APPLIED PLANT RESEARCH
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Filmcoating of tomato seeds with insecticides

Testing of insecticides applied as a filmcoating to control major pests present in tomatoes cultivated in Tanzania

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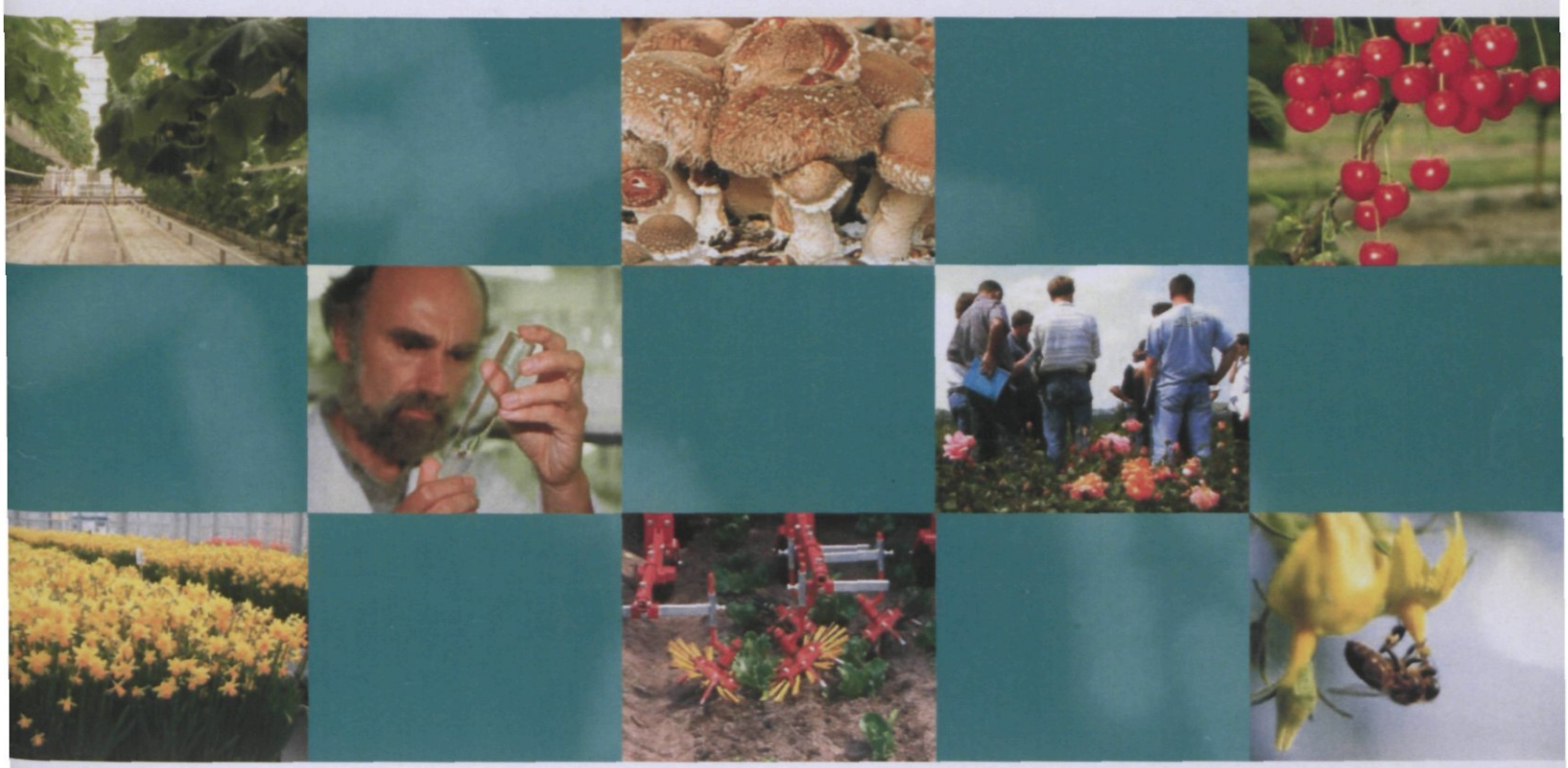

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1 Introduction

Filmcoating of vegetable seeds and seeds of arable and fodder crops with insecticides is becoming a standard application in order to protect seedlings and plants against insect pests. Seed coating of leek, cabbage, beans, peas, onions, sugar beet, flax, maize and oil rape with insecticides is common practice in Europe, North America and Australia. Yield levels increased due to a better emergence and to less leaf and fruit damage. A positive effect is also that because of the better protection of the plants less field sprayings are needed. With this less pesticides are needed and as a result risks to the environment and the user are reduced. With filmcoating or seedcoating the insecticide is already applied at low but still effective rates to the seeds and is available at the right spot at the right time.
Contrary to treating tomato seeds with fungicides to control damping off, filmcoating of tomato seeds with an insecticide to protect the plant against insect pests is a novel technique. Not much is published on filmcoating tomato seeds with insecticides. Ramesh and Ukey (2006) mentions the use of imidacloprid and thiamethoxam in tomato to control white fly (*Bemisia tabaci*) in India. Tested rates for imidacloprid where 7, 7.5 and 10 g active ingredient per kg seed and for thiamethoxam the rate was 3, 4 and 5 g active ingredient per kg seed. Observed was that with 10 g/kg imidacloprid and with 5 g/kg thiamethoxam the lowest white fly population density was present. When using Gaucho 70% and cruiser 70% as a source for respectively imidacloprid and thiamethoxam rates would be approximately 0.05 g and 0.025 g per 1000 seeds for respective active ingredients.
In Tanzania tomato cultivation is an important vegetable crop. A total acreage of approximately 7,000 hectare is under tomato cultivation with a total production of 160,000 ton (Shao et al., 2002). Production mainly takes place in the highland areas of which the area nearby Arusha and Kilimanjaro are one of the important areas. Tomato production in Tanzania however, is hampered by a few constraints of which presence of pests and poor controlling is one.

1.1 Target pests

Major pests in tomato cultivation present in Tanzania are white fly and thrips. White fly species in Tanzania are mainly *Bemisia tabaci*, *Bemisia afer*, *Trialeudorus vaporarium* and *Trialeudorus ricini*. Besides the two mentioned pests, leafminer (*Liriomyza* spp.) is present at a limited scale.
Next to the direct damage these insects cause to the tomato plants more important is the fact that whitefly and aphids are vectors for transferring viruses.
White fly is a vector for transferring Tomato mottle virus (ToMoV) and Tomato yellow curl virus (TYLCV) and these are transferred in a persistent manner. In Tanzania TYLCV is present at almost all tomato fields and at 9% of all surveyed farms showed 70 - 99% TYLCV incidence. Cultivar, crop stage and time of infection influences yield losses.
Western flower thrips is a vector of tomato spotted wilt tospovirus (TSWV), but also *Scirtothrips* and *Thrips tabaci* are reported as a vector for transmission. The virus is transmitted in a persistent manner and can cause yield losses ranging from 20 to 100%. Besides transmission by insects, TSWV is also transmitted via seeds. In the case farmers are using seeds from the previous crop this also stimulates the spread of this virus.
The mentioned viruses are non specific for tomato but are also present in other host crops and weeds. It is recommended to remove these weeds in the neighbourhood of tomatoes in order to prevent transmission of virus.

TYLCV spp. symptoms in tomato include:

a) severe stunting
b) marked reduction in leaf size
c) upward cupping and chlorosis of leaf margins
d) mottling
e) flower abscission

f) significant yield reduction in crops.

TYLCV symptoms in common bean include:
a) leaf thickening
b) leaf crumpling
c) upward curling of leaves
d) abnormal lateral shoot proliferation
e) deformation of pods and reduction in pod number

TYLCV symptoms in pepper include:
a) interveinal and marginal leaf chlorosis
b) upward curling of leaf margins
c) or symptomless

TYLCV symptoms in Lisianthus include:
a) distortion of the growing tips
b) cup-shaped leaves
c) swelling of veins on the lower surface of the leaves
d) significant reduction in flower quality
e) stunting

Symptoms of ToMoV in tomato:
a) chlorotic mottling
b) leaf distortion and curling
c) stunting

1.2 Potential insecticides to test

Mostly pesticides are used to control insect pests and to reduce the incidence of virus. However, pesticides are reported to be ineffective in reducing the virus incidence and also control of whitefly is poor.
A solution can be the introduction of seeds coated with insecticide.
When applying insecticide filmcoating target pests can be controlled as well the presence of virus can be reduced. Nevertheless it is still recommended then to use a broad range of measurements to reduce the risk of yield losses. Advisable is to use coated seeds in combination with host plant removing and in combination with field applications of insecticides.

For the control of thrips and white fly a broad range of insecticides might be effective when applied as a film coating. The insecticides are mostly systemic.
Insecticides that might be effective are:
- Imidacloprid (Gaucho) (shows often very phytotoxic effects on germination). Possible effective rate against thrips and white fly: 3 – 6 g/1000seeds
- Beta-cyfluthrin+Chlothianidin (Poncho-Beta). Possible rates: 3 – 6 g/1000 seeds
- Chlothianidin (Poncho). Possible rates: 3 – 6 g/1000 seeds
- Thiamethoxam (Cruiser) (A drench application in Indonesia tested in hot pepper against thrips did not show positive results thrips). Possible rates: 1.25 – 2.5 g/1000 seeds
- Fipronil (Mundial). Possible rates: 4-8 ml/1000 seeds

In Tanzania insecticides with the active ingredients imidacloprid, fipronil and thiamethoxam are already available at agro supply shops. Recommended is not to use the same insecticide or active ingredient for foliar applications later on in the crop when it is already used for seedcoating.
Thiamethoxam is available in the formulation of Cruiser and Apron Star 42 WS to be used as a seed treatment by dusting. Apron star 42 WS consists of thiamethoxam, and the fungicides 20% metalaxyl and 2% difenoconazole. Thiamethoxam shows a broad insecticide activity and displays root-systemic action.

Metalaxyl shows activity against fungi of the *Peronosporales*, while difenoconazole controls fungi of the *Ascomycetes*, *Basidiomycetes* and *Deuteromycetes*. In order to avoid resistance.
For Apron Star 42 WS recommended seed treatment rate for beans is 250 g per 100 kg seed (with a tkw of approximately 100 g this means a rate of 0.25 g per 1000 seeds)
Rates for tomato seeds treatment are selected on base of experience with other crops. Rates may seem very high but it is essential to start with highest possible rates where no phytotoxicity occurs and where efficacy against target pests is present. For Apron star 42 WS decided was to start with a rate comparable to the rate of thiamethoxam applied with Cruiser 70% WS.
Mentioned rates did not show phytotoxic effects with hot pepper germination tests. However, this does not mean that with tomato no phytotoxic effects might not be present as well.
When applying 3 gram formulated product per 1000 seeds an amount of 83.4 formulated product per hectare will be used (3 gram/1000 seeds x 27,800 plants per ha). In case 4 ml will be applied this will make 111 ml per ha. Currently, advised is to plant tomatoes at 60 x 60 cm which results in 27,800 plants per hectare.
In case 3 gram formulated product per 1000 seeds is applied a total amount of 938 gram per kg seed is applied assuming a thousand kernel weight of 3.2 g. With this test high rates of insecticides are tested to establish an effect of the insecticide seedcoating on controlling insect pests. In case an effect is observed, lower rates can be tested to establish optimum rates which can still control the pest but are also economically profitable.

1.3 Acknowledgements

Special thanks goes to AVRDC – RCA and Dr. Drissa Silué for their assistance in carrying out the experiment at the AVRDC – RCA premises. Also the support by Mr. Tjerk Scheltema and Mr. Hans Baart of Multiflower Ltd. to this experiment is very much appreciated.
Finally, a great deal of the field work was carried out by Mr. Shabani who did a great job.

2 Filmcoating procedure

2.1 Materials and method

For this experiment seeds of the tomato variety Onyx (OP variety of Royal Sluis) was used (Table 1). Beforehand seeds already received a dusting treatment with thiram, therefore with seed coating in this experiment no thiram was added to the suspension. Seeds where send from Tanzania to the Netherland on August 4 and received on August 6.
Beforehand the 1000 seed weight or TKG was established by randomly taking 5 samples from the seed batch and after counting 1000 seeds out of these samples, average weight was observed.

Average 1000 seed weight or TKG was assessed at 3.23 g based on 5 samples taken from the seed batch.

Table 1. Characteristics of used seed

Variety	:	Onyx
Batch	:	1467856
Amount	:	4 x 250 g
Treated	:	cl 3 Thiram
Lot no	:	08 13945 3
Min. pur	:	99%
Germination	:	85%
Packing date	:	August 2, 2008

For coating a suspension is prepared based on 120% of the seed weight that has to be treated (Table 2). From the prepared suspension an amount of 100% is measured to be applied onto the seeds plus an additional 1% to compensate for losses during the coating process.
Treatment A only 100 gram of seeds was treated. With this it was observed that the process was not optimal and decided was to treat 110 grams.
Tomato seed is very light and easily blown away and for this the function "Gebläse" on the treater was turned down when pouring the seeds in the bowl where the seeds are coated.
The coating process is started with a rpm of 6/7 for the revolving bowl and 5-6 for the "Gebläse" but once the pump starts to apply the suspension on the seeds these are quickly turned up to 9.
Temperature is set at 65°C in order to have a slow process. Tomato seeds are tiny and flat and with quicker coating seeds tend to stick to each other. The suspension needs to be watery otherwise the suspension is too sticky and also cooling of the seeds is not optimal causing more suspension to be sprayed onto the seeds. Thus seeds start to stick to each other very easily.

Table2. Calculation of filmcoating suspension and insecticide amount to be prepared

Treatment	Active ingredient	Trade name	Formulation	Rate form./1000 sds.	Gram form. prod./1000 seeds	Gram form. prod. /gram seed	Coating suspension (g)	Form. Insecticide product (g)	Additive for powder form. (g)
A	Onbehandeld	-	-	0	0	0	33	0	-
E	Beta-cyfluthrin + Clothianidin	Poncho-Beta	53.3g/l + 400g/l FS	6	7.2	2.23	33	294.24	-
F	Beta-cyfluthrin + Clothianidin			3	3.6	1.11	33	147.12	-
I	Imidacloprid	Gaucho	70 % WS	6	6	1.86	33	245.20	81.73
J	Imidacloprid			3	3	0.93	33	122.60	40.87
K	Thiamethoxam	Cruiser	70 % WS	2.5	2.5	0.77	33	102.17	34.06
L	Thiamethoxam			1.3	1.3	0.39	33	51.08	17.03
N	Fipronil	Mundial	500 g/l SC	4	4.9	1.52	33	201.07	-
P	Thiamethoxam +Metalaxyl +difenocanozole	Apron Star	20% 20% 2% WS	2.2	2.2	0.68	66	89.91	29.97

2.2 Results

Coating of treatment A, P, K and L performed on August 7; treatment I, J, E, F, N performed on August 8, 2008 (Fig. 1).

A: 30 gram of coating suspension (CS) was prepared and 25.25 g was applied onto the seeds.

P: 33.03 g (CS) + 33.0 g (CS) + 89.91 g Apron Star + 100.62 g water + 34.17 g additive was prepared. Total weight of the suspension was 290.73 g. Applied onto the seeds was 244.70 g
When dissolving this pesticide the powder showed a lot of grit and dust and it seems that higher rates cannot be dissolved in the coating suspension. At coating additional water was added in order to prevent forced stops of the coating process. Also temperature was reduced to 60°C, but later on increased again to 65°C. After coating some seeds stuck to each other were present. From preparing this amount, dissolving in the polymer and applying the amount on to the seeds it seemed that 2.2 g is the maximum possible.

L: prepared was 33.05 g (CS) + 51.08 g Cruiser + 25.68 g water + 25.72 g water + 17.23 g additive resulting in a total suspension weight of 152.66 g. Applied to seeds was 128.27 gram
A smooth coating process without any problems was present.

K: prepared was 33.03 g (CS) + 102.17 g Cruiser + 107.10 g water + 34.65 additive giving a total suspension weight of 276.95 g. Applied to seeds was 233.31 g
No problems during coating and a good coating result.

J: prepared was 33.06 g (CS) + 122.59 g Gaucho + 124 g water + 46.84 g additive + 10.21 g water resulting in a suspension weight of 336.68 g. Applied to seeds was 283.37 g.
Good coating process with this suspension was obtained.

I: prepared was 33.02 g (CS) + 245.21 g Gaucho + 245.49 g water + 81.80 g additive + 20.14 g

water which resulted in a total suspension weight of 625.66 g. Applied to seeds was 526.59 gram.
No problems with coating were present.

F: prepared was 33.01 g (CS) + 147.12 g Poncho Beta + 11.05 g water resulting in a total suspension weight of 191.18 g. Applied to seeds was 160.91 gram.
Process of coating went without problems

E: prepared was 33.02 g (CS) + 294.24 g Poncho Beta + 15.18 g water giving a total weight of 342.44 g. Applied to seeds was 288.22 gram.
No problems during coating were present.

N: prepared was 35.97 g (CS) + 201.07 g Mundial giving a suspension weight of 236.86 g. Applied to seeds was 199.35 g
Coating was a bit difficult since the viscosity of the suspension was a bit too low. At the start some seeds started to stick and during the process additional water was necessary to dilute the suspension to obtain a good coating result.

Figure 1. **Left below one sample with naked seeds (Thiram treated only), one sample treated only with coating suspension 2nd from the left bottom row and 8 samples treated with insecticides.**

3 Germination

In order to establish the effect of the seed coating on germination three different tests were carried out. All treatments were tested on germination capacity and compared with naked seed and seeds only treated with the polymer (Untreated) (Table 3).

Table 3. Insecticides in the germination tests.

Treatment	Active ingredient	Content & formulation	Rate per 1000 seeds		Trade name
			Formulated	Active ingredient (g)	
Z	Untreated (naked seed)	-	-	-	-
A	Untreated + coating suspension	-	-	-	-
E	Beta cyfluthrin + Clothianidin	53.3 + 400 g/l	6 ml	0.32 + 2.4	Poncho-Beta
F	Beta cyfluthrin + Clothianidin	53.3 + 400 g/l	3 ml	0.16 + 1.2	Poncho-Beta
I	Imidacloprid	70% WS	6 g	4.2	Gaucho
J	Imidacloprid	70% WS	3 g	2.1	Gaucho
K	Thiamethoxam	70% WS	2.5 g	1.75	Cruiser
L	Thiamethoxam	70% WS	1.25 g	0.875	Cruiser
N	Fipronil	500 g/l SC	4 ml	2	Mundial
P	Thiamethoxam + metalaxyl + difenoconazole	20 + 20 + 2% WS	2.2 g	0.44 + 0.44 + 0.044	Apron Star 42 WS

3.1 Preliminary test

In order to establish optimum observations dates for the germination test on top of paper a preliminary test was carried out. A second goal was to get an impression beforehand on phytotoxicity of the different treatments.

3.1.1 Materials and methods

On August 8 per sample 25 seeds (except for naked seed where 12 seeds were sown) were sown on petri dishes to check the germination period and possible phytotoxic symptoms.
A petri dish contained a paper filter with 30 ml of water.
After 3,4,6 and 7 days progress of germination was observed.

3.1.2 Results

From the preliminary test observations showed that for the germination test later on the first observation should take place after 10 days (Figures 2 till 5).

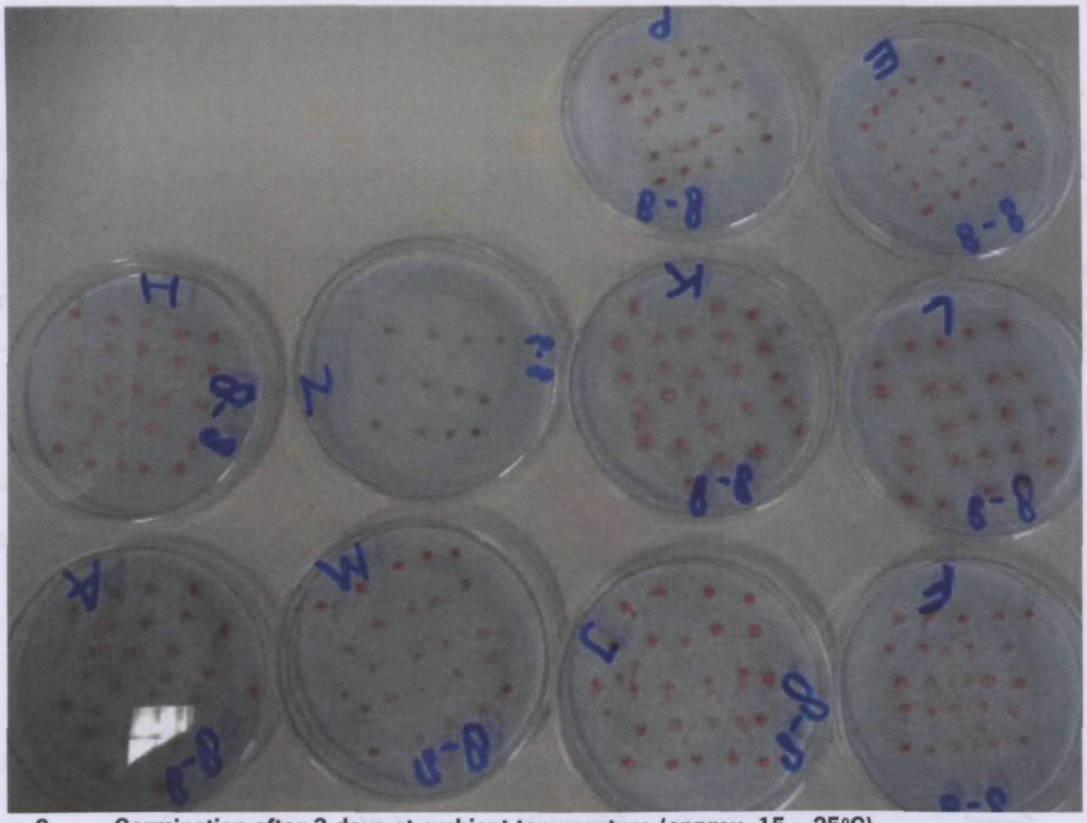


Figure 2. Germination after 3 days at ambient temperature (approx. 15 – 25°C).

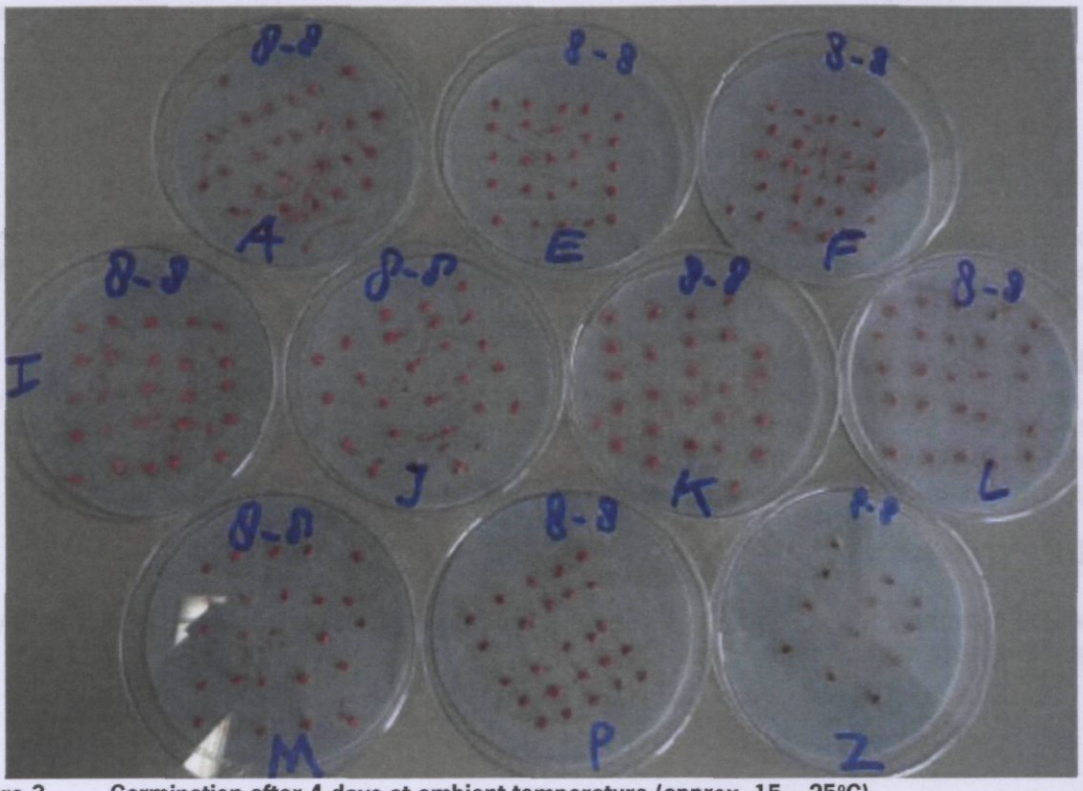


Figure 3. Germination after 4 days at ambient temperature (approx. 15 – 25°C).

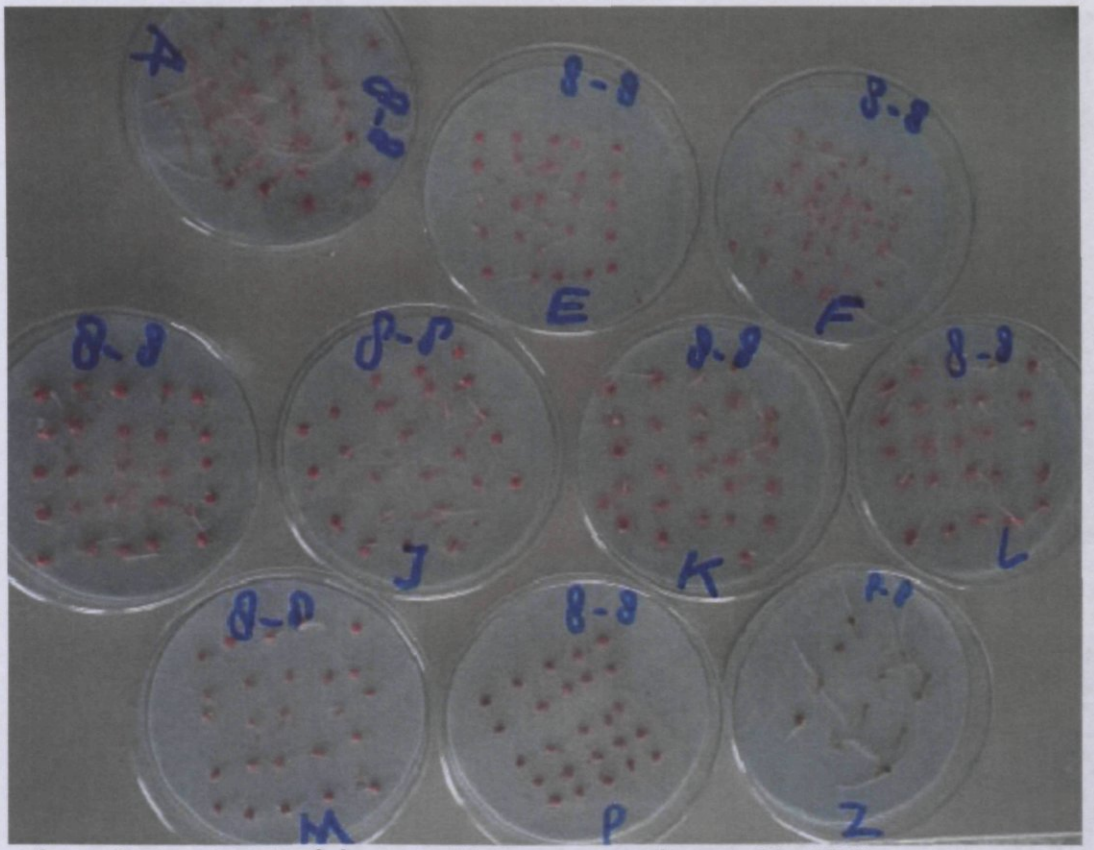
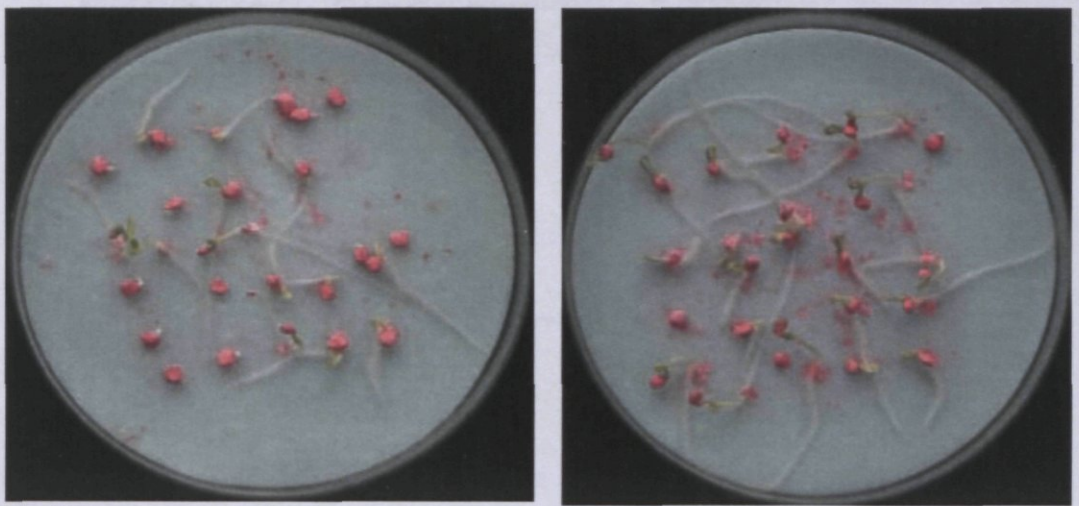


Figure 4. Germination after 6 days at ambient temperature (approx. 15 – 25°C).

Even after 6 days naked seed seedlings are not sufficient fully grown to assess on normal seedlings
It seems that germination only after 7 days can be assessed. However, when kept under optimal conditions germination might be observed after 5 – 6 days. This because after 6 days only 1 to 2 seeds are showing some germination where root tips become visible.
After 7 days it seems that treatments with Apron Star 42S at 2.2 g, Gaucho at both tested rates of 3 and 6 g, Poncho-Beta 6 ml and with Mundial 4 ml per 1000 seeds phytotoxicity is present when testing on paper. All treatments showed a delay in germination compared to naked seeds.



6 ml/1000 seeds Poncho-Beta *3 ml/1000 seeds Poncho-Beta*

Figure 5a. Germination of Poncho-beta treated seeds after 7 days at ambient room temperature.

6 g/1000 seeds Gaucho

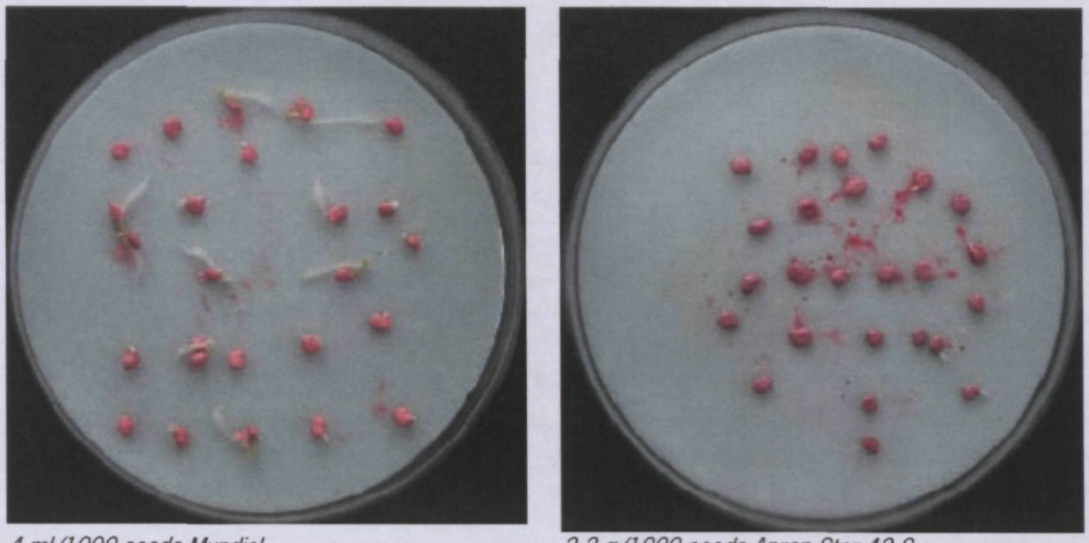
3 g/1000 seeds Gaucho

Figure 5b. Germination of Gaucho treated seeds after 7 days at ambient room temperature.

2.5 g/1000 seeds Cruiser

1.25 g/1000 seeds Cruiser

Figure 5c. Germination of Cruiser treated seeds after 7 days at ambient room temperature.



4 ml/1000 seeds Mundial *2.2 g/1000 seeds Apron Star 42 S*

Figure 5d. Germination of Mundial treated seeds after 7 days at ambient room temperature.

3.2 Test on top of paper

The test was carried out at Lelystad and sowing took place on 14 August.

3.2.1 Materials and methods

According ISTA rules germination should be tested as follows:
Tomato seeds (*Lycopersicon esculentum*)

- 100 seeds per plot (may be subdivided in 2x50 or 4 x 25)
- 4 replications

Germination method is:

- On top of paper or between paper or in sand;
- Add 0.2% KNO_3 to moist the paper;
- At later stage normal water may be used to add in order to prevent dehydration of the paper
- Temperature alternating 8 hours at 20°C and 16 hours at 30°C;
- First count after 5 days and second count after 14 days (may be sooner or later if necessary)

On August 14th a germination test according ISTA rules was started with the exception of adding KNO_3, instead demineralised water was used.
Papers of 1 – 1.5 mm thick were placed in transparent boxes with dimensions of 13 x 20 x 4 cm (width x length x height) containing 50 seeds each. Per field two boxes were used. Per box 40 ml water was added to the paper and 50 seeds were placed on the paper by a vacuum counter
Boxes were placed in a germination cell with alternating temperatures of 8 hours 20°C and 16 hours 30°C and with constant light of approximately 800 lux.
Boxes were stacked up to 4 boxes high were replication I and II were placed below and replication III and IV on top.

The order of the boxes in the cell placed on a table was as follows:

replication I		replication II		replication III		replication IV	
10	Z	20	I	30	E	40	N
9	J	19	E	29	L	39	L
8	A	18	Z	28	K	38	A
7	N	17	L	27	I	37	E
6	P	16	J	26	F	36	Z
5	L	15	K	25	J	35	P
4	K	14	A	24	P	34	J
3	I	13	F	23	N	33	I
2	F	12	P	22	A	32	F
1	E	11	N	21	Z	31	K

Also different with the ISTA rules was that after 10, 16 and 18 days counting's took place. This because germination didn't take place sooner and after that only 6 days later a second count needed to be done instead of 9 days later since after the first counting germination went quite fast.

The following observations were carried out according to ISTA rules:

- Normal seedlings
- Abnormal seedlings
- Just germinated seeds
- Not germinated

Also a mark was given for plant (hypocotyl) length and root length per box (Table 4).

Table 4. Observation on root and plant length.

	Mark	10 days	16 days	18 days
root	1=	> 3	> 5	> 5
	2=	1-3	2-5	2-5
	3=	< 1	< 2	< 2
plant	1=	> 1.5	> 3	> 3
	2=	0.5 - 1.5	1-3	1-3
	3=	< 0.5	< 1	< 1

3.2.2 Results

Compared to naked seeds untreated seeds did not show a lower germination percentage and a lower percentage of normal seedlings at all three observation dates (Table 5). Maximum percentage of normal seedlings at untreated was reached after 18 days where 88.8% normal seedlings were present.
After 10 days all insecticide treatments showed a lower percentage of normal seedlings.
Poncho-Beta showed a similar percentage of normal seedlings as naked seeds after 16 days. Mundial showed a lower percentage as with naked seeds but was not significant different from both Poncho-Beta treatments. Apron, Cruiser 1.25 g and 2.5 g, Gaucho 3 and 6 g per 1000 seeds showed a significant lower percentage where Apron showed almost no normal seedlings.
Eighteen days after sowing Cruiser 1.25 g, Mundial 4 ml, Poncho-Beta 3 and 6 ml per 1000 seeds did not show a different number of normal seedlings compared to untreated. Percentages at Gaucho 2.5 and 3 g, Cruiser 2.5 g and Apron 2.2 g were significant lower. Gaucho 3 g per 1000 seeds showed a lower number of normal seedlings compared to the rate of 6 g. While at Cruiser at the rate of 1.24 g a higher number of normal seedlings was present compared to the rate of 2.5 g per 1000 seeds.

Table 5. Effect of seed coating on percentage normal seedlings 10, a6 and 18 days after sowing.

Treatment per 1000 seeds	10 days		16 days		18 days	
P Apron 2.2 g	0.0	a	0.3	a	5.3	a
L Cruiser 1.25 g	2.0	a b	59.0	d	77.3	e

K Cruiser 2.5 g	0.3	a	29.8	c	55.5	d
J Gaucho 3 g	0.0	a	17.5	b	21.3	b
I Gaucho 6 g	0.0	a	13.0	b	39.0	c
M Mundial 4 ml	0.0	a	75.0	e	86.8	e f
F Poncho-Beta 3 ml	4.8	b	81.5	e f g	84.8	e f
E Poncho-Beta 6 ml	0.8	a	77.0	e f	82.0	e f
A Untreated	29.3	d	87.5	g	88.8	f
Z Naked	20.3	c	84.5	f g	85.5	e f
mean	5.7		52.5		62.6	
$LSD_{0.05}$	4.4		8.3		9.9	
p =	<0.001		<0.001		<0.001	

Percentage abnormal seedlings after 10 days was at Cruiser 1.25 g and 2.5 g and Gaucho 3 g similar to that at untreated and naked seed (Table 6). Other treatments showed a lower percentage, but this was mainly caused because at these treatments germination is still low after 10 days. At all insecticides when 2 rates were applied no differences in abnormal seedlings were present with different rates per insecticide. After 16 days percentage abnormal seedlings at Apron 2.2 g and Gaucho 3 g is higher then at untreated and naked seed. Gaucho 6 g did not show a different percentage compared to untreated and showed a lower percentage then Gaucho 3 g. A similar pattern is present after 18 days. Compared to untreated Apron 2.2 g and Gaucho 3 and 6 g per 1000 seeds showed a higher percentage of abnormal seedlings.

Table 6. Effect of seed coating on percentage of abnormal seedlings 10, 16 and 18 days after sowing.

Treatment per 1000 seeds	10 days		16 days		18 days	
P Apron 2.2 g	0.0	a	33.5	b c	77.0	d
L Cruiser 1.25 g	3.3	b c d	1.5	a	2.5	a
K Cruiser 2.5 g	3.8	b c d	2.0	a	4.0	a
J Gaucho 3 g	3.8	b c d	38.5	c	63.0	c
I Gaucho 6 g	2.3	a b c	13.0	a b	31.3	b
M Mundial 4 ml	0.8	a b	1.3	a	1.3	a
F Poncho-Beta 3 ml	2.8	a b c	4.0	a	3.8	a
E Poncho-Beta 6 ml	1.3	a b	2.8	a	4.0	a
A Untreated	6.0	d	2.5	a	2.5	a
Z Naked	5.0	c d	1.3	a	1.3	a
mean	2.9		10.0		19.1	
$LSD_{0.05}$	3.1		21.1		9.0	
p =	0.008		0.003		<0.001	

Percentage not germinated seeds at untreated after 10 days was 12.5 percent (Table 7) and was not different from naked seeds. Cruiser 1.25 g, Poncho-Beta 3 and 6 ml per 1000 seeds showed a same percentage of not germinated seeds as untreated. Cruiser 2.5 g, Gaucho 3 and 6 g, Mundial 4 ml and Apron 2.2 g showed a percentage of not germinated seeds higher then untreated. Cruiser 2.5 g showed a higher percentage then Cruiser 1.25 g. Also Gaucho 3 g showed a higher percentage then Gaucho 6 g per 1000 seeds.

Table 7. Effect of seed coating on percentage of not germinated seeds 10, 16 and 18 days after sowing.

Treatment per 1000 seeds	10 days		16 days		18 days	
P Apron 2.2 g	81.3	e	26.3	d	17.8	c
L Cruiser 1.25 g	17.3	a b	12.8	a b c	12.3	a b
K Cruiser 2.5 g	25.8	c	17.5	b c	13.5	b c
J Gaucho 3 g	22.8	b c	17.0	b c	15.8	b c
I Gaucho 6 g	46.0	d	19.3	c d	16.3	b c
M Mundial 4 ml	23.0	b c	11.5	a b	11.3	a b
F Poncho-Beta 3 ml	14.0	a	10.8	a b	10.5	a
E Poncho-Beta 6 ml	18.0	a b c	13.3	a b c	11.5	a b
A Untreated	12.5	a	8.0	a	7.8	a
Z Naked	14.0	a	12.5	a b c	12.0	a b
mean	27.5		14.9		12.9	
$LSD_{0.05}$	8.2		7.1		5.4	
p =	<0.001		0.001		0.03	

After 16 days Apron 2.2 g, Cruiser 2.5 g, Gaucho 3 and 6 g per 1000 seeds showed a higher percentage of not germinated seeds then untreated. However, except for Apron 2.2 g all treatments did not differ from naked seeds. Differences between rates per insecticide were not present.
After 18 days compared to naked seeds only Apron 2.2 g showed a higher percentage not germinated seeds. Compared to untreated Apron 2.2 g, Cruiser 2.5 g and Gaucho 3 and 6 g per 1000 seeds showed a higher percentage of not germinated seeds.
Root length was classified in three classes, where a high classification stands for a lower root length. After 10 days root length at untreated was classified as 1, indicating an average root length of more then 3 cm (Table 8). Cruiser 1.25 g and Poncho-Beta 3 ml showed a same root development. Other treatments showed a shorter root length then untreated. Cruiser 2.5 g showed a shorter root length then Cruiser 1.25 g.
After 16 and 18 days only Apron 2.2 g and Gaucho 3 and 6 g per 1000 seeds showed a shorter root length then untreated. At untreated the root length was on average more then 5 cm.
After 18 days root length of untreated and naked seeds was not the longest of all treatments. This can be explained due to the fact that after 16 days already most seedlings were observed as normal already and were removed from the test. After 18 days then only the more weak seedlings were left over for observations.

Table 8. Effect of seed coating on average root length 10, 16 and 18 days after sowing.

Treatment per 1000 seeds	10 days		16 days		18 days	
P Apron 2.2 g	2.5	d e	2.0	b	2.5	c d
L Cruiser 1.25 g	1.3	a	1.0	a	1.0	a
K Cruiser 2.5 g	2.1	c d	1.0	a	1.6	a b
J Gaucho 3 g	2.9	e	2.8	c	3.0	d
I Gaucho 6 g	2.8	e	2.3	b	2.5	c d
M Mundial 4 ml	2.0	c d	1.0	a	1.5	a b
F Poncho-Beta 3 ml	1.4	a b	1.0	a	1.8	b
E Poncho-Beta 6 ml	1.9	b c	1.0	a	1.6	a b
A Untreated	1.0	a	1.0	a	2.0	b
Z Naked	1.0	a	1.0	a	2.0	b c
mean	1.9		1.4		1.9	
$LSD_{0.05}$	0.5		0.3		0.6	
p =	<0.001		<0.001		<0.001	

Ten days after sowing all treatments showed a shorter stem length then untreated and naked seeds (Table 9). Cruiser 1.25 g showed a longer stem length then Cruiser 2.5 g. Also Poncho-Beta 3 ml showed a longer

stem length then Poncho-Beta 6 ml.
After 16 days only Apron 2.2 g and Gaucho 3 and 6 g per 1000 seeds showed a shorter stem length then untreated. Gaucho 6 g showed also a shorter stem length then 3 g per 1000 seeds.
After 18 days untreated and naked seeds showed a relative short stem length, however, this observation is biased since most normal seedlings were removed during earlier observations.

Table 9. Effect of seedcoating on average hypocotyl length 10, 16 and 18 days after sowing.

Treatment per 1000 seeds	10 days		16 days		18 days	
P Apron 2.2 g	3.0	c	3.0	d	3.0	d
L Cruiser 1.25 g	2.0	b	1.0	a	1.0	a
K Cruiser 2.5 g	2.8	c	1.0	a	1.0	a
J Gaucho 3 g	3.0	c	1.6	b	1.5	a b
I Gaucho 6 g	3.0	c	2.1	c	2.0	b
M Mundial 4 ml	3.0	c	1.0	a	1.9	b c
F Poncho-Beta 3 ml	2.0	b	1.0	a	1.4	a b
E Poncho-Beta 6 ml	2.9	c	1.0	a	1.6	a b
A Untreated	1.0	a	1.0	a	2.3	c
Z Naked	1.1	a	1.0	a	2.3	c
mean	2.4		1.4		1.8	
$LSD_{0.05}$	0.5		0.3		0.6	
p =	<0.001		<0.001		<0.001	

Figure 6. Phytotoxicity observed after 16 days at Apron 2.2 g per 1000 seeds.

Figure 7. **Phytotoxicity observed after 16 days at Gaucho 3 g per 1000 seeds.**

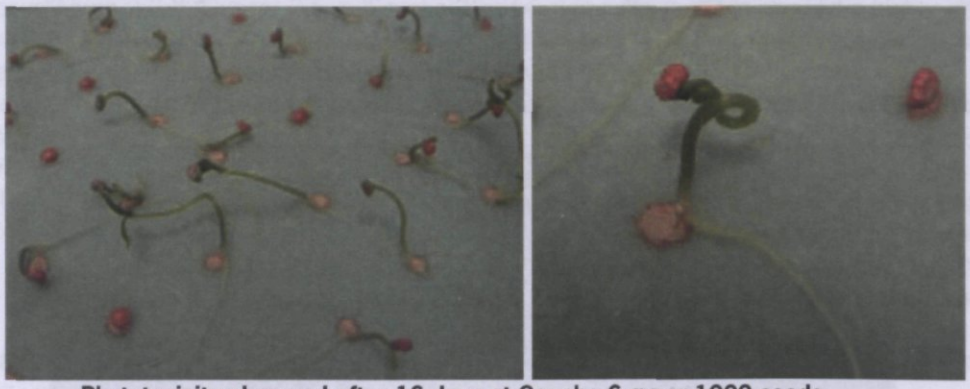


Figure 8. **Phytotoxicity observed after 16 days at Gaucho 6 g per 1000 seeds.**

3.2.3 Conclusion germination test on paper

With germination test on paper Apron 2.2 g per 1000 seeds showed a high level of phytotoxicity. Percentage of normal seedlings at all observations is very low with after 18 days only 5.3% present. Percentage of abnormal seedlings is high and also percentage of not germinated seeds is high. Finally root length and stem length is also much shorter compared to untreated.

Gaucho 3 and 6 g per 1000 seeds showed phytotoxicity as well but to a lesser extend as Apron 2.2 g. Percentage normal seedlings after 18 days is still lower compared to untreated, while percentage of abnormal seedlings is higher then at untreated. Remarkable is that with 6 g per 1000 seeds less abnormal seedlings are present then with 3 g per 1000 seeds. Sometimes this can happen because a lot of seeds don't germinate and are then not considered as abnormal. In this case a lot of seeds were germinated but at 6 g cotyledons were trapped in the seed coat still. In case the seed coat can not be removed manually without damaging the cotyledons those seedlings are also considered as abnormal. Root and stem length of Gaucho 3 and 6 was shorter as compared to untreated. Root length of the 3 gram treatment was shorter after 16 days as compared to 6 gram but was the stem length longer at the 3 gram treatment.

Mundial 4 ml showed only slight phytotoxic effects were mostly only a delay in germination and plant development takes place. After 18 days no differences with untreated are present.

Also Poncho-beta 3 and 6 ml showed after 18 days no phytotoxic effects compared to untreated. Only speed of germination is lower as compared to untreated. With the highest rate of 6 ml the development is slower as compared to 3 ml per 1000 seeds.

3.3 Germination test in potting soil

Two tests were carried out in Arusha, Tanzania. Per treatment only 1 tray was sowed (Fig. 9).

3.3.1 Materials and method

Approximately 7-9 grams per sample was send to Tanzania on August 11. In Tanzania per sample one tray was sown to check germination in potting soil. Potting soil has a buffer capacity to absorb pesticides thus phytotoxicity might be absent or at a lower level in potting soil compared to the germination tests on paper where phytotoxicity is present.

Per treatment 1 tray of 150 cells was sowed on 9 September 2008.
A second test was sowed on 3 October 2008.

When seedlings were in 2nd true leave stage, the fertiliser Polyfeed 19:19:19 at a concentration of 0.5 g/ l water was given to the plants each day at 9.00 am with the normal watering of the plants. At 15.00 pm a second time watering took place, but without any fertiliser.

Observations:

- Percentage of germination after 10 and 20 days
- Percentage of abnormal seedlings after 10 and 20 days
- Percentage of usable seedlings at transplant stage
- Phytotoxic symptoms will be described when present
- Per treatment 10 plants will be selected at transplant stage for:
    - Individual plant length
    - Individual fresh weight
    - Individual number of leaves
    - Total dry weight

3.4 Results

3.4.1 Results of test sowed on September 9

Emergence was observed 10 days after sowing and seedlings showed fully stretched cotyledons at that time (Fig. 10).

Figure 9. Seedling raising of the different treatments 12 days after sowing.

Cruiser 2.5 g/1000 seeds
Gaucho 6 g/1000 seeds

Apron S 2.2 g/1000 seeds
Untreated + coating

Gaucho 3 g/1000 seeds
Poncho-Beta 3 ml/1000 seeds

Poncho-Beta 6 ml/1000 seeds
Mundial 4 ml/1000 seeds

Cruiser 1.25 g/1000 seeds
Untreated (naked)

Figure 10. Seedling stage per treatment 10 days after sowing.

Naked seeds showed 85.3 % emergence and was slightly higher then the percentage at untreated where seeds were treated with the seed coating polymer only (Table 10). Seeds treated with Apron 2.2 9 per 1000 seeds showed clearly a lower emergence then untreated. Also treatment with Gaucho 6 gram showed a lower emergence. In general higher rates of Cruiser, Gaucho and Poncho-beta showed approximately a 10 to 20 percent lower emergence compared to the respective lower rates.

At the emergence after 20 days Apron 2.2 g still showed a lower emergence then untreated. Other treatments did not showed a much different emergence then at untreated. Also differences in rate per treatment were not present anymore.

After 30 days, at transplanting, Apron 2.2 g showed 53.3% emergence, which was still lower then at untreated, but compared with the initial emergence after 10 days significant higher. Other treatments did not differ much from untreated. At some treatments final emergence of normal seedlings is even lower then compared with the emergence at 10 days. This was caused by the presence of wilting during raising.

Table 10. Percentage of normal seedlings raised from seeds sowed on September 9 observed 10, 20 and 30 days after sowing.

Treatment per 1000 seeds	10 days (19 September)	20days (29 September)	30 days (13 October)
P Apron 2.2 g	1.3	24.0	53.3
L Cruiser 1.25 g	86.0	64.0	74.7
K Cruiser 2.5 g	70.0	82.0	73.3
J Gaucho 3 g	65.3	85.3	84.0
I Gaucho 6 g	41.3	81.3	81.3
M Mundial 4 ml	72.0	70.7	74.7
F Poncho-Beta 3 ml	73.3	73.3	60.7
E Poncho-Beta 6 ml	62.7	78.7	73.3
A Untreated	72.0	70.7	70.0
Z Naked	85.3	75.3	75.3
mean	62.9	70.5	72.1

Number of leaves was for all treatments about 4 (Table 11). Apron showed a somewhat lower number. Also plant length of seedlings treated with Apron was smaller then the length present at the other treatments. Gaucho 3 gram showed also a slightly shorter plant length compared to seedlings raised seeds treated with Gaucho 6 gram and from naked seeds.
Fresh weight and dry weight was the highest at seedlings raised from naked seeds and the lowest at seedlings raised from Apron treated seeds. Between the other treatments no big differences were present. Dry matter percentage ranged from 8 till 14.8 %.

Table 11. Number of leaves per seedling, average seedling length, average fresh weight, total dry weight per 10 seedlings and dry matter % at transplanting.

Treatment per 1000 seeds	Nr of leaves	Plant length (cm)	Fresh weight (g)	Dry weight (g of 10 plants)	Dry matter %
P Apron 2.2 g	3.7	4.5	0.4	0.4	9.6
L Cruiser 1.25 g	4.0	9.6	0.8	1.2	14.8
K Cruiser 2.5 g	4.0	9.4	1.1	0.9	8.3
J Gaucho 3 g	4.0	6.2	0.8	1.1	14.0
I Gaucho 6 g	4.0	10.9	1.1	1.1	10.5
M Mundial 4 ml	4.0	9.0	0.8	0.8	9.8
F Poncho-Beta 3 ml	4.0	7.8	1.1	0.9	8.0
E Poncho-Beta 6 ml	4.0	11.0	1.0	1.3	12.5
A Untreated	4.0	8.6	1.1	1.1	9.8
Z Naked	4.2	11.2	1.4	1.5	10.6
mean	4.0	4.0	8.8	1.0	1.0

3.4.2 Results of test sowed on October 3.

Ten days after sowing the percentage of emergence at naked seeds was 85.3% (Table 12). At Apron 2.2 g no emergence was observed. Cruiser 2.5 gram, Gaucho 3 and 6 gram, Mundial 4 ml and Poncho-Beta 6 ml showed emergence 10% lower then naked seed. Cruiser 2.5 gram showed a lower emergence then Cruiser 1.25 gram. Also the highest rates of Gaucho and Poncho-Beta showed a lower emergence as compared to the respective lower rates.
After 20 days the emergence at naked seeds was 82.7%. Due to the presence of damping-off emergence percentages decreased in some cases. Compared to naked seeds Apron 2.2 gram showed a very low emergence still. Also the emergence of seeds treated with Cruiser 2.5 gram and Poncho-Beta 6ml was somewhat lower then at naked seeds.
Percentage usable transplants after 30 days was at naked seeds 83.3% while Apron 2.2 gram showed only 33.3%. Compared to naked seeds Cruiser 2.5 gram showed a lower percentage. Untreated showed also a lower percentage but this was caused by the presence of damping off.

Table 12. Percentage of normal seedlings raised from seeds sowed on October 3 observed 10, 20 and 30 days after sowing.

Treatment per 1000 seeds	10 days (October 13)	20 days (October 23)	30 days (November 2)
P Apron 2.2 g	0.0	18.7	33.3
L Cruiser 1.25 g	80.0	80.7	78.7
K Cruiser 2.5 g	72.0	68.0	66.7
J Gaucho 3 g	75.3	78.7	77.3
I Gaucho 6 g	68.0	79.3	78.7
M Mundial 4 ml	72.7	76.0	76.0
F Poncho-Beta 3 ml	84.0	84.7	83.3
E Poncho-Beta 6 ml	72.0	68.0	70.0
A Untreated	83.3	62.7	64.7
Z Naked	85.3	82.7	83.3
mean	69.3		

At transplanting the number of leaves was four at all treatments with the exception of Apron 2.2 gram, where on average 2.9 leaves were present (Table 13). Plant length of Apron 2.2 gram was also the shortest of all treatments. Compared to naked seeds the plant length of Cruiser 1.25 gram and Gaucho 6 gram was somewhat shorter. Fresh weight was about 1 gram for all treatments. Only Apron 2.2 gram showed a lower fresh weight with 0.4 gram. A similar trend was present at dry weight. Dry matter percentage did not vary much and ranged from 9.5 till 13.5%. Dry matter percentage was the highest at naked seeds and the lowest at Apron 2.2 gram.

Table 13. Number of leaves per seedling, average seedling length, average fresh weight, total dry weight per 10 seedlings and dry matter % at transplanting.

Treatment per 1000 seeds	Nr of leaves	Plant length (cm)	Fresh weight (g)	Dry weight (g of 10 plants)	Dry matter %
P Apron 2.2 g	3	4.2	0.4	0.4	9.5
L Cruiser 1.25 g	4	6.0	1.0	1.0	10.2
K Cruiser 2.5 g	4	7.2	1.1	1.4	12.6
J Gaucho 3 g	4	7.5	1.0	1.2	11.8
I Gaucho 6 g	4	6.3	1.1	1.2	10.8
M Mundial 4 ml	4	7.2	1.0	1.0	9.8
F Poncho-Beta 3 ml	4	7.6	1.0	1.1	10.7
E Poncho-Beta 6 ml	4	7.6	0.9	1.0	10.6
A Untreated	4	7.1	1.0	1.1	11.5
Z Naked	4	8.1	1.0	1.4	13.5
mean	3.9	6.9	0.9	1.1	11.1

4 Efficacy test

Raised seedlings as described in section 3 were transplanted into a field and observed on efficacy on controlling thrips, white fly and virus incidence and also yield was observed.

4.1 Materials and method

Plants raised in the potting soil test (see section 3) were transplanted into the field when they were ready for transplanting.

4.1.1 Lay out of the plots and field

One plot contained 30 plants planted on 5 ridges of 6 plants each, at a planting distance of 60 x 60 cm (Fig. 11 and 12).

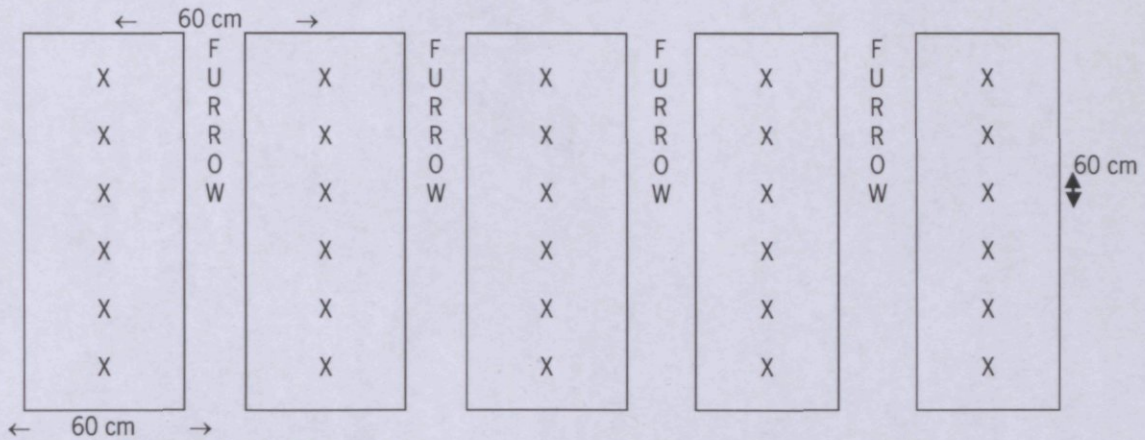


Figure 11. Layout of one plot.

Figure 12. One field consists of 5 ridges with 6 plants per ridge.

In 2008 at two different dates plants were transplanted into the field (Table 13)

Table 14. General information on the efficacy tests.

	First test	*Second test*
Location:	AVRDC – RCA	AVRDC – RCA
Sowing date:	9 September	3 October
Transplant date:	16 October	4 November
Planting distance:	60 x 60 cm	60 x 60 cm
Plants per plot:	30	30
Plot size:	3.0 x 4.2 meter	3.0 x 4.2 meter
Replications:	3	3
Harvest dates:	30 December	9 February
	5 January	18 February
	13 January	2 March
	22 January	

At the first planting date pots were arranged as shown in figure 13 and at the second transplant date as shown in figure 14.

replication 1	replication 2	replication 3
1:E	11:F	21:I
2:K	12:M	22:Z
3:M	13:J	23:L
4:Z	14:A	24:K
5:A	15:L	25:E
6:J	16:I	26:Z
7:F	17:K	27:M
8:P	18:Z	28:F
9:I	19:P	29:J
10:L	20:E	30:A

Figure 13. Layout of experimental field for the first test planted on October 16th, 2008.

replication 1	replication 2	replication 3
1:Z	11:K	21:Z
2:L	12:M	22:I
3:F	13:J	23:K
4:P	14:A	24:L
5:J	15:E	25:J
6:A	16:Z	26:M
7:M	17:P	27:F
8: I	18:I	28:E
9:E	19:F	29:A
10:K	20:L	30:Z

Figure 14. Layout of experimental field for the second test planted on November 4th, 2008.

At treatment P, Apron seed coating, not enough seedlings were present to accommodate all fields. Decided was to test this treatment in 2 replications only, and to have four replications of treatment Z (naked seed) (Fig. 13 and 14).

4.1.2 Observations

In the experiment transplanted on October 16 the following observations were done:

1) 7 November: Number of present plants was established and at random 5 plants per plot number of aphids and whitefly per plant was observed. Percentage infected plants and average number per plant was calculated.
2) 28 November: Number of infected plants per plot with whitefly was observed. Percentage of whitefly free plants was calculated.
3) 31 December: Number of infected plants per plot with virus incidence and with red spidermite presence was observed. Respective percentages were calculated.
4) 31 December, January 5, January 13 and on January 19: mature fruits were harvested. Fruits were graded in marketable and non marketable. Per grade total weight and number of fruits was established. At non marketable grade, fruits were classified as lost due to Bollworm, Rot, Sun scorching or Spider mite. Number of fruits per classification were counted.

In the experiment transplanted on November 4 the following observations were done:

1) 30 December: Number of present plants was established.
2) February 9, February 18 and on March 2: mature fruits were harvested. Fruits were graded in marketable and non marketable. Per grade total weight and number of fruits was established. At non marketable grade, fruits were classified as lost due to Bollworm, Rot, Sun scorching or Spider mite. Number of fruits per classification were counted.

4.1.3 Cultivation

Cultivation was carried out as common practice (Annex II). Bed preparation was done by hoeing and water was applied by using furrow irrigation. Fertilisation was given at planting where Farm yard manure was

incorporated in plant hole at 1 kg per m^2 (0.4 kg per plant) together with
250 kg/ha P_2O_5 with 550 kg/ha TSP (20 g/plant) incorporated in bed just before transplanting
Ten days after planting 555 kg/ha NPK 17-17-17 (12.5 g/plant) was placed at 10 cm from stem and incorporated in soil. At the start of visible stage of flower buds 555 kg/ha Calcium nitrate (CAN) (12.5g/plant) was placed at 20-30 cm from stem and incorporated. Finally at fruit set 555 kg/ha NPK 17-17-17 (12.5 g/plant) was placed at 20-30 cm from stem and incorporated.
Fungicides were applied in order to control diseases.
During the whole cultivation period no insecticides were applied.

4.2 Climate

During the experiments no rainfall was present and twice a week furrow irrigation was applied (annex II).
Temperature and rainfall records were taken from Kilimanjaro airport, 30 km to the east of the experimental site, and temperature records were also obtained from weather station Arusha, about 20 km to the west (Annex III). Altitude of the Kilimanjaro station located at 3.4° S and 37.1° E is 891 m ASL, the altitude of Arusha station at 3.4° S and 36.6° E, is 1387 m ASL. Altitude of the experimental field at AVRDC – RCA is 1290 m ASL and location is 4.8° S and 37° E.
A total precipitation of approximately 120 mm was recorded at Kilimanjaro Airport during the period of the experiments (Fig. 15). On average temperature at Kilimanjaro airport was about 5 degrees higher then the temperature recorded at Arusha. After the first transplanting no precipitation was recorded in the month October. Minimum temperature ranged from 15 to 20°C while maximum temperature ranged from 25 to 35°C. In November, after transplanting of the second experiment, precipitation of circa 50 mm was recorded at Kilimanjaro airport . In December, January and February almost no precipitation at all was recorded and maximum temperature was also 25 to 35°C . In March some precipitation was recorded, totalling some 25 mm.

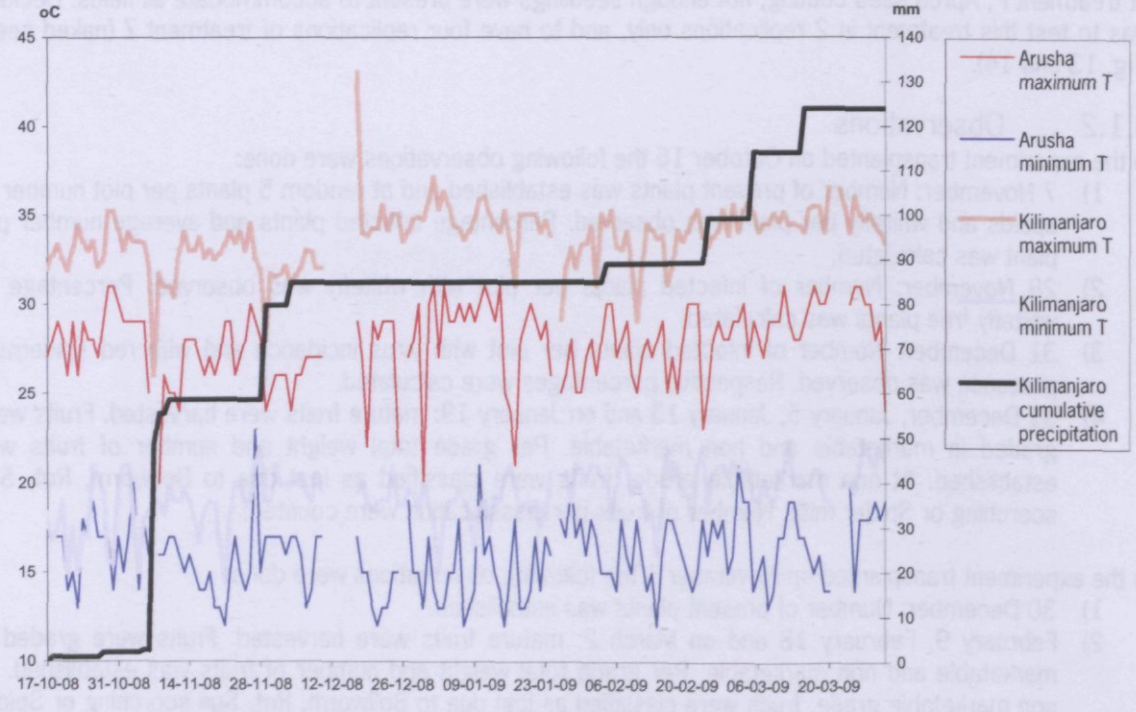


Figure 15. **Temperature (°C) recorded at Kilimanjaro and Arusha, and monthly rainfall (mm) recorded at Kilimanjaro.**

4.3 Results

4.3.1 Yield

No significant differences between treatments were present in yield and number of fruits for both total production of tomato (Table 15).

Table 15. Yield results of the first experiment transplanted on October 16, 2008.

Treatment per 1000 seeds		Total yield	Total fruits	Marketable yield	Marketable fruits	Individual fruit weight of total production	Individual fruit weight of marketable production	Share of marketable in total production
		g/plant	nr/plant	g/plant	nr/plant		gram	%
A	Untreated	1838	28	584	6	67	98	31
E	Poncho-Beta 6 ml	1814	27	444	4	67	102	25
F	Poncho-Beta 3 ml	1330	24	372	4	55	97	28
I	Gaucho 6 g	1982	31	598	6	64	94	31
J	Gaucho 3 g	1688	25	557	5	66	104	33
K	Cruiser 2.5 g	1565	25	553	6	64	96	34
L	Cruiser 1.25 g	1862	29	642	7	64	97	33
M	Mundial 4 ml	1794	28	611	6	63	104	34
P	Apron 2.2 g	1484	30	391	4	50	99	25
Z	Naked	1577	26	529	6	61	95	34
mean		1697	27	533	5	62	99	31
$LSD_{0.05}$		658.2	10.5	386.5	4.1	8.6	14.9	17.7
p =		0.6	0.9	0.8	0.8	0.01	0.8	0.9

Also in percentage of marketable production no differences were present between treatments. At individual fruit weight of marketable production also no differences were present between treatments. At individual fruit weight of total production the fruit weight of Apron 2.2 gram was significant lower compared to the weight present at plants raised from naked seeds and untreated. Also the individual fruit weight at Poncho-Beta 3 ml was significant lower compared to untreated but not different from naked. Also Poncho-Beta 6 ml, a higher rate, did not show different fruit weight as compared to untreated.

At the second experiment the yield was on average 1098 g per plant (Table 16). Yield levels were lower compared to the first experiment. In the second experiment on average 9.2 ton marketable yield per hectare was harvested while in the first experiment 14.8 ton was harvested.

No significant differences were present at the second experiment. However, treatments with Gaucho and Cruiser showed slightly higher yield levels and fruit numbers compared to untreated. Besides individual fruit weight was also higher as was the share of marketable fruits in total production.

Table 16. Yield results of the second experiment transplanted on November 4, 2008.

Treatment per 1000 seeds		Total yield	Total fruits	Marketable yield	Marketable fruits	Individual fruit weight of total production	Individual fruit weight of marketable production	Share of marketable in total production
		g/plant	nr/plant	g/plant	nr/plant		gram	%
A	Untreated	971	13	299	3	74	95	29
E	Poncho-Beta 6 ml	909	12	205	2	74	99	19
F	Poncho-Beta 3 ml	930	15	154	2	64	91	16
I	Gaucho 6 g	1169	15	334	3	82	114	25
J	Gaucho 3 g	1320	18	499	5	73	93	37
K	Cruiser 2.5 g	1215	16	446	5	78	88	34
L	Cruiser 1.25 g	1210	18	431	4	64	113	30
M	Mundial 4 ml	1105	16	356	4	70	94	32

P	Apron 2.2 g	1122	15	251	2	74	101	23
Z	Naked	1085	16	359	3	67	100	30
mean		1098	15	331	3	72	99	28
LSD $_{0.05}$		672.6	8.8	366.5	3.9	16.4	26.6	16.2
p =		0.9	0.8	0.6	0.6	0.3	0.4	0.2

Figure 16. **Experimental field of the second transplanting.**

4.3.2 Presence of pests

On November 7th, no different number of white fly per plant was present (Table17). All plants that were observed showed whitefly as well. In number of aphids per plant no significant differences were observed. At percentage of infected plants no significant differences were present either although Gaucho 3 gram showed no infected plants at all.

Table 17. **Percentage of plants with white fly and aphids and number of insects per plant observed on November 7, 2008 of the first experiment transplanted on October 16, 2008.**

Treatment per 1000 seeds		Whitefly (number per plant)	Infected plants with whitefly (%)	Aphids (number per plant)	Infected plants with aphids (%)
A	Untreated	4.8	100.0	0.8	46.7
E	Poncho-Beta 6 ml	4.9	100.0	0.3	33.3
F	Poncho-Beta 3 ml	4.9	100.0	0.3	20.0
I	Gaucho 6 g	5.1	100.0	0.3	20.0
J	Gaucho 3 g	4.9	100.0	0.0	0.0
K	Cruiser 2.5 g	4.0	100.0	0.4	33.3
L	Cruiser 1.25 g	5.3	100.0	0.2	20.0
M	Mundial 4 ml	4.7	100.0	0.2	13.3
P	Apron 2.2 g	4.7	100.0	0.1	20.0
Z	Naked	5.3	100.0	0.3	20.0
mean		4.9	100.0	0.3	22.7
LSD $_{0.05}$		1.8	-	0.5	33.0
p =		0.9	-	0.2	0.2

On November 28th, percentage of plants with whitefly was at naked seeds 41% (Table 18). At all other treatments this percentage was significant lower. Between these treatments no differences were present.

Percentage plants with virus was on December 30 low with a maximum of 3.4 % at Cruiser 1.25 gram. No significant differences were observed. Also plants with spider mite did not show significant differences between treatments. Mundial showed a lower percentage but this was not significant different from untreated or naked treatment.

Table 18. Percentage of plants with white fly on November 28, with virus and spider mite on December 30, 2008 of the first experiment transplanted on October 16, 2008.

Treatment per 1000 seeds		Total plants per plot	Plants with white fly on 28 November (%)	Plants with virus incidence on 30 December (%)	Plants with spider mite incidence on 30 December (%)
A	Untreated	21	6	0.0	9.1
E	Poncho-Beta 6 ml	23	11	0.0	6.0
F	Poncho-Beta 3 ml	21	4	0.0	5.2
I	Gaucho 6 g	17	10	2.2	9.5
J	Gaucho 3 g	18	0	0.0	3.7
K	Cruiser 2.5 g	25	0	1.3	4.2
L	Cruiser 1.25 g	22	0	3.4	2.1
M	Mundial 4 ml	23	4	1.6	1.6
P	Apron 2.2 g	14	7	0.0	3.6
Z	Naked	21	41	2.4	7.3
mean		21	9	1	5
$LSD_{0.05}$			19.1	4.8	15.3
p =			0.001	0.7	0.9

At harvest the number of infected fruits by bollworm did not show significant differences between treatments (Table 19). Also no significant differences in percentage of harvested fruits attacked by rot were present. Sun scorching is a physical disorder caused by sun burn. Also here no significant differences between treatments were present.
Presence of spider mites caused a big loss in fruits. On average 22.6 of all harvested fruits were degraded caused by spider mite damage. A significant lower percentage was present at Gaucho 6 and 3 gram compared to the percentage present at plants raised from naked seeds. Cruiser 1.25 g showed a lower but not significant different percentage compared to naked.

Table 19. Percentage of affected fruits per plant at harvest per classification of the first experiment transplanted on October 16, 2008.

Treatment per 1000 seeds		Bollworm %	Rot %	Sun scorch %	Spider mite %
A	Untreated	10.0	10.1	37.6	18.2
E	Poncho-Beta 6 ml	7.8	10.0	41.2	22.7
F	Poncho-Beta 3 ml	10.4	8.3	40.8	23.6
I	Gaucho 6 g	10.2	8.9	43.3	16.0
J	Gaucho 3 g	8.4	10.2	44.1	15.4
K	Cruiser 2.5 g	7.9	12.8	32.2	21.0
L	Cruiser 1.25 g	13.5	13.0	31.6	16.6
M	Mundial 4 ml	8.8	8.3	32.6	29.1
P	Apron 2.2 g	9.2	6.4	30.9	39.3
Z	Naked	9.5	8.1	30.3	28.1
mean		9.6	9.7	36.4	22.6
$LSD_{0.05}$		4.9	5.4	11.6	11.9
p =		0.4	0.3	0.07	0.01

Compared to the first experiment a high amount of fruits was lost due to rot problems while sun scorch problems were negligible (Table 20). Percentage of fruits lost due to spider mite damage was on average

21.1%. No significant differences between treatments were present. Cruiser 1.25 g showed 11% less fruits damaged by spider mite compared to untreated which is an almost significant difference.

Table 20. Percentage of affected fruits per plant at harvest per classification of the second experiment transplanted on November 4, 2008.

Treatment per 1000 seeds		Bollworm	Rot	Sun scorch	Spider mite
		%	%	%	%
A	Untreated	1.1	22.4	2.4	26.2
E	Poncho-Beta 6 ml	0.0	43.1	0.0	25.2
F	Poncho-Beta 3 ml	1.7	47.6	0.9	17.6
I	Gaucho 6 g	0.2	40.8	1.4	20.1
J	Gaucho 3 g	1.4	27.7	0.0	21.7
K	Cruiser 2.5 g	2.1	28.9	0.0	22.7
L	Cruiser 1.25 g	2.4	38.3	1.1	14.4
M	Mundial 4 ml	1.7	27.6	0.6	22.9
P	Apron 2.2 g	3.4	28.8	2.8	22.6
Z	Naked	1.8	34.5	1.3	19.1
mean		1.5	34.2	0.9	21.1
$LSD_{0.05}$		3.2	31.9	2.4	11.1
p =		0.7	0.7	0.5	0.4

5 Conclusions

5.1 General

Yield levels in ton per hectare were on average for the first experiment quite high if all plants would survive. With an average yield of about 0.5 kg per plant a yield of 15 ton per hectare would be achieved. However, only 70% of the transplanted plants survived and this results then in 10.5 ton per hectare which is still quite good for the area where on average yield levels of 5 till 6 tons per hectare are normal.
Incidence of the target pest whitefly was limited during the first experiment. Although at November 7 all plants were infected with whitefly and with aphids no field sprays with insecticides were deemed necessary. Also the incidence of virus was therefore limited. At the second experiment during cultivation, no pest occurred at notable levels.
At harvest of both experiments bollworm and spider mites became a big problem. Losses due to spider mite rose to an average of 22.6% of the total production. Bollworm caused loses up to 13.5%. secondly during cultivation shortage of water became a problem and as a result a lot of fruits were damaged by sun scorching. The presence of foliage is then important to provide shade to the fruits. Therefore it is also important to control insect pests that can reduce foliage.
Finally the experiment was carried out in three replications only which makes it difficult to show significant effects of treatments on insect control. This is also due to the fact that presence of insects in a field is not homogenous and results depends also on the fact if insect pressure is high enough in the control or untreated fields.

5.2 Insecticide results

Apron Star 42 WS (20% thiamethoxam + 20% metalaxyl + 2% difenoconazole WS)
From the tested insecticides only Apron Star at a rate of 2.2 g per 1000 seeds showed severe toxicity on tomato seeds. At the germination test on top of paper almost no seed germinated. In potting soil the effect was less pronoun but still total emergence was 25% lower compared to untreated.
No effect on yield on pests were observed. In spite of the metalxyl treatment also no effect on percentage of rot was present.

Cruiser (70% thiamethoxam WS)
Cruiser at a rate of 2.5 and 1.25 g per 1000 seeds showed some phytotoxic effects. When tested on paper a delay in germination was present. In potting soil no effects were present compared to untreated.
Marketable yield was at both experiments at Cruiser 1.25 g slightly higher then at naked seeds. However, this was not significant different and also the higher dose of 2.5 g did not show this effect in the first experiment.

Gaucho (imidacloprid 70% WP)
Gaucho at a rate of 3 and 6 gram per 1000 seeds showed phytotoxic effects. When tested on top of paper a lower percentage of germinated seeds was present compared to untreated. At the test in potting soil a delay in germination was noted but the final result was comparable to untreated. An effect of rate was present were phytotoxic effects at 3 gram per 1000 seeds was less then at 6 gram.
Effect on pests were not significant present. At both experiments Gaucho 6 g showed a higher, but not significant different yield compared to untreated.

Mundial (fipronil 500 g/l SC)
Mundial 4 ml did show only a slight delay in germination and plant development, but this effect was hardly noticeable. No effect on yield or pest control could be established.

Poncho-beta (400 g/l clothianidin + 53.3 g/l beta-cyfluthrin FS)
Poncho-beta at rates of 3 and 6 ml did show slight phytotoxic effects. On top of paper a delay in germination was present, in potting soil no differences with untreated were noted.
Yield was not different from untreated and also no significant effects on pests were observed.

With seed coating less crop sprayings are required.

6 Recommendations

Whitefly and aphids
Although in these experiments whitefly, aphids and virus incidence was not present or only at very low levels it can cause high losses as seen in practice fields nearby the site were the experiments were carried out. Recommended is to further investigate the efficacy of Poncho-beta, Gaucho, Cruiser and Mundial on controlling whitefly.

Nematodes
Besides whitefly and virus incidence in tomato cultivation, also nematodes can cause yield losses. Losses can be up tot 50% . Main species are root knot nematodes *Meloidogyne* spp (*M. hapla, M. incognita* and *M. javanica*). With 89% of all incidences *M. javanica* was the most prevailing specie. Therefore it is recommended to test other pesticides on controlling *Meloidogyne* nematodes as well. A pesticide suitable for controlling nematodes might be carbofuran (Furadan or Curater from FMC), oxamyl (Vydate from DuPont), etoprophos (Mocap 15G from Bayer), fenamiphos (Nemacur 15G from Bayer), cadusaphos (Rugby 15G from FMC) or terbufos (Counter 15G from BASF) . However, controlling effect of *M. Javanica* seems very limited by oxamyl. Oxamyl applied as a foliar spray shows controlling effects on leafminers, aphids, white fly and thrips. The mode of action is through ingesting plant containing oxamyl.
Carbofuran is a very toxic pesticide and also post harvest interval is over 21 days. With applying granular carbofuran observed was a high mortality under wildlife, especially birds. When applying this insecticide as a seedcoating, amount of applied carbofuran will be reduced and also the risk to wildlife will be less.
Etoprophos, fenamiphos and terbufos are only available in a granular form, making it difficult to apply as a seed coating.
Besides the already mentioned pesticides also imidacloprid may control *M. Javanica.* McLeod et al. (2002) has found that with seed treatment of *brassica napus* with Superstrike seed coating number of galls per plant was reduced. Superstrike contains Gaucho, thiram, rhizobium and molybdenum. Not mentioned in the article are the rates of Superstrike applied or the content of Gaucho present in Superstrike.

Red Spider mite
Also spider mites were present at high levels causing a high percentage of non marketable fruits. Possible solutions are the introduction of Nissorun, Oberon (spiromesifen) or Vertimec/Dynamec (abamectin).

Bollworm
In this experiment also boll worm did cause high losses. Insecticides like Tracer (active ingredient spinosad) may be effective in controlling. However, boll worm incidence occurs at harvesting and it seems unlikely that seed coating with Tracer can be effective for such a long period. If so it would also mean that high levels of spinosad will be present in the fruits since otherwise it will be not effective in controlling boll worm, but is undesirable in terms of food safety.

Registration
Finally, before commercialization of a seed coating, it is necessary to consult seed companies and pesticide manufactures in order to introduce successfully a formulation. Furthermore registration of new pesticides in Tanzania needs to be done through the Tropical Pesticides Research institute based in Arusha. The procedure is presented in annex I.

Tomatoes with rot symptoms

Tomato with Bollworm

Tomato with sun scorch symptoms

Marketable tomatoes

Literature

McLeod, R.W., C.C. Steel and J.A. Kirkegaard, 2002. effects of some crop management practices on reproduction of *Meloidogyne javanica* on *Brassica napus*. Nematology 4(3): 381 – 386.

Ramesh, R. and S.P. Ukey, 2006. Effect of seed treatment with newer insecticides on germination, survival of seedlings of tomato and in the management of whitefly. International Journal of Agricultural Science 2(1): 205 – 207.

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Annex I Registration of pesticides

Pesticides Registration
(from: Pesticide And Poverty A Case Study On Trade And Utilization Of Pesticides In Tanzania: Implication To Stockpiling Final Report August 2006)

PPA requires that all pesticides sold or distributed in Tanzania should be registered by the Registrar of Pesticide at TPRI. According to this Act and its regulations, it is illegal to trade/sell any pesticide which is not registered in the country for general use. Pesticide traders are also required by law to keep records of the type of pesticide, quantity acquired, purpose of use, batch number, and any other information which may be necessary for purposes of pesticides control.

All Pesticides that are to be introduced for use in the United Republic of Tanzania must undergo the necessary registration procedures that are executed under the authority of the TPRI. Registration of pesticide may be applied for by the producer of the plant protection substance; the marketing firm, if the plant protection substance is to be marketed for the first time in the country, and the importer of that plant protection substance. The registrant should submit to the registrar a dully filled PRC-1 (Application for Pesticides Registration); Three copies of registration dossier containing technical, toxicological, environmental data and method of analysis for the formulated product; Six copies of label specimen in English and Swahili; Formulation sample for laboratory and field tests; and one gram of technical material for laboratory analytical reference standard. The fees required are application fee (USD 50); experimental registration fee (USD 1,000) (payable once);
and field-test fee to cover field expenses (USD 2,000-5,000). The amount depends on the nature and extent of the field tests to be done. A scientist from a public pesticides research institution will carry out field trials of the product for three seasons, write a report and submit it to the Registrar. TPRI certified pesticides research institutions are of TPRI located in Arusha, Ukiliguru located in Mwanza, Seriani located in Singida, Ilonga located in Morogoro, Uyole located in Mbeya, Naliendele located in Mtwara and Lyamungo located in Kilimanjaro. The field report and dossier are submitted for scrutiny to the Pesticides Approval and Registration Technical Sub-committee (PARTS), and the
Plant Protection Advisory Committee (NPPAC). If approved by both committees, then the pesticide is registered after paying the registration fees and the pesticides registration certificate is issued. Full Registration fee is USD 1,000 for five years (renewable); Provisional registration is USD 1,500 for two years (renewable); and Restricted registration USD 1,000 for two years (renewable). Full and provisional registered products may be imported, sold and used by the general public while restricted products are sold in special pesticides shops for specific purposes, and can only be handled by specially trained personnel. Under normal conditions, minimum time of registration process takes about three and a half years. Provisional registration is issued for products that lacked some necessary documents that were required during analysis of the product so as to give way for further analysis to be conducted on the product by TPRI while full registration is provided when all necessary documents are filled. Re-registration (reactivating registration) fee that cost about USD 5,000 for the product that had not been imported for some time after being in trade and renewal of its registration was not done.

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Annex II. Management practices during the experiments.

First transplanting date

date	activity	remarks
September 9, 2008	sowing in trays	
October 15, 2008	irrigation	
October 16, 2008	transplanting	
October 16, 2008	fertiliser application	TSP 20 g /plant
October 17, 2008	irrigation	
October 20, 2008	irrigation	
October 24, 2008	irrigation	
October 26, 2008	weeding	
October 27, 2008	irrigation	
October 31, 2008	fertiliser application	NPK 17-17-17 12 g/plant
October 31, 2008	irrigation	
November 3, 2008	irrigation	
November 5, 2008	weeding	
November 7, 2008	irrigation	
November 11, 2008	irrigation	
November 13, 2008	fertiliser application	CAN 26% 12 g/plant at 20-30 cm from stem
November 14, 2008	irrigation	
November 15, 2008	weeding	
November 18, 2008	irrigation	
November 21, 2008	irrigation	
November 24, 2008	irrigation	
November 25, 2008	weeding	
November 28, 2008	fertiliser application	NPK 17-17-17 12 g/plant
November 28, 2008	irrigation	
December 1, 2008	irrigation	
December 5, 2008	weeding	
December 5, 2008	irrigation	
December 8, 2008	irrigation	
December 12, 2008	irrigation	
December 15, 2008	weeding	
December 15, 2008	irrigation	
December 19, 2008	irrigation	
December 22, 2008	irrigation	
December 25, 2008	weeding	
December 26, 2008	irrigation	
December 29, 2008	irrigation	
December 30, 2008	harvest	Market price: 1 kg or 8-12 fruits = 400-600 Tsh /kg or 2 fruits = Tsh 100
January 2, 2009	irrigation	
January 4, 2009	weeding	
January 5, 2009	harvest	
January 5, 2009	irrigation	
January 9, 2009	irrigation	
January 12, 2009	irrigation	
January 13, 2009	harvest	
January 14, 2009	weeding	
January 16, 2009	irrigation	
January 22, 2009	harvest	

Second transplanting date

date	activity	remarks
January 5, 2008	fertiliser application	NPK 17-17-17 12 g/plant
October 3, 2008	sowing in trays	
November 21, 2008	transplanting	
November 21, 2008	fertiliser application	TSP 20 g /plant
November 21, 2008	irrigation	
November 24, 2008	irrigation	
November 28, 2008	irrigation	
December 1, 2008	weeding	
December 1, 2008	irrigation	
December 5, 2008	fertiliser application	NPK 17-17-17 12 g/plant
December 5, 2008	irrigation	
December 8, 2008	irrigation	
December 11, 2008	weeding	
December 12, 2008	irrigation	
December 15, 2008	irrigation	
December 19, 2008	irrigation	
December 20, 2008	fertiliser application	CAN 26% 12 g/plant at 20-30 cm from stem
December 21, 2008	weeding	
December 22, 2008	irrigation	
December 26, 2008	irrigation	
December 29, 2008	irrigation	
December 31, 2008	weeding	
January 2, 2009	irrigation	
January 5, 2009	irrigation	
January 9, 2009	irrigation	
January 10, 2009	weeding	
January 12, 2009	irrigation	
January 16, 2009	irrigation	
January 19, 2009	irrigation	
January 20, 2009	weeding	
January 23, 2009	irrigation	
January 26, 2009	irrigation	
January 26, 2009	pesticide application	0.67 ml/l abamectine vs spidermite + 1 g/l easygrow
January 30, 2009	weeding	
January 30, 2009	irrigation	
February 2, 2009	irrigation	
February 6, 2009	irrigation	
February 9, 2009	weeding	
February 9, 2009	harvest	
February 9, 2009	irrigation	
February 13, 2009	irrigation	
February 16, 2009	irrigation	
February 18, 2009	harvest	
February 19, 2009	weeding	
February 20, 2009	irrigation	
February 23, 2009	irrigation	
February 27, 2009	irrigation	
March 2, 2009	harvest	

Annex III. Temperature and precipitation registration at Arusha and Kilimanjaro airport.

	Arusha maximum T	Arusha minimum T	Kilimanjaro maximum T	Kilimanjaro minimum T	Kilimanjaro cumulative precipitation	Kilimanjaro PP (mm)
1-11-2008	29	15	33	21	0	0
2-11-2008	29	17	34	21	0	0
3-11-2008	29	20	33.5	18	0	0
4-11-2008	29	14	33.5	15	0	0
5-11-2008	29	18	33.4	17.9	0.51	0.51
6-11-2008	25	16	32.3	18.4	0.51	0
7-11-2008			26	19	46.48	45.97
8-11-2008	20	16	31.7	18.9	53.59	7.11
9-11-2008	26	16	31	18.3	53.59	0
10-11-2008	25	17	31	19.9	56.64	3.05
11-11-2008	25	17	30.4	19	56.64	0
12-11-2008	24	16	33	19	56.64	0
13-11-2008	28	15	34	19.6	56.64	0
14-11-2008	28	16	33	19	56.64	0
15-11-2008	28	15	33	18	56.64	0
16-11-2008	27	14	33.7	16.7	56.64	0
17-11-2008	26	14	32.6	18.6	56.64	0
18-11-2008	27	15	33	19	56.64	0
19-11-2008	26	13	32.5	18.9	56.64	0
20-11-2008	27	13	32.8	16.6	56.64	0
21-11-2008	29	12	33.3	14.4	56.64	0
22-11-2008	29	15	34	18.2	56.64	0
23-11-2008	26	17	33.4	20	56.64	0
24-11-2008	27	15	34	20	56.64	0
25-11-2008	28	14	33	18.7	56.64	0
26-11-2008	30	15	34.5	19.2	56.64	0
27-11-2008	29	23	32.5	21.2	56.64	0
28-11-2008	28	15	32	22	56.64	0
29-11-2008	24	17	28	19	77.72	21.08
30-11-2008	25	17	31.7	19	77.72	0
1-12-2008	26	17	31.5	21	77.72	0
2-12-2008	26	17	31.7	19.8	77.72	0
3-12-2008	26	16	32.1	20	77.72	0
4-12-2008	24	17	31	20	82.8	5.08
5-12-2008	26	17	31.6	20	82.8	0
6-12-2008	26	16	32	20.5	82.8	0
7-12-2008	27	13	33	19.5	82.8	0
8-12-2008	27	14	32.9	19	82.8	0
9-12-2008	27	17	32	20.6	82.8	0
10-12-2008	27	17	32	19.6	82.8	
11-12-2008					82.8	
12-12-2008					82.8	
13-12-2008					82.8	
14-12-2008					82.8	
15-12-2008					82.8	

	Arusha maximum T	Arusha minimum T	Kilimanjaro maximum T	Kilimanjaro minimum T	Kilimanjaro cumulative precipitation	Kilimanjaro PP (mm)
16-12-2008					82.8	
17-12-2008	29	17	43	19.5	82.8	0
18-12-2008	27	15	34	20	82.8	0
19-12-2008	22	15	33.8	19	82.8	0
20-12-2008	29	13	34.2	18.4	82.8	0
21-12-2008	28	12	34.2	18.9	82.8	0
22-12-2008	29	13	35.5	19	82.8	0
23-12-2008	29	13	34.1	19	82.8	0
24-12-2008	29	15	35	20.9	82.8	0
25-12-2008	22	15	35	18.8	82.8	0
26-12-2008			33.5	18.7	82.8	0
27-12-2008	27	19	34	19.6	82.8	0
28-12-2008	28	15	34.7	19.4	82.8	0
29-12-2008	30	15	34.9	18.6	82.8	0
30-12-2008	20	13	34.7	19.9	82.8	0
31-12-2008	30	17	35.7	18.8	82.8	0
1-1-2009	31	14	37.1	18	82.8	0
2-1-2009	27	13	35.3	15	82.8	0
3-1-2009	31	13	36.3	17.6	82.8	0
4-1-2009	29	15	35.5	19	82.8	0
5-1-2009	29	15	34.4	19	82.8	0
6-1-2009	30	18	34.2	19.6	82.8	0
7-1-2009	29	12	33.6	19	82.8	0
8-1-2009	30	13	34	18.2	82.8	0
9-1-2009	29	14	34.7	16.6	82.8	0
10-1-2009	30	21	35.8	18.6	82.8	0
11-1-2009	31	16	36	19	82.8	0
12-1-2009	30	17	35	17.3	82.8	0
13-1-2009	29	15	34.4	19.3	82.8	0
14-1-2009	31	14	34	19	82.8	0
15-1-2009	25	12	35.2	20.3	82.8	0
16-1-2009	24	15	33.5	21	82.8	0
17-1-2009	21	18	31	19.8	82.8	0
18-1-2009	28	13	35	18.5	82.8	0
19-1-2009	29	13	35	18.9	82.8	0
20-1-2009	30	14	35	18.4	82.8	0
21-1-2009	29	17	35	19	82.8	0
22-1-2009	28	14	34	17.6	82.8	0
23-1-2009	29	17	34.6	18	82.8	0
24-1-2009	26	16	33.8	20.6	82.8	0
25-1-2009					82.8	
26-1-2009	25	18	29.1	20.4	82.8	
27-1-2009	26	17	32	20.6	82.8	0
28-1-2009	28	20	33.1	19	82.8	0
29-1-2009	25	17	32	21	82.8	0
30-1-2009	25	18	33.2	20.7	82.8	0
31-1-2009	27	16	33.4	20.2	82.8	0

	Arusha maximum T	Arusha minimum T	Kilimanjaro maximum T	Kilimanjaro minimum T	Kilimanjaro cumulative precipitation	Kilimanjaro PP (mm)
1-2-2009	28	18	34.3	21	82.8	0
2-2-2009	26	17	31	21	82.8	
3-2-2009	28	15	35	20.4	82.8	0
4-2-2009	30	15	34.4	20	86.86	4.06
5-2-2009	30	15	35.2	18.3	86.86	0
6-2-2009	27	14	33.2	19.8	86.86	0
7-2-2009	28	18	33	21.4	86.86	0
8-2-2009	29	16	34	21	86.86	0
9-2-2009	26	15	32.2	19.4	86.86	0
10-2-2009	25	18	29	20	86.86	0
11-2-2009	27	16	32	19.5	86.86	0
12-2-2009	28	14	34.4	18	86.86	0
13-2-2009	27	15	34.1	18.4	86.86	0
14-2-2009	28	12	33.6	16	86.86	0
15-2-2009	29	16	33.8	19	86.86	0
16-2-2009	25	18	31	22	86.86	0
17-2-2009	27	18	32	20.2	87.11	0.25
18-2-2009	25	17	34.1	21	87.11	0
19-2-2009	28	16	33.5	19.4	87.11	0
20-2-2009	30	15	34	19.3	87.11	0
21-2-2009	30	14	34.8	18	87.11	0
22-2-2009	30	15	35.2	21	87.11	0
23-2-2009	23	18	33.7	22	87.11	0
24-2-2009	25	16	33.2	18.8	97.02	9.91
25-2-2009	28	18	33.7	20.6	97.02	0
26-2-2009	29	17	34	20.9	97.02	0
27-2-2009	28	18	35.2	21	97.02	0
28-2-2009	28	15	33.8	20.4	97.02	0
1-3-2009	29	16	35.5	21.2	97.02	0
2-3-2009	29	21	34	20.8	97.02	0
3-3-2009	30	19	35.2	20.7	97.02	0
4-3-2009	27	19	35.6	21	97.02	0
5-3-2009	29	14	35.1	19.2	112.01	14.99
6-3-2009	28	15	34	19	112.01	0
7-3-2009	27	16	34.4	20.2	112.01	0
8-3-2009	29	13	34.5	19.3	112.01	0
9-3-2009	29	14	35	18.8	112.01	0
10-3-2009	29	17	34.6	20.7	112.01	0
11-3-2009	31	17	35.1	20.6	112.01	0
12-3-2009	29	19	34.4	22.4	112.01	0
13-3-2009	28	19	34.5	20	112.01	0
14-3-2009	28	17	34.3	19.9	112.01	0
15-3-2009	29	17	34	20	121.92	9.91

	Arusha maximum T	Arusha minimum T	Kilimanjaro maximum T	Kilimanjaro minimum T	Kilimanjaro cumulative precipitation	Kilimanjaro PP (mm)
16-3-2009	30	16	35.3	20	121.92	0
17-3-2009	31	15	35.5	20.8	121.92	0
18-3-2009	30	16	35.4	20.7	121.92	0
19-3-2009	30	14	34	19.1	121.92	0
20-3-2009	31	14	36.5	19	121.92	0
21-3-2009					121.92	
22-3-2009			36.4	19.8	121.92	0
23-3-2009			35.5	20.1	121.92	0
24-3-2009	30	20	34	20	121.92	0
25-3-2009	31	14	36	19.5	121.92	0
26-3-2009	31	18	35	21	121.92	0
27-3-2009	30	18	34.7	22.4	121.92	0
28-3-2009	30	18	35	21.3	121.92	0
29-3-2009	28	19	34.4	21	121.92	0
30-3-2009	29	18	34	22	121.92	0
31-3-2009	24	19	33.4	21.2	121.92	0