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The Test of DRIS Methodology to Determine the Best Balance of Phosphorus and Potassium Levels on Growth, Yield and Oil Content of Sunflower (Helianthus Annuus L.)

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Abstract: *This experiment was conducted at the Grdarasha farm field GPS reading (36.122170º N) and (44.016524 E) of agriculture college, Salahaddin University in Erbil. The soil texture class was silty clay loam, during summer growing season of 2013 conducted in the field, to study the effect of different levels of phosphorus TSP (0,60,120,180,240 Kg P_2O_5 ha^{-1}) ,potassium KCL (0,40,80,120,160 Kg K_2O ha^{-1}) and there combination on yield components and nutrient balance of sunflower plant by using DRIS methodology, Factorial randomized block design with two factors (P and K each one with 5 levels) 25 treatment with 3 replicates was used . The main results could be summarized as: The combination between phosphorus and potassium levels affected on the oil content of sunflower plant was significant also the maximum yield was recorded in treatment combination (P_3K_4) was (4.20 Mg ha^{-1}). Combination between phosphor and potassium levels affected significantly on the oil content. The highest mean value (23.600 %) was produced from the treatment combination (P_0K_3), whereas the lowest mean value (17.033 %) was recorded from treatment combination (P_4K_1).The combination between phosphorus and potassium levels significantly on the concentration of (phosphorus, potassium) in the sunflower plant, the highest means values (0.38%, 3.91%) was recorded from treatment combination (P_4K_0, P_0K_4), were is the lowest means values are (0.21%,2.57% were recorded from the treatment combination (P_0K_4, P_0K_0).The combination effect of phosphorus and potassium fertilizer on nutrient balance indices (NBI) and yield in sunflower plant .The lowest nutrient balance index were recorded from treatment combination (P_3K_4) was recorded (-3.77, 1.38, 2.38) .*

Keywords: *Sunflower yield and oil content best nutrient balance, DRIS methodology.*

I. Introduction

Sunflower (Helianthus annuus L.) is an important oilseed crop which ranks third next to soybean and groundnut as a source of edible oil in the world. It has shown its potential to contribute its share in domestic edible oil requirements (Anonymous, 2009).Sunflower can be grown twice in a year during spring and autumn. Sunflower grown in spring is usually slower in growth than that sown in autumn (Kaleem *et al*., 2009).

It has introduced to Iraq at the end of the sixties and began an extensive campaign to grown in different areas, but it is still get stuck due to the problems suffered by and represented in not providing the appropriate conditions for the growth and production including the service operations of soil and crop, birds attack during agriculture in two phases of seedling and maturity, the growing proportion of blank seeds know researchers focused on soil service operations and crop service, which determine the best levels of nutrients to provide optimum conditions to enable the plant to achieve maximum output productivity, and the importance of essential nutrients in influencing the quality of sunflowers yield Suhaula, (1983).

Due to its high uptake of nutrients, sunflower responds very well to applied nutrients. Applications of nutrients increased the seed yield of sunflower by 50 percent (Chorey and Thosar, 1997). Among the different nutrients required by sunflower, nitrogen and phosphorus are the primary limiting nutrients under most environments (Devidayal and Agarwal, 1998; Baldev et al., 1999).Sunflower had shown differential response to P and K fertilization in different environments. Sunflower seed oil concentration depends on genotype, but it may be expressed differently under different environments (Zheljazkov et al., 2008).

II. Materials And Methods

The (N, P and K) fertilizer was added before planting, then after flowering K fertilizer was added for second time. Urea fertilizer $CO(NH_2)_2$ which contain 46% nitrogen used in fixed level 200 kgh^{-1}, TSP tri-superphosphate $Ca(H_2PO_4)_2$ which contain (46 – 47% P_2O_5) in 5 level (0, 60, 120, 180 and 240 kgh^{-1}) was used, KCl Fertilizer contains (60% K_2O) used in 5 level (0, 40, 80, 120 and 160 kgh-^{1}) two time during experiment. After soil preparation the sunflower seeds (***Helianthus annuus L.***) were planted at 18 June 2013 at the depth of (4 – 5 cm), the space between two lines was 50 cm, the distance between two plants in each line was 25 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 sunflower plant, samples was taken from four plants in the center of each plot by cut off the

necessary leafs for the analysis. The samples was weight and oven dried at 65 ºC for 72 hours, after drying the samples was milling, then chemical analysis was performed. Plants was harvested on (20-10-2013), the plants was taken in 1 m^2 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 method was described by Baruah and Barthakur (1999), using Flame photometer .Soxhlet method used for determination oil in seeds after it was dried at 65ºC for 72 hours, and crushed, as described by Dalaly and Al-Hakim (1987).

Table (1) Some Physical and chemical properties of the studied soil

Soil Physical Properties	Particle size distribution	Sand $g.kg^{-1}$	143.81
		Silt $g.kg^{-1}$	471.77
		Clay $g.kg^{-1}$	384.42
	Texture class	Silty clay loam	
	Water content	0.33 bar	31%
		15 bar	19%
	Density	Bulk density $Mg.m^{-3}$	1.32
		Specific gravity $Mg.m^{-3}$	2.65
Soil Chemical Properties	Properties	Value	Unite
	pH	7.72	
	ECe	0.76	$dS.m^{-1}$
	Organic matter	11.75	$g.kg^{-1}$
	Calcium carbonate equivalent	310	$g.kg^{-1}$
	Active Calcium carbonate	14.30	$g.kg^{-1}$
	Total Nitrogen	0.28	$g.kg^{-1}$
	Available Phosphorus	3.10	$mg.kg^{-1}$
	Anions		
	Chloride	2.4	$Meq.L^{-1}$
	Bicarbonate	3.48	$Meq.L^{-1}$
	Carbonate	0.00	$Meq.L^{-1}$
	Cations		
	Calcium	4.30	$Meq.L^{-1}$
	Magnesium	1.70	$Meq.L^{-1}$

III. Norms Calculation

The most important step for diagnostic system in plants is the calculation of standard values for 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 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 norms values (Bailey, 1997).

IV. 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 nutrient(Mourão Filho, 2004).

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/bCV
When A/B ≤ a/b, f (A/B) = (1 – a/b) 1000 A/BCV
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.

V. Results and Discussion

Effect of different levels of phosphorus, potassium and their combination on grain yield (*Mg* ha^{-1}) of sunflower plant

Table (2) shows the effect of phosphor, potassium levels and their combination of yield in the sunflower plant.

Application of phosphor was no significant on yield in sunflower, the highest mean value (3.26*Mg* ha^{-1}) was produced from the level (P_1), whereas the lowest mean value (3.15*Mg* ha^{-1}), was recorded in (P_2). This agrees with Monotti, (1975) mentioned that the phosphor was no effect to the yield of sunflower, and dis agreement with (Elkouny and omran, 1981) says that the phosphor high effect to the yield of sunflower.

Application of potassium was significant on yield in sunflower, the highest mean value (3.77 *Mg* ha^{-1}), was produced from the level (K_4), whereas the lowest mean value(2.59*Mg* ha^{-1}) was recorded in (K_0). These results agree with Al-Nawaz (1988),Skin (1988), Ahmad (1989) and Ahmaed (1993) have also reported increase seed yield of sunflower with potassium application, also agree with Ayube et al (1999), but does not agree with Zaidi et al , (2012).

The high value of coefficient of determination (R^2 =0.986) shown that there was the good relation between levels of applied potassium and yield of sunflower plant as shown in figure (1)

Combination between phosphor and potassium levels affected significantly on the yield. The highest mean value (4.20*Mg* ha^{-1}) was produced from the treatment combination (P_3K_4), whereas the lowest mean value (2.50*Mg* ha^{-1}) was recorded from treatment combination (P_0K_0). Amanullah and Khan (2010) noted that sunflower yield and yield components responded positively to K and P fertilization.

Table (2) the effect of different levels of phosphorus, potassium and their combination on yield of Sunflower plant:

Treatment	P0	P1	P2	P3	P4	Mean
K0	***2.50***	2.64	2.57	2.56	2.66	***2.59***
K1	3.00	2.99	3.05	3.07	3.03	3.03
K2	3.45	3.20	3.27	2.97	3.03	3.18
K3	3.52	3.68	3.43	3.48	3.55	3.53
K4	3.78	3.80	3.41	***4.20***	3.66	***3.77***
Mean	3.25	***3.26***	***3.15***	3.26	3.19	
Tukey HSD (0.05)				**Value**		
Phosphorus				**0.21**		
Potassium				**0.21**		
Phosphor & potassium				**0.64**		

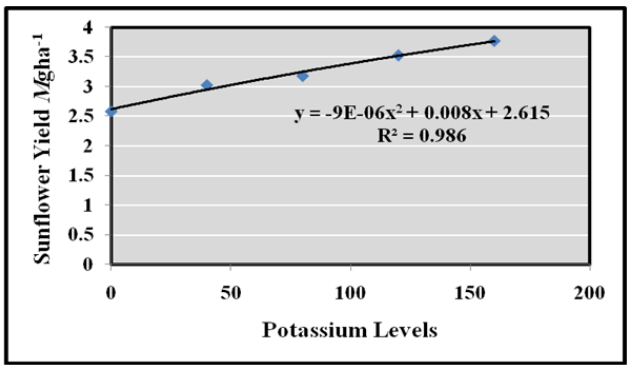

Figure (1): The relation between levels of applied potassium with yield

Effect of different levels of phosphorus, potassium and their combination on oil content (%) of Sunflower seeds

Table (3) shows that the application of phosphor was significantly decreased oil content in the seeds of sunflower , The highest mean value (21.95 %) was produced from the level (P_0) , whereas the lowest mean value (18.21 %) , was recorded in (P_4) .

The high value of coefficient of determination (R^2 =0.977) shown that there was the good relation between levels of applied phosphorus and oil content of sunflower plant as shown in figure (2) The negative slope explain the negative effect of phosphorus on oil content.

Application of potassium was significant on oil content in the seeds of sunflower, the highest mean value (21.36 %), was produced from the level (K_4); whereas the lowest mean value (18.55 %) was recorded in (K_0). The successive increase of potassium fertilizer increased the grain oil content (Christ and Drabbel, 1984) reported that application of potassium fertilizer as on time can led to increase of oil content in seed. (Soleiman zadeh et al., 2010) showed that application of potassium led to increase of oil content in sunflower seeds. And disagree with Faisal et al., (2013). The high value of coefficient of determination (R^2 =0.984) shown that there was the good relation between levels of applied potassium and oil content of sunflower plant as shown in figure (3)Combination between phosphor and potassium levels affected significantly on the oil content. The highest value (23.60 %) was produced from the treatment combination (P_0K_3), whereas the lowest value (17.03 %) was recorded from treatment combination (P_4K_1). This may be due to the single effect of both K and P fertilizer these result was disagree with Amanullah and Khan (2010), they recorded that the interaction (K x P) had non-significant effects on oil content in sunflower seeds.

Table (3) the effect of different levels of phosphorus, potassium and their combination on oil content (%) of Sunflower plant:

Treatment	P0	P1	P2	P3	P4	Mean
K0	18.63	19.97	18.53	18.50	17.13	***18.55***
K1	22.57	22.43	21.00	18.03	***17.03***	20.21
K2	21.70	22.83	20.47	20.07	18.63	20.74
K3	***23.60***	21.70	20.60	20.80	19.63	21.27
K4	23.23	22.03	21.33	21.60	18.60	***21.36***
Mean	***21.95***	21.79	20.39	19.80	***18.21***	
Tukey HSD (0.05)				**Value**		
Phosphorus				**1.81**		
Potassium				**1.81**		
Phosphor & potassium				**5.49**		

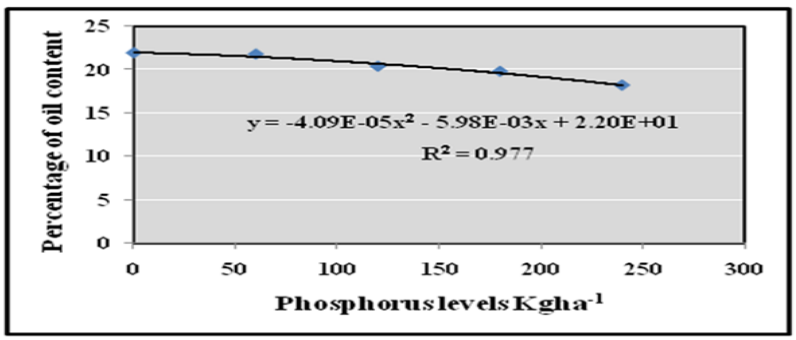

Figure (2): the relation between levels of applied phosphorus with percentage of oil content

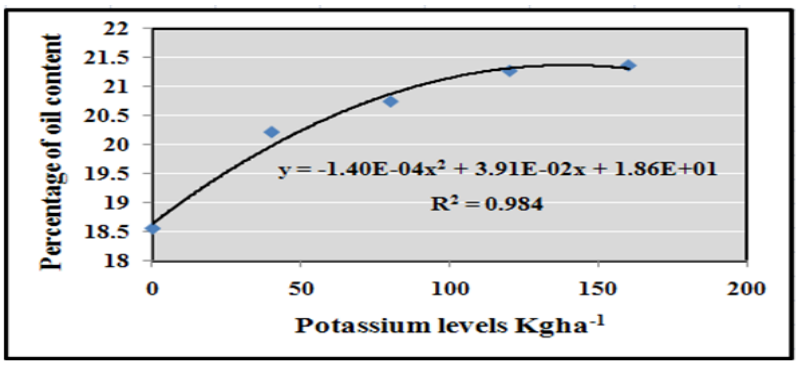

Figure (3): the relation between levels of applied potassium with percentage of oil content

Table (4) Coefficient of variance for yield above 80% for selecting the norms

	N/P	N/K	K/P	P/N	K/N	P/K
C.V%	37.366	9.802	39.983	23.806	10.410	23.728
Means	10.926	0.797	13.830	0.099	1.266	0.079

Table (5) DRIS indices, absolute total, yield and relative yield for Sunflower plant

	Conc.			**Nutrient ratio**			**INDICES**			**NBI**	**Yield *Mgh*$^{-1}$**	**R.Y%**
Treat	**N%**	**P%**	**K%**	**P/N**	**N/K**	**P/K**	**N index**	**P index**	**K index**			
P0K0	2.77	0.30	2.57	0.11	1.08	0.12	16.15	11.44	-27.59	55.18	2.50	59
P0K1	2.80	0.30	3.02	0.11	0.93	0.10	6.93	6.61	-13.54	27.08	3.00	71
P0K2	2.99	0.31	3.42	0.10	0.88	0.09	4.11	4.07	-8.18	16.36	3.45	82
P0K3	2.83	0.32	3.68	0.11	0.77	0.09	-5.12	5.62	-0.50	11.24	3.52	84
P0K4	2.95	0.21	3.91	0.07	0.76	0.05	4.95	-17.28	12.33	34.56	3.78	90
P1K0	2.58	0.30	2.59	0.12	1.00	0.12	9.20	13.43	-22.64	45.27	2.64	63
P1K1	3.00	0.29	3.03	0.10	0.99	0.10	12.53	4.49	-17.02	34.04	2.99	71
P1K2	2.67	0.31	2.97	0.12	0.90	0.10	3.24	9.84	-13.08	26.16	3.20	76
P1K3	2.67	0.29	3.37	0.11	0.79	0.09	-2.64	4.40	-1.75	8.79	3.68	88
P1K4	2.87	0.25	3.50	0.09	0.82	0.07	4.64	-5.72	1.08	11.44	3.80	91
P2K0	2.58	0.32	2.58	0.12	1.00	0.12	7.61	17.25	-24.87	49.73	2.57	61
P2K1	2.84	0.32	3.05	0.11	0.93	0.10	6.11	9.25	-15.36	30.72	3.05	73
P2K2	2.80	0.32	3.06	0.11	0.92	0.10	4.36	9.98	-14.34	28.68	3.27	78
P2K3	2.63	0.29	3.45	0.11	0.76	0.08	-4.38	3.13	1.25	8.76	3.43	82
P2K4	2.80	0.24	3.66	0.09	0.77	0.07	1.19	-7.58	6.39	15.16	3.41	81
P3K0	2.80	0.38	2.58	0.13	1.09	0.15	10.93	25.38	-36.31	72.62	2.56	61
P3K1	2.95	0.34	3.03	0.12	0.97	0.11	7.53	12.84	-20.37	40.74	3.07	73
P3K2	3.14	0.28	3.36	0.09	0.94	0.08	11.00	-0.65	-10.35	22.00	2.97	71
P3K3	2.87	0.25	3.64	0.09	0.79	0.07	1.98	-5.38	3.40	10.76	3.48	83
P3K4	2.73	0.29	3.60	0.11	0.76	0.08	-3.77	1.38	2.39	7.54	4.20	100
P4KO	2.82	0.38	2.61	0.13	1.08	0.14	10.71	24.76	-35.47	70.94	2.66	63
P4K1	2.81	0.32	3.02	0.11	0.93	0.10	5.68	9.72	-15.40	30.80	3.03	72
P4K2	2.79	0.36	3.17	0.13	0.88	0.11	-1.18	16.06	-14.88	32.12	3.03	72
P4K3	2.89	0.32	3.51	0.11	0.82	0.09	-0.54	5.21	-4.67	10.42	3.55	84
P4K4	3.14	0.32	3.73	0.10	0.84	0.09	2.17	2.86	-5.03	10.06	3.66	87

Table (4) calculated the NORM on the treatment interaction levels of (K&P) in which the yield above of 80% of relative yield and calculate coefficient of variances. This method is targeting method. In table (5) 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. 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 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 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 do not limit crop yield.

Means values of the data revealed that the highest absolute total were recorded from treatment combination (P_0K_0) and attained (55.18) if compared with other treatments the treatment combination is (P_0K_0) is highest value was recorded and also the DRIS index is the highest are (-27.59) in table (5) was recorded negative signal for (K) respectively . however for (N and P) means were (16.15,11.44) respectively excessive when the DRIS indices are negative and positive in these case imbalance as well as the nutrient balance is above or below the optimum the grain yield was recorded (2.50*Mg* ha^{-1}) and also the relative yield was low was (59%) , after addition of phosphor and potassium effected the nutrient balance to reduce , the result shows by increase the level phosphor and potassium to the soil increase the nutrient balance index like the treatment combination between phosphor and potassium effect of increase balance between nutrients after that to increase yield by increase levels of phosphor and potassium increased yield and balance.

Addition of (180 Kg P ha^{-1}) of phosphor with (160 Kg K ha^{-1}) of potassium in the treatment combination (P_3K_4) as well as to increase the grain yield to (4.201 *Mg* ha^{-1}).The treatment combination (P_3K_4) regards as a most balance treatment among the studied combinations , with the absolute nutrient index (7.54) which resulted from DRIS indices are (-3.77,1.38,2.39) for (N,P and K) respectively .The nutrient index for the treatment combination (P_3K_4) the DRIS index near the level optimum .In comparing between the highest and lowest nutrient balance index the results the highest (55.18) and the lowest (7.54) A.T values were recorded treatment combination (P_0K_0) and (P_3K_4) respectively and the highest and the lowest grain yield (4.20 *Mg* ha^{-1})

and (2.50*Mg* ha^{-1}) were recorded from (P_3K_4) and (P_0K_0) treatment respectively the nutrient balance index for the optimum absolute total is (7.54) also the highest yield was recorded in the optimum nutrient balance were recorded from (P_3K_4) .

The absolute total for the highest and lowest yield were (7.54, 55.18) respectively with the mean yield of (4.20, 2.50*Mg* ha^{-1}) and the mean relative yield of (100%, 59%) respectively.

the nutrient index as fellow for the N index is (16.15) decrease to (-3.77) 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 (P_3K_4) , phosphor index was recorded (11.44) reduced to (1.38) and also increase the nutrient balance in treatment combination (P_3K_4) 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 (-27.59) reduced to (2.39) and also increase the nutrient balance in treatment combination (P_3K_4) 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 (4) Show the yield divide to two-part high yield and less yield on high yield take it the norm which take on treatments which are above 80 %.

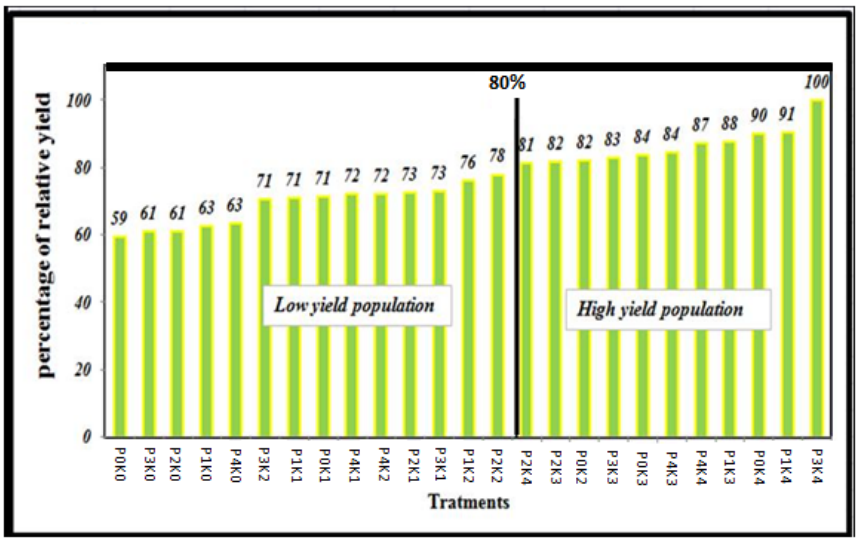

Figure (4) Show the Combination effect between Phosphorus and Potassium on grain yield *Mg*.h^{-1}

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