REPORT ON THE USE OF SLOW RELEASE FERTILIZERS IN
SELECTED CROPPING SYSTEMS AT CATIE

Rufo Bazán, Ph. D.

INTRODUCTION

Regular commercial fertilizers are in general, highly soluble and therefore are more suitable for tempered regions or others characterized by limited rainfall. On the contrary, their efficiency possibly decreases under conditions of high temperature and high rainfall like those prevailing in the low humid tropics; fertilizers losses can even be greater if soil drainage conditions are adequate, and if it is not, surface leaching by excess rainfall can be a detrimental factor as well.

Nitrogen and potash fertilizers along with fosfate fertilizers are widely used for various soils and crop conditions. On the other hand, not much research has been developed along the line of slow release fertilizers in Latin America. The Tennessee Valley Authority of the USA has designed and produced some research material of the slow release type known as sulphur coated urea, SCU, and sulphur coated muriate of potash, SKCl.

SCU has been a very successful material in the far East where it is commercially used for rice production, while in Latin America attempts have not reached yet beyond the experimental stage.
At CATIE, some research has been pursued since 1974 as it has been reported already.

Present report comprises research trials carried out in selected cropping systems for three consecutive years, as follows:

**Trials with S C U**
1. Performance of the system Beans + Corn + Cassava
2. " " " Beans + Corn - Corn

**Trials with K S K C1**
3. Performance of the system sweet potatoe + corn - S. Potatoe
4. " " " S. Potatoe + cassava + S. Potatoe

Each of the systems comprises combinations of short, medium and long cropping cycle species, in order to widen the spectrum of the cropping period for better testing of the slow release materials.

The selected systems are components of the Central Experiment being carried out by the Annual Crops Program, therefore the reported trials as Satellite Experiments of the Central Experiment.

Figures 1, 2, 3 and 4 shows the crop distribution in each of the systems accompanying the climatic conditions during each cropping cycle.

In system 1, beans, corn and cassava are interplanted in alternate rows; all crops were planted at the same date, while harvesting was made accordingly with its own vegetative cycle.

In system 2, corn and beans were interplanted (2 rows of the beans between each 2 rows of corn); both crops were planted at the same time.
Table 1. Monthly climatic data during the experimental period, November/75 - September/78

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Fig 1. CROP DISTRIBUTION

**Beans + Corn + Cassava**

- Cassava
- Corn
- Beans

**Corn + Beans - Corn**

- Corn
- Beans

**Sweet potato + Corn - S. potatoe**

- Corn
- S. potatoe

**Sweet potato + Cassava + S. potatoe**

- Cassava
- S. potatoe
Fig 2. Climatic data and crop distribution, Cycle 1975-1976

Temperature

Max.
Mean
Min.

Rainfall

mm

1975
1976

N
D
J
F
M
A
M
J
J
A
S
O
N

Cropping Systems

1. Cassava
   Corn
   Beans

2. Corn
   Beans
   Corn

3. Corn
   S. Potatoe
   S. Potatoe

4. Cassava
   S. Potatoe
Fig. 3 - Climatic data and crop distribution. Cycle 1976-1977

Temperature:
- Max.
- Mean
- Min.

Rainfall:
- 1976
- 1977

Cropping systems:
1. Cassava
   - Corn
   - Beans
2. Cassava
   - Corn
   - Beans
3. Corn
   - S. Potatoe
4. Cassava
   - S. Potatoe
Fig. 4: Climatic data and crop distribution. Cycle 1977-1978

Temperature

Max.
Mean
Min.

Rainfall

1977 1978

Cassava
Corn
Beans

1

Corn
Beans

2

S. Potatoe

3

Cassava

4
After their harvest, a second crop of corn was planted.

In system 3, corn and sweet potatoe were interplanted in alternate rows and planted at the same time. After their harvest a second crop of sweet planted was planted.

In system 4, cassava and sweet potatoes were also interplanted in alternate rows. Originally, a second planting of sweet potatoe was planned to be done five months prior to the harvest of cassava; however, this was not possible due to intense and heavy foliage developed by cassava stand, which in turn made impossible to perform any planting activity within the stand. A basic fertilizer level of 245 Kg/ha nitrogen, 105 Kg/ha phosphorus (P₂O₅) and 75 Kg/ha potash (K₂O) was applied supplementing the fertilizer treatment.

Testing of the slow release fertilizers was performed in comparison to the fertilizer application used at the Central Experiment as well as to a Ammonium nitrate and to regular muriate of potash, according to the following treatments:

**SCU Trials**

1. Regular fertilization, Central Experiment
2. 100% N of SCU
3. 75% N of SCU + 25% N of Am. Nitrate
4. 50% N of SCU + 50% N of Am. Nitrate
5. 25% N of SCU + 75% N of Am. Nitrate
6. 100% N of Am. Nitrate
7. No fertilizer applied
S K Cl Trials

1. Regular fertilization, Central Experiment
2. 100% K of SKCl
3. 75% K of SKCl + 25% K of KCl
4. 50% K of SKCl + 50% K of KCl
5. 25% K of SKCl + 75% K of KCl
6. 100% K of KCl
7. No fertilizer applied

Regular fertilization of the selected systems in the Central Experiment comprises the application of 15-30-8 (10% S - SO₄) at planting and am. nitrate and m. of potash 25-30 days after planting. Consequently in all other treatments, a basic treatment of P, N or K levels were applied accordingly besides the material (SCU or SKCl) being tested.

Main features of the tested materials are as follows:

SCU - Grade 38,9% N (Lot 1-17-73P)

dissolution rate in 7 days 27,5%
  " in 14 days 30,3%
  " daily days 0.3%

was coating 2%

microbicide coat 0.25% coal tar.

SKCl Grade 40.8% k₂O (Lot 5-13-71A)
Experimental period

Trials were run from November 1975 through September-October, 78 comprising two or three cropping cycles as it will be fully described individually for each system.

Cropping cycle 1975-1976

Figure 2, shows the spatial distribution of all four tested systems and the climatic conditions prevalent during the whole cycle.

All four systems were planted in the second half of December 1975 and terminated (harvested) by November 1976.

Systems 2 and 3, corn + beans - corn and corn + s. potatoe - s. potatoe had two planting seasons, the first in December 1975 and the second in May and June 1976.

Cropping cycle 1976-1977

The climatic (rainfall) conditions prevalent in this cycle, as shown by Figure 2 was quite abnormal and responsible for having only systems 1 and 2 completed by November 1976, both being planted by December 1975.

Thus, and due to drought, systems 3 and 4 were planted by June 1977 and therefore, their cycles were completed by April and June 1978 as it is shown in Figure 3.

Cropping cycle 1977-1978

As shown in Figure 4, systems 1 and 2 were planted late Nov. 1977 and partially completed by April 1978. In system 1, cassava and in system 2 corn, will be harvested by October 1978.
Fertilizer application

All SCU and SKCl fertilizer dosages were applied only once during the whole experimental period, both were applied only at the planting time of the first cropping cycle; regular fertilizers, such as ammonium nitrate, muriate of potash, superphosphate or fertilizer mixtures were applied at each planting season of each cropping cycle, except in the last cropping cycle, 1977-1978, where no fertilizer at all was applied in none of the systems, in order to check any residual effect of previous applications. Fertilizer application method was the same as of the Central Experiment, in that all P is applied at planting time (broadcast application) and all other elements are applied 25-30 days later (row application). Table 6 shows total fertilizer dosages applied during the experimental period.

Crop performance

System Beans + Corn + Cassava

Yield data, for each cropping cycle as well as total yields, is presented in Table 2 and in Figure 5. Two cycles were completed, 1975-1976 and 1976-1977, while in cycle 1977-1978 cassava remains to be harvested in late October/78.

In the first cycle, treatment comprising 100% N-SCU appears to be the most efficient in that total yield of commercial product was higher, 12619 Kg/ha, as compared to all other treatments. The crop responsible for such results was cassava, which yielded around 10 tons/ha and surpassed amply the rest of the treatments. However, corn and bean
Table 6. Fertilizers applied during the experimental period.

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<td>Kg/Ha</td>
<td>Kg/Ha</td>
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<td></td>
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Sources:
N = SCU, Ammonium nitrate and 15-30-3
P₂O₅ = Triple super and 15-30-3
K₂O = SKCL Muriate of potato and 15-30-3

Treatments
SCU
1 Regular fertilization Central Experiment
2 100% N of SCU
3 75% N of SCU + 25% N of Am. Nitrate
4 50% N of SCU + 50% N of Ar. Nitrate
5 25% N of SCU + 75% N of Am Nitrate
6 100% N of Am. Nitrate
7 0 Fertilizer
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Table 2. Performance of the system Beans + corn + cassava. Yields (Kg/ha) in SCU trial.

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**Treatments**

1. Fertilizer treatment
   Central Experiment (245 - 105 - 75 Kg/ha)
2. 100% N - SCU
3. 75% N - SCU + 25% N - A/N
4. 50% N - SCU + 50% N - A/N
5. 25% N - SCU + 75% N - A/N
6. 100% N - A/N
7. 0 Fertilizer
   A/N = Ammonium Nitrate
   \( \star \) to be harvested in Nov/78
FIG. 5  SYSTEM BEANS + CORN + CASSAVA

TEST OF SCU


YIELDS (kg/ha.)

1. Fert Treatment
2. 100% N - SCU
3. 75% N - SCU + 25% N - A/N
4. 50% N - SCU + 50% N - A/N
5. 25% N - SCU + 75% N - A/N
6. 100% N - A/N
7. 0 Fertilizer.

TREATMENTS
yields in the same treatment are the second and third highest respectively. During the second cycle, 1976-1977, beans and corn yields diminished noticeably, but still treatment 100% N-SCU gave the highest total commercial yield, 13354 Kg/ha.

Treatments comprising soluble fertilizers, such as treatment 1 and 6 gave the highest yields in beans as it was expected to occur. Corn yields in this cycle were highly affected by intense drought, from February to May, while cassava yields were higher than in the previous cycle.

Yields obtained in the last cycle, 1977-1978 are surprisingly high, since no fertilizer at all was applied to none of the treatments in order to check for residual fertilizer effects. In general, beans and corn yields are higher than in the previous cycle though lower than in the first one. Cassava yields in the 0 fertilizer treatment were unexpectedly high, 10.3 ton/ha while bean and corn yields were the lowest of all. Unfortunately, at this time complete evaluation of each treatment can not be done since cassava remains to be harvested shortly.

Nevertheless SCU treatments, mainly treatments comprising 100% N-SCU appears to be the most efficient, chiefly the first one, if it is taken into consideration the fact that less fertilizer was there applied, since in all others applications were made in two consecutive cycles, as it is shown in Table 6.
System Corn + Beans - Corn

Yield data produced by this systems is given in Table 3 and in Figure 6. During the first cycle, 1975-1976, corn cropped early in the cycle jointly with beans gave higher yields than the second crop of corn, in any treatment it appears to be some relationship in that the higher the amount of soluble fertilizer applied, the higher the yields produced.

In the cycle 1976-1977 lower yields for the first corn and beans obtained may have been due to adverse climatic conditions as earlier explained. Second harvest of corn was considerably higher than in the previous cycle. In this cycle it is also evident the positive effect of soluble fertilizers, as in the previous cycle, the treatment 50% N-SCU + 50% N-A/N was one of the more efficient since in both cycles it gave the second highest total production of commercial product. Decrease in bean yields during the last cycle, 77-78 were quite noticeable; corn yields went also down though not so drastically as for beans. It should be point out that no fertilizer was applied during this cycle in none of the treatments. However, it does not seem very clear any positive residual effect of SCU, since based in total commercial produce, treatments comprising only soluble fertilizers (1 + 6) gave the highest values, among the SCU treatments, the 50% N-SCU + 50% N-A/N appears to be the best.

A more complete evaluation will be done later when the last crop of corn gets harvested shortly in October.
Table 3. Performance of the system corn + beans - corn. Yields (kg/ha) in SCU trials.

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<th>1976-1977 Yields (kg/ha)</th>
<th>1977-1978 Yields (kg/ha)</th>
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<td>Beans</td>
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</table>

* Treatments
1. Fertilizer treatment
   Central Experiment (245-105-75 kg/ha)
2. 100% N-SCU
3. 75% N-SCU + 25% N - A/N
4. 50% N-SCU + 50% N - A/N
5. 25% N-SCU + 75% N - A/N
6. 100% N - A/N
7. 0 Fertilizer
   A/N - Ammonium Nitrate

** To be harvested in Nov. 1978
**Fig. 6**  SYSTEM CORN + BEANS - CORN

**TEST OF SCU**

1. Fert. treatment
   Central Experiment
2. 100% N - SCU
3. 75% N - SCU + 25% N - A/N
4. 50% N - SCU + 50% N - A/N
5. 25% N - SCU + 75% N - A/N
6. 100% N - A/N
7. 0 Fertilizer

**YIELDS (kg/ha)**

- **BEANS**
- **CORN**

**TREATMENTS**

- **1975-1976**
- **1976-1977**
- **1977-1978**
System Sweet Potato + Corn - Sweet Potato

Sweet potato and corn are two crops quite demanding in potassium for carbohydrate formation, and therefore both plus cassava could be the best qualified crops for testing SKCl.

According to the data given in Table 4 and in Figure 7 in the first cycle, 1975-1976, the second harvest of sweet potato gave higher yields than when corn was grown at the same time.

In fact, corn is a highly competitive crop, and it is evident that the higher corn yield, the lower potato yield was obtained. In this cycle, the treatment 75% K-SKCl + 25% K-KCl gave the highest total commercial produce.

The 1976-1977 cycle was quite irregular due to abnormal rainfall conditions (drought) prevalent in the period, so much that the planting season for this system was made in June 77. Yields in all treatments were lower as compared to those of the first cycle, but still the 75% K-SKCl + 25% K-KCl treatment gave the highest yield. This treatment was the most effective throughout the cropping cycle, 75-78 since the total commercial product there obtained was over 50 tons., which amply surpassed all other treatments.

System Sweet Potato + Cassava + Sweet Potato

Yields of the system are given in Table 5 and in Figure 8. Only two cropping cycles were completed due to abnormal (drought) conditions as stated before. Also, only one crop of sweet potato was obtained and not two as it was originally planned, thick foliage developed by
Table 4. Performance of the system sweet potatoe + corn - sweet potatoe yields (Kg/ha) in K - SKCL trials

<table>
<thead>
<tr>
<th>Treatment * No.</th>
<th>1975 - 1976 Yields (Kg/ha)</th>
<th>1976 - 1977 Yields (Kg/ha)</th>
<th>1975 - 1978 Yields (Kg/ha)</th>
</tr>
</thead>
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<td>S. Potatoe</td>
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<tr>
<td>6</td>
<td>10952</td>
<td>2905</td>
<td>18100</td>
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</tbody>
</table>

* Treatments
1. Fertilizer treatment
   Central Experimental (245 - 105 - 75 Kg/ha)
2. 100% K - SKCL
3. 75% K - SKCL + 25% K - KCl
4. 50% K - SKCl + 50% K - KCl
5. 25% K - SKCL + 75% K - KCl
6. 100% K - KCl

** Harvested in April/78.
Fig. 7  System Sweet Potatoe + Corn - Sweet Potatoe

Test of S-KCl

1. Fert. treatment
   Central Experiment
2. 100% K-SKCl
3. 75% K-SKCl + 25% K-KCl
4. 50% K-SKCl + 50% K-KCl
5. 25% K-SKCl + 75% K-KCl
6. 100% K-KCl

Yields (Kg/ha)

1975-1976

1  2  3  4  5  6

1976-1977

1  2  3  4  5  6
Table 5. Performance of the system sweet potatoe + Cassava + sweet potatoe
Yields (Kg/ha) in K-5-KCl trials.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cassava</td>
<td>Cassava</td>
<td>Cassava</td>
</tr>
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<tr>
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<td>4405</td>
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</tr>
</tbody>
</table>

* Treatments

1. Fertilizer treatment
   Central Experiment (245-105-75 kg/ha)

2. 100% K-SKCl
3. 75% K-SKCl + 25% K-KCl
4. 50% K-SKCl + 50% K-KCl
5. 25% K-SKCl + 75% K-KCl
6. 100% K-KCl
7. 0 Fertilizer
Fig. 8 - SYSTEM SWEET POTATO + CASSAVA + SWEET POTATO

TEST OF K-5KCL

1975 - 1978

1. Fertilizer treatment
   Central Experiment
2. 100% K-5KCL
3. 75% K-5KCL + 25% K-KCl
4. 50% K-5KCL + 50% K-KCl
5. 25% K-5KCL + 75% K-KCl
6. 100% K-KCl
7. 0 Fertilizer

YIELDS (kg/ha)

TREATMENTS
cassava made impossible to perform any planting activity for the 2d. crop of sweet potato.

In the first cycle, sweet potato yields were much higher than those of cassava except in treatment 4. Results were quite opposite in the 2d. cycle where cassava yields surpassed amply sweet potato yields.

In terms of total commercial product the 0 fertilizer treatment gave the highest value, > 45 Ton/ha mainly due to the high cassava yields. This is not much an unexpected event, since it is known that cassava performs well in low fertile soils.

High cassava yields in the 2d. cycle may have been promoted by adequate rainfall conditions, (June 1977 to July 1978), similar effects have been observed in the Central Experiment in that yields of late planting cassava (May-June) are higher than early plantings (November-December). In the latter case, normally a long dry spell occurs between late January to April and May that is detrimental to long cycle crops such as cassava when they are at the initial stages of growth.

Conclusions

Based on the data of the four experiments carried out at CATIR, there appears to be some tendency towards a positive effect of both SCU and SKCl as nutrient sources for short, medium and long cycle crops, if these are to be grown in the same field for over one cropping cycle. For short cycle crop such as beans or corn, when grown for just one
season, the slow release materials may not be adequate since nutrient
delivery may not be quick enough as to cope with the immediate needs
of the crop, therefore, long yield crop such as cassava may benefit
greatly from those materials.

Research on the effect of slow release fertilizers on cropping
systems should be also continued, since they may play an important
role in the management of the systems under various soil and climatic
conditions.

It is suggested that studies should be continued in other soil
types and with other crops as well. Present studies were concentrated
in just one soil type of alluvial origin; on a next step soils of
volcanic origin such as those of the Colorado soils series should be
tested and other crops such as sugar cane, and coffee be also considered.

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RB/cch