Foliar nutrition of PeaK on rice

RAMANATHAN Samidurai (1)**, STALIN Palaniandi** (1)**, THILAGAVATHI Thiagarajan** (1)**, NATARAJAN Kalyanasundara** (1) **and ANKORION Yossi** (2)

(1) Tamil Nadu Rice Research Institute, Aduthurai, 612 101, Tamil Nadu, India
(2) Nova PeaK Division, Rotem-Amfert-Negev Ltd., Israel

Abstract

Field experiments were conducted in the Cauvery Delta Zone of Tamil Nadu in wet and dry seasons of 1999-2000 in two soils i.e., silty clay (Typic Haplustert) and sandy loam (Udic Haplustalf), to study the efficacy of foliar application of "Mono Potassium Phosphate" (PeaK) at different concentrations viz., 0.5 and 1.0 percent of PeaK alone and in combination with 1 percent urea and compared with 2 percent Diammonium phosphate +1 percent urea + 1 percent Muriate of potash spray. Different stages of spraying viz., seed, nursery bed, end of tillering, panicle initiation and booting stages were tried. Seventeen treatment combinations replicated thrice in randomized block design were compared in rice in dry and wet seasons. The results of dry season experiment in the silty clay soil indicated that application of one percent PeaK was found to be the best concentration and the spray given at end of tillering and panicle initiation recorded the highest grain yield (5,412 kg/ha) as compared to soil application of 50:50 kg/ha of P_2O_5 and K_2O, respectively, (4,005 kg/ha) which could not meet the requirement of P and K, and needs supplementary addition through foliar spray of 1 percent PeaK at the critical stages viz., end of tillering and panicle initiation stages. However, the results of the grain yield obtained in the dry and wet seasons of sandy loam soil, and the wet season of silty clay soil indicated that the supplementation of P and K through 1 percent PeaK as seed enrichment, and spray at nursery, panicle initiation and booting stages recorded the highest grain yield (5,303-6,123 kg/ha). The supplemental requirement of P and K nutrients right from the early stages viz., seed enrichment upto booting besides the soil application indicated that the crop utilization of these two nutrients is comparatively slow but continuous in the wet season due to the prevailing occasional low temperature (below 20^0C) irrespective of the soils compared. The favourableness of getting higher yield with the same treatment in the sandy loam soil in the dry season could be ascribed to the clay mineralogy of the soil (kaolinite) which is not providing adequate quantities of the two nutrients during the growth phases despite the supply of these nutrients through soil.

Keywords: PeaK, foliar nutrition of PeaK, rice response to PeaK

Introduction

Rice forms the staple food in Asia and south East Asia and in India about 70 per cent people are rice eaters. India has the largest area under rice in the world (42.7 million ha) but producing only 123 million tonnes with the productivity of 2.9 t/ha. Tamil Nadu is an important rice growing state in India because of its geographical position with favorable soil, irrigation potential and climatic conditions. As such rice is

grown in this state in an area of 21 lakh ha with an annual production of 81.92 lakh tonnes of rice, ranking number one state in the productivity (3.9 t/ha). Cauvery Delta Zone known as the rice granary of the south is a major rice growing tract in Tamil Nadu.

In the rice cultivation, the farmers are bestowing much attention only to N fertilization and very often P and K application are carried out at minimal level, sometimes totally withheld. This practice of imbalance and inadequate fertilizer application affects the soil productivity in general, particularly depletes the essential nutrients. (Cassman *et al.,* 1996) Nutrient management practice determines the sustainability of most of the intensively cropped systems. (Flinn and De Datta, 1984; Flinn *et al.,* 1982). However, the practice of correct dose and timely application of fertilizer nutrient plays an important role in efficient use of fertilizers. At times, the indiscriminate and improper application with unfavorable conditions may not provide adequate nutrients supply of required fertilizer nutrients because of its poor absorption and translocation in plant system. Therefore, there is an imperative need to provide the required nutrients over and above the regular soil application through foliar nutrition practice. such foliar application practice in rice is in vogue in the Philippines and other south east countries. Mono Potassium Phosphate popularly known as Peak, a product from Rotem Amfert Negev Ltd., Isreal which is a nitrogen free fertilizer, due to its inherent properties such as low salt index with totally free of heavy metals could be used as foliar spray to provide supplementary dose of P and K with usual rate and time of soil application of these two nutrients. This product viz., Peak has brought very spectacular yield increase and quality in vegetable, fruits and flower crops both in green house as well as in field conditions particularly in tropical and subtropical situations (Williams and Kafkafi, 1995; Lavon, 1995; Yogaratnam and Sharples, 1982). In this line an attempt was made to asses the efficacy of foliar nutrition of Peak in two soil situations under irrigated rice in 3 duration rice varieties (Local popular varieties) viz., short, medium, long duration both in dry and wet seasons in the traditional rice cropped are of Cauvery Delta Zone.

Material and Methods

Filed experiments were carried out at Tamil Nadu Rice Research Institute (TNRRI), Aduthurai, Old Cauvery Delta (Cauvery Basin) and at Soil and Water Management Research Institute (SWMRI), Thanjavur, New Cauvery Delta (Grand Anaicut canal Basin) of Tamil Nadu during 1999-2000 in dry seasons as well as wet seasons. The soils of experimental sites were silty clay (Typic Haplustert) at Aduthurai and sandyloam (Udic Haplustalf) at Thanjavur. The data on the analysis of initial soil samples (0-15 cm depth) for organic carbon, pH, Ec, available N, P and K are furnished in Table1.

The experiment was laid out in a randomized block design with three replications comprising 17 treatments, as listed in Table 2. Recommended level of N, P and K applied as soil application was 125 kg N, 50 kg P_2O_5 and 50 kg K_2O per hectare for dry season (June-September) and 150 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare for wet season 1 (August-December/January) and wet season 2 (October-February). Gypsum and $ZnSO_4$ were applied basally @ 500 kg and 25 kg ha^{-1} respectively. The N, P and K were applied through urea, single superphosphate and muriate of potash respectively. Nitrogen and Potash were applied as split doses as given in Table 3. Mono Potassium Phosphate (peak) was given as foliar spray at different concentration and timing as per treatment schedule (Table 2).

Table 1 Soil physical and chemical properties (Initial analysis).

Location	Season	Soil type	pH 1:1H^2O	Electrical Conductvity	Organic Carbon (Walkley Black)	Total N (Kjeldahl)	C:N ratio	Extractable Bases (1 M NH_4OAc, pH 7) Extractable P Olsen's	Extractable P Bray/Kurtz	Potassium K	Effective CEC
				mm/cc	(%)	(%)		(ppm)	(ppm)	(cmol/kg)	(cmol/kg)
Location	*Season*	*Soil type*	*pH*	*Ec*	*OrgC*	*Total N*	*C:N ratio*	*POLSen*	*PBray*	*K*	*CEC*
TNRRI	Dry season 1999	Silty clay	7.4	0.5	0.78	0.074	10.6	19.3	48.8	0.479	29.8
Old Delta	Wet season 1 2000	Silty clay	7.05	0.6	0.85	0.77	11	18.8	43.6	0.46	28.3
	Wet season 2 2000	Silty clay	7.33	0.45	0.76	0.077	9.9	19.6	49.3	0.499	29.3
SWMRI	Dry season 1999	Sandy loam	6.9	0.32	0.45	0.058	7.8	13.1	35.4	0.187	8.0
(New Delta)	Wetseason 2 2000	Sandy loam	6.88	0.35	0.47	0.061	7.8	14.9	37.5	0.168	8.0

Table 2 Treatment details.

Tr.No	Treatment details	Spray 1	Spray 2	Total MKP (kg/ha)	Remarks
1	0.5 % PeaK	End of tillering	Panicle initiation	4 – 6	
2	1 % PeaK	End of tillering	Panicle initiation	4 – 6	Vietnamese System
3	0.5 % PeaK	Panicle initiation	Booting to heading	4 – 6	Chinese system
4	1 % PeaK	Panicle initiation	Booting to heading	8 – 12	
5	1 % PeaK		Panicle initiation	4 – 6	
6	0.5 % PeaK + 0.5% Urea	End of tillering	Panicle initiation	4 – 6	N:P:K in spray 1:1:1
7	1 % PeaK + 1% Urea	End of tillering	Panicle initiation	8 – 12	N:P:K in spray 1:1:1
8	1 % PeaK + 1% Urea	Panicle initiation	Booting stage	8 – 12	N:P:K in spray 1:1:1
9	0.5 % PeaK	End of tillering	Panicle initiation	6 – 8	3rd spray at booting to heading
10	1 % PeaK	End of tillering	Panicle initiation	8.5 – 12.5	Same as T2 but additional PeaK sprayed on seed bed few days before puling the seedling
11	Control	With out foliar application of PeaK			
12	1 % PeaK on seed	With out foliar application of PeaK			Same as T11 but seeds soaked for 24 hrs in 1 % PeaK
13	2 % DAP + 1% Urea + 1 % MOP	Panicle initiation	Booting stage	DAP–10kg Urea-5Kg MOP-5Kg	
14	1 % PeaK on seed + 1 % PeaK on nursery few days before pulling				
15	1 % PeaK on seed + Nursary + 1 % PeaK + 1 % Urea	Panicle initiation	Booting stage	8 – 12 Kg	
16	1 % PeaK on seed+ 1% PeaK on nursery few days before pulling without PK fertilizer application in soil				
17	1 % PeaK on seed + nursery + 1% PeaK + 1% Urea but with out PK fertilizer application in soil	Panicle initiation	Booting stage	8 – 12 Kg	

Note: Treatments (1-15) will receive recommended dose of NPK, secondary and micronutrients. Treatments 16 and 17 will receive recommended dose of N, secondary and micronutrients

Table 3 Time of split application of N and K.

Season	Number of split doses				
	I	II	III	IV	V
Dry	N + K basal	N 15 DAT*	N+K 30 DAT	N 45 DAT	-
Wet 2	N + K basal	N 20 DAT	N+K 40 DAT	N 60 DAT	-
Wet 1	N + K basal	N 20 DAT	N+K 40 DAT	N+K 60 DAT	N 80 DAT

* DAT–Days after transplanting

Uniform plot size of 6 m x 5 m ($30m^2$) was adopted for this experiment. Need based plant protection measures were taken up against pests and diseases. Locally popular rice varieties viz., ADT 43, ADT 44, ADT 38 and ADT 39 were used as test crops in dry season, wet season 1, and wet season 2 respectively. At Thanjavur, the experiment was not conducted in wet season 1.

At harvest, the grain and straw yields were recorded from a harvest area of 5 m^2 in each treatment plots and the data on grain yield were adjusted to 14 percent moisture in all the three seasons. Yield components like productive tillers/hill, number of filled grains per panicle and number of unfilled grains per panicle (except in dry season at Thanjavur) were recorded. Grain: straw ratio was worked out. The results are presented hereunder.

Results and Discussion

Yield attributes

Aduthurai

The results presented in Table 4 in general showed that the supplemental foliar spraying of nutrient elements registered clearly higher number of productive tillers in all the three seasons (dry season and wet seasons) when compared to soil application of NPK alone (control). In dry season, the foliar spraying of 1% Peak twice at the end of tillering and panicle initiation (PI) in the treatment T_2 gave significantly the highest number of productive tillers/hill (9.9), while the control registered the lowest number of 6.3 productive tillers/hill. Ramos *et al*. (1999) also found that soil application of NPK plus 1% Peak sprayed at twice resulted in the highest number of panicles per unit area. During wet seasons 1 and 2, significantly higher number of productive tillers were recorded in the treatment T_{15} viz., 1% peak on seed + nursery + 1% peak + 1% urea at PI and booting stages.

The number of filled grains/panicle did not show much difference among various treatments during dry season, while it exhibited significant differences in wet seasons. Significantly higher number of filled grains/panicle was recorded in treatments T_{10} (1% peak spray at the end of tillering and PI plus peak spray on nursery few days before pulling out of the seedling) and T_{15} (1% peak on seed +1% peak and 1%urea at PI and booting stage), on comparison with control (T_{11}) as evidenced from the Table 4. The results indicated that the grain filling, which is normally low during wet season due to cloudy weather conditions, is favoured by the compliment at foliar spraying of nutrients. The results in Table 4 further showed that the number of unfilled grains/panicle varied

form 3.1 to 11.5 in all the three seasons and there was no clear trend due to various treatments imposed.

Table 4 Effect of peak foliar spray on the yield attributes of rice at TNRRI, Aduthurai.

Treatment	Dry season			Wet season 1			Wet season 2		
	No. of productive tillers per hill	No. of filled grains/ panicle	No. of unfilled grains/ panicle	No. of productive tillers per hill	No. of filled grains/ panicle	No. of unfilled grains/ panicle	No. of productive tillers per hill	No. of filled grains/ panicle	No. of unfilled grains/ panicle
T1	9	68	6.9	7.9	69.3	6.4	8	57.4	8.1
T2	9.9	74.7	7.1	8.7	74.9	5.9	9	61.9	10.3
T3	8.6	72.6	7	7.5	71.6	5.8	7.7	59.1	8.8
T4	8.9	71.1	6.9	8.6	76	4.3	8.8	61.3	8.1
T5	9.3	68.4	6.6	7.8	78.7	11.5	7.8	59.4	7.2
T6	7.3	67.3	3.1	7.7	68.7	4.5	8.4	53.7	6.4
T7	8.4	70.9	7.9	8.3	74.9	7	8.7	60.9	7.8
T8	8.2	66.7	7	8	71.4	7.1	8.6	58.3	6.9
T9	9.9	58	4.7	8.5	80.2	8.4	8.9	55.4	9.2
T10	8.4	64.1	4.4	9	88	7.2	9.6	59.1	8.8
T11	6.3	68.2	7.9	6.7	71.4	5.3	7.3	59.8	8.2
T12	8.4	69	5.6	7.4	70.3	5.4	7.6	57.3	7.2
T13	8.6	69.2	10.1	8.4	82.2	5.6	9.2	53.8	6.8
T14	8.9	68	9.5	7.7	74.8	5.5	8	58.2	6.4
T15	8.6	67	10.2	9.5	86.2	6.5	10	53.9	5.6
T16	8.1	67.1	5.7	7.9	65.7	7	6.7	63.1	8.2
T17	7.1	67.1	7.3	7.6	70.3	6.5	7.4	60.5	8
CD (5%)	1.74	NS	3.8	0.38	4.4	2.8	0.63	NS	2.2

Thanjavur

The data on yield attributes in wet season 2 1999-2000 (Table 5) revealed that significantly higher number of productive tillers/hill was recorded in the treatments T_{10} and T_{15} compared to control (T_{11}). The number of filled grains unfilled grains per panicle did not vary significantly among various treatments.

Grain yield

Aduthurai

The grain yields obtained in three seasons viz., dry season, wet season 1 and 2 are presented in Table 6. The yield data in general revealed that there is a positive response for Mono Potassium Phosphate (peak) as foliar spray/and seed soaking in increasing the rice grain yield. During the dry season with short duration variety (ADT 43) the application of 1% peak spray twice at the end of tillering and PI (T_2) registered significantly higher grain yield (5412 kg/ha) than control which recorded only 4005 kg/ha (T_{11}). The treatment T_2 was however on par with T_{15} (1% PeaK spray on seed + nursery and 1% PeaK + 1% urea at PI and booting stage), T9 (0.5% PeaK thrice at end of tillering, PI and booting stages) and T_{13} (2% DAP + 1% Urea + 1% MOP at PI) recording grain yields of 4,883, 4,720 and 4,674 kg/ha respectively.

Table 5 Effect of PeaK foliar spray on the yield attributes of rice at SWMRI, Thanjavur (Wet season 2).

Treatment	No. of productive tillers per hill	No. of filled grains per panicle	No. of unfilled grains per panicle
T1	6.4	66.2	4.3
T2	7.0	67.7	4.3
T3	6.3	65.3	4.1
T4	6.6	71.0	4.3
T5	6.4	66.9	4.8
T6	6.1	66.5	3.5
T7	6.6	67.4	3.7
T8	6.6	65.9	5.2
T9	6.6	69.0	3.5
T10	7.5	64.4	3.6
T11	6.0	66.0	4.9
T12	5.9	65.7	5.3
T13	6.5	66.2	4.0
T14	6.5	63.8	4.3
T15	7.5	68.7	4.5
T16	5.8	64.3	4.1
T17	6.2	66.6	3.9
CD (5%)	0.35	NS	NS

The yield data in Table 6 further showed that during wet season 2 with medium duration variety (ADT 38), the highest grain yield of 4,844 kg/ha was obtained in T_{15}, which is on par with T_{10} recording a grain yield of 4,519 kg/ha. The grain yield recorded in the control (T_{11}) was only 3,213 kg/ha. In wet season 1 with long duration variety (ADT 44), the significantly highest grain yield of 6,123 kg/ha was obtained in T_{15} which is on par with T_9 with a grain yield of 6,075 kg/ha whereas the grain yield recorded in the control (T_{11}) was 4,406 kg/ha. As observed earlier, the higher number of productive tillers/hill might have contributed to higher grain yield in the respective treatments for all the three seasons studied.

The data grain: straw ratio calculated for various treatments showed (Table 6) that it depicts significant differences in all the three seasons. The treatments with higher grain yields had normally higher grain: straw ratio in the present study.

Thanjavur

During dry season with short duration variety (ADT 43) the yield data presented Table 7 showed that the higher grain yield of 5,303 kg/ha was realized in T_{15} which was on par with T_{13} with a grain yield of 4,860 kg/ha and T_2 recording a grain yield of 4729 kg/ha. In the control (T_{11}), only 3,471 kg/ha grains were obtained. Though the grain straw ratio was numerically higher in T_{15}, T_{13} and T_2, the differences were not significant.

Table 6 Effect of peak foliar spray on Grain yield (kg/ha) and Grain: straw ratio of rice in TNRRI, Aduthurai.

Treatment	Dry season		Wet season 1		Wet season 2	
	Grain yield	Grain straw ratio	Grain yield	Grain straw ratio	Grain yield	Grain straw ratio
T1	3862	1.20	4831	0.92	3574	0.90
T2	5412	1.20	4974	1.02	4380	0.89
T3	4002	1.20	4524	0.91	3540	1.00
T4	4431	1.20	5351	0.98	4195	0.96
T5	3899	1.20	4795	0.99	3445	0.96
T6	3729	1.10	4504	0.87	3355	1.00
T7	3685	1.10	5082	1.00	4094	1.06
T8	3641	1.10	5003	0.94	3921	1.04
T9	4720	1.10	6075	1.04	3851	1.04
T10	4017	1.20	5799	1.12	4519	0.87
T11	4005	1.00	4405	0.97	3213	1.03
T12	3622	1.20	4733	0.95	3295	0.97
T13	4674	1.20	5009	1.05	3807	0.93
T14	3970	1.10	4902	0.97	3892	1.10
T15	4883	1.20	6123	1.07	4844	0.88
T16	4339	1.00	4737	1.11	3276	0.98
T17	3763	1.00	5105	0.95	3364	1.00
CD (5%)	863	0.17	273	0.08	338	0.11

In wet season 2 with medium duration variety (ADT 39), significantly higher grain yield of 5,353 kg/ha was recorded in T_{15} which is on par with T10 having a grain yield of 4,974 kg/ha, when compared to control recording only 3,716 kg/ha. The grain: straw ratio exhibited significant differences among various treatments. The results indicated that the favourableness of getting higher yield with the same treatment in the sandy loam soil in the dry season could be ascribed to the clay mineralogy of the soil (Kaolinite) which is not providing adequate quantities of the two nutrients during the growth phases despite the supply of these nutrients through soil.

The pooled analysis of grain yield data recorded at both sites viz., Old Delta (Aduthurai) and New Delta (Thanjavur) revealed (Table 8) that during dry season, the treatment T_{15} comprising 1% peak on seed+ 1 % peak on nursery+ 1% peak and 1 % Urea foliar spray at PI and booting stages recorded the highest grain yield of 5093 kg/ha which is on par with T_2 (1 % peak spray at the end of tillering and PI) and with T_{13} (2 % DAP+1 % Urea+1 % MOP spray at PI and booting stage). In wet season 2, the treatment T_{15} was found to be the best in increasing the grain yield (5,098 kg/ha) compared to control (T_{11}) which recorded grain yield of 3,464 kg/ha. The finding emphasize the supplemental requirement of P and K nutrients right from the early stages viz., seed enrichment upto booting besides the soil application.

This indicated that the crop utilization of these two nutrients is comparatively slow but continuous in the wet season due to the prevailing occasional low temperature (below 20^0C) irrespective of the soils compared.

From the foregoing results it can be concluded that foliar application of PeaK as a supplement to soil applied nutrients is found to be effective in increasing the rice productivity in Cauvery Delta of Tamil Nadu.

Table 7 Effect of peak foliar spray on Grain yield (kg/ha) and Grain: straw ratio of rice in SWMRI, Thanjavur.

Treatment	Dry season		Wet season 2	
	Grain yield	Grain:straw ratio	Grain yield	Grain : straw ratio
T1	4381	0.91	4433	0.92
T2	4729	0.93	4855	0.93
T3	3892	0.91	4271	0.95
T4	4206	0.92	4743	0.91
T5	3744	0.88	4419	0.97
T6	3923	0.93	4183	0.97
T7	3880	0.92	4608	0.94
T8	3291	0.87	4554	0.96
T9	3447	0.84	4639	0.94
T10	4127	0.89	4974	0.98
T11	3471	0.98	3716	0.97
T12	4383	0.94	3593	0.95
T13	4860	0.92	4696	0.87
T14	3947	0.91	4120	0.95
T15	5303	0.96	5353	0.90
T16	3814	0.90	3352	0.90
T17	3097	0.86	3889	0.99
CD (5%)	744	NS	380	0.11

Table 8 Grain yield at 14% moisture (pooled analysis of 2 seasons for (TNRRI and SWMRI).

Treatment	Dry season 1999	Wet season 2 (1999–2000)
T1	4122	4004
T2	5071	4592
T3	3947	3905
T4	4319	4469
T5	3822	3932
T6	3826	3769
T7	3783	4351
T8	3467	4237
T9	3984	4246
T10	4072	4746
T11	3738	3464
T12	4003	3444
T13	4773	4251
T14	3959	4005
T15	5093	5098
T16	4077	3314
T17	3431	3627
CD (5%)	612	286

Acknowledgement

The financial support for the project by Ms. Rotem Amfert Negev Ltd., Isreal and the technical assistance rendered by Ms. K. Rubapathi, Senior Research Fellow of TNRRI, Aduthurai in carrying out the field experiments are gratefully acknowledged.

References

Cassman, K.G., A. Dobermann, P.C. Sta Cruz, G.C. Gines, M.I. Samson, J.P. Descalsota, J.M. Alcantara, M.A. Dizon and D.C. Olk. 1996. Soil organic matter and theindigenous nitrogen supply of intensive irrigated rice systems in the tropics. Plant and Soil 182:267-278.

Flinn, J.C. and S.K. De Datta. 1984. Trends in irrigated rice yield under intensivecropping at Philippine research stations. Field Crops Res. 9:1-15.

Flinn, J.C., S.K. De Datta and E. Labadan. 1982. An analysis of long term rice yields in a wetland soil. Field Crops Res. 5:201-216.

Ramos D.G., J.P. Descalsota and G.O. Sen Valentin. 1999. Efficiency of foliar application of mono potassium phosphate. Terminal report submitted to the Funding Agency, ROTEM AMFERT NEGEV. by PhilRice, Philippines.

Lavon, R. 1995. Improved of phosphorus and potassium content of “star-rubby” grapefruit by foliar application of MKP. *In* Symp. on foliar fertilization, Cairo, Egypt.

Williams L. and U. Kafkafi. 1995. Intake and translocation of potassium and phosphate by tomatoes, by late sprays of KH_2PO_4. *In* Symp. of Foliar Fertilization, Cairo, Egypt.

Yogaratnam N. and R.O. Sharples. 1982. Supplementing the nutrition of Bramley's seedling apple with phosphorus sprays: II. effects on fruit composition and storage quality. J. Hortic. Sci. 57:53–59.