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The DRIS methodology to determine the best balance of Nitrogen, phosphorus and potassium levels on the yield of Chickpea plant (*Cicer arietinum* L.)

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ABSTRACT

This experiment was conducted during the spring growing season of 2020 conducted in the field at the Grdarasha farm field of Agricultural Engineering College, Salahaddin University in Erbil, located in the south of Erbil city, Latitude: 36.11284 N, Longitude: 44.01247 E. The soil texture class was silty clay loam, the type of soil vertisols, to study the effect of four levels of phosphorus TSP (0, 20, 40, 60) Kg P. ha^{-1},Three levels of K (0, 15, 30) Kg K. $ha^{-1,}$ and Three levels of N (0, 15, 30) Kg N. ha^{-1}. There combination of yield components and nutrient balance of chickpea plants by using DRIS methodology, by using; split split block design with three factors (N, P, and K) 36 treatment with 3 replicates was used. The main results could be summarized as The combination between Nain plot potassium, Sub main plot nitrogen, and Sub sub main plot phosphorus levels affected the yield of the chickpea plant significant also the maximum yield was recorded in treatment combination ($K_2N_1P_2$) was (1.55*Mg* ha^{-1}). Whereas the lowest mean value (0.73*Mg* ha^{-1}) was recorded from the treatment combination ($K_0N_0P_0$). The combined effect of nitrogen, phosphorus and potassium fertilizer on nutrient balance indices (NBI) and yield in chickpea plants. The lowest nutrient balance index was recorded from the treatment combination ($K_2N_1P_2$).

نظام التشخيص والتوصيات المتكامل لتحديد افضل اتزان للنايتروجين والفوسفور والبوتاسيوم على الانتاج لنبات الحمص

يحيى عبد المنعم عبد صبري و الوند طاهر رشيد

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الخلاصة

أُجريت دراسة فى حقل كردرش- التابعة لكلية الزراعة جامعة صلاح الدين- اربيل، خلال موسم النمو الربيعي لسنة 2020، لمعرفة تأثير ثلاث مستويات مختلفه من سماد اليوريا (0، 15، 30 كغم/هكتار) واربع مستويات مختلفة من سماد سوبر فوسفات الثلاثى بتراكيز (0، 20، 40، 60 كغم/هكتار) مع ثلاث مستويات مختلفة من سماد كلوريد البوتاسيوم بتراكيز (0، 15، 30 كغم/هكتار) مع اضافة الحديد بشكل ثابت للمعاملات وتأثير التداخل بينهما على نسبة الانتاج و الاتزان الغذائى لمحصول الحمص بإستخدام تصميم split split plot design و بثلاث مكررات. و يمكن تلخيص اهم النتائج ، اعطت المعامله التي تحتوي على التركيز الثاني من البوتاسيوم مع التركيز الاول من النايتروجين مع التركيز الثاني من الفوسفور افضل اتزان غذائي وكان دليل الاتزان الغذائي لها (2.02) التي تم الحصول عليها من النتائج (-0.70 , -0.31 , 0.78 , 0.23) لكل من النايتروجين والفوسفور والبوتاسيوم والحديد . عند المقارنه مع اعلى واقل اتزان غذائي كانت النتيجه ان القيمة الاعلى للإنتاج هي (1.55 ميغا غرام/هكتار) يقابلها اقل قيمة دليل للإتزان الغذائي و هي (2.02)، أما القيمة الأقل للإنتاج (0.73 ميغا غرام/هكتار) تقابلها اعلى قيمة دليل للإتزان الغذائي (62.68). القيمة الكلية لدليل الاتزان الغذائي (62.68) انخفضت الى (2.02) التى سببت ارتفاع في الانتاج من (0.73 ميغا غرام/هكتار) الى (1.55 ميغا غرام/هكتار)

الكلمات المفتاحية: نتروجين، فسفور، الحمص .

INTRODUCTION

Chickpea (Cicer arietinum L.) belongs to the family fabaceae, an annual and one of important pulls crop. Chickpea is one of the important pulse crops that which contains high protein and starch percentage and it is very important for in human nutrition. Cicer suitable for region with warm weather and semi-dry conditions, in addition to having high protein content (20-22%) and rich in fiber and minerals, and it's the fourth largest grain legume crops in the world, with a total production of 10.9 million tons from an area of 12.0 million ha a productivity of 0.91 t ha-1. Major producing countries are India, Pakistan and Iran (FAO, 2016).Although it is one of the founder crops (Zohary& Hopf,2000) with potential nutritional or medicinal qualities, chickpea has not received the amount of research devoted to other founder crops such as wheat. It has been consumed by humans since ancient times due to its good nutritional properties. In addition, chickpea is of interest as a functional food with potential beneficial effects on human health. The total content of carbohydrate fat and sugar in chickpea is higher than in other pulses (Jukanti et al., 2012).Chickpea being a leguminous crop improves soil fertility by fixing atmospheric nitrogen up to 99 kgha^{-1} in available from (NH_3 and NH_4) in the root through the phenomena of symbiosis (Schwenke*etal.*, 1998).Among the various agronomic practices, The increased seed yield with higher plant density is largely due to improved water use and water use efficiency. Plants grown at lower plant density are usually shorter and branchy, which increases losses during combine harvest (Turner*et al.* 2001).

Seddique and Sedgely (1985).Chickpea contributes a significant amount of residual nitrogen to the soil and adds organic matter thereby improving soil health and fertility(Siddique et al., 2005).

There is also a wrong perception with the farmers that gram being a legume crop does not need any nutrition. They usually grow it without supplying any fertilizer, where as it is evident from the literature that application of NPK have beneficial effect on gram yield (Verma and Pandya, 2003; Saeed et al., 2004).But the question that how much NPK should be applied to which cultivar still remain sun quench able. This depends upon the final grain yield (Ruhul et al., 1998) and it's contributing components (Islam and Islam,2006) whether it is profitable combination or not (Singh et al., 2003). In modern agriculture, maximizing and sustaining crop yields are the main objectives. One of the major problems constraining the development of an economically successful agriculture is nutrient deficiency (Fageria and Baligar, 2005). Nitrogen, Potassium, and Phosphorus are considered the major nutrient elements for plants because their use as fertilizers is more widespread and in greater amounts than other elements. For above reasons foliar analysis can be a useful tool for assessing plant nutrient status only if adequate procedures are available for making diagnoses from analytical data. Due to the fact of the dynamic nature of foliar composition, which is strongly influenced by aging processes as well as interactions affecting nutrient uptake and distribution, foliar diagnosis can become a complex exercise. The diagnosis and recommendation integrated system (D.R.I.S.) was developed by Beaufils (1971, 1973) as an objective means of coping with the difficulties inherent in diagnostic procedures (Walworth and Sumner, 1987). The Diagnosis and Recommendation Integrated System (D.R.I.S.) is a diagnostic approach that uses nutrient concentration ratios rather than concentrations themselves, to interpret tissue analyses (Beaufils, 1971).

The Nitrogen , Phosphorus and Potassium are essential macronutrients, they are playing an important role in nutrient balance; on the other hand the plants calcareous soils suffering from deficiency of Nitrogen , Phosphorus and Potassium due to high calcium carbonate content and dominance of 2:1 clay minerals in the soil.

MATERIALS AND METHODS

A field study was conducted at the Grdarasha farm field of Agricultural Engineering Science College, Salahaddin University in Erbil, Which locate in south of Erbil city, Latitude: 36.11284 N, Longitude: 44.01247 E. During spring growing season of 2020. The soil texture class was silty clay loam, the type of soil vertisols. The (N, P and K) fertilizer was added before planting, , Iron fertilizer used in fixed level (6) kgh^{-1} Chelated form, Urea fertilizer which contain 46% nitrogen used in Three level of N (0 , 15 , 30) Kg N. ha^{-1} ,TSP tri-superphosphate fertilizer which contain (46 – 47% P_2O_5) in Four level of P (0 , 20 , 40 , 60) Kg P. ha^{-1} was used, KCl Fertilizer contains (60% K_2O) used in Three level of K (0 , 15 , 30) Kg K. ha^{-1}. After soil preparation Fertilizer was added by hand in the early morning on date at 25 February 2020, and then the Chickpea seeds (Cicer arietinum L.) were planted at the depth of (4 – 5 cm), the space between two lines was 30 cm, and the distance between two plants in each line was 10 cm. in each bed two seeds was planted after two weeks of germination thinned to one plant in each bed. At the stage of flowering of chickpea plant, samples were taken from four plants in the center of each plot by the cut off the necessary leaves for the analysis. The samples were weight and oven dried at 65 ºC for 72 hours, after drying the samples were milling, then chemical analysis was performed. Plants were harvested on (27-6-2020), and the plants were taken in two lines at the center of each block. The weight of the yield was determined for plants. Total nitrogen was determined by Kjeldahil method as described in Rowell (1996). Phosphate was determined according to colorimetric method using spectrophotometer at 660 nm, as described by Gupta (2006). Potassium was determined according to the method described by Baruah and Barthakur (1999), using a Flame photometer. Atomic absorption method used for determination of iron. Table (1) show some Physical and chemical properties of the studied soil.

Table 1. Physical and chemical properties of the studied soil

Soil Physical Properties	Particle size distribution	Silt gkg^{-1}	503.2
		Clay gkg^{-1}	396.5
		Sand gkg^{-1}	127.3
	Texture class	Silty clay loam	
	Water content	15 bar	0.19
		0.33 bar	0.31
	Density	Specific gravity gcm^{-}	2.647
		Bulk density gcm^{-33}	1.324
Soil Chemical Properties	Properties	Value	Unite
	ECe	0.76	dSm^{-1}
	pH	7.72	
	Active Calcium carbonate	14.3	gkg^{-1}
	Calcium carbonate equivalent	310	gkg^{-1}
	Organic matter	11.75	gkg^{-1}
	Available Phosphorus	3.1	$mgkg^{-1}$
	Total Nitrogen	0.28	gkg^{-1}
	Anions		
	Bicarbonate	3.48	$meqL^{-1}$
	Chloride	2.4	$meqL^{-1}$
	Cations		
	Magnesium	1.7	$meqL^{-1}$
	Calcium	4.3	$meqL^{-1}$

Norms Calculation

The most important step for the diagnostic system in plants is the calculation of standard values for the norm. In order to establish the DRIS norms, it is necessary to use a representative value of leaf nutrient concentrations and respective yields to obtain accurate estimates of means and variances of certain nutrient ratios that discriminate between high- and low-yielding groups Dizayee (2001) and Abd El-Rheem (2013).

After the establishment of the DRIS norms, the formula proposed by Beaufils (1973) calculates an index for each nutrient that range from negative to positive values. All nutrient indices always sum to zero (Elwali and Gascho, 1984). Essentially, a nutrient index is a mean of the deviations from the optimum or norm values (Bailey, 1997).

DRIS Methodology

DRIS norms and coefficients of variation (CVs) were derived according to the procedure by Walworth and Sumner (1987). The nutrient concentrations were expressed into as many ratios as possible (N/P, P/N, N/K,and inverse). DRIS indices were calculated for each nutrient using the general formula, for A to N nutrients (Mourão Filho, 2004). The overall status of nutrient balance in the plant in showed by the absolute sum of all of the individual D.R.I.S. indices. D.R.I.S. determines the sufficiency of each nutrient index simultaneously for each nutrient. This identifies not only the nutrient most likely to be limiting, but also order in which other nutrients most likely to be limiting, and D.R.I.S. calculates nutrient balance index (NBI), which indicates the overall nutrient balance in the plant. It provides a means of simultaneously identifying balances, deficiencies and excesses of crop nutrients, and ranking them order of importance (Walworth and Sumner, 1987).

Index A = [f (A/B) + f (A/C) + f (A/D) ……..+ f (A/N)] / Z

Index B = [-f (A/B) + f (B/C) + f (B/D) ……..+ f (B/N)] / Z

Index N = [- f (A/N) – f (B/N) – f (C/N) ……..- f (M/N)] / Z

When A/B ≥ a/b, f (A/B) = (A/B – 1)1000 a/b CV

When A/B ≤ a/b, f (A/B) = (1 – a/b) 1000 A/B CV

Where, A/B is the tissue nutrient ratio of the plant to be diagnosed;

a/b is the optimum value or norm for that given ratio;

CV is the coefficient of variation associated with the norm;

$$\%CV = \frac{S}{\bar{X}} * 100$$

Where:

X^- = Mean of the concentrations for certain nutrients

S = standard deviation of nutrients or (square root of variance).

$$S = \sqrt{\frac{\sum\left(X - X^{-}\right)}{n-1}}$$

Z is the number of functions in the nutrient index composition.

Values of other functions such as f (A/C) and f (A/D) were calculated in the same way using appropriate norms and CV.

The index value for each nutrient represents an integrated measure of its sufficiency as compared to all other nutrients. The more negative the index value for a nutrient, the more limiting is that nutrient. The descriptive statistics for yield, leaf nutrient concentration and nutrient ratio expressions were carried out using the Excel (2010) Microsoft package.

RESULTS AND DISCUSSION

DRIS approach provides the relative order of nutrient need, since the level of one nutrient is compared with those of all other nutrients balance is an inherent part of the system. DRIS determines the sufficiency of each nutrient index simultaneously for each nutrient and calculates the nutrient balance index (NBI), which indicates the overall nutrient balance in the plant (Girma and Beyene 2018). It provides a means of simultaneously identifying imbalances, deficiencies, and excesses in crop nutrients, and ranking them in order of importance (Walworth and Sumner, 1987).Standard deviation and coefficient of variance for (N, P, and K) ratio from these different conditions, these concepts are basic in DRIS application, also this system was used to measure the deviation actual cut-off line that is to say the norms were established locally. The standard deviation and coefficient of variance showed in a table (2).

Table (2) Standard deviation and coefficient of variance for yield above 80% for selecting the norms

	N/P	**N/K**	**N/Fe**	**p/K**	**P/Fe**	**K/Fe**
Means	3.92	2.57	109.23	0.66	28.22	42.56
S	0.57	0.21	14.63	0.07	4.17	4.82
CV%	14.54	8.17	13.39	10.61	14.78	11.33

The norms, standard deviation and coefficient of variance for nutrients under study were calculated from the high yield treatment ($K_2N_1P_2$). After establishment of norm, the formula proposed by (Beaufils, 1973) was applied for calculating nutrient indices that ranges from negative to positive values. The summation of all nutrient indices for the same treatment always equal to zero (Elwali&Gascho, 1984), for example the summation of nutrient index for control treatment ($K_0N_0P_0$) equal to zero (N-index (-19.42) + P-index (1.42) + K- index (-11.92) + Fe-index (29.92) = zero) table (4). A nutrient index in a mean of the deviation from the optimum or norms values the negative index values indicate that the nutrient levels are below the optimum. Consequently the negative index the more deficient the nutrients. A positive index indicates that the nutrient levels are above the optimum and more positive index the excessive the nutrients that are relative to normal.

Table (3) Percentage of nutrient concentration and nutrient ratio in leaf for chickpea plant

	Concentration				**Nutrient ratio**					
Treat	N%	P%	K%	Fe%	N/P	N/K	N/Fe	p/K	P/Fe	K/Fe
K0N0P0	2.93	0.89	1.22	0.04	3.29	2.40	73.25	0.73	22.25	30.50
K0N0P1	3.25	0.82	1.31	0.04	3.96	2.48	81.25	0.63	20.50	32.75
K0N0P2	3.25	0.75	1.25	0.03	4.33	2.60	108.33	0.60	25.00	41.67
K0N0P3	3.40	0.80	1.29	0.03	4.25	2.64	113.33	0.62	26.67	43.00
K0N1P0	3.42	0.87	1.36	0.03	3.93	2.51	114.00	0.64	29.00	45.33
K0N1P1	3.34	0.88	1.29	0.03	3.80	2.59	111.33	0.68	29.33	43.00
K0N1P2	3.28	0.85	1.30	0.03	3.86	2.52	109.33	0.65	28.33	43.33
K0N1P3	3.31	0.84	1.32	0.03	3.94	2.51	110.33	0.64	28.00	44.00
K0N2P0	3.37	0.74	1.33	0.03	4.55	2.53	112.33	0.56	24.67	44.33
K0N2P1	3.24	0.82	1.26	0.04	3.95	2.57	81.00	0.65	20.50	31.50
K0N2P2	4.47	0.99	1.57	0.03	4.52	2.85	149.00	0.63	33.00	52.33
K0N2P3	3.49	0.94	1.35	0.04	3.71	2.59	87.25	0.70	23.50	33.75

Continue Table 3.

	Concentration				**Nutrient ratio**					
Treat	N%	P%	K%	Fe%	N/P	N/K	N/Fe	p/K	P/Fe	K/Fe
K1N0P0	3.37	0.76	1.32	0.03	4.43	2.55	112.33	0.58	25.33	44.00
K1N0P1	3.06	0.85	1.22	0.04	3.60	2.51	76.50	0.70	21.25	30.50
K1N0P2	3.12	0.97	1.29	0.03	3.22	2.42	104.00	0.75	32.33	43.00
K1N0P3	3.41	0.91	1.33	0.03	3.75	2.56	113.67	0.68	30.33	44.33
K1N1P0	2.84	0.71	1.15	0.03	4.00	2.47	94.67	0.62	23.67	38.33
K1N1P1	3.01	0.72	1.15	0.03	4.18	2.62	100.33	0.63	24.00	38.33
K1N1P2	3.43	0.91	1.34	0.03	3.77	2.56	114.33	0.68	30.33	44.67
K1N1P3	3.62	0.85	1.39	0.03	4.26	2.60	120.67	0.61	28.33	46.33
K1N2P0	3.95	0.97	1.44	0.03	4.07	2.74	131.67	0.67	32.33	48.00
K1N2P1	3.46	0.74	1.33	0.03	4.68	2.60	115.33	0.56	24.67	44.33
K1N2P2	3.29	0.93	1.24	0.04	3.54	2.65	82.25	0.75	23.25	31.00
K1N2P3	3.28	0.95	1.26	0.03	3.45	2.60	109.33	0.75	31.67	42.00
K2N0P0	3.90	0.96	1.42	0.04	4.06	2.75	97.50	0.68	24.00	35.50
K2N0P1	3.42	0.93	1.33	0.03	3.68	2.57	114.00	0.70	31.00	44.33
K2N0P2	3.43	0.95	1.35	0.03	3.61	2.54	114.33	0.70	31.67	45.00
K2N0P3	3.11	0.78	1.29	0.03	3.99	2.41	103.67	0.60	26.00	43.00
K2N1P0	3.02	0.85	1.26	0.04	3.55	2.40	75.50	0.67	21.25	31.50
K2N1P1	3.33	0.89	1.30	0.03	3.74	2.56	111.00	0.68	29.67	43.33
K2N1P2	3.26	0.84	1.28	0.03	3.88	2.55	108.67	0.66	28.00	42.67
K2N1P3	3.34	0.84	1.32	0.03	3.98	2.53	111.33	0.64	28.00	44.00
K2N2P0	3.28	0.80	1.31	0.03	4.10	2.50	109.33	0.61	26.67	43.67
K2N2P1	3.49	0.93	1.35	0.03	3.75	2.59	116.33	0.69	31.00	45.00
K2N2P2	3.21	0.87	1.30	0.03	3.69	2.47	107.00	0.67	29.00	43.33
K2N2P3	4.04	0.98	1.45	0.03	4.12	2.79	134.67	0.68	32.67	48.33

Table (4) DRIS indices, absolute total, yield, and relative yield for chickpea plant

	INDICES						
Treat	N index	P index	K index	Fe index	AT	Yield	R.Y%
K0N0P0	-19.42	1.42	-11.92	29.92	62.68	0.73	47
K0N0P1	-9.75	-10.65	-5.48	25.88	51.76	0.89	58
K0N0P2	2.72	-8.67	2.20	3.75	17.34	1.05	68
K0N0P3	3.94	-5.46	1.44	0.08	10.92	1.24	80
K0N1P0	0.29	-0.63	3.97	-3.63	8.52	1.34	87
K0N1P1	0.06	2.51	-0.90	-1.67	5.14	1.43	92
K0N1P2	-1.06	-0.03	1.74	-0.65	3.48	1.53	99
K0N1P3	-0.61	-1.66	3.34	-1.07	6.68	1.38	89
K0N2P0	3.87	-13.03	7.84	1.32	26.06	1.22	79

Continue Table 4.

	INDICES						
Treat	N index	P index	K index	Fe index	AT	Yield	R.Y%
K0N2P1	-8.44	-9.31	-9.76	27.51	55.02	1.01	65
K0N2P2	16.98	-1.32	3.98	-19.64	41.92	1.02	66
K0N2P3	-7.27	-1.72	-9.49	18.49	36.97	1.15	74
K1N0P0	3.48	-10.39	6.04	0.87	20.78	1.19	77
K1N0P1	-13.66	-3.81	-12.22	29.69	59.38	0.92	59
K1N0P2	-8.78	12.47	-1.35	-2.34	24.94	0.93	60
K1N0P3	-0.11	3.71	0.33	-3.92	8.07	1.25	81
K1N1P0	-4.99	-7.18	0.75	11.42	24.34	1.18	76
K1N1P1	0.10	-7.39	-2.14	9.42	19.05	1.24	80
K1N1P2	0.12	3.33	0.87	-4.31	8.63	1.28	82
K1N1P3	5.17	-4.58	4.72	-5.30	19.77	1.18	76
K1N2P0	8.78	2.86	0.52	-12.16	24.32	1.06	68
K1N2P1	6.35	-13.74	6.76	0.63	27.48	1.19	77
K1N2P2	-9.29	1.73	-16.41	23.97	51.40	1.08	70
K1N2P3	-2.52	10.12	-5.22	-2.38	20.24	1.10	71
K2N0P0	0.68	-4.23	-9.27	12.82	27.00	1.22	78
K2N0P1	-0.37	5.41	-0.51	-4.53	10.82	1.27	82
K2N0P2	-1.24	6.60	0.24	-5.60	13.68	1.27	82
K2N0P3	-3.60	-5.40	6.04	2.96	18.00	1.16	75
K2N1P0	-16.40	-4.53	-7.93	28.86	57.72	0.97	63
K2N1P1	-0.79	3.23	-0.35	-2.09	6.46	1.37	88
K2N1P2	-0.70	-0.31	0.78	0.23	2.02	1.55	100
K2N1P3	0.20	-1.87	2.96	-1.30	6.33	1.45	94
K2N2P0	0.03	-5.11	4.55	0.53	10.22	1.33	86
K2N2P1	0.87	4.43	0.23	-5.53	11.06	1.31	84
K2N2P2	-3.58	2.31	1.91	-0.64	8.44	1.25	81
K2N2P3	10.45	2.94	-0.04	-13.34	26.77	1.27	82

A nutrient index in a mean of the deviation from the optimum or norms values the negative index values indicate that the nutrient levels are below the optimum. Consequently the negative index the more deficient the nutrients. Apositive index indicates that the nutrient levels are above the optimum and a more positive index the excessive nutrients that are relative to normal.If the DRIS index is equal to zero indicating that the nutrient is at optimum level (Baldock and Schulte, 1996).The relationship between plant nutrient concentration and yield is a premise to use the plant analysis as a diagnostic criterion and the relationship between nutrient concentration and DRIS indices may be a valuable criterion to validate the DRIS norms. If there is a relationship between plant nutrient concentration and DRIS index, this index can be used to make a nutritional diagnosis. This fitted model between nutrient concentration and respective DRIS index probably shows negative and positive DRIS index, and it could be used to determine optimum leaf concentration because the nutrient foliar concentration at null DRIS index possibly does not limit crop yield. Means values of the data revealed that the highest absolute total was recorded from treatment combination ($K_0N_0P_0$) and attained (62.68) if compared with other treatments the treatment combination is ($K_0N_0P_0$) is highest value was recorded and also the DRIS index is the highest are (29.92) and (1.42) in the table (4) was recorded positive signal for (Fe) and (P) respectively. however for (N and K) means were (-19.42,-11.92) respectively excessive when the DRIS indices are negative and positive in these cases imbalance as well as the nutrient balance is above or below the optimum the grain yield was recorded (0.73*Mg* ha^{-1}) and also the relative yield was low was (47%), after addition of Nitrogen, phosphor and potassium affected the nutrient balance to reduce, the result shows by increase the level nitrogen, phosphor, and potassium to the soil increase the nutrient balance index like the treatment combination between nitrogen, phosphor, and potassium effect of increase balance between nutrients after that to increase yield by increase levels of nitrogen, phosphor and potassium increased yield and balance.

Addition of (15 Kg N ha^{-1}) of nitrogen with (40 Kg P ha^{-1}) of phosphorus with (30 Kg K ha^{-1}) of potassium in the treatment combination ($K_2N_1P_2$) as well as to increase the grain yield to (1.55*Mg* ha^{-1}).The treatment combination ($K_2N_1P_2$) regards as the most balanced treatment among the studied combinations, with the absolute nutrient index (2.02) which resulted from DRIS indices (-0.70,-0.31,0.78,0.23) for (N,P,K, and Fe) respectively. The nutrient index for the treatment combination ($K_2N_1P_2$) is the DRIS index near the level optimum. In comparing the highest and lowest nutrient balance index the results of the highest (62.68) and the lowest (2.02) A.T values were recorded treatment combination ($K_0N_0P_0$) and ($K_2N_1P_2$) respectively and the highest and the lowest grain yield (1.55*Mg* ha^{-1}) and (0.73*Mg* ha^{-1}) were recorded from ($K_2N_1P_2$) and ($K_0N_0P_0$) treatment respectively the nutrient balance index for the optimum absolute total is (2.02) also the highest yield was recorded in the optimum nutrient balance were recorded from ($K_2N_1P_2$) . The absolute total for the highest and lowest yield was (2.02, 62.68) respectively with the mean yield of (1.55, 0.73*Mg* ha^{-1}) and the mean relative yield of (100%, 47%) respectively. The nutrient index as a fellow for the N index is (-19.42) and decrease to (-0.70) in these time the nitrogen a negative DRIS index indicates that the nutrient level is below the optimum in these time nitrogen is low near the optimum level or approximately in treatment Combination ($K_2N_1P_2$) , phosphor index was recorded (1.42) reduced to (-0.31) and also increase the nutrient balance in treatment combination ($K_2N_1P_2$) in these time the phosphor appositive DRIS index indicates that the nutrient level is above the optimum, and the DRIS index for potassium was recorded (-11.92) reduced to (0.78) and also increase the nutrient balance in treatment combination ($K_2N_1P_2$) in these time the potassium a positive DRIS index indicates that the nutrient level is above or near the optimum. This outcome is to be coupled with higher yield with the smaller absolute total for value nutrient index elements agree with (Saeed,2008) on corn and (Dizayee,2001) on soybean. The results in figure (1) supported the above discussion of the significant correlation between nutrient index balance and percentage of yield. The results in figure (1) Show the treatments for the yield above 80% to calculate the DRIS norms.

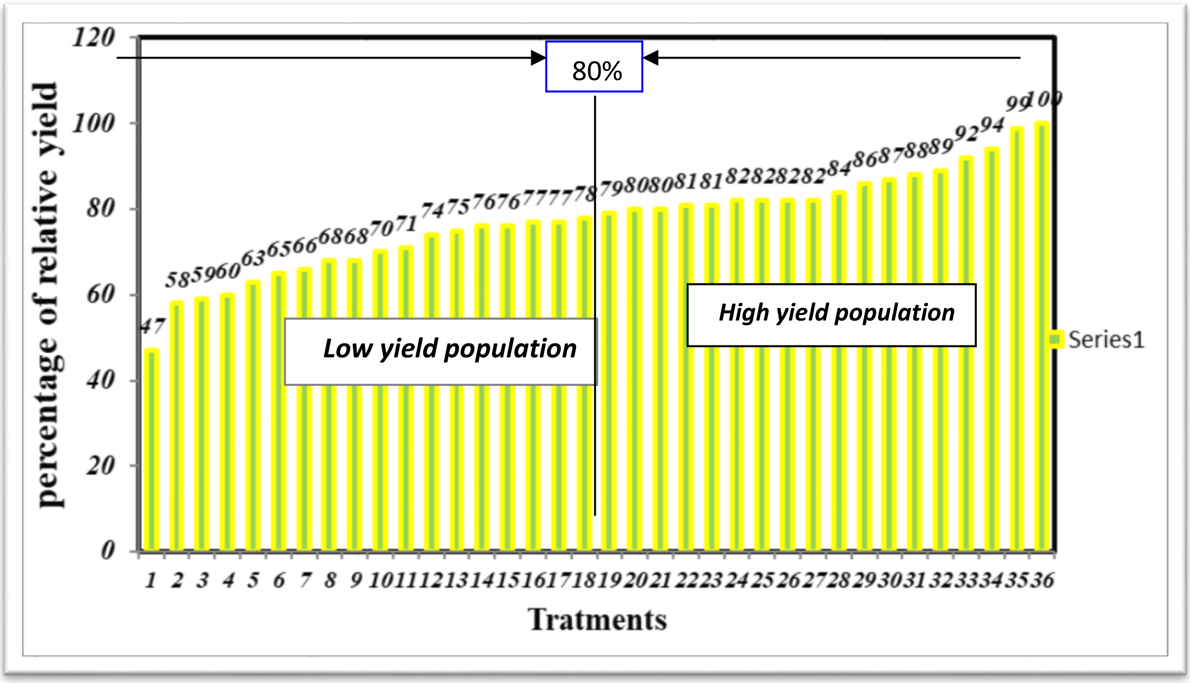

Figure (1): Combination effect between Nitrogen, Phosphorus, and Potassium on grain yield *M*g.ha^{-1}

The point of intersection of the six axes represents the optimum nutrient composition and where the highest yield is obtained. The concentric circles are confidence limits, the inner one being 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, when the arrow points to the above index of sufficiency when the arrow point down represents deficiency and for the right adequacy or optimum table (5),Fig. (2).

Table (5) The Optimum and Critical Value for Nutrient Ratios in Chickpea plant

Limits of confidence	**N/P**	**N/K**	**N/Fe**	**p/K**	**P/Fe**	**K/Fe**
+30%	5.10	3.34	142.00	0.86	36.69	55.33
+15%	4.51	2.96	125.62	0.76	32.45	48.94
Norm	3.92	2.57	109.23	0.66	28.22	42.56
-15%	3.33	2.19	92.85	0.56	23.99	36.18
-30%	2.74	1.80	76.46	0.46	19.75	29.79

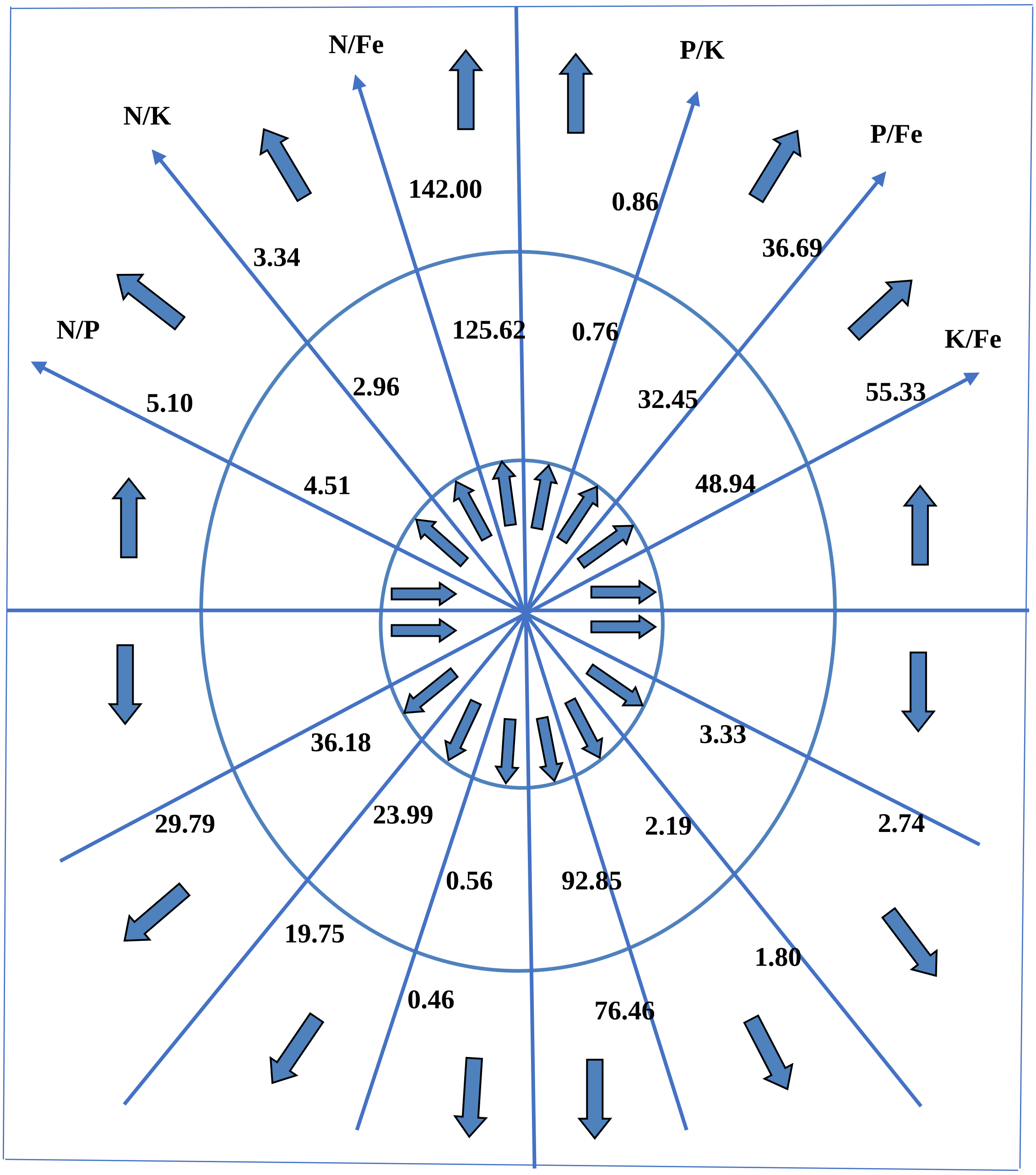

Figure (2) The DRIS chart for (N, P, K, Fe) The Optimum and Critical Value for Nutrient Ratios in Chickpea plants.

CONCLUSION

The field experiment was conducted during the winter season of 2020 at the College of Agricultural Engineering Science Dpt.of soil and water science- University of Salahaddin –Erbil-Iraq to study the "Using D.R.I.S. approach in the nutrient balance of N, P,K and Fe for Chickpea plant (Cicer arietinum L.) "using three levels of nitrogen (0, 15, 30) KgN.ha^{-1}, three levels of phosphorus (0, 20, 40, 60) Kg P. ha^{-1}, and three levels of potassium (0, 15, 30) Kg K. ha^{-1}. Iron fertilizer used in fixed level (6) kg.ha^{-1}. The experiment was laid out in split split plot design with three replications and 36 treatment combinations. The main results were summarized as fallow the treatment combination ($K_2N_1P_2$) regards as the most balanced treatment among the studied combinations, with the absolute nutrient index (2.02) which resulted from DRIS indices (-0.70,-0.31,0.78,0.23) for (N,P,K, and Fe) respectively. In comparing the highest and lowest nutrient balance index the results of the highest (62.68) and the lowest (2.02) A.T values were recorded treatment combination ($K_0N_0P_0$) and ($K_2N_1P_2$) respectively and the highest and the lowest grain yield (1.55 Mg ha^{-1}) and (0.73 Mg ha^{-1}) were recorded from ($K_2N_1P_2$) and ($K_0N_0P_0$) treatment respectively the nutrient balance index for the optimum absolute total is (2.02) also the highest yield was recorded in the optimum nutrient balance were recorded from ($K_2N_1P_2$) . The absolute total for the highest and lowest yield was (2.02, 62.68) respectively with the mean yield of (1.55, 0.73 Mg ha^{-1}) and the mean relative yield of (100%, 47%) respectively.

REFERENCES

Abd El-Rheem Kh. M. (2013). Using Diagnosis and Recommendation Integrated System (DRIS) to determine nutrient norms for peanut crop soils and water use dept., national research centre, Dokki, Giza, Egypt.

Bailey, JS. (1997). The diagnosis and recommendation integrated system (DRIS) for diagnosing the nutrient status of grassland swards: I Model establishment. Plant Soil 197:109–117

Baldock J.O. and Schulte E.E. (1996). Plant analysis with standardized scores combines DRIS and sufficiency range approaches for corn. Agronomy Journal, Madison, 88, 448-456.

Baruah, T.C. and H.P. Barthakur. (1999). A text book of soil analysis. Newdelhi.

Beaufils, E. R. (1971). Physiological Diagnosis -a guide for improving maize production based on principles developed for rubber trees. J. Fert. Soc. S.Afr. 1, 1-31.

Beaufils, E.R. (1973). Diagnosis and recommendation integrated system (DRIS) a general scheme for experimentation and calibration based on principle developed from research in plant nutrition. Soil Sci .Bui. No.1, Univ. of Natal, South Africa.

Dizayee.A.T.R. (2001). Determination of best nutrients balance of (NPK) for soybean crop in alluvial soil using (DRIS) methodology. Ph D. Thesis submitted to Coll. of Agric. Baghdad Univ. (in Arabic)

Elwali A.M.O. and Gascho, G.J. (1984). Soil testing foliar analysis and DRIS as guides for sugarcane fertilization. Agron J. 76: 466-470

FAO, Food and Agricultural Organization of United Nation.(2016). Production, Year Book, Roma, Italy.

Fageria, N. K. and Baligar V. C. (2005). Nutrient availability. In: Encyclopedia of soils in the environment, D. Hillel, Ed., 63–71. San Diego, California: Elsevier.

Girma, A.A. &Beyene, S. (2018). Assessment of the limiting nutrients for wheat (Triticum aestivum L.) growth using Diagnosis andRecommendationIntegratedSystem(DRIS).CommunicationsinSoilScienceandPlantAnalysis,49(21),26532663. https://doi.org/10.1080/00103624.2018.1526951.

Gupta, P.K. (2006). Soil, Plant, Water and fertilizer analysis. Dept. of Agri. Chemistry and Soil Science. Maharana Pratap Univ. of Agri. and Tech. ARS, Kota Rajasthan.

Islam MF and Islam MS, (2006).Response of chickpea to nitrogen, phosphate, potash, sulfur an zinc fertilization in calcareous dark gray flood plain soils of Bengladesh,11th Ann. Bengladesh Conference, Dhaka, BAAS., 1:26.

Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN (2012)Nutritional quality and health benefits of chickpea (Cicer arietinumL.): a review. Brit J Nutr 108: 11–26.

Mourão Filho, F.A.A. (2004). DRIS: Concepts and applications on nutritional diagnosis in fruit crops. Scientia Agricola.61:550-560.

Rowell, D.L. (1996). Soil Science. Methods and application. Univ. of Reading. UK.

Ruhul A, Mohammad S, and Mohammad Y, (1998). Response of wheat and gram to different levels of fertilizer under similar soil and rainfall condition of Potohar. Sarhad J. Agri., 5:217-220.

Saeed M, Akram HM, Iqbal MS, Yar A and Ali A,(2004). Impact of fertilizer on seed yield of chick pea genotypes. Int. J. Agri. Biol., 6:108-109.

Saeed, K.S. (2008). The effects of orthophosphate, pyrophosphate and magnesium on the availability of phosphorus to corn plants using a new DRIS methodology .Ph D. Thesis submitted to Coll. of Agric. Sulaimani Univ.

Schwenke, G. D.; M. B. Peoples; G. L.Turner and D. F. Herridge. (1998). Doses nitrogen fixation of commercial, dryland chickpea and faba bean crops in north-west New south wales maintain or enhance soil nitrogen. Aust, J. Ex, Agric., 38: 61-70.

Seddique, K. N. M. and Sedgely, R. H. (1985).The effect of reduced branching on yield and water use of chickpea in a Mediterranean type of environment. Field Crops Research, 12: 251-296.

Siddique KH, Johansen C, Kumar Rao JVDK,Ali M (2005) Role of legumes in sustainable cropping systems. In: Abstracts, Fourth International Food Legumes Research Conference – Food legumes for Nutritional Security and Sustainable Agriculture, 18-22 ct, New Delhi, India, p 31.

Singh A K, Choudry RK and Sharma RPR, 2003. Effect of inoculation and fertilizer level on yield, nutrient up take and economics of summer pulses. J. Pot. Res., 9: 175-178.

Turner, N.C. Wright, G.C. and Siddique, K.H.M. (2001). Adaptation of grain legumes (pulses) to water-limited environments, Adv. Agron, 71: 193 231.

Verma V K and Pandya KS, 2003. Response of rainfed chickpea to NPK fertilizer and its economics in light textured soils. Adv. Plant Sci., 6: 181-185 (Field Crop Absts., 47(10): 6530; 2004).

Walworth, J.L. and Sumner M.E. (1987). The diagnosis and recommendation integrated system (DRIS). Adv Soil Science 6: 149–188

Zohary D, Hopf M (2000) Domestication of Plants in the Old World,3rd edn. Clarendon Press, Oxford.