Spatial Distribution of The Elements and Assessment of The Status of Macro Elements in The Soils of Some Agricultural Districts within Al-Ramadi

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Abstract. This experiment was conducted to find a fertility case study to evaluate NPK elements in Ramadi city boundary. The experiment was carried out in Al-Bouabid, Al-Hamidiyah, Al-Tal’a, Al-Bu’asaf, Tawi, Tal Mashaid, Zwajir and Zankoura in Anbar Governorate, the land used were planted with wheat, Alfalfa, citrus and palm trees for the 2019-2020 season. The samples taken to objective fertility analyzes for depths of (0-30) cm and (30-60) cm, where the results of the spatial distribution of NPK levels in the soils of the study areas showed that The spatial distribution of nitrogen and depth (0-30) cm showed total nitrogen content ranged between (0.441-1.439%). As for phosphorus, its content in the study areas ranged between (0.203-9.79) mg. Kg-1 and the level form Low by 100%, while the potassium content of soils in the studied areas was between (24.2-224) mg. Kg-1, and the level was low about 82.13%, while the medium variety constituted 17.86% of the study areas. The results of the spatial distribution of nitrogen and depth (30-60) cm total nitrogen content ranged between (0.37-1.78) % and the person of the levels high and very high in the study areas, while the phosphorus content was between (0.215-17.3) mg. The two levels are Low and Medium, while the soil's potassium content was between (26-234) mg. Kg -1 and it was within two levels, namely Low and medium.

1. Introduction

The soil is one of the natural resources that weren't equivalent to another natural resource, so it occupies an important place due to its wealth, as it is the crucial resource that serves as the substrate for plant growth and the source of nutrients. Agricultural production depends mainly on the soil, as the good and permanent use of agricultural soils means full use of it and also means raising its fertility and increasing the productivity of crops by applying modern technical means in agriculture and thus can play a prominent role in agricultural development.

Modern agriculture has several characteristics, the most important of which is the constant pursuit of the highest possible productivity. And since the plant, like any other living organism, may suffer from malnutrition and may suffer from insufficient nutrients, it may need to supply the nutrients in sufficient quantities, in an appropriate and balanced manner, where the deficiency of one element with the availability of the rest of the elements leads to a decrease in productivity. As the missing element becomes the determining factor for production. Soil fertility refers to its ability to provide nutrients in a soft form for plant absorption to achieve maximum plant growth, and since production is the goal of any agricultural activity, it represents the main measure for assessing soil fertility, but many studies [1]; [2]; [3] indicated that productivity may indicate the current state of fertility but cannot predict the soil fertility status of the next crop. Hence, several attempts have been made to assess the level of fertility depending on the soil as the plant growth environment. The Food and Agriculture Organization has been interested in land valuation issues for a long time [4] but it has recently focused on topsoil characteristics for sustainable land management [5] and worked on developing previous methods, but it adopted the descriptive approach more than the quantitative approach, while it adopted On the quantitative approach and computational methods for assessing...
fertility. In the same direction, [6] used the Nutrient Availability Index mathematically to determine the level of readiness and complementarity of their availability. The method of cultivation and horizontal expansion does not serve the main objectives of agricultural development unless it is accompanied by the adherents of some good management methods that help increase productivity and preserve lands from the fertile degradation processes associated with the use processes. Without caring about fertilizing and maintaining its content of nutrients. Cultivated lands have a high percentage of macronutrients, and this is due to the use of fertilizers and leaving plant residues and other things that lead to an increase in the percentage of macronutrients [7]. The diversified agricultural exploitation brings about physical and chemical changes in the soil and the accompanying changes in the state of macronutrients [8].

The use of chemical fertilizers in Iraq is done regardless of the soil's nutrient content and without relying on soil or plant testing, and thus prevents the adoption of an approach to fertilizer recommendations for nutrients important to plants, and then a decline in production levels that can be avoided by following the soil test as a tool to estimate Fertile content of agricultural soils.

The aim of this study is to determine;

1- Distribution of macro nutrient elements NPK through statistical geographic analysis using geographic information systems program to determine their spatial patterns in the area and knowledge of fertilizer needs within those agricultural districts on standards [9].

2- To prepare fertile level maps of NPK elements to project soils for 0-60 cm depth.

2. Materials and Methods

To study the changes in soil characteristics as a result of spatial variation within the secondary physiographic units and its effect on the fertile state of the soil within the sedimentary plain, different districts from outside the boundaries of Ramadi city center were chosen to conduct the study. Figure (1) shows the administrative location of the project. It lies between longitudes 0 43 35° and 0 55 43° east and latitude 0 33 20° and 0 33 40° north. The field procedures consisted of a field investigation of the nature of exploitation, the type of current use of land in the area, and the method of soil management used in it. Eight agricultural exploited provinces have been identified on a strip parallel to the Euphrates, forming a path, as shown in Figure (1) by GPS, and after fixing the above sites, information on the management method followed in those lands was collected in the field through observation and inquiry by the owners of each type of land use above. As indicated in Table (1) the name of the province, the area of each district and the nature of the agricultural exploited land, and the picture (1) illustrates the nature of the use of the land in the area. With an emphasis when choosing the site on the period of time for the life of the used administrative system and the type of use, so that it is not less than ten years as a minimum, as it includes the following land uses, Table (2):
Figure 1. Map of study site for Anbar Governorate, shown the study sites.

Table 1. Some of the agricultural provinces, their painted areas, and the nature of the land use for the study areas

| County name      | Land area (km²) | The nature of agricultural exploitation |
|------------------|-----------------|-----------------------------------------|
| Al-Bouabid       | 2049.55         | Wheat, Alfalfa, Vegetable, Palm, Wheat  |
| Al-Hamidiyah     | 2170.01         | Vegetable, Palm, Wheat                  |
| Al-Tal’a         | 3677.48         | Alfalfa, Vegetable, Palm, Wheat         |
| Al-Bu’asaf       | 1367.97         | Vegetable, Palm, Wheat, Alfalfa         |
| Tawi             | 3572.59         | Vegetable, Palm, Wheat, Alfalfa         |
| Tal Mashaid      | 3468.49         | Vegetable, Palm, Wheat, Alfalfa         |
| Zwaijir          | 2050.95         | Vegetable, Palm, Wheat, Alfalfa         |
| Zankoura         | 1367.97         | Vegetable, Palm                         |
Table 1. Types of agricultural land use within the selected sites for study

| Pedon | Type of land use                  | Crop type          | Soil cultivation method | Irrigation method (1) | Fertilization method                                                                 |
|-------|----------------------------------|--------------------|-------------------------|-----------------------|-------------------------------------------------------------------------------------|
| P1    | Uncultivated land (Fallow)       |                   | --                      | --                    | --                                                                                  |
| P2    | Cultivated land to grow grain    | Wheat-barley-maize | Minimum tillage(2)      | Surface irrigation    | 200 kg. TSP(4) ha⁻¹ + 80 kg urea. ha⁻¹ to be added first in scattered when planting and the second after 60 days of planting |
| P3    | Cultivated land to grow fodder   | Alfalfa            | Minimum tillage         | Surface irrigation    | 25 kg urea. ha⁻¹ added by scattered when planting with the addition of cattle manure by 5 tons. ha⁻¹ recycled every five years |
| P4    | Cultivated land to grow vegetable| Beans-red beet     | Conventional tillage(3) | Surface irrigation    | 300 kg (4) TSP. ha⁻¹ + 100 kg urea. ha⁻¹, a second batch is added in two batches     |
| P5    | Cultivated land to grow citrus(orange) under palm |                   | Minimum tillage         | irrigation Surface   | Urea is added at the rate of 150 gm of urea to each tree annually. The orchard has not been fertilized for 5 years due to the economic and security conditions in the region. |

(1) The source of irrigation water is the Euphrates River, with an electrical conductivity degree of 1.40 dS.m⁻¹
(2) Minimum tillage involves plowing to a depth of 25 cm one time using an upside down plow with one-time smoothing with the use of the pulsating pulley and without any leveling of the field.
(3) Conventional tillage involves plowing to a depth of 25-30 cm twice by using a flip plow perpendicularly to smoothing one time using the spring nut with a leveling process of the field.
(4) TSP triphosphate superphosphate.

After completing the issue of selecting the required sites and their existence or non-existence within the province, determining them and fixing them, the morphological detection sites were started. Drilling tests were carried out at each of the study areas at a rate of 8 holes per site and to find out the extent of variation in determining the nutrients from the NPK, after which soil samples were obtained from the depths (0-30 cm) and (30-60 cm) for each punch hole. To the laboratory, it was air dried and loosened its orbits using a wooden hammer, then sifted through a sieve with holes (2 mm) in size and prepared for chemical NPK analyzes on it.
2.1. Fertility tests

It included the following:

2.1.1. Total nitrogen: was determined using Semi-Micro-Kjeldahl, according to the Bremner method reported by [10].

2.1.2. Available phosphorous: it was extracted from the soil using NaHCO3 (0.5 standard) with a pH of 8.5 and the color phase was used by using ammonium molybdate and ascorbic acid, then phosphorous was estimated by a spectrophotometer at a wavelength of 882 nanometers according to [11] and mentioned in [10].

2.1.3. Available potassium: extracted by shaking with calcium chloride (0.5 M) CaCl₂.2H₂O.

Then, the potassium was measured in the extract using a flame photometer.

The soil nutrient index was estimated using the equation suggested by [14] and is as follows:

\[
\text{Nutrient index value} = \frac{(\text{percent samples testing low x 1} + \text{percent testing high x 3})}{100} \ldots \quad (1)
\]

Soil is considered low in its content of the nutrient, if the value is less than 1.67 medium, as the index values range between 2.33-1.67, while it is considered high if the index is greater than 2.33.

4. Producing fertility level maps in geographic information systems by using one of the spatial interpolation methods in Arcmap v.

3. Results and Discussion

3.1. Spatial distribution of total nitrogen levels in soils of the studied areas.

Figures (2) and (3) and the results of Table (4) of the ArcMap system show the total nitrogen status in the soils of the study area, as the levels are Very low and optimum according to the fertility indicators of the soil based on what was stated in [13]. Depth (0-30) cm The soil content of total nitrogen ranged (0.056-0.271), where the highest value was recorded in the Tawi area with an area of 3572.59 hectares, while the lowest value of the total nitrogen level was recorded at Al-Bouabid area with an area of 2049.55 hectares. Vagan [15] pointed to the possibility of using modern technologies in preparing fertility maps with high spatial accuracy, which is the main reference for soil surveys of natural fertility.

As for the depth (30-60) cm, the soil nitrogen content ranged between (0.041-0.171%), as the highest value was recorded in Tawi areas amounting to 3572.59 hectares respectively. Whereas, the lowest level of total nitrogen was recorded at Al-Bouabid areas with an area of 2049.55 hectares. It is noticeable from the map that the area of the very low variety is expanded compared to the optimum variety. This is due to the nature of the agricultural activity in the region, not adding fertilizers and not following crop rotation in the region.
Figure 2. A map showing the nitrogen status in the study areas for a depth (0-30) cm.

Figure 3. A map showing the nitrogen status in the study areas for a depth of (30-60) cm.
Table 4. Status of NPK elements in the study areas.

| Area            | Total area | The nature of agricultural exploitation | Total nitrogen concentration rate N\% | Available phosphorous concentration rate (mg.kg\(^{-1}\)) | Available potassium concentration rate (mg.kg\(^{-1}\)) |
|-----------------|------------|----------------------------------------|--------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
|                 |            | (0-30)       | (30-60)    | (0-30)       | (30-60)    | (0-30)       | (30-60)    | (0-30)       | (30-60)    |
| Al-Bouabid      | 2049.55    | Wheat        | 0.079      | 0.062       | 4.32       | 6.51        | 83.66       | 97.00       |
|                 |            | Alfalfa      | 0.013      | 0.106       | 4.97       | 5.78        | 56.00       | 82.00       |
|                 |            | Vegetable    | 0.091      | 0.041       | 5.1        | 6.59        | 69.00       | 85.25       |
|                 |            | Palm         | 0.056      | 0.42        | 4.71       | 9.55        | 70.50       | 72.50       |
|                 |            | Wheat        | 0.101      | 0.076       | 2.22       | 3.05        | 45.50       | 47.75       |
| Al-Hamidiyah    | 2170.01    | Alfalfa      | 0.159      | 0.103       | 1.93       | 3.29        | 38.00       | 61.00       |
|                 |            | Vegetable    | 0.099      | 0.099       | 2.70       | 6.58        | 52.25       | 62.00       |
|                 |            | Palm         | 0.11       | 0.078       | 4.35       | 5.58        | 40.58       | 72.31       |
|                 |            | Wheat        | 0.125      | 0.071       | 3.15       | 4.35        | 42.31       | 45.69       |
| Al-Tal’a        | 3677.48    | Alfalfa      | 0.187      | 0.097       | 2.36       | 3.18        | 48.65       | 51.36       |
|                 |            | Vegetable    | 0.076      | 0.051       | 6.82       | 10.52       | 132.25      | 149.50      |
|                 |            | Palm         | 0.08       | 0.059       | 6.08       | 8.98        | 72.00       | 148.50      |
|                 |            | Wheat        | 0.102      | 0.085       | 3.01       | 5.63        | 39.87       | 60.35       |
| Al-Bu’asaf      | 1367.97    | Alfalfa      | 0.137      | 0.073       | 3.02       | 4.72        | 38.17       | 49.50       |
|                 |            | Vegetable    | 0.109      | 0.11        | 3.37       | 3.59        | 60.83       | 73.33       |
|                 |            | Palm         | 0.09       | 0.054       | 5.84       | 6.01        | 59.36       | 75.64       |
|                 |            | Wheat        | 0.102      | 0.106       | 4.59       | 17.29       | 75.00       | 88.00       |
| Tawi            | 3572.59    | Alfalfa      | 0.271      | 0.173       | 4.96       | 5.17        | 84.25       | 94.00       |
|                 |            | Vegetable    | 0.092      | 0.046       | 3.33       | 4.53        | 55.86       | 65.35       |
|                 |            | Palm         | 0.088      | 0.071       | 4.92       | 6.21        | 106.5       | 115.25      |
|                 |            | Wheat        | 0.139      | 0.126       | 3.99       | 4.07        | 39.50       | 132.25      |
| Tal Mashaid     | 3468.49    | Alfalfa      | 0.177      | 0.163       | 2.55       | 5.32        | 81.25       | 97.00       |
|                 |            | Vegetable    | 0.087      | 0.051       | 3.25       | 5.25        | 57.32       | 58.96       |
|                 |            | Palm         | 0.085      | 0.072       | 4.68       | 6.54        | 45.86       | 56.98       |
|                 |            | Wheat        | 0.144      | 0.072       | 2.62       | 4.64        | 39.00       | 40.50       |
| Zwajir          | 2050.95    | Alfalfa      | 0.185      | 0.171       | 3.42       | 3.58        | 42.50       | 49.50       |
|                 |            | Vegetable    | 0.088      | 0.048       | 3.20       | 4.36        | 62.31       | 70.52       |
|                 |            | Palm         | 0.089      | 0.133       | 2.26       | 3.71        | 26.75       | 43.50       |
|                 |            | Wheat        | 0.156      | 0.081       | 3.21       | 4.85        | 39.95       | 41.36       |
| Zankoura        | 1367.97    | Alfalfa      | 0.183      | 0.166       | 2.22       | 2.27        | 69.20       | 77.00       |
|                 |            | Vegetable    | 0.097      | 0.056       | 3.10       | 5.57        | 61.54       | 68.32       |
|                 |            | Palm         | 0.078      | 0.066       | 6.15       | 6.35        | 68.80       | 114.00      |

It is noticed from Figures (4) and (5) with respect to nitrogen depth of (0-30) cm and (30-60) cm that the highest value of the total nitrogen concentration was recorded in the Tawi areas cultivated with Alfalfa with a total nitrogen concentration value of (0.271\%) and (0.173\%) For the two depths, respectively, while the lower ones were at the Bouabid region, with a total nitrogen concentration value (0.056\%) palm trees cultivated and (0.041\%) for the same area cultivated with vegetable and for the two depths respectively.

The areas cultivated with jet outgrow the total nitrogen concentration, followed by areas planted with wheat, citrus and palm trees, respectively.
3.2. Spatial distribution of Available phosphorous in soils of the studied areas.

It is evident from the results of Table (4) that the soil content in the study ranged between (1.93 - 17.29) mg Kg⁻¹ with a clear trend to increase the soil content of this nutrient by increasing the depth and this is due to the irrigation operations in the area that contribute to the increase. The concentration of phosphorus in the soil is consistent with what was reported by [16]. When classifying the soil of the study area according to its content of Available phosphorous, shown in Figures (6) and (7), the expansion of the area of the Low level becomes clear, followed by a lesser degree, the Medium level, as the Low level constitutes 100% of the area under study within the depth (0-30) cm. As for the depth from (30-60) cm, the level was low by (92%) and the level (12%), with no diagnosis of the high variety for Available phosphorus in the soils of the study area. Kim [17] and others pointed out to the possibility of using modern and digital technologies in obtaining high-quality maps of the prepared phosphorous concentration in the soil. Phosphorous in soils, as soils are calcareous, and this agrees with [18].
Figure 6. A map showing the state of Available phosphorous in the study areas for a depth of (0-30) cm.

Figure 7. A map showing the state of Available phosphorous in the study areas for a depth of (30-60) cm.
Figure (8) shows with respect to the depth (0-30), the highest concentration of phosphorus was recorded at Al-Tala area cultivated with the vegetable system, with a ratio of (6.82) mg Kg⁻¹, while the lowest value for phosphorus content was at Al-Hamidyah area cultivated with the Alfalfa system at a rate of (1.93) mgKg⁻¹.

This is due to the addition of phosphate fertilizers in areas cultivated with vegetable, compared to areas cultivated with wheat and Alfalfa, for which small quantities of phosphate fertilizers are added. As for the depth (30-60) cm, it is clear from Figure (9) that the highest phosphorus content was at the Tawi area cultivated with a wheat system with a value of (17.29) mgKg⁻¹, while the lowest value was (2.27) mgKg⁻¹.

Figure 8. Values of Available phosphorus rates in the study areas for depth (0-30) cm.

Figure 9. Values of Available phosphorus rates in the study areas for depth (30-60) cm.
3.3. Spatial Distribution of Available Potassium Levels in the Soils of the Study Areas

The evaluation of soil fertility and its classification according to its Available potassium content depending on the values and limits proposed by [13] shown in Table (3) and based on the estimated values for this element and shown in Table (4), the soil content of the study area ranged between (149.50-26.75) (MgKg⁻¹) With a tendency to increase the soil content of the nutrient by increasing the depth, it is noticed from Figures (10) and (11) that only two levels of available potassium were recorded in the study area, namely Low and Medium, as the level was low 82.13% while the variety Medium It constituted 17.86% of the area of the study area for the depth (0-30) cm, and the highest percentage recorded for the medium level at the Al-Tala area. As for the depth (30-60) cm, the Low level constituted 74.57%, while the Medium type represented 25.42% of the area of the study area.

Figure 10. A map showing the state of Available potassium in the studied areas for a depth (0-30) cm.
through figures (12) and (13), the highest value of available potassium in the soils of the study area was recorded with a value of 132.25 mgKg$^{-1}$ at depth (0-30) cm. It was at the Al-Tala area cultivated with the vegetable system, while the lowest value was at the Zweiger area cultivated with the wheat system with a value of (26-75) mgKg$^{-1}$. As for the depth (30-60) cm, the highest value was recorded at the Al-Tala area cultivated with the vegetable system, with a value of (149.50) mgKg$^{-1}$, while the lowest value was at the Zweiger area of (40.50) mgKg$^{-1}$. This is consistent with what [19] stated, that the soils of the study were high in potassium content, and consistent with what [20] stated, that soils in dry areas have higher potassium content.
**Figure 13.** The values of Available potassium levels in the studied areas for depth (30-60) cm.

### 4. Conclusion

The aim of this study is to determine:

1. Distribution of macro nutrient elements NPK through statistical geographic analysis using geographic information systems program to determine their spatial patterns in the area and knowledge of fertilizer needs within those agricultural districts on standards [9].

2. To prepare fertile level maps of NPK elements to project soils for 0-60 cm depth.

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