The role of activated phosphorous sources in enhancing soil quality and rice productivity under saline sodic soil conditions

دور مصادر الفسفور المنشطة في تحسين جوده التربة وانتاجيه الارز تحت ظروف الأراضي الملحية الصوديه

BY

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Abstract:

Two field experiments were conducted at El-Sirw Agriculture Research Station, Damietta province, Egypt in 2018 and 2019 seasons to improve the efficiency of phosphorous fertilizer for rice under saline sodic soil using organic activation of phosphorous. The experiments were performed in randomized complete block design with four replications to cope with the phosphorous unavailability. Salinity and ESP levels of experimental sites were 9.00 and 9.12 dSm-1; 18.17% and 18.27% in both seasons respectively. The treatments involved, control, molasses, calcium super phosphate, rock phosphate, mono-ammonium phosphate and the three phosphorous sources in activation forms. Applying various sources of phosphorous were effective in enhancing rice growth, soil fertility and rice grain yield. The activated phosphorous was more efficient than the non-activated ones regarding elevated soil quality, soil fertility, root characteristic, growth parameters, rice grain yield and all yield attributing characteristics. Active calcium super phosphate was the superlative followed by active mono-ammonium phosphate. Rock phosphate was improved after applying the active material and equally to super phosphate in some studied characteristics. It could be concluded that applying organic activator material for different P sources much needed to enhance the beneficial of phosphorous application for rice plants growing under saline sodic soil.

Key words: Rice, Phosphorus, Molasses, Saline sodic soils.

المستخلص :

أقيمت تجربتان حقليتين بمحطه بحوث السرو الزراعيه- بمحافظه دمياط- مصر خلال موسمى الزراعه ٢٠١٨ و٢٠١٩ وذلك بهدف زياده كفاءه امتصاص الفسفوروذلك باضافه ماده عضويه منشطه (مولاس البنجر) الى مصادر مختلفه من الفسفورتحت ظروف الاراضى الملحيه الصوديه. وكان التصميم المستخدم فى الدراسه القطاعات الكامله العشوائيه فى اربعه مكررات. ادى اضافه الماده العضويه الى مصادر الفسفور المختلفه الى رفع كفاءتها بالمقارنه بالمصادرالتقليديه وانعكس ذلك على تحسين خواص التربه وايضا تحسين صفات النمووالمحصول ومكوناته لصنف الارز هجين مصرى واحد. واعطى كالسيوم سوبر فوسفات المنشط بالماده العضويه اعلى القيم وتلاه المونوامونيوم فوسفات المنشط اما صخر الفوسفات المنشط كانت كفاءته مساويه للسوبرفوسفات العادى فى معظم الصفات المدروسه. اعطت المعامله الكنترول اقل القيم من الصفات المدروسه وعليه اضافه المادة العضوية الى بعض مصادر الفوسفات يزيد من كفاءتها ويحسن خواص التربه ويزيد من صفات النمو والمحصول للارز المنزرع تحت ظروف الاراضى الملحيه الصوديه .

الكلماتُ المفتاحية: الارز،،الفسفور ،المولاس ،الاراضى الملحيه *الصوديه*

Introduction

The salt-affected soil in the Nile Delta is approximately, 35- 40% of irrigated lands of Egypt, it is expected to increase in the near future **(Shalaby et al, 2012)**. The northern part of Nile Delta is involving the majority of salt affected soil. The P deficiency frequently associates with the problem of salt affected soils (**Landon, 1991**). Phosphorus (P) is an essential macronutrient needed for optimum crop growth and production (**Mengel et al., 2001)**. Under salt affected soil, phosphorus application lessens the concentration of Na^+ resulted in superior growth and yield in rice **(Wan et al., 2018)**.The poor phosphorous availability under salt affected soil pebbledash numerous problems attributing to its fixation and precipitation as a result of tri-calcium phosphate formation (**Halell et al., 2019, Cordell et al. 2011**). **Flooding or excess water in soils with readily available organic matter causes anaerobic conditions, which alter both soil oxidation-reduction potential and soil pH, thereby directly, or indirectly influencing solubility and sorption/desorption of P** (**Scalenghe et al., 2002 and Racz., 2006**) such as in rice field a**mongst**, the antagonism between phosphorus and other elements. The Egyptian cultivated lands have pH 7.8–8.2, that makes it P unavailable to plant and hence, they are not convenient to apply phosphate, which needs soil pH between 6.0 to 6.5 **(Wilson et al., 1999)**. Egypt started phosphate local production in 1936, this industry need to improve **Hellal et al (2019**) particularly rock phosphate to become more available for rice plant. Molasses is one of the important by-products of sugar industry and produced by the factors of sugar cane in large amounts every year. The use of sugar beet molasses in agriculture causes nutrient uptake efficiency and soil biological activity improving **Chandraju (2008)**. Molasses is a main source for the production of alcohol in distilleries. They produce 40 billion liters of raw spent wash (RSW). The properties of raw spent wash are high acidic, high BOD and COD and containing easily oxidisable organic matter (**Rani et al., 1990**). The molasses contained 83.2% total soluble solids, 17.8% reducing sugars, 32.1% sucrose, 49.9% total sugars, 10.25% ash, o.54% calcium, 0.28% sodium, 2.89% potassium and it had a pH value of 5.6 (**Hafizet al., 2012)**. Use up of a diluted solution of molasses increased nutrient uptake by plants **Chandraju (2008)**.

This study targeted to improve P efficiency using adding active agent (molasses) to decrease salt affected soil pH and increase phosphorus release with high efficiency for rice cultivar Egyptian hybrid one. Assessment of the top source of phosphorus fertilizer and increasing its availability for rice plant are the most important agricultural practices needed for efficient phosphorus management under salt stress.

Materiel and method

Study site

The study was accomplished in El-Sirw agriculture research station Damietta governorate- Egypt, during 2018 and 2019 seasons to improve saline sodic soil properties, rice growth, yield attribute parameters and yield of Egyptian hybrid one rice cv(EHR1) fertilized by activated phosphorus.

Experimental set up

The field layout was randomized complete block design with four replications. The treatments were; Control (non P application), molasses of sugar beet (60lit./ha), calcium super phosphate (15.5% P_2O_5), rock phosphate (25%P_2O_5) and mono-ammonium phosphate (47%P_2O_5), active calcium super phosphate (ASP), active rock phosphate (ARP) and active mono-ammonium phosphate (AMAP).

activation processes

The used of molasses for activation was 5% out from the recommendation rate of each source of P. The recommendation rate for each source mixed with molasses and incubated for two weeks. Both of activated and non-activated phosphorous was basally applied, uniformly distributed and incorporated into soil. The proceeding crop was Egyptian clover in both seasons. The rate of seeds was 168 kg ha^{-1} was soaked in water for 48 hours after that incubated for 24 hours. Seeds after hasten early germination were uniformly broadcasted in the nursery bed on 3 $^{rd.}$ May in the first season and 1st May in the second one. After the permanent field was well prepared seedlings were transferred from the nursery after 30 days from sowing and distributed through the plots. Seedlings were manually transplanted into the plot (10 m^2 for each plot), 20X20 cm spacing 2-3 seedlings $hill^{-1}$ was applied. Seven days after transplanting the herbicide Saturn 50% [S-(4-Chlorophenol methyl) diethyl carbamothioate] at the rate of 4.8L ha^{-1}. Nitrogen fertilizer was applied at the rate of 165 Kg N ha^{-1} in the form of ammonium sulphate (20% N) in three equal splits application at 15 , 30 and 45 days after transplanting. Potassium in the form of potassium sulphate (50% K_2O) at the recommended rate (60 kg K_2O ha^{-1}) was added in two equal doses at 30 and 45 days after transplanting. The reminder agronomic practices were followed as recommended package of rice under salt affected soil during the growing seasons.

Soil sampling and sample preparation

Soil samples were taken before land preparation at the depth of 0-30 cm from the soil surface. The soil samples before cultivation were completely mixed, dried and grounded then both of physical and chemical characteristics were analyzed according to **Piper, (1950)** as presented in Table1.

Table1:Soil chemical properties of experimental soil in 2018 and 2019 seasons

season	EC, dSm-1	pH	Bulk density g m-3	ESP%	Cations m mol L-1				Anions mmol L-1			
					Ca++	Mg++	Na+	K+	CO3--	HCO3-	Cl-	SO4--
1st	9.00	8.3	1.67	18.17	18.81	10.80	61.20	0.90	---	12.10	42.84	36.77
2nd	9.12	8.2	1.65	18.27	19.06	10.94	62.02	0.91	---	12.30	43.41	37.22

season		NPK available (ppm)		OM %	CaCO3 %	CEC (meq /100g soil	Particle size distribution%			
	N	P	K				sand	Silt	Clay	Texture class
1st	35.5	8.5	262	0.75	1.23	31.5	11.8	25.3	62.9	Clayey
2nd	38.5	10.8	283	0.84	1.31	32.1	12.1	24.8	63.1	Clayey

After harvest soil was sampled, for chemical analysis and the other for physical analysis according to **Piper, (1950), Cottein et al., (1982)**, **Page et al. (1982)** and **Kemper and Rosenau (1986)**. Soil analysis and measurements includes soil Ec dS m^{-1} in soil paste extract, soil pH in 1: 2.5 soil water suspension, bulk density kg m^{-3} and different elements.

Relative water content measurement

The leaf relative water content (LRWC %) was calculated based on methods from **Yamas aki and Dillenburg (1999)**. Disc samples 0.5 cm in diameter were taken from old and young leaves was taken from each plot at harvest time. After FW was measured, the leaf discs were floated in distilled water in a closed petri dish. After 24 h, the leaf surface water of samples was wiped with tissue paper and weighed (TW). At the end of the turgid period, leaf samples were placed in a pre-heated oven at 65°C for 48 h, in order to obtain the dry weight (DW). All DW values were determined using an analytical scale, with precision of 0.001g. Measurements of FW, TW, and DW were used to calculate LRWC using the equation as follows: LRWC (%) = [(FW-DW) /(TW-DW)] x 100. During heading stage, plants of five hills were taken randomly from each plot to estimate leaf area, dry matter hill^{-1} and chlorophyll content. Leaf area of plant samples were measured by Portable Area Meter (Model LI– 3000A). Total chlorophyll content was determined in ten leaf by using chlorophyll meter (Model–SPAD502) Minolta Camera Co. Ltd., Japan. Dried rice leaves samples of each plot were analyzed for Kjeldahls to assessment of N content in leaf. Phosphorus content in leaves was also measured according to **Yoshida et al. (1976).** At harvest, plant height, panicle length and panicle numbers hill^{-1} were estimated. Ten panicles were collected randomly to estimate the panicle weight, panicle length, number of filled grain and unfilled grain per panicle and 1000-grain weight. The six inner rows of each plot were harvested, dried, threshed, and the grain and straw yields were calculated based on the moisture content of 14%. The yield converted to grain yield t ha^{-1}.

The obtained data were subjected to analysis of variance according to **Gomez and Gomez (1984).** Treatment means were compared by Duncan's Multiple Range Test **(Duncan, 1955).** All statistical analysis was performed using analysis of variance technique by means of "COSTAT" computer software package.

Results and discussion

The obtained results were discussed under the following titles:

1-Soil physical and chemical properties

2-Root characteristics

3-Growth parameters

4-Leaf nutrients content

5-yield components

6-Yields

7-Phosphourus use efficiency

1-Soil physical and chemical properties

Data related to effect of P treatments on soil reaction (pH), soil electrical conductivity (EC), the available soil P content and bulk density (g cm^{-3}) of salt affected soil are listed in Table2. Phosphorus treatment significantly lessened soil pH, Ec and bulk density furthermore, amplified available P content of the soil compared with control and sugar beet molasses treatments in 2018 and 2019 seasons. It was remarked that activated phosphorus treatments were more competent than traditional P treatments regarding their role in reducing the soil pH value, reflecting on nutrients availability. However the lowest values of the soil pH, amount of salts in soil (Ec) and bulk density were realized by activated calcium super phosphate followed by activated ammonium phosphate in both seasons. It is mentioning here that, applying the activation process had positive effect on rock phosphate, since it raised its efficiency to be at the same significant level with remainder of P fertilizer forms in lessening the soil pH value. As for the available soil P, the highest value of P content in the soil was noticed by applying activated calcium super phosphate in both seasons without significant difference with calcium super phosphate and active mono-ammonium phosphate in the first season only, followed by active rock phosphate. The effectiveness of phosphate sources needs to be enhancing by physic-chemical processes **FAO(2005**), especially the low grade of some phosphate rocks compared with higher-grade commercial phosphate fertilizers **(Hellal et al., 2019**). The most agricultural soils are misery from phosphorus deficiency due to it eagerly forms insoluble fixations with cation and the availability of P in soil depends on soil properties such as pH **(Cordell et al., 2011)**. From the previous results, applying the activated material accomplish the augmenting value of P fertilizer compared with other P sources, it may be due to increasing the release of P from P sources after activation processes **(liao, 2005)**.

Table 2: Effect of activated phosphorus fertilizer on some soil properties after harvest in 2018 and 2019 seasons

Factors	pH		EC (dSm^{-1})		Bulk density (gm-3)		Available P (ppm)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	8.30a	8.35a	8.55a	8.65a	1.57a	1.55a	10.5d	10.0d
Molasses	8.10b	8.15b	8.07b	8.21b	1.52ab	1.50ab	11.5cd	11.75c
CSP	8.04b	8.06bcd	6.55c	7.67d	1.35c	1.32c	15.75a	15.00b
RP	8.12ab	8.12bc	6.74c	7.07c	1.48ab	1.45ab	12.75bc	12.5c
MAP	8.03b	8.00cd	6.72c	6.8cd	1. 42b	1.40b	13.5bc	14.25b
ACSP	7.86c	7.81d	6.27d	6.35e	1.19e	1.17e	16.25a	16.55a
ARP	8.06b	8.18bc	6.33d	6.84cd	1.40b	1.39b	13.5bc	14.0b
AMAP	8.00bc	8.08bcd	6.35d	6.65d	1.32bc	1.30bc	14.75ab	14.25b
LSD0.05	0.17	0.20	0.29	0.29	0.10	0.11	2.03	1.20

** indicate $P < 0.01$. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

It is valuable to mention here that, applying both of phosphorous and molasses had beneficial effect on soil reclamation since they reduced both of pH and bulk density comparing to control treatment. As a results of reducing both bulk density and soil pH value, nutrients availability such as Ca^{+2} and K^{+} might be increased and soil aggregates resulted in soil drainage system improving, leaching process and reducing sodium soil content (**Zayed et al 2012** and **Prudhvi1 and Rao,**

2019). Releasing more Ca^{+2} in soil solution as a result of reducing pH soil value is going to efflux more Na^{+} from soil particle as Ca^{+2} substitution reducing Na^{+}/K^{+} ratio of soil resulted in improving soil quality of saline sodic soil.

Table 3: Effect of activated phosphorus fertilizer on some soil properties (Na $meqL^{-1}$, K $meqL^{-1}$ and Na/K ratio) after harvest in 2018 and 2019 seasons

Factors	Na $meqL^{-1}$		K $meqL^{-1}$		Na/K ratio	
	2018	2019	2018	2019	2018	2019
Control	873.9a	934.8a	540.0e	490.0e	1.62a	1.91a
Molasses	765.2a	787.0a	566.7de	550.0d	1.35a	1.43b
CSP	678.3b	669.6cd	710.0ab	666.7ab	0.96cde	1.00de
RP	739.1a	717.4b	626.7cd	583.3cd	1.18b	1.23c
MAP	687.0b	665.2cd	693.3abc	596.7cd	0.99cd	1.11cd
ACSP	621.7c	600.0e	736.7a	703.3a	0.84e	0.85f
ARP	687.0b	678.3c	626.7cd	630.0bc	1.10c	1.08d
AMAP	643.5bc	634.8de	726.7a	706.7a	0.89de	0.90ef
LSD0.05	43.5	34.8	70.0	50.0	0.08	0.10

** indicate $P < 0.01$. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

Data in Table3 show that applying various P sources otherwise activated ones or non-activated significantly reduced Na content in both seasons, except rock phosphate, which had no significant effect with comparing treatments in the first season. The lowest value of soil Na% was observed by ACSP in both seasons followed by AMAP. The effectiveness of ARP was clear in reducing Na% compared with RP in the second seasons. The treatments of ACSP, AMAP and CSP without significant differences among them surpassed other treatments in increasing K%. Moreover, applying ARP significantly increased K% compared with RP in both seasons. The Na /K ratio was decreased by applying different P sources, the lowest value of Na/K ratio was in favor ACSP followed by AMAP, meanwhile, ARP came in the third order. The concentrations of Na^+, K^+ and Na/ K ratio of salt affected soil are good indicators for soil quality and healthy. Activated P sources provide its superiority in dimensioning Na% and Na/K ratio also increasing K% under salt affected soil. High concentrations of Na^+ in the soil solution may depress nutrient-ion activities and produce excessive ratios of Na/K **(Grattana & Grieveb, 1999).**

2- Root characteristics

Table 4: Effect of different activated phosphorus fertilizer forms on some root characteristics of Egyptian hybrid one rice variety in 2018 and 2019 seasons

Factors	Root length (cm)		Root volume (cm3)		Root thickness (mm)	
	2018	2019	2018	2019	2018	2019
Control	16.11e	15.25e	57.5e	62.5d	0.43d	0.45e
Molasses	19.50d	21.0d	73.7d	77.5cd	0.59cd	0.66cd
CSP	24.37b	25.3b	97.5bc	97.5ab	0.88a	0.97ab
RP	20.87cd	22.3cd	77.5d	87.5bc	0.61c	0.64d
MAP	21.75bcd	24.7bc	88.75c	87.5bc	0.69bc	0.82bc
ACSP	30.12a	29.57a	112.5a	110.0a	0.84ab	1.03a
ARP	24.05bc	25.35bc	96.25bc	95.00ab	0.62c	0.67cd

AMAP	28.37a	29.32a	100.0b	101.2ab	0.74abc	0.90ab
LSD 0.05	3.27	2.93	9.13	15.1	0.18	0.17

** indicate P < 0.01 . Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

Data in Table4 indicated that root length (cm), root volume (cm3) and root thickness (mm) of Egyptian hybrid one rice variety as affected by P treatments in 2018 and 2019 seasons. Phosphorus treatments significantly increased the studied root traits compared with control treatments. The longest root was produced by ACSP without significant difference with AMAP in both seasons. The highest value of root volume was induced by ACSP in both seasons without significant difference with AMAP and ARP in the second season. Root thickness was improved by applying CSP in the two forms without any variation with the treatments of AMAP in both seasons. Under salt stress conditions the root rhizosphere, suffering from increasing salt amount and osmotic stress decrease the usable water amount causes cell expansion to diminish as well as a shoot development to hold up, reducing the capability of plants to absorb essential nutrients (**Dadkhah and Grrifiths, 2006** and **Tuteja, 2007**). Salinity decreases P accumulate in the root tissue of the plant and prompted a progressive absorption of Na and Cl in both shoot and root. The excessive Na concentration in the plant tissue hinders nutrient balance, osmotic regulation and causes specific ion toxicity (**Katerji et al., 2004** and **Arzani, 2008**). The availability of P under salt affected soil was low it may due to the fact that, the phosphorus application is mainly adsorbed by the soil and is not available for plants uptake. Phosphorus availability is crucial for the establishment of root system, increase root growth and influence early maturity

(Prosper, M. and M.Jerome 2017). As evident in Table3 the value of phosphorus sources after applying the activator agent was improved and reflects on the studied root characteristics it may be due to the activator agent increase the availability of P for plant under salt stress.

Data regarding effect of new technology of phosphorus fertilizer on leaf area index, leaf relative water content, chlorophyll content (SPAD value) and dry matter g hill^{-1} are presented in (Table5). It was obvious from the mean values of the data that applying different P sources enhanced aforementioned growth characteristics compared with control treatments. Higher leaf area index was noted in the treatment of ACSP in both seasons which was similar with other treatments of AMAP and CSP in the first season only.

3-Growth parameters

Table5: Effect of activated phosphorus fertilizer forms on some growth characteristics of Egyptian hybrid one rice variety in 2018 and 2019 seasons

Traits / treatments	Leaf area index		Leaf relative water content		Chlorophyll content	
	2018	2019	2018	2019	2018	2019
Control	3.87d	3.72e	68.00e	68.5f	39.5d	38.00c
Molasses	4.38c	4.28d	71.67d	70.6e	40.5cd	40.25c
CSP	5.46ab	5.34bc	76.13c	74.8cd	41.55abc	41.62b
RP	4.64c	4.48d	74.25c	73.5d	40.37cd	40.12c
MAP	5.24b	5.11c	76.49bc	76.4bc	40.92bc	41.27b
ACSP	5.59a	5.67a	82.86a	79.6a	42.70a	43.01a
ARP	5.18b	5.10c	79.71ab	75.2cd	41.8ab	41.55b

AMAP	5.38ab	5.38b	81.25a	78.5ab	42.37a	42.50a
LSD0.05	0.33	0.25	3.45	2.01	1.24	0.81

** indicate $P < 0.01$. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

Higher relative water content and chlorophyll content was found by ACSP and AMAP without significant difference between each other in both seasons and ARP in the first season only. The maximum dry matter g hill^{-1} was observed by ACSP without significant difference with AMAP in both seasons. Couple of treatments of ARP and CSP were at the same level of significant regarding relative water and chlorophyll contents in the second season as well as dry matter in the two seasons(Tables4&5). The increasing growth characters occurred by P application might be due to phosphorus role as a major component of ATP compound whereas, it provides energy required to the plant for different processes such as photosynthesis respiration protein synthesis, nutrient translocation and nutrient uptake. **Aroca et al.,(2012**) found that decreasing in leaf relative water content under saline conditions, the decrease of water uptake under salt stress conditions might be due to diminish the water flow from the roots to the soil while the soil osmotic potential is lesser than that of the roots. Reducing the external water potential with salinity decreases the cell osmotic potential required for the turgor press (**Munns, 2002**). This indicates that the low rate of water uptake under salt stress is responsible for the low transpiration rate, and also that salinity results in dehydration at the cellular level due to increased cellular water loss. Phosphorous application might be contributed to increasing the water potential and reducing the harmful effect of NaCl in plant uptake by antagonism and enhancing enzyme activities, cell membrane, biochemical and hormones development and stimulate plant to grow healthy (**Mengel and Kirkby., 2001 and Cordell et al., 2011).**

Table6: Effect of activated phosphorus fertilizer forms on N and P % leaf content of Egyptian hybrid one rice variety in 2018 and 2019 seasons

Traits / treatments	Dry matter g hill^{-1}		N%		P%	
	2018	2019	2018	2019	2018	2019
Control	45.15d	43.27c	2.04d	2.02d	0.157c	0.144d
Molasses	48.17c	45.6c	2.12cd	2.11c	0.173b	0.155cd
CSP	52.89b	52.64b	2.52ab	2.54ab	0.179abc	0.181b
RP	47.01cd	45.01c	2.19c	2.15c	0.175b	0.167bc
MAP	50.63bc	53.1b	2.39b	2.55ab	0.175b	0.181b
ACSP	59.01a	58.99a	2.605a	2.55ab	0.191a	0.204a
ARP	54.30b	52.80b	2.41b	2.48b	0.188ab	0.187ab
AMAP	57.99a	57.25ab	2.60a	2.65a	0.182ab	0.188ab
LSD0.05	3.67	4.76	0.12	0.09	0.009	0.014

** indicate $P < 0.01$. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

4-Leaf nutrients content

Data in Table6 showed that P and molasses treatments had a significant and positive impact on N% and P% leaf contents compared with control treatment in both seasons. The highest values of leaf N content were obtained by AMAP without significant difference with ACSP and CSP in both seasons and MAP in the second season only, ARP came in the second order. The highest value of P leaf content was observed by ACSP without statically difference with AMAP and ARP in both season and CSP in the first season only. Molasses causes nutrient uptake efficiency, and P implementation in a new forms was improve chemical and physical soil prosperities resulting in reducing Na, pH and increasing nutrient availability for rice plant. In addition to, P application might be suppressed Cl^- uptake and minimized its toxicity. The current results are in a good accordance with those reported by **(Chandraju, 2008; Alam et al., 2009 and Zayed et al., 2016).**

5-Yield components:

Data in Tables7and8 showed that plant height (cm), number of panicles hill^{-1}, panicle weight (gm) ,panicles length (cm) number of filled grain ,number of un filled grains and 1000-grain weight were significantly affected by application of P treatments in both seasons. The treatments of ACSP without statically difference with AMAP significantly produced the tallest plant in both seasons. Moreover, number of panicles hill^{-1} was increased by applied CSP and MAP in the two forms without statically differences among them. The heaviest and longest panicles were produced by ACSP without significant difference with AMAP in both seasons and ARP in the first season only.

Table7: Effect of different activated phosphorus fertilizer forms on some yield components of Egyptian hybrid one ric in 2018 and 2019 seasons

Factors	Plant height (cm)		Number of panicles hill^{-1}		Panicle weight (gm)		Panicles length (cm)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	92.51e	90.0e	13.25d	12.75d	2.60d	2.37f	20.22d	20.00e
Molasses	96.8bc	96.0cd	15.75c	14.2c	3.12c	2.87e	22.4bc	21.15d
CSP	98.62bc	97.1bc	17.93ab	17.6ab	3.45bc	3.35c	24.00ab	23.50b
RP	97.92bc	94.3cd	16.06c	15.18c	3.33bc	3.08de	22.35c	21.8cd
MAP	98.62bc	95.5cd	18.06ab	17.8ab	3.60abc	3.27cd	22.72c	22.97b
ACSP	104.1a	101.6a	18.31a	18.5a	3.98a	3.83a	24.57a	24.80a
ARP	98.1bc	97.1bc	16.68bc	17.1b	3.61abc	3.43bc	23.65abc	22.9bc
AMAP	101.5ab	99.8ab	17.93ab	18.4a	3.68ab	3.68ab	23.67abc	23.9ab
LSD0.05	5.14	3.31	1.5	1.06	0.49	0.26	1.60	1.00

** indicate $P < 0.01$. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

The treatments of ACSP without statically difference with AMAP significantly produced the tallest plants in both seasons. Moreover, number of panicles hill^{-1} was increased by CSP and MAP application in the two forms without statically differences among them. The heaviest and longest panicles were produced by ACSP without significant difference with AMAP in both seasons and ARP in the first season only. Moreover, the treatment of ACSP significantly produced the maximum number of filled grain and the heaviest 1000-grin as well as the minimum number of unfilled grains in both seasons. The P availability under salt stress is not enough to meet the needs of the rice plant during tillering, application of P has increased the magnitudes of the important yield attributes including number of panicles, number of spikelets per panicle, panicle length and improve rice production and soil fertility. The availability of P influenced the uptake of other essential plants nutrients due to improving of root system formation by P, particularly under salt stress(**Heluf and Mulugeta 2006**, **Zayed et al., 2016 and Prosper and Jerome 2017)**. The value of some measured traits of rice plants produced by ARP(activated rock phosphate) and CSP were equally and surpassed MAP indicating that the activation process might be improved the mode action of RP as well as CSP and MAP (**liao, 2005)**.

Table8: Effect of different activated phosphorus fertilizer forms on some yield component characteristics of Egyptian hybrid one rice variety in 2018 and 2019 seasons

Factors	No of filled grains panicle^{-1}		No of unfilled grains panicle^{-1}		1000-grain weight (gm.)	
	2018	2019	2018	2019	2018	2019
Control	105.5f	102.0e	37.5a	36.7a	22.00d	22.32d
Molasses	115.7e	118.2d	34.8a	31.3b	22.70cd	22.77cd
CSP	142.3b	132.1b	26.1b	24.8c	23.80b	23.60b
RP	124.7d	121.7cd	26.7b	28.2bc	22.62cd	22.87cd
MAP	134.2c	125.0c	26.0b	27.0c	23.05c	23.20bc
ACSP	151.6a	144.1a	20.00c	22.8d	24.69a	24.37a
ARP	135.2c	125.2c	27.4b	26.4c	23.01c	23.03c
AMAP	144.2a	140.0a	25.5b	23.0c	23.50bc	23.65b

F TEST	**	**	*	**	*	**
LSD0.05	4.49	5.14	4.81	3.09	0.67	0.55

*and** indicate P < 0.05, P < 0.01respectivaly. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

Generally, applying phosphorous fertilizer in different sources and forms significantly brought apparent improvement in yields of hybrid rice variety under saline sodic soil conditions. Furthermore, activation processes obviously elevated the efficiency of phosphorous mode of action since rice grain yield of those activated phosphorous sources high comparing to non-activated ones .

Table9: Effect of different activated phosphors fertilizer forms on yields and harvest index of Egyptian hybrid one rice variety in 2018 and 2019 seasons

factors	Grain yield t ha^{-1}		Straw yield t ha^{-1}		Harvest index	
	2018	2019	2018	2019	2018	2019
Control	5.72e	5.50e	6.24e	6.83cd	0.478a	0.446d
Molasses	6.00d	5.92d	7.05cd	6.71d	0.459bc	0.469a
CSP	6.61b	6.32bc	7.52b	7.57b	0.467b	0.455bcd
RP	5.97d	5.91d	6.87d	6. 94c	0.463bc	0.460abc
MAP	6.52b	6.12cd	7.45b	7.48b	0.466b	0.450cd
ACSP	7.03a	6.92a	8.00a	7.93a	0.466b	0.466ab
ARP	6.25c	6.02d	7.21c	6.94c	0.464bc	0.464ab
AMAP	6.63b	6.52b	7.86a	7.51b	0.457c	0.464ab
F test	**	**	**	**	*	*

LSD0.05	0.20	0.22	0.20	0.21	0.008	0.013

*and** indicate $P < 0.05$, $P < 0.01$respectivaly. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

6-Yields

The grain and or straw yields of Egyptian hybrid one markedly affected by different P sources in the two forms (Table9). Control treatment significantly produced the lowest values of grain and straw yields in both seasons. Molasses treatment was in the same trend with RP regarding increase grain yield over control. The highest values of grain and straw yields were noticed by ACSP. Moreover, AMAP without significant difference with CSP came in the second order. As for ARP, it was surpassed RP and came in the third order regarding increase grain and biological straw yields in the first season. Control treatment significantly produced the highest value of harvest index in the first season. Meanwhile, the highest value of harvest index was produced by molasses without significant differences with the treatments of RP, ARP, AMAP and ACSP in the second season. Phosphorus implementation in different sources, especially activated P forms increase rice plant withstanding to salinity stresses harmfulness and ensure nutrient availability for plant to healthy growth and proper assimilates transfer resulted in good grain filling and heavy panicle and finally higher yield. Increasing phosphorus leaf content as a result of applying activated P might be increased the ATP compound in active rice leaf such as flag leaf leading to high photosynthesis and dry matter production as well as assimilates conflict on yield components and high grain yield. This means that the performance of rice plant in terms of increasing grain yield depends on increased soil fertility, root characteristics and yield components which might be due to P application. The data are in a good agreement with those found by (**Heluf and Mulugeta 2006, Alam et al., 2009, Zayed et al., 2016 and Prosper and Jerome 2017).** Based on adopt the use of P fertilizers for sustainable productivity and soil fertility improvements.

7-Phosphourus use efficiency

Data in Table10 revealed that phosphorus use efficiency was significantly affected by various phosphorus treatments in both seasons. It is very interesting to mention that activation process happened to varying phosphorous sources significantly improved the mode action of them and raised their efficiency. The highest values of phosphorous use efficiency were produced by activated calcium super phosphate (ACSP) in both seasons followed by calcium super phosphate (Table10). The lowest use efficiency values were produced by application of rock phosphate (RP) in the first and second seasons. The activated di-ammonium phosphate came in the second regarding the use efficiency in the two study seasons. The activation ways might be reduced the loss of phosphorous under saline sodic soil attributed to high use efficiency.

Table10: Effect of activated phosphors on phosphorus use efficiency of Egyptian hybrid one rice variety in 2018 and 2019 seasons.

Treatments	Phosphorus use efficiency	
	2018	2019
Molasses	5.07f	7.60e
CSP	16.12b	14.8c
RP	4.52f	7.42e
MAP	14.4c	11.2d
ACSP	23.73a	25.7a
ARP	9.60e	9.42de
AMAP	16.40b	18.4b
F test	**	**
LSD0.05	2.76	1.7

** indicate P < 0.01. Means of each factor designated by the same latter are not significantly different at 5% level using Duncan's Multiple Range Test. (CSP)=calcium super phosphate, (RP)=rock phosphate , (MAP)=mono-ammonium phosphate, (ASP)=active calcium super phosphate, (ARP)= active rock phosphate and(AMAP)= active mono-ammonium phosphate

It could be concluded that, applied activated agent for P sources converted P sources form P less plant-available to readily plant-available, and this is an important process resulted in improving nutrient availability, ,enhancing phosphorus use efficiency, increasing saline sodic soil fertility and reflect on rice growth, yields and yield attributes characteristics of rice.

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