EFFECTE OF PHOSPHATE FERTILIZER ON GROWTH AND YIELD OF FIVE CULTIVARS BREAD WHEAT

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ABSTRACT

A field experiment was carried out at the College of Agriculture, Duhok University to study the effect of phosphorous levels (25, 30, and 35) kg P ha^{-1} in addition to control treatment and five wheat varieties (SDRAA-1, Sham-4, Maxipak, Abugraib-3, and JAWA-13) on yield and yield components of cultivated studied wheat varieties in calcareous soil during winter season (2014- 2015). The experiment units were laid out in the factorial arrangement using randomized complete block design (RCBD) with three replicates. The results revealed that wheat varieties were significantly affected on plant height, protein percent, leaf area, date of flowering, grain weight spik^{-1}, No. of grain spike^{-1}, 1000- grain weight, chlorophyll, harvest index, and grain yield. While the phosphorous levels exhibited significant effects on grain weight spike^{-1}, number of grain spike^{-1}, harvest index, and grain yield. While the interaction between phosphorous and varieties, show significant effects. The variety JAWA-13 was superior in traits of protein content, phosphorous concentration, harvest index, grain weight.

Keyword: wheat varieties, fertilizers , harvest index, chlorophyll, biological yield grain yield.

تاثير السماد الفوسفاتي في نمو وحاصل خمسة اصناف من حنطة الخبز

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المستخلص

نفذت تجربة حقلية في كلية الزراعة/ جامعة دهوك خلال الموسم الزراعي الشتوي (2014–2015) لدراسة تاثير اضافة اربع مستويات من الفوسفور (25، 30، 35) كغم P هـ$^{-1}$ فضلا عن معاملة المقارنة وخمسة اصناف من الحنطة (JAWA–13 وابوغريب–3 ومكسيباك و شام–14و1–SDRAA) في بعض صفات النمو والحاصل و مكونات الحاصل من الحنطة المزروعة في تربة كلسية باستعمال التجارب العاملية بتصميم القطاعات الكاملة المعشاة. اظهرت نتائج تحليل التباين بان لاصناف الحنطة تاثير معنوي في صفات (ارتفاع النبات، النسبة المؤية للبروتين، المساحة الورقية، تاريخ التزهير، حاصل الحبوب في السنبلة، عدد الحبوب في السنبلة، وزن الف حبة، المحتوى الكلي للكلوروفيل، دليل الحصاد و حاصل الحبوب للوحدة التجريبية). اثرت مستويات الفوسفور المضافة معنويا في صفات (وزن الحبوب في للسنبلة، عدد الحبوب في السنبلة، دليل الحصاد، حاصل الحبوب للوحدة التجريبية). كان تاثير التداخل معنويا بين مستويات الفوسفور المضافة و اصناف الحنطة المدروسة.اذ تفوق صنف JAWA–13 على باقي الاصناف المدروسة في صفات (محتوى البروتين وتركيز الفوسفور في الحبوب، دليل الحصاد وحاصل الحبوب).

كلمات مفتاحية: اصناف الحنطة، أسمدة، دليل الحصاد، الكلوروفيل، الحاصل البايولوجي، حاصل الحبوب.
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INTRODUCTION

Wheat (*Triticum aestivum L.*) is belong to family poaceas, it consider as one of the most important crop in the world and the widest distribution among cereal crops. The crops cultivate primary for grain yield that consumed by human in food, (7). Wheat is an important cereal crops in Kurdistan region/ Iraq, it's average productivity is low comparing to other advance countries in the world. Several factors such as good varieties, management practice like balanced fertilization is very important for high production of crops like wheat, (15). The plant variety is one of the most important factors which plays an important role in maximizing the yield production of wheat, (8). Mosali et al., (1) indicated that phosphorous conceder as the second most important factor, and essential for plant growth after nitrogen. Kacur and KatKat, (9) reported that phosphorous is taken up by plant as an orthophosphate ions ($H_2PO_4^{-1}$, and HPO_4^{-2}) which play a vital function in yield improvement. Ahmad and Rashid,(1) reported that application of phosphorous in adequate quantity and available source to plant medium has a vital role for plant growth, yield production, and improving yield quantity of wheat, also phosphorous is essential for cell division seed and fruit development. Many researchers (Tisdale et al., (17), Barber, (3), were studied phosphorous in calcareous soil and found that different parameters affected the availability of soil phosphorous to plant such as soil pH, Ca^{+2} concentration, $CaCO_3$ amount of organic matter content, type of clay mineral, soil moisture, soil texture, root density and root exudates. Awaad et al., (2) reported that phosphorous fertilizers is an expensive input and it's use efficiency by crop is poor (10- 25%) while (Kaleem et al., (10) were found through afield experiment using five levels of phosphorous (32, 42, 84, 96, and 128) kg p ha^{-1} on wheat variety lnqlab-91, the maximum grain yield was obtained at fertilization level 128 kg p ha^{-1} which indicates the high efficient use of phosphorous by crop at high dose, and achieved maximum wheat productivity. The maximum phosphorous doses contributed in achieving maximum 1000– grain weight, dry matter, highest numbers of grain $spike^{-1}$. The present study was devoted to study the yield and yield component of wheat varieties as affected by phosphorous fertilizers, and identifying the best wheat variety under the studied soil condition

MATERIAL AND METHODS

This study was carried out at the farm of the college of Agriculture, Summel, University of Duhok Kurdistan region-Iraq at latitude (36° 51′ 40.9″) N, longitude (42° 51′ 54.6″) E, and elevation 510 m above sea level during season 2014 – 2015. The climate data, some physical and chemical properties of the soil presented in Table 1. The experiment units were laid out in the factorial arrangement using randomized complete block design (RCBD) with three replications. The experimental units consist of 60 treatments units (plots) combined with five wheat varieties namely SDRAA-1, Sham-4, Maxipak, Abugraib-3, and JAWA-13, and four levels of phosphorous (0, 25, 30, and 35) kg P ha^{-1} in form of triple superphosphate (21% P) was applied at the time of sowing. 50 kg ha^{-1} of Nitrogen fertilizers was applied in the form of urea (46%), in two split dose, half applied at sowing date and the remaining half was applied after 60 days of sowing date. The seeds were sown in rows manually with sowing rate of (120) kg ha^{-1}, the area of each experimental units was (0.75*3) m (2.25 m^2) having three lines in each plot with (3m) length and (0.25 m) width. All agronomic practices were carried out uniformly for whole experiment when needed. At the maturity ten plants from each line were selected randomly to study following plant parameters, (plant height (cm), leaf area (cm^2), date to flowering, biological yield (g), harvest index, total chlorophyll, and phosphorous concentration in grain), which determined according to Tanddon, (16), the obtained data analyzed according to GLM procedure to estimate the significant effect of studied traits at probability (0.05) using Minitab software package 16.Tukey's HSD (Honestly Significant Differences) test was used to indentify significance between treatment

Table 1. Some chemical and physical properties of soil before planting, and climatic data of the studied area

Sample	Chemical parameters					Physical properties		Mean of rain fall (mm)/month During study	Mean of temperature ^{O}C during study	
	pH	EC dS m^{-1}	%O.M	%$CaCO_3$	Available phosphorus (mg kg^{-1})	Texture	Field capacity %		min	max
	7.87	0.46	1.23	24.62	5.44	Silty clay	32.73	21.61	1.48	8.28

RESULTS AND DISCUSSION

Table 2 shows the ANOVA Table of factorial analysis examination for the effect of wheat varieties, and phosphorous rate on growing and yield of wheat plants. The analysis revealed that wheat varieties show significant effects, while the phosphorous rates exhibited significant effect in grain weight spike^{-1}, number of grain spike^{-1}, harvest index and grain yield per 1.2 m^2. Regarding to the interactions between wheat varieties and phosphorous rates. The results in Table 2 indicates that the interaction show non significant effect in all traits and significant effect on biological yield, phosphorous in grain and grain yield per 1.2 m^2. These findings were accordance with results founding by Hossain et al., (6) and Li et al., (12), whom observed the wheat varieties and phosphorous rates significantly affects on some growth traits of plant and yield

Table 2. ANOVA of factorial analysis examining the effect of wheat verities and phosphorous level in growth and yield attributed of wheat plant

Traits	Varieties		P addition		Varieties × P addition	
	$F_{4,38}$	*P*	$F_{3,38}$	*P*	$F_{12,38}$	*P*
Plant height cm	94.59	<0.0001	0.28	0.840	0.42	0.947
Protein %	4.53	0.004	1.17	0.333	1.07	0.411
Flag leaf area cm^2	4.98	0.003	1.28	0.295	0.64	0.792
Date to flowering	98.92	0.000	1.07	0.373	0.54	0.871
Biological yield (g/1.2m^2)	0. 38	0.819	1.02	0.398	2.20	0.032
Grain weight spike^{-1} (g)	13.08	0.000	2.92	0.046	0.39	0.958
No. of grain spike^{-1}	34.36	0.000	3.04	0.041	1.32	0.294
1000 grain weight g spike^{-1}	50.77	0.000	1.25	0.304	0.20	0.998
Phosphorous percent	0.70	0.599	0.79	0.510	1.94	0.061
Chlorophyll	16.00	0.00	1.77	0.17	1.25	0.285
Harvest Index %	6.3	0.001	6.93	0.001	1.67	0.115
Grain weight (g 1.2 m^{-1})	21.93	<0.0001	46.24	<0.0001	5.19	<0.0001

Table 3. Influence of five wheat varieties in yield and its attributes of wheat plant.

Varieties	Plant height (cm)	flag leaf area cm^2	Date of flowering (Days)	Biological Yield (g $1.2m^{-2}$)	Grain weight $spike^{-1}$ (g)	No of Grain $spike^{-1}$	weight of 1000 grain (g)	Grain weight (g $1.2m^{-2}$)	%Harvest Index	Total chlorophyll (SPAD)	Protein (%)	P (mg kg-1)
SARAA-1	77.5d	45.6ab	120a	1262.5a	1.3b	50.7b	25.8c	251.4b	20.1ab	42.4c	10.6ab	1961.0a
Sham-4	82.7cd	46.6a	114c	1277.1a	1.5b	53.8ab	27.4c	232.8c	18.3b	44.4bc	10.4ab	1889.6a
Maxipak	84.2c	52.8a	114c	1278.8a	1.7a	55.7a	30.4b	254.3b	20.2ab	47.2a	9.8b	1865.8
Abugraib-3	100.9a	40.7ab	116b	1267.1a	1.7a	46.3c	37.3a	225.1c	17.9b	47.4a	10.4b	1781.4a
JAWA- 13	92.4b	33.3b	116b	1224.6a	1.4b	40.8d	34.9a	270.3a	22.3a	46.5ab	12.0a	1989.2a

Table 4. influence of four level of phosphorous in yield and its attributes of wheat plant.

Levels of applied P height (kg ha^{-1})	Plant (cm)	Flag leaf area cm^2	Date of flowering (Days)	Biological Yield (g $1.2m^{-2}$)	Grain weight $spike^{-1}$ (g)	No of Grain $spike^{-1}$	weight of 1000 grain (g)	Grain weight (g $1.2m^{-2}$)	%Harvest Index	Total chlorophyll SPAD	Protein (%)	P (mg kg^{-1})
0	86.7a	41.4a	116a	1261.3a	1.6a	49.8ab	31.7a	215.1c	17.4b	44.8a	10.4a	1970.6a
25	87.7a	41.8a	116a	1277.0a	1.5a	48.0b	30.6a	267.9a	21.2a	45.5a	11.2a	1918.6a
30	88.2a	43.3a	116a	1292.0a	1.5a	48.4ab	30.5a	260.3a	20.3a	46.3a	10.6.3a	1913.4a
35	87.6a	48.6a	116a	1217.7a	1.6a	51.5a	31.8a	243.8b	20.2a	45.7a	10.4.2a	1787.0a

Table 5. Effect of different wheat varieties and phosphorous fertilization level in yield and it's attributes of wheat plant.

Varieties	Plant height (cm)				Flag leaf area (cm2)				Date of flowering (Days)			
	0	25	30	35	0	25	30	35	0	25	30	35
SARAA-1	75.5d	79.3cd	78.9cd	76.4d	43.5a	42.1a	45.8a	50.9a	119.3a	120.3a	120a	120a
Sham-4	83.7bcd	82.0bcd	83.4bcd	81.9bcd	44.6a	40.6a	38.0a	63.2a	113.7de	114.3b-e	114cde	113.3e
Maxipak	83.8bcd	85.2bcd	85.1bcd	82.9bcd	49.2a	54.0a	53.9a	54.2a	114.3b-e	115b-e	114.3b-e	114cde
Abugraib-3	99.5a	99.5a	103.1a	101.4a	37.9a	42.6a	42.0a	40.2a	116.3bc	116bcd	116bcd	116.7b
JAWA- 13	91.2abc	92.5abc	90.6abc	95.4ab	31.8a	29.9a	37.0a	34.4a	115.7b-e	116.3bc	116bcd	116.3bc

Varieties	Biological yield (g .1.2m^{-2})				Grain weight spike^{-1} (g)				No Grain spike-1			
	0	25	30	35	0	25	30	35	0	25	30	35
SARAA-1	1313a	1272a	1370a	1095a	1.32abc	1.14c	1.24bc	1.53abc	48.5a-e	45.4cde	51.3a-d	57.7a
Sham-4	1197a	1362a	1365a	1185a	1.53abc	1.40abc	1.40abc	1.57abc	55.4abc	52.4a-d	51.6a-d	55.7abc
Maxipak	1443a	1138a	1265a	1268a	1.71ab	1.67ab	1.63abc	1.77ab	56.9ab	54.9abc	54.2abc	56.7ab
Abugraib-3	1207a	1300a	1308a	1253a	1.78 a	1.70ab	1.68ab	1.74ab	46.7a-e	47.0a-e	45.5cde	45.9b-e
JAWA- 13	1147a	1313a	1152a	1287a	1.48abc	1.41abc	1.37abc	1.46abc	41.7de	40.2d	39.6d	41.7de

Means having the same letters in rows and column are not significantly difference at P – value > 0.05.

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Varieties	1000 grain weight (g)				Grain weight (g 1.2m^{-2})				Harvest index			
	0	25	30	35	0	25	30	35	0	25	30	35
SARAA-1	27.5ef	25.0f	24.2f	26.4f	209.4ef	269bc	279.3ab	247.8b-e	16.0bc	21.2abc	20.4ab	22.6abc
Sham-4	27.6def	26.8f	27.1ef	28.1c-f	212.2ef	263bcd	240.8b-f	215.3ef	17.8abc	19.6abc	17.7abc	18.3abc
Maxipak	30.0b-f	30.2b-f	30.0b-f	31.2a-f	214.5ef	257.9bcd	275.8abc	269.3bc	14.9c	22.7ab	22.0abc	21.3abc
Abugraib-3	38.2a	36.3ab	36.9ab	37.9a	215.8ef	236.3c-f	242.1b-f	206.1f	18.5abc	18.3abc	18.6abc	16.4bc
JAWA- 13	35.4abc	34.9a-d	34.3a-e	35.1abc	223.8def	313.1a	263.6bcd	280.6ab	19.9abc	24.1a	23.0ab	22.2abc
Varieties	Total chlorophyll (SPAD)				protein (%)				P (mg kg^{-1})			
	0	25	30	35	0	25	30	35	0	25	30	35
SARAA-1	42.2bcd	42.0d	42.1cd	43.3a-d	9.12 a	12.24 a	10.62a	10.10 a	1809.5a	2043.3a	2233.8a	1757.6a
Sham-4	45.1a-d	44.6a-d	45.8a-d	42.0d	10.52 a	10.94 a	10.30a	10.20 a	1991.3a	2008.9a	1722.9a	1835.5a
Maxipak	44.9a-d	47.4a-d	48.8a	47.8abc	10.74 a	10.30 a	9..98 a	8.38 a	2207.8a	1645.0a	2069.3a	1541.1a
Abugraib-3	46.0a-d	47.9ab	47.4a-d	48.3a	10.10 a	10.42 a	10.30 a	10.84 a	1870.1a	1835.5a	1974.0a	1445.9
JAWA- 13	45.8a-d	45.7a-d	47.6a-d	46.9a-d	12.02 a	11.80 a	12.02 a	12.02 a	1974.0a	2060.6a	1567.1a	2355.0a

Means having the same letters in rows and column are not significantly difference at P – value > 0.05.

The data in Table 3 shows that wheat varieties were significantly affected on plant height, of Abugraib – 3 variety which recorded maximum plant height (100.9 cm) and followed by JAWA-13 variety (92.4 cm), while the minimum plant height was obtained by SDRAA -1 variety (77.5)cm. Regarding on the effect of wheat varieties on leaf area cm^2, the Maxipak variety recorded the highest value of leaf area (52.8 cm^2), while the SAWA-13 variety had the lowest value (33.3 cm^2), this indicated that wheat varieties are various in their adaptation to a given environment. For the data of flowering, the varieties Sham-4 and Maxipak were recorded the earliest day to flowering with value 114 days, while the SDRAA-1 variety recorded the latest with 120 days. Also the varieties significantly impacted on grain weight $spike^{-1}$, the variety Maxipak and Abugraib-3 had the maximum value (1.7g), where the SDRAA-1 gave the minimum value with (1.3g). Regarding on the number of grains $pike^{-1}$ the data shows that Maxipak variety obtained maximum number of grains $spike^{-1}$ (55.7), while the JAWH-13 was recorded the minimum number (40.8) grains $spike^{-1}$. The 1000 grain weight is an important yield component which may significantly contribute in increasing the yield in cereal crops including wheat. The variety Abugrib-3 and JAWA-13 had the greatest kernel size with 1000- grain weight (37.3 and 34.9)g respectively where as SDRAA-1 exhibited the lowest value with (25.8g). Regarding for grain weight in $1.2m^2$ and harvest index the JAWA-13 gave the highest grain weight in 1.2 m^2 and harvest index producing (270.3g. 1.2 m^{-2} and 22.3g) respectively. This variety was superior in yield and harvest index, because the same variety was superior in yield components, 1000 grain weight traits. For the total chlorophyll the Abugraib-3 and Maxipak obtained the maximum value (47.4 and 47.2) SPAD, while the SDRAA-1 recorded the minimum value with (42.4) SPAD.The Table 3 shows that the JAWA-13 was superior in protein percentage and phosphorous concentration, which recorded the highest value (12.0%) and (1989.2 $mg.kg^{-1}$) respectively where as the lowest concentration of protein was noticed for Maxipak with (9.8%). From the results above the wheat varieties were dilator to respond of phosphorous levels depend on the genotypes. Similar results were obtained by Ahmad and Rashid (1) and Kaleem et al., (10) whom reported that an application of phosphorous in different rates affect in yield and yield components in wheat plant. The data in Table 4 shows the effect of four levels of phosphorous in yield and wheat plant. The results were significantly influenced the number of grain $spike^{-1}$, grain weight per 1.2 m^2 and harvest index. Regarding to the number of grain $spike^{-1}$, the level 35 kg P ha^{-1} gave the highest value with 51.5, while the rest levels of phosphorous appear to have the same effect on this traits For grain weight per 1.2 m^2 the 25 and 30 kg P ha^{-1} was recorded the maximum values (267.9g) and (260.3 g) respectively, while the control had the lowest value (215.1 g). The result in the same table revealed the effect of phosphorous levels in harvest index. All levels of phosphorous (25, 30 and 35) kg P ha^{-1} gave the highest value in harvest index with value (21.2, 20.3, and 20.2) respectively, while the check treatment had the lowest value (17.4). This means that phosphorous application is more for increasing weights of grain $spike^{-1}$ because the phosphorous is the main source of energy which is main component of (ATP) and protein concentration in seeds this results are going with found by Brink et al., and Li et al., (13), whom reported that each incremental of P_2O_5 rate caused higher grain yield in wheat.Table 5 indicates to an interaction between varieties and phosphorous level (v*p). The maximum plant height value was (103.1 cm) recorded by Abugraib-3 at phosphorous rate 30 kg P ha^{-1}, when the lowest plant height value was (76.4 cm) recorded by SARAA-1 at the level 35 kg P ha^{-1}, and generally Abugraib-3 was significantly superior among all studied wheat varieties, at entire applied phosphorous levels exception JAWA-13. Relying on the interaction effect between varieties and phosphorous levels on days for flowering, Sham-4 variety recorded minimum average days of flowering (113.3 days) at level 35 kg P ha^{-1}, while the maximum average days for flowering obtained by SDRAA-1 (120.3 days) at level 25 kg P ha^{-1}, for this trait the wheat varieties differently responded to phosphorous

level and an application of p reduces the maturity period. While depending on grain weight spike^{-1} trait, the results revealed positive response of wheat varieties to the applied phosphorous levels.The maximum grain weight spike^{-1} was (1.78g) produced by Abugraib-3 in control treatment, and followed by Maxipak with (1.77g) at phosphorous level 35 kg P ha^{-1}. While the minimum value for this trait was (1.24g) recorded by SDRAA-1 at 30 kg P ha^{-1} phosphorous level. Regarding to the number of grain spike^{-1}, Maxipak variety recorded maximum number of grain spike^{-1}(59.9), at control treatment and followed by the same variety, which gave (56.7) at 35 kg P ha^{-1} phosphorous. Regarding to the number of grain spike^{-1}, Maxipak variety recorded maximum number of grain spike^{-1}(59.9) at control treatment and followed by the same variety, which gave (56.7) at 35 kg P ha^{-1} phosphorous level. When the minimum number of grain spike^{-1} was (39.6) obtained by JAWA-13, at level 30 kg P ha^{-1}. It appear from these results that Maxipak variety was superior in these traits (grain weight spike^{-1} and number of grain spike^{-1}) at control of phosphorous. While depending on trait of 1000- grain weight, wheat varieties were significantly various, and differently responded to added phosphorous levels. Abugraib-3 variety recorded highest value for this trait with (38.2 and 37.9) g at zero and 35 kg P ha^{-1} levels respectively. According to grain weight in 1.2 m^2 , it note that the highest grain yield was (313.1 g) recorded with phosphorous rates (25 kg P ha^{-1}) by JAWA-13, while the minimum value was (206.9g) recorded by Abugraib-3 at (35 kg P ha^{-1}). The impact of phosphorous fertilization on harvest index was clear on JAWA-13 variety, and it gave the highest harvest index (24.1%) at level 25 kg P ha^{-1}, this mean that JAWA-13 variety respond to add P level due to it's requirement from P is low in soil which is 5.44 mg. p kg soil^{-1} table 1 and there for, an application of P to soil increased it's growth which lead to be superior among the studied wheat varieties. This results are gonging with those results which obtained by the same variety for grain yield and biological yield in 1.2 m^2. From the same table it appear that Maxipak and Abugraib-3 were superior in total chlorophyll which recorded (48.8 and 48.3)%, at level 30 and 35 kg P ha^{-1} respectively. These results are in agreement with those state out by Kumar et al., (11), Ahmad and Rashid (1) and Awaad et al., (2) whom reported that an application of phosphorous is important for growth, reproduction, yield and improving yield quality of wheat, and these variation between studied wheat varieties and their response to applied phosphorous levels, may refer to differences between genetic factors of wheat varieties and/or differences between their requirements and mechanisms of nutrients acquisition as mentioned by Dohuki, (5) in barley and Barwari (4) in wheat

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