# Absorption, Distribution and Utilization of Radioactive Phosphorus in Healthy and Root (Wilt) Diseased Coconut Palms

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**ABSTRACT**

Radioactive $KH_2{}^{32}PO_4$ was fed to coconut leaves and palms under laboratory and field conditions. In healthy palms the absorption of phosphorus by roots and its accumulation in spindle and first fully opened leaves was found to be significantly higher till 9th hr as compared to that of diseased palms, but at later stages the reverse pattern was observed. The time required for $^{32}P$ to reach the spindle (top-most leaf) situated at 9.5 m height in both diseased and healthy palm was found to be 3 hr only. In contrast to the leaves, the activity of $^{32}P$ differed insignificantly in stem and roots of healthy and diseased palms and also the native P remained higher in the stem and roots of former palms as compared to latter. The analysis of total and different fractions of phosphorus and entry of $^{32}P$ in the different forms of organic phosphorus indicated that although total P was more in the case of diseased palms but the organic phosphorus especially the nucleic acid P was significantly less as compared to healthy ones. This revealed less utilization of absorbed P in the synthesis of P-constituted organic substances in diseased palms.

The disorders in the Physiological and biochemical processes are usual phenomena in diseased plants. In many diseased annuals and perennials the derangement in phosphate nutrition[1-3] and its metabolism specially the synthesis of phospholipids[4], nucleic acids and nucleotides[5,6] have been reported which have further been found to be one of the main reason for the deterioration in the growth and yield of plants. Such abnormalities could also be speculated in root (wilt) diseased palms since the disease is of obscure etiology which impairs the growth of palm and finally makes them unproductive[7]. The diseased coconut palms have higher concentration of inorganic nutrients specially NPK in their leaves than healthy ones[8]. It is not yet known whether the accumulation of nutrients in diseased tree is due to abnormalities caused in the absorption and translocation processes or due to ineffective utilization of inorganic nutrients into organic complexes. A preliminary study has indicated that both the total and organic phosphorus are more in the leaves of root (wilt) diseased palms[9] but efforts have not yet been made to study the different fractions of phosphorus to understand the important aspect of phosphate metabolism and the complexity of disease. In the present investigation an attempt was made to examine the mode of phosphate absorption, translocation, distribution and incorporation in different phosphate fractions using radioactive phosphorus in root (wilt) diseased and healthy coconut palms.

## Materials and Methods

The laboratory and field experiments were conducted using coconut leaves and palms, respectively, as the experimental materials. The radioactive $KH_2{}^{32}PO_4$ was mixed in Hoagland's solution containing 64 ppm P and fed to the leaves and palms by leaf injection and root injection techniques, respectively. Fourteenth leaf of uniform size from three healthy and root (wilt) affected coconut palms was sampled and brought to the laboratory. About 0.5 cm thick slice was removed from the bottom of the petioles with a sharp knife in water. Immediately, such leaves were fed with one litre Hoagland solution containing 250 $\mu$Ci $^{32}P$ under laboratory condition. Leaflets were collected from basal, middle and top portions of the leaf after 5, 10, 15, 30 min, 1, 3, 6, 9, 12 and 24 hr of treatment. This experiment was repeated twice and the average value of the results are presented in Table 1.

Three healthy and diseased palms (age 20 years; height 9.5 m) were selected. Four healthy roots covering four sides of palms were exposed and their distal ends were cut in water. The cut end of each root was fed with 250 $\mu$Ci of $^{32}P$ present in 400 ml Hoagland solution in a narrow mouth bottle. The samples from spindle, first fully opened, middle and outer leaves; upper, middle and basal portion of trunk and untreated roots were taken after 1, 2, 3, 6,

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12, 24, 48 hr, 3, 8 and 10 days of treatment. To aviod the chances of contamination and also to bring similarity in palm stand, all the nuts from healthy and diseased palms were removed before treating them with radioactivity. This experiment was repeated twice and the average values of the results are presented in Table 2.

Plant samples were dried and powdered. One hundred and 250 mg dried and powdered plant samples from laboratory and field experiments, respectively, were ashed and counted in the end window G. M. detector. The analysis of the total and different fractions of phosphorus in the leaves was done by the methods described by Jackson[10] and Similli and Krotkov[11]. The presence of $^{32}P$ in different fractions of phosphorus was also detected by G. M. counter.

## Results and Discussion

Under laboratory condition the $^{32}P$ was detected in the top leaflets of 2.5 m tall leaf within 15 min. This was true for both the leaves collected from diseased and healthy palms. The accumulation of $^{32}P$ in basal leaflets was more in the leaves collected from healthy palms as compared to diseased ones for 1 hr but in middle leaflets inconsistent results were obtained. In top leaflets of former leaves higher activity was recorded only upto 15 min. However, in general, after 1 hr all the leaflets of diseased palms accumulated more $^{32}P$ than that of healthy ones (Table 1).

It is interesting to note that $^{32}P$ was found accumulated in the spindle (topmost leaf) of 9.5 m tall coconut tree after 3 hr of treatment, in both healthy and diseased cases. The $^{32}P$ accumulation in the spindle and first fully opened leaves of healthy palms remained higher for 9 hr as compared to diseased one but at later stages the reverse was true. On the other hand, the middle and outer leaves of diseased palm accumulated significantly higher $^{32}P$ than that of healthy palm throughout the experimental period. The activity differed insignificantly in stem and roots of healthy and diseased palms but the native P was more in the stem of former palms as compared to latter (Table 2).

Ths higher accumulation of $^{32}P$ in the leaves of healthy palms as compared to that of diseased ones at early hours indicates that the tissues of healthy palms are metabolically more potential in absorption and translocation processes than that of diseased

TABLE 1 : *Absorption and accumulation of $KH_2{}^{32}PO_4$ by the 2.5 m tall leaves of middle whorls of diseased and healthy palms (laboratory experiment)*

| Position of leaflets | Condition of palm | $^{32}P$ activity (cpm/100 mg dry wt) at different period after injection | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Minutes | | | | Hours | | | | | |
| | | 5 | 10 | 15 | 30 | 1 | 3 | 6 | 9 | 12 | 24 |
| Basal | Healthy | 0 | 10 | 48 | 318 | 384 | 345 | 100 | 206 | 388 | 498 |
| | Diseased | 0 | 0 | 36 | 110 | 81 | 398 | 266 | 423 | 767 | 550 |
| Middle | Healthy | 0 | 0 | 15 | 224 | 289 | 139 | 217 | 250 | 492 | 175 |
| | Diseased | 0 | 0 | 60 | 93 | 377 | 533 | 385 | 616 | 731 | 634 |
| Top | Healthy | 0 | 0 | 20 | 80 | 56 | 154 | 201 | 189 | 264 | 397 |
| | Diseased | 0 | 0 | 10 | 168 | 266 | 303 | 518 | 454 | 680 | 685 |

C.D. 12.7 (Significant at 0.1% level).

TABLE : 2 *Absorption and accumulation of $^{32}P$ in 9.5 m tall healthy and diseased palms (field experiment)*

| Palm parts | Condition of palm | $^{32}P$ activity (cpm/250 mg dry weight) | | | | | | | | | | Elemental P (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Hours | | | | | | | | Days | | |
| | | 1 | 2 | 3 | 6 | 9 | 12 | 24 | 48 | 3 | 8 | 10 | |
| Spindle | Healthy | 0 | 0 | 305 | 330 | 330 | 300 | 485 | 330 | 205 | 150 | 90 | 0.170 |
| | Diseased | 0 | 0 | 130 | 225 | 175 | 375 | 635 | 353 | 250 | 60 | 43 | 0.206 |
| First fully opened leaves | Healthy | 0 | 0 | 60 | 180 | 250 | 255 | 295 | 175 | 55 | 110 | 120 | 0.157 |
| | Diseased | 0 | 0 | 40 | 265 | 181 | 330 | 380 | 260 | 125 | 115 | 220 | 0.185 |
| Middle leaves | Healthy | 0 | 0 | 45 | 320 | 333 | 520 | 540 | 320 | 255 | 130 | 120 | 0.163 |
| | Diseased | 0 | 0 | 240 | 410 | 445 | 560 | 715 | 355 | 265 | 250 | 200 | 0.192 |
| Outer leaves | Healthy | 0 | 0 | 110 | 330 | 280 | 290 | 440 | 390 | 260 | 125 | 120 | 0.155 |
| | Diseased | 0 | 0 | 240 | 195 | 355 | 490 | 400 | 420 | 250 | 170 | 200 | 0.160 |
| Stem | Healthy | 0 | 0 | 43 | 50 | 52 | 69 | 80 | 75 | 62 | 53 | 49 | 0.140 |
| | Diseased | 0 | 0 | 65 | 77 | 81 | 92 | 109 | 95 | 85 | 75 | 64 | 0.100 |
| Root | Healthy | 0 | 0 | 42 | 37 | 39 | 43 | 55 | 49 | 46 | 38 | 33 | 0.045 |
| | Diseased | 0 | 0 | 24 | 31 | 35 | 38 | 48 | 42 | 39 | 33 | 30 | 0.040 |

C.D. for radioactivity—13.4 (significant at 0.1%).

TABLE 3 : *Incorporation of $^{32}P$ (cpm/g dry matter) in total and different fraction of phosphorus*

| Condition of palm | Total phosphorus | M-P | TCA-P | E-P | PCA-P |
|---|---|---|---|---|---|
| Healthy | 2080 | 282 | 372 | 63 | 115 |
| | (1600) | (250) | (275) | (100) | (250) |
| Diseased | 2860 | 285 | 519 | 63 | 90 |
| | (2000) | (375) | (400) | (50) | (150) |

C.D. 20.6 (significant at 0.01% level).

Values in parenthesis indicate the concentration of P (μg/g dry wt.).

TCA-P : Trichloro acetic acid fraction of phosphorus; PCA : Perchloric acid fraction of phosphorus; M-P : Methanol fraction of phosphorus; E-P : Ethanol fraction of phosphorus.

ones. The low radioactivity in healthy palm at later stages of experiment might be due to their higher biomass because of larger circumference of trunk (76 cm) and more number of leaves (38) in healthy plants as compared to diseased ones (70 cm and 30 Nos.). The variation in the activity due to biomass appears to be logical since before applying radioactivity all the nuts from diseased and healthy palms were removed. Markedly faster rate of $^{32}P$ absorption by the leaves under laboratory conditions than that of palms in the field may be due to artifical and natural systems, respectively. This is in agreement with the findings of Nethsighe[12] and Ray *et al.*,[13] where the detection of $^{32}P$ in 9.5 m tall palms was further delayed (*i.e.*, 7 days after application) when applied through soil.

The analysis of total and different fractions of phosphorus and incorporation of radioactive P into different forms of organic phosphorus indicate that although the total and organic P in diseased palms are more but the nucleic acid P is significantly less than that of healthy ones. On the other hand TCA fraction was recorded to be significantly lower in the leaves of healthy palms as compared to diseased ones (Table 3). No significant difference was recorded for ethanol and methanol fractions of P in the leaves collected from healthy and diseased palms. High TCA-P in the leaves of diseased palm may be due to accumulation of sugars[14] since TCA extracts mainly sugar phosphate[11]. Accumulation of sugar phosphates (TCA-P) and reduction in nucleic acid (PCA-P) may be due to impeded conversion of former in the synthesis of latter[15]. The results of present investigations are also in agreement with those described by Smith[6], where phosphate metabolism, specially the nucleic acid synthesis and phosphate incorporation was disturbed in diseased tree.

From the findings of present study it appears that phosphate absorption and translocation rates in the root (wilt) affected palms are not hindered much but the phosphate metabolism is disturbed by impeded conversion of P into its different organic fractions.

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