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Effect of Dap Fertilizer Type and Growth Periods in Ammonium Concenteration in Rhizosphere of Rice Plant

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Abstract
In order to study the effect of the DAP fertilizer type on the concentration of Ammonium ion during the different periods of rice plant growth ,The experiment was carried out in one of the rice fields located in The Ghamas district / Diwaniyah governorate in the summer season 2019 using the design of the entire random sectors (RCBD). The experiment included the use of DAP fertilizer (mineral DAP, organic DAP and high potash DAP). Rice seeds were grown on 2019/6/10 and Anber 33 on 2019/6/15 to study the effect of fertilizer type and growth periods in the form of Ammonium ion in rice risphere during plant growth periods (105,75.45) days of agriculture .The results showed that the highest concentration of ammonium for Anber rice 33 was achieved at the mineral DAP fertilizer (41.73) mg kg^{-1} in the reduction layer during the time period (45) a day of cultivation and in organic DAP fertilizer (37.80, 36.70) mg kg^{-1} in the reduction layer during the two periods (75 and 105) on the day of cultivation in succession. Jasmine rice was the highest concentration of Ammonium treated at organic DAP fertilizer (39.83 and 36.30) mg kg^{-1} in the reduction layer during the two periods (105 and 75) days of successive planting and in the mineral DAP fertilizer (37.23) mg kg $^{-1}$ in the reduction layer during the period (45) days of agriculture in succession and in the metal DAP fertilizer (37.23) mg kg^{-1} in the reduction layer during the period (45) days of agriculture .The highest absorption of Jasmine rice germination of Ammonium ionin in the rissoflayer was at the time (45 and 75) days of cultivation. While Anber rice was the highest absorber at(105) days of cultivation, overall the (75) days of cultivation were the highest in both classes in the rice plant.
Keywords: Dap fertilizer type, growth periods, ammonium, rice plant

Introduction

The rice crop *Oryza Sativa L.* is the second most important grain crop economically after the wheat crop, because it is the main food of more than 2.5 billion people in the world of Nuaimi and others , (2000) and its grains are easy to digest, and it is rich in carbohydrates, which is an important source of energy (Al-Barzanji, 2006).

The damp is an effective fertilizer as it is a source of nitrogen and phosphorus to feed the plant and high soluble in water to release the phosphorus and amonium (IPNI, 2014). P and N are essential nutrients that the plant needs in large numbers for its important roles in the construction of proteins, nucleic acids, various membranes

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and energy (Krikby and Mengel,1982). The quantities needed by each crop of nutrients depending on the type of soil or medium in which the plant grows, the type, type, production capacity and capacity of each crop(Havlin and others, 2005). The thickness of the resisphere area is generally (2-1) mm, but the resisphere is functionally defined as the part of the soil physically and chemically affected by the growth and effectiveness of the roots, so the boundaries of this area vary depending on the mass and geometry of the plant roots (Jones et al., 2004, Hinsinger et al., 2006).

Ammonium produced due to the process of dissonance, or added as fertilizer to volatilization by Ammonia, is absorbed by plants, or is installed between layers of clay minerals (Camberato, 2001). The study also indicated that small amounts of soil-added fertilizers are taken by plant roots, particularly those developing in sand soils, while the high proportion of added fertilizers is lost through washing as well as loss by volatile, particularly nitrogen, and that the proportion of nitrogen lost is almost high and represents 62 of the added fertilizer (Dixon, 2003). Prassakert et al., (2001)Cai; The refore, the risk of a high level of risk is high. Ahmed et al., (2006) found a clear reduction in NH_3 volatility as well as the effective accumulation of NH_4 in the soil, indirectly due to the low degree of interaction and high catalytic exchange capacity generated by the addition of dabalik acid with nitrogen fertilizers to the soil. The researchers noted Mroczkowski and Stuczynski ,(2006). The existence of a moral association between the amount of volatile Ammonia, and increased levels of soil salinity, particularly in sand or sand mixture soils, and the reason is due to inhibition of the process of sand and accumulation of Ammonium and not to nitrate, and then volatilization in the form of ammonia gas, especially when the level of irrigation is less than (2.5cm) compared to its addition to urea, which turns into Ammonium carbon, and then to nitrates in the process of jerking .The amount of ammonia gas lost from urea fertilizer depends on a combination of factors related to soil properties and surrounding environmental conditions, as well as the level and method of addition of urea, and these factors control the increase, or decrease of the difference in the molecular pressure of ammonia gas between the surrounding atmosphere and those in balance with the soil moisture of Peoples et al., (1995). This difference is the driving force for ammonia volatility from FAO and IFA soils, (2001). Fernando and Aharon pointed out, (2005) That the processes of interfering with Ammonium with organic compounds to form complexes, and the stabilization of these complexities in the soil are taking place either simultaneously or consecutively, and it has been observed that Ammonium deposited from a liquid organic source needed 80 hours to reach the state of balance between soil solution and organic source compared to only 6 hours for the balance of Ammonium between a solution and $NH_4.2SO_4$ as a chemical source of Ammonium.

Based on the research objective to study the effect of the types of damp fertilizer (mineral, organic and high potash) in the concentration of Ammonium ion in the risesphere of rice plant class (Anber33 and Jasmine) during the various growth periods (105,75,45) days of agriculture.

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Materials and methods

The experiment was carried out in one of the rice fields located in The Ghamas district/ Diwaniyah governorate during the summer season of the year 2019. The field soil was ploughed, softened, settled and divided into experimental units, the experimental unit area (2.25x2.25 m), the distance between the experimental unit and the other (1m), the work of sub-irrigation channels and the connection to a major irrigation channel, and a pre-planting sample for the purpose of conducting and estimating some of the physical and chemical properties of the soil in the ways in Jackson (1958), Black (1965), Page et al (1982) and shown in Table 1. The experiment was designed in accordance with the complete randomized Block Design (C.R.B.D) using four experimental transactions (control treatment, metal DAP treatment, organic DAP and high potash DAP treatment) and three repeats per transaction, and randomly distributed transactions to experimental units to the number of units (12) experimental units for each type of rice plant (Anber 33 and Jasmine) i.e. the total units (24) units .In 2019/6/10, dry rice seeds (Jasmine variety) were planted and on 2019/6/15 dry rice seeds (Anber class 33) obtained from the rice research station in al-Mashkhab district/ Najaf governorate, and by 120 kg h^{-1} seeds in the manner of direct scattering directly on the pre-prepared ground and then covered with soil. The field was irrigated with the first (prolific) and then left to dry for (3-4) days and then again irrigated the wild germination and then the irrigation process continued every 3 days until the plants reached the appropriate height, the fertilizer of the dab was added at 120 kg per hectare for each treatment of rice trays (33 and Jasmine) and the addition was in two batches (35 days of agriculture and 30 days from the date of the first batch). 2019. After 3-4 days of grafting, the field was dried for 3 days. The irrigation process then continued until the flowering phase began on 21 September 2019, and the bush was manually combated by weeding whenever needed. Ammonium was estimated for oxidize soil, reduction and rhizosphere during plant growth periods after 45, 75 and 105 days of cultivation .Ion NH_4^+ was estimated to be extracted with potassium chloride solution (2N) and the use of MgO, and the qas through the macrochlordal device according to bremner(1965) described in Black, (1965). SAS (2012) in the analysis of data according to the design of the sectors full-year CRBD to study the effect of dab fertilizers and compared the moral differences between averages by testing the less significant difference (LSD) and at a moral level 0.05.

Table (1). Some chemical and physical properties of field soil before planting

Properties	Quantity	measruing unit
Soil pH reaction	7.53	——
ECe electrical conductivity	4.98	$ds.m^{-1}$
Cation exchange capacity	28.34	Cmol. Kg^{-1}
Carbonate minerals	328.7	$g.kg^{-1}$

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Organic matter		6.9	$g.kg^{-1}$
Nitrogen		23.0	$mg.Kg^{-1}$
Phosphorous		3.24	$mg.Kg^{-1}$
Potassium		93.0	$mg.Kg^{-1}$
Dissolved Calcium Ca^{+2}		30.0	$mmol.L^{-1}$
Dissolved Magnesium Mg^{+2}		13.5	$mmol.L^{-1}$
Dissolved Sodium Na^{+1}		8.25	$mmol.L^{-1}$
Dissolved Bicarbonate HCO_3		2.5	$mmol.L^{-1}$
Dissolved Carbonate CO_3^{-2}		Nil	---
Dissolved Potassium K.		4.25	$mmol.L^{-1}$
Bluck density		1.68	$Mg.m^{-3}$
Soil Fractions	sand	308	$g.kg^{-1}$
	Silt	388	$g.kg^{-1}$
	Clay	304	$g.kg^{-1}$
Soil texture		CL	

Results and discussion

Concentration of Ammonium ion in Anber rice:

Table (2) Shows the concentration of Ammonium ion in the oxidation layer, abattoide and resizophonic after 45 days of cultivation in Anber rice soils. The results showed that the highest values were in the treatment of mineral dab in the reduction layer and amounted to (41.73) mg kg^{-1}. The least in the treatment of control in the oxidation layer amounted to (8.90) mg kg^{-1} and with moral differences on a moral level 5% between transactions and the treatment of control and among them also, and this is due to the fact that the fertilizer used contains the ion of Ammonium and thus led to this increase has varied The dam persere through its processing of Ammonium ion and took the next sequence in this period of plant growth.

Metallic DAP > High potash DAP > Organic DAP

The results also show that the reduction layer (rhizosphere and reduction) is superior to the concentration of Ammonium ion compared to the oxidation layer in all transactions and that this may be due to the fact that the conditions are more suitable to be in this layer as a result of the reduction aryconditions available in them and this is consistent with what he found (Tamimi, 1999). I took the following sequence:

Reduction layer > Rhizosphere layer > Oxidation layer

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The decrease in the concentration of Ammonium in the rissof layer compared to the reduction layer is due to its absorption by the roots and its convergence of value with what is present in the reduction layer may be offset by it, and this is consistent with what I found (Al-Jayashi, 2020).

Table (2) Ammonium ion concentration (mg kg^{-1}) for Anber rice soil after 45 days of planting.

list	Sampling	Sampling area		
		Oxidizer	Rhizosphere	Reduction
1	Control	8.90	17.13	22.23
2	Organic DAP	13.93	28.70	33.00
3	Metallic DAP	17.93	37.60	41.73
4	High Potash DAP	16.63	36.83	39.80
	LSD 0.05	0.9174	0.6685	0.9107

Table (3) Shows the concentration of Ammonium ion in the oxidative layer, Reduction and resisphere after(75) days of cultivation in Anber rice soil, the results showed that the highest values were in the treatment of organic dab in the reduction layer and amounted to (37.80) mg kg^{-1} the lowest in the treatment of control in the oxidist layer and amounted to (6.63) mg kg^{-1} and with moral differences at a moral level 5% between transactions and control treatment and among them, and that this may be due to the addition of organic matter increases the effectiveness and activity of micro-organisms that do their part. By decomposing that substance and increasing the processing of Ammonium (Nasiriyah, 2005). The results also show that the reduction layer (rhizosphere and reduction) is superior to the concentration of Ammonium ion compared to the oxidative layer in all transactions and that this may be due to the fact that the conditions are more suitable to be in this layer as a result of the reduction arya conditions available in them and this is consistent with what he found (Tamimi, 1999).

Table (3) Concentration of Ammonium ion (mg kg^{-1}) for Anber rice soil after 75 days of planting.

list	Sampling	Sampling area		
		Oxidizer	Rhizosphere	Reduction
1	Control	6.63	12.60	16.80
2	Organic DAP	19.03	30.93	37.80
3	Metallic DAP	11.83	20.80	29.53
4	High Potash DAP	9.53	20.70	27.70
	LSD 0.05	0.4756	0.568	0.2884

Table (4) shows the concentration of Ammonium ion in the oxidative layer, The results showed that the highest values were in the treatment of organic DAP in the

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reduction layer of (36.70) mg kg^{-1} the lowest in the treatment of control in the oxidation layer and amounted to (5.03) mg kg^{-1} with moral differences of 5% between transactions and control and among them, and that this may be due to the addition of organic matter increases the effectiveness and activity of micro-organisms in turn. By decomposing that substance and increasing the processing of Ammonium (Nasiriyah, 2005). The results also show that the rhizosphere is superior to the concentration of Ammonium ion compared to the oxidative layer in all transactions and that this may be due to the fact that the conditions are more suitable to be in. We find through the durations (75,105) the day we process the Ammonium ion by the fertilizer of the dab taking the following order

Organic DAP > Metallic DAP > High potash DAP

Table (4) concentration of Ammonium ion (mg kg^{-1}) for Anber rice soil after 105 days of planting.

list	Sampling	Sampling area		
		Oxidizer	Rhizosphere	Reduction
1	Control	5.03	12.23	14.93
2	Organic DAP	18.03	30.30	36.70
3	Metallic DAP	11.53	20.10	26.80
4	High Potash DAP	8.80	19.60	26.40
	LSD 0.05	0.1526	0.88	0.7498

We note from the results in the tables (2,3,4) and figure (1) the continued decrease in the concentration of Ammonium with measurement durations (45,75,105) days of cultivation in the soil of oxidative matter, rhizosphere, all transactions and the reason for the decrease in Ammonium may be due to absorption by the plant and loss of part of the nitrogen in the soil through the loss of nitrogen by volatilization, slackness and stabilization of organic matter, or clay minerals, or used by soil organisms when carbon is available as a source of energy and growth. This is consistent with what Barker and Bryson found, (2007) which was more pronounced for the third stage in the period (105) days as well as consistent with what I found (Jarallah and Fatimah , 2020a). We also find from the results in Figure (1) increased processing of Ammonium with increased growth times in the treatment of organic DAP, which indicates that this fertilizer is processed gradually while the metal DAP exceeds the first period only (45) days, indicating that it processes ion when added and is later lost in the rest of the period in which the plant needs are low for this ion causing its loss.

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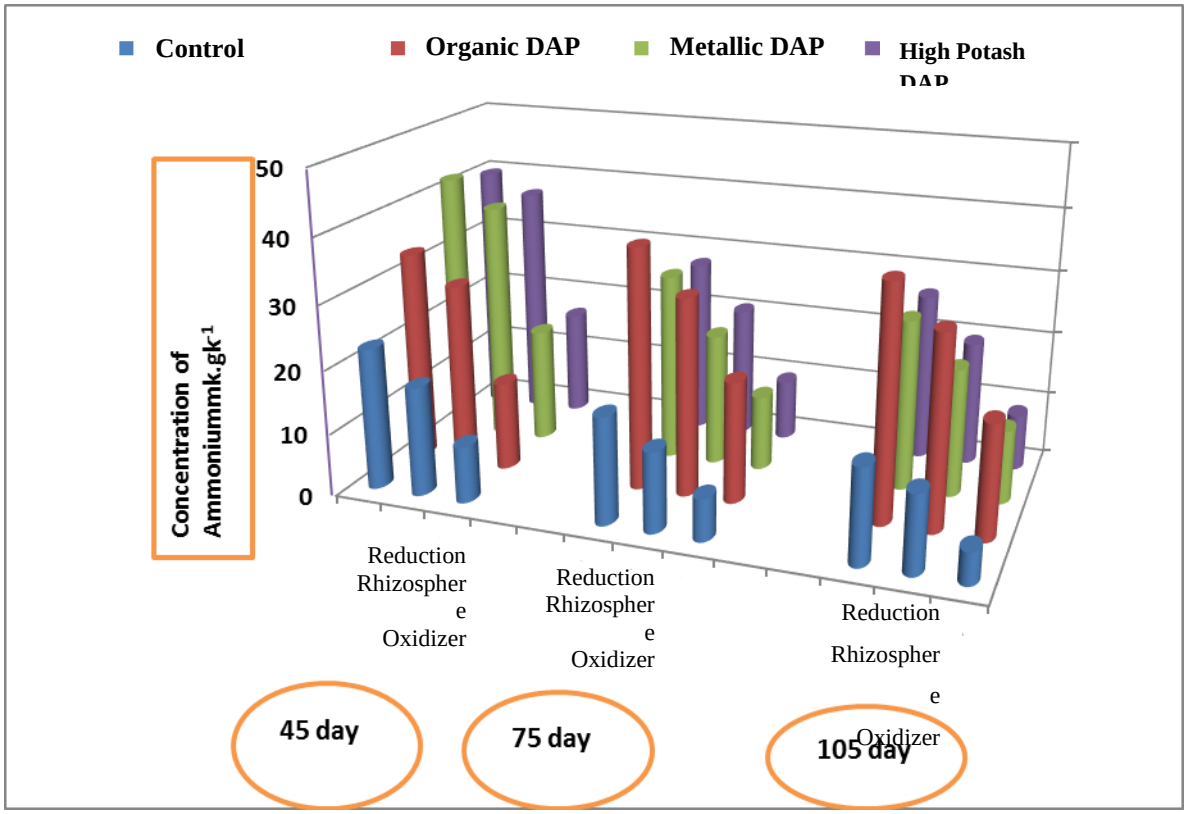

Form (1) Ammonium concentration during periods of growth of Anber rice.

Ammonium concentration in Jasmine rice:

Table (5) shows the concentration of Ammonium in the oxidation layer, The results showed that the highest values were in the treatment of metal DAP in the reduction layer and amounted to (37.23) mg kg^{-1} the lowest in the treatment of control in the oxidation layer and reached (6.43) mg kg^{-1} and moral differences at the level of 5% between transactions and the treatment of control and among them as well, and that this may be due to the compost used on the Ammonium and took the fertilizer sequencing of the ati Where you met her on Ammonium processing:

Metallic DAP > High Potash DAP > Organic DAP

We find from the results also the superiority of the rhizosphere and the reduction with the concentration of Ammonium ion compared to the oxidation layer in all treatments, and that this may be due to the fact that the conditions are more suitable for it to be in this layer as a result of the reduction conditions available in it, and this is consistent with what he found (Al-Tamimi, 1999). The following sequence was taken in terms of the presence of the Ammonium ion in all the studied periods.

Reduction layer > Rhizosphere layer > oxidation layer

Table (5) Ammonium ion concentration (mg kg^{-1}) for Jasmine rice soil after 45 days of planting.

list	Sampling	Sampling area		
		Oxidizer	Rhizosphere	Reduction
1	Control	6.43	12.70	15.23
2	Organic DAP	12.53	25.30	28.03

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3	**Metallic DAP**	16.03	33.73	37.23
4	**High Potash DAP**	14.40	30.73	34.90
	LSD 0.05	**0.5502**	**0.9324**	**1.1079**

Table (6) shows the concentration of Ammonium in the oxidation layer, The results showed that the highest values were in the treatment of organic DAP in the reduction layer and amounted to (36.30) mg kg^{-1} the lowest in the treatment of control in the oxidation layer and amounted to (5.03) mg kg^{-1} and moral differences at the level of 5% between transactions and control treatment and among them as well, and that this may be due to the addition of organic matter increases the effectiveness and activity of micro-organisms that do their part. By decomposing that substance and increasing the processing of Ammonium (Nasiriyah, 2005). We also find that the risosphere and the reduction in the concentration of Ammonium in relation to the oxidation layer in all transactions and that this may be due to the fact that the conditions are more suitable to be in this layer as a result of the reduction conditions available in them and this is consistent with what he found (Tamimi, 1999.

Table (6) Ammonium ion concentration (mg kg^{-1}) for Jasmine rice soil after 75 days of planting.

list	**Sampling**	**Sampling area**		
		Oxidizer	**Rhizosphere**	**Reduction**
1	**Control**	5.03	10.13	14.43
2	**Organic DAP**	18.33	30.73	36.30
3	**Metallic DAP**	10.03	19.43	24.03
4	**High Potash DAP**	9.03	17.20	22.32
	LSD 0.05	**0.3412**	**1.3114**	**0.6289**

Between table (7) the concentration of Ammonium in the oxidation layer, The results showed that the highest values were in the treatment of organic DAP in the reduction layer and amounted to (39.83) mg kg^{-1} the lowest in the control treatment in the control layer and reached (5.80) mg kg^{-1} and with moral differences at a moral level 5% between transactions and control treatment and among them, and that this may be due to the addition of organic matter with fertilizer to increase the effectiveness of oxidation and the activity of micro-organisms. Which in turn decomposes that substance and increases the processing of Ammonium (Nasiriyah, 2005). We also find that the rhizosphere is superior to the rhizosphere and reduced by the concentration of Ammonium in all transactions, and that this may be due to the fact that the conditions are more suitable to be in this layer as a result of the reduction conditions available in it and this is consistent with what he found (Tamimi, 1999). From the results, the

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duration (105,75) days of cultivation was the processing of Ammonium from the fertilizer of the dab, taking the following sequence.

Organic DAP > Metallic DAP > High potash DAP

Table (7) Ammonium ion concentration (mg kg^{-1}) for Jasmine rice soil after 105 days of planting.

list	Sampling	Sampling area		
		Oxidizer	Rhizosphere	Reduction
1	**Control**	5.80	12.20	12.90
2	**Organic DAP**	19.00	35.43	39.83
3	**Metallic DAP**	13.33	22.93	30.30
4	**High Potash DAP**	12.53	21.83	29.10
	LSD 0.05	**0.9107**	**1.9854**	**1.1019**

Based on the results in the tables (7.6.5) and figure (2) the concentration of Ammonium with measurement durations (45,75105) days of cultivation in the soil of oxidation, rhizosphere, and reduction, this may be due to the tension shed by the roots of plants as a result of ion ostenifyase as well as its representation in the bodies of micro-soil organisms (Geachi, 2020). as well as the transformations to which this ion is exposed. Figure 2 also found that organic dab was increasingly processed for ammonium with increased growth periods (75,105) days of cultivation and more mineral DAP in the first period. In general, the absorption of amber rice for Ammonium was higher than that of Jasmine rice in all time periods and layers studied, and this is due to the different plant requirements of this ion form(1 and 2) this situation was reflected in the comparative treatment, which confirms the role of fertilization in improving plant growth and thus increasing its nutrient nutritional needs.

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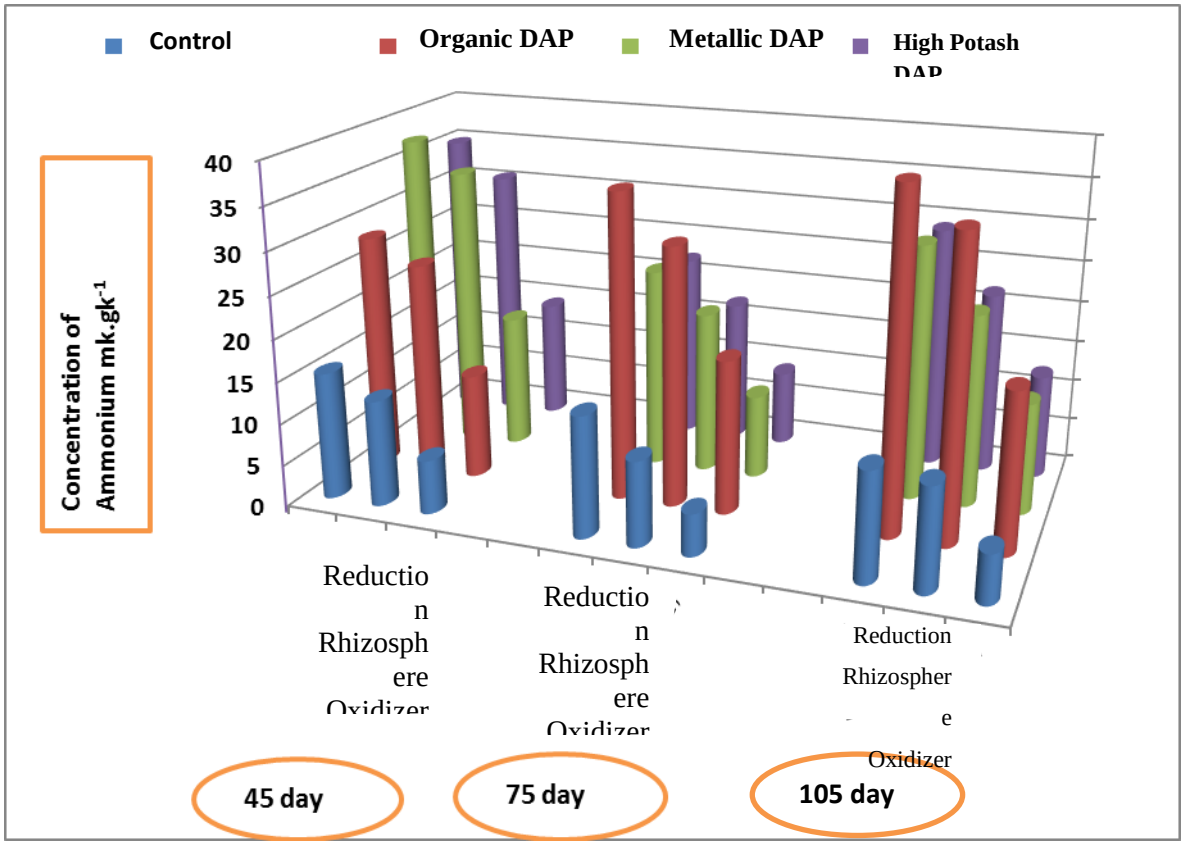

Figure (2) Ammonium ion concentration during Jasmine rice growth periods.

References

1. **Al-Barzanji, I.M.Gh; Muhammad,Q.J. and Muntaha,Gh.Th. 2006.** The effect of spraying with Magnesium salts on the chlorophyll content of leaves. Iraqi Journal of Agricultural Sciences 37 (4): 17-26.
2. **Al-Tamimi, A.F.A .1999.** Oxidation conditions and herbicides and their relationship to the decomposition of urea and nitrification in soils planted with rice and yellow corn. PhD thesis. Faculty of Agriculture. Baghdad University.
3. **Al-Jayashi, F.M.R. 2020.** The effect of mineral, organic and bio fertilization on the presence of Nitrate and Ammonium ions in the rhizosphere and outside and the growth of the yellow corn plant (Zea may L.). Master Thesis . College of Agriculture - Al-Qadisiyah University.
4. **Al-Naseri, A.A.H. 2005.** The effect of adding peat of some organic plant residues and their aqueous extracts on the growth of yellow corn (Zea mays L). Master Thesis. College of Agriculture - University of Baghdad.
5. **Al-Naimi, S.N.A. 2000**. Principles of Plant Nutrition. Ministry of Higher Education and Scientific Research. University of Al Mosul.
6. **Ahmed , O. H. ; M. H. A. Husni ; A. R. Anuar and M. M. Hanafi .2006.** Effects of urea, humic acid and phosphate interactions in fertilizer microsites on Ammonia volatilization and soil ammonium and nitrate contents. Int. J. Agric. Res., 1: 25-31.
7. **Barker, A.V. and M. Bryson. 2007 .** Nitrogen .in A.V. Barker, and D.J. Pilbeam, (Ed)" Handbook of Plant Nutrition". CRC Taylor & Francis Group.
8. **Black, C.A. 1965.** Methods of soil Analysis.AM.Soc. Agron. No.9 Part 1. Madison, Wisconsin. USA. Pp.374-390.

9. **Cai GX, Chen DL, Ding H, Pacholski A, Fan XH, Zhu ZL .2002 .** Nitrogen losses from fertilizers applied to maize, wheat and rice in the North China Plan. Nutr. Cycl. Agroecosyst.63:187-195.
10. **Camberato , J. J. 2001.** Nitrogen in soil and fertilizers First published in SC Turfgrass foundation News, January –March –Vol 8 No. 1 page (6-10).
11. **Dixon , Rc. 2003 .**Foliar fertilization improves nutrient use efficieney .Fluid Journal winter.
12. **FAO and IFA.2001 .**Global estimates of gaseous emission of NH_3 NO and N_2O from agricultural land.1st ed.FAO and IFA .Pub.Rome.
13. **Fernando, W. A. R. N.; K. Xia and C. W. Rice.2005 .** Sorption and desorption of ammonium from liquid swine waste in soils. Soil Sci. Soc. Amer. J., 69: 1057 – 1065.
14. **Havlin, J.L.; J.D. Beaton; S.L. Tisdale and W.L. Nelson. 2005.** Soil fertility and fertilizers: An introduction to nutrient management (Vol. 515, pp. 97-141). Upper Saddle River, NJ: Pearson Prentice Hall.
15. **Hinsinger ,P. ; C. Plassard and B. Jaillarad .2006 .** Rhizosphere: A new frontier for soil biogeochemistry. Journal of Geochemical Exploration , 88:210-213.
16. **International Plant Nutrition Institute [IPNI]. 2014.** 4R Nutrient stewardship portal. Available at: http://www.ipni.net/4R [Accessed Sept. 22, 2015].
17. **Jackson, M.L. 1958.** Soil chemical analysis. prentice-Hall. Inc. Engelwood. Cliffs, N.J .
18. **Jarallah, R.SH.; Fatimah, M.R. 2020a.** Fertilizer type effect on the concentration of Ammonium ion into the rhizosphere of Zea mays L.Plant Archives . Vol:20.No. 1, pp.1284-1288.
19. **Jones , D. L. ; A. Hodge and Y. Kuzukov 2004 .** Plant and mycorrhizal regulation of rhizodeposition . New Phytologist , 163:459-480 .
20. **Mengel , K. and E. A. Kirkby .1982**. Principles of plant nutrition. 2nd ed. Inter. Potash Inst. Bern, Switzerland.
21. **Mroczkowski, W. and T. Stuczynski, 2006.** Toxic effects of ammonia volatilizing from sandy soil fertilized with Ammonium salts and urea on Barley crop decreases. Pollish J. of Environ. Stud.15(5): 827 -832.
22. **Page, A. L ; R.H. Miller. and D.R.Keeny (Eds).1982.** Methods of soil analysis. Part2. 2nd edition. Chemical and Microbiogical properties. Am.Sco. of Agr,.s.s.s.Am.inc., Madison, Wisconson, USA.
23. **Peoples, M. B.; J. R. Freney and A. R. Mosier.1995 .** Minimizing gaseous losses of nitrogen. In: p. E. Bacon (ed.). Nitrogen fertilization in the environment. Marcel Dekker, Inc. New York.
24. **Prasertsak P, Freney JR, Saffiga PG, Denmead OTm, Prove BG .2001 .** Fate of urea nitrogen applied to a banana crop in the wet tropics of Queensland. Nutr. Cycl. Agroecosyst. 59:65-73. DOI: 10.1023/A:1009806826141.