IDRC *Striga* Project
***Striga* Physiology 3-P-85-0343**

Progress Report 1988
and
Experiments 1989

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1. Progress Report Rainy Season 1988

1.1. Introduction

Striga germination and infestation will not occur unless specific conditions are met. The seasonal fluctuation of *Striga* incidence often observed in the field is regarded as a direct result of changes in environmental and ecological factors. It has been shown that soil temperature, moisture and soil fertility play a major role in its life cycle. Therefore, identification of optimum conditions required for its growth and development is crucial for its control.

Two field experiments were conducted at ICRISAT Center during the Kharif season of 1988. The effect of soil temperature, moisture and nitrogen on *Striga asiatica* (L.) Kuntze. germination, viability and emergence were investigated. These experiments and the results obtained are presented below.

1.2. *Striga* experiments

1.2.1. Soil temperature and moisture as preconditioning treatments

In this experiment, 4 x 1.2 m plots were selected to test the effect of soil temperature and moisture on *Striga* germination and viability. On 14 May, 1988, these plots were hand sown with *Striga* at the rate of 0.9 kg ha^{-1}. A small sample of the same seeds were put in small nylon bags and were buried at a depth of 2 cm in each plot. Polythene, bare soil and hay mulches were used to impose temperature treatments giving high, medium and low soil temperatures, respectively. The mean maximum daily temperatures recorded at 2 cm and 10 cm soil depths in the polythene,hay mulch and bare soil treatments are shown in Figures 1a and 1b.

These temperature conditions were expected to simulate the average soil temperatures that prevail in many parts of the SAT region during the year. Soil moisture treatments were applied on the same plots (twice and 10 days apart) using irrigation levels of 0, 30 and 60 mm. The average soil moisture contents taken a day before and after irrigations are shown in Tables 2. The amount of rainfall received during the study period was above normal (Table 1).

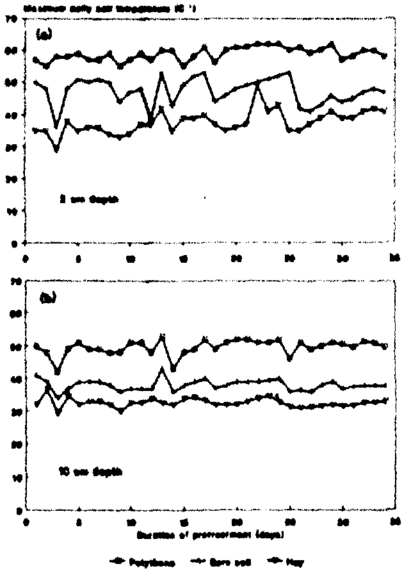


Figure 1. Maximum daily soil temperatures recorded at 2 cm (a) and 10 cm (b) soil depths. ICRISAT Center, rainy season 1988.

Table 1. Total monthly rainfall at the study area in 1988 compared to the long term average monthly rainfall in ICRISAT Center.

	Total rainfall (mm)	
Month	1988	Normal
June	109.3	115.5
July	236.3	171.5
August	215.3	156.0
September	169.2	181.0
Total	730.1	624.0

Table 2. Mean soil moisture content (v/v) across all soil treatments at 15 cm depth taken a day before and after irrigation, ICRISAT Center, rainy season 1988.

Irrigation level (mm)	Soil moisture content (v/v)	
	Before irrigation (%)	After irrigation (%)
0	15.0	14.0
30	13.8	24.1
60	14.5	28.0
SE	±3.4	±1.5
CV (%)	6.7	4.6

A factorial experimental design in randomized complete block was used. The temperature-moisture treatment combinations represented the blocks and these were replicated 4 times.

1.2.1.1. **Effect of soil temperature on *Striga* germination, viability and emergence.**

The nylon bags containing the *Striga* seeds were recovered from the soil after 34 days of preconditioning. Percent *Striga* seed germination and viability were measured. The data presented in Table 3 show that seeds exposed to 60°C (polythene) at top 2 cm soil depth did not germinate and were not viable after 34 days of pretreatment at the top 2 cm soil depth. At 48 and 37°C (bare and hay treatments, respectively, Fig.1a), however, seed germination and viability were high and similar. In these treatments, about 75% of the seeds germinated in the laboratory and about 87% were viable (Table 3).

Some researchers argue that *Striga* seeds stored in hot humid conditions do not necessarily lose viability but under go a state designated as 'wet dormancy' and such seeds will germinated if dried and sufficiently preconditioned. Several viability tests conducted to verify this hypothesis showed that the *Striga* seeds stored under the polythene were killed.

Table 3. Germination and viability of *Striga* seeds in response to soil temperature (as obtained under polythene, hay and bare soil mulch treatments), ICRISAT Center, rainy season 1988.

Soil treatment	Germination[1] (%)	Viability (%)
Polythene	0.0 (0.0)[2]	0.0 (0.0)
Bare	75.1 (60.1)	87.8 (69.8)
Hay	73.5 (59.1)	87.1 (69.0)
SE	±1.54	±1.75
CV (%)	5.5	5.3

1. *Striga* seeds were buried at 2 cm soil depth for 30 days.
2. Arcsine transformed data are shown in parentheses.

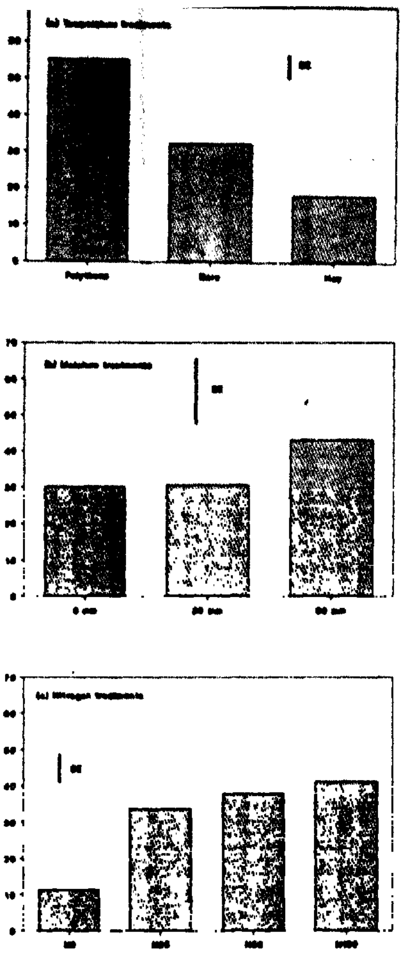


Figure 2. Total number of *Striga* plants emerged in plots pretreated with different temperature (a), irrigation (b) and nitrogen treatments (c), ICRISAT Center, rainy season 1988.

On June 13, 1988, immediately after temperature treatments were completed, all plots were sown with a *Striga*-susceptible sorghum genotype (CSH-1). *Striga* seedlings started to appear above ground about 35-40 days after sowing. Counts of emergence were initiated 2 weeks later and at a weekly interval there after. The results presented in Figure 2a show that about 55, 31 and 15 *Striga* plants emerged in the polythene, bare soil and hay mulch treatments, respectively.

While emergence of high numbers of *Striga* plants in the polythene treatment confirms earlier laboratory findings that high temperature promotes *Striga* infestation, it does not explain the lack of germination and viability observed for seeds recovered from the same plots (Table 3). It is possible that the observed *Striga* plants could have come from lower soil depths where conditions were not detrimental to the seeds. For example, mean maximum soil temperature at the 10 cm soil depth (Fig. 1b) was about 10°C lower than that recorded at the top 2 cm (where seeds were buried) soil depth. At 2 cm, also, soil moisture was expected to be much higher than that observed at the 15 cm depth (Table 2) because any water that evaporated was trapped by the polythene cover and was then precipitated at the soil surface. Therefore, it is likely that a combination of high temperature and moisture killed the seeds. This indicates that any *Striga* control practices involving only top soil surfaces may not be effective.

1.2.1.2. Effect of soil moisture on *Striga* germination, viability and emergence, ICRISAT Center, rainy season 1988.

Striga germination and viability as influenced by irrigation levels are presented in Table 4. It appears that *Striga* seeds were not affected by the level of irrigation used in this study. Regardless of the amount of water applied, germination and viability of seeds remained 48-50% and about 59%, respectively, across all irrigation levels. In our study, therefore, either (a) the frequency (twice) or the irrigation levels used were not enough to cause significant change (except under the polythene) in soil moisture content at the desired depth (2 cm), or (b) irrigation as pretreatment under field conditions, unless a continuous wetting of soil results, does not have significant effects on *Striga* germination and viability.

However, as sorghum matured, more *Striga* plants emerged in plots previously applied with 60 mm water compared to those receiving lower rates (Fig. 2b). The cause of the large increase in *Striga* emergence under high irrigation is obscure. Laboratory and field studies show that *Striga* incidence is inversely related to soil moisture content. This phenomenon, however, is observed only when moisture treatments are applied during crop growth period where wet conditions were observed to kill emerged *Striga* plants. In our study, all of the *Striga* plants died 34 days after emergence (Fig. 3) and non of these plants reached flowering stage. This was attributed to the unusually high rainfall obtained during the growth period (Table 1).

Table 4. Germination and viability of *Striga* seeds in response to different levels of irrigation.

Irrigation level (mm)	Germination[1] (%)	Viability (%)
0	50.2 (40.2)[2]	58.3 (40.4)
30	48.4 (39.0)	57.8 (45.8)
60	50.0 (40.0)	58.9 (46.8)
SE	±1.28	±2.10
CV (%)	4.5	6.3

1. *Striga* seeds were buried at top 2 cm soil depth for 34 days.
2. Arcsine transformed data are shown in parentheses.

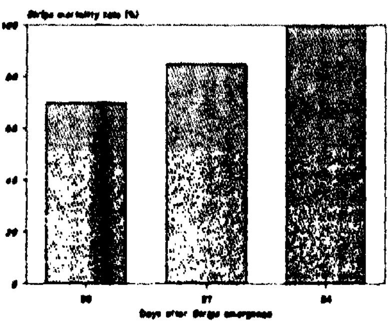


Figure 3. Rate of *Striga* mortality observed in the field after the weed plants emerged, ICRISAT Center, rainy season 1988.

1.2.2. Effect of nitrogen on *Striga* emergence

In this experiment, the effect of nitrogen on *Striga* was evaluated. Plots used were identical in size to those used in Experiment I. The soil was tested for residual nitrogen before treatments were applied. The soil analysis showed a mean nitrogen content of 20 kg ha^{-1} at the top 30 cm soil depth.

Using urea (46-0-0) as the nitrogen source, levels of 0, 25, 50 and 100 kg ha^{-1} were added to the soil and were applied as a top dressing at sowing. *Striga*-susceptible sorghum (CSH-1) was sown on June 13, 1988.

The experimental design used was a randomized complete block with 4 replications. Each nitrogen level was assigned to a block giving a total of 4 blocks per replication.

Striga emergence at the high rates of fertilizer application was delayed a little (data not presented) so counts were not started until 65 days after sowing. The total number of *Striga* plants (mean over replications for each reading) observed under different rates of nitrogen applications is shown in Figure 2c. The final number of *Striga* plants recorded at 0, 25, 50 and 100 kg ha^{-1} levels of nitrogen applications was 11, 34, 38 and 40 plants per plot. This is contrary to laboratory results where *Striga* infestation was observed to be inversely proportional to nitrogen level. Despite the relatively high infestation at the high levels of nitrogen, however, there was not any apparent loss of vigor in sorghum. This suggests that nitrogen fertilizer increases crop tolerance to the parasite probably by rendering the host plants more competative for moisture and nutrients. The exact mechanism involved, however, is unclear and further studies are needed to examine the phenomenon. The increase in *Striga* emergence may be related to an improved host root system which, in turn, had some stimulating effects on the parasite.

1.3. Conclusions and recommendations

The present study indicates that:

- high temperature and probably excess moisture seem to break seed dormancy very rapidly and these seeds will die if such conditions are prolonged,
- most infested fields contain a large reservoir of *Striga* seeds ,therefore, even if seed at soil surface is killed *Striga* may continue to emerge from lower soil depths if conditions are favorable and
- increased soil fertility seems to increase crop tolerance to *Striga* attack without apparent reduction in parasite infestation.

Based on these conclusions, it is obvious that a number of points need to be verified with special emphasis on:

- *Striga* species, races and strains in West Africa (b) the behavior of *Striga* seeds at different soil depths which we believe (1) changes with temperature, moisture and nutrient level within the soil profile and (2) has large influences on the spatial and seasonal distribution of *Striga* incidence as often experienced in field situations. This can be verified by burying seed samples in different soil depths and then testing germination, viability and, may be, emergence.

- identification of optimum soil temperature and moisture level needed for maximum *Striga* infestation or death. These can be used for screening for crop tolerance/resistance as well as for eradication purposes. Part of these experiments will be conducted in the laboratory using a thermogradient plate.

- and adoption of techniques , e.g. fertilizers, that improve crop growth and development. Such techniques may not necessarily reduce *Striga* incidence but there is strong evidence that the parasite effect is somehow reduced. Why and how this happens need to be examined.

2. Field Layouts and Experimental Designs Rainy Season 1989

2.1. *Striga* experiments IDRC project

2.1.1. Effect of nitrogen on *Striga* infestation

Experiment STRINI

Objectives To investigate the response of *Striga hermonthica* in association with pearl millet to various levels of soil nitrogen.

Locations Sadoré : STRINIS 1, STRINIS 2 in field B2.
Bengou (2 farmers' fields) STRINIS 1: Mallam Garba.
STRINIS 2: Yaou Gouyma.

Design RBD.

Plot size Sadoré: 5 rows 7.2 m long
Bengou : 8 rows 8 m long

Spacing Sadoré: 80 cm between hills, 80 cm between rows and 1 m (alley) between plots.
Bengou: 1 m between hills and rows.

Thinning 3 plants per hill.

Weeding Remove all non *Striga* weeds.

Replications Six

Fertilizers Apply ONLY urea during planting.

Treatments A : No nitrogen (control)
B : 30 kg of nitrogen ha^{-1} (urea 46%)
C : 60 kg of nitrogen ha^{-1} (urea 46%)
D : 90 kg of nitorgen ha^{-1} (urea 46%)

Variety: Sadoré local (Sadoré), HK Gaya (Bengou).

Date of planting Sadoré: June 29, 1989; Bengou: June 22, 1989.

Crop protection As required.

Irrigation Rainfed.

Observations
1) First date of *Striga* emergence.
2) # of emerged *Striga* plants; Sadoré: weekly, Bengou: bi-weekly.
3) # of *Striga* reaching flowering.
4) # of *Striga* plants at harvest.
5) # of hills harvested.
6) # of panicles per hill.
7) Panicle weight.
10) Total grain yield.

2.1.1.1. Treatments of *Striga* nitrogen trial 1 at Sadoré (STRINIS 1)

STRINIS1

	Plot numbers					
Treatments	R1	R2	R3	R4	R5	R6
A	101	203	303	404	501	602
B	103	204	301	402	504	603
C	102	201	304	401	503	604
D	104	202	302	403	502	601

Fieldplan:

101 A	201 C	301 B	401 C	501 A	601 D
102 C	202 D	302 D	402 B	502 D	602 A
103 B	203 A	303 A	403 D	503 C	603 B
104 D	204 B	304 C	404 A	504 B	604 C
R1	*R2*	*R3*	*R4*	*R5*	*R6*

24.2 m; 3.2 m; 7.2 m; 31.8 m; 1.0 m

Treatments:

A: Control, no nitrogen

B: Nitrogen 30 $kgha^{-1}$

C: Nitrogen 60 $kgha^{-1}$

D: Nitrogen 90 $kgha^{-1}$

2.1.1.2. Treatments of *Striga* nitrogen trial 2 at Sadoré (STRINIS 2)

STRINIS2

	Plot numbers					
Treatments	R1	R2	R3	R4	R5	R6
A	102	203	304	404	503	602
B	101	204	301	402	504	601
C	103	202	302	403	502	603
D	104	201	303	401	501	604

Fieldplan:

24.2 m

3.2 m

	101 B	201 D	301 B	401 D	501 D	601 B	7.2 m
	102 A	202 C	302 C	402 B	502 C	602 A	1.0 m
31.8 m	103 C	203 A	303 D	403 C	503 A	603 C	
	104 D	204 B	304 A	404 A	504 B	604 D	
	R1	R2	R3	R4	R5	R6	

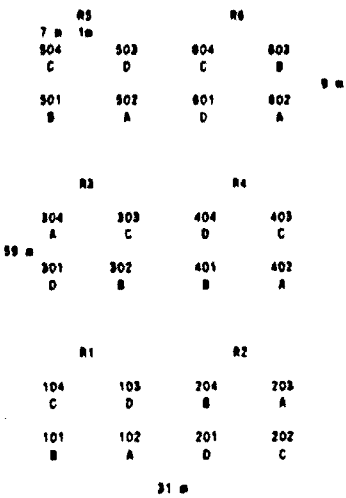
Treatments:

A: Control, no nitrogen
B: Nitrogen 30 $kgha^{-1}$
C: Nitrogen 60 $kgha^{-1}$
D: Nitrogen 90 $kgha^{-1}$

2.1.1.3. Treatments of *Striga* nitrogen trial at Bengou (STRINIB)

Treatments	Plot numbers					
	R1	R2	R3	R4	R5	R6
A	102	203	304	402	502	602
B	101	204	302	401	501	603
C	104	202	303	403	504	604
D	103	201	301	404	503	601

Fieldplan:



Treatments:

A: Control, no nitrogen
B: Nitrogen 30 $kgha^{-1}$
C: Nitrogen 60 $kgha^{-1}$
D: Nitrogen 90 $kgha^{-1}$

2.1.2. Effect of soil temperature on *Striga* germination and emergence

Experiment STRITEMP

Objectives To study the effect of different soil temperatures on *Striga* seeds buried at different depths in the soil

Locations Sadoré

Design RBD

Plot size Three rows 8 m long.

Spacing 80 cm between hills and 80 cm between rows.

Thinning 3 plants per hill.

Weeding Remove all weeds except *Striga*.

Applications Ten.

Fertilizers NPK (15-15-15 $kgha^{-1}$).

Cultivar Sadoré local

Treatments

a) Soil treatments
   1) Polythene cover (increase temp.)
   2) Bare soil (control)

b) *Striga* seed treatments
   1) Seed buried at 5 cm
   2) Seed buried at 10 cm
   3) Seed buried at 15 cm
   4) Seed buried at 20 cm

Date of planting June 29, 1989

Crop protection As required.

Irrigation Rainfed.

Observations

1) Daily soil temperature (4 depths).
2) Germination of *Striga* seeds recovered from soil.
3) First date of *Striga* emergence.
4) # of emerged *Striga* plants at weekly interval.
5) First date of *Striga* flowering.
6) # of *Striga* plants at harvest.
7) # of panicles per hill at harvest.
8) Plant height in cm.
9) # of hills harvested.
10) Total grain yield.
11) 1000 grain weight.

2.1.2.1. Treatments of *Striga* temperature trial

	Plot numbers									
Treatments	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
A	101	201	301	401	501	601	701	801	901	1001
B	102	202	302	402	502	602.	702	802	902	1002

Fieldplan:

24.0 M

1.25 m 1.15 m

	101	201	301	401	501	601	701	801	901	1001
	A	B	B	A	A	A	B	A	B	A
18.0 m					2.0 m					
	102	202	302	402	502	602	702	802	902	1002
	B	A	A	B	B	B	A	B	A	B
	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*

Treatments:

A: Control, Bare soil
B: Polythene covered soil

2.2. *Striga* experiments ISC

2.2.1. Longterm observation of *Striga hermonthica* in a millet field

Experiment STRI001

Objectives To observe *Striga hermonthica* in a field where millet is planted precisely each year in the same hill over a period of five years. Experiment started in 1989. in field B2.

Locations Sadoré, B2.

Plot size 25 m x 60 m

Spacing 1 m x 1 m

Thinning Three plants per hill.

Weeding Twice before emergence of *Striga*.

Fertilizers None.

Date of planting June 19, 1989, partially replanted 29 June, 1989.

Crop protection As required.

Irrigation Rainfed.

Observations 1) Date of emergence of first *Striga*

2) Counting *Striga* plants in two week intervals after first emergence till two weeks after planting. Counting is done with handcounter for each hill with a frame of 1x1m.

3) Head and grain yield for each hill.

2.2.2. Effect of cultural practices on *Striga* infestation of pearl millet

Experiment STRINAH

Objectives To study the effect of weeding and intercropping of pearl millet with cowpea on the infestation of *Striga hermonthica* on farmer's field.

Locations Sengou, 3 farmer's field heavily infested with *Striga* in previous season. STRINAH 1 Malam Abdou, STRINAH 2 Na Fana, STRINAH 3 Kimba Gouywa.

Design 2 x 2 factorial experiment.

Plot size 6 rows of 9 m length.

Spacing 1 m x 1 m for millet, 2 m x 2 m for millet/cowpea.

Thinning 3 plants per hill.

Weeding Two weeding before first *Striga* emergence.

Replications Six.

Fertilizers 15 kg ha^{-1} N, 15 kg ha^{-1} P2O5, 15 kg ha^{-1} K
(100 kg ha^{-1} 15/15/15) at land preparation.

Treatments

Handweeding of all weeds except *Striga*	: A
Weeding of all weeds including *Striga*	: B
Intercropping millet (Gaya local)/cowpea (Gaya local)	: C
Control (no weeding)	: D

Date of planting STRINAH 1: June 21; STRINAH 2 and 3: June 22, 1989.

Irrigation Rainfed.

Observations
1) Emergence of millet.
2) Date of 75% flowering.
3) Date of first emergence of *Striga* in all plots.
4) Count number of *Striga* plants from first emergence in a two weeks interval till two weeks after harvest.
5) Final stand count (nursery of hills of the two central rows).
6) Yield of heads and grains of two central rows.
7) 1000 grain weight.

2.2.2.1. Treatments and randomisation of *Striga* management trial

Treatments	Plot numbers					
	R1	R2	R3	R4	R5	R6
A	104	201	301	403	502	602
B	102	203	303	401	501	604
C	101	204	302	402	504	603
D	103	202	304	. 404	503	601

Fieldplan:

		R5		R6	
	7 m	1m			
	504 C	503 D	604 B	603 C	
					9 m
	501 B	502 A	601 D	602 A	
		R3		R4	
	304 D	303 B	404 D	403 A	
59 m					
	301 A	302 C	401 B	402 C	
		R1		R2	
	104 A	103 D	204 C	203 B	
	101 C	102 B	201 A	202 D	
		31 m			

Treatments:

- A: Handpulling all weeds except *Striga*
- B: Weeding all weeds including *Striga* with «dabba»
- C: Intercropping with cowpea (Gaya local)
- D: Control (no weeding)

2.2.3. Effect of handpulling of *Striga* on yield of pearl millet

Experiment STRIHP1

Objectives To study the effect of handpulling of *Striga hermonthica* on yield of pearl millet in a longterm experiment

Locations Bengou, field of farmer Mallam Balla, Sadoré 81

Design RBD.

Plot size 10 rows of 10 m length.

Spacing 1 m x 1 m

Thinning 3 plants per hill.

Weeding Two weedings before first emergence of *Striga*.

Replications Five at Bengou, 20 at Sadoré.

Fertilizers 15 kg ha^{-1} N, 15 kg ha^{-1} P2O5, 15 kg ha^{-1} K
(100 kg ha^{-1} 15/15/15) at land preparation.

Treatments Handpulling of *Striga* only, no other weeding A
Control, no handpulling of *Striga* and no weeding C

Date of planting Bengou June 22, 1989, Sadoré June 30, 1989.

Crop protection As required.

Irrigation None.

Observations
1) Emergence of millet.
2) Date of 75% flowering.
3) Date of first emergence of *Striga* in all plots.
4) Count number of *Striga* plants from first emergence in a two weeks interval till two weeks after harvest.
5) Final stand count.
6) Yield of heads and grains.
7) 1000 grain weight.

2.2.3.1. Treatments and randomisation of *Striga* handpulling trial at Bengou

Treatments:

A: Handpulling *Striga* at two weekly intervals
C: Control (no weeding)

2.2.3.2. Treatments and randomisation of *Striga* handpulling trial at Sadoré

A = Arrachage de Striga *T = Témoin*

50 m

A 40	T 39	A 38	A 37	T 36	
T 31	A 32	T 33	T 34	A 35	
T 30	T 29	A 28	T 27	T 26	
A 21	A 22	T 23	A 24	A 25	80 m
A 20	T 19	A 18	A 17	T 16	
T 11	A 12	T 13	T 14	A 15	
A 10	A 9	T 8	T 7	T 6	
T 1	T 2	A 3	A 4	A 5	