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RESIDUAL EFFECT OF PHOSPHORUS FERTILIZATION DURING MULTIPLE CROPPING SYSTEMS

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ABSTRACT

Response of faba bean to 30.0, 37.5 and 45 kg P_2O_5/fad., and P residual effect on both sunflower and maize treated with 90 (N_1), 105 (N_2), 120 (N_3) and 135 (N_4) kg N/fad., were examined during two farming years of 2009/2010 and 2010/2011at Agricultural Research Station, Alexandria University. Faba bean yield and yield attributes, number of pods/main stem, 100 seeds weight and seed yield/plant showed maximum records with application of/ P. Residuals P had either insignificant or significant greater effects on sunflower compared to residuals of 37.5 and 30.0 kg P_2O_5/fad. Maize ear-grain yield and grain yield/fad., significantly responsed to P residuals, N level and PX N interactions. Maize showed maximum records for such traits with each of P_3 residuals, N_4 level and the combination of both.

Keywords: Residual effect, phosphorus, fertilization, multiple, cropping system.

INTRODUCTION

Egypt is faced with a difficulty in increasing arable land area due to shortage of irrigation water which exerted shortage in food crops production and inability to provide food self sufficiency. Towards effective uses of land with optimum levels of agricultural inputs, such as fertilizer are necessary. To reach land maximal yields through intensive sequential cropping systems, multiple cropping of more than two crops a year can be established by planting short duration crops (e.g. sunflower) and/or overlapping of the sequential crops (relay cropping).

The inclusion of faba bean, as a leguminous crop, in rotation with cereals and other none legumes increases soil productivity due to it's ability to fix N and to produce deep roots which add active organic matter and scavenge nutrients from lower soil depths (Nawar, 2004 and Khalil *et al.,* 2011).

Phosphorus considered an important nutrient affecting crop growth and agronomic performance. P applications is associated with plant vigorous growth, coupled with greater assimilates build up and partitioning into plant fruiting parts leading to plants better phenology and development, in terms of vegetative traits and in addition yield and it's attributes were reported by Gardner *et al.,* 1985 and Parihar and Tripathi, 1989.

These effects are attributed to increases in the uptake of all nutrients with increasing P level (Sheng-Xiu *et al.,* 2011). Studies on the prolonged effects with a large initial application of P fertilizer are scarce. In soybean-wheat cropping system, Chatterjee and Roauib (1977) observed that P. Manuring to both crops in the sequence gave a slightly response than when either of the crops was manured once a year. Rao *et al.* (1996) reported that, when soybean was supplied with P, there was more efficient use of P by the succeeding crops.

Nitrogen controls biomass production through its effects on the development of vegetative and reproductive organs (Sinclair and Horrie, 1989). Nevertheless, the practice of N application above requirements may be a reason for N leaching (Hooker *et al.,* 1983). Buerkert *et al.* (1998) indicated, in a soil deficient in N and

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P supply, P supply resulted in much better response to P fertilization and better effect on cereal crops. Amer *et al.* (1995) reported that, N supply to maize increased number of leaves/plant and leaf expansion. However, Nawar (2004) attributed the increases in maize grain yield to increases in number of grains/ear and a single grain yield weight, as affected by increasing N levels. Nawar (2004), also revealed high linear, with a lock of quadratic, response of maize grain yield to N rates documenting that the increase in N level by unit (one kg/fad.) increased the yield of maize (Giza, 310 cv.) by 8 ardab.

The present investigation was conducted to study the effect of P fertilization on faba bean performance, in addition to it's residual effects on succeeding sunflower crop followed by maize with different levels of nitrogen.

MATERIALS AND METHODS

Two field trials was conducted at Agricultural Research Station, Alexandria University, from 2008 winter season to 2010 summer season, to investigate the effect of phosphorus fertilizer levels on faba bean (Giza 716, cv.). Phosphorus levels were 30.0 (P_1), 37.5 (P_2) and 45.0 (P_3) kg P_2O_5/fad.,in the form of Calcium monophosphate (15.5%). In addition, the residual effect of phosphorus was examined regarding sunflower growth and productivity. Phosphorus levels were arranged in R.C.B design with three replicates. Sunflower was sown as a relay crop into faba bean plots of 24 ridges for each P level. Faba bean and sunflower data were analyzed as one-factor experiment. Sunflower plots were then divided into four sub plots in which maize (Giza 310, cv.) was sown, as a relay crop to sunflower and was fertilized with N levels, i.e. 90, 105, 120 and 135 kg N/fad. Thus, the analysis of maize data was worked out as a spilt plot design, where the P levels occupied the main plots and the N fertilization levels were assigned to the sub plots. Each sub plots was 12.6 m^2 in area and comprised seven ridges (each 3 m long and 0.6 m in width). Soil chemical properties as the average of two seasons were PH 7.8, total organic matter 1.1%, available nitrogen 35.6 ppm, available p 10.5 ppm and available k 610.0ppm.

Faba bean was sown on the upper and one side of ridges in hills (2 plants/hill), spaced at 20 cm apart. Sunflower relaycropping was applied on the empty side of faba bean ridges, in hills (one plant/hill), at intraspacing of 20 cm. however, maize was relaycropped on the opposite sides of sunflower ridges (after removal of faba bean) in hills (one plant /hill) at a distance of 30 cm between hills.

Sowing dates were November 15^{th} for faba bean, March 25^{th} for sunflower and June 5^{th} for maize in the first season with five days later for these crops in the second season.

Nitrogen, as ammonium nitrate (33.5%N), was added to maize into two equal splits, at the first and second irrigation for the designated N levels.

At faba bean, sunflower and maize harvesting, the plants of the inner five ridges were taken from each experimental unit. At maturity, the following characters were measured on 10 guarded plants of each of faba bean, maize and sunflower from each sub-plot.

Faba Bean Yield and Yield Determination

Traits recorded for faba bean were: plant height (cm), number of branches/plant, number of pods/main stem, seed weight/plant (g), 100-seeds weight (g) and seed yield/fad. (ardab). Seed yield/fad., kg was determined from the weight of seeds/plot adjusted to 15.5% moisture.

Measured traits of sunflower at harvest were: plant height (cm), number of leaves/plant, head diameter (cm), weight of seeds/plant (g), 100-seeds weight (g) and seed yield/fad., (kg). The seed yield was recorded in kg/ m-2, then converted into seed yield in kg/fad.

Regarding maize, measured characters were: plant height (cm), ear height (cm), number of leaves/plant, ear leaf area (cm^2), 100-grains weight (g), ear grain weight (g) and grain yield /fad., (Ardab) adjusted at 15.5% moisture, recorded on the basis of sub-plot area. Total leaf area of maize plant determined as leaf length x leaf width x 0.75. Analysis of data was carried out according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of P Levels on Growth Traits of Faba Bean

The analysis of variance, presented in Table 1, showed significant effects for phosphorus levels on plant height, number of pods/main stem, seed yield/plant, 100 seeds weight and seed yield/fad., in both seasons.

Means of the studied characters are presented in Table 2. Differences in number of pods/main stem, as influenced by P application were significant and hold the same trend in both seasons. Maximum values for such trait were recorded when faba bean plots received the highest P level (P_3), whereas, the minimum values were produced as a result of P_1 application during the two successive seasons. The plots received P_3 level ,produced plants associated with higher number of pods/main stem by 0.46 and 1.46 in the first season beside 0.47 and 1.8 pods in the second season, compared to the pod number of P_2 and P_1 plots, respectively. This emphasizey role of phosphorus in encouraging faba bean growth and increasing flowering (Khalil, 1986). These results were in agreement with those reported by El-Douby and El-Mohamed (2002) and Nawar and Khalil (2004).

Data in Table 2, also documented significant variations in seed yield/plant, 100 seeds weight and seed yield/fad., between P levels in both seasons. The P_1 level was lower, as average of the two seasons, by 1.24 and 0.85 g for seed yield/ plant; 6.4 and 3.42 g for seed weight in addition to 1.10 and 0.62 ardab for seed yield/fad., than P_2 and P_3 corresponding values.

These results showed that, phosphorus application in excess of plant requirements may be associated with a decrease in yield and yield attributes due to much rapid maturity at the expense of seed filling during maturity period (Yagodin, 1984). Increases in P application may have increased the uptake of the other macro and micronutrients in addition, it's role in increasing nodule formation and N fixation by faba bean plants (Sheng-Xiu *et al.*, 2011) and eventually, lead to an increase in photosynthesis and photoassimilates partitioning to the reproductive organs, thus increasing the flower and pod formation while decreasing shedding percentage and with an increase in plant seed weight (Gardner *et al.*, 1985; Khalil, 1986 and Sheng-Xiu *et al.*, 2011). Several studies were conducted to investigate the effect of the increased P level on yield and yield attributes of faba bean. They all reported that increasing P application level increased faba yield and yield components (Ali *et al.*, 1997; El-Douby and Mohamed, 2002; Nawar and Khalil, 2004 and Sheng-Xiu *et al.*, 2011). Further more, the data showed significant increase in plant seed yield, 100 seeds weight and seed yield/fad., with increasing P level up to 37.5 kg P_2O_5/fad., then exhibited significant decrease in those characters with further increase in P level up to 45 kg/fad., in both seasons.

Residual Effect of Phosphorus Fertilizer on Sunflower

The analysis of variance presented in Table 3 showed significant responses, of all the studied traits of sunflower, to the residual effect of P levels which were previously applied to faba bean, except for plant height and number of leaves/plant in both seasons.

Means of the studied traits, as affected of phosphorus, are presented in Table 4. Differences in head diameter among the different residual treatments of P_1, P_2 and P_3 were significant in both seasons, greater for sunflower in P_3 plots, followed by those of P_2, compared to those of P_1 residual effects. The reason for this, in case of P_3 residual effect, was the greater availability and uptake of phosphorus which increases reproductive parts, in terms of head diameter (Buerkert *et al.* 1998) and Sheng-Xiu *et al.* 2011).

Residual amount of P in plots receiving 30 kg P_2O_5/fad., significantly increased head- seed weight, compared to those receiving 3.5 kg P_2O_5/fad., however, further P-increasing (P_3) applied to faba bean was associated with P-residual effect that insignificantly increased seed weight/head in both seasons.

One hundred seeds weight of sunflower, also, was significantly affected by the residual effects of different levels of phosphorus applied to faba bean over the two seasons. Responses of such trait were arranged in descending order, where, P_3 residual effect produced the maximum 100-seeds weight, whereas, the P_1 residual effect gave the minimum value.

Table 1. Mean squares of Faba bean characters in 2008/09 and 2009/2010 seasons

S.O.V	df	Plant height (cm)		No.of Branches/plant		No.of pods/main stem		Seed yield/plant (g)		100-seeds weight (g)		Seed yield/fad. *(ardab)	
		2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Phosphorus levels	2	*	*	N.S.	N.S.	*	*	*	*	*	*	*	*
error	4	3.32	4.65	0.017	0.035	0.031	0.084	0.111	0.003	0.101	0.084	0.007	0.003

N.S., not significant,*significant at 0.05 level of probability

*Ardab-155 kg.

Table 2. Mean values of Faba bean characters in 2008/09 and 2009/2010 seasons

Treatment	Plant height (cm)		No.of Branches/plant		No.of pods/main stem		Seed yield/plant (g)		100-seeds weight (g)		Seed yield/fad. (ardab)	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
30.0 kg P_2O_5/fad. (P_1)	114.23	119.43	2.71	2.78	13.47	12.60	7.87	7.80	47.53	46.33	7.60	7.40
37.5 kg P_2O_5/fad. (P_2)	118.27	123.53	2.71	2.76	14.87	13.93	9.27	7.87	54.13	52.53	8.70	8.50
45.0 kg P_2O_5/fad. (P_3)	128.13	126.80	2.71	2.77	15.33	14.40	8.80	8.57	52.40	49.30	8.20	8.03
L.S.D. 0.05	4.13	4.89	-	-	0.40	0.66	0.36	0.13	1.02	0.66	0.19	0.10

Table 3. Mean squares of Sunflower characters in 2008/09 and 2009/2010 seasons

S.O.V	df	Plant height (cm)		No.of leaves/plant		Head diameter (cm)		Seed yield/head (g)		100-seeds weight (g)		Seed yield/fad. (kg)	
		2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Phosphorus levels	2	N.S.	N.S.	N.S.	N.S.	*	*	*	*	*	*	*	*
error	4	28.07	4.21	0.37	0.75	0.27	0.44	0.28	1.69	0.018	0.074	169.50	511.58

N.S., not significant ,*significant at 0.05 level of probability.

Table 4. Mean values of Sunflower in 2008/09 and 2009/2010 seasons

Treatment	Plant height (cm)		No.of leaves/plant		Head diameter (cm)		Seed yield/head (g)		100-seed weight (g)		Seed yield/fad. (k.g)	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
30.0 kg P_2O_5/fad. (P_1)	178.11	178.90	26.05	25.60	15.00	17.11	33.60	30.06	6.28	5.66	934.67	949.67
37.5 kg P_2O_5/fad. (P_2)	178.67	179.30	26.17	25.63	17.66	19.94	37.80	36.94	6.81	7.76	1078.33	1039.33
45.0 kg P_2O_5/fad. (P_3)	179.78	180.10	26.39	25.96	18.30	20.56	38.30	37.50	6.91	8.00	1101.47	1120.00
L.S.D. 0.05	-	-	-	-	0.68	0.87	0.69	1.70	0.18	0.36	29.27	29.60

The statical analysis of seed yield/fad., indicated significant differences among the residual effects of different p levels previously applied to faba bean in both seasons. Results on seed yield, also, revealed that the highest seed yield of sunflower was obtained when sunflower was preceded by faba bean supplied with P_3 level, whereas, sunflower produced the minimum yield with P_1 applications to the preceding faba during the two seasons.

The previous findings revealed that head diameter, seed weight/head, 100 seeds weight and seed yield/fad. of sunflower had the same course of change due to the P residual effects. The maximum records of these traits were the results of the P carrying over from P_3 application to faba bean, whereas, the lowest values were obtained from P_1 residual effect. The greater yields of sunflower with P_3 residual effect may be due to increase in soil P availability, and hence an increase in P uptake by sunflower. These events may have been associated with the increase in absorption of other nutrients to increase LAI, light capture and conversion into photoassimalates translocated to the heads. All these processes increased head diameter, head seed weight (a single seed weight) and seed yield/fad. (Loomis and Coonor, 1992).

Effect of Previous Phosphorus Levels and N Fertilization on Yield and it's Attributes of Maize

The analysis of variance Table 5, indicated that, 100-grains weight, ear grain weight and grain yield/fad. were significantly influenced by the residual P in both seasons, whereas ear-leaf area was significant in the second season only. Application of nitrogen fertilizer exhibited significant effects on ear-leaf area, 100-grains weight, ear grain weight and grain yield/fad., in both seasons. Interaction effects of residual phosphorus x N level showed significance only for ear grain weight and grain yield/fad. during the two seasons.

Means of the studied characters, as affected by the two factors under study in both seasons, are presented in Table 6. Differences in 100-grains weight among the three residual effects of P levels, were significant and proved superior to P_2 and P_1. Increases, in 100-grains weight for the P_3 residual effect were 2.56 and 5.39 g in the first season,as well as, 1.27 and 5.81 g in the second season, compared to residual effects to P_2 and P_1, respectively.

Data regarding ear grain weight revealed that such trait exhibited significant responses, as affected by the residual effects of P levels. The response of weight of grain/ear to the P_3 level residual effect was (an averages of the two seasons) greater by 11.39 and 23.09 than those of P_1 and P_2, respectively.

The analysis of grain yield/fad. indicated significant differences among the residual effect of phosphorus levels on maize. These results hold the same trend in both seasons. The maximum grain yield of maize was obtained from the residual effect of 45.0 kg P_2O_5, while, the value of that trait was minimum when P_1 was applied to faba bean. These findings revealed that greater P residual effect was obtained with the more previous application of P level to faba bean crop. Studies on prolonged effects of large initial application of P fertilizer are not available. Nevertheless, the positive effects of P residuals might be attributed to increases in soil available P and it's more use efficiently. As consequence there has been enhancement in the uptake of other growth resources to increase photoassimilates production and translocation to the ears resulting in increases in single grain weight and in turn, grain yield/fad.

Concerning N fertilizer effects, data in Table 6 revealed the presence of significant variations in ear leaf area with N supply. The trend fairly hold true over the two seasons, where increases of such trait with increasing N level occupped during the two seasons.

Responses of ear-leaf area, as an average of the two seasons, were 713.7, 736.8, 777.5 and 805.8 cm^2 due to addition of 90, 105, 120 and 135 kg N/fed., respectively. The increase in nitrogen fertilization may have increased the uptake of water and other macro and micronutrient from the soil (Voyas *et al.*, 1995 and Buerkert *et al.*, 1998) which may have increased ear leaf dimensions (length and width) leading to increase of over all leaf expansion (Uhart and Andrads, 1995 and Nawar, 2004). These results disagreed with those of Mc- Cullough *et al.* (1994) and agreed with Uhart and Andrade (1995), Nawar (2004) and Khalil *et al.* (2011) who reported that a single leaf expansion increased proportionally to the increase in N level.

Table 5. Mean squares of studied characters of maize in 2009 and 2010 seasons

S.O.V	df	Plant height (cm)	Ear height (cm)	No. of leveas/plant	Ear leaf area (cm²)	100-grain weight (g)	Ear grain weight (g)	Grain yield/fad. *(ardab)
					2009			
Phosphorus ratio (A)	2	N.S.	N.S.	N.S.	NS.	*	*	*
Error (a)	4	33.871	4.361	0.070	2010.125	0.276	8.434	0.127
Nitrogen levels (B)	3	N.S.	N.S.	N.S.	*	*	*	*
A x B	6	N.S.	N.S.	N.S.	N.S.	N.S.	*	*
Errora (b)	18	33.472	5.574	0.117	457.796	0.376	6.822	0.074
2010					2010			
Phosphorus ratio (A)	2	N.S.	N.S.	N.S.	*	*	*	*
Error (a)	4	2.538	1.944	0.107	1697.375	0.051	9.211	0.111
Nitrogen levels (B)	3	N.S.	N.S.	N.S.	*	*	*	*
A x B	6	N.S.	N.S.	N.S.	N.S	N.S.	*	*
Errora (b)	18	6.407	0.273	0.137	448.907	0.240	4.386	0.047

N.S. Not significant ,*Significant at 0.05level of probability. * Ardab-140kg.

Table 6. Mean of studied characters in maize during both seasons

S.O.V	Plant height (cm)		Ear height (cm)		No. of leveas/plant		Ear leaf area (cm²)		100-grains weight (g)		Ear grain weight (g)		Grain yield/fad. (ardab)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
P. Residual Effects														
30.0 kg P_2O_5/fad. (P_1)	258.83	244.92	122.42	119.33	16.11	16.37	678.25	749.42	31.01	31.18	110.18	107.73	15.57	14.14
37.5 kg P_2O_5/fad. (P_2)	259.17	248.42	122.33	120.50	16.16	16.34	762.50	778.25	31.58	31.75	115.70	125.41	16.12	15.79
45.0 kg P_2O_5/fad. (P_3)	258.08	250.58	121.83	121.08	16.14	16.27	787.08	794.67	32.38	32.42	126.49	137.10	17.88	17.04
L.S.D. 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	46.76	N.S.	1.44	0.23	3.44	0.60	0.38	0.41
N. Levels														
N_1 =90 kg N/fad.	257.76	250.00	122.00	119.89	15.29	15.40	698.00	729.44	31.12	31.27	110.52	100.16	15.54	14.45
N_2 =105 kg N/fad.	258.67	249.11	122.11	119.59	15.45	15.31	720.11	753.44	31.51	31.53	114.40	119.30	16.14	15.11
N_3 =120 kg N/fad.	259.44	248.49	122.22	121.15	15.44	15.34	759.56	795.44	31.79	32.01	120.30	129.49	16.84	15.95
N_4 =135 kg N/fad.	259.00	250.56	122.24	120.50	15.32	15.24	792.78	818.78	32.21	32.39	125.01	148.19	17.56	17.11
L.S.D. 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	20.97	21.18	0.11	0.29	3.73	4.65	0.26	0.33

One hundred grains weight, ear weight and grain yield /fad., (Table 6 appeared to show similar trends in their response to N supply over the two seasons. They proportionally increased to the increase of N level applied in both seasons. The values of 100-grains weight as an average of the two seasons, were 26.8, 28.2, 29.3 and 31.3 g for N_1, N_2, N_3 and N_4, respectively. Furthermore, weight of grains/ear in N4 was (as an average of the two seasons) 31.4, 21.9 and 11.6 g greater than that obtained from N_1, N_2 and N_3, respectively. Maize grain yield/fad.was directly proportional to the applied N level. The maximum records for this trait were 17.1 (in 2009) and 16.6 (in 2010) ardab when 135 kg N/fad. was applied. The lowest yield values in both seasons were 14.5 and 15.5, respectively, and resulted from nitrogen level of 90 kg/fad. it could be concluded that lack of N significantly affected the grain yield/fad., because it reduced 100-grains and ear grain weight. Reduction in N supply may resulted in decreased plant growth activity, causing a drop in assimilates efflux to the spikelets. Therefore, there has been an association with spikelets fertilization failure and decrease in grain number and weight and finally a decrease in grain yield. This conclusion has been reported by several investigators (Uhart and Andrade, 1995 and Hassan, 1995). These results are also, in agreement with those obtained by Ali *et al.* (1997), Nawar (2004) and Khalil *et al.* (2011).

The phosphorus residual effects x N levels interactions (Table 7) indicated that increase in N supply significantly increased ear grain weight and grain yield/fad. over all the residual effects of P applied previously of faba bean in both seasons. The differences of the increase magnitude in these two characters were in favor of P_3, followed by P_2 then P_1 in the successive seasons. The highest records of ear grain weight and grain yield/fad. were obtained for each of the P_3 residual effects when the N_4 level was applied. Hence, data presented in Table 7 revealed that, the combination of P_3 residual effect and the N_4 level produced the maximum values for ear grain weight and grain yield/ fad. in both seasons. Differences in ear grain weight (as an average of the two seasons) between N_1 and N_4 were 27.89, 35.61 and 35.03 g, respectively, for P_1, P_2 and P_3. The same respective difference in grain yield/fad. were 1.67, 2.10 and 2.45 ardab.

The superiority of P_3 x N_4 compared to all combinations of P x N, of these characters might be attributed to the favorable effect of such combination on plant growth performance. Increase in N supply (N_4) in addition to the increase in soil available P, as a result of highest (P_3) application to faba bean and carry over residual, increased the uptak P, N, water and growth factors and consequently the photoassimilates production and translocations into ears and this increase both grain weight/ ears and grain yield/fad. These results agreed with Voyas *et al.* (1995) who reported that, increases in N level applied to a cereal under the increase in soil P availability increased the yield and yield attributes of a cereal crop.

Table 7. Interaction effect of the phosphorus residual effects x N levels on ear grain weight and grain yield/fed.

	Nitrogen level (kg/fad.)							
	Ear grain weight (g)				Grain yield/fad.* (ardab)			
	N_1	N_2	N_3	N_4	N_1	N_2	N_3	N_4
P. Residual Effects				**2009**				
30.0 kg P_2O_5/fad. (P_1)	83.63	99.90	114.83	132.57	13.32	13.79	14.15	15.30
37.5 kg P_2O_5/fad. (P_2)	105.37	129.60	130.93	145.73	14.50	15.19	16.18	17.00
45.0 kg P_2O_5/fad. (P_3)	111.47	128.40	142.72	166.27	15.53	15.35	17.52	18.33
L.S.D. 0.05		4.48				0.57		
P. Residual Effects				2010				
30.0 kg P_2O_5/fad. (P_1)	106.87	107.87	111.83	117.70	14.98	15.30	15.67	16.33
37.5 kg P_2O_5/fad. (P_2)	106.13	110.17	119.47	127.03	15.03	15.60	16.60	17.03
45.0 kg P_2O_5/fed. (P_3)	118.57	125.17	129.60	133.83	16.80	17.53	18.27	18.90
L.S.D. 0.05		3.59				0.45		

*Ardab-140kg

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دراسة الأثر المتبقى للتسميد الفوسفورى خلال نظم التحميل المتعددة

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درست استجابة محصول الفول البلدى للتسميد الفسفورى تحت معدلات ٣٠ ، ٣٧,٥ و ٤٥ كيلوجرام/للفدان من فو٢أ٥ وتوصلت الدراسة لمعرفة التأثير الباقى لهذه المستويات من السماد الفسفورى مع كل من محصول دوار الشمس ثم الذرة الشامية والتى سمدت بمستويات من السماد النيتروجينى بـ٩٠ وحدة آزوتية (N1)، ١٠٥ وحدة آزوتية (N2) و ١٢٠ وحدة آزوتية (N3) و١٣٥ وحدة آزوتية (N4) فى عاميين متتالين هما ٢٠٠٩/٢٠١٠ ، ٢٠١٠/٢٠١١. وأوضحت النتائج أن أكبر محصول للفدان ومكونات المحصول وهى عدد القرون على الساق ووزن الـ١٠٠ بذرة ووزن البذور على النبات جاء عند تسميد الفول البلدى بأكبر معدل وهو ٤٥ كيلوجرام /فدان وذلك بالمقارنة بالمعدلات الأخرى. وجاء الأثر الباقى لمستويات السماد الفسفورى معنويا عند إضافة ٤٥ كيلوجرام من فو٢ أ٥ كسماد فسفورى/فدان للفول البلدى بزيادة محصوله ومكوناتة مع دوار الشمس بالمقارنة بالمعدلين ٣٧,٥ و ٣٠ كيلوجرام من فو٢ أ٥ كسماد فو٢أ٥/فدان للفول البلدى. أما بالنسبة لمحصول الذرة الشامية فقد أظهرت النتائج استجابة محصول الذرة من الكيزان والحبوب/فدان استجابة موجبة ومعنوية لتأثير إضافة الأسمدة الفسفورية والنتيروجينة والتفاعل بينهما وجاء اكبر محصول للكيزان والحبوب للذرة الشامية عند إضافة أكبر معدل من السماد الفسفورى للفول البلدى وهو ٤٥ كيلو جرام فو٢أ٥/فدان وأكبر معدل سماد نيتروجينى وهو ١٣٥ كيلوجرام ن /فدان والتفاعل بينهما.