USE THE DRIS METHOD TO DETERMINE THE BEST NUTRIENTS BALANCE FOR CHICKPEA PLANTS THROUGH THE RELATIONSHIP BETWEEN NORMS AND CRITICAL POINT RATE

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This study was aimed to determine the best nutrient balance for chickpeas from the relationship between the Norms of nutrients with the critical point for each nutrient using the DRIS system. This experiment was carried out at the Grdarasha farm, college of Agriculture Engineering Science, University of Salahaddin during the spring growing season of 2020, to find out the effects of three levels of nitrogen (UREA) (0, 15, 30 Kg N ha^{-1}), four levels of triple super phosphate (0, 20, 40, 60 Kg P ha^{-1}), and three levels of KCl fertilizer (0, 15, 30 Kg K ha^{-1}) and their combination on Chickpea yield and nutrient balance by using Split Split plot design with three replicates. The highest yield (1.55 Mg ha^{-1}) was recorded from the lowest (2.02) AT or NBI (nutrient balance index), while the lowest yield (0.73 Mg ha^{-1}) was obtained from the highest AT value (62.68).

Keywords: Nitrogen, Phosphorus, Potassium, Iron, DRIS, Norms, Critical point

نظام التشخيص والتوصيات المتكامل لتحديد افضل اتزان للمغذيات لنبات الحمص من العلاقة بين القيمة المطلقة ومعدل النقطة الحرجة

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المستخلص

الهدف من هذه الدراسه تحديد افضل اتزان غذائي لنبات الحمص ومقارنة العلاقه بين القيمه المطلقه للمغذيات مع نقطة الحد الحرج لكل مغذي.أُجريت هذه الدراسة فى حقل كردرشه التابعة لكلية علوم الهندسه الزراعيه جامعة صلاح الدين، خلال موسم النمو الربيعي لسنة 2020، لمعرفة تأثيرثلاث مستويات من النايتروجين (يوريا) بمستويات (0، 15، 30 كغم N هكتار) واربع مستويات مختلفة من سماد سوبر فوسفات الثلاثى بمستويات (0، 20، 40، 60 كغم P هكتار) مع ثلاث مستويات مختلفة من سماد كلوريد البوتاسيوم بمستويات (0، 15، 30 كغم K هكتار) و تأثير التداخل بينهما في الانتاج و الاتزان الغذائى لمحصول الحمص باستعمال تصميم (Split Split Plot Design) بثلاثة مكررات. وكانت القيمة الاعلى للإنتاج هي (1.55 ميغا غرام/هكتار) يقابلها اقل قيمة للإتزان الغذائي و هي (2.02)، أما القيمة الأقل للإنتاج (0.73 ميغا غرام/هكتار) تقابلها اعلى قيمة للإتزان الغذائي (62.68).

الكلمات المفتاحية: النايتروجين، الفوسفور، البوتاسيوم، الحديد، نظام الاتزان الغذائي، القيمه المطلقة، النقطة الحرجة.

Received:16/1/2023, Accepted:14/5/2023

INTRODUCTION

The chickpea plant belongs to the Fabaceae family and is one of the most important legume crops. (*Cicer arietinum* L.). With a high starch and protein content is essential for human nutrition. The world produces 10.9 million Mg of grain from 12.0 million hectares of land with a productivity of 0.91 Mg ha^{-1}. It has high protein content (20-23%), is abundant in fiber and minerals, and is suitable for regions with warm climates and semi-dry conditions. Iranians, Pakistanis, and Indians are the top three producers, (16). Despite the fact that chickpea are an important crop (35) with nutritional potential or medical qualities, there are few researches on it. It has been consumed by humans since prehistoric times due to its beneficial nutritional qualities. Chickpeas are also intriguing as useful food with potential human health advantages. Compared to other pulses, chickpeas have a higher overall sugar, fat, and carbohydrate content, (22). Leguminous plants, like chickpeas, increase soil fertility by symbiotically fixing up to 99 kg ha-1 of atmospheric nitrogen (NH_4) in their roots. (23). Two agronomic practices increased seed yield and higher plant densities have been largely credited for improving water use and water use efficiency. Lower plant densities result in higher harvesting losses because the plants typically grow shorter and branchier, (33). The soil is made healthier and more fertile by the addition of organic matter and a sizable quantity of chickpea nitrogen residue, (31). Crop yield is greatly influenced by the nutrients phosphorus, potassium, and nitrogen (30). Another false belief among farmers is that a legume crop does not require any dietary support. They typically grow it without any fertilizer (4, 10), but it is clear from the literature that applying NPK positively impacts grain yield. (34); (27). However, the issue of how much NPK should be applied to which cultivars that can still withstand sunlight still exists (17). If urea and triple superphosphate were mixed together intimately, urea's agronomic effectiveness might be increased. Whether or not this combination is profitable will depend on the final grain yield and its contributing factors (21). Increase plant growth and yield with chemical fertilizer without having a long-term impact on soil quality (8, 9, 11, 20, 32) Maximizing and maintaining crop yields and quality is the primary goal of modern agriculture (5, 6, 7, 25). One of the main issues impeding the development of agricultural practices that are profitable is nutrient deficiency, (15), because they are used as fertilizers more frequently and in higher concentrations than other nutrients, nitrogen, potassium, and phosphorus are regarded as the major nutrients for plants. Foliar analysis can be an effective tool for figuring out the nutritional status of plants because of the aforementioned reasons, but only if sufficient procedures are in place for drawing conclusions from analytical data. Foliar diagnosis can be difficult due to the dynamic nature of the foliar composition, which is greatly influenced by aging processes as well as interactions affecting nutrient uptake and distribution. In order to deal with the challenges posed by diagnostic procedures, created the integrated system for (D.R.I.S.), (18), A diagnostic technique called the Diagnosis and Recommendation Integrated System (D.R.I.S.) interprets tissue analyses by contrasting ratios of nutrient concentrations rather than the concentrations themselves. On the other hand, the plant's calcareous soils suffer from a deficiency of Nitrogen, Phosphorus, and Potassium due to the high calcium carbonate content and dominance of 2:1 clay mineral in the soil. Nitrogen, Phosphorus, and Potassium are essential macronutrients that play a significant role in nutrient balance. According to the literature, a critical value is a concentration at which a specific nutrient becomes deficient. Even though this critical level might not apply at all growth stages, critical values for many plants have been widely published. The aim of this study is to determine the best nutrient balance for chickpeas from the relationship between the Norms of nutrients with the critical point for each nutrient using the DRIS system.

MATERIALS AND METHODS

A field investigation was carried out in the spring season of 2020 at the Grdarasha Field of Salahaddin University in Erbil. The soil texture type was clay loam. The (N, P, and K) fertilizer was added before planting, Iron fertilizers were used at a constant level (13) (kg Fe ha^{-1}) Chelated form, Urea fertilizer $CO(NH_2)_2$ which contain 46% N used in three levels of N (0, 15, and 30) Kg N ha^{-1}, TSP tri-superphosphate $Ca(H_2PO_4)_2$ which contain (46 - 47% P_2O_5) used in Four level of P (0, 20, 40, and 60) Kg P ha^{-1}, KCl Fertilizer contains (60% K_2O) used in Three level of K (0, 15, 30) Kg K ha^{-1}. Following soil preparation, chickpea (*Cicer arietinum* L.) class name (Hazar merd). Field that has been vertically and horizontally plowed and cleared of bushes. Rotavator was used to soften the soil before it was divided into (108) plots, each plot $2.4m^2$ (2 *1.2 m) area. the distances between the two experimental units (1 m) and between the replications (2 m). four factors (N, P, K, and Fe) and 36 treatments with three replicates, a split split block design was used depending upon the program (SPSS), (12). Each plot has four lines. Seeds were sown on 25 February 2020, at a depth of four to five centimeters. The distance between the lines was 30 cm and between the plants was 10cm. After two weeks of germination, one plant was kept in each bed. Four plants were randomly selected from the middle line at the flowering stage, by taking plant samples from the leaves to estimate the (N, P ,K, and Fe) nutrients in them. The plants were manually harvested on (27-6-2020), and they were taken from the center of each block in two lines.

Establishing norms

In contrast to the traditional field experimental approach of soil fertility, the D.R.I.S. approach employs a survey technique representative of the sector for which norms are desired. A sizable number of websites are selected at random from the entire industry for this survey. These can be plots from ongoing field studies as well as production fields. Since each site can be compared to a plot in a field experiment, the survey approach generates numerous sets of observations that can be compared to specific plots in a significant "field" experiment that is replicated over a sizable area. Each site has samples of the soil and leaf tissue that will be analyzed, and documentation of the farming practices, weather, cultivars, irrigation techniques, types of fertilizers used, etc. Traditional techniques are used to check the soil and leaf samples for a number of essential nutrients. An accessible data bank is created by keeping all of this information in a computer. Once it has been established, a data bank of this kind can be used to investigate and calibrate these relationships. Only the foliar diagnosis components of D.R.I.S will be discussed in this presentation. The norms are the averages of the different ways to express the leaf analysis data for a subpopulation of high-yielding observations chosen from the database up to (80% of the relative yield target method to calculate the Norms), along with their corresponding coefficients of variation. Because these norms DRIS are not available in our library or data bank, the experiment's highest yield was used as the standard (24). This approach is referred to as the "target method" to calculate the Norm, The (17) treatments that were deemed high-yielding populations in the experiment (those that produced more than 80% of the relative yield) and each of which had (3) replication equals (51) readings calculated for each stage was used to determine the best norm using the Microsoft Excel program. After calculating all potential norms, the choice of the coefficient was chosen based on the correlation of variation (CV%) of each norm DRIS, where a lower value indicates a more accurate coefficient (C.V) (1).

Relative yield (R.Y)

Can be calculated the relative yield by using R.Y% = (Mi. Yield / Max. Yield) *100 For example, in the table (2) Relative yield for treatment combination ($K_0N_0P_0$) = 47% depending upon the above equation R.Y = (0.73 / 1.55) * 100 = 47 %

Nutrient balance index (NBI): Nutrient balance is an expression of the balance method, for example, to calculate the (NBI) in the table (2) for treatment combination ($K_0N_0P_0$) Plural the nutrient index for (N index) + (P index) + (K index) + (Fe index) Regardless of whether the sign is negative or positive (NBI) for ($K_0N_0P_0$) = -19.42 + 1.42 + -11.92 + 29.92 = 62.68

Level of critical point rates

The literature states that a critical value is a concentration at which a particular nutrient becomes deficient. Even though this critical level might not apply at all growth stages, the critical values for many plants have been widely published. (29) used graphic and statistical methods, which are extensively covered in the review of the literature, to determine the critical level of concentration of nutrients in the plant.

Determination of element critical level

The critical level of nutrients in the plant was determined by (29) using graphic methods and statistical methods that were extensively discussed in the review of the literature. The Critical point rates were calculated solely using the Graphic Method for nutrients.

Graphic method

The critical level of nutrient concentrations in plant tissue was established by (29) to determine the critical point rates for nutrients like nitrogen, phosphorus, potassium, and iron by examining the relationship between relative yield and concentration of nitrogen, phosphorus, potassium, and iron Drawing two perpendicular lines, one parallel to the X-axis and the other to the Y-axis by Excel program, was the technique used to ensure that the upper left and lower right quadrants contained the fewest number of observations. The intersection of the X-axis and the perpendicular line was found to be the critical level (29).

RESULTS AND DISCUSSION

In order to calculate DRIS Norm, the best nutrient balance index of (N, P, and K) concentration from the chickpea plant was examined. Since the levels of each nutrient are compared to one another, nutrient balance is a natural part of the system. The DRIS Norm approach provides the relative order of nutrient needs. The nutrient balance index (NBI), which represents the overall nutrient balance in the plant, is calculated by DRIS by simultaneously determining the sufficiency of each nutrient index for each nutrient. It presents a method for simultaneously identifying crop nutrient imbalances, deficiencies, and excesses and classifying them according to importance. These results agree with those (3) who Evaluate the Elements that Limit the Yield, and carried out a field experiment to ascertain the nutrient component limiting the yield.

Table 1. Some chemical and physical properties of the soil before planting with a concentration of nutrients in leaves before flowering

Soil physical properties	Particle size distribution	Silt g kg^{-1}	503.1
		Clay g kg^{-1}	396.4
		Sand g kg^{-1}	127.2
	Texture class	Silty clay loam	
	water content	15 bar	0.18
		0.33 bar	0.32
	Density	Specific gravity Mg m^3	2.646
		Bulk density Mg m^{-3}	1.323
Soil chemical properties	Properties	Value	Unite
	[ECe]	0.77	dS m^{-1}
	[pH]	7.73	
	Active calcium carbonate	14.4	g kg^{-1}
	Calcium carbonate equivalent	311	g kg^{-1}
	Organic matter	11.74	g kg^{-1}
	Available phosphorus	3.2	mg kg^{-1}
	Total nitrogen	0.27	g kg^{-1}
	Anions		
	Bicarbonate	3.47	meq L^{-1}
	Chloride	2.3	meq L^{-1}
	Cations		
	Magnesium	1.6	meqL^{-1}
	Calcium	4.2	meqL^{-1}
Kjeldahl method	Available (N) in plant leave (18).	Range 2.39- 4.47	%
Spectrophotometer	Available (P) in plant leave (12)	Range 0.71- 0.99	%
Flame Photometer	Available (K) in plant leave	Range 1.15- 1.57	%
atomic absorption	Available Fe in plant leave	Range 0.03- 0.04	%

Fertilizer potassium nutrient was the limiting factor, followed by nitrogen, phosphorus, and Iron. The N, P, K and Fe nutrient indices at flowering and harvest DRIS, an acronym for a comprehensive approach to interpreting tissue analysis, were developed to interpret the results of the chemical analysis of plant tissue samples, from which incorrect fertilizer recommendations were derived. Table (2) Show The highest (62.68) and lowest (2.02) for N.B.I (nutrient balance index) values were obtained for the treatment combinations ($K_0N_0P_0$) and ($K_2N_1P_2$), respectively. The highest and lowest grain yields (1.55Mgha^{-1}) and (0.73Mgha^{-1}) were shown from the treatments ($K_2N_1P_2$) and ($K_0N_0P_0$), respectively, the highest and lowest yields, in terms of absolute total, were (2.02 and (62.68), respectively, according to the nutrient balance index for the ($K_2N_1P_2$), which had a mean yield of (1.55, 0.73Mg ha^{-1}, and a mean relative yield of (100%, 47%). When the DRIS index is negative, the nutrient level is below optimal. When compared to the N index, the nutrient index is (-19.42) and decreases to (-0.70) at this time. The phosphorus index was recorded as (1.42) reduced to (-0.31) and also improved the nutrient balance in treatment combination ($K_2N_1P_2$) at these times the nitrogen is low near the optimum level or roughly, this result will go hand in hand with a higher yield and nutrient index elements that agree with (26) for corn, (13) for soybeans, (2) for Sunflower, and (14) for broccoli, in terms of value. The findings in Figure (1) confirmed the importance of the relationship between the nutrient index balance and percentage yield discussed above. Figure (1) findings display the treatments for yields greater than 80% in order to determine, (DRIS-norms) concentration for the chickpea plant is shown in Table (3). To calculate the DRIS norms, norms were established locally based on the nutrient concentration and their ratio from high- Yield and nutrient yielding plant treatments and also defined the nutrient ratio for all nutrients. Applying DRIS or any other foliar diagnostic system is the establishment of the standard values of norms to get the concentration ratio of the treatments for the yield above 80%. The results for the norm with the cut-off line of 80 % and above as shown in Figure (1).

Table 2. lists the chickpeas plant DRIS indices, Nutrient balance index, yield and relative yield

	Concentration				Indices						
Treat	N%	P%	K%	Fe%	N Index	P Index	K Index	Fe Index	NBI	Yield $Mgha^{-1}$	R.Y%
$K_0N_0P_0$	2.93	0.89	1.22	0.04	-19.42	1.42	-11.92	29.92	62.68	0.73	47
$K_0N_0P_1$	3.25	0.82	1.31	0.04	-9.75	-10.65	-5.48	25.88	51.76	0.89	58
$K_0N_0P_2$	3.25	0.75	1.25	0.03	2.72	-8.67	2.20	3.75	17.34	1.05	68
$K_0N_0P_3$	3.40	0.80	1.29	0.03	3.94	-5.46	1.44	0.08	10.92	1.24	80
$K_0N_1P_0$	3.42	0.87	1.36	0.03	0.29	-0.63	3.97	-3.63	8.52	1.34	87
$K_0N_1P_1$	3.34	0.88	1.29	0.03	0.06	2.51	-0.90	-1.67	5.14	1.43	92
$K_0N_1P_2$	3.28	0.85	1.30	0.03	-1.06	-0.03	1.74	-0.65	3.48	1.53	99
$K_0N_1P_3$	3.31	0.84	1.32	0.03	-0.61	-1.66	3.34	-1.07	6.68	1.38	89
$K_0N_2P_0$	3.37	0.74	1.33	0.03	3.87	-13.03	7.84	1.32	26.06	1.22	79
$K_0N_2P_1$	3.24	0.82	1.26	0.04	-8.44	-9.31	-9.76	27.51	55.02	1.01	65
$K_0N_2P_2$	4.47	0.99	1.57	0.03	16.98	-1.32	3.98	-19.64	41.92	1.02	66
$K_0N_2P_3$	3.49	0.94	1.35	0.04	-7.27	-1.72	-9.49	18.49	36.97	1.15	74
$K_1N_0P_0$	3.37	0.76	1.32	0.03	3.48	-10.39	6.04	0.87	20.78	1.19	77
$K_1N_0P_1$	3.06	0.85	1.22	0.04	-13.66	-3.81	-12.22	29.69	59.38	0.92	59
$K_1N_0P_2$	3.12	0.97	1.29	0.03	-8.78	12.47	-1.35	-2.34	24.94	0.93	60
$K_1N_0P_3$	3.41	0.91	1.33	0.03	-0.11	3.71	0.33	-3.92	8.07	1.25	81
$K_1N_1P_0$	2.84	0.71	1.15	0.03	-4.99	-7.18	0.75	11.42	24.34	1.18	76
$K_1N_1P_1$	3.01	0.72	1.15	0.03	0.10	-7.39	-2.14	9.42	19.05	1.24	80
$K_1N_1P_2$	3.43	0.91	1.34	0.03	0.12	3.33	0.87	-4.31	8.63	1.28	82
$K_1N_1P_3$	3.62	0.85	1.39	0.03	5.17	-4.58	4.72	-5.30	19.77	1.18	76
$K_1N_2P_0$	3.95	0.97	1.44	0.03	8.78	2.86	0.52	-12.16	24.32	1.06	68
$K_1N_2P_1$	3.46	0.74	1.33	0.03	6.35	-13.74	6.76	0.63	27.48	1.19	77
$K_1N_2P_2$	3.29	0.93	1.24	0.04	-9.29	1.73	-16.41	23.97	51.40	1.08	70
$K_1N_2P_3$	3.28	0.95	1.26	0.03	-2.52	10.12	-5.22	-2.38	20.24	1.10	71
$K_2N_0P_0$	3.90	0.96	1.42	0.04	0.68	-4.23	-9.27	12.82	27.00	1.22	78
$K_2N_0P_1$	3.42	0.93	1.33	0.03	-0.37	5.41	-0.51	-4.53	10.82	1.27	82
$K_2N_0P_2$	3.43	0.95	1.35	0.03	-1.24	6.60	0.24	-5.60	13.68	1.27	82
$K_2N_0P_3$	3.11	0.78	1.29	0.03	-3.60	-5.40	6.04	2.96	18.00	1.16	75
$K_2N_1P_0$	3.02	0.85	1.26	0.04	-16.40	-4.53	-7.93	28.86	57.72	0.97	63
$K_2N_1P_1$	3.33	0.89	1.30	0.03	-0.79	3.23	-0.35	-2.09	6.46	1.37	88
$K_2N_1P_2$	3.26	0.84	1.28	0.03	-0.70	-0.31	0.78	0.23	2.02	1.55	100
$K_2N_1P_3$	3.34	0.84	1.32	0.03	0.20	-1.87	2.96	-1.30	6.33	1.45	94
$K_2N_2P_0$	3.28	0.80	1.31	0.03	0.03	-5.11	4.55	0.53	10.22	1.33	86
$K_2N_2P_1$	3.49	0.93	1.35	0.03	0.87	4.43	0.23	-5.53	11.06	1.31	84
$K_2N_2P_2$	3.21	0.87	1.30	0.03	-3.58	2.31	1.91	-0.64	8.44	1.25	81
$K_2N_2P_3$	4.04	0.98	1.45	0.03	10.45	2.94	-0.04	-13.34	26.77	1.27	82

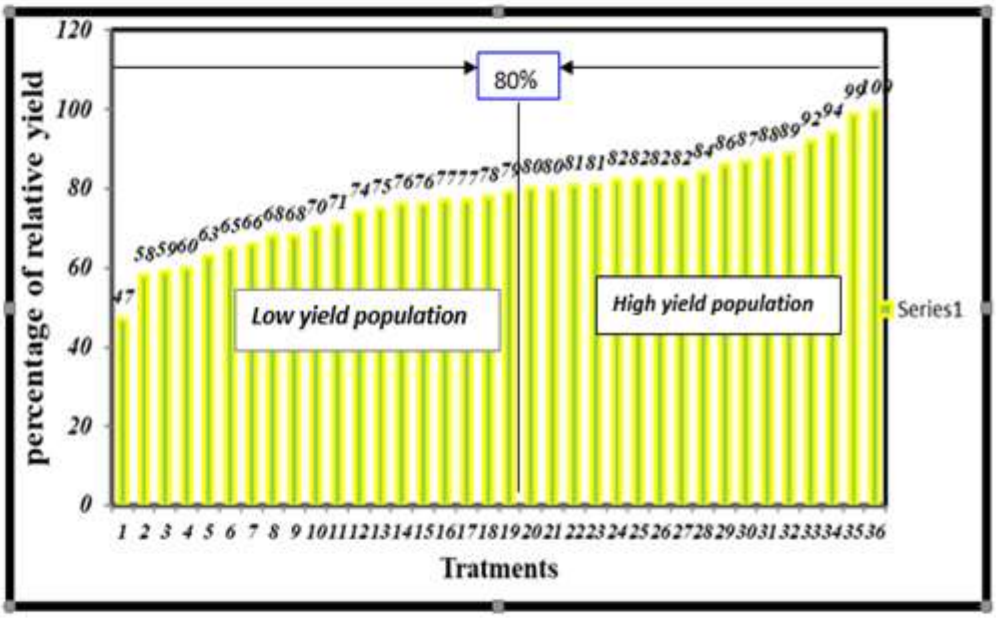

Figure 1. Combination effect between Nitrogen, Phosphorus and Potassium on grain yield Mgha^{-1}

Finding the critical levels of nitrogen, phosphorus, potassium, and iron for the chickpea plant

The graphic method was used to determine the critical point rates for each component figures (2), (3), (4) by using Excel program to calculate critical point rates, the nitrogen, phosphorus, potassium, critical points for chickpea plants were (3.37), (0.86), (1.31), and (0.03) %, respectively, as shown in figures (2), (3), (4), depending on each nutrient concentration in the plant (%) and relative yield as shown in table (2). These findings are consistent with (29).

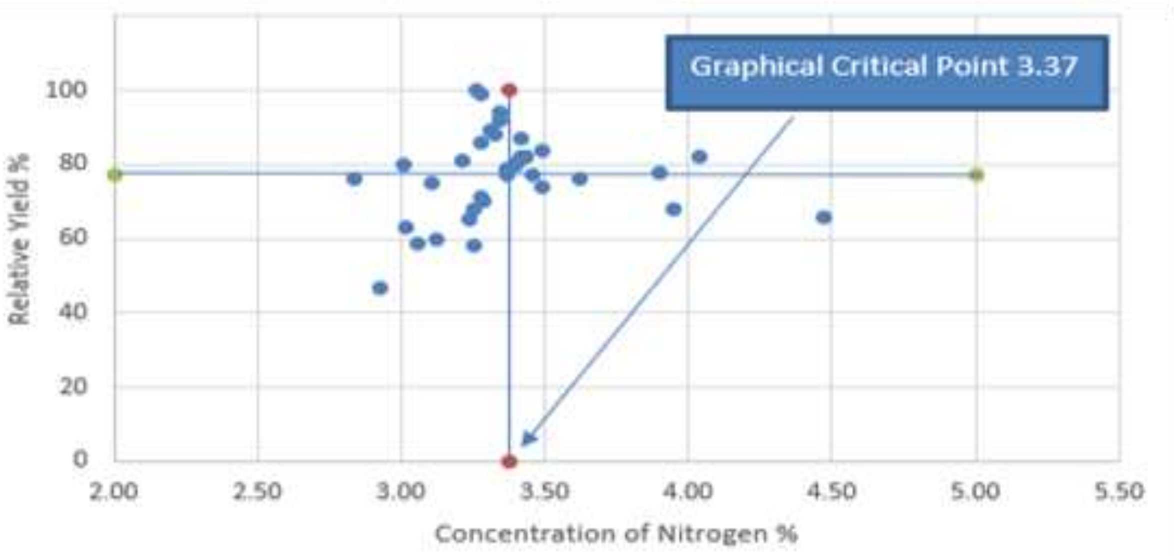

Figure 2. Critical Point of Nitrogen in Chickpea Plants (graphical method)

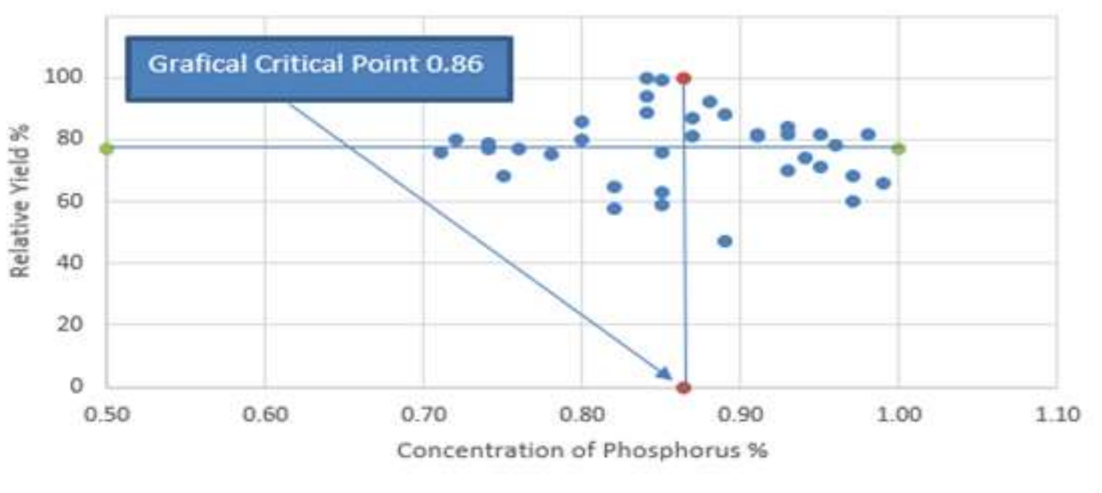

Figure 3. Critical Point of Phosphorus in Chickpea Plants (graphical method)

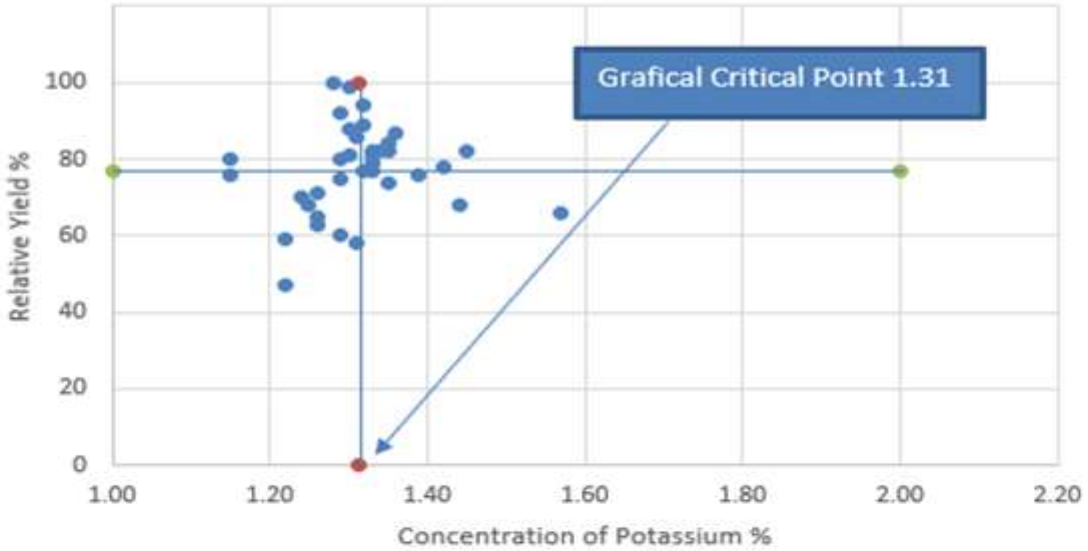

Figure 4. Critical Point of Potassium in Chickpea Plants (graphical method)

Table (3) Shows the result for the Norms is similar to the result of the Critical point or close to the same, this method contributed to the inclusion of another method for calculating the norm, based on the critical points for each nutrient. Confidence limits for each ratio are represented by the inner and outer concentric circles, with the inner one set at the mean (+,-15%) and the outer one at the mean (+,-30%). The values outside of both circles denote high sufficiency or high deficiency, depending on which way the arrow points. For example, when the arrow points up, it indicates deficiency; when it points down, it indicates sufficiency Figure (5), Fig. (6). Finally, a chart can be created to explain nutrient ratios in stages. This chart is made up of six axes for (N/P), (N/K), (N/Fe), (P/K), (P/Fe), and (K/Fe), with the mean value norms of the highest yield (more than 80% or relative yield) located at the point of intersection for each ratio (center of the circle).

Table 3. The relationship between Norms and Critical Point rates for Chickpea Plant

	N/P	N/K	N/Fe	p/K	P/Fe	K/Fe
Norms	3.92	2.57	109.23	0.66	28.22	42.56
	N/P	N/K	N/Fe	P/K	P/Fe	K/Fe
Critical Point Rates	3.92	2.57	112.33	0.66	28.67	43.67

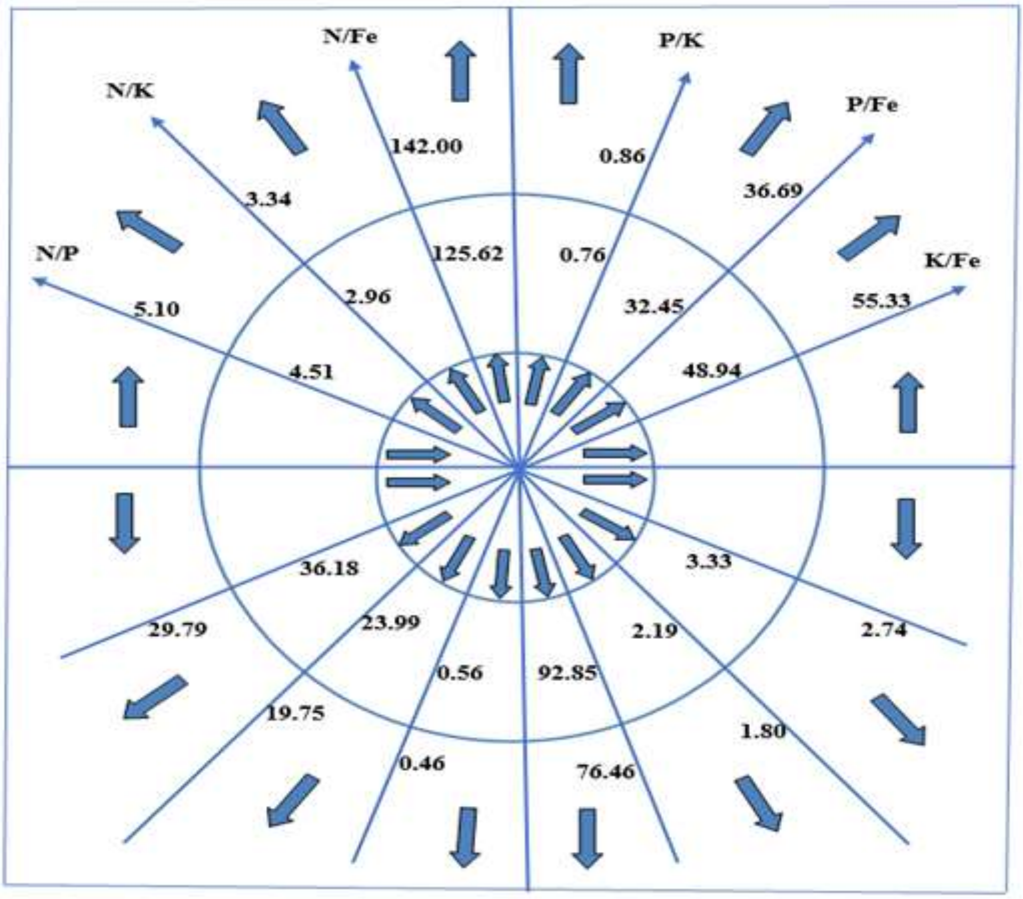

Figure 5. The DRIS Norm chart for (N, P, K, Fe) The Optimum and Critical Value for Nutrient Ratios in Chickpea plants

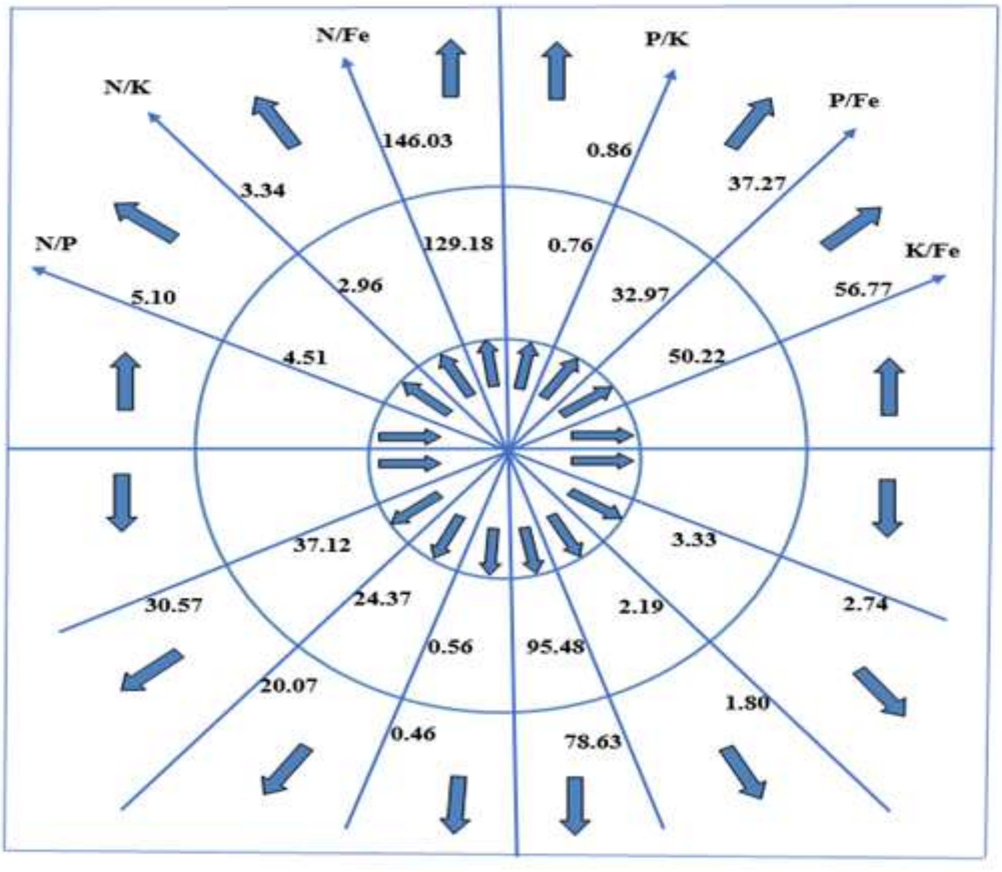

Figure 6. The Critical point rates chart for (N, P, K, Fe) in Chickpea plants within the limits of near critical limit and the limits of the far ones

The optimum nutrient composition and highest yield are found at the intersection of the six axes. The concentric circles represent confidence limits, with the inner one set at the mean (15%) and the outer one at the mean (30%) for each ratio. The values outer both circles represent high sufficiency or high deficiency depending on the arrow direction, Figure (5). This method helped to lead the inclusion of another method for calculating the norm, based on the critical points for each nutrient, because the result for the Norms is similar to, or nearly the same as, the result of the Critical point, and the rise in the Absolute total was brought on by an increase in phosphorus application. Phosphorus and nitrogen levels in the control treatment were sufficient for the chickpea plant based on nutrient index values. Most treatment combinations in (80%) yield and above to calculate the norm.

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