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UNTRADITIONAL METHODS OF P-APPLICATION FOR RAISING ITS EFFICIENCY ON SANDY SOIL

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ABSTRACT

Soils of Egypt characterize with raising pH values, $CaCO_3$ content, clay and Fe & Al oxides. These factors contribute, to a large extent, in P-fixation in soil and its transformation into unavailable forms. This reflect, in turn, on plant growth and the resultant crop. So, the main target of this investigation is raising the use efficiency of P-fertilization, decreasing P-fixation, increasing its availability in soil and promoting its uptake by plant through testing new methods for P-application compared with the traditional one (P-application before sowing). Therefore, two field experiments were designed in sandy soils during the two winter seasons 2002/2003 and 2003/2004 at South Tahrir Res. Station, Ali Moubark village, El-Bustan region, Behira governorate under drip irrigation system. For the two experiments, P was applied as soil or seed coating. Soil application treatments were added at a rate of 30 kg P_2O_5/fed., once before sowing, twice: before sowing and during the vegetative growth stages or in three portions, before sowing and during the vegetative and flowering growth stages. In seed coating method, seed were coated before sowing with P at rates of 0.1, 0.2 and 0.3 kg P_2O_5/kg seed. Data obtained revealed that the treatments of P-soil application generally surpassed the P-seed coating ones. In this respect, P-soil application in three portions (at sowing and during the vegetative and flowering growth stages) gave the highest increments in seed, straw and seed protein yields as well as macro- and micronutrients contents in both seed and straw compared with the traditional method of soil P-application. Moreover, seed coated with 0.2 kg P_2O_5/kg seeds attained the highest increases in all abovementioned yield components and nutritive contents among the treatments of seed coating method, whereas, coating of seeds with 0.3 kg P_2O_5/kg seeds caused the least ones. Therefore, it can be concluded that the addition of P to sandy soil at a rate of 30 kg P_2O_5/fed., in three portions, i.e. at sowing and during the vegetative and flowering growth stages reduce P-fixation by soil factors, increase its availability, promote its uptake by plant, achieve the highest productivity of faba bean seed, straw and seed protein yields and improve the nutritive contents of both seeds and straw.

Key words: P-fertilization , Seed coating , Faba bean , Sandy soil.

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INTRODUCTION

As faba bean takes the first place among the most important legumes raised in Egypt, back-up research has been focused on this particular crop to maximize its production through increasing the efficiency of fertilization.

Phosphatic fertilization is generally important for leguminous crops. This, in fact due to a fundamental role of P in a large number of enzymatic reactions depending on phosphorylation and in the synthesis of various organic compounds in the plant. For this reason, plant meristematic tissues take up much of P in the early stages of growth and become vigorous **(Mohammad, 1998 and Nassar *et al* 2001).** Moreover, P has an enhancing impact on plant growth and the resultant crop through its importance as energy storage and transfer necessary for the metabolic processes. P also raises the activity of rhizobia and increases the number of branches and pods/ plant, consequently produces more sizeable organs **(Omran *et al* 1999; Nassar & Ismail, 1999; Rahmou, 2003 and Nassar *et al* 2004).**

Numerous investigators tried to find out the best and suitable method of P-fertilizer. This attention was related to the problems of P availability in most of the soils of Egypt where, P-availability is a very sensitive to pH value, $CaCO_3$% and contents of both organic matter and Fe & Al oxides. So, several investigations tried to raise the efficiency of P-fertilizer through its splitting into several doses or its application as seed coating before sowing. In this concern, **Dawood & Abou Salama (1994) and Rahmou (2003)** found that P splitting into two doses, at the sowing and first irrigation (Mohayah irrigation) led to an increase of yield and its attributes. The highest values of seed protein were recorded when applying P-fertilizer in two splitted doses (at first irrigation and flowering stage). On the other hand, **Ibrahim & Shalaby (1994); Nassar (1997) and Nassar *et al* (2002)** attributed the efficiency of seed coating method with the nutrients to their effect on the proliferation of roots through the soil. This leads the plant roots to absorb more nutrients and correct the suitable requirements of macro- and micronutrients for plant growth that reflect on the resultant crop.

Therefore, the aim of this work was to throw some light on the effect of P application either to the soil, in splitting doses, or as seed coating on the quantity and quality of faba bean grown on sandy soil.

MATERIAL AND METHODS

Two field experiments were carried out at South Tahrir Agric. Res. Station, Agric. Res. Center, Ali Moubark Village, El-Bustan region, Behira governorate during the two winter seasons (2002/2003 and 2003/2004). This study was performed as sake of comparing the effect of P-fertilization added either to the soil in splitting doses or as seed coating. Soil samples were taken, before sowing, from the surface layer (0-30 cm) for physical and chemical analyses according to **Jackson (1973).** Some soil physical and chemical characteristics are shown in Table (1).

Faba bean seeds, Gizablanka cultivar, were sown in rows on 9^{th} and 15^{th} November for the first and second seasons, respectively. The treatments were arranged in complete randomized blocks with four replicates. The plot area was

Table 1. Some physiochemical characteristics and fertility status of the studied soils during 2002/2003 and 2003/2004 winter seasons.

I- Physiochemical characteristics

Season	Particle size distribution			Soil texture	pH (1:2.5)	E.C. (d.S/m)	Available water (%)	O.M. (%)	$CaCO_3$ (%)
	Sand (%)	Silt (%)	Clay (%)						
2002/2003	91.15	5.74	3.11	Sandy	8.57	0.77	4.61	0.13	4.70
2003/2004	89.84	6.23	3.93	Sandy	8.43	0.64	4.79	0.18	4.59

II- Fertility status

Season	Available nutrients (ppm)						
	Macro-			Micro-			
	N	P	K	Fe	Zn	Mn	Cu
2002/2003	20.4	1.9	62.8	0.69	0.10	0.25	0.06
2003/2004	22.1	2.2	71.9	0.85	0.15	0.32	0.09

10.5 m^2 (3 x 3.5m). Each replicate was divided into two parts. The first one was fertilized with 30 kg P_2O_5/fed. as monocalcium phosphate, at one dose (before sowing, tradional methed), two doses (at sowing and during the vegetative growth stage at 30 days old, respectively) and three equal doses (before sowing and during the vegetative and flowering growth stages at 30 and 50 days old, respectively). Whereas, the second part was P fertilized by seed coating method with monocalcium phosphate. Treatments of P seed coating were carried out before planting at the rates of 0.1, 0.2 and 0.3 kg P_2O_5/kg seeds. A control treatment (without P) was also taken into consideration. The normal cultural practices needed for growing faba bean were done.

At harvesting on 9th and 11th April for the two seasons, respectively, seed, straw and whole faba bean yields were estimated. Some seed yield components, i.e. number of seeds/plant, seed weight (g/plant) and 100 seed weight (g) were also recorded. From each plot, samples of both seeds and straw were taken for determining NPK as well as Zn, Mn, Fe and Cu uptake according to **Chapman and Pratt (1961)** and data of their contents were expressed as (Kg/fed.) for macronutrients and (g/fed) for micronutrients.

Seed protein content was estimated by multiplying seed N content by a factor of 6.25.

The obtained data for all treatments except control were statistically analyzed according to **Gomez and Gomez (1984).** L.S.D. test at 5% level of significance was used for comparison between the means of different treatments.

RESULTS AND DISCUSSION

I-Yield and yield components

Data obtained in Table (2) indicate that application of P-fertilization under the investigated methods of application (splitting the soil application dose or seed coating methed) significantly increased both faba bean seed and straw yields and insignificantly enhanced the components of seed yield, i.e. number of seeds, seed weight/ plant and 100 seed weight except 100 seed weight for the second season. Respecting the P soil application, splitting P-fertilizer into three equal doses (at sowing and during the vegetative and flowering growth stages, respectively) gave the highest increments of all tested characteristics. Whereas, seed coating with 0.2 kg P_2O_5/kg seeds was the best treatment for increasing the same parameters among the treatments of seed coating method. Generally, treatments of P-soil application surpassed the seed coating ones. In this concern, soil application of 30 kg P_2O_5/fed. at three equal doses had the superiority effect.

The enhancing impact of P-fertilization on faba bean seed and straw yields may be due to that P enables the plants to grow well, raises the efficiency of plants to photosynthesis, enhances the activity of rhizobia, enzymes and hormones and increases the number of branches and pods/ plant. Consequently, P produces more sizeable organs **(Szirtes *et al* 1986).** P also has an enhancing impact on plant growth and biological yield through its importance as energy storage and transfer necessary for metabolic processes **(Marschner, 1998).** These results are in hormony with those attained by **(Omran *et al* 1999; Nassar & Ismail, 1999; Rahmou, 2003 and Nassar *et al* 2004).** On the other hand, the positive effect of P when its addition as seed coating on faba bean yield may be due to the increase of P concentration in the vicinity of plant roots and raising its availability in the soil solution as well as reducing P fixation by soil factors **(Fontes & Welcox, 1983 and Nassar *et al* 2001).**

The superiority impact of P when its application in several portions may be attributed to one or more of the following:

1- Reducing P-fixation by soil factors.
2- Producing the plants with available P along with their different growth stages, consequently increasing the corresponding values of both seed and straw yields, Table (2). Similar findings were reported by **Dawood and Abou Salama (1994) and Rahmou (2003).**

II- Macro-and micronutrients contents

1- Macronutrients content

Data presented in Table (3) show that NPK uptake in seed, straw and whole faba bean plants and seed protein content significantly increased with P-fertilization. The highest values of NPK

uptake and seed protein content were attained by the soil application of 30 kg P_2O_5/fed. in three splitted equal doses. For P seed coating method, data of Table (3) also cleared that NPK uptake by all abovementioned parameters gradually increased as raising the rate of applied P up to 0.2 kg P_2O_5/kg seeds then it declined but all values still higher than the control treatment. In general, the soil application method surpassed the seed coating one in its impact on NPK uptake by faba bean seed, straw and whole plant and seed protein content for the two investigated seasons. Similar findings were also reported by **Mahmoud *et al* (1991)** on soybean and **Rahmou (2003)** on faba bean.

2- Micronutrients content

Data in Table (4) show the effect of P application under the two investigated methods on micronutrients uptake (Fe, Zn, Mn and Cu) by seed, straw and whole faba bean plants. The obtained results clearly revealed that micronutrients uptake in all abovementioned parameters took trends similar to those attained with macronutrients.

The positive effect of P application on the contents of macro-and micronutrients in various organs of faba bean plants may be due to:

A- Enhancing the activity of rhizobia as well as increasing the nodule number, size and mass, which in turn increase N_2-fixation by N_2 fixing microorganisms **(Nassar *et al* 2001).**

B- The close relationship between K-uptake and ATP-ase activity which increases by P application **(Marschner, 1998).**

C- Contribution of macro-and micronutrients in vital plant processes such as protein and carbohydrate construction, cell division and expansion, proteins and nucleic acids synthesis as well as respiration and photosynthesis **(Dwivedi and Chaubey, 1995).**

D- Contribution of P and the determined micronutrients (Fe, Mn, Zn and Cu) in assimilation processes of organic and inorganic phosphatic compounds, i.e. phosphoproteins, phospholipids and phosphocarbohydrates **(Nassar *et al* 2002).**

E- Increasing the corresponding values of seed and straw yields, as indicated in Table (2).

The promoting impact of P when its addition as seed coating on NPK and micronutrients uptake could be attributed to increasing the proliferation of roots through the soil. This leads them to absorb more nutrients and correct the suitable requirements of macro- and micronutrients for plant growth.

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طرق غير نمطية لإضافة الفوسفور ورفع كفاءته فى الأراضى الرملية [17]

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تتميز الأراضى المصرية باتجاه رقم حموضتها الى القاعدية ، وإرتفاع نسب كربونات الكالسيوم والطين واكاسيد الحديد والألمونيوم فيها والتى تساهم بدرجة كبيرة فى تثبيت الفوسفور فى التربة وتحويله لصور غير ميسرة للنبات وهذا ينعكس بدوره على نمو النبات وبالتالى المحصول الناتج 00 لذا فإن رفع كفاءة استخدام الفوسفور بتقليل تثبيته وزيادة تيسره فى التربة وتشجيع امتصاص النبات له كان هدفا جوهريا من أهداف هذه الدراسة 00 لذا اتجه هذا البحث الى دراسة طريقتين جديدتين لإضافة الفوسفور مقارنة بالأسلوب التقليدى لإضافته (إضافته كجرعة واحدة قبل الزراعة) فى محطة بحوث جنوب التحرير (قرية على مبارك . منطقة البساتين . محافظة البحيرة) خلال موسمى الزراعة الشتويين 2003/2002 ، 2004/2003 حيث أضيف الفوسفور فى كلا التجربتين بأسلوبين : الإضافة الأرضية فى صورة سماد السوبر فوسفات الكالسيوم الأحادى (15% فو$_2$أ$_5$) بمعدل 30 كجم فو$_2$أ$_5$/ فدان والذى أضيف إما مرة واحدة عند الزراعة (الطريقة التقليدية) أو مرتين : الأولى عند الزراعة والثانية بعد 30 يوم من الزراعة (مرحلة النمو الخضرى) أو ثلاث مرات : الأولى عند الزراعة والثانية والثالثة بعد 30 ، 50 يوم من الزراعة (مرحلتى النمو الخضرى والزهرى) أما الأسلوب الآخر المختبر لإضافة الفوسفور فهو تغليف البذور قبل الزراعة بسماد السوبر فوسفات الكالسيوم بمعدلات0.1 ، 0.2 ، 0.3 كجم فو$_2$أ$_5$/كجم بذور 00 وفى نهاية موسمى الزراعة حللت النتائج احصائيا لتقييم التيسر النسبى للفوسفور باستخدام كلا طريقتى الاضافة وتأثيره على محصولى البذور والقش لنباتات الفول البلدى ومحتواهما من العناصر الغذائية الكبرى والصغرى.

أشارت نتائج الدراسة الى تفوق طريقة الإضافة الأرضية للفوسفور على طريقة تغليف البذور بالفوسفور 00 وقد حققت الإضافة الأرضية للفوسفور على ثلاث دفعات (عند الزراعة ، خلال مرحلتى النمو الخضرى والزهرى) أعلى الزيادات فى محصولى البذور والقش ومحتوى العناصر فى كل منهما وأيضا محتوى البذور من البروتين مقارنة بمعاملتى الكنترول (الغير مضاف إليها فوسفور) ، ومعاملة الإضافة النمطية للفوسفور (إضافته كدفعة واحدة عند الزراعة) 00 فضلا عن أن معاملة تغليف بذور الفول

بمعدل 0.2 كجم فو$_2$أ$_5$ / كجم بذور قد حققت أعلى الزيادات فى مقاييس النمو والمحتوى الغذائى السابقين مقارنة بباقى معاملات التغليف أما أقل الزيادات على الإطلاق فقد سجلت عند تغليف البذور بمعدل 0.3 كجم فو$_2$أ$_5$/كجم بذور.

ومن ثم يمكن التوصية بإضافة الفوسفور للأراضى الرملية بمعدل 30 كجم فو$_2$أ$_5$/فدان على ثلاث دفعات : عند الزراعة وخلال مرحلتى النمو الخضرى والزهرى بهدف تقليل تثبيته فى التربة وزيادة تيسره فيها وتشجيع امتصاص النبات له وللعناصر الغذائية الأخرى وتحقيق أعلى إنتاجية لمحصولى البذور والقش لمحصول الفول البلدى.

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