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Effect of virus infection and watering system on Quantity and Quality of  
hybrid tomato seeds.

**EFFECT OF VIRUS INFECTION AND WATERING SYSTEM  
ON QUANTITY AND QUALITY OF HYBRID TOMATO SEEDS**

An experiment was made in summer 1970. Seeds were sown on March 3. On March 16 small seedlings with open cotyledons were infected with a weak strain of tomato virus (a mixture of all known TMV-strains). At about April 3 the infected plants showed a delay in growing of about 3-4 days (in comparison with not-infected plants). Plants were planted in pots on March 24 and on April 9 they were planted out in two neighbouring greenhouses. In each greenhouse 24 rows were planted, 12 plants per row. Ten female plants (v) and twelve male plants (m) were used for the trial, these female and male plants being the parent lines of the hybrid tomato variety (Aze). Different systems of water supply were installed in the compartments: in compartment no. I the Volmatic system (dropping system), in compartment no. II a raining system (overhead sprinkling). The first crossings were made on April 27. The first symptoms of natural infection with virus on the non-infected plants were observed on May 20, while the artificially infected plants remained healthy. During the vegetation period the plants in the compartment with the Volmatic system grew more vigorously and had more and bigger flowers, moreover anthers were thicker and contained more pollen. The artificially infected plants in both compartments gave more pollen too than the non-infected plants and that difference was higher in the compartment with the sprinkling-system. At about June 10 abnormal flowers with very thin and not well-developed anthers without pollen were observed in the compartment with the sprinkling-system. At about July 17 two rows of male plants (45 and 46) in compartment no. II proved to be strongly infected with red spider, which originated from the neighbouring greenhouse. The infection spreaded continuously and at about August 10 all rows in compartment no. II were badly infected; plants dried up and died.

At the same time the plants in compartment no. I remained vigorous. The first ripe tomatoes were picked from the male parent lines in compartment no. II on June 15. Every time only well-ripened fruits were picked. The seeds were taken out by hand and then left for natural fermentation; after that washed up with tap-water and dried on nets in the small greenhouse. For the process of fermentation and drying the temperature inside the greenhouse was not always optimal, neither was it equal for all the harvesting dates; f.i. the seed of the fruits harvested on June 2 was dried at the extremely high temperature of  $> 30^{\circ}\text{C}$ ., whereas the seed from the fruits harvested on August 8 was dried at an extremely low temperature of  $< 18^{\circ}\text{C}$ ., because of weather conditions.

At the end of the experiment there were still green fruits left. These fruits were also picked, weighed and counted, but the seeds were only taken from ripe fruits. There were more green fruits in the greenhouse with the Volmatic system. The seeds have been tested for germination at the Experimental Station at Wageningen. The germination took place under lamps with a temperature of  $30^{\circ}\text{C}$ . during the day (8 hours) and of  $20^{\circ}\text{C}$ . during the night (16 hours). The seeds with black spots were counted when they were laying on the germination-beds, so that only one side of the seeds could be seen.

The data of the experiments have been statistically examined by the Research and Experiment Station at Naaldwijk. The whole duration of the experiment has been divided into 3 periods.

The first period comprises information about the influence of artificial infection on the early crop, particularly to see whether there is any delay.

The second period comprises all data until July 23 (this means that the second period included the first period as well), in order to get information about the effect of infection on the seeds and fruits, which have setted before the symptoms of natural infection were observed. As symptoms of natural infection at not infected plants had been noticed on May 20, fruits, which had been picked before July 20, must have setted before the natural infection took place. So the dividing line between the second and the third period may include as well as exclude July 23. But, as the first picking dates (June 15, June 19) mostly concern male parent lines, there would be too few real values for the most important treatments (crossings). Therefore it had been decided to include the date of July 23 into the second period yet. The third period has been calculated in two ways: a) including- and b) excluding green fruits.

#### RESULTS:

An artificial infection with a weak strain of TMV in the early stage of growing plants (the cotyledons stage) gave good results for fruit and seed production. There is a significantly higher yield of seed (in the second and the third period) from artificially infected selfpollinated male parent plants than from not infected plants. The average yield of seed from male parent plants was in the second period as follows: M+ = 212.7 gr./plot (12 plants)

M- = 192.2 gr./plot  
and in the third period : M+ = 290.2 gr./plot  
M- = 265.9 gr./plot

which means that artificially infected plants gave an average of 44.8 gr. of seed per plot more than "not infected" plants.

Artificially infected female parent plants gave also a significantly higher of yield seed per plot. The average values were as follows:

	Yield of seed per plot (10 plants) in grams		
	second period	third period	total
V-M-	70.4	124.2	194.6
V-M+	69.4	117.8	187.2
V+M-	82.7	136.4	219.1
V+M+	80.6	129.4	210.0

Differences in the third period are statistically not significant, but the data show the same tendency as those of the second period and that means a significant difference for the whole experiment, being 47.3 gr. of seed per plot more from artificially infected plants than from not infected plants. Pollination of female parent plants with pollen M+ of M- did not influence the yield of seed and the combination V+7- seems even to be better. The differences between V+M- and V+M+ = 7.4 gr/plot for the second period and 9.1 gr./plot for the third period are not significant.

There is no influence of virus infection on the weight of the seeds per fruit. There was no influence of virus infection in the early (first) period neither.

The yield of fruits is also influenced by virus infection. The total weight of fruits per plant and the total number of fruits per plant in both periods is significantly higher for artificially infected plants. There is no influence on the mean weight of the fruits.

Only the V+M+ treatment in the third period gave a significantly lower value than other treatments.

The watering system was of no influence on the total yield of the seeds. There were no significant differences between both compartments for the whole period, but there were slight (but significant) differences between the periods. In the second period a higher yield was obtained in the compartment with the sprinkling system (No. II), but in the third period the yield of seeds was higher in the compartment with the Volmatic system. Compartment Nr. I (Volmatic system) gave a significantly higher weight of the seeds per fruit (in the second period), but there was no significant difference in the total yield of seed between the two compartments, as much more fruits were obtained from compartment Nr. II. In the third period there was not such differences.

Second period

Third period

	Yield of seed gr./plot	Weight of s. gr./fr.	Number of fr. p.plant	Mean weight of fr.	Yield of s. gr./plot	Weight of s. gr./fr.	Number of fr. p.plant	Mean weight of fr.
Comp. I	108.3	0.35	26.2	75.6	184.1	0.30	54.3	62.3
Comp. II	127.7	0.33	34.0	60.8	170.6	0.29	53.1	51.5
Diff. I-II	-19.4	0.02*	-7.8*	14.8*	13.5*	0.01	1.2	10.8*

\* - sign.diff. (0.05)

Compartment nr. I (Volmatic system) gave significantly heavier fruits than compartment nr. II in all periods. The number of fruits per plant was much higher with the sprinkling system in the first and second period, but in the third period there was no difference. The total weight of fruits was much higher with the Volmatic system in the third period, but there was no difference in the second and the first period. The self pollinated male parent lines gave significantly more fruits per plant than had been obtained from the crossings. The total weight of the fruits per plant was higher as well. These fruits contained more seeds than the fruits obtained through hand pollination. The difference between self pollination and crossing in the compartment with Volmatic system and in the first period was less than in the compartment with sprinkling system (interaction):

	Number of fruits per plant		Weight of fruits per plant		Weight of the seeds per plot	
	Comp. I	Comp. II	Comp. I	Comp. II	Comp. I	Comp. II
Mean M	9.1	16.9	0.79	1.11	50.8	84.4
Mean VM	9.3	9.8	0.67	0.73	27.7	35.0
Diff. M-VM	- 0.2	7.1	0.12	0.38	23.1	49.4

This difference is caused by the fact that, compared with compartment Nr. I, there were more ripe fruits from male parent lines in compartment Nr. II at that period. No differences were stated regarding the weight of the seeds per fruit and the mean fruit weight.

The number of seeds with black spots seems to be dependent on the virus infection, but there is also a great difference between the replications, which gives the impression that the presence of black spots depends also (mostly?) on the temperature.

Dec. 23 - '70

Barbara Steenks-Kasprovier

# **FIRST PERIOD**

## **Percentage <sup>3-day</sup> total germination**

comp. treatment	I	II	mean
M -	53,1	34,9	44,0
M +	51,7	36,4	44,0
V - M -	41,4	32,6	37,0
V - M +	32,3	42,4	37,4
V + M -	36,3	32,8	34,5
V + M +	35,4	40,4	37,9
mean	41,7	36,6	39,1

## **Percentage abnormal**

comp. treatment	I	II	mean
M -	1,20	0,70	0,95
M +	1,35	0,64	1,00
V - M -	5,08	1,96	3,52
V - M +	4,60	2,31	3,45
V + M -	5,35	1,84	3,60
V + M +	7,01	1,40	4,21
mean	4,10	1,48	2,79

## **Percentage <sup>7-day</sup> good germination**

comp. treatment	I	II	mean
M -	90,1	75,8	82,9
M +	91,5	81,0	86,2
V - M -	72,8	50,5	61,7
V - M +	67,5	60,9	64,7
V + M -	72,6	65,2	68,9
V + M +	68,8	64,7	66,8
mean	77,2	66,4	71,8

## **Percentage black seeds**

comp. treatment	I	II	mean
M -	5,0	4,2	4,6
M +	4,8	2,6	3,7
V - M -	11,1	8,8	10,0
V - M +	7,6	10,1	8,9
V + M -	13,7	8,0	10,9
V + M +	12,8	10,8	11,4
mean	9,5	7,3	8,2

## **Conclusions :**

a) 3-day : germination : M is better than the crossings (P 0,06)

No differences between M + and M - and

also no differences within the crossings.

The differences between the compartments is not significant.

b) 7-day : germination : The difference between M and the crossings is highly significant ( P < 0,01)

No other significant differences.

Comp. I is better than Comp. II ( P < 0,01).

c) Percentage abnormal seeds.

The crossings have more abnormal seeds than M ( P < 0,01). No difference within the crossings and no difference between M + and M -.

Comp. I has more abnormal seeds than Comp. II ( P < 0,01)

(First period)

d) Percentage black seeds

M less than the crossings (  $P < 0,01$  )

No significant differences within the crossings.

Comp. II has less black seeds than Comp. I  
(  $P = 0,08$  ).

SECOND PERIOD

Percentage total germination <sup>3-day</sup>

comp. treatment	I	II	mean
M -	80,0	73,0	76,5
M +	81,8	77,0	79,4
V - M -	68,8	75,4	72,1
V - M +	67,6	72,0	69,8
V + M -	73,3	67,8	70,6
V + M +	79,9	78,6	79,2
mean	75,2	73,9	74,6

Percentage abnormal

comp. treatment	I	II	mean
M -	0,42	0,68	0,55
M +	0,63	0,42	0,52
V - M -	2,07	2,33	2,20
V - M +	1,78	1,83	1,83
V + M -	1,74	1,56	1,65
V + M +	2,10	1,77	1,94
mean	1,45	1,38	1,41

Percentage good germination

comp. treatment	I	II	mean
M -	91,8	91,0	91,4
M +	90,7	94,7	92,7
V - M -	83,2	87,9	85,6
V - M +	82,1	88,5	85,3
V + M -	84,5	88,5	86,5
V + M +	89,0	91,9	90,5
mean	86,9	90,4	88,7

Percentage black seeds

comp. treatment	I	II	mean
M -	5,5	5,9	5,7
M +	3,0	2,0	2,4
V - M -	13,2	11,0	12,1
V - M +	9,1	10,6	9,9
V + M -	12,5	6,6	9,6
V + M +	11,4	6,9	9,2
mean	9,1	7,2	8,1

Conclusions :

a) 3-day germination :

No significant differences.

b) 7-day germination :

M is better than the crossings (  $P < 0,01$  ).

From the crossings the combination V + M + is higher than the other 3 combinations.

Comp. II is better than Comp. I (  $P < 0,04$  ).

c) Percentage abnormal seeds

M is less than the crossings (  $P < 0,01$  ).

No differences within the crossings.

No significant differences between the compartments.

d) Percentage black seeds

Same conclusions as c).

## THIRD PERIOD

3 day

Percentage total germination

comp.	I	II	mean
treatment			
M -	85,4	83,0	84,7
M +	87,4	84,5	86,0
V - M -	94,3	87,0	90,6
V - M +	91,6	90,2	90,9
V + M -	92,3	91,4	91,8
V + M +	94,3	92,4	93,3
mean	91,1	88,1	89,6

Percentage good germination

comp.	I	II	mean
treatment			
M -	91,8	87,4	89,6
M +	90,0	90,8	90,4
V - M -	94,4	94,1	94,3
V - M +	92,8	94,3	93,6
V + M -	95,6	95,7	95,7
V + M +	94,8	95,6	95,2
mean	93,3	93,0	93,1

## Percentage abnormal

Comp.	I	II	mean
treatment			
M -	1,23	0,82	1,02
M +	0,70	0,92	0,80
V - M -	0,95	0,98	0,96
V - M +	0,57	0,73	0,65
V + M -	0,63	0,41	0,52
V + M +	0,47	0,74	0,60
mean	0,76	0,76	0,76

## Percentage black seed

comp.	I	II	mean
treatment			
M -	7,4	14,3	10,8
M +	3,6	7,5	5,6
V - M -	5,9	7,2	6,5
V - M +	5,9	5,5	5,7
V + M -	6,1	6,5	6,3
V + M +	5,6	5,3	5,5
mean	5,8	7,7	6,7

## Conclusions

## a) 3 day-germination

Crossings are better than M.

No difference within the crossings and between M - and M +.

No difference between the compartments.

## b) 7-day germination

Same conclusions as 3-day germination.

## c) abnormal seeds (percentage)

No significant differences.

## d) black seeds (percentage)

M - is better than the other treatments. This difference is in compartment II greater than in comp. I.

# 1.000 SEED WEIGHT

## First period

comp. treatment	I	II	mean
V - R -	4.296	4.139	4.218
V - R +	4.443	4.066	4.254
V + R -	4.486	4.212	4.354
V + R +	4.472	4.236	4.354
mean	4.417	4.163	4.290

## Second period

comp. treatment	I	II	mean
V - R -	4.066	4.053	4.059
V - R +	4.229	4.000	4.115
V + R -	4.152	3.971	4.061
V + R +	4.100	4.001	4.050
mean	4.137	4.006	4.072

## Third period

comp. treatment	I	II	mean
V - R -	3.580	3.273	3.431
V - R +	3.652	3.271	3.462
V + R -	3.596	3.126	3.361
V + R +	3.510	3.243	3.381
mean	3.589	3.229	3.409

## Conclusions

In all periods is the weight of the seeds incompartment I (Venetic) higher than in the compartment with the raining system (  $P < 0,01$  ).

During the first period the difference between V - and V + is significant (  $P = 0,01$  ).

The difference between R - and R + is not significant.

In the second and third period the differences between the crossings are not significant.