliar	21.05	6.372	26.53	22.98	7.565	27.35
Humic acid	26.63	8.115	30.34	27.63	8.890	31.88
Fulvic Acid	23.38	7.295	28.51	24.74	8.210	29.35
Humic+ Fulvic	28.98	9.490	34.74	30.35	9.818	34.48
LSD at 5%	0.5597	0.3182	0.5247	0.3304	0.2950	0.4968
Interaction between nitrogen sources and foliar spray of organic acids						
(AA) + Without	21.90	6.680F	27.45	23.18	7.850	28.33
(AA) + Humic	27.42	8.330	31.28	28.64	9.420	33.87
(AA) + Fulvic	24.10	7.510	29.63	24.57	8.570	30.53
(AA) + Humic+ Fulvic	30.00	9.830	35.57	31.84	10.51	36.41
Urea + Without	20.20	6.063	25.62	22.77	7.280	26.36
Urea + Humic	25.83	7.900	29.40	26.61	8.360	29.88
Urea + Fulvic	22.66	7.080	27.38	24.90	7.850	28.17
Urea + Humic+ Fulvic	27.95	9.150	33.92	28.85B	9.130	32.55
LSD at 5%	0.7916	0.4501	0.7421	0.4673	0.4172	0.7026

Data presented in Table 4 show the responses of the achieved of N, P and K content of straw rice yield as influenced by the addition of foliar application of organic acids. As a general pattern, significant differences were clearer amonghumic, fulvic and humic+fulvic treatments in comparison with control one. The pronounced increases in the N, P and K content of straw rice yield were recorded when mixture of humic + fulvic were practiced. Alternatively, the lowest ones were obtained by control one through the two growing seasons. The stimulatory effects of humic and fulvic substances have been directly correlated with enhanced uptake of macronutrients, such as nitrogen, phosphorus, potassium and micronutrients. Humic substances enhance the uptake of minerals through the stimulation of microbiological activity [30] Humic substances actually coat mineral surfaces with a membrane-like bi-layer, which aids in the solubilization of otherwise insoluble compounds [31] by dissolving, complexing and chelating the dissolved nutrients.

As a general view, data in Table 4indicate that the treatments of mixture organic acids and anhydrous ammonia was superior significantly compared to other treatments with regard to N, P and K content of straw in both growing seasons. On the other hand, the lowest ones were recorded when control (without foliar spray organic acids) was practiced. The surpass of such treatments was confirmed generally, with the most above mentioned results.

NO_2 and NO_3 content of grain and straw rice yield

Data in Table 5 reveal obviously that the highest NO_2 and NO_3 content of grain were achieved with the treatment of anhydrous ammonia in both seasons. Also, NO_2 and $NO_3$of straw were increased significantly in first season only. Meanwhile, urea fertilizer decreased significantly NO_2 and NO_3 of grain and straw rice in both seasons. On the other hand, NO_2 and NO_3 of grain weren't affected significantly by addition of nitrogen fertilizer sources in second one.

Table 5 Effect of nitrogen fertilizer sources and foliar application of organic acids on NO_2 and NO_3 contents of rice grain and straw yield

Treatments	NO_2 in straw (ppm)	NO_3 in straw (ppm)	NO_2 in grain (ppm)	NO_3 in grain (ppm)	NO2 in straw (ppm)	NO3 in straw (ppm)	NO2 in grain (ppm)	NO3 in grain (ppm)
	1ST season				2ND season			
Nitrogen sources								
Anhydrous ammonia (AA)	5.007 *	6.288 *	2.317 *	3.298 *	5.465 *	7.318*	2.759	3.700
Urea	4.444	5.575	1.885	2.610	4.732	6.322	2.463	3.312
LSD at 5%							NS	NS
Foliar spray of organic acids								
Without foliar	3.910	5.075	1.800	2.755	4.390	6.005	2.175	3.050
Humic acid	5.133	6.330	2.265	3.095	5.485	7.205	2.765	3.585
Fulvic Acid	4.170	5.630	1.735	2.465	4.560	6.505	2.502	3.275
Humic+ Fulvic	5.690	6.690	2.605	3.500	5.960	7.565	3.003	4.115
LSD at 5%	0.388	0.417	0.434	0.419	0.432	0.360	0.339	0.5819
Interaction between nitrogen sources and foliar spray of organic acids								
(AA) + Without	4.050	5.480	1.920	3.050	4.630	6.480	2.370	3.250
(AA) + Humic	5.380	6.730	2.550	3.410	5.920	7.710	2.910	3.820
(AA) + Fulvic	4.270	5.980	1.920	2.780	4.790	7.100	2.600	3.400
(AA) + Humic+ Fulvic	6.330	6.960	2.880	3.950	6.520	7.980	3.157	4.330
Urea + Without	3.770	4.670	1.680	2.460	4.150	5.530	1.980	2.850
Urea + Humic	4.887	5.930	1.980	2.780	5.050	6.700	2.620	3.350
Urea + Fulvic	4.070	5.280	1.550	2.150	4.330	5.910	2.403	3.150
Urea + Humic+ Fulvic	5.050	6.420	2.330	3.050	5.400	7.150	2.850	3.900
LSD at 5%	0.5483	0.5900	0.6137	0.5927	0.611	0.5094	0.4807	0.8230

Regarding the foliar spray of organic acids on NO_2 and NO_3 content of grain and straw rice, data in Table 5 show that the treatment of humic and fulvic acids as mixture gave the highest significant values of all parameters in both seasons. The same trend of NO_2 of straw as well as NO_2 and NO_3 of grain was observed with foliar application of humic acid alone in both seasons. Oppositely, the lowest significant values of NO_2 and NO_3 content of grain and straw were recorded by control treatment or / and sole application of fulvic acid as a foliar in all parameters except NO_3 of straw in both seasons.In this connection, [32] found that foliar spray of humic acid gave significantly higher values of NO_3 in grain compared to no addition of any organic compounds.

With respect to the interacted factors under study on NO_2 and NO_3 content of grain and straw, results in Table 5 reveal that the highest significant values of NO_2 and NO_3 of two parts of rice yield were achieved with foliar application of humic and fulvic together with anhydrous ammonia in both seasons. On the other hand, the lowest significant ones were obtained by control treatment with urea fertilizer in both seasons.

NO_2 and NO_3 of drainage water as well as NO_2, NO_3 and $NH_4$of soil after harvesting

Data available in Table 6 show that the highest significant mean values of NO_2 and NO_3 in drainage water were obtained when urea fertilizer was applied compared to anhydrous ammonia form in both seasons. Vice versa, NH_4 of soil after harvesting was increased significantly by adding anhydrous ammonia form compared with urea in both seasons. Also, $NO_3$of soil after harvesting was increased significantly by adding anhydrous ammonia form compared with urea one in 2nd season only. On the other hand, NO_2 of soil wasn't affected by adding nitrogen fertilizer sources in 1st one.In this connection, [33 and 34] stated that in aerobic condition, NH_4^+ may be transformed to nitrate (NO_3^-) via nitrification . Since groundwater is an indispensable water resource for human consumption particularly in emerging countries and the fact that ultimately pollutants in the drainage water will be discharged into the river or streams which is also a source of drinking water, most authors referred to the drinking water standard guidelines as a baseline to assess the contamination level.

Table 6 Effect of nitrogen fertilizer sources and foliar application of organic acids on NO_2 and NO_3 contents of drainage water as well as NO_2, NO_3 and NH_4contents(ppm) of soil after harvesting rice

Treatments	NO_2 in drainage	NO_3 in drainage	NO_2 in soil	NO_3 in soil	NH_4 in soil	NO_2 in drainage	NO_3 in drainage	NO_2 in soil	NO_3 in soil	NH4 in soil
	1st season					2nd season				
Nitrogen sources										
Anhydrous ammonia (AA)	5.748	8.100	3.050	5.695	14.150 *	6.740	8.872	2.745	5.340*	13.647*
Urea	6.838*	8.721*	2.728	5.282	13.258	7.255 *	9.477 *	2.443	4.838	12.708
LSD at 5%			NS	NS				NS		
Foliar spray of organic acids										
Without foliar	6.850	9.550	3.095	5.840	15.52	7.600	10.32	2.795	5.385	14.48
Humic acid	6.210	8.142	2.815	5.485	12.98	6.925	8.808	2.520	4.935	12.66
Fulvic Acid	6.535	8.675	2.985	5.665	13.84	7.290	9.365	2.695	5.325	13.35
Humic+ Fulvic	5.575	7.275	2.660	4.965	12.48	6.175	8.205	2.365	4.710	12.22
LSD at 5%	0.466	0.382	NS	0.403	0.550	0.448	0.477	0.428	0.398	0.443
Interaction between nitrogen sources and foliar spray of organic acids										
(AA) + Without	6.120	8.950	3.250	6.100	15.95	7.300	9.780	2.930	5.840	14.97
(AA) + Humic	5.700	8.000	2.980	5.650	13.70	6.730	8.550	2.660	5.100	13.22
(AA) + Fulvic	5.920	8.350	3.100	5.880	14.10	7.000	9.100	2.890	5.550	13.87
(AA) + Humic+ Fulvic	5.250	7.100	2.870	5.150	12.85	5.930	8.060	2.500	4.870	12.53
Urea + Without	7.580	10.15	2.940	5.580	15.10	7.900	10.86	2.660	4.930	14.00
Urea + Humic	6.720	8.283	2.650	5.320	12.25	7.120	9.067	2.380	4.770	12.10
Urea + Fulvic	7.150	9.000	2.870	5.450	13.58	7.580	9.630	2.500	5.100	12.83
Urea + Humic+ Fulvic	5.900	7.450	2.450	4.780	12.10	6.420	8.350	2.230	4.550	11.90
LSD at 5%	0.6585	0.540	0.6365	0.571	0.778	0.634	0.675	0.606	0.563	0.626

With regard to the effect of organic acids as foliar application on nitrogen fraction of drainage water and soil after harvesting rice, results obviously show that the control treatment increased significantly the values of such parameters in both seasons. On the other hand, the same parameters were decreased significantly by adding mixture application of humic and fulvic acids in both ones. NO_2 of soil wasn't affected by adding organic acids as foliar application in 1stseason only. The concentrations of inorganic N in the soil solutions throughout the vertical soil profile were mainly subjugated by NH_4^+ ion rather than NO_3^-because the source of N fertilizer was ammonium chloride. Significant increase in NO_3^-N in the soil solution was observed at 60 days and after harvesting. This implied that nitrification was relatively slow in the soil during the monsoon period. This might be attributed to the high NH_4 concentration which inhibits the activity of nitrifies in the soils and the low soil organic matter which reduces the population of nitrifies [35].

Concerning the effect of interacted factors under investigation on nitrogen fraction of drainage water and soil after harvesting rice, in most cases, data in Table 6 reveal that the highest significant values of most parameters were obtained by humic and fulvic acids as foliar spray with either nitrogen fertilizer sources in both seasons. Meanwhile, the lowest ones were recorded when control treatment (without foliar spray any organic acids) under two applied nitrogen fertilizer forms in both seasons.

Economic evaluation

Anhydrous ammonia increased all economic criteria in both 2010 and 2011 seasons (Table 7). The average increasing percentage in gross income, net income, benefit / costs ratio and profitability in the first and second seasons due to using anhydrous ammonia were 8.52, 21.03, 11.46 and 24.70 % ,respectively, as compared with applying urea solid nitrogen fertilizer as check treatment. The same trend were obtained by [22] who found that the highest benefit of the rice crop was recorded when Super Net or ammonium sulphate nitrate were applied, however, the minimum value for benefit cost ratio was obtained from the plots where urea was added.

Data presented in Table 7 reveal that the applying humic and fulvic acids together realized the highest average of the two seasons for gross income, net income, benefit/costs ratio of and profitability by 26.26, 58.51, 25.56 and 57.82, respectively compared to without foliar application of any organic acids.

With regard to the interacted factors under this study on economic criteria of rice production, applying anhydrous ammonia with foliar application of humic and fulvic acids as mixture increased all average economic criteria i.e., ross income, net income, benefit/costs ratio of and profitability by 34.49, 85.19, 38.15 and 89.98 % compared with control treatment (without foliar spray) under urea fertilizer in both seasons. Therefore, these treatments are considered the most profitable to be used in this study to nitrogen fertilizer sources and foliar spray of organic acids under conditions of this experiment.

Table 7 Effect of nitrogen fertilizer sources and foliar application of organic acids on the economics of rice cultivation

Treatments	Soil rent	plowing	Trans planting	Irrigation	H	F	fertilizer			Weeds	Harvesting	Total cost	Gross income(L.E.)			Net income (L. E.)			Benefit / Costs ratio			Profitability %		
							N	P	K				2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Anhydrous ammonia (AA)	1500	250	1000	400	11	11	276	180	230	300	750	4908	10164	10862	10513	5255	5954	5605	2.07	2.21	2.14	107.07	121.31	114.19
Urea	1500	250	1000	400	11	11	425	180	230	300	750	5057	9336	10039	9688	4279	4982	4631	1.85	1.99	1.92	84.62	98.52	91.57
Without foliar	1500	250	1000	400	0	0	351	180	230	300	750	4961	8432	9434	8933	3471	4473	3972	1.70	1.90	1.80	69.97	90.16	80.06
Humic acid	1500	250	1000	400	22	0	351	180	230	300	750	4983	10542	10910	10726	5559	5928	5744	2.12	2.19	2.15	111.56	118.96	115.26
Fulvic Acid	1500	250	1000	400	0	22	351	180	230	300	750	4983	8927	10004	9466	3944	5021	4483	1.79	2.01	1.90	79.15	100.76	89.96
Humic+ Fulvic	1500	250	1000	400	11	11	351	180	230	300	750	4983	11101	11456	11279	6118	6474	6296	2.23	2.30	2.26	122.78	129.92	126.35
(AA) + Without	1500	250	1000	400	0	0	276	180	230	300	750	4886	8675	9638	9157	3789	4751	4270	1.78	1.97	1.87	77.55	97.24	87.39
(AA) + Humic	1500	250	1000	400	22	0	276	180	230	300	750	4908	11003	11465	11234	6095	6557	6326	2.24	2.34	2.29	124.19	133.60	128.89
(AA) + Fulvic	1500	250	1000	400	0	22	276	180	230	300	750	4908	9457	10447	9952	4549	5539	5044	1.93	2.13	2.03	92.69	112.86	102.77
(AA) + Humic+ Fulvic	1500	250	1000	400	11	11	276	180	230	300	750	4908	11520	11901	11711	6611	6993	6802	2.35	2.42	2.39	134.70	142.48	138.59
Urea + Without	1500	250	1000	400	0	0	425	180	230	300	750	5035	8186.4	9230	8708	3151.4	4195	3673	1.63	1.83	1.73	62.59	83.32	72.95
Urea + Humic	1500	250	1000	400	22	0	425	180	230	300	750	5057	10080.3	10353	10217	5023.3	5296	5160	1.99	2.05	2.02	99.33	104.73	102.03
Urea + Fulvic	1500	250	1000	400	0	22	425	180	230	300	750	5057	8397.6	9559	8978	3340.6	4502	3921	1.66	1.89	1.78	66.06	89.03	77.54
Urea + Humic+ Fulvic	1500	250	1000	400	11	11	425	180	230	300	750	5057	10681.5	11011	10846	5624.5	5954	5789	2.11	2.18	2.14	111.22	117.74	114.48

From the above mentioned results, we can conclude that the anhydrous ammonia with foliar application of humic and fulvic acids together improve rice productivity, quality, nitrogen fraction of drainage water at growth period and soil after harvesting as well as economic criteria under the same conditions of this study.

CONCLUSION

1-Anhydrous ammonia achieved significantly increases of tillers No. /m^2, 1000 grains weight (g) and straw yield (t/fed.,) in first season only.The same trend was observed on grain and straw yield of rice plant in second one. N, p & K content of grain and straw as well as NO_2 and NO_3 of grain and straw were increased significantly by adding anhydrous ammonia. While, the lowest significant values of such parameters were recorded by urea nitrogen fertilizer in both growing seasons.
2-In most cases, foliar application of humic and fulvic acids together led to significant increases of plant height, tillers No. /m^2, 1000 grains weight (g), grain, straw rice yield and N, p & K content of grain and straw as well as NO_2 and NO_3 of grain and straw, whereas, the lowest significant ones were obtained when control treatment (without foliar application of organic acids) in both seasons.
3-On the whole, the highest significant values of plant height, tillers No. /m^2, 1000 grains weight (g), grain, straw rice yield and N, p & K content of grain and straw as well as NO_2 and NO_3 of grain and straw were obtained by foliar application of humic and fulvic acids together under anhydrous ammonia fertilizer form. While, the lowest ones were recorded with control (without foliar application of organic acids) under urea fertilizer in both seasons .
4-The highest significant values of NO_2 and NO_3 in drainage waterat 60 days from transplanting were obtained when urea fertilizer was applied compared to anhydrous ammonia form in both seasons. Vice versa, NH_4 of soil after harvesting was increased significantly by adding anhydrous ammonia form compared with urea in both seasons. In most cases, the same parameters were increased significantly by foliar spray of both organic acids together, but the lowest ones were achieved by control (without foliar application of organic acid) in both season. On the other hand, such parameters were significantly increased by without foliar application of organic acid with both sources of nitrogen fertilizer. The lowest ones were observed by foliar spray of humic and fulvic acids together with both nitrogen sources in two seasons.
5-Anhydrous ammonia increased gross income, net income, benefit / costs ratio and profitability, The average increasing percentage were 8.52, 21.03, 11.46 and 24.70 % ,respectively, as compared with applying urea in both seasons . humic and fulvic acids together realized the highest average of such parameters by 26.26, 58.51, 25.56 and 57.82, respectively compared to without foliar application of any organic acids in two seasons. Anhydrous ammonia with foliar application of humic and fulvic acids as mixture increased same parameters by 34.49, 85.19, 38.15 and 89.98 % compared with control treatment (without foliar spray) under urea fertilizer.

REFERENCES

[1] Place, G.A., Sims J.L. and Hall, U.L., **1970**. *Agron. J.*, 62: 239–41.
[2] Yoshida S., **1981**. Fundamentals of rice Crop Science. International Rice Research Institute, 269 p.
[3] Fageria, N.K., Baligar, V.C., Jones, C.A., **1997** Growth and Mineral Nutrition of Field Crops; 2nd Ed; Marcel Dekker: New York.
[4] Samonte, S. O. P. B., L. T. Wilson, J. C. Medley, S. R. M. Pinson, A. M. Mc- Clung, and J. S. Lales. **2006**. *Agronomy Journal* 98: 168–176.
[5] Fageria, N. K. **2003**. *Communications in Soil Science and Plant Analysis* 34: 259–270.
[6] Tayefe, M., A. Gerayzade, E. amiri1 and A. NasrollahZade, **2011**. International Conference on Biology, Environment and Chemistry. IPCBEE vol.24 (**2011**) © (2011)IACSIT Press, Singapoore.
[7] Bagayoko, M., **2012**.*Journal of Agricultural and Biological Science*. 7:620-632.
[8] Gately, T.F. and Kelly, D., **1987**.Sources ofnitrogen for spring barley. Soils and Grassland Production Research Report, pp 27–8. Dublin. An ForasTaluntais.
[9] Gately, T.F., Quirke, L. and Ormonde, S., **1988**.Sources of nitrogen for spring barley. Soils and GrasslandProduction Research Report, pp 14–15. Dublin. An ForasTaluntais.
[10] Senn, T.L., **1991**. Humates in Agriculture. Acres USA, Jan.
[11] McDonnell R., N.M. Holden, S.M. Ward, J.F. Collins, E.P. Farrell and M.H.B. Hayes, **2001**. *Biology and Environment,* 101(3): 187-197.
[12] Yildirim, E., **2007**. ActaAgriculturaeScandinavica. *Section B. Soil and Plant Science*, 57(2): 182-186.
[13] Scheuerell, S.J. and W.H. Mahaffee, **2004**. *Phytopathology*, 94: 1156-1163.
[14] Scheuerell, S.J. and W.H. Mahaffee, **2006**. *Plant Dis.,* 90: 1201-1208.

[15] Atiyeh, R.M., S. Lee, C.A. Edwards, N.Q. Arancon and J.D. Metzger, **2002**. *Bioresource Technology*, 84: 7-14.
[16] Chen, Y., M. De Nobili and T. Aviad, **2004**.Stimulatory effect of humic substances on plant growth.In"Soil organic matter in sustainable agriculture".(Eds F. Magdoff, R.R. Weil). 103-130, Boca Raton, FL.
[17] Ryan, J., S. Garabet, K. Harmsen, and A. Rashid (**1996**). A soil and plant Analysis Manual Adapted for the West Asia and North Africa Region. ICARDA, Aleppo, Syria. 140pp.
[18] Black, C. A. (**1982**). Methods of Soil Analysis.Part 2.Chemical and Microbiological Properties.Second Edition.Amer.Soc. of Agron. Madison, Wisconsin, U.S. A.
[19] Singh, J. P. (**1988**). *Plant and Soil*, 110:137-139.
[20] Gomez, K. A. and A. Arturo, Gomez. (**1984**). Statistical Procedures for Agricultural research, (2nd ed.), pp. 20-29 & 359-387.
[21] Waller, R. A. and C. B. Duncan(**1969**). A bays rule for symmetric multiple comparison problem Amer. State Assoc. J. December, (5):1485-1503.
[22] Chaturvedi, I.,**2005**. J. Cent. Eur. Agric. 6: 611-618
[23] Debiprasad D, Hrusikesh P, Ramesh C. Tiwari and Mohammad S, J. *Adv. Appl. Sci. Res*. **2010** 1, 36-49.
[24] Ali Abdalla Basyouni Abou-Khalifa, J. *Adv. Appl. Sci. Res*., **2012**, 3, 1144-1149.
[25] Alim,M. A. **2012**. J. *Environ. Sci. & Natural Resources*, 5: 273- 282,
[26] Zhang, X. and E. H. Ervin (**2004**). *Crop Sci.*, 44: 1737-1745.
[27] El-Ghamry, A. M., Kamar M. Abd El- Hai and K. M. Ghoneem,**2009**. *Aust. J. Basic & Appl. Sci*., 3(2): 731-739, 2009
[28] Laila K.M. Ali and M.M. Elbordiny, **2009**. *J. Appl. Sci. Res.*, 5(9): 1202-1209, 2009
[29] Habashy, N.R. and laila, M. Aly, **2005**. *Minufiya J. Agric. Res.*, 30: 1607-1624.
[30] Day, K.S., Thornton, R. and Kreeft, H., **2000**. Humic acid products for improved phosphorus fertilizer management in humic substances, Versatile Components of Plants, Soil and Water, E.A. Ghabbour, ed. Royal Society of Chemistry, pp.321-325
[31] Tombacz, E. and Rice, J.A., **1999**. Changes of Colloidal State in Aqueous Systems of Humic Acids.In:Ghabbour, E.A. and Davies, G. (eds.), Understanding Humic Substances: Advanced Methods, Propertiesand Applications. Royal Society of Chemistry, Cambridge, UK.. pp. 69-77.
[32] El-Gohary, A. A.; E.A.M. Osman and K. A. Khatab, **2010**. *J. of Soil Sciences and Agricultural Engineering*, 1 : 77 - 91
[33] Umezawa, Y., T. Hosono, S.I. Onodera, F.Siringan, S. Buapeng and C. Yoshimizu, **2009**. *Sci. Environ*., 407: 3219-3231.
[34] Bouman, B.A.M., A.R. Castaneda and S.I. Bhuiyan (**2002**). *Ecosyst.Environ*., 92: 185-199.
[35] Erickson, H., M. Keller and E. A. Davidson (**2001**). *Ecosystems*., 4: 67-84.