



The effect of several compounds against *Rhizoctonia solani* by soil application

Efficacy and phytotoxicity in tulip

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1 Introduction

Rhizoctonia solani in tulip and iris consists of 'warmth preferring' (AG-4) and 'cold preferring' isolates (AG-2-t). Epidemiological differences result in variation in symptoms and occurrence between these groups of isolates. 'Cold preferring' isolates infect in cold and warm periods. These isolates can infect both sprouts and new bulbs in the field. 'Warmth preferring' isolates only cause symptoms in warm periods on new formed bulbs in the field.

In this project fungicides were tested for their efficacy against infections caused by *Rhizoctonia solani* ('cold preferring' isolate AG-2-t) and their phytotoxicity in tulip.

2 Material and method

This chapter gives a short description of the experimental setup. A detailed overview can be found in appendix 1.

The treatments (table 2.1) were applied in two experimental field trials (coded with FRh08t4 and FRh08t5) at two different locations at the same time. The treatments 2, 9 and 10 were included for phytotoxicity.

Table 2.1. Treatment schedule

Treatment no.	product	Name active ingredient (a.i.)	% a.i.	Formulation	Dosis in kg, l/ha	Infection yes/no	Mode of application/timing
1	Untreated	-	-	-	-	Yes	-
2	Untreated	-	-	-	-	No	-
3	Rizolex	tolclofos-methyl	500 g/l	liquid	50	Yes	Plantbed spraying
4	A12705B	azoxystrobine	250 g/l	SC	6	Yes	Plantbed spraying
5	A12705B	azoxystrobine	250 g/l	SC	9	Yes	Plantbed spraying
6	A12705B + Rizolex	azoxystrobine + tolclofos-methyl	250 g/l 500 g/l	SC liquid	9 + 33	Yes	Plantbed spraying
7	A 15149W	SYN520453 125EC	-	EC	6	Yes	Plantbed spraying
8	A 15149W	SYN520453 125EC	-	EC	12	Yes	Plantbed spraying
9	A12705B	azoxystrobine	250 g/l	SC	9	No	Plantbed spraying
10	A12705B	azoxystrobine	250 g/l	SC	18	No	Plantbed spraying

The efficacy of the treatments was determined by observing / measuring crop symptoms, bulb symptoms and yield. For bulb symptoms a classification was used:

1. no symptoms: healthy bulbs
2. light symptoms: little and small spots on the bulb surface
3. heavy symptoms: almost the whole bulb surface infected by Rhizoctonia. For *Tulipa turkestanica* it means that the bulbs were not found back after harvesting.

Phytotoxicity was determined by crop stand, number of flowers and yield.

3 Results

3.1 Crop

In both trials no phytotoxic effects occurred at emergence and during the growth of the tulips. In several treatments in trial FRh08t5 no emergence was seen because of the severe sensitivity of *Tulipa turkestanica* to *Rhizoctonia solani*.

Application of the combination of A12705B and Rizolex gave a significantly better crop stand of the cultivar Guiseppe Verdi on April 3rd and a higher number of flowers than application of Rizolex only (standard treatment). At the end of the growth there was no difference in die back of the canopy. Crop stand and number of flowers of *Tulipa turkestanica* after application of A12705B + Rizolex were not different from the treatment with Rizolex only, although the combination of the two fungicides gave better scores.

Crop stand in both trials after application of 6 l/ha A15149W was not as good as Rizolex, and for Guiseppe Verdi also not as good as A12705B. The results of a dosis of 12 l/ha A15149W were not different from those of the treatment with Rizolex.

Table 3.1. Evaluation of crop stand, number of flowers and die back for trial FRh08t4 (Guiseppe Verdi). Scores with different characters within the column are significantly different from each other (ANOVA, $P < 0.05$).

Treatment no.	product	Dosis (kg, l/ha)	Crop stand ¹⁾ April 3 rd	Number of flowers April 24	Die back (percentage green canopy) June 23
1	Untreated infected	-	3.5 a	48 a	15 a
2	Untreated not infected	-	9.0 f	94 ef	88 ef
3	Rizolex	50	7.3 c	79 c	65 cd
4	A12705B	6	7.3 c	80 c	50 b
5	A12705B	9	8.0 de	86 cde	60 bc
6	A12705B + Rizolex	9 + 33	8.3 e	89 def	75 de
7	A 15149W	6	6.5 b	69 b	53 bc
8	A 15149W	12	7.5 cd	80 cd	60 bc
9	A12705B	9	9.0 f	94 ef	83 ef
10	A12705B	18	9.0 f	99 f	93 f
		<i>F</i> prob	<.001	<.001	<.001
		<i>LSD</i>	0.6	9	14

¹⁾ crop stand: 10 = excellent crop, 0 = no plants emerged

Table 3.2. Evaluation of crop stand and number of flowers for trial FRh08t5 (*Tulipa turkestanica*). Scores with different characters within the column are significantly different from each other (ANOVA, $P < 0.05$).

Treatment no.	product	Dosis (kg, l/ha)	Crop stand ¹⁾ April 3 rd	Crop stand ¹⁾ May 7	Number of flower stems May 19
1	Untreated infected	-	0.0 a	0.0 a	0 a
2	Untreated not infected	-	9.0 e	10.0 e	246 d
3	Rizolex	50	3.5 cd	3.3 cd	52 bc
4	A12705B	6	1.5 ab	1.3 ab	10 ab
5	A12705B	9	2.0 bc	1.8 abc	17 ab
6	A12705B + Rizolex	9 + 33	5.0 d	4.8 d	91 c
7	A 15149W	6	1.3 ab	1.0 a	9 ab
8	A 15149W	12	4.8 d	3.0 bcd	52 bc
9	A12705B	9	9.0 e	10.0 e	247 d
10	A12705B	18	9.0 e	10.0 e	241 d
		<i>Fprob</i>	<i><.001</i>	<i><.001</i>	<i><.001</i>
		<i>LSD</i>	<i>1.5</i>	<i>1.8</i>	<i>50</i>

¹⁾ crop stand: 10 = excellent crop, 0 = no plants emerged

3.2 Yield

In both trials no phytotoxic effects occurred.

Application of the combination of A12705B and Rizolex gave the highest yield in both trials, but there was no significant difference compared with application of Rizolex (standard treatment). In trial FRh08t5 the combination of A12705B and Rizolex was also better than the treatment where only A12705B was applied. Application of 6 l/ha A15149W gave a lower yield than Rizolex only and 9 l/ha A12705B only in the trial with Guiseppe Verdi.

Table 3.3. Yield of Guiseppe Verdi in trial FRh08t4. Scores with different characters within the column are significantly different from each other (ANOVA, $P < 0.05$).

Treatment no.	product	Dosis (kg, l/ha)	Total bulb weight (g), size <10	Total bulb weight (g), size >10
1	Untreated infected	-	244 a	1281 a
2	Untreated not infected	-	728 e	2101 d
3	Rizolex	50	546 cd	1840 c
4	A12705B	6	443 bc	1833 c
5	A12705B	9	502 cd	1834 c
6	A12705B + Rizolex	9 + 33	603 d	1924 cd
7	A 15149W	6	385 b	1612 b
8	A 15149W	12	499 bcd	1769 bc
9	A12705B	9	758 e	2072 d
10	A12705B	18	757 e	2102 d
		<i>Fprob</i>	<i><.001</i>	<i><.001</i>
		<i>LSD</i>	<i>117</i>	<i>188</i>

Table 3.4. Yield of Tulipa turkestanica in trial FRh08t5. Scores with different characters within the column are significantly different from each other (ANOVA, $P < 0.05$).

Treatment no.	product	Dosis (kg, l/ha)	Total bulb weight (g), size <6	Total bulb weight (g), size >6
1	Untreated infected	-	112 ab	0 a
2	Untreated not infected	-	0 a	2301 c
3	Rizolex	50	342 de	332 ab
4	A12705B	6	166 bc	46 a
5	A12705B	9	244 bcd	70 a
6	A12705B + Rizolex	9 + 33	695 e	606 b
7	A 15149W	6	142 abc	45 a
8	A 15149W	12	273 cde	179 a
9	A12705B	9	0 a	2388 c
10	A12705B	18	0 a	2444 c
		<i>Fprob</i>	<i><.001</i>	<i><.001</i>
		<i>LSD</i>	<i>150</i>	<i>348</i>

3.3 Bulb infection

In both trials no phytotoxic effects occurred.

Application of the combination of A12705 and Rizolex gave the highest bulb quality and the highest number of healthy bulbs. This treatment was even better than the application of Rizolex only. With an application of

A12705B bulb quality and number of healthy bulbs were not different from the treatment with Rizolex. The results of the treatment with A15149W were not statistically different from the results with Rizolex. Because of the severe sensitivity of *T. turkestanica* there were hardly any healthy bulbs and therefore these results were not statistically analysed.

Table 3.5. Bulb quality and bulb infection of Guisepe Verdi in trial FRh08t4. Scores with different characters within the column are significantly different from each other (ANOVA, $P < 0.05$).

Treatment no.	product	Dosis (kg, l/ha)	Bulb quality ¹⁾	Number of bulbs (n=100)		
				no symptoms	light symptoms	heavy symptoms
1	Untreated infected	-	1.3 a	15 a	13 bc	72 e
2	Untreated not infected	-	8.8 ef	95 e	5 a	0 a
3	Rizolex	50	4.5 bc	54 bc	11 b	36 bcd
4	A12705B	6	4.3 bc	51 bc	11 b	38 cd
5	A12705B	9	5.8 cd	67 cd	9 ab	24 bc
6	A12705B + Rizolex	9 + 33	6.8 de	72 d	9 ab	20 b
7	A 15149W	6	3.0 ab	37 b	12 b	52 d
8	A 15149W	12	5.0 bcd	51 bc	19 c	31 bc
9	A12705B	9	9.0 f	95 e	5 a	1 a
10	A12705B	18	9.0 f	97 e	3 a	0 a
		<i>F</i> prob	<.001	<.001	<.001	<.001
		LSD	2.1	17	6	16

¹⁾ Bulb quality: 10 = excellent, 1 = very bad.

Table 3.6. Bulb quality and bulb infection of *Tulipa turkestanica* in trial FRh08t5 (n=300).

Treatment no.	product	Dosis (kg, l/ha)	Number of bulbs (n=300)
			Percentage healthy bulbs harvested
1	Untreated infected	-	0
2	Untreated not infected	-	100
3	Rizolex	50	11
4	A12705B	6	1
5	A12705B	9	1
6	A12705B + Rizolex	9 + 33	21
7	A 15149W	6	1
8	A 15149W	12	1
9	A12705B	9	100
10	A12705B	18	100

4 Conclusions

- non of the applied fungicide treatments caused visible phytotoxicity
- all applications of Rizolex, A12705B and A15149W had a positive influence on bulb quality or symptoms of Rhizoctonia, compared to untreated
- the application of a combination of Rizolex and A12705B (9 l/ha) had the best crop stand and bulb quality and the most healthy bulbs. In some cases this treatment was better than the application of Rizolex or A12705B solo.
- A dosage of 9 l/ha A12705B, compared with a dosage of 6 l/ha, gave a better crop stand of Guiseppe Verdi in the beginning of the growth, but did not improve bulb quality or percentage healthy bulbs.
- Doubling the dosage of A15149W gave a better crop stand of Guiseppe Verdi in the beginning of the growth, but did not improve bulb quality or percentage healthy bulbs.

Appendix 1 Experimental data

1	<u>Experimental data</u>	
1.1.	Crop	: Tulip
	- cultivars	: Guiseppe Verdi (trial FRh08t4)) and Tulipa turkestanica (trial FRh08t5)
	- plant size	: resp. 9/10 and 6/7
	- Pretreatment bulbs	: standard
	- Standard disinfection bulbs	: yes (0.3% prochloraz+ 1% Topsin M+0.5% captan)
1.2.	Disease-, pest-, weed pressure	: <i>Rhizoctonia solani</i> isolate AG-2-t (cold strain)
	- natural occurrence	: no
	- artificially	: yes
	* Inoculation method (of infection)	: soil inoculation with oat grains overgrown with fungus
	* amount	: 20 g/m ²
1.3.	Location	
	- greenhouse/field	: field: PPO Lisse (Guiseppe Verdi, trial FRh08t4)) and Noordwijkerhout (T. turkestanica, trial FRh08t5)
	- soiltype	: sandy soil
	- previous crop	: lily (trial FRh08t4), fallow (trial FRh08t5)
	- standard fumigation or soil disinfection	: no
1.4.	Plot size (brutto area/surface.)	: trial FRh08t4: 1.5 x 1.7 = 2.6 m ² trial FRh08t5: 1.5 x 2.2 m = 3.3 m ²
	- netto surface.	: trial FRh08t4: (1x1) 1.0m ² ; trial FRh08t5: (1x1.5) 1.5m ²
	- number of bulbs	: 100 (trial FRh08t4), 300 (trial FRh08t5)
	- plantweight	: trial FRh08t4: 1285g ; trial FRh08t5: 1382g
	- number of replications	: 4
1.5.	Trial data	
	- infection	: trial FRh08t4: 6-12-2007 trial FRh08t5: 10-12-2007
	- soil treatment(s)	: trial FRh08t4: 6-12-2007 trial FRh08t5: 10-12-2007
	- chemical application	: trial FRh08t4: 6-12-2007 trial FRh08t5: 10-12-2007
	- planting date(s)	: trial FRh08t4: 6-12-2007 trial FRh08t5: 10-12-2007
	- plant depth	: 10 cm
1.6.	Observations	
	<u>I. Efficacy</u>	
	- crop damage	: yes
	- bulb infection	: yes
	- root damage	: no
	- yield	: yes

II. Phytotoxicity

- emergence : yes
 - stand(crop) : yes
 - die back or decrease : yes
 - yield : yes

Observation scale phytotoxicity : 0-10 scale: 0 = 100% severe phytotoxicity, plants dead, 10 = no phytotoxicity

Observation scale efficacy : 0-10, where 0 = 100% diseased, 10 = healthy, excellent plants

1.7. Remarks or notes : -

1.8. Exceptions : -

1.9. additional information : Standard Operation Procedures (SOP): SOP02, 03, 04, 06, 07, 08
 : For statistical analysis Genstat 10th edition was used.

2.1. Number of treatments and coding

Treatment no.	product	Name active ingredient (a.i.)	% a.i.	Formulation	Dosis (kg, l/ha)	Infection yes/no	Mode of application/ timing
1	Untreated	-	-	-	-	Yes	-
2	Untreated	-	-	-	-	No	-
3	Rizolex	tolclofos-methyl	500 g/l	liquid	50	Yes	Plantbed spraying
4	A12705B	azoxystrobine	250 g/l	SC	6	Yes	Plantbed spraying
5	A12705B	azoxystrobine	250 g/l	SC	9	Yes	Plantbed spraying
6	A12705B + Rizolex	azoxystrobine + tolclofos-methyl	250 g/l 500 g/l	SC liquid	9 + 33	Yes	Plantbed spraying
7	A 15149W	SYN520453 125EC	-	EC	6	Yes	Plantbed spraying
8	A 15149W	SYN520453 125EC	-	EC	12	Yes	Plantbed spraying
9	A12705B	azoxystrobine	250 g/l	SC	9	No	Plantbed spraying
10	A12705B	azoxystrobine	250 g/l	SC	18	No	Plantbed spraying

2.2. Preparing the spray solution

Spraying :

-sprayer type	: Veeze hand airsprayer with 3 nozzles
- nozzle type	: Lechler AD110 03 VS
- pressure	: 3 bar
- water volume soil treatments	: 1000 L /ha
- spraying-surface trial FRh08t4	: field length 1.7 m, spray width 1.25 m spraying surface 2.125 m ²
- Spraying-surface trial FRh08t5	: field length 2.2 m, spray width 1.25 m spraying surface 2.75 m ²

Preparing solution trial FRh08t4 (Lisse, Guiseppe Verdi)

Treatment no.	Product	Dosis (kg, l/ha)	Solution to be prepared ml/treatment	Total product to be measure / weighed (ml,g per treatment per trial)	Solution to be applied (ml/treatment)
1	Untreated	-		-	-
2	Untreated	-		-	-
3	Rizolex	50	1000	50	850
4	A12705B	6	1000	6	850
5	A12705B	9	1000	9	850
6	A12705B + Rizolex	9 + 33	1000	9 + 33	850
7	A 15149W	6	1000	6	850
8	A 15149W	12	1000	12	850
9	A12705B	9	1000	9	850
10	A12705B	18	1000	18	850

Preparing solution FRh08t5 (Noordwijkerhout, T. turkestanica)

Treatment no.	Product	Dosis (kg, l/ha)	Solution to be prepared ml/treatment	Total product to be measure / weighed (ml,g per treatment per trial)	Solution to be applied (ml/treatment/trial)
1	Untreated	-		-	-
2	Untreated	-		-	-
3	Rizolex	50	1500	75	1100
4	A12705B	6	1500	9	1100
5	A12705B	9	1500	13.5	1100
6	A12705B + Rizolex	9 + 33	1500	13.5 + 49.5	1100
7	A 15149W	6	1500	9	1100
8	A 15149W	12	1500	18	1100
9	A12705B	9	1500	13.5	1100
10	A12705B	18	1500	27	1100

Appendix 2 Plot design

A. Trial scheme

Rhizoctonia solani (cold strain), trial FRH08t4 in Lisse, cultivar Guiseppe Verdi

north

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

south

B. Trial scheme

Rhizoctonia solani (cold strain), trial FRH08t5 in Noordwijkerhout, cultivar T. turkestanica

north

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

south

Appendix 3 Raw data crop

Trial FRh08t4 (Guiseppe Verdi, Lisse)

treatment	replication	Number of flowers	Crop stand	Die back (percentage green canopy)
		April 24	April 3 rd	June 23
1	A	36	3	1
1	B	47	3	2
1	C	52	4	2
1	D	56	4	1
2	A	97	9	8
2	B	94	9	9
2	C	91	9	9
2	D	94	9	9
3	A	69	7	5
3	B	89	8	7
3	C	84	7	6
3	D	73	7	8
4	A	78	7	4
4	B	82	7	6
4	C	82	8	4
4	D	76	7	6
5	A	85	8	6
5	B	79	8	6
5	C	87	8	5
5	D	91	8	7
6	A	83	8	7
6	B	92	8	6
6	C	87	8	8
6	D	95	9	9
7	A	66	7	6
7	B	77	6	5
7	C	53	6	3
7	D	79	7	7
8	A	74	8	6
8	B	76	8	6
8	C	86	7	5
8	D	84	7	7
9	A	98	9	9
9	B	93	9	9
9	C	95	9	7
9	D	91	9	8
10	A	98	9	10
10	B	93	9	10
10	C	99	9	9
10	D	104	9	8

Trial FRh08t5 (Tulipa turkestanica, Noordwijkerhout)

Treatment	Replication	Number of flowerstems May 19	Crop stand April 3rd	Crop stand May 7
1	A	0	0	0
1	B	0	0	0
1	C	0	0	0
1	D	0	0	0
2	A	284	9	10
2	B	268	9	10
2	C	224	9	10
2	D	208	9	10
3	A	15	3	2
3	B	16	2	2
3	C	140	6	7
3	D	35	3	2
4	A	2	1	1
4	B	15	2	2
4	C	20	2	1
4	D	4	1	1
5	A	24	3	2
5	B	4	1	2
5	C	10	1	1
5	D	31	3	2
6	A	38	4	2
6	B	34	4	4
6	C	176	7	8
6	D	114	5	5
7	A	2	1	1
7	B	3	1	1
7	C	1	0	0
7	D	31	3	2
8	A	18	3	2
8	B	43	5	3
8	C	39	4	2
8	D	109	7	5
9	A	212	9	10
9	B	268	9	10
9	C	236	9	10
9	D	272	9	10
10	A	232	9	10
10	B	248	9	10
10	C	248	9	10
10	D	236	9	10

Appendix 4 Raw data bulbs

Trial FRh08t4 (Guisepe Verdi, Lisse)

Treatment	Replication	Bulb quality	Bulbweight (g) size >10	Bulbweight (g) size <10	Bulb infection		
					No symptoms	Light	heavy
1	A	1	1140	186	2	7	91
1	B	1	1259	191	9	16	75
1	C	1	1393	255	24	19	57
1	D	2	1333	343	24	11	65
2	A	9	2120	720	93	7	0
2	B	9	2018	794	95	5	0
2	C	9	2284	761	96	4	0
2	D	8	1981	636	96	3	1
3	A	1	1561	353	23	8	69
3	B	8	2018	733	70	12	18
3	C	3	1761	496	49	10	41
3	D	6	2022	602	72	14	14
4	A	2	1690	316	14	13	73
4	B	3	1846	431	56	9	35
4	C	5	1808	485	63	15	22
4	D	7	1989	539	69	8	23
5	A	5	1746	475	46	15	39
5	B	7	1902	473	65	9	26
5	C	4	1824	480	63	6	31
5	D	7	1865	581	93	7	0
6	A	5	1905	481	55	11	34
6	B	7	1872	648	60	12	28
6	C	6	1908	623	78	7	15
6	D	9	2011	659	95	4	1
7	A	2	1587	352	23	8	69
7	B	6	1789	421	38	14	48
7	C	2	1341	315	51	11	38
7	D	2	1731	453	35	14	51
8	A	4	1710	414	41	20	39
8	B	6	1806	560	57	13	30
8	C	6	1795	547	65	12	23
8	D	4	1765	473	41	29	30
9	A	9	2100	864	94	6	0
9	B	9	2167	706	97	3	0
9	C	9	2070	810	96	2	2
9	D	9	1949	653	92	8	0
10	A	9	2255	718	98	2	0
10	B	9	2040	814	98	2	0
10	C	9	2138	763	95	5	0
10	D	9	1975	734	96	4	0

Trial FRh08t5 (Tulipa turkestanica, Noordwijkerhout)

Treatment	Replication	Total bulbweight (g)		Number of healthy bulbs
		Size >6	Size <6	
1	A	0	121	0
1	B	0	69	0
1	C	0	110	0
1	D	0	150	0
2	A	2432	0	300
2	B	2350	0	300
2	C	2360	0	300
2	D	2063	0	300
3	A	22	201	2
3	B	85	192	3
3	C	1056	687	116
3	D	164	289	13
4	A	0	128	0
4	B	50	160	5
4	C	100	176	7
4	D	34	198	3
5	A	67	230	3
5	B	25	137	1
5	C	37	162	0
5	D	153	445	5
6	A	63	218	1
6	B	158	328	4
6	C	1244	595	142
6	D	957	438	109
7	A	13	111	0
7	B	18	119	1
7	C	0	118	0
7	D	148	218	7
8	A	40	107	0
8	B	128	242	0
8	C	165	265	4
8	D	384	479	8
9	A	2437	0	300
9	B	2249	0	300
9	C	2420	0	300
9	D	2447	0	300
10	A	2417	0	300
10	B	2429	0	300
10	C	2601	0	300
10	D	2329	0	300

