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Effect of foliar phosphorus nutrition on growth and yield of Banana cv. Martaman

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Abstract
An experiment was conducted at Banana Research Centre, Bidhan Chandra Krishi Viswavidyalaya, Mondouri to study the "Effect of foliar phosphorus nutrition on growth and yield of Banana cv. Martaman" during the year 2010-2013. Maximum finger weight (135.62g), finger length (14.69cm), finger diameter (4.42 cm) and finger volume (132.44cc) were recorded in 1% disodium hydrogen phosphate (T_3). The application of 3 sprays of 1% disodium hydrogen phosphate there was an increase in yield by 17.36%, reduction in crop duration by 12.66 days and increase of benefit-cost ratio by 0.75 over control. Further application of 3 sprays of 1% sodium dihydrogen phosphate also increase yield by 14.04%, reduction in crop duration by 8.03 days and increase of benefit-cost ratio by 0.73 over control.

Keywords: Foliar nutrition, phosphorus, yield, Martaman

Introduction
Banana being an exhaustive crop, optimum manuring and fertilizer application is desirable for proper growth and higher yield. The choice of fertilizers, the dosage of nutrients, time of application etc. varies widely with respect to agro climatic regions and varieties (Lahav and Turner, 1983) [4]. Banana plants absorb most of its nutritional requirements of the plant in the plant cycle, between three to nine months after planting. The amount of nutrient to be applied should be standardised depending upon the quantity of nutrient removed. In banana during the reproductive phase uptake is decreased by 80%; however the rate of phosphorus absorption was higher in Rasabale and Robusta during shooting while Elakki and Monthan had highest absorption of phosphorus during post-shooting. Root affinity for phosphorus decreased uniformly in all cultivars during post-shooting (Murthy and Iyengar, 1996) [5].

Foliar feeding has been used as a means of supplying supplemental doses of minor and major nutrients, plant hormones, stimulants and other beneficial substances. Observed effects of foliar fertilization have included yield increase, resistance to disease and insect pests, improved drought tolerance and enhanced fruit quality. Application of some nutrients through foliage can be 10 to 20 times more efficient than soil application.

Phosphorus plays an important role in sucrose translocation from source to sink. Greater absorption of P through foliar application helps the plant to increases the rate of translocation of source from expanded leaves as phosphorus deficiency reduce the translocation from source leaves (Radin and Eidenbolk, 1986) [6]. Young growing leaves depend on carbohydrates imported from older expanded leaves for their growth and if there is sufficient P supply sucrose translocation is accelerated. An increase in yield was observed in mango trees by spraying 0.5 per cent orthophosphoric acid (H_3PO_4) and 2.0 per cent urea (Reddy and Majumdar 1983, Kumar and Reddy, 2008) [3, 7]. Foliar sprays of 1.0 per cent mono-ammonium phosphate increase the P content and growth of peach seedlings grown in deficient soil (Sato *et al.*, 1954) [8]. Hence improved yield could be attributed to improved nutrient uptake and probably improved photosynthetic rate of such plants. In view of above discussion the present experiment entitled "Effect of foliar phosphorus nutrition on growth and yield of Banana cv. Martaman" was undertaken to optimize the foliar phosphorus nutrient supply and was conducted at Banana Research Centre, Bidhan Chandra Krishi Viswavidyalaya, Mondouri.

Material and Methods
An experiment was conducted at Banana Research Centre, Bidhan Chandra Krishi Viswavidyalaya, Mondouri to study the "Effect of foliar phosphorus nutrition on growth and yield of Banana cv. Martaman" during the year 2010-2013. The experiment was laid out with

five treatments in a Randomised Block Design (RBD) and replicated four times with nine number of plants/treatment with a spacing of 2m x 2m. The first planting was carried out on 15.02.2010 and the second planting on 22.03.2011. Two and half to three month old healthy sword suckers weighing about 1-1.5kg having four leaves were selected, the roots were trimmed properly and planted for this experiment The treatments included T_1: Orthophosphoric acid (H_3PO_4) @ 1% foliar sprays, T_2: Sodium dihydrogen phosphate ($NaH_2PO_4.2H_2O$) @1% foliar sprays, T_3: Disodium hydrogen phosphate ($Na_2\ HPO_4$) @ 1% foliar sprays, T_4: Trisodium orthophosphate ($Na_3PO_4.12H_2O$) @ 1% foliar sprays and T_5: Control (water sprays). Treatments were imposed at 5th, 7th and 9th months after planting in aqueous solutions with stickers.

Result and Discussion

The effect of foliar phosphorus nutrition through different sources of phosphorus on plant height was statistically insignificant. However treatment with 1% Disodium hydrogen phosphate (T_3) resulted higher plant height at 7 MAP, 9 MAP and shooting (Table 1). The plant girth varied significantly at 9 MAP and shooting. Foliar application of 1% orthophosphoric acid (T_1) resulted maximum plant girth at 9 MAP and shooting though the same treatment produced minimum girth at 5 MAP and 7 MAP. Treatment with 1% Disodium hydrogen phosphate (T_3) recorded maximum girth at 5 MAP and 7 MAP and moderate values for girth at 9 MAP and shooting (Table 2).

The number of functional leaves at 5 MAP and shooting were maximum by the foliar application 1% Disodium hydrogen phosphate (T_3), the same treatment also resulted moderate values for number of functional leaves at 7 MAP and 9 MAP. Accordingly it might be perceived that 1% Disodium hydrogen phosphate (T_1) was more effective in increasing the plant height, plant girth and number of functional leaves than the other sources of phosphorus (Table 3).

The treatments resulted significant difference in days to shooting and days to harvesting. In banana it may be desirable to have early shooting and early harvesting in order to reduce the crop duration. The foliar application of 1% orthophosphoric acid (T_1) produced earliest shooting in 279.03 days and earliest harvesting in 372.79 days (Table 4). Shooting and harvesting was maximum delayed in control (water sprays). The enhancement may be due to more number of leaves and resulting in higher assimilates and translocation of photosynthates towards floral parts (Radin and Eidenbolk, 1986) [6].

The pooled data revealed that maximum hands/bunch and fingers/bunch in 1% Disodium hydrogen phosphate (T_3) which were followed in 1% Trisodium orthophosphate (T_4). The foliar application of phosphorous thrice at 5th, 7th and 9th MAP resulted in increase of hands/bunch and fingers/bunch by 14.03% and 19.23% respectively in T_3 over the control. It was also observed that fingers/hand was maximum in T_3, though the increase was of 0.82 finger over control (Table 5).

Foliar phosphorus nutrition increased the fruit weight in all the treatments, though it was maximum in 1% disodium hydrogen phosphate (T_3) in which fruit weight increased by 8.53% over control. The increase of hands/bunch, fingers/bunch, finger/hand and fruit weight finally resulted in increase of bunch weight in 1% disodium hydrogen phosphate (T_3) treatment. Bhargava *et al*., (1993) [1] advocated that optimum potassium content in leaves improves fruit weight, number of fruits per bunch and TSS in banana. The highest fruit weight in T_3 might be due to highest potassium content in this treatment.

The bunch weight was maximum in 1% disodium hydrogen phosphate (T_3) among the treatments and the same was 9.34% more over the control (Table 5). The application of phosphorous in readily available form might had increase the photosynthesis rate through the increased number of functional leaves (at flower differentiation and shooting stage) in 1% disodium hydrogen phosphate treatment resulting in higher bunch weight through its contributing characters.

The maximum yield was obtained in 1% disodium hydrogen phosphate (T_3) in both the plant crop as well as in pooled data. However in second plant crop and pooled data the yield in 1% disodium hydrogen phosphate (T_3) were at par with 1% Sodium dihydrogen phosphate (T_2). The 1% disodium hydrogen phosphate (T_3) recorded 17.42% higher yield over control treatment which produced minimum yield (Table 5). Such increase in yield in T_3 was definitely due to the higher values of yield contributing characters in this treatment. Further the increased growth parameters increased the yield attributing characters could be due to formation of higher sink capacity. The source to sink translocation can be more effective only when the rates of photosynthesis are high (Johnson, 1984).

From the present investigation it can be concluded that by application of 3 sprays of 1% disodium hydrogen phosphate there was an increase in yield by 17.36%, reduction in crop duration by 12.66 days over control. Further application of 3 sprays of 1% sodium dihydrogen phosphate also increase yield by 14.04% and reduction in crop duration by 8.03 days over control.

Table 1: Effect of foliar phosphorus nutrition on plant height (m) of banana cv. Martaman on two consecutive plant crop

Treatment	5 MAP			7 MAP			9 MAP			Shooting		
	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled
T_1	2.19	2.06	2.13	2.45	2.46	2.46	2.66	2.73	2.70	2.78	2.82	2.80
T_2	2.15	2.07	2.11	2.51	2.47	2.49	2.65	2.71	2.68	2.82	2.85	2.84
T_3	2.15	2.10	2.12	2.59	2.58	2.58	2.77	2.84	2.80	2.77	2.93	2.85
T_4	2.12	2.10	2.11	2.53	2.53	2.53	2.79	2.73	2.76	2.81	2.82	2.81
T_5	2.10	1.99	2.05	2.51	2.46	2.49	2.76	2.75	2.75	2.81	2.89	2.85
SE.m (±)	0.02	0.06	0.03	0.04	0.06	0.03	0.06	0.06	0.05	0.03	0.05	0.03
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of foliar phosphorus nutrition on plant girth (cm) of banana cv. Martaman on two consecutive plant crop

Treatment	5 MAP			7 MAP			9 MAP			Shooting		
	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled
T_1	30.69	33.83	32.26	66.11	69.25	67.68	74.64	74.17	74.40	76.08	75.48	75.78
T_2	31.68	33.50	32.59	66.21	70.00	68.11	70.32	75.13	72.72	73.53	76.91	75.22
T_3	32.93	34.25	33.59	65.29	71.00	68.15	72.52	72.44	72.48	73.81	74.75	74.28
T_4	30.30	34.58	32.44	65.50	70.50	68.00	70.45	71.50	70.97	72.73	73.42	73.07
T_5	30.93	33.67	32.30	66.51	69.58	68.05	71.61	70.58	71.09	73.35	72.78	73.06
SE.m(±)	1.29	0.49	0.82	0.73	1.05	0.40	0.87	0.99	0.62	1.48	0.99	0.87
CD(5%)	NS	NS	NS	NS	NS	NS	2.69	3.05	1.90	4.55	3.05	2.69

*NS: Non-significant
*MAP: Months after planting

Table 3: Effect of foliar phosphorus nutrition on number of leaves of banana cv. Martaman on two consecutive plant crop

Treatment	5 MAP			7 MAP			9 MAP			Shooting		
	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled
T_1	9.14	9.17	9.15	10.90	10.33	10.62	9.89	10.00	9.94	8.58	8.70	8.64
T_2	9.58	9.17	9.37	11.35	11.08	11.22	9.67	10.00	9.83	9.33	9.41	9.39
T_3	9.53	9.50	9.51	10.90	10.83	10.87	10.00	9.92	9.96	9.34	9.38	9.40
T_4	9.50	9.42	9.46	11.25	10.58	10.92	10.25	9.92	10.08	8.89	9.01	8.95
T_5	9.25	9.08	9.17	10.95	10.75	10.85	10.36	9.50	9.93	9.00	9.12	9.06
SE.m(±)	0.22	0.18	0.10	0.24	0.31	0.20	0.23	0.37	0.23	0.17	0.16	0.17
CD(5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

*Non-significant
*MAP: Months after plnating

Table 4: Effect of foliar phosphorus nutrition on days to shooting and days to harvesting of banana cv. Martaman

Treatment	Days to shooting			Days to harvesting		
	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled
T_1	282.78	275.28	279.03	374.70	370.89	372.79
T_2	284.03	277.67	280.85	377.75	373.81	376.42
T_3	287.56	283.92	285.74	382.06	378.34	381.44
T_4	286.06	282.75	284.40	380.78	377.84	381.61
T_5	296.56	290.92	293.74	388.92	383.81	385.45
SE.m(±)	0.68	2.17	1.20	1.93	1.47	1.37
CD(5%)	2.11	6.67	3.71	5.94	4.52	4.23

Table 5: Effect of foliar phosphorus nutrition on bunch character and yield of banana cv. Martaman

Treatment	Hands/bunch			Fingers/bunch			Fingers/hand			Bunch weight(kg)			Yield(t/ha)			Fruit weight(g)		
	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled	2010-2011	2011-2012	Pooled
T_1	8.24	7.10	7.67	122.72	101.67	112.20	14.90	14.73	14.82	13.58	14.45	14.02	33.96	36.13	35.04	123.55	140.30	131.93
T_2	8.09	6.67	7.38	120.25	98.00	109.13	15.16	14.51	14.84	13.84	14.49	14.16	34.59	36.23	35.41	121.95	142.60	132.27
T_3	8.47	7.28	7.88	128.37	103.94	116.15	15.25	14.70	14.98	14.53	14.64	14.58	36.33	36.59	36.46	124.96	146.28	135.62
T_4	8.46	7.17	7.81	126.79	102.07	114.43	15.00	14.01	14.51	13.39	14.14	13.76	33.46	35.36	34.41	122.48	141.00	131.74
T_5	7.61	6.22	6.91	111.73	82.93	97.33	14.68	13.36	14.02	11.65	13.19	12.42	29.13	32.97	31.05	118.13	131.79	124.96
SE.m(±)	0.04	0.10	0.06	1.32	1.43	0.69	0.19	0.24	0.13	0.08	0.06	0.05	0.20	0.16	0.13	1.15	2.34	1.00
CD(5%)	0.12	0.32	0.17	4.08	4.40	2.13	0.58	0.74	0.39	0.25	0.20	0.16	0.62	0.49	0.40	3.54	7.20	3.07

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