# Effect of phosphorus application on fruit yield quality and leaf nutrient content of Kew pineapple.

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**EFFECT OF PHOSPHORUS APPLICATION ON FRUIT YIELD QUALITY AND LEAF NUTRIENT CONTENT OF KEW PINEAPPLE.**

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ABSTRACT - A study on four levels of phosphorus viz., 0, 2, 4 and 6 g/plant/year was studies on 'Kew' pineapple under rainfed conditions indicated that the phosphorus influence was more apparent in the ratoon crops than the plant crop. Phosphorus application increased the fruit and yield parameters significantly in the ratoons. It decreased the T.S.S., acidity and total sugars but increased the ascorbic acid content of the fruit significantly in all the three crops. The leaf N and P contents were significantly increased while decreased the leaf K, Ca and Mg contents. The regression analysis indicated that the requirements of phorphorus for the ratoon crops were less compared to plant crop as was indicated by the leaf P concentrations.

**EFFET DES APPLICATIONS DE P, SUR LE RENDEMENT ET SUR LES TENEURS FOLIAIRES EN ELEMENTS NUTRITIFS CHEZ L'ANANAS KEW.**

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RESUME - Une expérimentation à 4 niveaux de phosphore (0,2, 4, 6 g/plant/an) conduite sur l'ananas Kew indique que l'influence de cet élément est plus marquée pour les 2e et 3e récoltes que pour la première ; les applications de phosphore ont accru, de façon significative, les valeurs des paramètres du rendement et du fruit sur les 2e et 3e cycles. Elles ont diminué l'extrait sec, l'acidité et les sucres totaux mais ont augmenté l'acide ascorbique significativement sur les trois récoltes.
Les niveaux foliaires en N et P s'élèvent alors que ceux en K, Ca et Mg diminuent. L'analyse de la régression montre que les besoins en P sont moindres pour les cycles faisant suite à la première récolte.

## INTRODUCTION

Phosphorus is one of the important nutrient for 'Kew' pineapple. Phosphorus which constitutes to the composition of large number of compounds like nucleoprotein and phosphoprotein is required for the development of fruits. Eventhough, the requirement of phosphorus is very less and has no influence on the growth characters (MUSTAFFA, 1984), it increases the root system and physiological activity of the plant thereby increases the yield (MARCHAL, 1971 ; JOHNSON and YOGARATHNAM, 1978). TAY *et al.* (1968) reported that increasing rates of phosphorus application raised the fruit weight but not to a significant extend. The response to plant crop was poor and PAN (1957) found that phosphorus treatment promoted the development of ratoons. The literature on the effect of phosphorus on the yield and leaf nutrient concentration of ratoon crops are meagre. Hence, a study was undertaken to find out the effect of different levels of phosphorus on fruit yield and leaf nutrient contents of 'Kew' pineapple in a three crop cycle viz., plant, first and second ratoons under rainfed conditions.

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## MATERIALS AND METHODS

The study was conducted at Central Horticultural Experiment Station, Chethalli, Karnataka of India, which is situated at an altitude of 950 m and receives an annual rainfall of 1700 mm mostly during June to September. Pineapple variety 'Kew' was planted in a randomised block design with six replications. The phosphorus levels were 0 (control), 2, 4 and 6 g $P_2O_5$/plant/year. Uniform suckers weighing 450 g were planted in a two row system of planting with 60 plants/treatment/replication at a population density of 44,444 plants/hectare during 1979. The available nutrient status of the experiment plot soil was low in N (229 kg/ha), medium in P (8.2 kg/ha) and K (227 kg/ha). The pH of the soil was 6.1 and the texture is clay loam. Phosphorus as single super phosphate was applied in two split doses at third and sixth month. Nitrogen and potassium at 16 g each were applied along with phosphorus

application. Nitrogen as soil application was applied in the form of Urea in two equal split doses @ 8 g N/application. Potassium as soil application as muriate of potash applied in two equal split doses @ 8 g K/application at third and sixth month. Similar dosage and method of applications was adopted in the first and second ratoons also. Flowering was induced at 12th month stage by pouring 50 ml of 10 ppm alpha naphthyl acetic acid solution into the heart of the plant. The fruits were harvested 5 to 5 1/2 months after the treatment.

The variates recorded were : fruit length, breadth and fruit weight with crown from twenty fruits selected at random from each plot. The hectare yield was computed by multiplying the fruit weight with flowering percentage. The fruit quality characters viz., T.S.S., acidity, ascorbic acid and total sugars were estimated from five fruits adopting standard procedures. The leaf samples were collected at 12th month stage from the 'D' leaf base (SUBRAMANIAN *et al.*, 1974) and were analysed for leaf N, P, K, Ca and Mg contents. All these observations were recorded for plant, first and second ratoon crops. Regression analysis and economic optimum were worked out as per the models suggested by GUINARD (1982).

## RESULTS

### Fruit characters :

Phosphorus application increased the fruit characteristics and yield (table 1). Phosphorus application had no significant influence on the average fruit length, breadth, weight and hectare yield of the plant crop. Significant differences were observed in the first and second ratoons. Fruit length, breadth, weight and hectare yield were highest at 4 g level and thereafter it reduced. Maximum length and breadth of fruits were recorded at 6 g level in the second ratoon. The increase in hectare yield was 14 and 25 per cent at 4 g level in first and second ratoon respectively than control.

### Quality characters :

Significant differences were observed between phosphorus levels for quality characters (table 2). The T.S.S. content of the fruit significantly decreased with increasing levels of phosphorus recording the highest (14.2) at control. Similarly, the acidity also decreased significantly with increasing levels of phosphorus being highest with no application of P (1.22 %). Phorphorus application significantly increased the ascorbic acid content recording a maximum (34.5 mg) at 6 g level. The total sugars also decreased with increasing levels of phosphorus and the control recorded the highest content (13.04 %). Similar trend was observed in the first and second ratoons also.

### Leaf nutrient composition :

Phosphorus application significantly influenced the 'D' leaf nutrient content (table 3 and 3a). The leaf nitrogen concentration increased with higher phosphorus application and 6 g level recorded the highest in all the three crops. The second ratoon crop recorded the maximum leaf N content (2.28 %) followed by first ratoon and the least by plant crop (2.00 %). The phosphorus application significantly increased the leaf P content recording the highest (0.267%) at 6 g level. The leaf P content was significantly high in the second ratoon crop (0.26 %) and the first ratoon (0.22 %) while the least (0.135 %) was registered at the plant crop (table 3a). The leaf K, Ca and Mg contents decreased with higher application of phosphorus (table 3). Control treatment recorded the maximum leaf K, Ca and Mg contents while 6 g level registered the lowest in the plant crop. The leaf Ca and Mg contents were higher in the ratoons than the plant crop.

### Regression analysis :

Yield prediction models based on applied P levels and leaf P concentrations with hectare yield were worked out (table 4). The models indicated that an economic optimum P level and leaf P concentration were 4.15 g and 0.141 per cent respectively for plant crop, 3.95 g and 0.257 per cent respectively for first ratoon and 3.37 g and 0.28 per cent for the second ratoon crop respectively. The economic optimum yield of 69.01 and 70.22 tons for plant, 61.44 and 61.62 tons for first ratoon and 50.69 and 50.94 tons for second ratoon crop respectively were predicted.

## DISCUSSION

The positive response on fruit length, breadth, weight and hectare yield by phosphorus application indicated that the phosphorus is important for pineapple too (SU, 1965 ; TAY *et al.*, 1968 ; MARCHAL, 1971 ; TAY, 1972) though PY *et al.* (1957) and CHADHA *et al.* (1976) reported that there is no response to phosphorus by pineapple. Due to its low soluability in soil and slow availability to plants, the availability to the ratoons was higher than the plant crop thereby promoted the development of ratoons (PAN, 1957). SUBRAMANIAN *et al.* (1974) found that in 'Kew' pineapple the phosphorus application increased the leaf P content in the plant crop and the results have indicated that the higher availability to ratoon plants was reflected in their leaf D contents (table 3a). Higher phosphorus application increased the leaf N concentration which was due to P-N synergism which could also be the reason for increased fruit weight and yield (MARCHAL, 1971). The phosphorus application reduced the leaf K, Ca and Mg contents which may be due to antagonism between P-K, P-Ca and P-Mg. The fruit length, breadth, weight and hectare yield increased upto 4 g level and thereafter reduced (SAMUELS *et al.*, 1956) and could be attributed to the excess leaf N and low leaf P:K ratio (DEGEUS, 1961). An economic optimum leaf P contents of 0.14, 0.26 and 0.28 per cent were obtained by regression analysis models corroborated with the findings of DEGEUS (1973) and SUBRAMANIAN *et al.* (1978) indicating an economic optimum P level of 4.15, 3.95 and 3.37 g/plant for plant, first and second ratoon respectively which showed a reduced requirement of phosphorus for the subsequent ratoon crops.

Phosphorus application resulted in a decrease of T.S.S., acidity and total sugars and increased the ascorbic acid content of the fruit. TAY *et al.* (1968) and TAY (1972) found that phosphorus application reduced the sugar content and also reduced the acidity content of the fruit (TAY, 1972 ; MARCHAL, 1971).

TABLE 1 - Effect of phosphorus on fruit and yield characters of Kew pineapple.

| Treatments (g/plant) | Fruit length (cm) | | | Fruit breadth (cm) | | | Fruit weight (kg) | | | Hectare yield (tons) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | I | II | III | I | II | III | I | II | III |
| 0 | 15.78 | 15.85 | 11.72 | 12.26 | 12.45 | 10.50 | 1.76 | 1.43 | 1.07 | 67.82 | 55.30 | 41.45 |
| 2 | 16.39 | 16.64 | 12.55 | 12.58 | 13.06 | 11.07 | 1.77 | 1.54 | 1.21 | 67.87 | 59.34 | 46.31 |
| 4 | 16.59 | 17.41 | 13.88 | 12.80 | 13.66 | 11.60 | 1.82 | 1.63 | 1.35 | 69.44 | 63.00 | 51.64 |
| 6 | 16.09 | 15.42 | 14.88 | 12.59 | 12.41 | 12.17 | 1.81 | 1.30 | 1.20 | 69.41 | 50.13 | 46.25 |
| L.S.D. (0.05 %) | NS | 1.401 | 0.478 | NS | 0.465 | 0.151 | NS | 0.082 | 0.096 | NS | 2.786 | 2.221 |

NS : non significant I : plant crop II : first ratoon III : second ratoon

TABLE 2 - Effect of phosphorus on quality of pineapple fruits.

| Treatments (g/plant) | T.S.S. (°Brix) | | | Acidity (%) | | | Ascorbic acid (mg/100 g) | | | Total sugar (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | I | II | III | I | II | III | I | II | III |
| 0 | 14.2 | 14.99 | 15.2 | 1.22 | 1.93 | 1.11 | 28.3 | 37.82 | 31.76 | 13.04 | 13.22 | 12.94 |
| 2 | 13.9 | 14.30 | 13.8 | 1.16 | 1.78 | 1.00 | 31.6 | 40.11 | 34.02 | 12.16 | 12.33 | 11.83 |
| 4 | 13.4 | 13.00 | 12.7 | 1.04 | 1.61 | 0.92 | 33.7 | 42.46 | 36.21 | 11.63 | 11.31 | 10.64 |
| 6 | 13.0 | 12.00 | 11.9 | 0.92 | 1.43 | 0.82 | 34.5 | 43.20 | 38.27 | 11.48 | 10.18 | 9.41 |
| L.S.D. (0.05 %) | 0.369 | 0.608 | 0.374 | 0.07 | 0.059 | 0.030 | 0.851 | 0.785 | 0.8206 | 0.63 | 0.262 | 0.3651 |

I : plant crop II : first ratoon III : second ratoon

TABLE 3 - Effect of phosphorus on leaf N, K, Ca and Mg contents of Kew pineapple.

| Treatments (g/plant) | N (%) | | | K (%) | | | Ca (%) | | | Mg (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | I | II | III | I | II | III | I | II | III |
| 0 | 1.50 | 1.58 | 1.57 | 3.80 | 3.54 | 3.86 | 1.01 | 1.56 | 1.65 | 0.185 | 0.23 | 0.26 |
| 2 | 1.66 | 1.79 | 1.62 | 3.02 | 3.08 | 2.43 | 0.96 | 1.03 | 1.53 | 0.25 | 0.19 | 0.25 |
| 4 | 1.77 | 1.99 | 1.99 | 2.54 | 2.75 | 2.28 | 0.79 | 0.72 | 1.32 | 0.13 | 0.17 | 0.16 |
| 6 | 2.00 | 2.23 | 2.28 | 2.31 | 2.62 | 2.03 | 0.60 | 0.61 | 1.25 | 0.09 | 0.9 | 0.11 |
| L.S.D. (0.05 %) | - | - | - | - | - | - | - | - | - | 0.056 | 0.066 | 0.033 |
| (0.01 %) | 0.169 | 0.132 | 0.164 | 0.473 | 0.018 | 0.515 | NS | 0.659 | 0.263 | - | - | - |

NS : non significant I : plant crop II : first ratoon III : second ratoon

TABLE 3a - Effect of phosphorus on leaf P content of Kew pineapple.

| Treatments (g/plant) | Leaf P (%) | | | Mean of three crops |
|---|---|---|---|---|
| | Plant | First ratoon | Second ratoon | |
| 0 | 0.10 | 0.15 | 0.16 | 0.137 |
| 2 | 0.12 | 0.19 | 0.22 | 0.177 |
| 4 | 0.15 | 0.26 | 0.31 | 0.240 |
| 6 | 0.17 | 0.28 | 0.35 | 0.267 |
| L.S.D. | 0.042* | 0.027** | 0.041** | 0.0217 ** |

| Crop | Leaf P (%) |
|---|---|
| Plant crop | 0.135 |
| First ratoon | 0.220 |
| Second ratoon | 0.260 |
| L.S.D. | 0.0188** |
| Interaction (Crops x Levels) | NS |

NS : non significant * : significant at 5 % level ** : significant at 1 % level

TABLE 4 - Yield prediction models for the effect of applied $P_2O_5$ (g) and leaf P (%) on hectare yield of Kew pineapple (Tons).

| Yield prediction model | | Economic * optimum level (g) | Economic optimum yield (tons/ha) |
|---|---|---|---|
| | **Yield (Y) Vs P level (x)** | | |
| Plant crop | $Y = 52.48 + 0.347x - 0.005x^2$ | 4.15 | 69.01 |
| First ratoon | $Y = 49.44 + 5.077x - 0.516x^2$ | 3.95 | 61.44 |
| Second ratoon | $Y = 40.885 + 4.825x - 0.568x^2$ | 3.37 | 50.69 |
| | | Economic optimum leaf P (%) | Economic optimum yield (tons) |
| | **Yield (Y) Vs leaf P level (x)** | | |
| Plant crop | $Y = 28.83 + 584.58x - 20.64x^2$ | 0.141 | 70.22 |
| First ratoon | $Y = -12.89 + 579.46x - 1126.67x^2$ | 0.257 | 61.62 |
| Second ratoon | $Y = -8.63 + 421.65x - 746.09x^2$ | 0.280 | 50.94 |

* - Calculated with a fertilizer cost : fruit price ratio of 1 (both in Rs/kg).

## CONCLUSION

Phosphorus at four levels were applied for 'Kew' pineapple at a population of 44,444 plants/ha under rainfed conditions during 1979-84 for a three crop cycle. The results indicated that the average fruit length, breadth, weight and hectare yield were increased by phosphorus application and 4 g level recorded the highest. Significant differences were obtained for the first and second ratoon crops however, no differences were found for the plant crop. The phosphorus application reduced the T.S.S., acidity and total sugars contents while increased the ascorbic acid content. The leaf N and P contents were increased by the phosphorus while decreased the leaf K, Ca and Mg contents of the 'D' leaf. The leaf P contents were higher in the ratoons than in the plant crop. The regression analysis also showed that the ratoons require less phosphorus application than the plant crop.

Thus, a phosphorus application of 4.15, 3.95 and 3.37 g/plant/year was found economically optimum for plant, first and second ratoon crops respectively for high yield and good quality fruits. The leaf P concentration also indicated a lesser requirement of phosphorus application for ratoon crops than plant crop.

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## REFERENCES

**CHADHA (K.L.), SUBRAMANIAN (T.R.) and MELANTA (K.R.). 1976.**
**Effect of varying levels of N, P and K on growth yield and quality of pineapple in variety Queen.**
*Indian J. Hort.*, 33, 224-226.

**DEGEUS (J.G.). 1961.**
**Fertilizer requirement for sugar cane, deciduous fruits, Citrus and pineapple in the Union of South Africa.**
*Stikst of Eng. (Ed.)*, 5, 53-68.

**DEGEUS (J.G.). 1973.**
**Fertilizer guide for the tropics and Sub tropics,** *Zurich.*

**GUINARD (A.). 1982.**
**Economic optimization of fertilizer applications : a method for field staff based on response curves and surfaces.**
*Trop. Agric. (Trinidad)*, 59 (3), 257-264.

**JOHNSON (D.S.) and YOGARATHNAM (N.).1978.**
**The effects of phosphorus sprays on the mineral composition and storage quality of Cox's orange Pippin apples.**
*Jour. Hort. Sci.*, 53 (3), 171-178.

**MARCHAL (J.). 1971.**
**Le phosphore chez l'ananas.**
*Fruits*, 26 (3), 189-206.

**MUSTAFFA (M.M.). 1984.**
**Annual Report.**
*Indian Institute of Horticultural Research, Bangalore.*

**PAN (K.Y.). 1957.**
**Research on the three essential fertilizers for pineapples.**
*J. Agri. Assoc. China*, 19, 111-129.

**PY (C.), TISSEAU (M.-A), CURY (B.) et AHAMAD (F.). 1957.**
**La fumure de l'ananas en Guinée.**
*Fertilité*, 3, 5-25.

**SAMUELS (G.), LANDRAN (Jr) and ALEN (S.A.). 1956.**
**Influence of phosphate manuring on pineapples yields.**
*J. Agric. Univ. Puerto Rico*, 40, 218-222.

**SU (N.R.). 1965.**
**Phosphorus in pineapple culture in Taiwan.**
*J. Agric. Ass. China*, 51, 26-30.

**SUBRAMANIAN (T.R.), CHADHA (K.L.), MELANTA (K.R.) and SRINIVASA MURTHY (H.K.). 1974.**
**Studies on nutrition of pineapple.**
**III.- Effect of varying levels of N P K on leaf nutrient status in var. Kew in high fertility soil.**
*Ind. J. Hort.*, 31, 219-222.

**SUBRAMANIAN (T.R.), CHADHA (K.L.), SRINIVASA MURTHY (H.K.), RAO (M.P.H.) and MELANTA (K.R.). 1978.**
**Critical levels of N P K in pineapple variety Queen.**
*Vatika*, 1, 51-55.

**TAY (T.H.), WEE (Y.C.) and CHONG (W.S.). 1968.**
**The nutritional requirement of pineapple on peat soil in Malaya.**
**I.- Effect of nitrogen, phosphorus and potassium on yield sugar**

and acid content of the fruit.
*Malays. Agric. J.*, 46, 458-468.

TAY (T.H.). 1972.
Comparative study of different types of fertilizer as source of nitrogen, phosphorus and potassium in pineapple cultivation.
*Trop. Agric.*, 49, 51-59.

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**DER WIRKUNGSMECHANISMUS VON P-BEHANDLUNGEN GEGENÜBER ERTRAG UND NÄHRSTOFFGEHALT DER BLÄTTER BEI DER KEW-ANANAS.**

**M.M. MUSTAFFA.**

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KURZFASSUNG - Aus einem Versuch mit vier verschiedenen Phosphorgaben (0, 2, 4 und 6 g/Pflanze/Jahr) bei der Kew-Ananas geht hervor, dass dieses Element auf den zweiten und dritten Ernteertrag stärkeren Einfluss hat als auf den ersten. Die Phosphoranwendungen haben die Parameterwerte von Ertrag und Frucht im zweiten und dritten Wachstumszyklus erheblich gesteigert. Trockenextrakt, Azidität und Gesamtzucker gingen zurück, aber die Ascorbinsäurewerte stiegen für alle drei Ernten beträchtlich an.
Das N- une P-angebot im Blattwerk steigt, aber jenes an K, Ca und Mg regrediert. Die Regressionsanalyse hat erwiesen, dass der P-Bedarf während den der ersten Ernte folgenden Wachstumszyklen geringer ist.

**EFECTO DE LAS APLICACIONES DE P SOBRE EL RENDIMIENTO Y SOBRE LOS CONTENIDOS FOLIARES EN ELEMENTOS NUTRITIVOS EN LA PINA KEW.**

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RESUMEN - Una experimentación a 4 niveles de fósforo (0, 2, 4, 6 g/planta/año) conducida sobre la piña Kew indica que la influencia de este elemento es más acusada para las 2a y 3a cosechas que para la primera ; las aplicaciones de fósforo han acrecentado de manera significativa los valores de los parámetros del rendimiento y del fruto sobre los 2o y 3o ciclos. Han disminuido el extracto seco, la acidez y los azúcares totales, pero han aumentado el ácido ascórbico significativamente sobre las tres cosechas.
Los niveles foliares en N y P se elevan, mientras que los niveles en K, Ca y Mg disminuyen. El análisis del retroceso muestra que las necesidades en P son menores para los ciclos que siguen a la primera cosecha.