



Broomrape:

Damn this parasitic weed!



Gene Miyao, Farm Advisor, UCCE, Yolo, Solano & Sacramento counties
Yaakov (Coby) Goldwasser, Newe Yaar Research Center, Israel
Radi Aly and Hanan Eizenberg, visiting scientists, Volcani Institute, Israel



Control of Egyptian Broomrape in Processing Tomato: A Summary of 20 Years of Research and Successful Implementation

Hanan Eizenberg[†]

Department of Plant Pathology and Weed Research, Neve Ya'ar Research Center, ARO, Israel

Yaakov Goldwasser

Department of Plant Pathology and Weed Research, Neve Ya'ar Research Center, ARO, Israel;
and The RH Smith Institute of Plant Sciences & Genetics in Agriculture, Faculty of Agriculture,
Food & Environment, The Hebrew University of Jerusalem, Rehovot, Israel.



P. aegyptiaca

Solanaceae

tomato

potato

eggplant

tobacco

Cruciferae

cabbage

broccoli

cauliflower

kohlrabi

Oleaceae

olive

Asteraceae

sunflower

lettuce

Fabaceae

pea

faba bean

chickpea

peanut

vetch

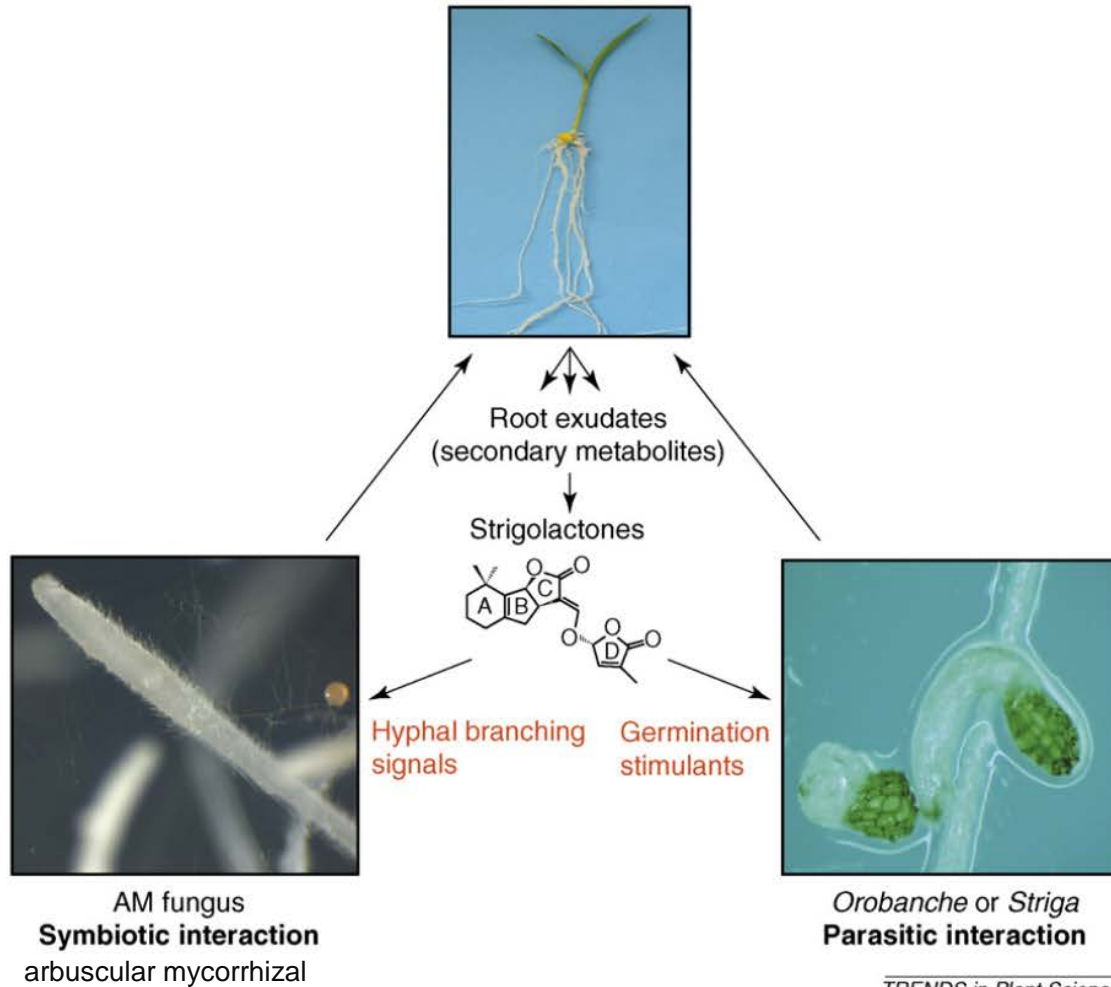
lentil



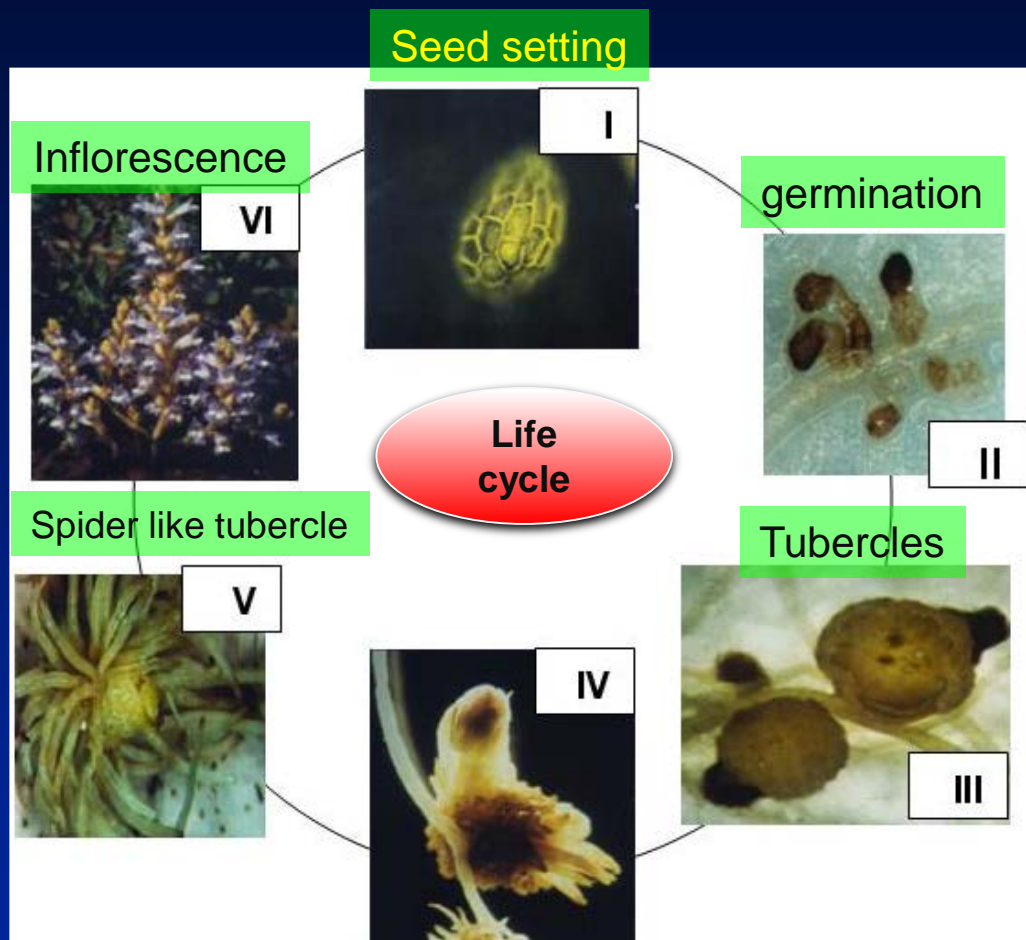
Family/crop	<i>O. ramosa</i>	<i>O. aegyptiaca</i>	<i>O. minor</i>	<i>O. cernua</i>	<i>O. crenata</i>
Alliaceae					
onion	x	—	—	—	—
Cannabidaceae					
hemp	xx	—	—	—	—
Compositae					
lettuce	xx	—	x	—	x
noog/niger seed	—	—	x	—	—
safflower	—	—	x	—	x
sunflower	x	xx	—	xxx	x
Cruciferae					
cabbage	x	x	—	—	—
mustard	xx	xxx	—	—	—
rapeseed	xxx	x	—	—	—
Cucurbitaceae					
cucumber	x	xx	—	—	—
melon	x	xx	—	—	x
squash	x	xx	—	—	—
water melon	x	xx	—	—	—
Leguminosae					
bird's foot trefoil	—	—	x	—	—
chickpea	x	x	—	—	xx
clovers	x	—	xx	—	—
groundnut	x	x	x	—	x
faba bean	x	x	x	—	xxx
lentil	x	x	—	—	xx
lucerne/alfalfa	—	—	xx	—	—
pea	x	x	—	—	x
Solanaceae					
eggplant	xxx	xxx	—	xx	—
pepper	x	x	—	—	—
potato	x	x	—	—	—
tobacco	xxx	xxx	x	xxx	—
tomato	xxx	xxx	—	xx	x
Umbelliferae					
carrot	x	x	x	—	xx
celery	x	x	x	—	x
fennel	x	x	—	—	—
parsnip	.x	x	—	—	—

xxx seriously attacked; xx moderately attacked; x lightly attacked; — attack doubtful.

Strigolactone is a stimulant for the parasite seed germination



Once conditions are optimal, the parasite seeds will germinate



P. aegyptiaca reduced quality and yield quantity in tomato fields



Cabbage highly infested with *P. aegyptiaca*



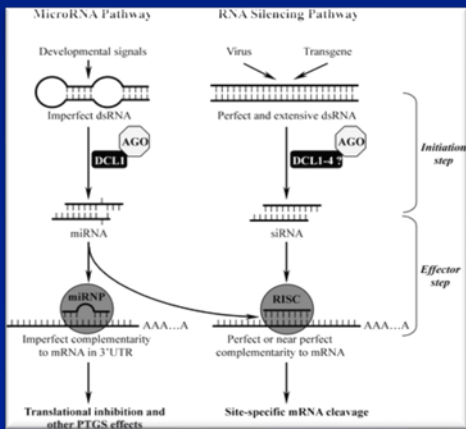


Novel control strategy

Approaches

Gene silencing and editing

Plant arming by toxic compounds



Non-transgenic

Transgenic

(Aly et al., 2006); (Hamamouch et al., 2005)

Non-transgenic



Transgenic

(Aly et al., 2006); (Hamamouch et al., 2005)

Orobanche aegyptiaca



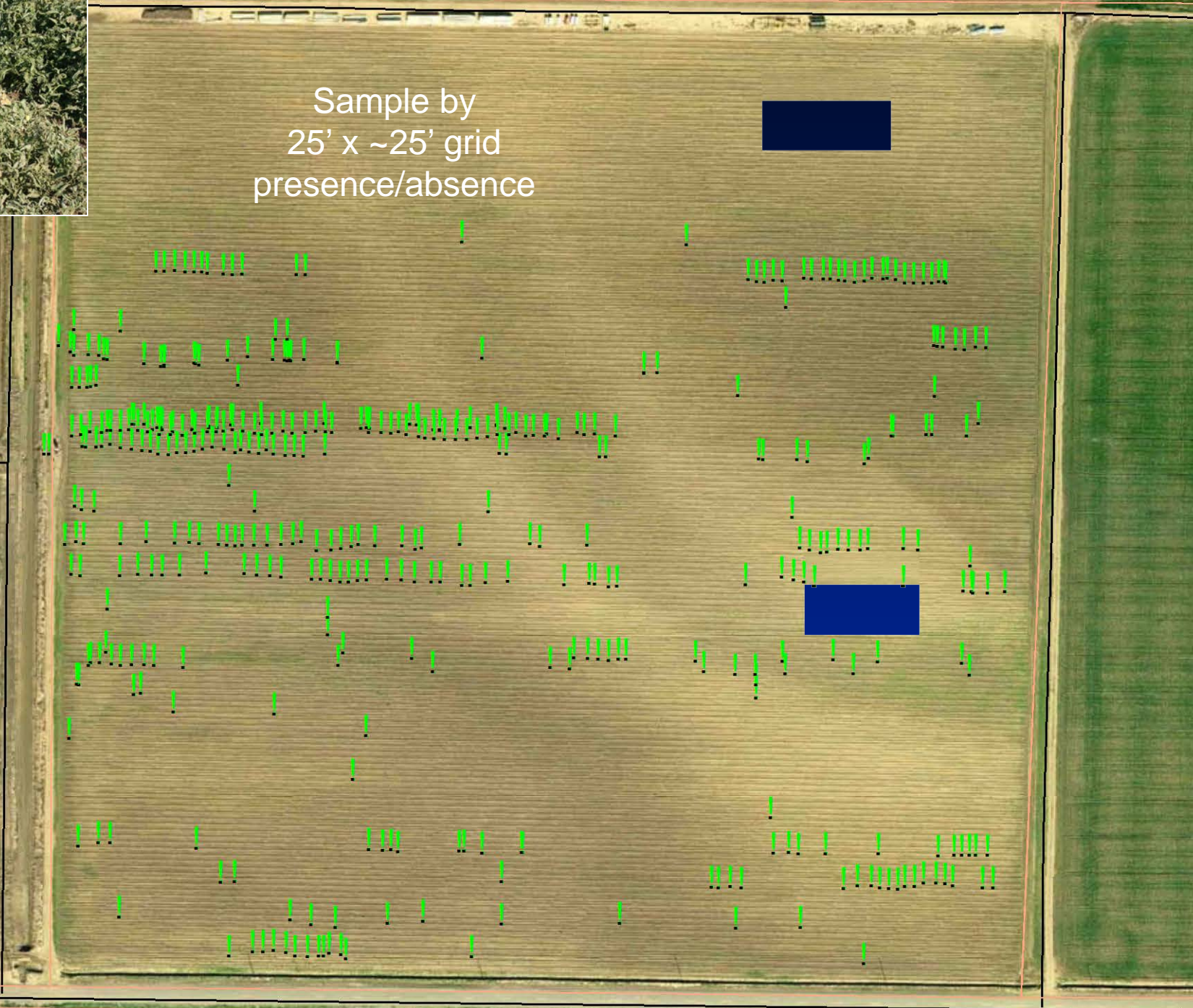
Orobanche ramosa

Broomrape: Egyptian species an introduction into U.S.





Sample by
25' x ~25' grid
presence/absence





1. ✓ Limit spread (quarantine)
2. Reduce seed production
 - ✓ 1. Kill host
 2. Hand Remove weed
 3. Flame-kill seed
 4. Fumigation
3. Post: scout for escapes
4. SANITATION (in general)





1. ✓ Limit spread (quarantine)
2. Reduce seed production
 1. Kill host
 2. ~~Hand Remove weed~~
 3. Flame-kill seed
 4. Fumigation
3. Post: scout for escapes
4. ✓ SANITATION (in general)

88 hours/acre





Seeds







- 1. Limit spread (quarantine)
- 2. Reduce seed production
 - 1. Kill host
 - 2. ~~Hand Remove weed~~
 - ✓ 3. Flame-kill seed
 - 4. Fumigation
- 3. Post: scout for escapes
- 4. SANITATION (in general)

~ \$200 per acre

**GRANT AGREEMENT
SIGNATURE PAGE**

AGREEMENT NUMBER

14-0488-SA

- This Agreement is entered into between the State Agency and the Recipient named below:
STATE AGENCY'S NAME
DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)
RECIPIENT'S NAME
UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
- The term of this Agreement is: November 1, 2014 through June 30, 2015
- The maximum amount of this Agreement is: \$88,223.00
Eighty Eight Thousand Two Hundred Twenty Three Dollars and
Zero Cents
- The parties agree to comply with the terms and conditions of the following exhibits which are by this reference made a part of the Agreement:

Exhibit A: 3 Page(s)
• Recipient and Project Information
• Scope of Work

Exhibit B: 2 Page(s)
• Budget & Payment Provisions
• Budget

Exhibit C – General Terms and Conditions 2 Page(s)

Name of Project: Egyptian Broomrape (EBR)

IN WITNESS WHEREOF, this Agreement has been executed by the parties hereto.

RECIPIENT

RECIPIENT'S NAME (*Organization's Name*)
UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION

BY (*Authorized Signature*)

DATE SIGNED (*Do not type*)

PRINTED NAME AND TITLE OF PERSON SIGNING

ADDRESS
70 Cottonwood Street, Woodland, CA 95695

STATE OF CALIFORNIA

AGENCY NAME
DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)

BY (*Authorized Signature*)

DATE SIGNED (*Do not type*)

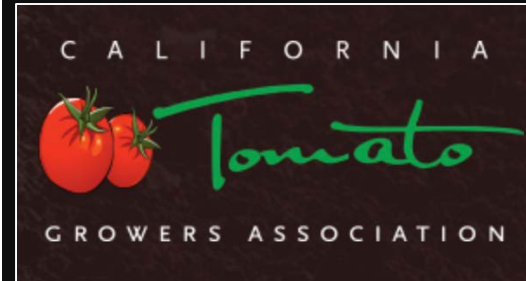
PRINTED NAME AND TITLE OF PERSON SIGNING
CRYSTAL MYERS, MANAGER - FEDERAL FUNDS MANAGEMENT OFFICE

ADDRESS
1220 N STREET, ROOM 120
SACRAMENTO, CA 95814

CJ



**CA Tomato
Processors**





1. Limit spread (quarantine)
2. Reduce seed production
 1. Kill host
 2. Hand Remove weed
 3. Flame-kill seed
 4. Fumigation ~ **\$4K per acre**
3. ✓ Post: scout for escapes
4. SANITATION (in general)



Table 1. Chemical control of *Orobanche* in field trials.

Herbicide	Formulation	Rate (g ai/ha)	Application Method	Crop
Glyphosate	360 g/l SL	80 + 80 + 80	POST ^a	Faba bean
		90 + 90	POST	Vetch
		36 + 36 + 36	POST	Parsley
		36 + 36 + 36	POST	Carrot
		54 + 54	POST	Celery
<i>Sulfonylureas</i>				
Chlorsulfuron	75% WG	2.5 + 2.5 + 2.5	CHEM+IRRI ^b	Tomato
Rimsulfuron	25% WG	25 + 25 + 25	CHEM+IRRI	Tomato
		12.5 + 12.5 + 12.5	CHEM+IRRI	Potato
		7.5 + 7.5 + 7.5	CHEM+IRRI	Tomato
Triasulfuron	75% WG	7.5 + 7.5 + 7.5	CHEM+IRRI	Tomato
Sulfosulfuron	75% WG	37.5 + 37.5 + 37.5	POST+IRRI ^c	Tomato
<i>Imidazolinones</i>				
Imazapic	240 g/l SL	2.4 + 4.8 + 4.8	POST	Parsley
		2.4 + 2.4 + 2.4	POST	Carrot
		2.4 + 2.4	POST	Peanut
		2.4 + 2.4 + 2.4	POST	Sunflower
Imazethapyr	100 g/l SL	20 + 20 + 20	POST	Pea

POST= Sprayed on host foliage at 200 l/ha spray volume.

^bCHEM+IRRI= Chemigated by sprinkler irrigation and washed into the root zone by additional sprinkler irrigation.

POST+IRRI= Sprayed on host foliage at 200 l/ha spray volume and followed by 300 m³/ha sprinkler irrigation.

Application of sulfonylurea herbicides directly to the soil, pre-broomrape attachment, controlled Egyptian broomrape in tomato (*Solanum lycopersicum*) and potato



Table 4. *PICKIT* broomrape management balance sheet^a

Additional costs	Cost/income (\$/ha) ^b
Rototilling	112
Sulfosulfuron 50 g ha ⁻¹	108
Sulfosulfuron application (sprayer)	24
Imazapic 80 g ha ⁻¹ (split application)	275
Total cost	519
Additional income	
Additional yield: 50 t ha ⁻¹	5,250 ^c
Net revenue	4,731

^a Summary of five semi-commercial plots treated in 2014, 1.5 to 2.5 ha each.

^b Exchange rate of US \$1 = 3.5 NIS.

^c Based on a tomato price of \$105 ton⁻¹.

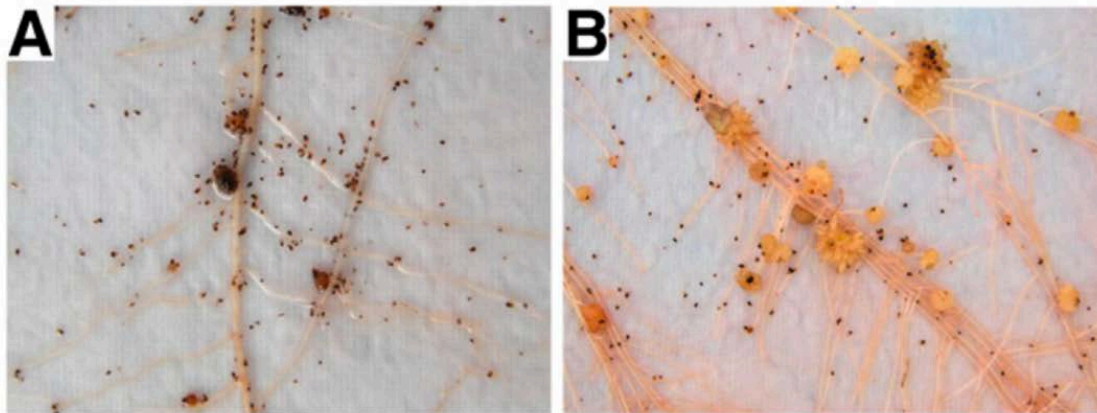


Fig. 5. Effect of imazapic application on Egyptian broomrape attached to tomato roots in the polyethylene bag system. (A) Treated with 5 ppb imazapic. (B) Untreated control.



Fig. 6. Damage to tomato fruit caused by foliar application of 4.8 g a.i. ha⁻¹ imazapic. Left, damage to fruit set. Right, damage to young fruits.

