SIXTH PROGRESS REPORT (FINAL)

(July 1, 1990 - June 30, 1991)

STUDIES ON BROOMRAPE (OROBANCHE SPP) AVOIDANCE AND CONTROL

GRANT NO DPE-544-G-55-7054-00

Submitted to

U S - AID - ISRAEL CDR PROGRAM, WASHINGTON D C

By

Reuven Jacobsohn, Israel, Principal investigator

Vishwanath P Agrawal, Nepal

Govind B Khattri, Nepal

TABLE OF CONTENT

Page

NEPAL

Study on host (Brassica campestris var toria) parasite (Orobanche aegyptiaca) phenology 3

Effect of planting date of tori (Brassica campestris var toria) on the parasitization of Orobanche aegyptiaca 6

Control of Orobanche aegyptiaca in tori (Brassica campestris) var toria) by foliarly applied glyphosate 9

Evaluation of foliarly applied Imidazolinone and Sulphonyl urea herbicides in Orobanche infected tori (Brassica campestris var toria) plants 11

A preliminary study on host range of Orobanche aegyptiaca 13

ISRAEL

Broomrape test plots - Summr 1990 16

Broomrape test plots - Winter 1990-91 23

Control of Egyptian broomrape in rape (Brassica spp) with foliarly applied herbicides (90-91) 29

Broomrape control in tomatoes with foliarly applied sulfonyle urea herbicides at low rates (Bet Dagan, Spring 1991) 31

Control of Sunflower Broomrape with foliarly applied sulfonyl urea herbicides in sunflower (Bet Dagan 1990) 33

Broomrape control in carrots using mechanically applied Telone II in the Bet Shean Valley during 1990-1991 35

Foliarly applied Imazethapyr for crenate broomrape control in peas 41

1 Exp 1990-91 Residual effect on wheat, Bet Dagan

2 Field exp in Yad Mordechai

2 1 - Algiya 1990-91

2 2 - Bet Girga 1990-91

Study on host (Brassica campestris var tori) parasite (Orobanche aegyptiaca) phenology

Introduction

The study is a repetition of the previous year experiment

Materials and Method

The experiment was conducted in the same area in Chitawan but in a different field Design of the field was randomize complete block with five replications and ten treatments Area of a plot was 4 m^2 There were three rows of plants in a plot and each row contained about 7 plants at a spacing of 30 cm Locally collected tori seeds were planted on October 25, 1990 Sampling was started when tori plants were one month old and 10 tori plants were sampled from each plot in a sampling date While sampling, plants were carefully dug up so as to take out much of the root system Growth parameters of host and parasite used were as in the previous year (see Fifth Progress report)

Results and Discussion

Table 1 Time course of appearance of growth stages of Orobanche plants in an experimental tori field

Data of the study is presented in the Table 1

Date of observation	Host growth stage	GROWTH STAGE OF OROBANCHE a-stage (0-5 mm)	b-stage (5-20 mm)	c-stage (21-emerged)	d-stage (flowering)	Total
Oct 25, 90	Planting					
Nov 24, 90	efl	2 0 c	1 0 b	0 0	0 0	3 0
Dec 01, 90	mfl	3 6 b	1 2 b	0 4 d	0 0	5 2
Dec 08, 90	lfl	6 4 a	4 0 ab	3 8 bc	0 0	14 2
Dec 15, 90	efr	4 4 ab	5 8 a	7 0 abc	0 4 d	17 6
Dec 23, 90	fr	2 6 c	5 2 ab	1 6 cd	2 6 cd	22 0
Dec 31, 90	lfr	1 6 c	4 0 ab	5 4 bc	5 0 bc	26 0
Jan 07, 91	fm	0 8 c	2 8 ab	12 0 a	9 0 ab	24 6
Jan 15, 91	sm	0 0	2 4 ab	9 6 ab	11 4 a	23 4

Growth stages of host plant

efl = early flowering, mfl - mid flowering, lfl = late flowing

efr = early fruiting, fr = fruiting, lfr = late fruiting, fm = fruit maturation

sm = seed maturation Values followed by common letters are not different at 5% level of significance according to DMRT

Progress of phenological development of *Orobanche* in respect to that of tori has followed almost the same pattern as was found in the experiment conducted in 1989 (fifth Progress Report) Important phenological phenomena common in the experiments of both the years (1989-1990 and 1990-1991) are

a Attachment of *Orobanche* to a four weeks old tori plant (early flowering)

b Highest percentage of the growth stage 'a' of *Orobanche* in the third observation when tori was about 6-7 week old (late flowering)

c Emergence of *Orobanche* (d-stage) when tori was about eight weeks old (fruiting stage)

d Existence of all the stages of *Orobanche* up to fruit maturation stage of tori

e Association of highest percentage of 'c' and 'd' growth stages of *Orobanche* with fruiting stage of tori

The above observation has supported our earlier assumption that germination of Orobanche is not limited to a specific growth stage of tori, of course, it favours the tori in flowering stage, and coincidence of active period of Orobanche growth with the fruiting and seed maturation period largely affects the fruit development and, consequently, the seed production

The observations are also supporting our earlier supposition that application of herbicide would be effective when tori plants are about five weeks old (early flowering stage) provided tori plants are sown in a usual planting date

Effect of planting date of tori (Brassica campestris var toria) on the parasitization of Orobanche aegyptiaca

Introduction

This is a repetition of the experiment conducted in the 1989 (see Fifth Progress Report)

Materials and Method

The experimental field was located in the same area as was in the previous year but in a different field The experimental design was randomize complete blocks with five replications The field was naturally infested with Orobanche seeds Area of a plot was 5 m^2 and it contained three rows of plants at a spacing of 30 cm

Distance between plants in a row was 20 cm Host seeds were locally aquired

Planting dates are given in Table 2

Results and Discussion

Results are presented in Table 2 and 3

Originally, dates of first and second plantings were set on 3rd and 13th October Due to the constant raining, first planting was shifted to 9th October and the second to 22nd October So, first and second planting dates were comparable to the second and third planting dates of the previous year experiment

Emergence of Orobanche plants in first planting date was first recorded on Nov 24 which was about two weeks earlier to the planting date sown in about the same date in the previous year experiment Orobanche plants stayed with tori plants for about 4 weeks Tori plants of the same planting dates in both the years were in late flowering stage This indicated that in tori plants, sown in second week of October, temperature started to favour Orobanche seed germination when tori plant was in an advanced growth period

In tori plants, sown in 4th week of October, Orobanche started emerging from the first week of December when the host plants were in mid-flowering stage The parasite stayed with tori plants for about 7-8 weeks

In subsequent planting dates, tori plants took a very slow growth, may be because of lowering temperature Late emergence of Orobanche plants (4th week of December) in those planting dates might be due to the poor growth of host plant Moreover, the host

In subsequent planting dates, tori plants took a very slow growth, may be because of lowering temperature Late emergence of Orobanche plants (4th week of December) in those planting dates might be due to the poor growth of host plant Moreover, the host plants dried before attaining full maturity

Orobanche count was higher in the first two planting dates and it was negligible in the later planting dates Compared to the first, the second planting date has a higher number of Orobanche plants

On contrary to our assumption, the second planting date has about same seed yield with higher number of Orobanche compared to the second planting date with lesser number of Orobanche plants

Finally, it can be concluded that ideal planting date of tori coincides with the favourable growth period of Orobanche in agronomic condition of Nepal

2 Progress of Orobanche emergence in tori crop planted in different planting dates

	PLANTING DATE											
	Oct 09		Oct 22		Nov 01		Nov 11		Nov 21		Dec 01	
Date of observation	OaN	HGS	OaN	HGS	OaN	HGS	OaN	HGS	OaN	HGS	OaN	HGS
Nov 24, 1990	1 2	mfl	-	-	-	-	-	-	-	-	-	-
Dec 01, 1990	3 2	fr	-	-	-	-	-	-	-	-	-	-
Dec 08, 1990	9 2	frm	0 8	mfl	-	-	-	-	-	-	-	-
Dec 15, 1990	11 4	sdm	5 4	fr	-	-	-	-	-	-	-	-
Dec 23, 1990	13 8	hv	16 4	frm	0 2	mfl	-	-	-	-	-	-
Dec 31, 1990	-	-	27 8	sdm	1 6	fr	-	-	-	-	-	-
Jan 07, 1990	-	-	31 2	hv	3 0	frm	-	mfl	-	fl	-	efl

Short notations OaN = number of Orobanche plants per plot, HGS = growth stages of host plants efl = early flowering, mfl = mid flowering, fr = fruiting, frm = fruit maturation, sdm = seed maturation, hv = harvest

Table 3 Effect of planting date of tori plant on the emergence of Orobanche plant and seed yield of the host

Planting date	Orobanche plants/plot	Seed Yield gr/m^2
Oct 09, 1990	13 8	20 7
Oct 22, 1990	31 2	21 8
Nov 01, 1990	03 0	00 0
Nov 11, 1990	00 0	00 0
Nov 21, 1990	00 0	00 0
Dec 01, 1990	00 0	00 0
Dec 11, 1990	00 0	00 0

Control of Orobanche aegyptiaca in tori (*Brassica campestris* var toria) by foliarly applied glyphosate

Introduction

This is a repetition of the experiment conducted in the previous year

Materials and Method

The experiment was conducted in Chitwan at the same location as in the previous year but in a different field The field was naturally infested by *Orobanche* seeds The experimental design was latin squire with six replications Area of a plot was 8 m^2 and it contained three rows of host plants at distance of 30 cm, and spacing between plants in a row was 20 cm Locally obtained seeds were sown on October 25, 1990 The spray volume was 250 l/ha and 0 1% of the surfactant Triton x-100, was added to all the treatments except the sixth Regular visual evaluation and Orobanche was recorded

Rates and dates of glyphosate applications are presented in Table 4

Table 4 Rates of Round-up[1)] and number of it's applications on tori plants

Treatment number	cc Round up / ha Spray-I (Nov 29, 1990)	Spray-II (Dec 20, 1990)
1	50	50
2	50	100
3	100	100
4	100	150
5	Surfactant	Surfactant
6	Control	Control

1 Round-up-commercial formulation of glyphosate containing 36% active ingredient

Results and Discussion

Results are presented in Table 5

Phytotoxic effect of first and second applications of glyphosate on tori was similar as was in the experiment conducted in 1989 The most encouraging aspect of the experiment was that there was an increase of seed yield in first treatment compared to that of control The increase was about 10% although not statistically significant

There was, almost, a complete control of *Orobanche* in all the treatments *Orobanche* count in control plots was about four times more than in control plots of a similar experiment conducted in 1989

A high level of *Orobanche* infestation in the control plots must have inflicted a substantial loss in the crop, and the loss might be higher than the phytotoxic effect of the herbicides

Table 5 Effect of foliarly applied Round up on tori plants in controlling Orobanche plants

Treatments cc Round up/ha		Visual evaluation	Host Growth component[a]			Seed yield	Orobanche
Spray I	Spray II		PH	NB	NP	g/m^2	pl/m^2
50	50	4 6	66 7	9 4	104	32 11 a[b]	0
50	100	4 6	56 5	8 3	83	30 08 ab	0
100	100	3 9	57 0	7 8	79	26 15 bc	0
100	150	3 9	56 5	7 6	77	25 81 c	0
Control		5 0	56 4	8 3	87	29 15 ab	27 44

a Values are an average of 90 plants,

b values having common letter are not significantly different at 5% level of significance according to DMRT

Short Notations PH = Plant Height, NB = Number of branches, NP = Number pods

Evaluation of foliarly applied Imidazolinone and Sulphonyl urea herbicides in Orobanche infected tori (Brassica campestris var toria) fields

Introduction

In recent years, there are reports of successes of some new Imidazolinone and Sulphonyl urea herbicides in controlling *Orobanche* in certain crop plants A preliminary experiment was conducted to evaluate the effect of the herbicides on Orobanche and tori plants

Materials and method

The experiment was conducted in 1990 - 1991 in a farmer's field located at Chitawan The field was naturally infested with *Orobanche* seeds The experimental design was randomize complete block with five replications Each plot had an area of 8 m^2 and contained three rows of host plants The distances between the rows and plants in a row were 0 3 and 0 2 respectively

Tori seeds, collected locally, were planted on October 26, 1990

The spray volume was 250 l/ha and 0 1% of Triton x-100 was added to each of the treatments except the eighth Herbicides were applied on five week old tori plants with an experimental sprayer provided with four nuzzle boom Visual evaluation was conducted two weeks after the herbicide application The crop was harvested on Jan 19, 1991

Results and Discussion

Results are presented in Table 6

Although, there was a complete control of Orobanche in all the rates of herbicides tested, the herbicides caused almost a complete damage to the tori plants at the rates tested So, the herbicides can not be used to control Orobanche in tori crop

Table 6 Control of Orobanche in tori plants by foliarly applied Imidazolinone herbicides

Treatments gr a i /h	Visual evaluation	Seed Yield g/m^2	Orobanche pl/m^2
Scepter, 20	2 31 b[a]	04 66 bc	00 00
Scepter, 40	1 61 c	02 46 bc	00 00
Persuit, 20	2 57 b	10 61 b	00 00
Persuit, 40	1 62 c	04 31 bc	00 00
Glean, 0 5	2 35 b	05 17bc	00 00
Glean, 1 0	1 26 c	01 41 c	00 00
Surfactant	5 00 a	47 79 a	19 73
Control	5 00 a	42 42 a	20 00

a 5 = normal growth, 1 = no yield

b values having common letters are not significantly different at 5% level of significance according to DMRT

A preliminary study on host range of Orobanche aegyptiaca

Introduction

Second progress Report contains a report on the host range of *Orobanche* spp found in Nepal The report was based on field observations during the survey trip The report indicated *Orobanche* aegyptiaca to be most trouble some *Orobanche* species in Nepal parasitizing a wide variety of crop plants specially the *Brassica* crops Having realized this, a preliminary field experiment was conducted to determined relative susceptibility of some *Brassica* crops to Orobanche aegyptiaca

Materials and Method

The experimental field was located in chitawan in 1990 The field had natural infestation of the *Orobanche* seeds The field design was randomize complete block with four replications Area of a plot was 4 x 2m and it contained three rows of plants at a distance of 30 cm, and spacing between plants in a row was 20 cm *Brassica* plants tested for the study are given in Table 1 Final count of *Orobanche* plants was done a week before harvest

Table 7 List of host plants to be tested

Treatment number	Treatments Host plants
1	Brassica campestris var sarson
2	B juncea, an oil yielding variety
3	B campestris, a Canadian variety
4	B rapa
5	B napus
6	B campestris var toria (CHLS)
7	B juncea (foliage variety)
8	B oleracea var botritis
9	B campestris var toria (vikasa)
10	B oleracea var capitata

Results and Discussion

Results are presented in Table 8

Table 8 Degree of susceptibility of host plants to O aegyptiaca

Treatments Host species	Number of Orobanche plants/plot
Brassica campestris var sarson	36 25 ab
B juncea, an oil yielding variety	0 25 e
B campestris, a Canadian variety	6 25 de
B rapa	11 50 de
B napus	30 25 abc
B campestris var toria (CHLS)	21 50 bcd
B juncea (foliage variety)	17 25 cd
B oleracea var botritis	0 25 e
B campestris var toria (vikasa)	45 00 a
B oleracea var capitata	0 50 e

Host plants showed a varying degree of susceptibility to the Orobanche species Of the host plants tested, *B campestris* var toria (vikasa) appeared to be the most susceptible host to the *Orobanche* species Other species of *Brassica* which were equally favoured by the parasite are *B campestris* var sarson, *B napus* and *B campestris* var toria

B juncea (a very common vegetable in Nepal), reported as a higly favoured host of the Orobanche species in the Second Progress Report, responded rather differently in the field experiment The possible reason of the disparity might be that the growing condition set for the toria did not suit the Brassica host and, as a consequence, the host plants failed to take a normal growth to have more *Orobanche* plants May be, so was the case with cabbage and cauliflower also

Reason for why *B rapa* (turnip) and a Canadian variety of *B campestris* got low infection appeared to be different Turnip plants got so early *Orobanche* infection that

the plants could not attain their full maturity, consequently, failed to bear more parasite plants The Canadian variety of *Brassica* had poor growth and it was due to the severe fungal infection Impaired growth of the host plants might be the reason for poor infection of the parasite

Of the host spp tested, oil yielding B juncea proved to be the only host that showed resistance against the parasite in it's normal growing condition

Based on our earlier report of host range study and the present experiment, it seems pertinent that before any field experiment is conducted, normal growing condition to all the host spp should be secured

Broomrape test plots - summer 1990

Materials and Methods

All plots were cleared from the previous season on early May 1990 Irrigation of about 50 mm, deep cultivation and bed preparation using a rototiller with a bedshaper was conducted from early May until the 10th Each plot consisted of 4 m long bed section of which 3 5 m were planted or seeded The following crops were tested

Solanaceae

1 Tomato (Lycopersicon esculentum Mill) cv M82

2 Bell pepper (Capsicum frutescents L) cv Ohad

3 Eggplant (Solanum melongena L) cv Classic

Curcubitaceae

4 Melon (cucumis melo L) cv Galia

5 Water melon (citrullus vulgaris Schrad) cv Tavor

6 Cucumber (cucumis sativus L) cv 101

Compositae

7 Sunflower (Helianthus annuus L) cv DI-3

Papilonaceae

8 Peanuts (Arachis hypogaea L) cv Shulamit

The first seven crops were planted or seeded on May 14-15, 1990 Peanuts were planted on May 28, 1990

Method of planting was the same including, in and between row spacing, as previously described

All seeded crops were initially sprinkler irrigated until emergence Finally, the whole experiment was drip irrigated Data was collected throughtout the season according to the nature of each crop

Results and Discussion

The data are presented in Table 1

As already mentioned in one of the previous reports, the experiments in the test plots are a single replication experiment Therefore, each crop is tested at least two seasons and in the future, it will be repeated once more in commercial fields in other areas of the country We believe that we have to take every possible precaution prior to recommending to a farmer to grow a crop on an infested field with one or another broomrape species

Solanaceae crops

In general, the three crops tested were decreasingly sensitive to the parasites in the following order Tomato, Eggplant and Bell pepper The first two were similarly sensitive to O aegyptiaca ("summer" strain) and to O muteli Pepper "raised" a considerable number of "summer" egyptian broomrape plants, but they were poorly developed and caused no visible or measurable damage Tomato was considerably more sensitive to O cernua than Eggplant while pepper was resistant One of the two tomato plots (in each broomrape infested field) was planted on a plot which had been heavily infected sunflowers with O cumana The other tomato plot was planted in a plot previously planted with melons A few O cumana spikes appeared on the tomatoes planted on the sunflower plots and none on the tomatoes planted in the melon plots Similar observations were made in commercial fields, sometimes, even to the extent of crop damage

Cucurbitaceae crops

Out of the three crops, melons, watermelons and cucumbers, the first was the most sensitive

Melons were parasitized by both Egyptian and Muteli broomrape Although infection with Egyptian broomrape was eventually heavy, it occured late and the broomrape plants were small and not well developed which reminds the situation with Egyptian broomrape parasitism in pepper

Yield differences do not seem to be a result of broomrape parasitism

Sunflowers

The two most damaging broomrape species to sunflowers are O aegyptiaca "summer" strain (first emergence after 38 days) and O cumana first emergence after 33 days Some infection was observed by O crenata and O muteli, and non by O cernua and O aegyptiaca "winter strain" It is extreemly difficult to obtain information on yield in small plots of sunflowers because of bird damage As an indication to broomrape affect on the sunflower plants we measured the height of the plants, the diameter of the heads and a visual evaluation of crop condition (on a 1-5 scale)

Peanuts

Peanuts were heavily parasitized by the "summer" strain of O aegyptiaca and less so by the other brunching broomrape - O muteli

Minimal infection occurred by O aegyptiaca - "winter" strain As last year, also in this experiment O crenata spikes were observed, which is very unusual and generally unexpected We were unable to wait until the ripening of the peanuts as the field had to be prepared for the 1990-91 experiments Therefore, we expressed the effect of the broomrapes on the foliage weight

Table 1 The extent and affect of several broomrape species parasitism on different crops (Bet Dagan test plots - summer 1990)

	Plant/seed date	Observation date	Winter O aegypt	Summer O aegypt	O muteli	O crenata	O cernua	O cumana
Tomato								
Date first emergence	14 5 90	1st emerg	10 7 90	11 6 90	17 6 90	-	18 6 90	16 7 90
Broomrape count		10 7 90	1	many	many	0	41	0
per 1 m row		20 7 90	4	many	many	0	63	0
		30 7 90	7	many	many	0	69	0 2
		6 8 90	6	many	many	0	many	0 06
Crop condition		6 8 90	4 5	1	2 5	5	2	5
Yield kg/2plots			131	15	36	137	53	107
Eggplant								
Date first emergence	14 5 90	1st emerg	29 6 90	13 6 90	17 6 90	-	24 6 94	-
Broomrape count		10 7 90	0 3	many	many	0	1 6	0
per 1 m row		20 7 90	1 6	many	many	0	2 7	0
		30 7 90	2 6	many	many	0	2 9	0
		10 8 90	3 2	many	many	0	4	0
Crop condition		6 8 90	5	1	3	5	5	5
Yield kg/2 plots			8 16	0	6 5	86 4	85 5	83 5

Table 1 (continue)

	Plant/seed date	Observation date	Winter aegyptiaca	Summer aegyptiaca	O muteli	O crenata	O cernua	O cumana
Pepper								
Date first emergence	14 5 90	1st emerg	-	23 6 90	27 6 90	-	-	-
Broomrape count		10 7 90	0	many	2	0	0	0
per 1 m row		20 7 90	0	many	2 1	0	0	0
		30 7 90	0	many	2 4	0	0	0
		10 8 90	0	many	3 1	0	0	0
Crop condition		6 8 90	4	4	5	5	5	5
Yield kg/2 plots			31	42 6	40 8	36 4	46 1	36
Cucumber								
Date first emergence	15 5 90	1st emerg	-	-	5 7 90	-	-	-
Broomrape count		10 7 90	0	0	1 2	0	0	0
per 1 m row		30 7 90	0	0	1 2	0	0	0
		10 8 90	0	0	1 7	0	0	0
Crop condition		6 8 90	5	4 5	3 5	3 5	4	4
Yield kg/2 plots			75 5	98 4	77 5	74 9	84 3	62

Table 1 (continue)

	Plant/seed date	Observation date	Winter aegyptiaca	Summer aegyptiaca	O muteli	O crenata	O cernua	O cumana
Melon								
Date first emergence	14 5 90	1st emerg	-	5 7 90	5 7 90	-	-	-
Broomrape count		10 7 90	0	1	0 4	0	0	0
per 1 m row		30 7 90	0	9 6	10 7	0	0	0
		10 8 90	0	many	10 8	0	0	0
Crop condition		6 8 90	4 5	4 7	4 5	4 5	4 5	4 5
Yield kg/2 plots			90 5	118 8	56 3	71	80 2	79
Water melon								
Date first emerg	15 5 90	1st emerg	-	-	7	-	-	-
Broomrape count		10 7 90	0	many	4 9	0	0	0
per 1 m row		30 7 90	0	0	3 4	0	0	0
		10 8 90	0	0	4 0	0	0	0
Crop condition			5	5	5	4	5	4
Yield/2plots			111 3	136 6	75 8	60 9	77 1	70 9
Sunflower								
Date first emergence	14 5 90	1st emerg	-	22 6 90	5 7 90	7 7 90	-	16 6 90
Broomrape count		10 7 90	0	many	0 1	0 06	0	many
per 1 m row		30 7 90	0	many	2 7	0 7	0	many
		10 8 90	0	many	3 2	1 0	0	many
Crop condition		6 8 90	4	3	5	5	5	2
height (cm)		10 8 90	155	143	143	153	147	121
Head diameter (cm)			21	13	23	21	25	11

Table 1 (continue)

	Plant/seed date	Observation date	Winter aegyptiaca	Summer aegyptiaca	O muteli	O crenata	O cernua	O cumana
Peanuts								
Date first emerg	15 5 90	1st emerg	26 7 90	27 7 90	4 7 90	25 7 90	-	-
Broom count		10 7 90	0	many	4 9	0	0	0
per 1 m row		30 7 90	0 6	many	8 7	0 2	0	0
		10 8 90	0 7	many	9 4	3 2	0	0
		31 8 90	1 4	many	12 8	14 2	0	0
		16 9 90	0 5	many	10 8	11 5	0	0
Crop condition		16 9 90	3 5	2	3	4 5	4 5	5
Foliage wt /2 plots		16 9 90	47 9	16 3	29 1	40 5	46 5	58 9

Broomrape test plots - winter 1990-91

Materials and Methods

All plots were cleared from the remnants of the summer experiment by late September Irrigation and bed preparations were conducted during the first half of October 1990 Plots were ready for planting on the 21 of that month Plot size and experimental design were also as in previous experiments

The crops that were selected in this experiment will be tested the second time as already discussed earlier

They were as follows

Solanaceae

Tomato (Lycopersicon esculentum Mill) cv Na'ama

Eggplant (Solanum melongena L) cv classic

Pepper (Capsicum frutescens L) cv 1005

Potato (Solanum tuberosum L) cv Desiree

Cruciferae

Chinese cabbage (Brassica pekinensis [lour] Rupr) cv Spring A

Rape (Brassica napus) cv westar

Cauliflower (Brassica oleracea L) cv snowball

Papilonaceae·

Clover (Trifolium alexandrinum L) cv Carmel

Lentiles (Lens culinaris Medic) cv Chilean

Broadbean (Vicia faba L) cv California 23

Compositae

Lettuce (Lactuca sativa L) cv Li-Tal

Safflower (Carthamis tinctorius L) cv PI 262442

Linaceae

Flex (Linum usitatissimum L)

Planting and seeding was conducted as described previously (progress report #5 and dates are given in the table) Irrigation started with sprinklers and followed with drip irrigation after the emergence of the seeded crops Data was collected along the season according to the nature of each crop

Results and Discussion

Data are presented in Table 2

Solanaceae crops

The crops were planted on Oct 28 and were covered with polyethylen to form low tunnels

Potatoes, although belonging to the same family, were planted early february according to the usual agricultural practics Tomatoes proved to be the most sensitive crop to the various broomrape species, and under different environmental condition, this crop is parasitized by all species found in Israel

Eggplants were not parasitized by O crenata and not by O cumana under the present experimental condition, and neither was that observed in the previous experiments The least sensitive to broomrape parasitism was pepper The crop was only parasitized by the brunching broomrape and even the spikes of those were poorly developed and caused only minimal suffering to the pepper plants

Potatoes were only heavily parasitized by the "summer" strain of O aegyptiaca O muteli can also cause heavy damage to potatoes as was observed in several commercial fields

Cruciferae crops

Chinese cabbage, rape and cauliflower were parasitized by the brunching and not by the non-brunching broomrape species Least papilonaceae crops susceptible was the cauliflower Chinese cabbage and rape were severely retarded

The papilonaceae crops

Clover, lentiles and broadbeans are diverse in their response to broomrape parasitism Clover was only slightly affected by the brunching broomrapes None of the none brunching was observed to parasitize this crop However, O minor which belongs to the none brunching broomrapes (Section Osproleon) is recorded in the literature to parasitize clover The two other crops - lentiles and broadbeans- belonging to the papilonaceae family are very sensitive O crenata and resistant to O cumana and O cernua

Compositae

Lettuce was not parasitized by O cernua, cumana and aegyptiaca - "summer" strain None of the broomrapes seemed to cause major damage to the crop Most of the broomrape emerged relatively late when the crop was already well developed, a fact that may explain the minor damage inflicted to the host Although the "summer" strain of O aegyptiaca is one of the most virulent, it did not parasitize the lettuce in this experiment Safflower was not parasitized by O muteli which was somewhat a surprise The "winter" strain of O aegyptiaca was again, as in lettuce, more effective than the usually more agressive "summer" strains although both infected the host to a limited extent Safflower proved to be by far most sensitive to O crenata Great number of spikes emerged and the crop suffered major damage The emergence of a few O cernua spikes should be noticed

Flex

Flex was severely parasitized by the "summer" strain of O aegyptiaca About one month later, we observed emergence of a few O aegyptiaca plants of the "winter" strain

In a few instances, very specific relationship between host and parasite were demonstrated in the course of those experiments The different infections of the "winter" and "summer" strains in lettuce and flex are examples

Table 2 The extent and affect of several broomrape species parasitism of different crops

(Bet Dagan test plots - winter 1990-1991)

Crop	Plant/seed date	Observation date	"Winter" O aegyp	"Summer" O aegyp	Orob muteli	Orob crenata	Orob cernua	Orob cumana
Rape								
	7 12 90	1st emerg	16 2 91	3 2 91	14 2 91	-	-	-
Broomrape count		27 1 90	0	0	0	0	0	0
per 1 m row		7 3 91	1 6	4	3	0	0	0
		12 5 91	many	many	many	0	0	0
Yield Biomass/pl gr		3 5	249	287	303	1761	1565	1654
Cauliflower								
	28 10 90	1st emerg	15 1 91	10 1 91	1 2 91	-	-	-
Broomrape count		27 1 90	0 3	0 6	0	0	0	0
per host plant		7 3 91	0 6	3 2	0 05	0	0	0
Av head wt gr		3 4 91	1372	1040	1564	1665	1847	1292
Clover								
	26 10 90	1st emerg	26 2 91	26 2 91	1 3 91	-	-	-
Broomrape count		27 1 91	0	0	0	0	0	0
per 1 m row		7 3 91	4	0 2	2	0	0	0
crop condition		12 4 91	5	5	5	5	5	4
Biomass/m row gr			2000	789	2231	2751	2966	948

Table 2 (continue)

Crop	Plant/seed date	Observation date	"Winter" O aegyp	"Summer" O aegyp	Orob muteli	Orob crenata	Orob cernua	Orob cumana
Lentiles								
	11 11 90	1st emerg	24 1 91	18 1 91	21 7 91	25 2 91	-	-
Broomrape count		27 1 91	9	8	1	0	0	0
per 1m row		7 3 91	dead	many	many	dead	0	0
Yield Biomass (gr) m		7 3 91	0	315	445	0	2330	3015
row crop condition			1	2	3	1	5	5
Broadbean								
	1 11 90	1st emerg	3 1 91	4 1 91	20 1 91	11 1 91	-	-
Broomrape count		7 1 91	0 1	1 8	0	0	0	0
per 1 m row		27 1 91	10	18	1	4	0	0
		7 3 91	many	many	many	dead	0	0
Biomass gr/m row		5 4 91	0	0	0	0	4005	3135
Crop condition			1	1	1	1	5	5
Lettuce								
	28 10 90	1st emerg	12 1 91	-	14 1 91	3 2 91	-	-
Broomrape count		27 1 91	0 6	0	0 9	0	0	0
per lettuce head		7 3 91	2 4	0	5 7	1 8	0	0
Average wt/head (gr)		7 3 91	349	257	382	392	385	402

Table 2 (continue)

Crop	Plant/seed date	Observation date	"Winter" O aegyp	"Summer" O aegyp	Orob muteli	Orob crenata	Orob cernua	Orob cumana
Safflower								
	12 12 90	1st emerg	12 3 91	12 3 95	-	26 3 91	29 3 91	-
Broomrape count		27 1 91	0	0	0	0	0	0
1 m row		13 5 91	2 5	0 5	0	15	0 3	0
Crop condition		13 5 91	4	4 5	4	1	4	4
Flex								
	29 11 90	1st emerg	7 2 91	5 1 91	-	-	-	-
		7 1 91	0	2	0	0	0	0
Broomrape count		27 1 91	0	13	0	0	0	0
per 1 m row		7 3 91	5	many	0	0	0	0
		12 5 91	2	many	0	0	0	0
Biomass/7 m row		30 5 91	11320	0	10880	11480	12820	11320
Crop condition			5	1	5	5	5	5
Potato								
	1 2 91	1st emerg	15 3 91	22 4 91	18 4 91	-	4 5 91	-
Broomrape count		30 5 91	2 3	many	10	0	5	0
per 1 m row								
Crop condition		3 4 91	5	5	4 5	5	5	5

Control of Egyptian broomrape in Rape (Brassica spp.) with foliarly applied herbicides (Bet Dagan 1990-91)

There are rape cultivars belonging to the species Brassica napus that develop a sizeable biomass and were considered for forage production The rapes are known to be sensitive to parasitism by the branching broomrape species The cultivars tested in Israel for possible forage production are also, as the others, sensitive to the parasite Broomrape in animal fodder is of particular concern as thay may be one of the means of broomrape dispersal

Materials and Methods

The experiment was conducted in a highly infested field at Bet Dagan on raised beds, 2 m wide (center wheels) on which two rows of rape were planted Plots were 4 m long of which 2 m were finally harvested The cultivar Brassica napus 3-84742 was planted and irrigated on Nov 26, 1990 The herbicides were sprayed in a volum of 250 L/ha containing 0 1% surfactant Triton x-100 The first application was conducted on February 5 and the second on March 4, 1991 The experiment was designed in randomized blocks with four replications Final broomrape count and harvest of the foliage was performed on April 4, 1991

The compounds selected for this study belong to two groups, all known to have activity against broomrape and have systematic capability Chlorosulfuron, Ribenuron methyl, Triasulfuron and Rimsulfuron belong to the sulfonyl urea group Imazethapyr belong to the Imidazolinone group Glyphosate belongs to neither and is a compound by itself

Results and Discussion

Results are presented in Table 6

Most of the compounds showed activity against broomrape Weakest were Ribenusulfuron methyl and Rimsulfuron Imazethapyr, Chlorosulfuron and Triasulfuron were more active against the parasite but were also phytotoxic and caused significant reduction of foliage weight Glyphosate provided the most promising results

The plots sprayed with the compound yielded the highest weight of green material although it was not significantly different from the untreated control plots Broomrape control was not complet but yet significantly different from the untreated

Future work will continue with glyphosate testing a wider range of rates different numbers of applilcations and at different time intervals

Table 6 Effect of foliarly applied herbicides on foliage weight of rape plants and on Egyptian broomrape emergence

	grams a i/ha		Rape	Foliage	Broomrape
Compound	1st	2nd	plant/m	wt/m row	plants/m row
1 Glyphosate	36	50	10 0	7590 a [1)]	6 b
2 "	50	50	7 0	7370 a	5 7 b
3 Imazethapyr	20	40	10 0	1700 b	0 9 b
4 "	40	40	6 5	750 b	0 5 b
5 Chlorosulfuron	0 5	0 5	9 0	2150 b	1 2 b
6 "	0 5	1 0	7 0	1300 b	0 b
7 Ribenuron ethyl	0 5	0 5	9 5	2480 b	22 a
8 "	0 5	1 0	8 5	2210 b	19 a
9 Triasulfuron	0 5	0 5	7 5	1570 b	6 4 b
10 "	0 5	1 0	6 5	610 b	1 2 b
11 Rimsulfuron	0 5	0 5	7 5	5550 a	24 a
12 "	0 5	1 0	9 0	5990 a	13 ab
13 Control			10 0	6300 a	25 a

1 Along columns, values followed by the same letters, do not differ significantly (p = 05) according to SNK multiple range test

Broomrape control in tomatoes with foliarly applied sulfonyle-urea herbicides at low rates (Bet Dagan, Spring 1991)

This experiment is a continuation of previous year experiment in which no phytotoxic effect of several sulfonyl urea herbicides was observed
The compounds of this group are know to be effective against broomrape when applied on the foliage of carrots (progress report no 3)

Materials and Methods
The experiment was conducted in a broomrape infested field However we added some more Egyptian broomrape seeds under the rows to be planted
That is done by seeding a mixture of dry seeds and sand into a farrow using a planet Jr hand driven planting machine The field was first cultivated to a depth of 30 cm fertilized 1000 kg/ha of ammonium sulphate and 1000 kg/ha of super-phosphate Raised beds, 1 93 m wide, were prepared and the tomatoes were planted in two rows 80 cm apart and at a distance of 20 cm apart in the row The tomato cultivar M-82 used for processing was planted on April 30, 1991
Drip irrigation was used and usual plant protection measures were used The treatments are listed in Table 7 The herbicides were applied at a spray volum of 250 L/ha with 0 1% of surfactant Triton x-100 Each plot was 4 m long and 1 93 m wide First spray was applied on May 25 and the second on June 16, 1991 Experimental design was Randomized blocks with 5 replications

Results and Discussion
First broomrape attachment were discovered on the tomato roots on May 26, 1991 and first emergence occured on June 4, 1995 The data are presented in table 7 Counts of Egyptian broomrape is considerably more difficult than in the case of the "none" branching broomrapes Therefore, if infection exceeds 20 plants/m , counts are extremely inaccurate and we prefer to record "many" None of the herbicides had any effect on broomrape infection Knowing from other crops, (carrot, tobacco) that those compounds are phytotoxic to broomrape, we conclude that possibly the tomato plant degrades the sulfonyl urea compounds relatively rapidly

That might also explain the fact that the tomatoes themselves were resistant at least, to the rates uses

Table 7 Effect of foliarly applied herbicides on Egyptian broomrape parasitism on tomatoes (Bet Dagan-summer 1991)

Treatment			
Herbicides	gr a i/ha		Broomrape
	1st	2nd	counts/per plot
Chlorosulfuron	0 5	0 5	many
	1 0	1 0	many
Ribenuron Ethyl	0 5	0 5	many
	1 0	1 0	many
Triasulfuron	0 5	0 5	many
	1 0	1 0	many
Rimsulfuron	1 0	1 0	many
	5 0	5 0	many
0 + broomrape			many
0 - broomrape			1 8

Control of Sunflower broomrape with foliarly applied sulfonyl urea herbicides in sunflowers (Bet Dagan 1990)

The Sunflower broomrape (0 cumana wallr) is one of the major constrains of sunflower production in Israel It is spreading probably more rapidly throughout the country than any of the other broomrape species There are already a few areas where sunflowers are not grown any more due to infestation with the parasite

Materials and Methods

Sunflowers were planted in an infested field at Bet Dagan experiment station on June 22 1990 with the cultivar DI-3 A single spray was applied on July 28, 1990 namely 36 days after planting Spray volum was 250 l/ha + 0 1% surfactant Triton x-100 Plots were 5 m long and 1 m wide having one row of sunflowers plants

Experimental design - randomized block with four replications Broomrape count on the 5 middle plants was conducted Aug 22, 1990 Treatments listed in the table

Results and Discussion

In most treatments, mainly in the higher rates, signs of malformation could be seen

Data are presented in Table 8 The broomrape infestation in the field was extreemly variable as the range is suggesting In most cases, there were less broomrape spikes in the higher rates Only in the plots treated with 1 0 gr a i/ha chlorosulfuron the control was considerable

It is very difficult to obtain yield in isolated sunflowers experiments because of bird damage, and even more so, if the planting was done as late as in the present experiment

Table 8 Effect of foliarly applied sulfonyl urea herbicides on broomrape control in sunflowerse (Bet Dagan summer 1990)

Herbicide	Rate gr a i/ha	Broomrape plants/plot	Range
Chlorosulfuron	0 5	12 7	0-28
	1 0	1	0-4
Ribenuron methyl	0 5	18 2	0-47
	1 0	8 7	2-18
Triasulfuron	0 5	9 5	0-31
	1 0	4 2	0-7
Resulfuron	0 5	8 7	1-24
	1 0	8 0	1-20
Control	0	20 2	0-52

BROOMRAPE CONTROL IN CARROTS USING MECHANICALLY APPLIED TELONE II IN THE BET SHEAN VALLEY DURING 1990-1991

Materials and Methods

The experiments were conducted in a commercial field of Kibbutz Sde Eliyahu in the Bet Shean Valley

The soil medium heavy aluvial was heavily infested with O crenata Telone II was applied in two dates First application was conducted on September 23, 1990 and was planted with carrots on October 23, 1990 Second application was conducted on October 19 and was planted with carrots on November 27, 1990 Soil moisture was determined just prior to fumigation The two plantings were adjacent to each other in the same field

Each field was sprinkler irrigated to about 50 cm depth about one month prior to fumigation and a second lighter irrigation was given 10 days before fumigation Carrot cultivar was "Nanco" - a Nantes type The previous crop was potato Telone II was aplied mechanically using pressurized air as a driving force to inject the liquid compound into the soil Accurate calibration of the applicator was very difficult to achieve Altlhough two rates of 300 and 500 liters per hectar were initially planned, it finally ended up that in each application date we had two settings of the machine each of them applying a lower and a higher rate on half of field, and the data was analyzed as two experiments The experiments were as follows

First planting, first experiment, rates 0, 180, 310 L/ha
second experiment, rates 0, 260, 440 L/ha

Second planting, third experiment, rates 0, 290, 480 L/ha
fourth experiment, rates 0, 400, 670 L/ha

The Telone II treated plots were 70 m long and 1 75 m wide The applicator had 6 chanks, 25 cm apart Untreated (control) plots were 35 m long The applicator was immediately followed by a roler, and finally

the field was sprinkler irrigated with about 10 mm of rain to improve sealing of the upper Layer Soil moisture at the time of treatment was 21% (64% of field capacity) in the first planting date and 17 5% (54% of field capacity) in the second planting

Foliar sprays of glyphosate were applied as secondary treatments on the first planting (exp 1 and 2) The treatments consisted of a single spray of 30 gr/ha applied on Dec 6, 1990 and of two sprays applied on Dec 6 1990 (30 gr/ha) and Jan 2, 1991 (50 gr/ha) Each glyphosate treated subplot was 5 m long and 1 8 m wide

On the 30th of December 1990, we sampled 1 m length of row to determine the level of infection (Table 1) Sampling was done on carrots not previously treated with glyphosate Due to a communication failor, no further broomrape counts were performed in experimnet 1 and 2 of the first planting prior to harvest The experiments of the first planting were harvested on May 5 1991 The harvested plots were 1 m^2

Broomrape counts in the experiments of the second planting were conducted on the 29.5.91 and plots were harvested on 6 6 91

Carrot roots were graded Grade A - root longer than 12cm Grade B - root shorter than 12 cm

The experiments of the first planting were analyzed using a complete randomized split plot design with six replication The experiments of the second planting were analyzed using a complete randomized block design, also with six replications

Results and Discussion

First observation was conducted by digging out carrots in the field of the first planting on December 30, 1990, namely 68 days after planting At that stage, no broomrape emergence or stress on the carrot plants could be seen

The results are presented in Table 3

Table 3 Broomrape infection of carrots roots along 1 m of row [1]

Rate of Telone II L/ha	Broomrape on carrot roots		Size of broomrape plants		
	Infected	Uninfected	smaller 1 cm	larger 1 cm	fresh wt (gr)
0	53	24	122	23	53
180	44	31	76	6	29
260	24	57	47	3	17
310	11	63	19	1	9
440	7	84	9	0 5	4 4

1 Average of four replications

Already at this stage it was obvious that the crop was highly infected, and that the treatment drastically reduced the number of broomrape infections although did not control the pest completely
Experiment 1 and 2 of the first planting were harvested on 5 5 1991 and the data are presented in Table 4

Table 4 Effect of soil fumigation with Telone II (A) and foliar sprays with glyphosate (B) on the yield of carrot planted on October 23, 1990 Data represent 1 m^2

	Foliage	Roots-grade B		Root-Grade A	
Rate	weight(gr)	Number	weight	Number	weight (gr)
A Telone II (L/ha)					
Exp 1 - South beds					
0	820 c	53 c	1680 c	4 b	370 c
180	1260 b	85 b	2550 b	26 a	1760 b
310	1615 a	90 a	3110 a	38 a	2500 a
Exp 2 - North beds					
0	900 c	50 c	1740 b	6 c	560 c
260	1280 b	83 b	3100 a	19 b	1570 b
440	1540 a	95 a	3170 a	34 a	2460 a
B glyphosate (gr/ha)					
Exp 1 South beds					
0	1090 b	62 c	2180 b	19 a	1410 a
30	1270 a	76 b	2760 a	19 a	1560 a
30 + 50	1370 a	89 a	3070 a	21 a	1610 a
Exp 2 North beds					
0	1250 a	65 b	2170 b	20 a	1590 a
30	1230 a	77 a	2380 b	23 a	1580 a
30 + 50	1200 a	85 a	2730 a	24 a	1400 a

1) Values followed by the same letter do not differ significantly (p = 0.05) according to Duncan's Multiple range test

The experiments of the second planting were harvested on June 6 and Broomrape counts were done one week earlier The data are presented in Table 5

Table 5 Effect of soil fumigation with Telon II on the yield and broomrape incidence in carrots planted in November 27, 1990 Data represents 1 m^2

Rate	Foliage	Roots-Grade B		Root-Grade A		Broomrape
L/ha	weight(gr)	Number	weight(gr)	Number	weight(gr)	Number
Exp 3 - South beds						
0	2490 b	144 b	4270 b	0 b	0 b	102
290	3220 a	196 a	6750 a	29 a	2460 a	86
480	3730 a	219 a	7560 a	32 a	2580 a	47
Exp 4 - North beds						
0	1980 b	143 b	4070 b	0 c	0 c	115
400	3300 a	201 a	6200 a	27 b	2120 b	60
670	3690 a	220 a	6420 a	47 a	3260 a	52

Values followed by the same letters do not differe significantly (P = 05) according to Duncan's multiple range test

In all instances was the yield at the treated plots significantly higher than in the untreated and in most cases was the yield in the high rate significantly higher than in the lower rate of Telone It seems that the fumigant had also a positive effect on the crop stand That is probably a result of the fumigant suppressing or controlling effect on various detremental damping off pathogens or other so called "minor soilborne pathogens" In both the early and late plantings, even the highest rate of Telone did not result in complet broomrape control and that was the main significance in adding the glyphosate treatment Although we are unable to present data The glyphosate treat plots were mostly broomrape free This effect is of major importance as it avoids new broomrape seed formation and ensures the long term effect of the fumigant

As the rates of glyphosate are very low, the additional expense caused by this treatment is minor The use of glyphosate on Telone II treated fields is considerably more safe because the crop plants are more healthy and vigorous and thereby the margin of safety increases

It seems that soil fumigation with Telone II is promising for the

control of crenate broomrape which is one of major importance In the case of umbelliferae crops like carrot and celery, which are relatively tolerant to glyphosate, the combined treatment of Telone complemented with the herbicide seems to be a promising solution Broomrape control with Telone II need further study in order to determine the effectiveness of the fumigant on other economically important broomrapes, improve control, and reduce rates of application

FOLIARLY APPLIED IMAZETHAPYR FOR CRENATE BROOMRAPE CONTROL IN PEAS

Experiments of 1990-1991

1 Studies on possible residual effect of foliarly applied Imazethapyr, on peas for broomrape control on the following year crop

There are indication in the literature that Imazethapyr is a very stable compound resulting in residues in the soil The purpose of the present work was to verify those observations under the prevailing conditions and the rates of Imazetapir used in the experiment in Bet-Dagan in the previous year

Materials and Methods

The experiment was placed exactly on the same plots of last year experiment, the beds and the marks were kept By mid November 1990, each bed was deep cultivated, fertilized with 600 kg/ha of Ammonium sulphate and superphosphate and roto tilled

Three rows 30 cm apart of the wheat cultivar "Bet-Hashita", used as a test plant, were planted on each bed on November 20 The marks of the plots were returned to the same spots after the planting

During the growing season, the wheat was fertilized with nitrogen using 100 kg/ha of urea Weeds were controlled by a single application of the herbicide Puma at the rate of 1000 cc/ha and some late hand pulling

The experiment was harvested on June 12, 1991. Weight of 1000 seeds was determined by twice, sampling and weighing 100 seeds, from each plot

The experimental design did not change from the previous year pea experiment, namely complet randomized blocks with four replications

Results and Discussion

The results are presented in Table 9 and they indicate no significant difference in neither wheat yield per plot and weight of 1000 seeds indicating no residual effect of the Imazetapir treatments on peas the year before We assume that phytotoxic levels of Imazethapyr will not occur due the low rates required for broomrape control

Table 9 Effect of foliarly applied Imazethapyr on peas at different rates on wheat yield and weight of 1000 seeds grown the following year (Bet-Dagan 1990-91)

Imazethapyr treatments in peas rates gr/ha					Wheat yield	Weight of 1000
No	1st	2nd	3rd	surfac	gr/plot	seeds(gr)
1		10	10	-	2270 a	33 5 a
2		10	10	+	2530 a	33 9 a
3		20	20	-	2380 a	33 1 a
4		20	20	+	2250 a	33 4 a
5	20	20	20	+	2390 a	32 2 a
6		40	40	-	2500 a	33 0 a
7		40	40	+	2470 a	33 2 a
8	20	40	40	+	2210 a	33 9 a
9		80	80	-	2410 a	33 1 a
10		80	80	+	2450 a	33 9 a
11	Control				2580 a	34 1 a

1 1st spray = 8 2 90, 2nd spray - 22 2 90, 3rd spray - 15 3 90

2 Plots were 5 m long and all three rows were harvested

3 Along columns, values followed by the same letters, do not differe significantly (p = 05) according to Duncan's multiple range test

2 Field experiments at Yad Mordehai (1990-91)

Introduction

Previous year results clearly indicated that the rate of 10 gr/ha a i of Imazetapir applied twice was insufficient for broomrape control in peas All other rates tested showed considerable effectiveness The purpose of the present studies to verify last year results under commercial field conditions

Materials and Methods

Two experiments were conducted in the fields of Kibbutz Yad Mordehii located in the southern coastal plains of the country

2 1 First experiment was conducted in a commercial field on heavy loess soil

Peas (Pisum sativum L cv Puget) were planted on 4 12 90 The plots received three foliar sprays on 28 1 1991, 21 2 1991 and 11 3 1991 The herbicide was applied in a spray volume of about 250 L with 0 1% of surfactant Triton x-100, using a back-pak sprayer equipped with a 4-nussle (Tee-Jet 110015) boom

Plot size was 2 m wide and 8 m long Treatments are listed in Table 6 Plots of 3 m^2 were harvested on 8 4 1991, determining fresh weight of foliage and green peas The green peas were threshed mechanically using a special green pea threshing machine

The experiment was designed in randomized complet blocks with five replications

2 2 Second experiment was placed in a field that was heavily infested the year before The field was not part of a commercial field of peas but was planted especially on the farmers expense for the experiment

The experiment was planted on January 6, 1991 with the same cultivar of peas as the previous experiment (2 1) Plots were 12 m x 2 m in size Sprays were done as previously described Two sprays were performed on 25 2 91 and 20 3 91 testing rates listed in Table 7 The experiment was terminated on 21 4 91, by harvesting 3 m^2, determining weight of total foliage and green peas Broomrape spikes were also counted The experiment was designed in randomized complet blocks with four replicates

Results and Discussion

The results of the first experiment are presented in Table 10 It turned out that the experiment was located at a very low infested corner of the field (average of 2 spikes/m^2) Such a low infection can cause no measurable damage to the crop Therefore, the experiment was mostly a phytotoxicity study The results indicate no crop damage as a result of those treatments Also, the very few broomrape that probably have been present were controlled by the various treatments

Table 10 Effect of foliarly applied Imazethapyr on garden pea foliage and green peas yield and number of crenate broomrape spikes (Yad Mordehai-Algia 1990/91)

Treatments					Weight gr/m^2		Number
Spraying dates and rates gr/ha				Total	Total	Green	broomrapes
	Jan 28	Feb 21	Mar. 11	rate	foliage	peas	spikes/m
1	20	20	20	60	2600 a	470 a	0
2	20	20	40	80	2750 a	560 a	0
3	20	40	40	100	2490 a	480 a	0
4	40	40	40	120	2870 a	470 a	0
5	20	40	84	140	2630 a	520 a	0
6	40	40	84	160	2770 a	507 a	0
7	control.				2720 a	490 a	2

1 Values followed by the same letters do not differ significantly (P =0 05) according to Duncan's Multiple Range Test

The second experiment (Table 11) was conducted on a highly infested field causing devastating damage in a few of the control plots Results presented in Table 7

Table 11 Effect of foliarly applied Imazethapyr on total foliage and green pea yield and the number of crenate broomrape spikes (Yad- Mordehai, Bet Girga 1990/91)

	Spraying dates and rates gr/ha		Total rate	Weight gr/m		Number broomrape
	25 2	20 3	gr/ha a i	Total foliage	Green peas	spikes/m^2
1	20	20	40	2190 b	340 b	55 b
2	20	40	60	2170 b	390 b	26 bc
3	40	40	80	2540 ab	460 ab	7 c
4	40	80	120	3200 a	610 a	10 c
5	control			580 c	50 c	208 a

1 Values followed by the same letter do not differ significantly (p = 0 05) according to Duncan's multiple range test.

The results demonstrate the effectiveness of Imazethapir in controlling Crenate broomrape while causing no apparent damage to the crop, although we had no broomrape-free plots in this experiment for comparison

However, the results of the previous experiment demonstrated no phytotoxic effect of Imazethapyr to peas even at higher rates

The broomrape spikes that were counted in the treated plots at the day of harvest after removing the foliage, were very young and mostly just after emergence, while in the control plots the broomrape spikes were fully grown (Figure 3, south edge) or even advanced stage maturation or dry as a result of the host death (Figure 3, North edge) The results so far suggest that Imazethapyr has potential in broomrape control in peas having no detrimental residues in the soil and provided that no residues will be found in the green peas

Figure 1 Effect of foliarly applied Imazethapyr on the control of crenate broomrape in garden peas (Top - South edge, botton - North edge)