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THE IMPACT OF PHOSPHORUS FERTILIZER SOURCES AND RATES ON CANOLA PLANT (*Brassica napus* L.) GROWN IN CALCAREOUS SOIL

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ABSTRACT

Two field experiments were carried out at El- Areish Agricultural Research Station, North Sinai Governorate during the two winter growing seasons of 2005/2006 and 2006/2007 to study the effect of canola varieties (Serw 4 and Bactol) with superphosphate and rock phosphate at rates (15.5 and 31 kg P_2O_5 /fed.) on some yield components, seed yield and chemical composition of canola plant grown in calcareous soil.

Results can be summarized as follows:

1- Variety Serw 4 was significantly higher than Bactol one for plant height only in the first season. Also, the higher rate of P fertilizer in form of superphosphate was better than other treatments in the first season.
2- Variety Serw 4 gave the highest significant value of seed weight/ plant (g) and oil yield (kg/fed.) in the first season, and oil yield (kg/fed.) in the second season compared to Bactol one. In addition, higher rate of P fertilizer for both P sources was better than lower one for seed weight/ plant (g), seed yield (kg/fed.) and protein % in the first season as well as seed yield (kg/fed.), oil yield (kg/fed.) and protein % in the second season. Variety Serw 4 received any of both P sources at higher level produced significantly better yield and its components than those recorded by other treatments.
3- The treatment of superphosphate and rock phosphate at higher rate gave a significant increase in N- uptake of canola plants in comparison with the other fertilization treatments in both seasons.
4- N- Uptake of variety Serw 4 fertilized with superphosphate at a rate of 31 kg P_2O_5/fed. was significantly higher than those obtained by others treatments.

INTRODUCTION

In Egypt, Canola is considered a new oil seed crop in the newly reclaimed areas, because there is a great shortage in edible oils, and large amounts are imported annually from abroad. Canola, as a winter crop can play an important role to partially cover or reduce this shortage. There is a growing need to understand the effects of bio- and mineral phosphorus fertilization on canola growth, development, productivity, and seed quality especially in the newly reclaimed soils. So, increasing yield of canola requires improving agricultural practices, i.e., chemical and natural phosphorus fertilization to achieve higher seed and oil yields.

Soil phosphorus availability is low in newly cultivated soil, and most soils require Phosphorus additions to produce adequate canola yields. Phosphorus deficiencies result in poorly developed root systems, reduced seed production, and delayed maturity. Severe phosphorus deficiencies show up as a purplish color on leaves. The minimum phosphorus requirement of

canola in newly cultivated soil is 30 kg P_20_5/fed. Canola germination can be reduced if phosphorus added with the seed exceeds 20 kg P_20_5/ha. Phosphorus mobility is limited, and therefore, canola plant roots must grow to the phosphorus to use it. Higher rates of phosphorus may be necessary to adequately supply to the canola crop. Newly cultivated calcareous soils are commonly P deficient and fertilization usually increases yield and economic returns. Good P fertilizer management is important to optimizing canola production. Phosphorus fertilization is an important input for producing canola. Brennan and Bolland (2001) reported that yield of canola increased as P rate increased.

Hassanein (2000), Abdel-Mouty et al. (2001), Adam (2002) and Abdalla(2002), concluded that the positive effect of phosphorus fertilizer on growth characters, herein, may be due to the physiological role of P on the meristematic activity of plant tissues and consequently increasing plant growth, also, its function as a part of enzymes system having a vital role in the synthesis of other foods from carbohydrates.

Canola has an ability to absorb native soil P through acidification of the rhizosphere. Pot experiments have demonstrated that canola can utilize more rock phosphate than other crops, apparently due to the rhizosphere acidification. This has prompted promotion of rock phosphate as a viable alternative P fertilizer for canola. Rock phosphate is the relatively insoluble, grey-black powdery material that is refined by fertilizer manufacturing plants into soluble phosphate fertilizer (Grant et al., 2001 and Karamanos et al., 2002).

Thus, the objective of this study is to investigate the effect of different phosphorus fertilizer sources and rates on the growth, productivity and nutritional value of some canola cultivars in newly cultivated soil.

MATERIALS AND METHODS

Two field experiments were conducted at El -Areish Agricultural Research station, North Sinai Governorate, Egypt during the two successive winter seasons of 2005/2006 and 2006/2007 to study the effect of natural and mineral phosphorus fertilizer on the productivity and nutritional value of canola plant (*Brassica napus* L.). A split-plot design with three replications was implemented. Two rapeseed varieties (*Brassica napus* L.) were allocated to the main plots. The sub-plots (3.5 m length and 3.0 m width) were devoted to the following phosphorus fertilizer sources and rates:

1- 15.5kg P_2O_5, Super Phosphate (SP)
2- 31 kg P_2O_5, Super Phosphate (SP)
3- 15.5kg P_2O_5, Rock Phosphate (RP)
4- 31 kg P_2O_5, Rock Phosphate (RP)

Soil characteristics are evaluated according to Black (1982) and presented in Tables (1a & 1b). A basal application of 75 kg N /fed. as ammonium sulphate (20.6%) and 48 kg K_2O /fed. as potassium sulphate (48% K_2O) were added to all experimental plots at 21 and 35 days after sowing. Normal cultural practices were followed as usual in canola fields.

On November, 24th and 18th in 2005/2006 and 2006/2007seasons, respectively, seeds of French rapeseed Bactol cultivar and Egyptian variety, Serw 4 as (double zero) because of low or absence of erucic acid and low glucosinolate content were sown. Both varieties were obtained from Oil Crop Res. Dept., Agric. Res. Center, Giza, Egypt.

Table (1,a) Some physical and chemical properties of the studied soils.

Season	pH	*EC dSm	$CaCO_3$	C. sand	F. sand	Silt	Clay	Soil
			%					texture
2006/2007	8.40	2.28	22.80	27.15	40.40	31.30	1.15	Sandy loam
2007/2008	8.30	2.63	25.30	25.70	42.57	30.73	1.00	Sandy loam

***In soil paste extract**

Table (1,b) Cations and anions concentration in a paste extract of the studied soil samples together with the nutrients concentrations.

Season	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
	Meq/L								Available (ppm)		
2006/2007	4.10	5.33	11.20	0.37	0.00	7.65	8.50	4.85	13.10	4.40	36.35
2007/2008	4.88	6.10	12.80	0.43	0.00	7.21	10.10	6.90	14.30	5.80	39.00

At harvest, the canola plants of three inner rows from each sub-plot were collected to determine the seed yield and yield attributes, i.e., Plant height (cm), number of branches/plant, weight of 1000-seed (g) and seed weight /plant (g). The dry seed samples were ground and wet digested with H_2SO_4-$HclO_4$ mixture. NPK were determined using the method as described by Rayan et al. (1996). Crude protein percentage was calculated by multiplying N% by the converting factor 6.25 (Robinson, 1975). Seed oil percentage was determined according to A.O.A.C. (1990). Oil yield (kg/fed.) was calculated by multiplying oil percentage by seed yield.

The results were statistically analyzed using M-Stat computer package to calculate F ratio according to Snedecor and Cochran (1980). Least significant differences method (L.S.D) was used to differentiate means at the 0.05 level (Waller and Duncan, 1969).

RESULTES AND DISCASSION

1-**Yield and its components.**

Data in Tables (2&3) indicate that to some extent, there was various response of the studied yield components of canola plant as influenced by the studied factors in both seasons. Apparently, plant height only was significantly affected by crop variety in both seasons, while phosphatic fertilization treatments had a positive significant effect on such trait in the first season only. Plant height of variety Serw 4 was significantly higher than Bactol one. This result may be due to genetic characteristic of such variety, also, to suitable Egyptian agro-ecological conditions for growing the local

varieties. These results are in full agreement with those obtained by Abdel Gawad et al. (1990), Ahmed et al. (1999) and Keshta and Leilah (2003).

Phosphatic fertilizer source did not affect significantly plant height while the rate of such fertilizer significantly affected such attribute, when canola plants received higher rate of P fertilizer (31 kg P_2O_5/fed.) plant height was better than those fertilized with lower one (15.5 kg P_2O_5/fed.).

Table (2): Effect of phosphorus source and rate on some yield components of two varieties of canola plant grown on calcareous soil in the season of 2005/2006

Treatments	Plant height (cm)			No of branches/ plant			Weight of 1000 seeds(g)		
	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean
*SP 15.5kg P_2O_5	92.00	88.00	90.00	4.00	4.00	4.00	3.66	3.60	3.63
SP 31 kg P_2O_5	101.0	95.00	98.00	4.00	4.00	4.00	3.78	3.74	3.76
**RP 15.5kg P_2O_5	87.00	84.00	85.50	4.00	4.00	4.00	3.63	3.54	3.58
RP 31 kg P_2O_5	98.00	93.00	95.50	4.00	4.00	4.00	3.71	3.67	3.69
Mean	94.5*	90.00		4.00	4.00		3.70	3.64	
LSD at 5%									
treatments	1.204			NS			NS		
Interaction	NS			NS			NS		

***Super Phosphate (SP)**
****Rock Phosphate (RP)**

Table (3): Effect of phosphorus source and rate on some yield components of two varieties of canola plant grown on calcareous soil in the season of 2006/2007

Treatments	Plant height(cm)			No of branches			Weight of 1000 seeds(g)		
	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean
SP 15.5kg P_2O_5	101	97	99	5.00	5.00	5.00	3.80	3.71	3.75
SP 31 kg P_2O_5	110	104	107	5.00	5.00	5.00	3.92	3.85	3.88
RP 15.5kg P_2O_5	93	91	92	5.00	5.00	5.00	3.71	3.65	3.68
RP 31 kg P_2O_5	108	102.0	105	5.00	5.00	5.00	3.81	3.74	3.78
Mean	103.0*	98.50		5.00	5.00		3.81	3.74	
LSD at 5%									
treatments	NS			NS			NS		
Interaction	NS			NS			NS		

It is worthy to mention that the effect of interaction between canola variety and phosphorus treatments was insignificant on canola plants components in both tested seasons. This result could be due to the individual effect, mentioned above, of the factors under study. These results are in harmony with those obtained by Hassanein (2000), Adam (2002) and Abdalla (2002).

2- Yield

The net results tabulated in Tables (4 &5) show that the trend of seed weight / plant and / or seed yield of canola plant resulted from the influence of variety and / or phosphatic fertilization treatments was different in both seasons. It is obvious that seed weight / plant was significantly affected by the studied factors either individually or the interaction between them in the

first season only, where such characteristic of variety Serw 4 was significantly increased in comparison with another variety (Bactol). On the other hand, such trait of canola plants fertilized with the higher P rate of any used source, herein, was significantly better than that of the lower one. It is interesting to note that seed weight of canola plant was significantly increased when canola plants of variety Serw 4 were fertilized with any phosphorus sources at the higher rate. These results are in harmony with those obtained by Brennan and Bolland (2001), Hassanein (2000), Abdel-Mouty et al. (2001), Adam (2002) and Abdalla(2002).

Results pertaining to seed yield showed that the variety of canola cultivated in the second season only had a positive significant effect on canola seed yield of Serw 4 had significantly surpassed the other one. At the same time, phosphatic fertilization treatments had a positive significant effect on seed yield in both seasons. Results also indicated that seed yield of canola plants cultivated in the first season took the same trend of the second one, where such yield was significantly increased by the application of higher level of phosphorus fertilizer(31.0 kg P_2O_5/fed.) either as superphosphate or rock phosphate. This result may be interpreted to the little availability of phosphorus in calcareous soil; consequently better yield of canola plant needs more quantity of phosphorus fertilizer. It is worthwhile to note that seed yield was significantly affected by interacted treatments; canola plants of variety Serw 4 received any used source of phosphorus fertilizer with higher level produced significantly better seed yield than the other treatments. This result ascertains those aforementioned regarding the effect of individual factors under study.

3- Nutritional constituents

Data of some nutritional constituents stored in canola seed are shown in Tables (4 & 5) . For oil, the trend of oil percentage differed than that of oil yield in both seasons. It is noticeable that neither variety of canola or phosphatic fertilization had a significant effect on oil percentage in both seasons, but it could be said that oil % of Serw 4 variety fertilized with superphosphate at a rate of 31 kg P_2O_5/fed was relatively higher than those resulted from the other treatments in both seasons. On the contrary, oil yield was significantly affected by variety of canola or phosphatic fertilization treatments but such effect was slightly different between both growing seasons. In the first season, oil yield of Serw 4 was significantly better than that of Bactol one. However, such constituent was not significantly affected due the fertilization treatments or the interaction between the factors under study. The latter result may be related partially to oil percentage more than seed yield, since oil yield results from such two characteristics. In the second season, variety of canola plant had no significant effect on oil yield while the vice versa was true for fertilization treatments or the interacted ones. Apparently, both phosphorus fertilizer sources at the level of 31 kg P_2O_5/fed resulted in a significant increases of oil yield compared to the lower level of phosphorus fertilizer (15.5 kg P_2O_5/fed.).

T4-5

Regarding the effect of interaction between the studied factors, results pinpointed that the oil yield values of canola plants (variety Serw 4) fertilized with either superphosphate or rock phosphate at a rate of 31 kg P_2O_5/fed. were significantly higher than those resulted from the other treatments. Although the phosphatic fertilization or the interacted treatments had no significant effect on oil percentage, the significant effect of such treatment on oil yield is probably due to seed yield, which was significantly affected by such treatments mentioned previously. This finding agrees with that obtained by Adam (2002) and Abdalla (2002).

With respect to protein percentage, data in Tables (4 & 5) indicate similarity in the effect of the studied factors in both seasons. The variety of canola plant didn't significantly affect such nutritional constituent but it could be said that the protein percentage of Serw 4 variety was relatively higher than that of Bactol one. On the other hand, fertilization treatments and the interaction between the factors under study had a significant effect on protein % in both seasons. The application of superphosphate followed by rock phosphate at the higher rate (31 kg P_2O_5/fed.) resulted in a significant increase in protein % compared to the other additions. At the same time, protein percentage of Serw 4 fertilized with superphosphate at the level of (31 kg P_2O_5/fed.) was significantly higher than those recorded by the other treatments. The aforementioned results are logic, since they are in harmony with those observed regarding the N- uptake (Tables, 6 & 7).

4- Nutrients uptake

Data presented in Tables (6 & 7) pointed out that, the exception of the effect of fertilization treatments or interacted ones on N- uptake of canola seeds, none of the other factors under investigation had a significant effect on N, P and K- uptake by canola plant in both seasons .

Table (6): Effect of phosphorus sources and rates on nutrient uptake (kg /fed.) of two varieties of canola plant grown on calcareous soil in the season of 2005/2006

Treatments	N-uptake (Kg/fed.)			P-uptake (Kg/fed.)			K-uptake (Kg/fed.)		
	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean
SP 15.5kg P_2O_5	17.89	17.40	17.64	2.123	1.916	2.019	12.73	12.30	12.52
SP 31 kg P_2O_5	19.94	18.97	19.45	2.431	2.194	2.313	13.77	13.35	13.56
RP 15.5kg P_2O_5	17.30	16.77	17.03	1.988	1.847	1.917	12.48	12.05	12.26
RP 31 kg P_2O_5	19.07	18.58	18.83	2.228	2.207	2.218	13.25	12.88	13.06
Mean	18.55	17.93		2.193	2.041		13.06	12.64	
LSD at 5%									
treatments	1.386			NS			NS		
Interaction	1.961			NS			NS		

The treatment of superphosphate with a rate of (31 kg P_2O_5/fed.) followed by same P rate of rock phosphate gave a significant increase in N-uptake of canola plants in comparison with the other fertilization treatments. Such results could be elucidated to P fertilizer applied at the higher rate (31

kg P_2O_5/fed.), which can enhance the absorption of N – ammonium (cation form) found in the added ammonium sulphate fertilizer, since P is absorbed as anion form. Moreover, N- uptake of variety Serw 4 of canola plants fertilized with superphosphate at a rate of 31 kg P_2O_5/fed was significantly higher than that recorded by the others treatments.

Table (7): Effect of phosphorus sources and rates on nutrient uptake (kg /fed.) of two varieties of canola plant grown on calcareous soil in the season of 2005/2006 2006/2007

Treatments	N-uptake (Kg/fed.)			P-uptake (Kg/fed.)			K-uptake (Kg/fed.)		
	Ser. 4	Bact.	mean	Ser. 4	Bact.	mean	Ser. 4	Bact.	mean
SP 15.5kg P_2O_5	16.81	16.69	16.75	1.933	1.804	1.868	12.13	11.63	11.88
SP 31 kg P_2O_5	18.28	18.07	18.17	2.125	1.995	2.060	12.85	12.56	12.70
RP 15.5kg P_2O_5	16.34	16.27	16.31	1.859	1.802	1.831	11.86	11.27	11.57
RP 31 kg P_2O_5	17.86	17.44	17.65	1.998	1.938	1.968	12.35	11.74	12.04
Mean	17.32	17.18		1.979	1.885		12.30	11.80	
LSD at 5%									
	1.146			NS			NS		
	1.621			NS			NS		

In the light of the previous results, it can be concluded that Serw 4 variety of canola plants as oil crop which is fertilized with phosphorus fertilizer either superphosphate or rock phosphate at a rate of 31 kg P_2O_5/fed produced better quantity and quality of seed yield, but that would not be completed without some mention of interactions with a whole range of factors and conditions such as full coordination with other agronomic practices for maximizing crop yields, the overall productivity and the prevailing economic conditions. Also, it can be concluded that, under P deficiency, canola plants increase the length and density of root hairs. This enables the plants to explore a greater volume of soil, thus increasing P uptake by the plant. Plant roots take P from the soil as water soluble P. Under conditions of P deficiency, canola plants secrete acids just behind the root tip. This acidifies the region of the soil near the root tip leading to dissolve insoluble forms of P in the soil than increasing P uptake from insoluble sources of P, such as rock phosphate.

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أثر مصادر ومعدلات السماد الفوسفاتى على نبات الكانولا النامى فى ارض جيرية

عصـــام الـــدين عبـــدالعزيز محمـــد عثمـــان – فهمـــى عبـــدالمنعم فهمـــى زهـــران و عبدالعزيز ابراهيم الدسوقى الشافعى
معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أقيمت تجربتين حقليتين بمحطة بحوث العريش محافظة شمال سيناء خلال الموسمين الشتويين ٢٠٠٦/٢٠٠٥ و ٢٠٠٧/٢٠٠٦ لدراسة تأثير صنفين من الكانولا (سرو ٤ و باكتول) مع مصدرين من التسميد الفوسفاتى (السوبر فوسفات والصخر الفوسفاتى بمعدلات (١٥,٥ و ٣١ كجم فو٢أه / فدان.) على بعض مكونات المحصول ووزن البذور والمحتوى الكيميائي لنبات الكانولا فى الارض الجيرية.

ويمكن تلخيص النتائج على النحو التالي :

١ – تفوق صنف سرو ٤ معنويا على الباكتول فى صفة ارتفاع النبات في الموسم الأول ، وكذلك بارتفاع معدل التسميد الفوسفاتى فى صورة السوبر فوسفات اعطى تفوقا مقارنة بباقى المعاملات فى الموسم الاول فقط.

٢ –اعطى الصنف سرو ٤ زيادة معنوية فى وزن البذور / نبات ومحصول الزيت (كجم / فدان) في الموسم الأول ، ومحصول الزيت فقط في الموسم الثاني مقارنة بصنف الباكتول وبالإضافة إلى ذلك ، انه كلما ارتفع معدل معدل التسميد الفوسفاتى باى من المصادر المستخدمة كان افضل من المستوى المنخفض فى وزن البذور / نبات ، ومحصول البذور (كجم / فدان) والنسبة المئوية للبروتين في الموسم الاول وكذلك محصولى البذور والزيت (كجم / فدان .) والنسبة المئوية للبروتين في الموسم الثاني. وان معاملة الصنف السرو ٤ بأى من مصادر التسميد الفوسفاتى بالمعدل الاعلى اعطى تفوقا معنويا فى معظم صفات المحصول ومكوناتة مقارنة بباقى المعاملات.

٣ –أعطت معاملة السوبر فوسفات والصخر الفوسفاتى بالمعدل العالى زياده معنوية فى النيتروجين الممتص فى نبات الكانولا بالمقارنة مع باقى معاملات التسميد فى كلا الموسمين. النيتروجين الممتص لصنف السرو ٤ المسمد بالسوبر فوسفات ٣١ كجم فو٢أه / فدان اعطى زياده معنوية مقارنة بباقى المعاملات.

Table (4): Effect of phosphorus sources and rates on seed weight /plant, seed yield, oil percentage and oil yield as well as Protein percentage of two varieties of canola plant grown in calcareous soil in the season of 2005/2006

Treatments	Seed weight /plant(g)			Seed yield (Kg/fed.)			Oil %			Oil yield (Kg/fed.)			Protein %		
	Ser. 4	Bact.	**Mean**	Ser. 4	Bact.	**Mean**	Ser. 4	Bact.	**Mean**	Ser. 4	Bact.	**Mean**	Ser. 4	Bact.	**Mean**
SP 15.5kg P_2O_5	23.40	22.00	22.70	585.7	581.7	583.8	40.75	39.97	40.36	240.1	233.3	236.7	18.43	18.13	18.28
SP 31 kg P_2O_5	25.60	24.40	25.00	589.5	586.8	588.1	41.69	41.30	41.49	247.8	242.3	245.0	20.00	19.44	19.72
RP 15.5kg P_2O_5	23.00	21.00	22.00	581.8	581.3	581.5	40.70	40.85	40.78	236.7	237.4	237.1	17.94	17.56	17.75
RP 31 kg P_2O_5	25.00	24.00	24.50	586.8	587.2	587.5	41.50	41.05	41.28	244.0	241.1	242.5	19.25	18.94	19.09
Mean	24.25*	22.85		586.0	584.0		41.16	40.80		242.14*	238.53		18.91	18.52	
LSD at 5%															
treatments	**1.289**			**1.59**			**NS**			**NS**			**1.320**		
Interaction	**1.823**			**2.25**			**NS**			**NS**			**1.867**		

Table (5) :Effect of phosphorus sources and rates on seed weight /plant, seed yield, oil percentage and oil yield as well as Protein percentage of two varieties of canola plant grown in calcareous soil in the season of 2006/2007

Treatments	Seed weight /plant(g)			Seed yield (Kg/fed.)			Oil %			Oil yield (Kg/fed.)			Protein %		
	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean	Ser. 4	Bact.	Mean
SP 15.5kg P_2O_5	25.40	33.05	29.33	606 .2	600 .4	603.3	39.32	39.90	39.61	238.4	239.3	238.9	17.94	17.94	17.94
SP 31 kg P_2O_5	28.35	26.60	27.48	623 .5	610.3	616.4	41.18	40.85	41.01	256.5	248.9	252.7	19.38	19.25	19.31
RP 15.5kg P_2O_5	24.78	23.23	24.00	603 .5	596.1	600.3	39.31	40.05	39.68	236.9	238.9	237.9	17.56	17.50	17.53
RP 31 kg P_2O_5	26.15	26.00	26.08	619 .2	613 .2	616.2	41.05	40.50	40.78	254.2	248.5	251.3	19.00	18.56	18.78
Mean	26.17	27.22		613.5*	605.3		40.22	40.33		246.53	243.89		18.74	18.31	
LSD at 5%															
treatments	NS			1.6			NS			9.90			1.232		
Interaction	NS			2.3			NS			14.0			1.742		