# 沖縄の石灰質土壌で栽培された秋植サツマイモに対するカリ肥料の効果(農芸化学科)

# Effects of Potassium Fertilization on the Yields of Sweet Potato Autumn Crop Grown on a Calcareous Soil of Okinawa

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## Introduction

Sweep potato (*Ipomea batatas* Lam.) is a popular crop in Okinawa, where it is grown throughout the year because of its warm climate. Fertilizer experiments have been done on sweet potato summer crop in mainland Japan as well as in Okinawa [5, 6]. Only scarce data, however, have been obtained for the autumn crop of sweet potato. Inamine series soil, which is derived from the marl deposite and called "Jaagaru" by Okinawan dialect, is calcareous and clayey, and contains montmorillonite as a dorminant clay mineral[1, 4].

One of the authors is aiming to study responses of sweet potato autumn crop to fertilizers on this particular soil as reported previously[2, 3]. The objectives of the present study were (i) to investigate response of sweet potato autumn crop to potassium and (ii) to investigate changes in potassium status of the soil by cropping.

## Materials and Methods

The present experiment was done in the university farm located at Ishimine, Naha, of which soil belongs to Inamine series. The experimental plot had been used to grow vegetables for several years. Physical and chemical properties of the soil, of which samples were taken just before the sweet potato experiment started in september, 1975, are shown in Table 1.

A fertilizer trial was carried out twice on the same plot in an intermittent sequence with a variety of sweet potato (*Ipomea batatas* Lam.), "Nakamurasaki" of a registered number Norin 17. The first crop of sweet potato was planted on September 18, 1975, and a part harvested on January 22, 1976 (as expressed 4-month growth period) and a part harvested on March 29, 1976 (as expressed 6-month growth period). The second crop was planted on September 18, 1976 and

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Table 1. Physical and chemical properties of the soil used*

| Location | Depth (cm) | pH ($H_2O$) | CEC | Exchangeable base Ca | Mg | K | Na | Available $P_2O_5$ | Organic matter | Texture Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | me/100g | | | | | mg/100g | % | | | |
| Ishimine, Naha | 0 - 20 | 7.3 | 22.8 | 29.94 | 2.73 | 0.49 | 0.15 | 2.5 | 0.86 | 17.6 | 44.9 | 37.5 |

* pH was measured on a suspension of soil:water ratio of 1:2.5 with a glass electrode pH meter. CEC (cation exchange capacity) and exchangeable base were determined by a method using neutral N $NH_4OAc$ solution. Available $P_2O_5$ was extracted with 0.002N $H_2SO_4$. Organic matter was determined by Walkley method. Sand silt and clay denote fractions of 2-0.02mm, 0.02-0.002mm and smaller than 0.002mm in diameter, respectively.

harvested on February 25, 1977 (as expressed 5-month growth period).

Nitrogen and phosphorus were applied at constant rates, equivalent to 150 kg/ha of N as ammonium sulfate and 75 kg/ha of $P_2O_5$ as superphosphate, respectively. Potassium was applied at four rates, equivalent to 0, 150, 300 and 450 kg/ha of $K_2O$ as potassium chloride. Half of the given amount of fertilizers was applied as basal dressing and halves of the rest were as top dressings applied twice at 30-day intervals after planting. The same fertilizer treatment was given to the respective crops of the experiment.

Each plot of the fertilizer treatment had 14 $m^2$ (4 m x 3.5 m) consisting of four ridges (1 m in width, 3.5 m in length and 0.2 m in height). Young tops of sweet potato vine, as seedlings, were planted with spaces of 25 cm, in two rows apart 30 cm on the ridges. Central two ridges of each plot were harvested for the yield measurement. Of the first crop only, one of the central two ridges was harvested for the yield of 4-month growth period and the other for that of 6-month growth period. Necessary cultivation practices were applied in a manner locally recommended.

In order to reduce residual effects of the previously applied fertilizers, corn was grown for two months before the sweet potato experiment started and sudane grass was grown from April 4 to August 27, 1966 between the two crops of sweet potato. Small amounts of ammonium sulfate only were applied to the corn and sudane grass.

Temperatures recorded by a nearby station, the Okinawa Meteorological Station, varied from an average minimum monthly of 14.9°C in January to an average maximum of 27.3°C in September during the growth of the first sweet potato crop. During the second crop experiment, temperatures varied from an average minimum monthly of 14.9°C in February to an average maximum of 25.9°C in September. Monthly precipitations varied from 24 mm to 85 mm from November to March during the growth of both crops except for January, 1977 when the monthly precipitation was 144 mm.

A randomized block design was followed with four treatments replicated three times. Composite samples of the soil were taken from each plot immediately after harvesting sweet potato in February, 1977. By using neutral normal ammonium acetate solution, exchangeable potassium was displaced from the air-dried soil samples and determined with a flame photometer.

## Results and Discussion

The yields of root tuber and vine of sweet potato were recorded, respectively, and shown in Table 2. It is apparent that sweet potato received no effects from the potassium applied in the both trials on this particular soil.

Table 2. Yields of sweet potato autumn crop grown on a calcareous soil as affected by applied potassium*

| $K_2O$ applied (kg/ha) | 1975-1976 crop | | | | 1976-1977 crop | |
|---|---|---|---|---|---|---|
| | Root tuber | | Vine | | Root tuber | Vine |
| | 4 mos. | 6 mos. | 4 mos. | 6 mos. | 5 mos. | 5 mos. |
| | Fresh wt., t/ha | | | | | |
| 0 | 20.9 | 29.0 | 10.1 | 8.7 | 13.5 | 7.2 |
| 150 | 20.1 | 28.8 | 9.9 | 8.0 | 18.0 | 8.0 |
| 300 | 20.4 | 28.4 | 10.1 | 9.1 | 13.7 | 7.0 |
| 450 | 20.4 | 28.4 | 10.6 | 9.0 | 15.3 | 7.5 |

* The values are averages of three replications.

It should, however, be noted that the yields of root tuber gave 20.1 to 20.9 tons per hectare with 4-month growth period, yet increasingly 28.4 to 29.0 tons with 6-month growth period in the first trial showing that the sweet potato autumn crop in Okinawa requires a longer duration of growth to reach its full yields. In contrast with root tuber, the vine yields decreased as the growth period was prolonged. In the second trial, with 5-month growth period the yields of root tuber and vine were 13.5 to 18.0 tons and 7.0 to 8.0 tons per hectare, respectively, and were much lower than those of the first experiment. This might have been caused by a higher precipitation in January of the second experiment as indicated earlier in Material and Methods section.

It does not appear, as far as fertilizers are concerned, that the amounts of nitrogen and phosphorus applied in the present experiment were the limiting factors from the results obtained in the previous experiment which were carried out on the adjacent farm with the same type of soil that had 0.54 me of exchangeable K and 3.1 mg of 0.002 N $H_2SO_4$ extractable $P_2O_5$ per 100 g before cropping[2,3). In that experiment, the sweet potato autumn crop responded to nitrogen but not to phosphorus when N was applied up to 70 kg per hectare and $P_2O_5$ at rates of 35 kg and 70 kg with a constant rate of $K_2O$ (70 kg/ha)[2). Analysis in the previous report showed N and $P_2O_5$ absorbed by the sweet potato (vine + root tuber) were less than 70 kg and 30 kg, respectively, when the yield of root tuber gave 17 tons per hectare[3).

The yield of root tuber may be reduced when too much nitrogen is applied as recognized elsewhere, since excessive nitrogen brings in more vigorous growth of the vine rather than the root tuber of sweet potato. In order to check, whether or not the applied amount of nitrogen was excessive, the ratio of vine to root tuber in the present experiment was calculated as shown in

Table 3. The 1976-1977 crop was rather high in the ratio of vine to root tuber. This was probably resulted from January precipitation causing prolonged growth of the vine even in the maturing stage. There, however, is little difference in the ratio of vine to root tuber between the 1975-1976 crop of the present experiment and the previous one of Oya (1974) which as calcualted had the ratios highest of 0.57 and 0.35 with 4-month and 5-month growth periods, respectively. It, therefore, does not prove that excessive nitrogen was applied in the present experiment.

Table 3. Ratio of vine to root tuber

| $K_2O$ applied* (kg/ha) | Crop | | |
|---|---|---|---|
| | 1975-1976 | | 1976-1977 |
| | 4 mos. | 6 mos. | 5 mos. |
| 0 | 0.48 | 0.30 | 0.53 |
| 150 | 0.49 | 0.28 | 0.44 |
| 300 | 0.50 | 0.32 | 0.51 |
| 450 | 0.52 | 0.32 | 0.49 |

* N and $P_2O_5$ were applied at constant rates of 150kg and 75kg per hectare, respectively.

Exchangeable potassium determined on the soil samples taken immediately after cropping was shown in Figure 1. The level of exchangeable potassium before and after cropping shows little change in the control plot in spite of effective potassium absorption of sweet potato as estimated from the previous results of Oya (1975). Exchangeable potassium after cropping tends to increase proportionally with the applied amounts in the potassium treated plots. Standard deviations of exchangeable potassium among the replications, of which averages were shown in Figure 1, were 0.02, 0.08, 0.10 and 0.13 for the treatment plots with 0, 150, 300 and 450 kg/ha of $K_2O$, respectively.

Since no specific cause was found to have minimized potassium absorption of the sweet potato crop, the above mentioned results will indicate that the crops of the present experiment were well supplied with potassium released from the soil and did not respond to applied potassium. The potassium suppling capacity of the soil must be studied in the future.

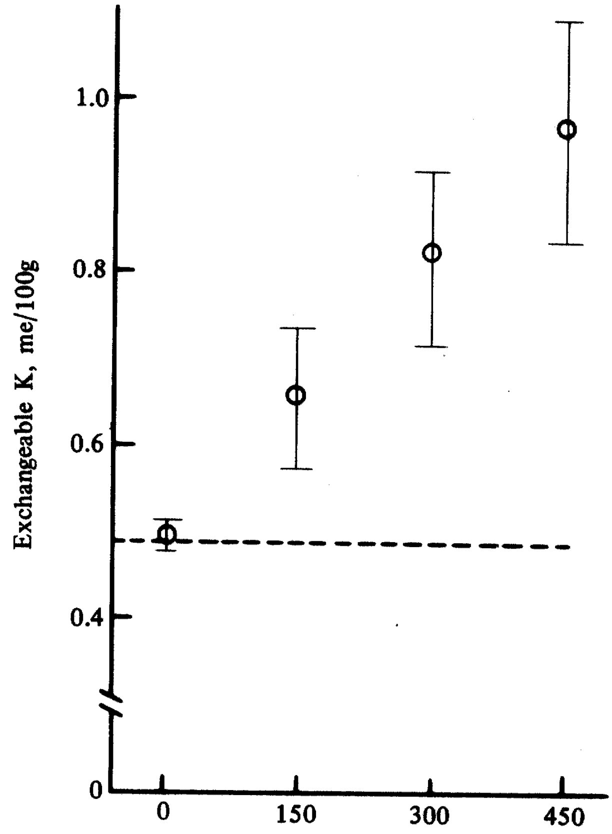


Fig. 1. Exchangeable K of the soil before (dotted line) and after (open circle) cropping in $K_2O$ treated plots. The vertical lines show standard deviations


## Summary

Two autumn crops of sweet potato were grown on a calcareous soil in the duration of September, 1975 to March, 1976 and September, 1976 to February, 1977. Potassium was applied to each crop at rates equivalent to 0, 150, 300 and 450 kg/ha of $K_2O$, while nitrogen and phosphorus were applied at constant rates, 150 kg/ha of N and 75 kg/ha of $P_2O_5$, respectively.

The yield response to applied potassium was not obtained neither from the first crop nor from the second crop. It, however, was proved in the first crop that the root tuber yields of 6-month growth period which ranged from 28.4 to 29.0 tons per hectare were much higher than those of 4-month growth period which ranged from 20.1 to 20.9 tons per hectare. From the obtained results, assumed was that a longer duration of growth is necessary for the sweet potato autumn crop to produce a higher yield of root tuber. The yields of vine did not show response to applied potassium but decreased as the duration of growth prolonged from 4 to 6 months.

There was little difference between the levels of exchangeable potassium before and after cropping in the control plot. In the potassium treated plots, exchangeable potassium after cropping increased proportionally with the applied amounts. It was concluded that the soil used for the present experiment has a good capacity of suppling potassium, from which the poor response of the sweet potato to potassium fertilization resulted.

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# 沖縄の石灰質土壌で栽培された秋植サツマイモに対するカリ肥料の効果

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## 要　　約

粘土鉱物にモンモリロナイトを含む石灰質土壌にサツマイモの秋作を1975年9月から1976年3月までと，1976年9月から1977年2月までの2回にわたって栽培しカリ肥料の効果を試験した。

栽培は琉球大学石嶺農場で行ない，窒素（N）とりん酸（$P_2O_5$）はそれぞれヘクタール当たり150 kgと75 kgの割合で施用した。カリ（$K_2O$）施用量はヘクタール当たり0, 150, 300, 450 kgの割合とした。

第1作と第2作のいずれについても塊根収量およびかずら収量に対するカリ施用の効果は認められなかった。ただし第1作で栽培期間が4か月のものと6か月のものを比較した場合に4か月のものがヘクタール当たり塊根収量20.1トン～20.9トンであるのに対し，6か月のものは28.4トン～29.0トンであり明らかに栽培期間の長い場合に高い収量が示された。かずらの収量について同様な比較をすると逆の関係がみられた。

栽培前と栽培後の土壌の置換性カリを測定した結果は栽培前と栽培後の対照区では置換性カリのレベルに大差はみられなかった。カリ施用区においては栽培後の置換性カリのレベルはカリ肥料の施用量と比例して高くなっていることが認められた。このようなことからこの実験に使用した土壌はカリ供給力が大きく，そのために施用カリ肥料に対するサツマイモの収量応答が得られなかったものと考えられる。