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

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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 Cl

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.

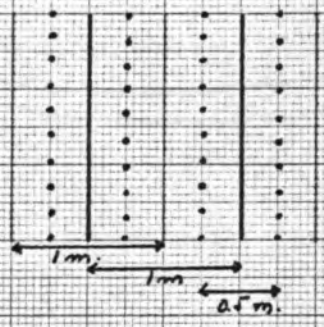
In system 2, corn and beans were interplanted (2 rows of the beans between each 2 rows of corn); both crops were planted at the same time.

Table 1. Monthly climatic data during the experimental period, november/75 - September/78

		J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Rainfall (mm)														
1975		131.3	19.7	27.7	32.9	112.2	226.5	326.7	329.6	418.2	326.5	420.2	569.9	2941.4
1976		258.9	105.4	12.5	143.1	350.5	420.7	575.9	205.6	415.8	152.3	370.1	281.1	3291.9
1977		118.3	31.2	56.1	43.3	84.2	384.9	373.0	378.1	177.4	224.9	182.1	74.1	2127.6
1978		62.5	267.0	85.2	50.4	233.0	252.6	244.0	173.2					
Temperature (°C)														X
1975	Max.	24.9	25.2	26.9	26.6	27.8	26.8	26.3	26.6	27.4	27.2	26.1	24.5	26.3
	Mean	19.9	19.9	21.4	21.3	22.2	21.4	20.9	21.1	21.5	21.5	21.4	19.4	20.9
	Min.	16.1	15.9	17.7	17.5	18.6	18.3	17.7	18.1	18.3	18.3	18.9	16.7	17.7
1976	Max.	24.7	24.9	26.3	27.4	27.1	27.5	26.3	26.9	27.3	27.2	26.2	26.2	26.5
	Mean	19.2	19.3	20.4	21.5	21.8	21.7	21.5	21.4	21.8	22.1	21.4	20.6	21.0
	Min.	15.8	15.2	15.9	17.7	18.8	18.4	19.1	18.1	18.7	18.5	18.2	16.5	17.6
1977	Max.	25.0	26.3	25.9	27.4	28.9	27.5	26.6	27.4	27.2	27.2	27.0	26.4	26.9
	Mean	19.7	20.9	21.1	21.5	22.9	22.3	21.7	21.9	21.7	22.0	21.7	21.1	21.5
	Min.	16.0	16.9	17.7	17.6	18.6	18.9	18.9	18.3	18.5	18.6	18.1	17.4	17.9
1978	Max.	26.1	25.4	26.7	27.7	28.6	27.4	27.5	27.3					
	Mean	19.9	20.8	21.2	21.9	22.7	21.9	21.8	22.0					
	Min.	16.1	17.6	17.6	17.6	19.1	18.5	18.6	18.7					

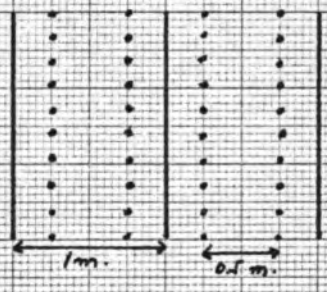
Fig 1. CROP DISTRIBUTION

Beans + CORN + Cassava



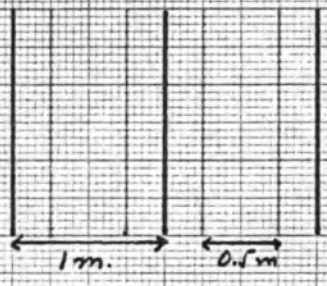
— Cassava
— CORN
... Beans

CORN + Beans — CORN



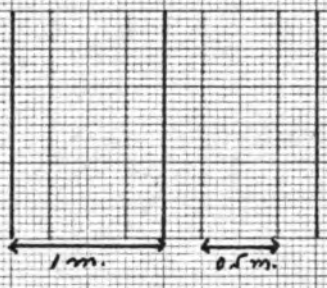
— CORN
... Beans

sweet potatoe + CORN — S. potatoe



— CORN
— S. potatoe

Sweet potatoe + Cassava + S. potatoe



— Cassava
— S. potatoe

Fig 2. Climatic data and crop distribution. Cycle 1975-1976

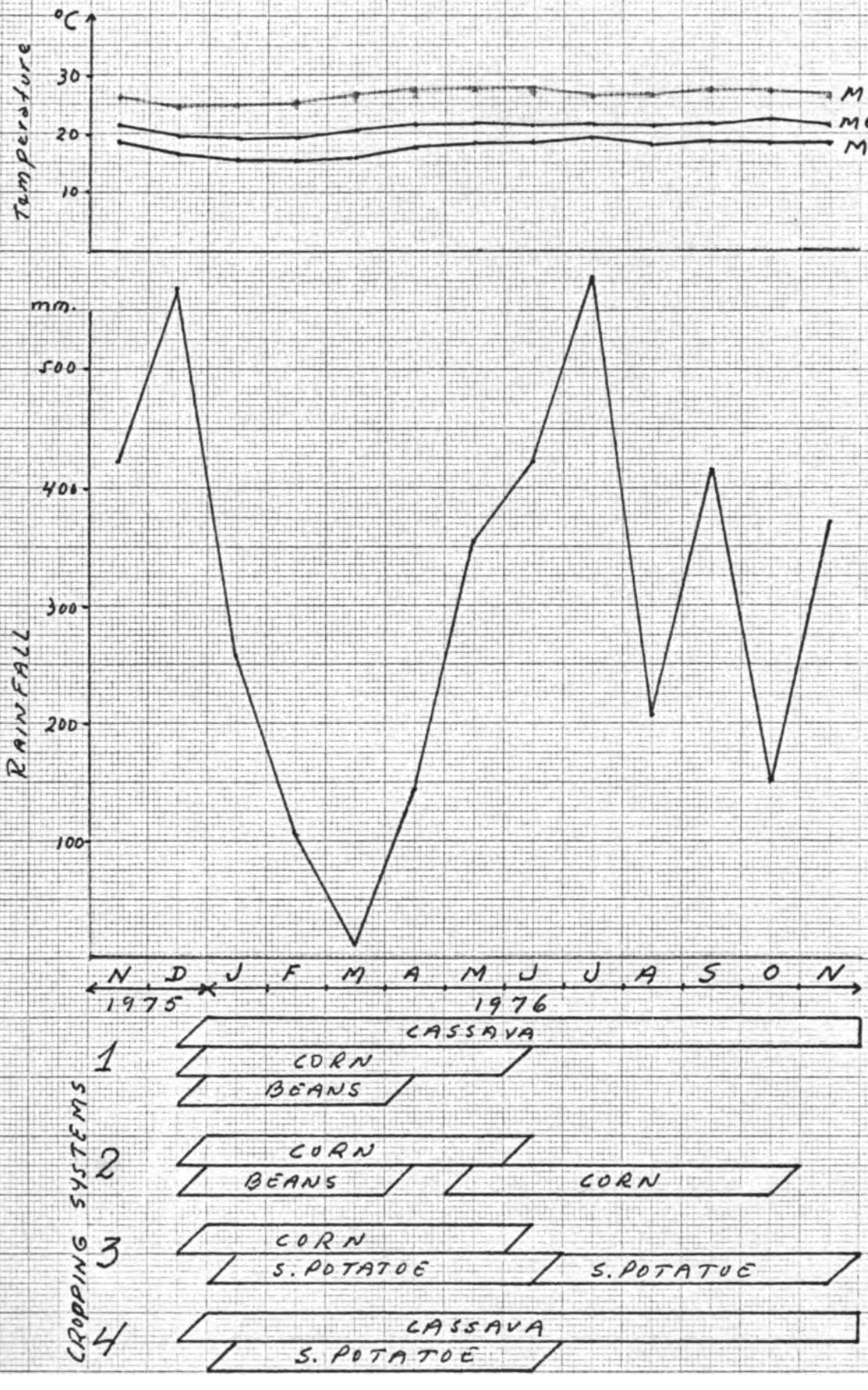


Fig. 3 - Climatic data and crop distribution. Cycle 1976-1977

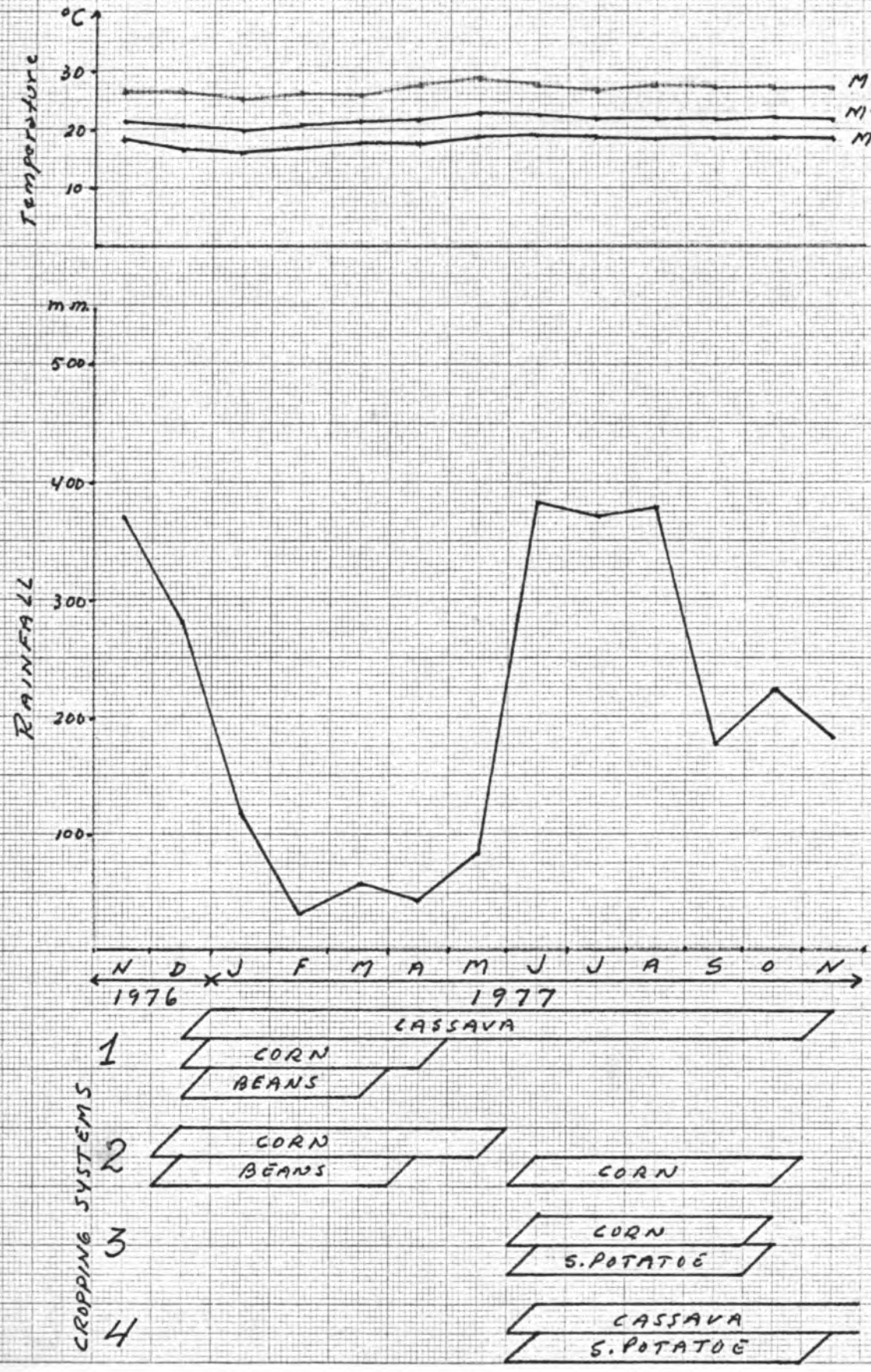
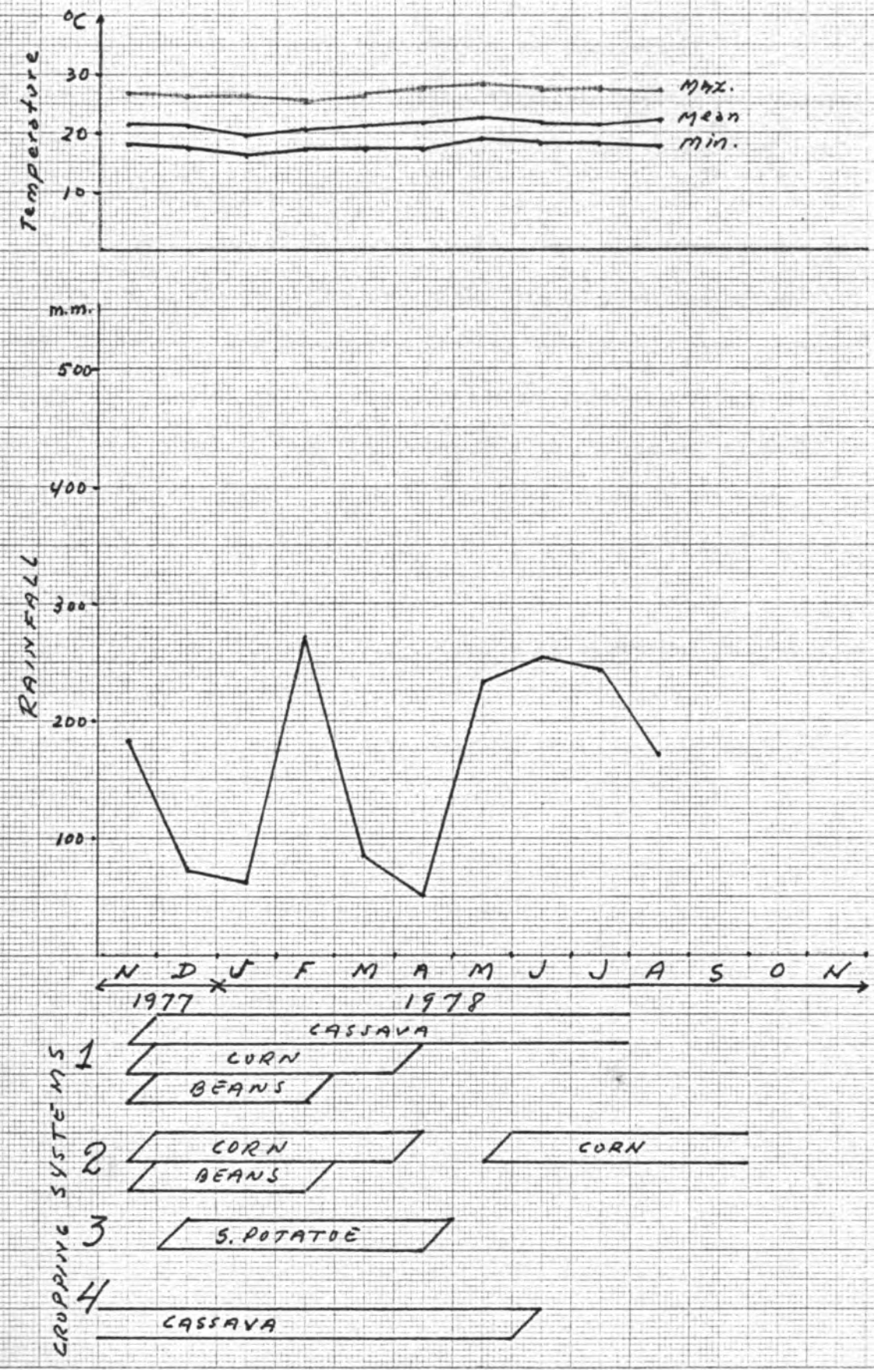


Fig. 4 - Climatic data and crop distribution. Cycle 1977-1978



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 withing the stand. A basic fertilizer level of 245 Kg/ha nitrogen, 105 Kg/ha phosphorus (P_2O_5) and 75 Kg/ha potash (K_2O) was applied suplementing 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 Ammoniun nitrate and to regular muriate of potash, according to the following treatments:

S C U Trials

1. Regular fertilization, Central Experiment
2. 100% N of S C U
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 - SO_4) 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:

S C U - Grade 38,9% N (Lot 1-17-73F)

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.

S K Cl Grade 40.8% k_2O (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 amonium 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.

System	Treat.	1975-1976 Kg/Ha N	P_2O_5	K_2O	1976-1977 Kg/Ha N	P_2O_5	K_2O	Total 1975-77 Kg/Ha N	P_2O_5	K_2O
SCU										
1 y 2	1	245	105	75	245	105	75	490	210	150
	2	245	105	75	---	105	75	245	210	150
	3	245	105	75	61	105	75	306	210	150
	4	245	105	75	122	105	75	367	210	150
	5	245	105	75	185	105	75	430	210	150
	6	245	105	75	245	105	75	490	210	150
SKCl										
3 y 4	1	245	105	75	245	105	75	490	210	150
	2	245	105	75	245	105	--	490	210	75
	3	245	105	75	245	105	19	490	210	94
	4	245	105	75	245	105	32.5	490	210	107
	5	245	105	75	245	105	56	490	210	131
	6	245	105	75	245	105	75	490	210	150

Sources:

N = SCU, Ammonium nitrate and 15-30-8

P_2O_5 = Triple super and 15-30-8

K_2O = SKCl Muriate of potato and 15-30-8

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 Am. Nitrate
5 25% N of SCU + 75% N of Am Nitrate
6 100% N of Am. Nitrate
7 0 Fertilizer

Table 6. (Cont.)

SKCl	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	0 Fertilizer

Table 2. Performance of the system Beans + corn + cassava. Yields (Kg/ha) in SCU trial.

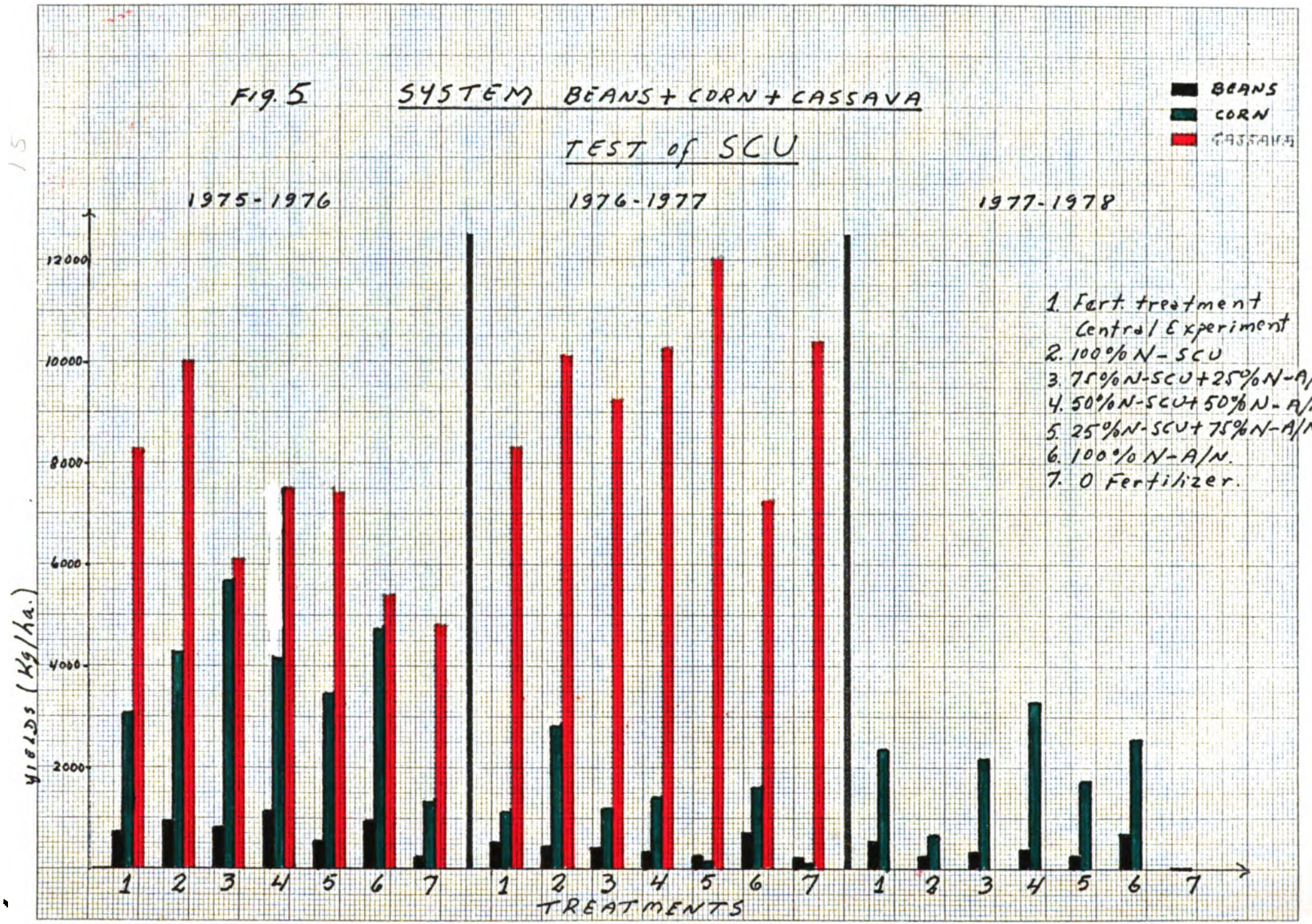
Treatment No. *	1975 - 1976 Yields (Kg/ha)			1976 - 1977 Yields (Kg/ha)			1977 - 1978 Yields (Kg/ha)			1975 - 1978 Total Yield (Kg/ha)		
	Beans	Corn	Cassava	Beans	Corn	Cassava	Beans	Corn	Cassava	Beans	Corn	Cassava
1	724	3048	8300	539	1102	8333	548	2381		1811	6531	16633
2	953	4310	10000	428	2807	10119	274	678		1655	7795	20119
3	829	5690	6100	436	1205	9285	345	2143		1610	9038	15385
4	1124	4119	7500	361	1426	10238	441	3304		2991	8849	17738
5	552	3476	7400	229	152	12024	274	1738		1055	5366	19424
6	990	4750	5400	738	1600	7262	690	2536		2418	8886	12662
7	229	1375	4800	241	92	10358	-	-		470	1476	15158

* 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/78



yields in the same treatment are the second and third highest respectively. During the second cycle, 1976-1977, beans and corn yields diminished noticeable, 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 drough, 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.

Treatment* N°	1975-1976 Yields (kg/ha)			1976-1977 Yields (kg/ha)			1977-1978 Yields (kg/ha)			1975-1978 Total Yields (kg/ha)		
	Corn	Beans	Corn	Corn	Beans	Corn	Corn	Beans	Corn**	Corn	Beans	Corn
1	2917	857	1950	3037	1078	2957	2655	429		8609	2364	
2	3531	1057	1250	1403	706	2734	1310	357		6244	2120	
3	3047	819	1200	1574	783	2582	1476	214		6097	1816	
4	4381	1067	1750	2774	947	3328	2810	464		9965	2478	
5	3321	933	1400	3144	998	3321	2405	333		8870	2264	
6	4274	953	1800	3524	1041	3225	3333	571		11131	2565	
7	1643	157	500	416	306	1002	--	--		2059	463	

* 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

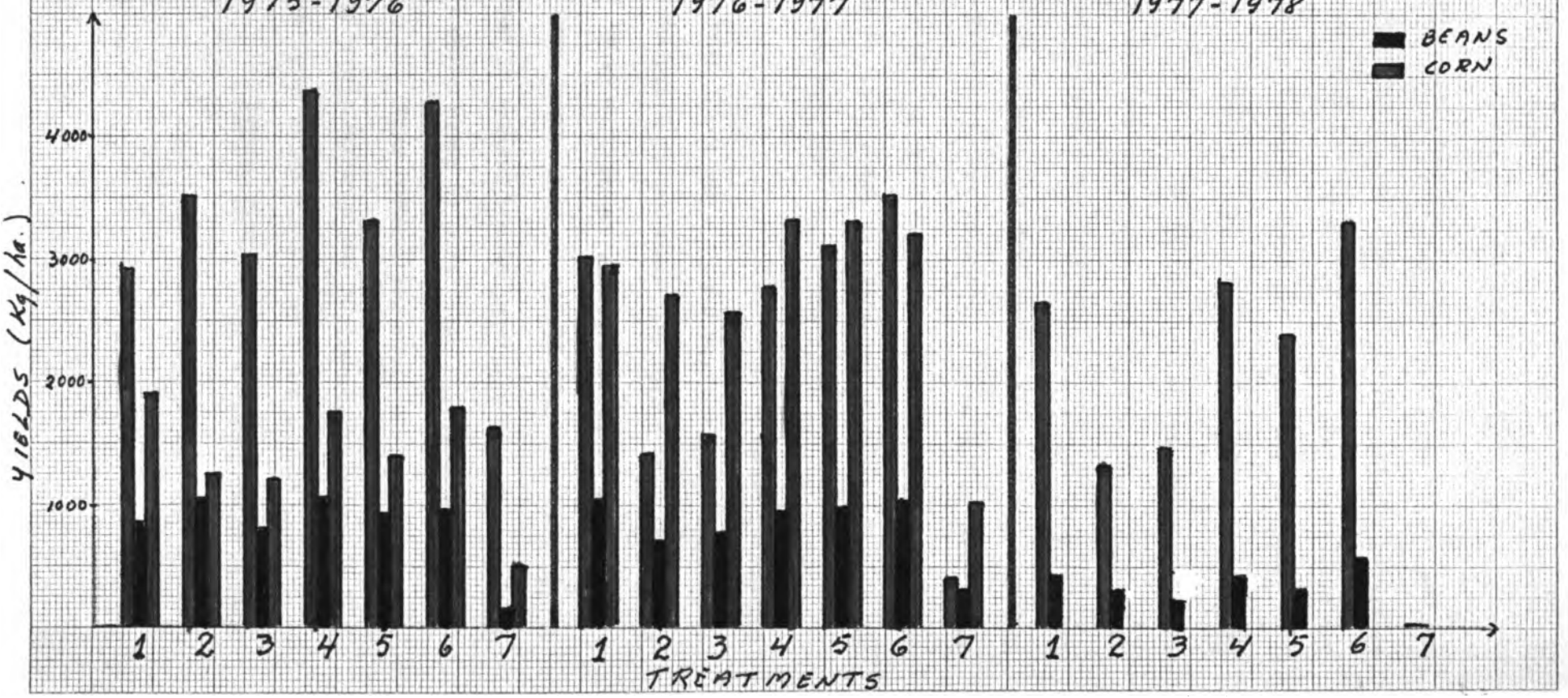
A/N - Ammonium Nitrate

** To be harvested in Nov. 1978

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

Fig 6 SYSTEM CORN + BEANS — CORN

TEST of SCU



System Sweet Potato + Corn - Sweet Potato

Sweet potato and corn are two crops quite demanding in potassium for carbohidrate 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

Treatment * No.	1975 - 1976 Yields (Kg/ha)			1976 - 1977 Yields (Kg/ha)			1975 - 1978 Yields (Kg/ha)		
	S. Potatoe	Corn	S. Potatoe	S. Potatoe	Corn	S. Potatoe **	S. Potatoe	Corn	S. Potat
1	9166	5393	15700	714	3845	6250	9880	9238	21950
2	10833	3048	16800	2500	3750	3095	13333	6798	19895
3	10535	6869	18200	4821	3285	7143	15356	10154	25343
4	13036	3476	14600	3571	3643	3750	16607	7119	18350
5	10059	5405	12600	1071	3571	5268	11130	8976	17868
6	10952	2905	18100	4285	2905	7858	15237	5810	25958

* 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.

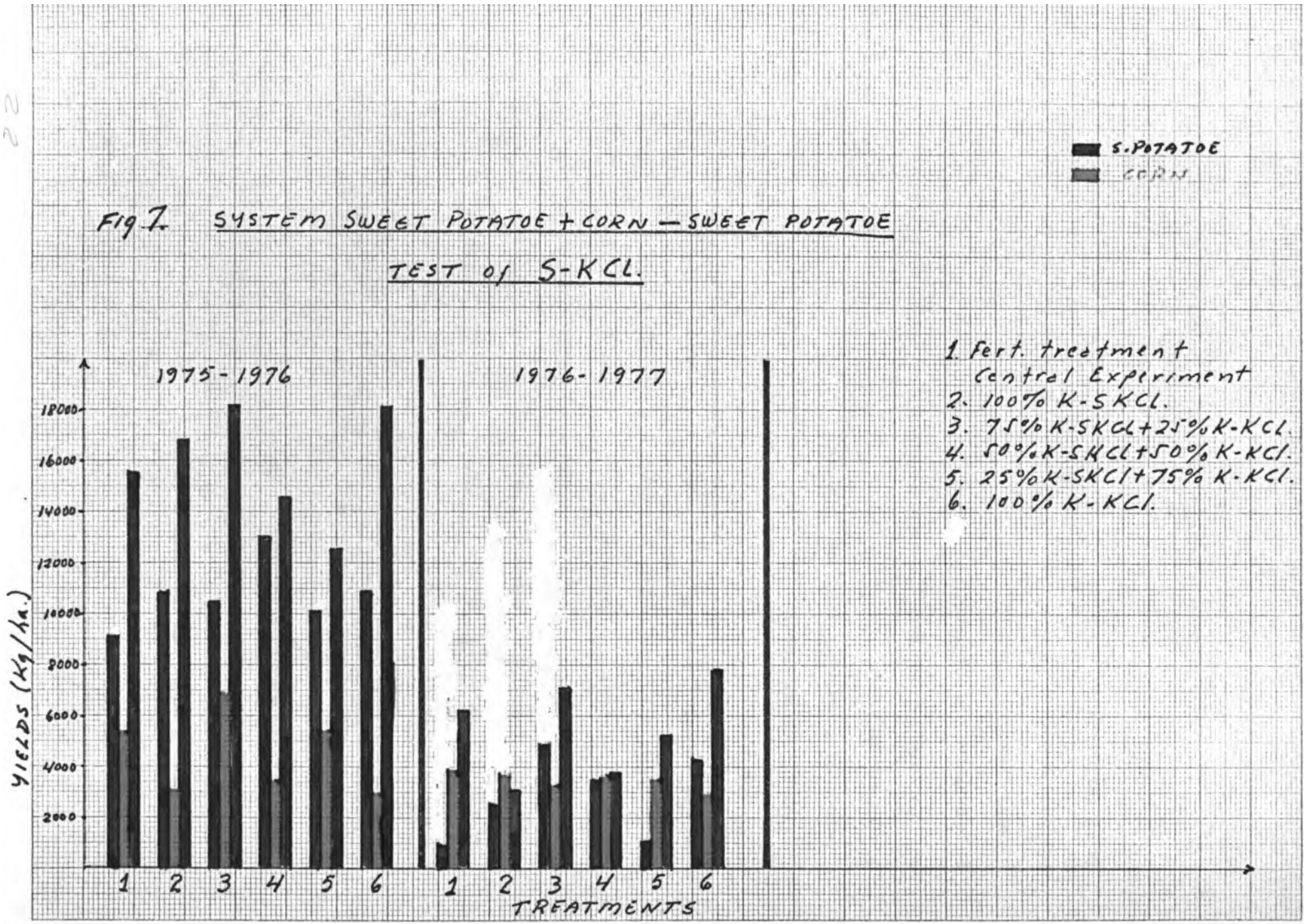


Fig. 7. SYSTEM SWEET POTATOE + CORN — SWEET POTATOE

TEST of S-KCL.

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

Treatment* N°	1975-1976 Yields (Kg/ha)		1976-1978 Yields (kg/ha)		1975-1978 Total Yields (kg/ha)	
	S. Potatoe	Cassava	S. Potatoe	Cassava	S. Potatoe	Cassava
1	13333	7300	4643	17618	17976	24918
2	11666	6900	4107	17738	15773	24638
3	9643	8600	3036	23333	12979	31933
4	8928	14700	4286	16428	13214	31128
5	10357	8400	3393	21963	13750	30363
6	10238	9600	1965	22142	12203	31742
7	12857	7900	4405	19999	17262	27899

* 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

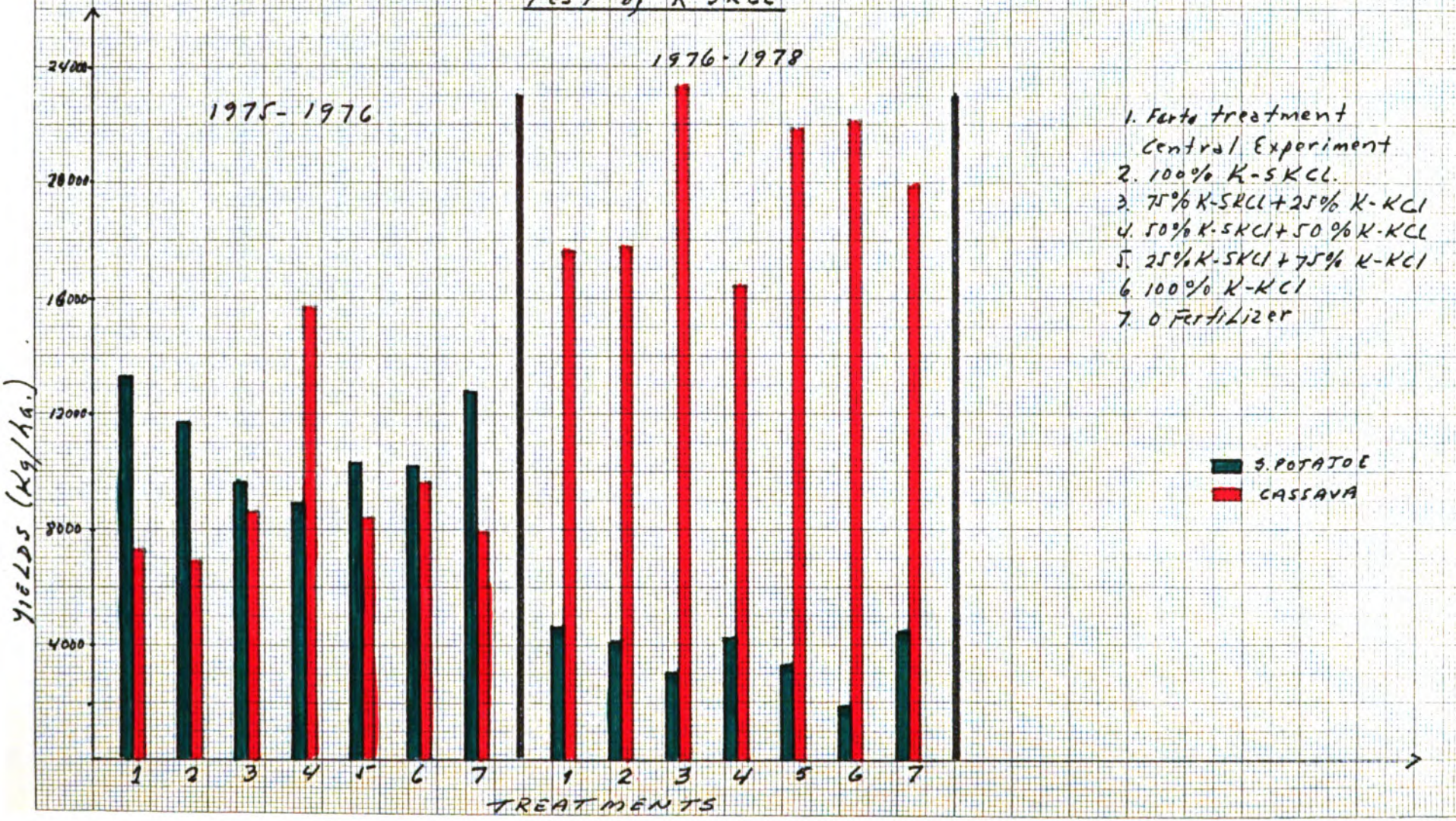
5. 25% K-SKCl + 75% K-KCl

6. 100% K-KCl

7. 0 Fertilizer

Fig. 8 - SYSTEM SWEET POTATOE + CASSAVA + SWEET POTATOE

TEST of K-SKCL



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 CATIE, 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.

Fito-844-78

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