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ROLE OF PHOSPHOROUS MANAGEMENT FOR ENHANCING RICE PRODUCTIVITY UNDER EGYPTIAN CONDITIONS

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ABSTRACT

Integrating crop management of rice is the main strategy for maximizing rice productivity in Egypt. Optimizing phosphorous application will ensure high productivity of rice and soil sustainability. Two field experiments were conducted during 2010 and 2011 seasons at the Farm of Sakha Agriculture Research Station, Kafr-El Sheikh Governorate, Egypt. The soil texture was clayey. EC was 1.6 and 1.5 dS/m during 2010 and 2011, respectively. The eleven suggested treatments studied the response of Giza 178 rice variety to various alternates of phosphorous management namely; control(1), basal application the rate of 54 kg P_2O_5/ha (2), Diammonium phosphate (DAP) spray with the concentration of 2% at mid tillering stage (MT) (3), Potassium triphosphate (KTP) spray at MT 2% (4), DAP spray 2% at panicle initiation (PI) (5), KTP 2% at (PI) (6), DAP spray 2% at booting stage (BT) (7), KTP2% at (BT) (8), basal application of phosphorous+ 2%of DAP at BT(9), basal application of phosphorous + 2% of KTP at BT(10) and DAP spray at the concentration of 2% at the three growth sage (11). The results of this study can be summarized as follows.

Phosphorous application treatments either basal or foliar and their combination at beginning of boot growth stage were significantly increased P leaf content and its uptake. Also, phosphorous application significantly improved growth parameters at heading date viz; LAI, dry matter production, tillers number/hill and plant height. Flag leaf characteristics, i.e. flag leaf area, dry weight of flag leaf and chlorophyll content were significantly improved by phosphorous either basal or foliar spray as combination particularly, at booting stage. Yield components and rice grain yield were significantly improved by phosphorous application involving basal, foliar application and their combinations at booting growth stage were found to the most . Basal application of phosphorous+ 2%of DAP at BT and basal application of phosphorous+ 2%of KTP at BT were found to be the most effective treatments , whereas they were comparable regarding all above mentioned traits and recorded the maximum values of them. Furthermore, DAP spray at three growth stage at mid tillering stage+ panicle initiation + beginning of booting stage and basal application treatments were comparable regarding rice grain yield but the basal application economically surpassed it.

From economic point of view, the treatment of basal application of recommended phosphorous+ 2%of DAP at BT was the best and it could be recommended under similar conditions.

INTRODUCTION

The application of essential plant nutrients, particularly major and micronutrients in optimum quantity and right proportion, through correct method and time of application is the key to increase and sustain rice crop production.

Phosphorous is the second major nutrient for plant growth as it is an integral part of different biochemical like nucleic acids, nucleotides, phospholipids and phosphoproteins. Phosphate compounds act as "energy currency" within plants(Tisdale *et al*., 1985). Plant-available P deficiency is common in most of our soils which hinders crop production. In relation to plant growth, sufficient P nutrition improves several plant processes that include photosynthesis, nitrogen fixation, flowering, fruiting, seed formation, root development, and crop maturation (Memon, (1996). It is understandable that phosphate concentrations in field-grown agronomic crops decreased as pH increased (Sharpley *et al*., 1992) since Egyptian soils tend to be alkaline.

Rice (*Oryza sativa* L.) is the second most important crop and Egypt after wheat, and currently supported nearly one half of the world population. It has already been observed that P fertilization reduced the concentration of Na^+ in shoots, resulting in better survival, growth and yield (Qadar, 1998, Naheed *el al.,*(2008) and Zayed *et al.,* 2010). Annadurai and Palaniappan (1998) found that application of 19 kg P_2O_5 /ha $_+$ spray of 2% diammonium phosphate (DAP) of at boot leaf +50% flowering + milky stage gave the highest rice grain yield and some of its components, i.e. panicles numbers, filled grain numbers, 1000-grain weight but didn't effect panicle length. Nagarayan, (1999) recommended to apply two foliar sprays of diammonium phosphate (DAP) at rate of 20 kg m^{-3} with 10 kg m^{-3} of urea and KCl, one at panicle initiation and the other at 10% flowering. This may increase yields up to 0.75 t/ha^{-1}. Maibangsa *et al.* (1999), Basker *et al.* (2002) and Elayaraja and Angayarkanni (2007) stated that foliar spray of 2% DAP at boot leaf + 50 % flowering + milky stage were significantly increased LAI, chlorophyll accumulation, dry matter production and rice grain yield as well as main yield components such as filled grains and panicle weight. Furthermore, Kalyanasundaram and Surrndirakumar (2003) reported that among different treatments, NPK+12.5 FYM /ha + 6.25 t/ha + Azosperillum + foliar spray of 2% DAP and 1% KCL at panicle initiation and booting stage recorded the highest number of tillers, leaf area index, dry matter production, at harvest, number of panicles/hill, number of filled grains, grain yield and net return. Sivakumar *et al*. (2007) and Reddy *et al*. (2009) revealed that foliar spray of nutrient viz, 2%DAP + 1% KCl+ 1% Zn SO_4 combination at panicle initiation + boot leaf significantly gave the highest values of growth attributes, dry matter, chlorophyll content, yield attributes, productive tillers, filled grains, panicle weight and grain as well as straw yields and lowest value of sterility %. Regarding the favorable effect of potassium combined phosphorous, Ramanathan *et al* (2002) found that spraying mono potassium phosphate with the concentration of 1% at tillering stage, panicle stage, boot stage and flowering stage significantly surpassed the foliar spray of DAP and basal application of potassium and phosphorous in enhancing rice grain yield and its components.

In view the concept of effective role of P as well as effective P management, the present study was conducted to observe the effect and efficiency of proper P management in standardizing rice productivity under Egyptian conditions.

MATERIALS AND METHODS

The present investigation was conducted in the seasons of 2010 and 2011 at the Farm of Sakha Agriculture Research Station, Kafr-El Sheikh Governorate, Egypt. The soil texture was clayey. EC levels were 1.6, 1.5 dS/m during 2010 and 2011, respectively. The suggested treatments studied the response of Giza 178 rice variety to various alternates of phosphorous management namely; control.(1), basal application of phosphorous at the rate of 54 kg P_2O_5/ha (2), Diammonium phosphate (DAP) spray with the concentration of 2% at mid tillering stage (MT) (3), Potassium triphosphate (KTP) spray at MT 2% (4), DAP spray 2% at panicle initiation(PI) (5), KTP 2% at (PI) (6), DAP spray 2% at booting stage(BT) (7), KTP 2% at (BT) (8),basal application of phosphorous+ 2% of DAP at BT (9), basal application of phosphorous+ 2%of KTP at BT(10), DAP spray at the concentration of 2% at the three growth sage (11) .

Diammonium phosphate (DAP) compound contains 47% of P_2O_5 and 18% N, while; potassium tri-phosphate (KTP) contains 34% K_2O and 47% of P_2O_5. The amount of water for each plot for dissolving the above mentioned compound was calculated based on 500 Lwater/ha. The spraying was done before sun set for avoiding leaf burring and losses. The experiment was laid out in randomized complete block design, with four replications. Seedling of 30 days old of Giza 178 rice variety was transplanted with 3 seedlings $hill^{-1}$, spaced at 20 x 20 cm transplanting was done on May, 1^{st}, and harvested on September10^{th} in both seasons. Nitrogen fertilizer was imposed in 2 doses, 2/3 as basal and 1/3 at panicle initiation (PI). All plots received 165 kg N $ha^{-1}$and 48 K_2O ha^{-1} in the form of urea and potassium sulphate. Plot area was adjusted to$10m^2$ (2 m width*5m length). The soil was clay and the soil chemical properties were listed in Table 1.

Table1: Soil chemical properties at the experimental sites during 2010 and 2011seasons.

seasons	pH	EC dS m^{-1}	Cation (meq L^{-1})			Anion (Meq L^{-1})		
			Ca^{++} + Mg^{++}	Na^+	K^+	$SO_4^=$	Cl^-	HCO_3^-
2010	8.15	1.6	7	12	0.3	8	10	4
2011	8.00	1.5	5	10	0.35	5	9	3
Available nutrients mg kg^{-1}								
	N	**P**	**K**	**Zn**	**S**	**Fe**		**Cu**
2010	31	10.02	395.0	3.22	10.7	5.00		6.2
2011	30	10.05	380.0	3.16	10.5	5.13		6.0

At heading stage, 10 hills from each plot were taken to estimate flag leaf area , flag leaf dry weight, chlorophyll content (SPAD value), leaf are index (LAI) and dry mater (the dry samples were weighed and dry matter g m^{-2} was computed). The dried leaves were ground and kept to determine the P, P uptake and P recovery % according to Yoshida *et al*. (1968).

At harvest, panicles of 10 guarded hills from each plot were counted to determine the number of panicles m^{-2} and also, plant height (cm) was measured. Ten main panicles from each plot were packed to determine panicle length (cm), filled and unfilled grains panicle $^{-1}$, panicle and 1000-

grain weight. The plants of the six inner rows of each plot were harvested, dried, threshed, then grain and straw yields were determined at 14 % moisture content and converted into t ha^{-1}.

All data collected were subjected to standard statistical analysis following the proceeding described by Gomez and Gomez (1984) using the computer program (IRRISTAT). The treatment means were compared using Duncan's multiple range test Duncan (1955). * and ** symbol used in all Tables indicate the significant at 5% and 1% levels of probability, respectively, while, NS means not significant.

RESULTS AND DISCUSSION

Phosphorous content in rice leaves:

Phosphorous application involving single application as foliar or basal and their combination significantly at booting stage increased the measurement of phosphorous nutrient contents in rice leaves in both seasons (Table 2). Regarding P% in leaf, the treatment of basal application plus diammonium phosphate (DAP) spray at booting stage gave the highest values of leaf P content in both years. In the first season, both treatments of basal application plus diammonium phosphate (DAP) spray at booting stage and basal application plus potassium triphosphate (KTP) spray at booting stage were approximately at a par regarding P% with significant difference among them, while in the second season the latter treatment occupied the second rank. On the other hand, the lowest values of phosphorous leaf content were given by control treatment in both seasons. Obviously, the basal application (B) was found to be at the third order regarding p% in both seasons. With respect to P uptake, the response of P uptake to the studied treatments had the same response of p % in rice leaves under current experiment. The lowest values of p uptake were recorded for control followed by KTP spray at MT treatments.

Phosphorus recovery% recoded its highest values when rice plants were sprayed by DAP at booting stage followed by KTP spray at PI and DAP spray at PI in the first season (Table 2). On the contrary the lowest P recovery % were recorded by DAP spray MT +PI + BI and basal (B) application in both seasons. The highest values of P uptake were given by DAP spray at BT + basal application of phosphorous in both seasons. It seems that foliar spray at late growth stage might improve the P recovery and P uptake by increasing the efficiency of rice plant in nutrient uptake and avoiding nutrient uptake problem happened under saline soil. The desired effect of P application might be mainly due to some possibilities. Phosphorus application had positive effect on soil resulted in improving its physical proprieties leading to increase nutrients availability (Qadar, 1998 and Naheed *et al*., 2008). Phosphorous application either basal or foliar spray encourage rice growth involving shoot and root systems resulted in high capability for nutrient uptake. Foliar spray of P increased its content in leaf and avoiding the problem happened under saline soil. Using DAP which has two molecules of NH_4 enhanced the growth of plant and increase the uptake of P

(accompanied ionic effect) that increase the energetic compound such as ATP, NADPH and FADP consequently increase root power and photosynthesis in up -ground parts of rice plants. Similar results were reported by Qadar (1998), Naheed *et al*.(2008) and Zayed *et al.* (2010).

Table 2: Phosphorous %, P uptake and P recovery% of rice as affected by various phosphorous treatments 2010 and 2011 seasons.

Treatment	P %		P uptake kg /ha		P recovery %	
	2010	2011	2010	2011	2010	2011
Control	0.185	0.182	27.21	27.30	-	-
Basal application(B)	0.275	0.270	46.62	45.25	35.94	33.24
DAP spray at MT	0.205	0.200	30.93	30.98	37.20	36.80
KTP spray at MT	0.203	0.210	30.37	30.82	31.60	35.20
DAP spray at PI	0.216	0.207	32.99	31.99	57.80	46.90
KTP spray at PI	0.213	0.205	33.07	31.86	58.60	45.60
DAP spray at BT	0.213	0.213	33.13	32.89	59.20	55.90
KTP spray BT	0.204	0.207	31.91	32.61	47.00	53.10
B+DAP spray at BT	0.315	0.327	54.68	56.33	42.92	45.36
B+KTP spray at BT	0.309	0.314	54.07	53.36	41.96	40.72
DAP spray MT+PI+BT	0.232	0.235	36.41	37.83	30.33	35.40
F test	**	**	**	**	-	-
LSD at 5%	0.005	0.004	1.70	1.73	-	-

MT= mid- tillering, PI= panicle initiation, and BT= the beginning of booting stage.

Flag leaf characteristics:

Flag leaf was played an important role in improving rice grain yield formation and its maximization, and their role is more beneficial for obtaining reasonable yield. Thereby, data in (Table3) reveal that phosphorous application as basal, foliar spray apart and in combination at beginning of booting stage significantly improved flag leaf characteristics; flag leaf area, flag leaf dry weight and chlorophyll content comparing with their control. The improved previous mentioned traits reach to their maximum values when rice plants were fertilized by phosphorous as basal + sprayed KTP or DAP at booting without significant between them. Phosphorous basal application and DAP foliar spray came in the second rank regarding their favorable effect of flag leaf characteristics. On the other hand, the control treatment (non of phosphorous application) exerted the lowest values of studied flag leaf characteristics.

Phosphorous application *via* root medium might be promoted and accelerated early rice growth as well as enhanced rice vigorous by improving root growth. At the same time, rooting medium phosphorous application using calcium super phosphate might induce improving in soil physical and chemical prosperities. Furthermore, spraying P at late growth stage might increase some biochemical compound such as RNA and DNA as well as ATP resulted in cell elongation and division leading to heavy flag leaf and largest area. Both large leaf area and heavy one is a good indicator its properness under current situation and their high capability of photosynthesis process.

Phosphorous application treatments either as basal or spray particularly at late growth stage markedly increased the nutrient content in the rice leaves and delayed chlorophyll degradation which increased chlorophyll content which contribute to high photosynthesis rate. Moreover, as previously detected phosphorous application keep the vital role of flag leaf might enable it to increase its photosynthesis rate. Improving flag leaf characteristics might be increased its photosynthesis rate resulted in improving grain filling leading to reduction in sterility % in rice grains. Generally, the lowest values of flag leaf characteristics were recorded by control treatment application. These results are in accordance with those reported by Reddy *et al*. (2009) and Zayed *et al*. (2010)

Table 3 : Flag leaf area (cm^2), flag leaf dry weight (g) and chlorophyll content in flag leaf of rice as affected by various phosphorous treatments during 2010 and 2011 seasons.

Treatment	Flag leaf area (cm^2)		Flag leaf dry weight (g)		Chlorophyll flag leaf SPAD Value	
	2010	2011	2010	2011	2010	2011
Control	37.33	37.69	0.147	0.148	41.74	41.17
Basal application(B)	41.26	41.69	0.183	0.191	43.90	43.98
DAP spray at MT	40.22	40.28	0.184	0.188	44.62	44.83
KTP spray at MT	39.42	39.97	0.179	0.176	43.09	41.76
DAP spray at PI	41.08	41.02	0.177	0.187	45.57	45.73
KTP spray at PI	40.22	40.46	0.182	0.189	43.13	43.53
DAP spray at BT	40.95	42.31	0.183	0.163	43.41	43.80
KTP spray BT	41.02	41.8	0.193	0.187	44.27	44.37
B+DAP spray at BT	42.68	43.61	0.199	0.203	45.60	45.59
B+KTP spray at BT	42.90	43.54	0.203	0.202	45.52	45.57
DAP spray MT+PI+BT	40.20	41.54	0.188	0.196	45.01	45.12
F test	**	**	**	**	**	**
LSD at 5%	1.05	0.94	0.018	0.026	1.33	1.41

MT= mid- tillering, PI= panicle initiation and BT= the beginning of booting stage.

Growth parameters at heading stage.

Data presented in Table 4 indicated that phosphorus application as basal and foliar as well as their combination at booting growth stage significantly and positively affected growth parameters, i.e. leaf area index (LAI), dry matter gm^{-2} and plant height in both seasons.

Interestingly, phosphorous application pronounced improved leaf area indexes in both seasons of study and that was true with all methods of application at various growth stages. The largest leaf area index was produced by phosphorus application as basal + DAP spray at booting stage followed by basal application + KTP 2% sprayed at booting stage without any significant differences between those treatments

Basal application + KTP spray at BT, DAP at MT+PI+BT and basal application alone were comparable regarding LAI in both seasons. Meanwhile, the lowest values of LAI were produced by control treatment in both seasons.

The highest estimated values of dry matter were recorded by phosphorus application as basal +DAP or +KTP at BT without any significant difference between them in the first season, while such estimates were significant in the second season followed by basal application (B) in the both seasons. However the lowest values of dry matter production were recorded when rice plants did not received any phosphorus fertilizer and when it were fertilized by KTP at MT treatments in both seasons (Table4)

Continuously, the tested phosphorous treatments significantly affected plant height in both seasons, basal phosphorus application + KTP spray at BT stage gave the tallest plant ,while control treatment (non P application) gave the shortest plant. The treatments of P basal application + fliar spray either DAP or KTP at BT growth stage, DAP spray at MT, PI and BT and alone phosphorus application were at a par regarding plant height.

As previously mentioned the phosphorous application either through soil or foliar and their combination significantly improved nutrient availability and contents, early growth and might be raised photosynthesis rate. Furthermore, cell division and elongation resulted in higher dry matter production, large leaf area and proper tall plants. These results were in harmony with those reported by Kalyanasundaram and Surrndirakumar (2003), Elayaraja and Angayarkanni (2007), Reddy *et al. (*2009) and Zayed *et al*. (2010).

Table (4); Leaf area index (LAI), dry mater production and plant height at heading stage of rice as affected by various phosphorous treatments during 2010 and 2011 seasons.

Treatment	LAI		Dry matter g m^{-2}		Plant height	
	2010	2011	2011	2011	2010	2011
Control	5.50	5.58	1470.8	1500.5	97.0	97.3
Basal application(B)	6.23	6.09	1695.3	1663.5	103.6	103.3
DAP spray at MT	5.96	5.86	1508.8	1521.0	100.6	100.8
KTP spray at MT	5.97	5.95	1496.3	1505.5	97.8	98.0
DAP spray at PI	6.06	5.97	1527.3	1545.5	97.8	98.0
KTP spray at PI	6.07	6.01	1552.5	1554.0	98.1	98.3
DAP spray at BT	6.32	6.14	1555.3	1547.0	99.1	99.3
KTP spray BT	6.49	6.28	1563.3	1575.5	98.3	98.5
B+DAP spray at BT	6.65	6.53	1735.8	1722.5	104.3	104.5
B+KTP spray at BT	6.42	6.37	1749.8	1699.3	105.8	106.0
DAP spray at MT+PI+Bt	6.21	6.07	1569.5	1609.8	102.3	102.5
F test	**	**	**	**	**	**
LSD at 5%	0.33	0.30	64.97	60.52	3.40	3.50

MT= mid- tillering, PI= panicle initiation and BT= the beginning of booting stage.
MT= mid- tillering, PI= panicle initiation, BT= the beginning of booting stage.

Yield components:

Data in Tables 5, 6 and 7 revealed that phosphorus application significantly influenced yield components of rice in both seasons. That was true with all treatments of phosphorus application in both seasons.

As for tiller numbers, phosphorus application in different forms and methods at different growth stages significantly affected tillers number $hill^{-1}$ in both seasons of study. General speaking, the treatment of phosphorus basal application gave the highest value of tillers number $hill^{-1}$ in both seasons (Table5). The treatments of phosphorus basal application +KTP and DAP foliar spray followed by BT and they were comparable regarding tillers number in both seasons. Non phosphorus application treatment produced the lowest values of tillers number $hill^{-1}$ in both seasons.

The treatments of basal application and B + KTP spray at BT in both seasons, respectively, produced the highest numbers of panicles hill^{-1} .On the other hand, the lowest values of panicles number hill^{-1} were recorded when rice plants didn't receive any phosphorous (Table 5).

Table 5: Tiller and panicle numbers hill^{-1}, and panicle length of rice as affected by various phosphorous treatments during, 2010 and 2011 seasons.

Treatment	Tiller numbers hill^{-1}		Panicle numbers hill^{-1}		Panicle length (cm)	
	2010	2011	2010	2011	2010	2011
Control	20.75	19.75	19.15	18.30	21.7	21.9
Basal application(B)	24.25	25.50	23.25	23.50	23.7	23.3
DAP spray at MT	22.25	21.50	20.50	20.25	22.1	22.8
KTP spray at MT	21.20	20.75	20.00	19.50	22.2	22.5
DAP spray at PI	22.00	21.25	20.70	20.00	22.2	22.1
KTP spray at PI	21.25	20.50	20.25	18.75	22.0	21.8
DAP spray at BT	22.00	21.25	21.00	19.50	22.8	21.9
KTP spray BT	21.25	20.50	20.50	19.25	23.8	22.6
B+DAP spray at BT	23.50	23.65	22.25	22.50	23.2	23.8
B+KTP spray at BT	22.90	23.50	21.75	22.25	23.9	24.0
DAP spray at MT+PI+Bt	21.75	21.00	20.25	20.00	22.5	23.0
F test	**	**	**	**	**	**
LSD at 5%	1.27	2.00	1.40	1.73	0.93	0.94

Data in Tables 5, 6 and 7 demonstrated that the treatments of phosphorus basal application plus DAP and KTP spraying at the beginning of booting stage significantly surpassed other phosphorus fertilizer application treatments. Phosphorus basal application plus DAP gave the maximum values of filled grains panicle^{-1}, panicle weight 1000-grain weight and grain yield followed by basal application (B) with some exception and they were increasing grain yield from 1.3 to 1.8 t/ha^{-1}over the control.

At the same time, the treatments of phosphorus basal application plus DAP and KTP spraying at the beginning of booting stage gave the lowest values of number of unfilled grains panicle^{-1}. The control treatment (non phosphorus fertilizer) recorded the lowest values of yield components and the highest, unfilled grains panicle^{-1}. It could be concluded that both root medium of phosphorus application and foliar application starting from panicle initiation growth stage up to booting stage is more essential for high yield components.

Root medium phosphorous application might be improve of physical and chemical properties of soil leading improving growth of rice under such conditions. Phosphorus application in combination as basal or foliar spray might increase nutrient availability, improving nutrient contents and uptake as seen previously and subsequently encourage growth of rice and photosynthesis. Increasing K^+ uptake in rice plant improved growth, photosynthesis, increased the leaf rice healthy particularly flag leaf area characteristics and increasing P content in leaf at growth stage particularly during reproductive stage and active tillering stage that might improve current photosynthetic rate. Expected improving current photosynthesis rate by late phosphorous application might improved grain filling processes resulted in higher value of filled grains, lower value of unfilled grains panicle^{-1},heaviest panicle and 1000-grain weight and encouraged rice plant to produce more bearing panicle. All previous reasons provide reasonable yield components. Similar findings are reported by Kalyanasundaram and Surrndirakumar (2003), Elayaraja and Angayarkanni (2007), Reddy *et al*. (2009) and Zayed *et al.* (2010).

Table 6: Filed grains number panicle^{-1}, unfilled grains number /panicle and panicle weight of rice as affected by various phosphorous treatments during 2010 and 2011 seasons.

Treatment	Filled grains panicle^{-1}		Unfilled grains panicle^{-1}		Panicle weight (g)	
	2010	2011	2010	2011	2010	2011
Control	125.5	123.3	32.0	36.0	3.05	2.88
Basal application(B)	143.8	142.5	23.0	29.0	3.34	3.22
DAP spray at MT	125.0	120.8	28.0	28.5	3.11	2.84
KTP spray at MT	127.8	126.5	28.0	32.8	3.10	3.12
DAP spray at PI	128.0	130.3	23.5	24.8	3.21	2.95
KTP spray at PI	131.0	126.3	23.8	27.5	2.99	2.98
DAP spray at BT	134.5	133.0	20.3	24.5	3.02	3.37
KTP spray BT	138.0	134.3	18.3	22.3	3.12	3.08
B+DAP spray at BT	148.8	147.3	15.8	17.0	3.55	3.48
B+KTP spray at Bt	147.3	145.5	15.5	20.5	3.42	3.46
DAP spray at MT+PI+Bt	140.3	140.5 b	19.3	19.8	3.16	3.09
F test	**	**	**	**	**	**
LSD at 5%	4.9	5.2	3.94	4.98	0.17	0.22

MT= mid- tillering, PI= panicle initiation and BT= the beginning of booting stage.

Table 7: 1000-grain weight and grain yield and yield increase over control t/ha^{-1} of rice as affected by various phosphorous treatments during 2010 and 2011 seasons.

Treatment	1000 grain weight (g)		Grain yield t ha^{-1}		Yield increase over control t ha^{-1}	
	2010	2011	2010	2011 g	2010	2011
Control	20.6	21.84	10.24	10.15	-	-
Basal application(B)	21.8	23.11	11.07	11.34	0.841	1.184
DAP spray at MT	20.9	22.13	10.52	10.67	0.284	0.518
KTP spray at MT	20.9	22.15	10.35	10.45	0.117	0.297
DAP spray at PI	20.5	21.70	10.86	10.79	0.618	0.635
KTP spray at PI	21.3	22.56	10.60	10.70	0.367	0.551
DAP spray at BT	22.0	23.32	10.60	10.70	0.367	0.551
KTP spray BT	22.0	23.32	10.57	10.84	0.334	0.685
B+DAP spray at BT	22.4	23.74	11.71	11.92	1.453	1.770
B+KTP spray at BT	22.3	23.64	11.57	11.67	1.333	1.517
DAP spray at MT+PI+Bt	21.1	22.37	10.91	11.01a	0.668	0.852
F test	**	**	**	**	-	-
LSD at 5%	0.86	0.91	0.63	065		

MT= mid- tillering, PI= panicle initiation and BT= the beginning of booting stage.

Economic values:

Data arranged in Table 7 indicated that rice grain yield was significantly improved by various phosphorus application alternatives at different growth stage comparing with non phosphorus application. Marked improvement in rice grain has been detected as a result of phosphorus application for rice root media plus foliage application at booting stage. Phosphorous basal application+ DAP spray at booting stage recorded the highest values of grain yield in the two seasons of study without any significant differences with those produced by phosphorous basal application + KTP spray at booting stage which came in the second order in this issue (Table7). Meanwhile, the lowest values of rice grain yield were produced when no phosphorous was applied. Also, it was found that the treatments of phosphorous basal application + KTP spray at booting stage, DAP spray at The three studied growth stages and basal phosphorous application alone were at a par regarding rice grain yield in the second season. In both seasons both treatments of DAP spray at The three growth stages and phosphorous basal application alone were at a par regarding rice grain yield.

From going discussions, it could be observed that both of early phosphorous application and via root medium and late phosphorous application via foliage was found to be effective for rice growing under saline soil .Basal application via root medium improved soil properties, root growth, rice growth during vegetative stage resulted in high dry matter production during post –head stage late phosphorus application on sure healthy growth for active leaves particularly flag leaves.

Table 8: Economic values of rice as affected by various phosphorous treatments under.

Treatment	Production of yield increase over control IE ha^{-1}		Cost of applied phosphorous LE ha^{-1}		Value cost ratio		Net return LE ha^{-1}	
	2010	2011	2010	2011	2010	2011	2010	2011
Control	-	-	-	-	-	-	-	-
Basal application(B)	1670	2368	288	288	5.79	8.22	1382	2080
DAP spray at MT	568	1036	50	60	11.36	17.26	518	970
KTP spray at MT	234	1270	120	130	1.95	9.76	114	1140
DAP spray at PI	1236	594	50	60	24.72	9.9	1186	534
KTP spray at PI	734	1102	120	150	6.12	7.34	614	952
DAP spray at BT	734	1102	50	60	14.68	18.36	684	1042
KTP spray BT	668	1370	120	130	5.73	10.53	548	1240
B+DAP spray at BT	2866	3540	338	348	8.47	10.17	2528	3192
B+KTP spray at BT	2666	3034	408	418	6.53	7.26	2258	2616
DAP pray at MT+PI+Bt	1336	1704	150	180	8.90	9.46	1180	1524

Average paddy rice price from Oct 2010 to Oct 2011= 2000LE/metric tone.

Furthermore phosphorus application in combination with nitrogen or potassium increased energy compounds such as ATP in flag leaf increased energy compounds such as ATP in flag leaf increased current photosynthesis and translocation to rice grain improving panicle improving panicle characteristics leading to higher grain yield. It promotes vigorous, early plant growth and development with strong root systems and profuse tillering, in addition to flowering, fruiting, and many other biochemical processes in the plant.

From data documented in Table 8, the most economic treatment and applicable one is basal application of recommended phosphorous+ DAP at BT(13) which gave the highest value of net return LE ha^{-1}, medium rate of value cost ratio and almost the highest value of yield increase over control. The highest values of value cost ratio was produced by DAP% at PI and BT in the first and second seasons, respectively, (Table 8). By the way, foliar application of phosphorus at late growth stage combined with early application via rooting medium as basal is urgent need conditions from the point view of yield and economic as well as salinity hazardous effect alleviation. Similar data had been reported by Ramanathan *et al*. (2002) Kalyanasundaram and Surrndirakumar (2003), Elayaraja and Angayarkanni (2007), Reddy *et al*. (2009) and Zayed *et al.* (2010).

It could be concluded that both phosphorous application as basal + foliar application at late growth stage was found to be much needed for high grain yield of rice under Egyptian conditions.

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دور إدارة الفسفور المثلى في زيادة إنتاجية الأرز تحت الظروف المصرية

بسيونى عبدالرازق زايد و احمد محمد الاختيار وعلي عبدالله أبو خليفة و إبراهيم عثمان الرويني
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إدارة المحصول المتكاملة للأرز هي ألاستراتجيه الرئيسية وذلك لتعظيم إنتاجية المحصول في مصر ومن ثم فان إضافة بعض العناصر الغذائية للنبات مثل الفسفور بصورة مثلي سوف تساهم في زيادة إنتاجيته تحت الظروف المصرية مع المحافظة علي خصوبة التربة .

أجريت تجربة خلال موسمى ٢٠١٠و ٢٠١١ بالمزرعة البحثية لمحطة بحوث سخا الزراعية بكفر الشيخ وذلك فى تربه طينية.وصممت المعاملات لدراسة استجابة الصنف جيزة ١٧٨ لتباديل مختلفة من إضافة الفوسفور وذلك بغرض رفع إنتاجيته, وكانت المعاملات هي المعاملة الكنترول بدون اى إضافات, إضافة الموصي بة مخلوط بالتربة, رش النباتات بفوسفات الألمونيوم الثنائية بنسبة ٢% في مرحلة التفريع المتوسط, الرش بـ ٢ % بوتاسيوم ثلاثي الفوسفات عند مرحلة التفريع المتوسط, ٢ % فوسفات الأمونيوم الثنائية عند مرحلة بداية تكوين السنبلة, ٢ % رشاً ببوتاسيوم ثلاثي الفوسفات عند مرحلة بداية تكوين السنبلة, الرش بـ ٢% فوسفات الأمونيوم الثنائية عند مرحلة بداية طور الحبلنة, الرش ٢ % ببوتاسيوم ثلاثى الفوسفات عند مرحلة بدايه طور الحبلنة الرش بكل منهما عند نفس الطور+ الإضافة الأرضي و الرش ٢% من فوسفات الأمونيوم الثنائيه عند المراحل الثلاثة معا .

وكانت أهم النتائج كالتالي:

أثرت المعاملات معنويا على محتوى الأوراق من الفوسفور , ومعدل امتصاصه و كذلك رفع كفاءة امتصاصه. نجحت معاملات إضافة الفوسفور سواء أرضى أو رشاً أو كليهما معاً عند المراحل المختلفة فى تحسين النمو وكذلك كل الصفات المساهمه فى تكوين المحصول ومحصول الحبوب, حيث وجد أن اعلي القيم للمحصول ومكوناته وكذلك صفات النمو المقاسه فى مرحلة الطرد سجلت عند رش النباتات بفوسفات الأمونيوم الثنائية أو بوتاسيوم ثلاثى الفوسفات عند مرحلة بداية الحبلنة + الإضافة الأرضي بدون فرق معنوي.

ومن الناحية الإقتصاديه فان المعاملة الرش بـ فوسفات الأمونيوم الثنائية + الإضافة أرضى للفوسفور الموصى بها حيث أعطت أعلى صافى ربح وعليه يمكن التوصية بهذه المعاملة تحت الظروف المصرية.

قام بتحكيم البحث

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