Effect of adding different levels of nitrogen and potassium fertilizer on the phosphorus availability in the soil and the growth of wheat crop (Triticum aestivum L.)

Anmar Hamoudi Kadhim
Agriculture College, Al-Muthanna University, Iraq.

Mohamed Karim Obaid
Agriculture College, Al-Muthanna University, Iraq.

Abstract

An experiment was conducted in the garden of the College of Agriculture, Al-Muthanna University for the agricultural season 2017-2018, to determine the adding nitrogen fertilizer (urea) CO (NH2)2 and potassium (potassium sulfate) K2SO4, with different availability phosphorus levels in soil and growth of wheat crop cultivar (Ibaa 99). Treatments were arranged according to RCBD with four replicates. The levels of nitrogen fertilizer (200, 400 and 600) kg N ha-1 and potassium fertilizer (100, 150 and 200) kg K2O ha-1 were distributed in plastic pots. The results showed that the application levels of 600 kg N ha-1 and 200 kg K2O ha-1 gave the highest average availability of phosphorus in the soil in the seedling and flowering stages, while the levels gave 200 kg N ha-1 and 100 kg K2O ha-1 the lowest levels, at the same stages. Addition levels of 600 kg N ha-1 and 200 kg K2O ha-1 gave the highest mean for plant height, leaf chlorophyll content and number of tillers, while the levels of 200 kg N ha-1 and 100 kg K2O ha-1 gave the lowest mean for the same traits.

Keywords: *nitrogen and potassium fertilizer, phosphorus availability, wheat (Triticum aestivum L.).*

INTRODUCTION

Phosphorus necessary elements in plant nutrition, involved in the construction of energy-rich compounds (ATP and ADP) and enzyme cofactors and aids, without which the plant cannot perform its vital functions, it is involved in the processes of growth, development, division of plant cells, seed formation and fruit fertilization. It is also of great importance in achieving root growth and increasing the number of its branches, reflects positively on increasing production, its available in the soil (Mengel and Kirkby, 1982; Abu Dahi and El-Younes, 1988; Tisdale et al., 1997).

The soils of arid and semi-arid regions, including Iraqi soils, are characterized by a high proportion of lime, which ranges in most regions of Iraq in the range of 10-30%, as well as the degree of their alkaline reactivity, being saturated with calcium ions, this makes these soils suffer from a lack of availability of some nutrients, such as phosphorous, which is subject to cases of seizure and sedimentation in calcareous soils, or reaction with the solid phase of calcium carbonate, which leads to a lack of plant available, to the appearance of deficiency symptoms on growing plants (Al-Adhami, 1981).

It has been considered to use materials with an acidic effect as Amendment materials for calcareous base soils, it reduces the degree of soil interaction, which increases the solubility of elemental compounds in the soil, increasing the soil's ability to process phosphorus and some plant nutrients, the most important of these commonly used materials are ammoniac fertilizers, sulfur of all kinds, sulfuric acid, phosphate gypsum, and organic fertilizers (Al-Uqaili et al., 2002).

Potassium is an essential nutrient for humans, animals and plants, it is found in plants in the form of dissolved inorganic salts or salts of organic acids, unique without the rest of the other nutrients in that it does not enter into the composition of organic matter in plant tissues. The concentration of potassium in plant tissues ranges between 2-6% of the dry weight of the plant, may reach 8% in some plants, it is one of the mobile elements within the plant and is absorbed by plants in the form of potassium ion K+. Potassium is present in soil in amounts that vary widely, the total potassium ranges between 0.5-5%, and this is due to the difference in the origin material, the degree of weathering, and other factors (Abu Dahi and El-Younes, 1988).

Wheat is a strategic grain crops, as it comes at the forefront in terms of area and production, main source for more than (35)% of its population. Provides an adult with more than 25% of his protein requirement, more than 50% of his energy need, this crop was called the king of all crops because of its many characteristics, it is grown almost all over the world in hot and cold regions and at different altitudes from sea level (Curtis, 1982). Iraq is one of the originating countries of wheat, in which there are factors for the success of its cultivation, its productivity in it is still below the required level if the average yield per unit area of wheat reached (568.79) kg ha-1 (FAO, 2013). Thus, it does not amount to more than 30% of global productivity, to increase production and improve its quality, agricultural technology was used in general, and grass crops in particular, which special wheat, and at appropriate times, will increase the quantitative and qualitative components of the wheat yield, in addition, it can achieve maximum leaf area and prolong the duration of leaf greening (Gooding et al., 1989).

Due to the lack of studies on the topic of conditioners, this study was conducted using chemical fertilizers with an acidic effect, which is ammoniac nitrogen fertilizer. The use of potassium fertilizer as a basic and complementary element for plant nutrition, it also contributes to the development of agricultural production by raising the efficiency of phosphate fertilizers added to the soil. Therefore, this study aims to increase the availability of the phosphorus element in the soil by using nitrogen fertilizer (urea) and potash fertilizer (potassium sulfate), the effect of this on the growth of wheat yield cultivar (Ibaa 99).

Material and Methods

This study was carried out during the 2017/2018 season in the garden of the College of Agriculture, Al-Muthanna University, to study the effect of nitrogen fertilizer levels (urea) and potassium (potassium sulfate), on soil phosphorus availability and growth of wheat cultivar Ibaa 99. Three levels of urea fertilizer 200, 400 and 600 kg N ha-1 were added and denoted by the symbols (N1, N2 and N3). Three levels of potassium sulphate fertilizer 100, 150 and 200 kg K2O ha-1 and symbolized by symbols (K1, K2 and K3).

The experimental soil was brought from the Basateen Al-Sharqi area located in Al-Muthanna Governorate, it was mixed well, homogenized and air-dried, the soil was ground and a sieve with a diameter of 2.0 mm were used, a composite sample was taken from it for the purpose of estimating some chemical and physical education characteristics of the research soil (Table 1).

A total of 36 prepared plastic pots, put 5 kg of soil from the above field in them, urea fertilizer levels were added in two batches at planting and before flowering, and mixed well with the soil, as for the potassium fertilizer, it was added before planting with three levels of addition, and it was mixed with the soil. An average of ten seeds of wheat of IPA 99 cultivar were planted in each pot, according to the treatments on 11/20/2017. The process of serving the crop took place from preparing the soil for planting until harvesting, which included irrigating each experimental unit, starting from the planting date until the pre-maturity date, and according to the need. The aphid control process was carried out using the Super Genta pesticide.

The experiment was carried out using a Randomized Complete Block Design (RCBD). The experiment was followed up from irrigation and weeding as needed, up to the harvesting stage, after making sure that the crop was fully ripe, some whole plants were taken to study their growth and yield characteristics.

Chemical and physical properties of the experimental field soil:

First: Physical properties (soil texture):

The volume distribution of soil classifiers was estimated using the Pipette Method, according to Black (1965).

Second: Chemical properties:

1. pH: The saturated soil paste leachate using a pH-meter, according to the method described in Page et al. (1982).

2. E.C: was measured in the saturated soil paste filter by using an E.C-meter.

3. CEC: was estimated by saturation with sodium acetate 1 Molarity, and extraction with ammonium acetate 1 Molarity (Richards, 1954).

4. Carbonate minerals ($CaCO_3$): were estimated by reverse leaching method with NaOH (1N) acid, according to Richards (1954).

5. Gypsum: It was determined by the precipitation method using an acetone solution (Richards, 1954).

6. Dissolved carbonates: They were estimated by leaching with sulfuric acid (0.01 standard H_2SO_4) using a phenolphthalein reagent as mentioned in Richards (1954).

7. Available nitrogen: It was extracted with a solution of potassium chloride (2 M), estimate by the microcalcification device (Page et al., 1982).

8. Available phosphorus: It was extracted with a sodium bicarbonate solution at (pH=8.5), colour by a ammonium molybdate and ascorbic acid as a reducing agent, and it was measured by a spectrophotometer (Biochrom (Libra S5) at a wavelength of 882 nm, according to the Watanabe and Olsen (1965) method.

9. Available Potassium: It was extracted with ammenium acitate solution (1N), estimeted using flame photometer type AFP100, according to the method described in Page et al. (1982).

Table (1) Some physical and chemical characteristics of the study soil before planting.

Items	Value	Unit
pH	7.80	-
EC	1.30	dm. m^{-1}
CEC	5.80	cmol kg^{-1} soil
Organic matter	1.90	gm kg^{-1}
Carbonate	0	cmol kg-1 soil
Bicarbonate	2.15	
Available nitrogen	21.00	mg kg-1
Available phosphorus	14.37	
Available Potassium	35.60	
Sodium	352.60	ppm
Calcium	721.40	
Magnesium	48.60	
Clay	65.70	gm kg-1
Loam	148.20	
Sand	786.10	
Texture	Sandy loam	

Results and discussion

phosphorus availability in the soil during the germination stage

Table (2) indicates that the increase in the addition of nitrogen fertilizer to the soil, an incrase in P in the soil during the germenation stage, it gave the highest mean at 600 kg N ha-1, (29.3 mg P kg-1 soil), compared to 200 kg N ha-1, (23.9 mg P kg-1 soil).

The level of potassium fertilizer (200 kg K ha-1) gave it the highest average phosphorus availability at this stage, (31.0 mg P kg-1 soil), compared to 100 kg K ha-1, which gave the lowest average phosphorus availability of 23.2 mg P kg-1 soil. The reason for this is due to the effect of ammonia fertilizers and their role in increasing the degree of interaction of the soil, contributes to increasing the soil P availability.

Interaction between the two fertilizers also had a significant impact on incrasing the soil P availabilit, where the interaction between 600 kg N ha-1 and 200 kg K ha-1 soil achieved the highest average availability of 33.9 mg P kg-1 soil, while the interaction 200 kg ha-1 to both fertilizers gave the least availability for phosphorus, amounting to 25.9 mg P kg-1 soil.

Table (2) The effect of nitrogen and potassium levels on the soil P (mg P kg-1 soil) upon germination.

K	N			Mean
	N1	N2	N3	
K1	55.5	57.2	62.1	58.3
K2	57.8	59.4	63.5	60.3
K3	64.7	64.8	78.2	69.2
Mean	59.3	60.5	67.9	62.6
$L.S.D_{0.05}$	K	N	K×N	
	1.455	1.455	3.216	

phosphorus availability in the soil at the flowering stage

Table (3) indicates that increasing the addition of nitrogen fertilizer to the soil, an incerease in the soil P in the in the flowering stage. It gave the highest mean at 600 kg N ha-1 (67.9 mg P kg-1 soil), compared to the level of 200 kg N ha-1 (59.3 mg P kg-1 soil). The level of potassium fertilizer 200 kg P ha-1 gave it the highest average phosphorus availability at this stage, (69.2 mg P kg-1 soil), compared 100 kg K ha-1, which gave the lowest average (58.3 mg P kg-1 soil). The reason for this is due to the effect of ammonia fertilizers and their role in incrasing the degree of interaction of the soil, which in turn contributes to increasing the readiness of phosphorus in the soil. The interaction between the two fertilizers also had a significant impact on increasing the readiness of phosphorus in the soil, where the overlap between the additions of 600 kg N ha-1 and 200 kg K ha-1 soil achieved the highest average readiness of 78.2 mg P kg-1 soil, while the overlap in the addition of 200 kg ha-1 to both fertilizers gave the least readiness for phosphorus, amounting to 64.7 mg P kg-1 soil.

Table (3) The effect of nitrogen and potassium levels on the phosphorus concentration in the soil (mg P kg-1 soil) when flowering.

K	N			Mean
	N1	N2	N3	
K1	55.5	57.2	62.1	58.3
K2	57.8	59.4	63.5	60.3
K3	64.7	64.8	78.2	69.2
Mean	59.3	60.5	67.9	62.6
$L.S.D_{0.05}$	K	N	K×N	
	1.336	1.336	2.997	

growth characteristics

Plant height (cm)

Table (4) indicate that increasing the addition of nitrogen fertilizer to the soil, an incrase in plant height, it gave the highest mean at 600 kg N ha-1 (41.0 cm), compared to 200 kg N ha-1 (38.2 cm). The level of potassium fertilizer application of 200 kg ha-1 was superior in giving it the highest plant height (42.0 cm), compared to 100 kg K ha-1, (37.0 cm). The reason for this may be attributed to the encouragement of nitrogen to form a dense and deep root system, absorb water and nutrients, to increase the availability of phosphorus in the flowering stage, as shown in Table (2), necessary elements plant nutrition for its direct role in many vital processes in the plant, it was involved in the construction of energy-rich compounds (ATP and ADP) and enzyme cofactors and aids, without which the plant cannot perform its vital functions. In addition, it is involved in the processes of growth, development and division of plant cells.

The interaction between the two fertilizers also had a significant impact on incrasing the soil P availability, where the interaction between 600 kg N ha-1 and 200 kg K ha-1 soil achieved the highest average availability of 44.0 mg P kg-1 soil, while interaction in 200 kg ha-1 to both fertilizers gave the lowest availability for phosphorus, amounting to 41.0 mg P kg-1 soil.

Table (4) Effect of nitrogen and potassium levels on plant height (cm).

K	N			Mean
	N1	N2	N3	
K1	35.7	37.0	38.3	37.0
K2	37.8	39.1	40.7	39.2
K3	41.0	41.1	44.0	42.0
Mean	38.2	39.1	41.0	39.4
$L.S.D_{0.05}$	K	N	K×N	
	0.987	0.987	1.884	

Leaves chlorophyll content (SPAD)

Table (5) indicate that increasing the addition of nitrogen fertilizer to the soil led to an increase in the chlorophyll content of the leaves, it gave the highest mean at 600 kg N ha-1, (25.1 SPAD), compared to 200 kg N ha-1, (13.9 SPAD). It also exceeded the level of 200 kg K ha-1 in giving it the highest content of this characteristic, which amounted to 22.4 SPAD, compared to 100 kg K ha-1, which gave the lowest mean, it was 16.3 SPAD. The reason for this may be attributed to the fact that nitrogen is part of chlorophyll, as it is important in the process of photosynthesis. It is included in the composition of the nucleic acids RNA and DNA, so it is important in transmitting the genetic code, increasing the amount of nitrogen absorbed by the plant due to excessive additions has effects, including increasing the size of the plant cell and giving it thin walls, and increasing vegetative growth and giving a dark color to the plant, and prolonging the period of vegetative growth, it also leads to an increase in the readiness of phosphorus, its direct role in many vital processes in the plant, being involved in the processes of growth, development and division of plant cells. The interaction between the two fertilizers also had an effect on the chlorophyll content, where the overlap between 600 kg N ha-1 and 200 kg K ha-1 achieved the highest mean for this characteristic, which was 29.3 SPAD, while the interaction in 200 kg ha-1 to both fertilizers gave the lowest readiness for phosphorus, amounting to 15.4 SPAD.

Table (5) The effect of nitrogen and potassium levels on the leaf chlorophyll content (SPAD).

K	N			Mean
	N1	N2	N3	
K1	13	17.2	20.2	16.3
K2	13.3	17.5	25.8	18.9
K3	15.4	22.6	29.3	22.4
Mean	13.9	19.1	25.1	19.2
$L.S.D_{0.05}$	K	N	K×N	
	0.466	0.466	1.102	

Number of tillers (tiller pot-1):

Table (6) indicate that increasing the addition of nitrogen fertilizer to the soil led to an increase in tillering for each pot, it gave its highest average at 600 kg N ha-1 (4 tiller pot-1), compared to 200 kg N ha-1 (3 tiller pot-1). It also exceeded the level of adding potassium fertilizer 200 kg ha-1 in giving it the highest content for this characteristic, which reached 4 tiller pot-1, compared to the level of addition of 100 kg K ha-1, which gave the lowest average for this characteristic, it reached 3 tiller pot-1. The reason for this may be attributed to the increase in the amount of nitrogen absorbed by the plant, due to excessive additives, effects such as increasing the size of the plant cell and giving it thin walls, it increases vegetative growth, giving a dark color to the plant, and prolonging the vegetative growth period, it also leads to an increase in the readiness of phosphorus, being involved in the processes of growth, development and division of plant cells. The interaction between the two fertilizers also had an effect on the chlorophyll content, where the overlap between 600 kg N ha-1 and 200 kg K ha-1 achieved the highest average for this characteristic, which was 5 tiller pot-1, while the overlapping in 200 kg ha-1 to both fertilizers gave the least readiness for phosphorous, which reached 3 tiller pot-1.

Table (6) The effect of nitrogen and potassium levels on the number of shoots (tiller pot-1).

K	N			Mean
	N1	N2	N3	
K1	2	3	3	3
K2	3	3	4	3
K3	3	4	5	4
Mean	3	3	4	3
$L.S.D_{0.05}$	K	N	K×N	
	0.311	0.311	0.599	

Reference

Abu Dahi, Y.M. and M.A. El-Younes. 1988. Handbook of Plant Nutrition. Ministry of Higher Education. Baghdad University.

Al-Adhami, Z.A.A. 1981. Studies on the effect of some factors affecting iron availability in sedimentary and structural soils. Master Thesis. College of Agriculture and Forestry. University of Al Mosul.

Al-Uqaili, J.K., A.A. Al-Hadethi and A.K.A. Jarallah, 2002. Adsorption – desorption of iron in some calcareous soils. Basrah J. Agric. Sci. 15(2): 49 – 64.

Black, C.A. (ed.) 1965: Methods of Soil Analysis, Part I and Part 2, Am. Soc. Agron. Inst. Pub!', Madison, WI.

Curits, B.C.(1982). Potential for a yield increase in wheat. In Proc. Natl. wheat Res. Conf. , Beltsville, MD, USA, 26-28 Oct. p. 5-19. Washington, DC, National Association of wheat Growers Foundation.

FAO (2013). "Crop Prospects and Food Situation." FAO/global information and early warning system on food and agriculture (GIEWS)(2).

Gooding , Mike .J. and Davis , W. Paul (1997). Wheat production and utilization Systems, quality , and environment. Walligford , Oxon , UK and New York, NY, USA ,Book(ISBN 0851991556) V,355p.

Mengel, K. and E.A. Kirkby. 1982. Principles of Plant Nutrition. 3rd ed. Int. potash. Inst. Bern. Switzerland.

Page, A.I., Miller, R.A. and Keene, D.R. (1982) ”Methods of Soil Analysis”. Part 2, Chemical and Microbiological Properties. 2nd ed., Amer. Soc. of Agron., Madison, Wisconsin, USA.

Richards, L. A. (Ed). 1954. Diagnosis and improvement of saline and alkali soils. USDA Handbook No. 60 (Washington, DC), pp. 79-81.

Tisdale, S.L., W.L. Nelson, J.D. Beaton and J.L. Havlin. 1997. Soil fertility and fertilization prentice. Hall of India Newdelhi.

Watanabe, F.S. and Olsen, S.R. (1965) Test of an ascorbic acid method for determining phosphorus in water and NaHCO3 extracts from soil. Soil Science Society of America Proceedings 29, 677-678.