Novel and Sustainable Weed Management in Arid and Semi-Arid -Ecosystems, Rehovot, Israel, October 7-12, 2007

Local organizing and scientific committee:

- Rubin, Baruch - Chairman
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- Gressel, Jonathan
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- Yaacoby, Tuvia

Novel and Sustainable Weed Management in Arid and Semi-Arid -Ecosystems, Rehovot, Israel, October 7-12, 2007

Sponsors:

- The Hebrew University of Jerusalem
- The Faculty of Agricultural, Food and Environmental Sciences
- European Weed Research Society (EWRS)
- The Weed Science Society of Israel (WSSI)
- The Agricultural Research Organization (ARO)
- Israeli association of agrochemicals producers and importers
- Makhteshim Agan Industries Ltd.
- Israel Luxembourg Industries Ltd.
- Tarsis Ltd, Israel

Scientific Program

All conference sessions will take place in Ariowitsch Auditorium (on Rehovot campus).

Sunday, October 7

08:30-19:00 Arrival and registration at Reisfeld Residence

Registration desk will be open throughout the day.

09:15-16:45 Statistical Analysis Course by Prof. J. C. Streibig, EWRS Education and Training Working Group "Nonlinear regression problems in weed science with the free software R"

Course will take place in Computer Room 16 - Aaronsohn Building.

12:00-18:00 Poster mounting

19:00- Welcome Reception

Monday, October 8

Opening session

07:30-08:30 Registration at Ariowitsch Auditorium

Moderator: B. Rubin

08:30-09:00 Welcome address:

Prof. B. Rubin, Chairman of the Organizing Committee

Prof. E. Feinerman, Dean of the Faculty of Agricultural, Food and Environmental Sciences, The Hebrew University of Jerusalem, Rehovot

Dr. M. Quadranti, President of EWRS. Research and development in weed control: challenges and opportunities.

09:00-09:30	**(1) Keynote lecture**: Potential biotech solutions for intractable weed problems in our arid and semi-arid ecosystems, **J. Gressel**, Weizmann Institute of Science, Israel.

Biotechnology and Molecular Biology in Weed Science

	Moderators J. Gressel and B. Rubin
09:30-10:00	**(2)** Transgenic herbicide-resistant crops and their impact of on weeds and the environment, B. Rubin
10:00-10:30	*Coffee break*
10:30-10:50	**(3)** Transgenic mitigation to reduce risks of transgene flow from engineered crops into related weeds and other crop cultivars, H. Al-Ahmad and J. Gressel
10:50-11:10	**(4)** Inter–generic introgression from domesticated wheat (*Triticum aestivum*) to related wild and weedy species and ways to prevent it, S. Weissmann, M. Feldman and J. Gressel
11:10-11:20	Discussion

Application methods and formulations

	Moderators: Y. Mishael and A. Gamliel
11:20-11:40	**(5)** Exploiting clay/organic-molecules interactions for the preparation of enhanced herbicide formulations, G. Rytwo
11:40-12:00	**(6)** Controlled release herbicide formulations based on modified clay minerals, Y. Mishael, Y. El-Nahhal, D. Ziv, A. Radian, S. Nir and B. Rubin (Invited)
12:00-12:20	**(7)** Application of new modified organo-clay formulations of alachlor and sulfosulfuron in the field, O. Rabinovitz, Y. Mishael, S. Nir, C. Serban and B. Rubin

12:20-12:40 **(8)** Alternative weed control methods in LPS drip-irrigated crops, S. Kleifeld

12:40-12:50 Discussion

13:00-14:30 *Lunch at the Faculty Restaurant*

Herbicide behavior in soils: bio-remediation and methyl bromide alternatives

Moderators: E. Capri, Z. Gerstl and U. Mingelgrin

14:30-14:50 **(9)** Current status of 1,3 D and other M.B. alternatives in E.U., P. Tsakonas and J. Dawson (Invited)

14:50-15:10 **(10)** Fumigant risk assessment in Europe. The case of sulfuryl fluoride, O. J. Magrans (Invited)

15:10-15:30 **(11)** Environmental impact indicators for herbicides: aggregation from field to country, S. Vergucht and W. Steurbaut (Invited)

15:30-15:50 **(12)** Modelling complex crop rotations in a GIS based risk assessment, M. Balderacchi and M. Trevisan (Invited)

15:50-16:10 **(13)** Phytoremediation of atrazine-polluted water with *Pistia stratiotes*, C. Del-Campo, B. Rubin and E. Tel-Or

16:10-16:20 Discussion

16:20-16:50 *Coffee break*

Weed management in arid and semi arid farming systems: dry-land crops, irrigated crops and site specific weed management

Moderators: H. Eizenberg and Y. Goldwasser

16:50-17:20 **(14)** Optical methods for weed detection for site specific weed management, V. Alhanatis (Invited)

17:20-17:40	**(15)** Development of integrated approach for weed detection in cotton, for site specific weed management, R. Efron, V. Alchanatis, Y. Cohen, A. Levi, H. Eizenberg, Z. Yehuda and U. Shani
17:40-18:00	**(16)** Site specific weed management application in Israel: from satellite to the field - an overview, S. Mey-Tal
18:00-18:20	**(17)** Evaluation of herbicides for selective weed control in grafted watermelons, R. Cohen, H. Eizenberg, M. Edelstien, C. Horev, T. Lande, A. Porat, G. Achdari and J. Hershenhorn
18:20-18:40	**(18)** The vegetation management in the archaeological site of Eleusis, M. Papafotiou , I. Kanellou and G. Economo
18:40-19:00	**(19)** Integrated weed management in cotton in India, S. Singh and S. S. Punia
19:00-19:10	Discussion
20:00	Graduate Students Evening: Visit to Tel-Aviv/Jaffa.

Tuesday, October 9

	Moderator: H. Eizenberg
08:30-09:15	**(20) Keynote lecture:** Status on physical and cultural weed control methods for field crops in Europe, **B. Melander**, Faculty of Agricultural Science, Denmark

Bio-control, organic farming and allelopathy in weed management

	Moderators: B. Melander and J. Hershenhorn
09:15-09:45	**(21)** Potential use of essential oils as bio-herbicides: ecology, physiology and agro-technology aspects, N. Dudai (Invited)

09:45-10:05	**(22)** Three years of evaluation of mulch materials for weed control in tomato, A. Cirujeda, J. Aibar J, A. Anzalone, M. León and C. Zaragoza
10:05-10:35	*Coffee break*
10:35-10:55	**(23)** Cover crops for weed suppression in orchards, J. Abrahams and Y. Goldwasser
10:55-11:15	**(24)** Weed infestation and water availability for summer crops following winter cover crops in organic farming, S. Shahal, Y. Saranga, M. Sibony and B. Rubin
11:15-11:35	**(25)** Enhancing mycoherbicide activity, S. Meir, Y. Hershkovitz, C. Larroche, H. Al-Ahmad, Z. Amsellem and J. Gressel
11:35-11:55	**(26)** A mobile field robot for weed control in maize crops, A. Cirujeda, D. Abadía, J. Peña, S. González, T.Seco, J. Aibar, J. Paniagua and C. Zaragoza
11:55-12:05	Discussion

Meetings of EWRS Working Groups

12:10-12:35	Parasitic weeds
12:35-13:00	Weed management in arid and semi-arid climate
13:00-14:30	*Lunch at the Faculty Restaurant*

Invasive weeds: biology, control and quarantine regulations

Weed biology, ecology and modeling

Moderators: S. Brunel, T. Yaacoby and J. Kigel

14:30-15:00	**(27)** EPPO Pest Risk Analysis of *Solanum elaeagnifolium* and international management measure proposed, S. Brunel (Invited)

15:00 -15:20	**(28)** Crownbeard (*Verbesina encelioides*) physiology, geographical distribution and response to herbicides in Israel, R. Sade, T. Yaacoby and B. Rubin
15:20 -15:40	**(29)** Invasive alien species (IAS) current situation in Israel, T. Yaacoby
15:40-16:10	**(30)** Weed biology between old knowledge and new challenges, M. Sattin (Invited)
16:10-17:00	*Coffee break and poster viewing*
17:00-17:30	*Poster discussion:* **Moderator***:* Y. Goldwasser
17:30-18:00	**(31)** A hydrothermal model of weed seed germination using *Bromus tectorum* L., P. S. Allen and S E. Meyer (Invited)
18:00-18:20	**(32)** Reducing the persistent seedbank of plant invader-*Acacia saligna*, application and implication. O. Cohen, J. Riov, J. Katan, A. Gamliel and P. Bar (Kutiel)
18:20-18:40	**(33)** Invasion and integrated management of *Lantana camara* L. under agroclimatic conditions of Eritrea and India, N. N. Angiras.
18:40-18:50	Discussion
18:50-19:00	*Instructions and information regarding the field trip*

Wednesday, October 10

Full day field trip

06:30	Departure from Reisfeld Residence
	Hi tech agriculture in the Arava Valley
	Swimming at the Dead Sea
	Breakfast and Lunch will be provided.
19:00	Hebrew University of Jerusalem's Mt. Scopus campus; Dinner in restaurant overlooking the Old City of Jerusalem

Thursday, October 11

Moderator: T. Yaacoby

08:30-09:15	**(34) Keynote lecture:** Strigolactones: chemistry, biological activities, distribution in the plant kingdom, and regulation of production by plant nutrients, **K. Yoneyama**, Utsunomiya University, Japan

Parasitic weeds

Moderators: M. Vurro and D. M. Joel

09:15-09:35	**(35)** Integrated *Striga* spp. weed management under smallholder agriculture, F. Kanampiu (Invited)
09:35-09:55	**(36)** *Orobanche* spp. distribution in Greece: host range, biogeography, inter- and intra- specific variability, G. Economou, D. Lyra and F. Triantos
09:55-10:15	**(37)** Broomrapes *(Orobanche* spp.*)*: new threat to tomato, linseed and pulse crops production in Tigray region, northern Ethiopia, T. Araya and K. Meles
10:15-10:30	**(38)** Parasitic plant *Orobanche palaestina* Reut. as a potential threat to agriculture in Israel, E. Dor, H. Eizenberg, D. M. Joel, T. Lande, G. Achdari, E. Smirnov and J. Hershenhorn
1030-11:00	*Coffee break*
11:00-11:20	**(39)** Drip irrigation to improve biological control of broomrapes, M. Vurro and A. Boari
11:20-11:40	**(40)** PIKEET: A new Decision Support System for *Orobanche aegyptiaca* control in tomato, H. Eizenberg, T. Lande, G. Achdari, S. Bringher, I. Smirenov and J. Hershenhorn (Invited)
11:40-1200	**(41)** Struggling towards an effective biological control of broomrape, J. Hershenhorn

12:00-12:20	**(42)** The study of genetic aspects in parasitic weeds of the genus *Orobanche,* D. Plakhine, Y. Tadmor, I. Levin and D. M. Joel
12:20-12:40	**(43)** Parasitic weeds their potential threat to crop production and management in north-eastern region of Nigeria, N. Gworgwor
12:40-12:50	Discussion
13:00-14:30	*Lunch at the Faculty Restaurant*

Herbicide resistant weeds and crops

	Moderators: A. Fischer and M. Sibony
14:30-15:00	**(44)** A technical review and management recommendations concerning glyphosate-resistant weeds, R. Garnett, N. Mülleder, M. Obermeier-Starke and M-P. Plancke (Invited)
15:00-15:20	**(45)** Glyphosate-resistant johnsongrass (*Sorghum halepense*) in Argentina: Current status and collaborative action for its prevention and management, B. E. Valverde, J. Gressel, S. Passalacqua, J. C. Rodríguez and A. Fischer (Invited)
15:20-15:40	**(46)** Response of glyphosate-resistant (Roundup Ready®) crops to glyphosate, H. Yasuor, J. Riov and B. Rubin
15:40-16:00	**(47)** Glyphosate-resistant crops as a tool for the management of troublesome weeds, G. Tsuk, H. Yasuor, M. Sibony and B. Rubin
16:00-16:30	*Coffee break*
16:30-17:00	**(48)** Metabolic herbicide resistance evolution: Late watergrass (*Echinochloa phyllopogon*), a case study, A. Fischer and H. Yasuor (Invited)
17:00-17:20	**(49)** Triazinone-resistant *Chenopodium album* due to two different *psbA* mutations, E. Mechant, T. De Marez, O. Hermann, R. Olssen and R. Bulcke

17:20-17:40	**(50)** Elucidation of the molecular bases for the resistance to ACCase inhibiting herbicides in grass weeds, O. Hochberg, M. Sibony, A. Tal and B. Rubin
17:40-18:00	**(51)** Current status of herbicide resistance in *Phalaris minor* and management strategies in rice-wheat cropping systems in India, A. Kumar and R. K. Malik
18:00-18:20	**(52)** Herbicide resistance evolution and management in Central and Southern Italy, A. Collavo, G. Pignata, L. Scarabel, A. Frezza and M. Sattin
18:20-18:30	Discussion
18:30-18:45	Conference discussion
19:30	Closing ceremony, banquet, and traditional folklore show

Posters

(53) The success or failure of soil solarization in weed control – a review, O. Cohen and B. Rubin

(54) First results on chemical weed control in olive oil orchard of southern Italy optimizing the use of flazasulfuron, M. Fracchiolla, C. Lasorella, D. Caramia and M. Montemurro.

(55) The role of water resources management in weed control- a case study of cotton crop in greece, G. Economou, V. Kotoulas, V. Vlachos, I. Travlos and A. Karamanos

(56) Factors affecting the efficacy of *Orobanche cumana* control in sunflower, J. Ephrath, J. Hershenhorn and H. Eizenberg.

(57) Effect of glyphosate on *Orobanche aegyptiaca* parasitism in tomato (*Lycopersicon esculentum* Mill.), T. Araya, M. Sibony and B. Rubin

(58) Differences in sensitivity to glyphosate of common weeds in maize in temperate zone, J. Soukup, K. Nováková, P. Hamouz, and M. Jursík

(59) Fat-hen (*Chenopodium album* L.) resistant to metamitron: monitoring methods, T. De-Marez, E. Mechant, O. Hermann, R. Olssen and R. Bulcke

(60) Clay-polycation composites as bases for imazapyr controlled release formulations, A. Radian and Y. Mishael

(61) Herbicide Controlled Release Formulations based on Solubilization in Micelles Adsorbed on Clay, D. Ziv and Y. Mishael

(62) Controlled release of Bromoxynil: Influence of pH., Y. El-Nahhal

(63) *Solanum eleagnifolium*, a serious threat for the Greek agroecosystems, E. Kotoula-Syka

(64) The influence of soil type and nutrition intensity to herbicides breakdown, Š. Tóth, M. Danilovič, A. Sústriková, A. Pavlišinová

(65) The influence of bacterial preparates to herbicides breakdown, S. Tóth, M. Danilovič, A. Sústriková, A. Pavlišinová

(66) Factors effecting bromoxynil application in sweet corn (*Zea mays*), O. Stern, B. Rubin B, J. Hershenhorn, E. Dor and H. Eizenberg

(67) The side-looking spectral signature of Maize (*Zea mays*); a preliminary study, R. Aviram.

(68) Field dodder extracts obtain significant antioxidant activity, A. I. Jusupova and M. K. Murzakhmetova

(69) The influence of different agro-technics to herbicides breakdown, M. Danilovič, S. Tóth and M. Pešta

(70) Weed dispersal in wheat fields by sheep stubble grazing, I. Schoenbaum, J. Kigel, S. Landau and D. Barkai

(71) Effect of herbicides on different categories of weeds in Japanese mint (*Mentha arvensis*) in eastern India, R. C. Samui and D. Debtanu

(72) Rotation: a key factor in weed management in Israeli semi-arid and arid wheat fields. I. Mufradi, D. J. Bonfil1, S. Asido and B. Rubin.

ABSTRACTS

(1) Potential biotech solutions for intractable weed problems in our arid and semi-arid ecosystems

Gressel J

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As the center of origin of many of the worlds' crops and weeds, with great biodiversity, it is now the home of some of the most intractable weed problems that have no simple chemical solutions. The advent of graminicides for wheat have allowed many closely related weeds to remain uncontrolled and become major problems, whether by evolving resistance (*Lolium* and *Phalaris* spp.) or by replacing eliminated weeds, by being naturally resistant (*Aegilops*, *Bromus* spp.). Spain and Italy pioneered direct seeding in rice only to have feral forms become uncontrollable weeds. Sorghum has its feral form shattercane as a major weed, and feral sunflowers and beets have also become problematic. Transgenic herbicide resistant wheat, rice, sorghum, sunflower, and beets would be solutions, but failsafe mechanisms must be instituted to prevent transgene flow to the relatives. The parasitic weeds that plague us can be controlled by transgenic herbicide target site resistances to systemic herbicides. Micro-RNAi constructs are being tested, as well as transgenically enhanced biocontrol agents. *Sorghum halepense* and *Conyza* spp. have evolved "phoenix"-type resistance to the systemic herbicides that penetrated to rhizomes and hidden buds (by regrowing from the burnt down plant), seemingly by preventing herbicide transmission to those buds. Infecting these weeds with disarmed viruses containing transgenes against vegetative storage protein production (RNAi) or with genes restoring the herbicide translocation system could allow herbicides to deal with those weeds. Thus, imaginative biotech solutions could be found for our most intractable problems.

Key words: Transgenic resistance, transgenic biocontrol, *Lolium, Phalaris, Aegilops, Sorghum, Bromus, Oryza*, *Conyza* weeds

(2) Transgenic herbicide-resistant crops and their impact of on weeds and the environment

Rubin B

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The main genetically modified herbicide resistant crops (HRC), soybean, corn, cotton and oil seed rape are currently cultivated on more than 100 million ha throughout the world. There are mainly two approaches in production of HRC: the first is based on enhanced detoxification of the phytotoxic compound to non-herbicidal products such as nitrilase in bromoxynil-resistant cotton, phosphinothricin acetyl transferase (PAT) in various "Liberty" crops, N-acetylase that acetylates glyphosate in corn and other crops and monooxyganse that inactivates dicamba in soybeans. The other approach mainly used in glyphosate-resistant crops (GRC) is based on expression of an insensitive form of the target site - enolpyruvyl-shikimate-phosphate synthase (EPSPS). The adoption of GRC resulted in significant changes in agronomic and weed management practices, along with changes in the spectrum and amount of herbicide use. GRC offer the farmer a cost-effective way to manage weeds including troublesome weeds in irrigated and in arable crops including in reduced- or zero-tillage fields. However, the extended use of glyphosate resulted in a clear shift of the weed population toward more 'naturally-tolerant' weeds and the evolution of a large number of glyphosate-resistant weed (GRW) populations. GRW populations were confirmed in Australia, Asia, the Americas and Africa in grass and broad leaf weeds. In spite of the low level of resistance, the phenomenon poses a real threat to the environment and to the sustainability of numerous cropping systems worldwide. The expected increase in the adoption of HRC, and particularly of GRC throughout the world calls for caution and requires the development and adoption of preventive management practices.

Key words: Glyphosate, resistance, troublesome weeds

(3) Transgenic Mitigation to Reduce Risks of Transgene Flow from Engineered Crops into Related Weeds and other Crop Cultivars

Al-Ahmad H[1,2] and Gressel J[1]

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There is a growing concern of transgene flow from engineered crops into related weeds and crop cultivars. Containing transgenes within crops is not absolute and thus their risky effects should be mitigated once escaped. In tansgenic mitigation (TM) technology, mitigator genes that lower transgenic hybrids fitness are tandemly linked to primary transgene(s) (e.g. herbicide resistance, pharmaceutical trait, etc.). TM genes are neutral or positive to crops, conferring traits such as dwarfism, no secondary dormancy, non-shattering of seedpods, etc. The TM concept was tested in *Nicotiana tabacum*, and *Brassica napus* that may remain in fields as volunteer weeds and still can interbreed with nearby weedy *B. rapa*. Both TM crops were engineered with *ahas*^{R} conferring herbicide-resistance in tandem with Δ*gai* for dwarfism. The risk of transgene establishment in transgenic volunteer or intraspecific hybrids was effectively reduced at different levels of competition, at the close spacing typical of weed populations, under greenhouse and screen-house conditions. The yield of transgenic monocultures was significantly higher than the corresponding wild type of both crops due to the increased harvest index conferred by dwarfism. The yield of TM *B. napus* was nearly double the wild type when growing by itself. Conversely, TM hybrids with wild type *B. napus* or with weedy *B. rapa* were unfit to reproduce well when interspersed with tall non-transgenic cohorts. Their fitness based on seed yield relative to non-transgenics was between zero and 11%, demonstrating the advantage of TM technology to minimize risks of transgene establishment and spread, while increasing crop yield.

Key words: Transgenic mitigation, transgene flow, dwarfism, *Brassica napus*, tobacco.

(4) Inter–generic introgression from domesticated wheat (*Triticum aestivum*) to related wild and weedy species and ways to prevent it

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Genetic engineering is a powerful technology that could allow the insertion of useful genes into wheat, such as transgenes for resistance to non-wheat selective graminicides that do not have a propensity for evolved resistance. e.g. genes conferring resistance to protox inhibitors and chloroacetamides. We found that genes can spontaneously escape from wheat into the dissimilar (homoeologous) genomes of related weedy or wild species of the tribe Triticeae, and establish in the wild. Crop transgenes introgressed into wild relatives might increase the capability of wild relatives to adapt to agricultural environments and compete with crops. Contrary to contemporary thought, DNA introgression through recombination rarely occurs in F_1 hybrids between wheat and its relatives due to the *Ph*1 gene on wheat chromosome arm 5BL, which prevents homoeologous pairing to non-homologous chromosomes. The wild/weedy species recombination occurs during backcrossing after 5BL (and *Ph*1) elimination. We propose two methods to prevent transgene establishment: 1. Link the transgene in proximity to *Ph*1, such that when 5BL is eliminated in backcrossing, so is the transgene; 2. Randomly insert the transgene in tandem with lethal *barnase*, in wheat plants where *barstar*, which suppresses *barnase* is already on 5BL near *Ph*1. *Ph*1 in backcross plants containing 5BL will prevent the homoeologous establishment in the wild of *barnase* coupled to the desired transgene. 5BL itself will be eliminated during repeated backcrossing to the wild parent, and progeny bearing the desired transgene-*barnase* without the *Ph*1-*barstar* complex die. The two interrelated mechanisms described should be effective in preventing wheat gene establishment in wild species with homoeologous genomes.

Key words: Transgenic wheat, *Ph1*, prevention of transgene establishment

(5) Exploiting Clay/Organic-Molecules Interactions for the Preparation of Enhanced Herbicide Formulations

Rytwo G

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The lecture will review clay/organic-molecules interactions, and focus on possible applications. Knowledge and understanding of such interactions might be helpful for the preparation of herbicide formulations. For some herbicides, by *binding* them to a suitable organo-clay based platform, enhanced activity might be observed due to reduced decomposition and/or leaching or evaporating. A somehow opposite application is based on *minimizing the binding* of contact herbicides to soil clay-sized particles, and by that- avoiding deactivation. In both cases- lower application rates might be achieved, even though the improvement results from completely different behavior caused by very similar clay-organic interactions. Organo-clay/herbicide formulations that exploit the first mechanism are based on three elements: (a) The substrate- a clay mineral that due to mineralogical structure offers binding sites available to molecules (b) The organic molecule bound to the clay- the additive: Usually, an organic cation with a hydrophobic moiety, in order to increase the affinity of the herbicide to the organo-clay. (c) The pesticide: an organic molecule that has a biocidal effect, whose function is to improve the quality or yield of the crop where it is applied. In all the formulations developed, the rationale is to lower the amounts of applied *hazardous* chemicals. This is achieved either by reducing migration of the pesticide to non-target size, or by avoiding its decomposition via biological, physical or environmental influences. The second mechanism, used in order to avoid deactivation might be achieved by addition of chemicals that successfully compete with the pesticide on the adsorption to non-target particles. Examples of both mechanisms will be presented.

Key words: Clay-organic interaction, organoclays, herbicide, formulation.

(6) Controlled Release Herbicide Formulations Based on Modified Clay Minerals

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Herbicide controlled release formulations (CRFs) are designed to reduce undesired herbicide leaching and increase herbicide concentration at the top of the soil for improved herbicidal activity. The past decade we have designed a variety of CRFs based on modified clay-minerals. The first formulations designed were for hydrophobic herbicides such as alachlor, metolachlor and achetochlor. The clay (montmorillonite) surface was modified from hydrophilic to hydrophobic by adsorbing small organic cations (organo-clays). Bioassays in soil columns and field experiments demonstrated reduced herbicide leaching and enhanced herbicidal activity when applying the CRFs. Sulfonylurea herbicides pose a serious problem since their solubility is high which increases their mobility in the soil. The CRFs designed for sulfometuron, sulfosulfuron and sulfentrazone were based on binding the herbicides both electrostaticly and by solubilization to cationic micelles adsorbed on montmorillonite. A bioassay in soil columns showed that these CRFs reduced herbicide leaching by 2-5 folds while increasing activity at the top of the soil. Recently we have developed micelle-clay CRFs for metolachlor with a high percent of active ingredient (higher than the organo-clay ones). Currently we are focusing on developing novel CRFs based on polycation-clay composites. CRFs of imazapyr were designed by binding it to polydimethyl-diallylammonium-montmorillonite composites. Imazapyr release from these formulations was tested and compared to the commercial formulation by applying the formulations to thin soil layers and on soil columns. IMP release from the CRFs was substantially slower than its release from the commercial formulation and the soil column experiment demonstrated reduced herbicide leaching when applying the CRFs.

Key words: Controlled release formulations, modified clays, reduced leaching

(7) Application of new modified organo-clay formulations of alachlor and sulfosulfuron in the field

Rabinovitz O[1], Mishael Y[2], Nir S[2], Serban C[2] and Rubin B[1]

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Herbicide movement and leaching from application sites to non-target areas, such as water reservoirs, streams, ground water, and neighboring fields is one of the main environmental concerns. Reducing herbicide leaching can be achieved by designing clay-based formulations. Recently, two different strategies were developed for the design of slow release formulations based on adsorption of herbicides on natural or modified clay-minerals. The hydrophobic herbicide alachlor was adsorbed on a clay-mineral whose surface was modified from hydrophilic to hydrophobic by preadsorbing it with an organic cation. The anionic herbicide sulfosulfuron was adsorbed on the clay-mineral by prebinding it to micelles of the organic cation octadecyltrimethylammonium (ODTMA), and the micelles were adsorbed on the clay- mineral. The aim of this study was to test the behavior of the new formulations under field conditions. New formulations of alachlor and sulfosulfuron were tested for commercial crops, forage corn and processed tomatoes (respectively). The field experiment was conducted in mineral soil. There was no phytotoxicity of the new formulation of sulfosulfuron after applying 37.5 g ha^{-1} post planting in tomatoes. Both the commercial formulation (Monitor®) and the new formulation inhibited similarly the growth of weeds and the foxtail test plants. The new formulation of alachlor (1000 g ha^{-1}) which was applied pre-planting at a reduced rate inhibited the growth of foxtail and weeds, the same way as the commercial formulation (Alanex®) applied at a double rate. Both formulations did not show any phytotoxicity to the crop plants.

Key words: Organo – clay formulation, Reduce leaching

(8) Alternative weed control methods in LPS drip-irrigated crops

Kleifeld Y

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Using drip irrigation in arid and semi-arid area enables high crop production at low water consumption and effective fertilization. Recently developed Low Pressure System (LPS) solved the obstacle in getting full stands of direct seeded crops and successful taking roots of young transplants. Using selective residual herbicides in drip-irrigated crops is limited at pre-planting and pre-emergence by the need of herbicide activation by a following rain or sprinkler irrigation. In many cases the change to drip irrigation after the activation results in a quick decrease in herbicidal activity as a result of pushing it from the dripper zone and on the other hand remaining of toxic herbicide residues in the dry soil zones after crop harvest. In recent field experiments we achieved efficient weed control by selective herbicide applied pre-planting, mixed in the upper soil layer by shallow mechanical incorporation and irrigated by LPS drip irrigation only. The mechanical incorporation was done on leveled beds, using a power driven incorporator to a depth of 4-6 cm, pre-planting ground nuts, 5 or 10 cm preplanting paprika and on ridges using a "Lilyston harrow" to a depth of 2-4 cm post-planting potatoes or pre-planting sweet potato. In all cases the fields were irrigated by LPS drip irrigation only and no rain fell during the growing season. Crop stand in both experiments was full, plants developed vigorously and yields were above the local accepted means.

Key words: Drip-irrigation, herbicide application, residual herbicides.

(9) Current status of 1, 3 D and other Methyl Bromide alternatives in E.U.

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The international project to replace M.B. by another method / product is a multi year effort and involved hundreds of scientists and products globally. The outcome of this significant effort is that valid / ready to use alternatives have been identified and commercial use of these options is a fact. One of the most important options is 1,3D and it's combinations with other chemicals (chloropicrin) or methods (solarization). These combinations in parallel with other old and some new products had a significant effect in reducing the critical use exceptions requested by the member states (from 5,000 tons in 05 to 500 tons in 07). However, these molecules had to go through the EU Annex 1 process and 1,3D was the first fumigant, with others following (expected decision in 2008). The recent decision for non inclusion raises strong concerns from the consumers and the various stakeholders involved in the effort to establish alternatives to MB. Trying to address these needs the Annex 1 decision clarified that the product will be available until March 2009 with a possible extension until September 2010. Additionally and most important, Dow AgroSciences is committed to follow an aggressive resubmission process with the objective to achieve Annex 1 inclusion before these timelines expire.

Key words: 1,3 D, methyl bromide alternatives, Annex 1.

(10) Fumigants risk assessment in Europe

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Directive 91/414/EEC establishes a harmonized procedure to authorize active ingredients of plant protection products marketed and used in the European Union. Safety of all active ingredients needs to be evaluated with respect to the human and animal health and environmental effects. In January 2002 the European Food Safety Authority (EFSA) was set as an independent source of scientific advice and communication on risks associated with the food chain. EFSA ensures a risk assessment independent of risk management. Since its foundations, EFSA is responsible of the EU peer review of active substances used in plant protection products. This task is carried out, in cooperation with EU Member States, by the Pesticides Risk Assessment Peer Review Unit (PRAPeR) in line with procedures and deadlines set by the European legislation. The current status of the EU Peer Review of proposed alternatives of MeBr is outlined with special emphasis to the soil fumigant alternatives. Specific issues identified during the EU risk assessment for some of the substances are examined. Envisaged time frame for the completion of the EU process is also given.

Key words: Methyl bromide alternatives, directive 91/414/EEC, soil fumigants

(11) Environmental impact indicators for herbicides: aggregation from field to country

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PRIBEL (Pesticide Risk Indicator for BELgium) is a multi-impact indicator created at Ghent University which evaluates the agricultural pesticide impact for five environmental modules: surface water (aquatic organisms), ground water, earthworms, birds and bees. It follows a new approach of the risks linked to pesticides because it balances each individual risk of pesticide use by the number of risk events (frequency of use). Each risk value obtained by modelling is associated with a risk event which corresponds to a unitary time and area in which an environmental compartment is exposed to a pesticide, and for which only one hazard is envisaged. In a given region or time period, the number of risk events can be counted and is denominated as risk frequency. Two aggregation methods are applied: the total risk or impact and the weighted median risk. The impact is the result of multiplying the risk index of each application by the frequency of use. The sum of these multiplications RI*F gives an estimation for one year of the total risk for Belgium, for a specific pesticide group or crop group. The weighted median risk is calculated as the weighted 50th percentile of the risk indices having the frequency of use as weight. The aggregation from field to country provides a description of general tendencies in agricultural pesticide impact for the environment and affords risk managers to gain a better perception of the bottlenecks of pesticide usage in specific crops and hence to tackle particular problems in an efficient way.

Key words: Impact indicators, herbicides, spatial aggregation

(12) Modelling complex crop rotations in a GIS based risk assessment

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Pesticides may affects the quality of environment and for this reason a number of software has been developed in the last years at EU level to simulate pesticide fate from field to regional scale and several approaches has been proposed to characterise the sustainability of the use of a compound or to identify the vulnerable areas to leaching. Actually development of tools that link GIS technology with pesticide fate models is essential to draw pesticide vulnerability maps. FitoMarche is a tool which spatialises a pesticide leaching 1D model (MACRO 5.0) using a GIS software (ArcGIS 9.x) allowing to analyse the variability of the use of agrochemicals both along the space and along the time. This work reports an example made by FitoMarche showing further refinements (tier approach) of a vulnerability assessment about a dummy herbicide applied on maize on pre-emergence. The starting point of the assessment was the study of the worst case according the FOCUS (an EU pesticide modelling harmonisation task force) approach: applications every year, all the soils in the region were suitable for the crop. In the first refinement only the areas cropped with maize were considered suitable for the assessment. In the further step, the real crop rotations in the region where considered and therefore the pesticide application was modelled according an ordinary rotation. Subsequent refinements improved the agriculture and environment representation allowing a better identification of areas at the risk of leaching and in which starting monitoring studies or in which restricting the use.

Key words: Leaching, Vulnerability, GIS assessment, Crop rotation

(13) Phytoremediation of atrazine-polluted water with *Pistia stratiotes*,

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To evaluate the potential of *Pistia stratiotes* for phytoremediation of atrazine-polluted waters, the response to and the uptake of atrazine by this species was studied. The effect of atrazine concentration on plant biomass production and on atrazine removal from water was assessed in hydroponics with three atrazine treatments: 0.5, 1, and 10 mg/l for 18 days. Throughout the time of cultivation, biomass production (increase in fresh weight) of plants in the treatment 0.5 mg/l was comparable to that of controls (without atrazine), whereas in the treatments 1 and 10 mg/l, it decreased after 6 days of cultivation. Atrazine removal from solution was between 30 and 40 % in all treatments until day 12 of cultivation; after this, removal decreased in the treatments 1 and 10 mg/l. These results indicate that, although atrazine concentration above 1 mg/l affects plant biomass production, *P. stratiotes* is able to remove atrazine continuously, for at least 12 days, from water that contains up to 10 mg/l. Atrazine uptake by *P. stratiotes* was studied by cultivating plants with solution containing 1 mg/l atrazine spiked with ^{14}C-atrazine for 8 days. Atrazine concentration in the plants increased constantly during the time of cultivation; shoots concentration was five times larger than in the roots. Autoradiography of shoots and roots revealed atrazine accumulation in the leaf tip; accordingly, herbicide injury was observed in the leaf tip expanding towards the center of the lamina. Our findings demonstrate that plants of *P. stratiotes* take up atrazine, translocate it from roots to shoots, and accumulate it in the leaves. Thus, this species seems promising for phytoremediation of atrazine-polluted waters. The fate of atrazine in the plant tissues is under investigation.

Key words: Water lettuce, bioremediation, herbicied

(14) Optical methods for weed detection for site specific weed management

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The conventional practice of applying herbicides uniformly across whole fields is undesirable. Health care considerations and environmental and economic factors are stimulating the development of sensors and technologies for selective application of herbicides. Selective application of herbicides requires automatic detection and evaluation of weeds in the field. Several methods are available for such automatic detection, among which are those based on machine vision or spectroscopy. Machine vision methods are based on digital images, within which, geometrical, textural or other statistical features are used to detect the weeds. Spectroscopic methods, utilize spectral reflectance or absorbance patterns to discriminate between weeds and crops. Most of the features were measured in the visible and near-infrared range, from 400 to 1000 nm. However, features that depend on water content, moisture, humidity and other related properties, were measured in the near and mid-infrared range, from 900 to 2800 nm. Under laboratory conditions, researchers were able to discriminate between young crop plants and weeds according to their spectral reflectance in specific wavelengths in the range 200-2000 nm. Field studies have also found a potential for distinguishing weeds from agricultural crops according to their relative spectral reflectance characteristics. The combination of computer vision with spectroscopic methods yields hyperspectral imaging methods, in which spectral and spatial data are analyzed to aid weed detection.

Key words: Precision agriculture, remote sensing

(15) Development of integrated approach for weed detection in cotton for site specific weed management

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The ability to properly control and eliminate weed infestation in cotton fields can be a crucial factor for the crop's profitability. Site specific weed management has long been marked as the next step in precision agriculture and the tools of remote sensing and image processing stands in the front line of this discipline. Several researches that have being conducted in this field showed encouraging results for distinguishing weeds from the crop, but no mechanism has been implemented yet in the agriculture routine. This fact has been driven us to develop a low cost, yet effective, method for weed map preparation which later on will be used for on-the-go herbicide application. A new approach is being suggested here which includes combining information from a hydro-thermal model into image processing algorithms. This information consists of the expected number of plants per m^2, leaves per plant, etc. The suggested system is constructed from a simple RGB camera, mounted on a tractor's sprayer boom and connected to an on-board computer. The information coming from the camera is a video file with a rate of 7.5 frames per second. The pictures are then being extracted from this file and analyzed in a MatLab™ environment. The process involves applying different vegetation indices using the RGB channels, object separation based on morphological features compared with incoming information from the hydro-thermal model and data from previous years. The result of this process is a 'weed map' calibrated with dGPS data that had been collected during the image acquisition stage. The information achieved each year will also be used for continuous update and amendment of the hydro-thermal model.

Key words: Remote sensing, image analysis, weed control

(16) Site specific weed management application in israel: from satellite to the field - an overview

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Precision farming methods were developed since the mid 1990's. At first, the focus was on site specific fertility management. Layers such as satellite images, air images, electric conductivity maps, and scouting gave us the opportunity to start developing and to understand the possibilities and the limits of Site Specific Weed Management (SSWM). But, it seems that these basic layers are not precise as needed for weed detection. We think that the challenge today is to create profitable SSWM models based on these basic layers, good understanding of the farm practices, and appropriate geo-statistical models. Another option is the developing of new, high resolution layers based on precise sensors. A short overview on the data layers that are available today for the Israeli farmers will be given in the presentation. Our experience and insights on profitable SSWM models and new technology needed will be presented.

Key words: Precision farming, SSWM.

(17) Evaluation of herbicides for selective weed control in grafted watermelons

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Grafted watermelon is a combination of two plants, a *Cucurbita* rootstock and a watermelon scion. Therefore, weed control for this crop faces a unique problem: the safety of the selected herbicide has to be tested for both plants making up the grafted plant. In the current study, we evaluated the safety of selected herbicides for use in *Cucurbita* rootstocks, as well as for non-grafted and grafted watermelons and for the control of *Amaranthus retroflexus*. The herbicides were applied through a system imitating a drip irrigation system. In addition, the residual effect of the herbicides was tested for seeded and transplanted melons representing the next crop following cultivation of the grafted watermelons. The herbicides ethalfluralin, pendimethalin, trifluralin, sulfentrazone, oxyfluorfen, chlorsulfuron and clomazone were chosen for their potential control of *A. retroflexus*. However, pendimethalin and trifluralin were less effective in controlling *Amaranthus retroflexus*. Sulfentrazone, chlorsulfuron and clomazone were not safe for the tested cucurbits and thus cannot be used for weed control in grafted watermelons. We conclude, by eliminating the herbicides that are toxic to cucurbits and those that are less effective for *A. retroflexus* control, that the herbicides ethalfluralin and oxyfluorfen can be considered effective and safe for weed control in grafted watermelons and could be potentially applied effectively through the drip irrigation system

Key words: Cucurbits, chemical control, grafting, rootstocks

(18) The vegetation management in the archaeological site of Eleusis

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By this study we approach the vegetation management in the archaeological sites. Weeds, bushes and shrubs cover in same cases a great part of the monuments constituting a severe problem. The control of the undesirable vegetation by herbicides is considered prohibitive in order to avoid the deterioration of the monuments. We recorded the vegetation following a stratified procedure in selected sites, whereas we applied alternative methods which were proved effective to control the undesirable vegetation. The soil solarization was applied for weeds control, while an integrated method consisted of mechanical and chemical means was applied to bushes and shrubs. On this vegetation, after cutting the branches, we treated a dense pastry of glyphosate by specialized application. Additionally, the glyphosate was directly applied, in a dense suspension formula, by injection inside the cambium. A particular problem is the olive trees seedlings occurrence on the monuments. Spraying with 400 mg l^{-1} naphtalinacetic sodium, at the end of the spring, resulted in complete fruit abortion, suggesting an effective control of the great distribution of olive trees. It is worth mentioning the particular method applied for weed control on a mosaic floor in a Romanic Villa. The floor was covered with layers of quartz sand, matting, LECA and gravel, inhibiting the weeds development. Furthermore, a study was carried out for installation of particular plant species aiming to the restoration of the Villa.

Key words: Vegetation management, archaeological site, glyphosate

(19) Integrated weed management in cotton in India

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Cotton is one of the major cash crops of India. It suffers severely from weeds due to wide spaced planting and slow initial growth. Broadleaf weeds and sedges offers stiff competition in early growth stages, later on irrigation or rainfall triggers emergence of weeds in several flushes. Pre-emergence herbicides are not largely used due to lower soil moisture at sowing time, weather conditions and application factors. There are no major POST herbicides to control a large spectrum of weeds. Several field studies were conducted to integrate various methods for effective weed management. Application of trifluralin (PPI) and pendimethalin (PRE) provided good control but up to 5-6 weeks only. Pyrithiobac-sodium (PRE) was effective only against broadleaf weeds; its POST application was also not effective on large weeds and it does not control grasses. Similarly, trifloxysulfuron alone was not effective; its POST application after one dry hoeing was effective at higher rates. Trifluralin was found better in controlling several weed species than other PRE herbicides and was also cost effective when integrated with POST herbicides or mechanical methods 45 DAS. Protected spray of glyphosate or paraquat in plots treated with pendimethalin or trifluralin (PRE/PPI) 45 DAS provided good control of weeds. Tank mix application of trifloxysulfuron with fenoxaprop and pyrithiobac 45 DAS provided good control of weeds and had no adverse effect on cotton. Application of PRE herbicides are required to integrate with a broad spectrum POST herbicide or their mixtures after one dry hoeing/interculture operation 45 DAS for season-long weed control.

Key words: Broadleaf weeds, sedges, grasses, inter-culture, tank mix applications

(20) Status on physical and cultural weed control methods for field crops in Europe

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European research in physical and cultural weed control methods has largely been driven by national pesticide policies and an increasing conversion to organic farming. This paper reviews some of the major results achieved with non-chemical methods and strategies, especially adapted for row crops and small grain cereals and pulses. It also highlights some of the future directions. Intra-row weeds in row crops constitute a major challenge, and research has mainly aimed at replacing laborious hand weeding with mechanization. Investigations have focussed on optimising the usage of physical methods, often in combination with preventive and cultural methods, against intra-row weeds. Although the need for hand weeding has been reduced markedly, partly thanks to the achievements in research, new research is now aimed at eliminating the need. Robotic weeding and GPS-technology are investigated for row crops with abundant spacing between individual plants. For row crops developing dense stands in the rows, band-steaming prior to sowing show effective and prolonged control. In small grain cereals and pulses, mechanical weed control methods, such as weed harrowing and inter-row hoeing, has played a significant role. Both methods provide the best results when they become part of a strategy that also involves preventive and cultural methods. However, physical weed control has made less progress in broad sown crops as compared to row crops. The European work on physical and cultural weed control is based in the working group: *Physical and Cultural Weed Control* (www.ewrs.org/pwc) under the *European Weed Research Society*.

Key words: Mechanical control, thermal control, non-chemical control, advanced technologies

(21) Potential Use of Essential Oils as Bio-Herbicides: Ecology, Physiology and Agro-technology Aspects

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Allelopathic activity of aromatic plants has been described frequently. Essential oils inhibit germination and growth of various plants. Incorporation of the leaves of aromatic plants in soil inhibited the growth and the emergence of seedlings. We have developed a good quantitative assay to test for the inhibitory activity of volatiles on seed germination and have screened dozens of essential oils and their components. The major active allelochemicals were found to be aldehydic and ketonic monoterpenes, having a α-β unsaturated double bond, such as citral, (geranial and neral) and pulegone. Exposure of seeds for 4h to the compounds was enough to cause inhibition of the rate of germination and of seedling development in wheat, *Amaranthus palmeri* and *Brassica nigra*. Using histochemistry, we observed that citral is absorbed by wheat seed through the abscission layer, and that it reaches highest concentration in the embryo, where it accumulated in the aleurone, scutellum and parts of the endosperm. After exposure of wheat seeds to pure components of essential oils, GC-MS analysis of extracts of the seeds showed the presence of new products in the endosperm and embryo. These were probably formed by the metabolic detoxification of the inhibitors by the seed. The derivatives of the toxic compounds usually found in the seeds were less toxic than the original compound. Detoxification occurs in both embryo and endosperm during the first day of imbibitions. In field studies, in which known amounts of residues of aromatic were mixed with soil in which wheat seeds sown, some components of the essential oil were found in the seed embryo and endosperm. Further work of formulation and application of essential oils as bio-herbicides will be present.

Key words: Allelochemicals, allelopathy, bioherbicides, essential oils, monoterpenes, seed germination

(22) Three years evaluation of mulch materials for weed control in tomato

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Field trials have been carried out in Zaragoza (Spain) in 2005, 2006 and 2007 using different biodegradable mulching materials in the same plots all years. The aim was to study non-chemical weed control techniques in drip irrigated processing tomato as alternatives to the normally-used techniques in the area. The trial comprised of 10 treatments with 4 replicates, randomly distributed within blocks. The treatments were: (1) rice straw mulch; (2) barley straw mulch; (3) maize straw mulch; (4) *Artemisia absinthium* plant mulch; (5) biodegradable black plastic mulch (Mater Bi 15 μ); (6) brown Kraft paper (Saikraft 200 g/m^2); (7) black polyethylene mulch (15 μ); (8) herbicide (rimsulfuron in 2005; rimsulfuron + metribuzine in 2006); (9) manual weeding (two times); (10) unweeded control. All the straw mulches were applied at 1 kg/m^2. Weed density of the main species (*Cyperus rotundus* L., *Portulaca oleracea* L., *Chenopodium album* L. and *Digitaria sanguinalis* (L.) Scop.) was assessed and yield was determined. The straw mulch (1,2,3) achieved a moderate weed control while the paper (6) had an excellent control on all weed species, even better than plastic mulch (5,7), especially by avoiding *C. rotundus* emergence. Tomato yield was generally related to weed control. After three years of trials, paper (6), rice (1) and the biodegradable plastic mulch (5) seemed to be true alternatives to polyethylene (7) and herbicide (8) use. Maize (3) gave irregular yield results, and barley (2) and especially *A. absinthium* mulch (4) generated less attractive results.

Key words: Biodegradable, plastic, straw, paper, *Cyperus rotundus*.

(23) Cover crops for weed suppression in orchards

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Cover cropping has shown to be an effective environmentally sound management tool for weed control in orchards. The effectiveness of a plant species to suppress weeds depends on it's ability to act as a living or dead mulch. Other plants are either smothered and/or inhibited during germination and early seedling growth through allelopathic inhibition. Recently in northern and central Israel, oats (*Avena sativa*) have been successfully grown as a cover crop under winter rain fed conditions for weed suppression in the alley ways between tree rows in non-shaded subtropical and deciduous orchards. In a recent field study, the efficacy of a dead oat mulch was tested in early spring by placing mowed debris before weed seedling emergence on newly prepared tree row strips before planting. Significant suppression of spring germinating weed species was seen in the mulch treated plots versus no herbicide bare soil control treatments, which allowed unhindered weed growth. Physical smothering was assumed to be the principal mechanism for weed suppression, since the mulch was mostly in a dry state. More field trials are planned for further analysis of the mechanisms responsible for weed suppression with a dead oat mulch along tree rows over a longer time period that includes decomposition by winter rains. The long-term benefits and applicability of an oat mulch for non-chemical weed suppression will be studied further.

Key words: *Avena sativa*, cover crops, orchards, weed control

(24) Weed infestation and water availability for summer crops following winter cover crops in organic farming

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Weed infestation is one of the most limiting factors in the development of organic farming. One of the measures used through out the world in Integrated Weed Management (IWM) is the use of cover crops to reduce weeds abundance in the field. However under water-limited Mediterranean conditions, water consumption of the cover crop should be carefully considered. In field studies conducted for two consecutive years, three cover crops: rye (*Secale cereale*), berseem clover (*Trifolium alexandrinum*) and oilseed rape *(Brassica napus)*, were grown during winter. Cover crops biomass was incorporated into the soil in the spring followed by planting of irrigated corn (*Zea mays*) and cotton (*Gossypium hirsutum*) under organic conditions. Cover crops influence on weed infestation, water availability, and yield of the summer crops was studied. All three cover crops reduced weed infestation in the field throughout the season and decreased soil water availability by 60 - 80mm. Rye and oilseed rape residues reduced the summer crops' growth and yield as compared with the control, whereas clover residues had either no effect or positive effect on crops yield.

Key words: Cover crops, organic agriculture, water availability, weed control

(25) Enhancing mycoherbicide activity

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Inundative mycoherbicides have not been successful in weed control in row crops, probably due to evolutionary balance. The addition of virulence factors is essential to obtain mycoherbicides with higher level of virulence (hypervirulence) that will allow the mycoherbicides to overcome host defense responses. Exogenous addition of the products of various genes was used to ascertain synergy as a prelude to adding them transgenically. Transgenically over-expressing single 'soft' genes encoding cell wall degrading enzymes or 'hard' genes encoding toxins, results in different degrees of virulence enhancement of the fungal pathogens *Fusarium oxysporum* (CNCM I-1622) and *Fusarium* sp. (CNCM I-1621) that attacks *Orobanche,* and *Colletotrichum coccodes* that attacks *Abutilon*. In this study we transformed these mycoherbicides with 'soft' genes encoding pectinase, cellulase, and expansin, enzymes that facilitate the penetration and growth of the fungi in the weed tissues. Callose biosynthesis is a rapid defense response against fungal attack, and, oxalate irreversibly complexes calcium, a key co-factor in callose biosynthesis. Hence we over-expressed the enzyme oxaloacetate hydrolase (OahA) that increases oxalate formation. Genes encoding natural hormone synthesis such as IAA were transformed to our fungal model systems. Transformation of 'hard' genes encoding toxins such as *NEP*1 and cerato-platanin (*CP*), has insufficiently enhanced virulence. The results of the *Fusarium oxysporum* (CNCM I-1622) system showed a variety of responses, while the other fungal system, *Fusarium* sp. (CNCM I-1621) showed a different pattern: The foliar pathogen system *Colletotrichum coccodes* was the most influenced of our model systems. We suggest that combinations of various genes will be the optimal solution to obtain additive and synergistic effects. Gene stacking is the best way to achieve sufficient virulence and to delay the evolution of weed resistance to the biocontrol agent.

Key words: Biocontrol, transgenic mycoherbicides, weeds

(26) A mobile field robot for weed control in maize crops

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The aim of this project is to obtain an autonomous vehicle able to move in a maize field, obtaining information based on position and georeference systems, artificial vision systems and odometry. This vehicle must tow a second module of tools that will identify crop and weeds and a third module will proceed to the mechanical elimination of undesirable plants.The first phase of this work has been a simulation where different strategies of navigation have been tested. We are also working at the optimization of the weed-crop discrimination system based on vision and image processing through morphological descriptors. The weeding module will consist in vertical axe rotary brushes that will eliminate weeds in a selective way. This project is included in organic and precision agriculture looking for an optimal use of resources and a reduction of the environmental impact of weed control practices. It is expected to have an operative field prototype at the end of 2008.

Key words: Autonomous navigation, machine-vision, mechanical weeding.

(27) EPPO Pest Risk Analysis of *Solanum elaeagnifolium* and international management measure proposed

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Solanum elaeagnifolium (Solanaceae) originates from the Americas and is considered invasive worldwide. Within the Euro-Mediterranean area, *Solanum elaeagnifolium* has already been introduced in several countries (Algeria, Morocco, Tunisia, Syria, Turkey, Croatia, etc.) and there is a risk of establishment in other countries where it is scarcely present or absent. The European and Mediterranean Plant Protection Organization (EPPO) is the Regional Plant Protection Organisation for Europe under the International Plant Protection Convention (IPPC) and is the major focal point for Pest Risk Analysis development in the region. The EPPO decision support scheme for Pest Risk Analysis (PRA) for quarantine pests is a simple, scheme based on a sequence of questions, for deciding whether an organism has the characteristics of a quarantine pest, and, if appropriate, to identify potential management options. The EPPO Panel on Invasive Alien Species performed a PRA on *Solanum elaeagnifolium* which has officially been approved, this plant now being included in the List of pests recommended for regulation directed to the 48 EPPO member countries. This PRA was done at the scale of the EPPO region and aims to identify measures to limit introduction and spread of pests via international exchanges.
Different international pathways of introduction from countries where *S. elaeagnifolium* occurs have been evaluated as representing a risk:

- consignments of plants with growing media (ornamental plants, etc.),
- consignments of seeds for planting,
- consignments of grain,
- soil as a contaminant on machinery and footwear,
- consignments of soil and growing medium as a commodity.

Key words: *Solanum elaeagnifolium*, pest risk analysis, international management measures

(28) Crownbeard (*Verbesina encelioides*): physiology, geographical distribution and response to herbicides in Israel

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Golden crownbeard (*Verbesina encelioides*) is an "invasive species" first identified in Israel during the late 70's. This aggressive weed occupies large areas, mostly on sandy soils, competes with weeds and crops, reduces biodiversity and causes severe yield losses. The geographical distribution of the plant in Israel was studied, using Geographic Information System (GIS) analysis, whereas seed behavior and response to herbicides commonly used in the infested crops were studied in the laboratory, greenhouse and field experiments. Seeds emergence tests conducted in three soil types have showed that 92% of the seeds emerged when placed on the soil surface, with the emergence rate declining with soil depth in all soil types, but seeds were still able to emerge when buried up to 7.5 cm from soil surface. The seed germinated in a temperature range between 5°C to 35°C, but the highest germination rate was in a range of 10°C to 20°C. GIS maps were prepared for the weed distribution according to climate, precipitation and soil types. It appears that the only factor which influences the distribution pattern is the soil type. We found that this species is spreading massively in sandy soils. Crownbeard plants grown in pots were sensitive to most commonly-used herbicides applied, either pre- or post-emergence in arable and vegetable crops, but sensitivity declines with plant age. Fumigation of mulched soil with metham-sodium (650 kg/ha) was highly effective in sandy soil but was almost non effective in the heavy clay soil. These data indicate that with proper attention further distribution could be stopped as the management of golden crownbeard is feasible under most non-crop and crop conditions in Israel.

Key words: Verbesina, seed, germination, GIS, herbicide

(29) Invasive alien species (IAS) current situation in Israel

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The most aggressive perennial invader weed that threatens open fields and agricultural areas in Israel is *Ambrosia confertifolia*. Patches of this weed were first found several years ago along the Alexander River in the Heffer Valley. These patches were detected in the river banks, nearby arable crops like chickpea and cotton and in avocado orchards. Dissemination and persistency of *A. confertifolia* occurs by seeds, underground rhizomes and re-growth of previous year aboveground shoots. The infested zone of Heffer Valley is located in the central coastal plain of Israel, posing a real threat to surrounding agriculture land and to inhabitants in this region. The total area infested with different densities of the weed is about 1,000 ha. Eradication programs started in summer 2006 and will continue for three years using a tank-mix of 2,4-D or fluroxypyr with glyphosate. Feeding bird migration in the Hula Valley with corn grains imported from the US resulted in infestation with new weed species such as *Ambrosia trifida*, *A. artemisifoli*a, *Cassia obtusifolia*, and *Fagopyrom* spp.. Immediate action against these weeds was taken by application of 2,4-D which eliminated them at once. Another major threat is yellow nutsedge (*Cyperus esculentus*) infesting a total area of about 200 ha in the northern Negev, with heavy infestation of vegetable and arable fields resulting in significant yield losses. More dominant is the massive establishment of *Verbesina encelioides*, which currently spread out from road sides in the coastal plain to open fields and natural reserve sites in the northern Negev.

Key words: Herbicides, infested area, invasive weed

(30) Weed biology between old knowledge and new challenges

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Agriculture is facing the challenge to achieve sustainability and this needs strong scientific input. It is now widely accepted that herbicides as the only means to control weeds is not a sustainable approach and there is a strong demand from society for a reduction in pesticide use. The current situation is a paradox: we often have excellent and innovative research, long-established concepts (e.g. IPM, IWM, ICM, PRM) and some field-scale validation, but meanwhile weed management is highly dependent on herbicides. Partly due a general reduction in farm subsidies, several stakeholders are also calling for multi-purpose agriculture where production, lower environmental impact, ethical values, aesthetics and tourist-related activities can coexist. At the same time an ever-growing world population needs to be fed. An understanding of weed biology/ecology has always helped in weed management; but it is recognised that, despite the considerable amount of experimental data available, the contribution of these disciplines to devising sustainable integrated weed management strategies is rather limited. We need to properly address the complexity and variability of agricultural plant communities and a clearer understanding on how to efficiently implement biology-based research findings. A few research areas like seed bank and seed physiology, weed population dynamics, genetics and genomics still need basic data, while other areas need revisiting, further thought and modelling of the existing information. Knowledge on some key biological aspects of weeds typical of arid and/or semi-arid environments is still often lacking. More effort should be devoted to system approaches, i.e. assessing systems rather than single components.

Key words: Weed biology, sustainability, integrated weed management, system approach

(31) A hydrothermal model of weed seed germination using *Bromus tectorum* L.

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In semiarid habitats, the process of seed germination is regulated primarily by seed zone temperature and water potential. Hydrothermal time modeling provides a way of integrating the effects of these two variables on seed germination under fluctuating conditions. This makes it possible to use equations based on laboratory data to predict dormancy loss and germination in the field. To validate such models, it is necessary to measure fluctuations in seed zone conditions from the time seeds are dispersed in the field until they germinate. For *Bromus tectorum*, a highly invasive winter annual grass weed, this can encompass the time period between late June and late October, when seed zone conditions range from near 60°C and – 800 MPa to 5°C and near 0 MPa. During three years of field trials, accurate predictions were facilitated through the use of thermal after-ripening time and hydrothermal after-ripening time, approaches used to describe dormancy loss. By linking these dormancy-loss models with traditional hydrothermal-time models for describing germination, we were able to predict germination outcomes for all seed fractions through over 90 days of highly fluctuating weather conditions. In order to refine the predictive ability of our models, we need a better understanding of the effects of intermittent wetting and drying, especially of partially after-ripened seeds.

Key words: After-ripening, *Bromus tectorum*, hydrothermal models, seed dormancy

(32) Reducing the persistent seed-bank of a plant invader: *Acacia saligna*: applications and implications.

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The fast growing Australian tree *Acacia saligna* (Mimosaceae) is considered one of the most invasive species in the Mediterranean Basin and the South African Cape. The invasion of this species is followed by significant modification of the ecosystems and homogenization of the landscape. *A. saligna* accumulates a huge persistent seed-bank in the upper soil layer (0-3 cm) due to the physically dormant seeds. The aim of this study was to examine the effect of heat exposure (soil solarization and fire) on the *A. saligna* seed-bank deterioration as opposed to aboveground cutting and uprooting. The study was conducted at the Palmachim Sand Dune Nature Reserve. The effectiveness of various treatments on seed viability was analyzed by the seed-bag-burial method and by counting emerging seedlings during three germination seasons (2003-2005). Soil solarization treatment, by mulching the soil with transparent plastic, completely eliminated *A. saligna* seed-bank. Fire reduced seed viability by 50%. But, unexpectedly, the dormancy rate of the remaining seeds was not affected directly by fire. The post-fire conditions, i.e. the direct exposure of the soil surface to the solar irradiation, significantly reduced the dormancy rate of seeds, leading to re-establishment of seedlings after the fire. Proliferation of seedling emergence was also observed when the soil was exposed to solar irradiation by removing the vegetation with a bulldozer. Treatments that did not increase soil temperature did not increase seed-bank decay. All the studied plots were invaded by *Heterotheca subaxillaris* (*Asteraceae)* immediately after treatment, as a result of the increase in the unused resources. It is suggested that rehabilitation of the natural vegetation must be taken into consideration in the invasive plant management program.

Key words: *Acacia saligna*, control, deterioration, fire, invasive plant, seedbank

(33) Invasion and integrated management of *Lantana camara L.* under agroclimatic conditions of Eritrea and India

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Lantana camara L. (Bunchberry or wild sage),an alien invasive obnoxious weed with its origin in tropical America was introduced as an ornamental plant by colonial rulers in India and Eritrea. But because of favourable agro-climatic conditions for its growth and development, its ability to propagate by seeds, stem and roots and dissemination by birds, water and animals, it has spread like a wild fire to pasture and grasslands, forests, orchards, tea gardens, road sides and fallow lands in almost all uncultivated parts of India since its introduction. In Eritrea, this weed is still being grown as an ornamental plant in the form of hedge around the boundary of houses, parks and Govt. offices. In this country it is in the initial stage of its spread to orchards, fallow lands, grasslands. Being a weed of uncultivated lands, it may pose a serious threat to the browsing and grazing land and barren lands of Eritrea as they constitute 57.2 and 33.2 per cent ,respectively of the total land area (12189 thousand hectares) as per present land use pattern . The competitive and allelopathic effects of this weed has threatened the plant biodiversity and reduced the productivity of grasslands by 90 per cent in India apart from its hazardous effects to health of animals due to presence of toxic alkaloids Lantadene-a, Lantadene-b and Lancamarene. Under Eritrean conditions it has been found to compete with *Opuntia ficus-indica* and the other vegetation in grasslands, orchards and non-cropland ecosystems. Three phased integrated technology to manage this weed which includes combination of cutting and utilization of cut biomass, application of glyphosate (0.31-0.41 per cent)on the regenerated foliage at the critical time and utilization of land as per its capability developed and demonstrated by the author in India has been described in this paper. The spread of this weed in Eritrea can be checked by adopting preventive and management methods developed in India with the active participation of public, development agencies of the Government and the scientists.

Key Words: Bunchberry or wild sage, invasion, integrated management.

(34) Strigolactones: chemistry, biological activities, distribution in the plant kingdom, and regulation of production by plant nutrients

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Plants exude a bouquet of strigolactones that trigger both symbiotic interactions with arbuscular mycorrhizal (AM) fungi and parasitic interactions with root parasitic plants of the Orobanchaceae (e.g. *Striga*, *Orobanche*, and *Alectra*). Only five natural strigolactones, strigol, strigyl acetate, sorgolactone, alectrol, and orobanchol, were known until the recent identification of 5-deoxystrigol by Akiyama *et al.* as a branching factor for AM fungi. Subsequently, additional five novel strigolactones including 2'-epi-orobanchol, solanacol, orobanchyl acetate, and sorgomol, have been isolated and characterized in the last three years (2005–2007). In addition, the compound that was temporarily named alectrol was recently identified as orobanchyl acetate, which is not a strigol isomer. It should be noted that non-hosts of AM fungi such as *Arabidopsis*, spinach, and white lupine also produce strigolactones, indicating that strigolactones may play additional unknown important roles in plants. The detection of strigolactones in shoots and fruits of several plant species supports this hypothesis. The chemistry of novel strigolactones, structure-activity relations, distribution in the plant kingdom, and effects of nutrients on the strigolactone production will be discussed in our presentation.

Key words: Strigolactones, germination stimulants, parasitic weeds, branching factors, arbuscular mycorrhizal fungi

(35) Integrated *Striga* weed management under smallholder agriculture

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Damage caused to three most important crops, maize, sorghum and pearl millet by *Striga* spp. in Africa is devastating to resource-challenged farmers whose main source of livelihood can be threatened by complete crop loss to this root-parasitic weed. A range of effective component technology control practices focusing on factors such as hoe weeding and hand pulling; use of inorganic fertilizer and manure; crop rotations, fallowing, and early planting; use of *Striga* tolerant varieties; soil fertility management and herbicides have shown value in reducing losses - but these have been poorly adopted and have thus failed to slow the spread of *Striga*. New technologies to deal with the high levels of Striga in African soils must meet four criteria to be widely adopted by farmers: (1) have the ability to control *Striga* early in its growing cycle in order to reduce yield loss; (2) deplete the *Striga* seed bank in the soil; (3) be cost effective; and (4) be compatible with existing cropping systems and technologies. The most promising new *Striga* control practice in maize is coating seeds with resistance to ALS-inhibiting herbicides with herbicides such as imazapyr prior to planting. Extensive on-farm testing in several African countries has demonstrated the cost effectiveness of this technology. It is highly effective in reducing *Striga* incidence two-fold - in terms of reduced seed bank in the soil and decreased infection in maize. Integration with other control options and deployment of this technology offers medium-term solution for an urgent *Striga* problem in Africa until breeders identify sources of resistance for the long-term.

Key words: Africa, farmers, maize, soil fertility, technology

(36) *Orobanche* spp. distribution in Greece: host range, biogeography, inter- and intra-specific variability

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Studies on the host range of *Orobanche spp*. (broomrapes) were conducted through screening several crops and herbs in Greece with the aid of geographic information systems (GIS). The "state of the art" on *Orobanche* dispersal is created as follows: a) *O. cumana* infests sunflower in North-Eastern Greece in a medium scale, with severe inoculation in some cases; b) *O. crenata* parasitizes mainly faba bean in Central-Southern Greece, with a low parasitic potential; and c) *O. ramosa* and *O. aegyptiaca* are distributed from Northern to Southern Greece principally infecting tobacco and tomato with a variation in the infection level. Other broomrape species have been observed to parasitize minor crops or herbal plants. In addition, newly introduced crops such as rapeseed were parasitized by *O. ramosa* in rural areas. The use of molecular markers e.g. RAPDs was useful in identifying polymorphisms and inter- and intra- specific variations in the three major broomrape species in Greece (*O. ramosa*, *O. aegyptiaca* and *O. crenata*). Special attention was focused on screening genetic variability for specimens collected in fields where *O. ramosa* and *O. aegyptiaca* simultaneously parasitized tobacco plants. The morphological characters were confusing in samples identification, but RAPDs discriminated them effectively. AMOVA, Nei's and Shannon analyses of the populations indicated the existence of three distinct groups: *O. ramosa*, *O. aegyptiaca* and *O. crenata*. In general, two conclusions were derived; firstly, the total genetic diversity is primarily attributable to individual differences within populations for all species with higher values for *O. crenata* group. Secondly, low genetic differentiation among regions implies that within each species the populations are very similar to each other, whatever their geographic origin is. Inter- and intra- specific variations were also examined for *O. ramosa* and *O. aegyptiaca* seed populations, assessed for their ability to germinate and to attack tomato and tobacco roots. The two species differentiated statistically in the number of hard callus formations. *O. ramosa* was more aggressive to both crops compared to *O. aegyptiaca*. The former species established feedback bonds with the root system of tomato more easily and faster than with the tobacco roots. *Orobanche ramosa* populations originating from Central Greece demonstrated the highest parasitic potential.

Key words: *Orobanche* spp., distribution, population variability

(37) Broomrapes *(Orobanche spp)*: new threat to tomato, linseed and pulse crops production in Tigray region, Northern Ethiopia

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A wide range of parasitic weeds, i.e. dodder, broomrapes and witchweed cause a significant damage on several crops and natural vegetation in Ethiopia. Broomrapes (*Orobanche* spp.) are obligate parasitic flowering plant. Complete yield loss of tomato and cool season pulse crops in some localities by this weed forced farmers to replace them by other crops like wheat and barley. However, exclusion of rotation with legume crops can lead to reduction of soil fertility. To obtain relevant information on broomrape introduction and distribution, a survey was conducted in 24 'Woredas.' Infested fields were marked using GPS. *O. minor*, *O. ramosa* and *O. cernua* were widespread and caused serious problems in the region. *O. crenata* was severely damaging pulse crops. In some localities there was more than 90% yield loss of faba bean and field pea while it reaches 100% on lentil. This species seemed to parasitize certain *Xanthium species*. *O. minor* was seen attacking different wild plants like marigold, tagetes and *Bidens* species. *O. ramosa* was also attacking tomato, potato, and also seen in onion and garlic fields. It was also observed parasitizing linseed crop. Hand pulling was effective to control *O. crenata* where there is light infestation. However, using hand of *O. ramosa* was difficult due to its small size and branchy habit. Thus, an effort towards developing integrated control options is crucial in order to curb its damage and further spread.

Key words: Ethiopia, broomrape, tomato, linseed, pulse

(38) Parasitic plant *Orobanche palaestina* Reut. as a potential threat to agriculture in Israel

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Broomrapes (*Orobanche* spp.) are obligatory root parasites. *Orobanche palaestina* Reut. is an endemic Mediterranean species, previously reported as a wild plant that parasitizes annual legumes and thistles (*Notobasis syriaca* L. and *Cirsium phyllocephalum*) (1). *O. palaestina* is widespread in fallow fields and in wild Mediterranean habitats in Israel. It grows during the winter and flowers in the spring. Seeds of *O. palaestina* parasitizing *N. syriaca* were used in a study aimed to examine the ability of this wild parasite to attack cultivated plants. In net house experiments it was found that Lettuce (*Lactuca sativa* L.), safflower (*Carthamus tinctorius* L.), artichoke (*Cynara scolymus* L.) and the ornamental species gazania (*Gazania uniflora* Gaertn.), but not sunflower, are susceptible to *O. palaestina*. Lettuce was the most sensitive crop. Three lettuce cultivars were severely infected by the parasite, with 100% incidence. About 60% of the safflower plants were infected by the parasite, while artichoke and gazania were only lightly infected, with 10% and 20% incidence, respectively. This is the first report on susceptibility of cultivated Asteraceae to *O. palaestina.* Since these crops are grown within the distribution range of *O. palaestina* and share the same growth season, this new information is essential, and should be taken into consideration before planting the susceptible crops in *O. palaestina* infested fields.

Key words: Broomrape, *Orobanche palaestina*, host range, parasitism

(39) Drip irrigation to improve biological control of broomrapes

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Considering that broomrapes have a long underground phase during which they cause most of the damage to the host, the use of mycoherbicides, which infect at or below the soil surface, could be an attractive option to combat these weeds. As most of the crop plants parasitized by broomrapes are irrigated, the biocontrol agents could be delivered by drip-irrigation systems, allowing tubercle attachment at an early stage, but preventing further development of the parasite. These systems could allow the uniform distribution of the bio-agent at the desired site and amount, protect it from environmental factors such as wind and UV radiation, and lead to reduction of the application costs. To ascertain if conidia can pass through the irrigation system and be uniformly distributed without compromising their viability or the efficiency of the system, a pilot system has been designed in a greenhouse using dripper lines, drippers, filters and other tools that are commonly used in irrigation and precision agriculture. Among others, conidial suspensions of *Fusarium solani* and *F. oxysporum,* two promising mycoherbicides for *Orobanche ramosa* biocontrol, were used. Experiments were carried out releasing known amounts of conidial suspensions through the irrigation systems, and then measuring the volume and CFU of the suspensions coming out of the drippers. None of the dripper lines or drippers were clogged during the applications. The viability of the conidia, measured as CFUs at full capacity of the lines during the treatments, was also without variation and was not influenced by the kind of conidia supplied.

Key words: Biological control, drip irrigation, broomrape management

(40) PIKEET: A new decision support system for *Orobanche aegyptiaca* control in tomato

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Broomrapes (*Orobanche* spp.) are chlorophyll-lacking root parasites of many dicotyledonous species that cause severe damage to vegetable and field crops worldwide. Egyptian broomrape (*O. aegyptiaca*) is common throughout Israel where it parasitizes a wide range of crops. It is a devastating pest in the processing tomato fields in Israel. Its economical impact endangers the future existence of this crop. Dozens of experiments conducted in the last ten years produced excellent results in *O. aegyptiaca* control in processing tomato using the herbicides sulfosulfuron and imazapic. The efficacy of *Orobanche* control is highly correlated with the rate and timing of herbicide application. A decision support system PIKEET for *O. aegyptiaca* control in processing tomato was developed based on risk assessment and the following sub-models: a) growing degree days (GDD) model and b) herbicide rate optimization model. Both models were validated under field conditions using minirhyzotron camera. The alpha version of PIKEET should be evaluated in the next season under commercial processing tomato field conditions.

Key words: Broomrape, chemical control, decision support system, model

(41) Struggling towards an effective biological control of broomrape

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The parasitic flowering plants of the genus *Orobanche* (broomrapes) are obligatory chlorophyll-lacking root parasitic weeds that infect dicotyledonous plants and cause severe damage to legumes, vegetables, tobacco and sunflower in warm-temperate and subtropical regions. *O. aegyptiaca* and *O. cumana* are the most troublesome broomrapes in Israel causing tremendous damage to tomato and sunflower yield, respectively. *Fusarium solani* (Fs) and *F. oxysporum* f. sp. *orthoceras* (Foo) are specific broomrape pathogens that demonstrate a synergistic affect on *O. cumana* when applied together. Field experiments revealed the potential of using the mixture of the two fungi to control this species in sunflower. However, repeated applications throughout the season are needed to elevate the control rate. The two fungi inhibit soil microflora, themselves and each other. They produce fungitoxic metabolites, which explain their inhibitory effect on other soil borne fungi. The positive effect of these two fungi on soil microflora is compensated by the negative effect on each other. Therefore, the survival and competitive ability of Foo and Fs can not explain the synergistic affect in their pathogenic ability. The toxin production, the enzymes associated with pathogenicity, the influence of growth conditions on pathogenicity and the spore production were extensively studies. Yet, the road to a commercial product is still not paved.

Key words: Parasitic plants, biological control, synergism

(42) The Study of Genetic Aspects in Parasitic Weeds of the Genus *Orobanche*

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Genetic studies of obligatory parasitic weeds are difficult because of the dependence of the parasitic life cycle on connection to a host. We have developed a protocol that enables the production of hybrid seeds for the study of genetic aspects of *Orobanche* germination, based on two main steps: infection in vitro and parasite maturation in soil. This system has been used to find genes that are involved in germination control. We assumed that the trait requiring stimulant receptivity evolved by the development of genes that inhibit germination, and switch off inhibition upon chemical stimulation. For this we analyzed inter-specific hybrid populations of *Orobanche cernua* and *Orobanche cumana*, segregating for spontaneous germination, a lethal trait that occurs without chemical stimulation. The segregation results are consistent with two putative epistatic genes that are responsible for germination control. We hypothesize that one gene is involved in seed dormancy and the other in the reception or transduction of the germination stimulus. For spontaneous germination a seed should express the recessive alleles of the first gene and the dominant allele of the other gene. Our results agree with the 3:13 (spontaneous *vs* non-spontaneous germination) ratio in the first segregating generation, which matches to our assumption that one parent species possess the two dominant genes, and the other has the two recessive genes. These results indicate that spontaneous germination of *Orobanche* is genetically controlled. Such genetic control ensures a low incidence of this lethal trait among natural parasite populations, and increases the rate of its successful germination in the vicinity of host roots.

Key words: Broomrape, *Orobanche*, Germination control, Seed dormancy, Epistatic genes.

(43) Parasitic weeds their potential threat to crop production and management in north-eastern region of Nigeria

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In North-eastern Nigeria, a survey carried out in 1999 revealed the types of parasitic weeds in the region, their potential threats to various crop production and management practices that could be feasible by farmers to effectively curtail the menace of theses weeds. Five families of parasitic weeds were represented in the region with 7 genera and 10 species. The Scrophulariaceae family was represented by 3 genera – *Alectra, Buchnera*, and *Rhamphicarpa*, with one species each, *A. vogelii, B. hispida* and *R. fistulosa*, respectively. The Convulvulaceae, Lauraceae, and Loranthaceae families had one species each in the region – *Cuscuta campestris, Cassytha filiformis*, and *Tapinanthus oleifolius*, respectively. Orobanchaceae family had one genera with 4 species, namely, *Striga aspera*, *S. densiflora, S. gesnerioides*, and *S. hermonthica*. There is an observed prominence of *C. campestris*, *R. fustilosa, B. hispida* and *T. oleifolius* infestation in the region which poises new threat to crop production in addition to the already devastating effect of *Striga* on major cereal and legume crops in the region. The use of agroforestry tree (*Faidherbia albida*), brine (NaCl) solution, trap crops and arbuscular mycorrhizal (AM) fungi have shown great success in the management of *Striga* species in particular in the region which will be discussed.

Key words: Parasitic weeds, management, Nigeria

(44) A technical review and management recommendations concerning glyphosate-resistant weeds

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Glyphosate has been used extensively for both agricultural and non-agricultural uses for over 30 years. The approval for cultivation of glyphosate tolerant crops has facilitated additional uses of this broad spectrum and non-selective herbicide in crops. Glyphosate-resistant weeds have been found in both conventional and in glyphosate tolerant cropping systems. Today there are 13 biotypes of glyphosate-resistant weeds reported from around the world (Heap, 2007, see www.weedscience.org). However the number of species that have developed resistance is low when put in perspective with the substantial areas treated worldwide. Glyphosate has a unique mode of action (competitive inhibition of the EPSPS enzyme) that is less sensitive to resistance development than several other herbicides. The resistance mechanism varies across resistant weeds and seems to be complex. While resistance may result from target site alteration in some cases (*Eleusine indica, Lolium rigidum*), some seem to result from metabolism exclusion (*Lolium rigidum, Conyza canadensis*), and several from a combination of mechanisms. Resistant biotypes are likely to have been present in small quantities in weed populations, and have increased under the selective pressure of glyphosate applications. Being the leading provider of its proprietary products, namely herbicides and herbicide tolerant crops, Monsanto pursues leadership in stewarding them and providing customer care. Monsanto therefore urges farmers to report any incidence of repeated non-performance on a particular weed and investigates cases of unsatisfactory weed control in order to determine the cause. In general, most cases of failure to control weeds in agricultural applications of Roundup® agricultural herbicides result from management problems or adverse environmental conditions. In the cases where resistance is suspected, Monsanto provides users with recommendations for alternative control methods. In order to optimize the effectiveness of Roundup® agricultural herbicides and to reduce the risk of developing resistance, applications should be made according to recommendations and following established good agronomic practices: know the weed population and dynamics in the fields, use the right herbicide product at the right rate and at the right time as indicated on the product use recommendations (label, etc.), control weeds early, monitor the herbicide's effect to control weed escapes and prevent weeds from setting seeds, add other herbicidal mode(s) of action (e.g. a selective and/or a residual) and cultural practices (e.g. tillage or crop rotation) where appropriate. Experience clearly demonstrates that following these good weed management practices when making glyphosate applications, keeps the risk of developing resistance biotypes low.

Key words: Glyphosate, resistance, weed

(45) Glyphosate-resistant johnsongrass (*Sorghum halepense*) in Argentina: current status and collaborative action for its prevention and management

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Glyphosate-resistant *S. halepense* populations have been confirmed in Argentina under continuous no-till and glyphosate-resistant soybean production. Disclosure of resistance by alerted local phytosanitary authorities (SENASA) to investigate the extent of the problem and call for international consultation. The authors have been involved in assessing the problem and conducting activities to cope with it, including visits to affected regions, interviews with farmers, researchers and industry representatives, planning of research activities, and providing training. Resistant populations, originally appearing in clumps, are locally spreading to cover extensive proportions of fields. Currently, an estimated 17000 ha of fields with resistant johnsongrass have been identified in a soybean area of about 110 000 ha in Salta province. Additional sites are now found in the provinces of Tucumán, Santiago del Estero, Córdoba, Santa Fe and Corrientes. In two workshops, national research priorities and coordinated policies to contain and prevent spread of the resistant weed were outlined (Buenos Aires, 2006) and advances in research were reviewed (Tartagal, 2007) as part of a coordinated effort involving key national regulatory authorities, industry and research institutions. Since November 2006 a National Advisory Commission on Resistant Pests (CONAPRE) coordinates all activities aiming to prevent and manage glyphosate-resistant johnsongrass populations.

Key words: Argentina, glyphosate resistance, herbicide resistance, johnsongrass, *Sorghum halepense*

(46) Response of glyphosate-resistant (Roundup Ready®) crops to glyphosate

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With the expected adaptation of new genetically modified glyphosate-resistant crops in the EU countries, mainly in the Mediterranean region, it is important to evaluate the response of these crops to glyphosate under local condition. Glyphosate-induced male sterility in (Roundup Ready®) glyphosate-resistant cotton (GRC) is a well documented phenomenon. In order to determine if it is unique to GRC, we examined the response of several Roundup Ready® crops, soybean, canola, and corn, to glyphosate applied during the reproductive growth stage. Soybean plants did not show any visible damage in the reproductive organs following glyphosate application. Canola plants (*cv* Hyola 357RR and *cv* DKL-35-85RR), on the other hand, exhibited severe damage in the treated leaves mainly chlorotic and necrotic lesions. Glyphosate treatment resulted in significant increase in essential microelements in canola leaves and floral organs. The increased levels of microelements were apparently toxic to the plants, causing leaf and other organs chlorosis, necrosis, and plant growth inhibition. The anthers of these plants did not dehisce during anthesis. The specific mechanism which led to hypersensitivity observed in GR-canola is not clear yet. The double promoters in GR-corn (*cv* DKC44-45, DKC64-10) provided an excellent resistance with almost no damage to the vegetative parts. However, glyphosate applied over the top (OTT) at high rates (above 2.08 kg ae ha^{-1}) to corn plants at V6 to V8 growth stages resulted in male sterility. As previously shown in cotton, glyphosate-induced male sterility in RR corn is caused by inhibition of pollen development and anther dehiscence, leading to a significant yield reduction. These data emphasize the importance of herbicide application in the proper timing and rates according the instructions in the label.

Key words: Glyphosate, male sterility, corn, canola

(47) Glyphosate-resistant crops as a tool for the management of troublesome weeds

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Weed management in cotton and other irrigated row crops is well established practice, including cultivation, pre- and post-emergence herbicides. However, long-term use of these practices contributed to an increased infestation with troublesome weeds such as purple nutsedge (*Cyperus rotundus*) that causes severe yield and quality losses. The possible adoption of genetically-modified glyphosate-resistant (Roundup Ready®, RR) crops as a component of purple nutsedge management was examined using DP5415RR cotton and DK44/45RR corn. Laboratory studies have shown that glyphosate applied to the leaves prevented tuber sprouting along the "tuber chain". In addition, the shading imposed by cotton and corn canopies severely affects the purple nutsedge growth and tuber production. Field experiments were conducted for four consecutive years have shown that glyphosate applied within the optimal application windows (early post and later on as a directed spray) provided better weed control than the "commercial treatments". A general decline in density of all weeds without any 'shift' toward a specific species was recorded in glyphosate-treated plots. The irrigation facilitated the emergence of a large proportion of the plant propagules in the seedbank that was controlled by the herbicide. The soil moisture enhanced tuber sprouting that combined with the suppression imposed by the shading of the crop canopy and the impact of a timely application of glyphosate, resulted in an excellent control of purple nutsedge. A field heavily infested with purple nutsedge was nearly cleaned out of this noxious weed after three consecutive years of RR cotton monoculture, or after using a rotation of wheat – RR cotton– RR corn, without causing a shift in the weed population. We concluded that a careful and rational introduction of RR crops such as cotton and corn into the crop rotation significantly improves on the current weed management practices and may become an ecologically sustainable, cost-effective and powerful tool for troublesome weed management.

Key words: GMO, Roundup Ready, glyphosate, *Cyperus rotundus*

(48) Metabolic herbicide resistance evolution: Late watergrass (*Echinochloa phyllopogon*), a case study

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The successful spread of herbicide-resistant late watergrass (*Echinochloa phyllopogon*) in California's flooded rice probably results from the introduction of a single source biotype, followed by dispersal and selection by the prevailing herbicides management in rice fields. In this overview we highlight the events and practices that led to the evolution and spread of these "super biotypes" with resistance to multiple herbicides that differ chemically and in their modes of action, which represent almost all herbicides available in California for rice (thiobencarb, molinate, fenoxaprop-ethyl, cyhalofop-butyl, bispyribac-sodium, penoxsulam, and clomazone). All resistant biotypes showed similar morphological and amplified fragment length polymorphism (AFLP) traits as compared to the susceptible biotypes. The water-seeded and continuously-flooded rice system of California favored the proliferation of the aquatic and highly competitive watergrass species (*E. phyllopogon and E. oryzoides*) that are well adapted to the submergence stress imposed by this environment. Weed-suppressive flooding of rice fails to control watergrass and farmers have to rely heavily on herbicides. Studies conducted since the last ten years have shown variable resistance levels from low to high (R/S ratios 2 to > 400). Although resistance due to target site alterations has been well document for some of these herbicide groups (ACCase and ALS inhibitors), such resistance mechanism has not been found in California's late watergrass. The use of specific enzyme inhibitors and induction by substrate experiments suggested resistance was due to enhanced herbicide metabolism involving inducible Cytochrome P450 monooxygenases. In addition, glutathione S-transferases may also be involved in late watergrass resistance to fenoxaprop-ethyl. Similar mechanisms may have endowed resistance to *E. oryzoides* and *E. crusgalli*, which are also present in California rice fields and exhibit similar patterns of resistance. These inducible and stress-related enzymatic systems have endowed remarkable metabolic versatility to a genus that has evolved adaptation to a variety of contrasting environments.

Key words: Cytochrome P450 monooxygenases, glutathione S-transferases, rice, AFLP

(49) Triazinone-resistant *Chenopodium album* due to two different *psb*A mutations

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In recent years, sugar beet growers in several European countries are experiencing problems with the control of fat hen (*Chenopodium album* L.), a cosmopolitan weed species. Seeds of *C. album* were collected in fields with unsatisfactory control in different European countries. Greenhouse bioassays revealed resistance to metamitron and metribuzin in most of these Belgian, French and Swedish populations. The triazinones metamitron (a key herbicide in sugar beet) and metribuzin (selective to a variety of crops) are inhibitors of photosynthesis at Photosystem (PS) II (HRAC Group C_1). The expected cross-resistance to atrazine (a triazine also belonging to Group C_1) was found in all metamitron-resistant populations except for the Swedish one, which is highly resistant to metamitron but sensitive to atrazine. DNA sequence analysis confirmed the presence of a Ser264 to Gly mutation on the p*sbA* gene for all populations that are resistant to metamitron and metribuzin as well as to atrazine. This mutation on the p*sbA* gene encoding the D1 protein of PS II is well known for atrazine-resistance and cross-resistance to other PS II inhibitors in many weed species. In the Swedish population, with an aberrant resistance profile, a substitution of Ala to Val at position 251 on the *psbA* gene was identified. As this mutation has been previously reported only in unicellular green algae such as *Chlamydomonas* and in cell cultures of *Chenopodium rubrum* L., this is the first report of a higher plant from the field with this substitution at position 251 and resistance to PS II inhibitors.

Key words: Fat hen, triazinones, resistance, Photosystem II, *psbA* gene

(50) Elucidation of the molecular bases for the resistance to accase inhibiting herbicides in grass weeds

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Annual ryegrass (*Lolium rigidum*) and hood canary grass *(Phalaris paradoxa* L.*)* are aggressive annual winter weeds in wheat and other arable crops. These weeds are effectively controlled by acetyl CoA carboxylase (ACCase) inhibitors: cyclohexane-diones (DIMs), aryloxyphenoxypropionates (FOPs) and phenylpyrazolines (DENs, e.g., pinoxaden), herbicides that exclusively inhibit the chloroplastic enzyme ACCase in grasses. Several *L. rigidum and P. paradoxa* populations, selected by continuous application of ACCase inhibitors in the field, were collected and their response to FOP, DIM and DEN herbicides was examined in field and greenhouse experiments. The level of resistance was found to be up to 170 folds in comparison to sensitive biotypes. The amino acid substitutions responsible for resistance were detected in the carboxyl transferase domain of the chloroplastic isoform of the enzyme ACCase. The first substitution, Ile_{1718} → Leu, endows resistance to all FOPs, and to the DIMs cycloxydim and tralkoxydim. The second substitution, Asp_{2078} → Gly, was detected in a population that demonstrated resistance to all FOPs, DIM and DEN herbicides, except tepraloxydim. The third substitution, Ile_{2041} → Asn or Val, was detected in two populations, both highly resistant to all FOPs, but their response to DIMs varied. While the *L. rigidum* population was susceptible to DIMs, the *P. paradoxa* population showed resistance to cycloxydim, sethoxydim and tralkoxydim. Interestingly, one *L. rigidum* population, that showed high resistance to FOPs only, was found to be composed of two different haplotypes. Most of the plants included an Ile_{2041} → Thr substitution linked with Ile_{1718} → Val and Ala_{2044} → Ser substitution. The second haplotype, with the substitution, Ile_{1781} → Val, was detected in some plants survived diclofop P-methyl. Our study clearly indicate that lack of herbicide and crop rotation may result in the evolution of diverse target site mutations in grass weeds, leading to differences in the response of the whole plant to ACCase inhibitors, hence precluding adequate design of weed management strategy.

Key words: Grass weeds, FOPs, DIMs

(51) Current status of herbicide resistance in *Phalaris minor* and management strategies in rice-wheat cropping systems in India

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Rice-wheat cropping systems in India comprise 10 m ha out of 13.5 m ha of land in the Indo- Gangetic Plains. Modern technology embedded with dwarf varieties, assured irrigation facilities and improved input supply contributed to an impressive increase in the productivity of this cropping system. However, it became more fragile and system productivity showed signs of fatigue mainly due to infestation of littleseed canary grass (*Phalaris minor*) in wheat and decline in soil productivity. Evolution of resistance in *P. minor* against isoproturon further aggravated the situation particularly in N-W India and currently, the resistance affected area ranges between 0.8 and 1.0 m ha. Due to large-scale failure, isoproturon was replaced with clodinafop, fenoxaprop, sulfosulfuron and tralkoxydim during winter season of 1997-98. These alternate herbicides brought the *P. minor* infestation under control and restored wheat yields to their previous levels. But, future use of alternate herbicide is not a sure one-way bet. Red signals of resistance against these alternate herbicides in few biotypes of *P*. minor have already been reported. Diagnostic survey involving 419 farmers in R-W belt of Haryana during 2005-06 indicated that large number of farmers use lower than recommended dose of herbicides, lower volumes of spray and almost all still use single flood jet/cut or hollow cone nozzle instead of flat fan nozzle. A holistic approach including integrated methods of weed management, farmers participatory approach and interventions in the form of new resource conservation technologies (zero-tillage, bed planting, laser leveling etc.) is needed to tackle these second generation problems and sustain wheat productivity in future.

Key words: *Phalaris minor*, wheat, herbicide resistance, management strategies

(52) Herbicide resistance evolution and management in Central and Southern Italy

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Some of the worst herbicide resistance problems in Italy are found in arid and semi-arid areas in the centre and south. These areas are often characterised by poor soils, rainfall concentrated during the winter and simplified agriculture systems where durum wheat is the main crop, often monoculture. In some areas there are no alternative cash crops, while in others tomato and sugarbeet are rotated with the cereal. However, there is frequently no rotation of herbicide mode of action. Six species have evolved resistant populations: four grasses – *Avena sterilis* (first report in 1992), *Lolium* spp. (1995), *Phalaris paradoxa* (1998) and *P. brachystachys* (2001) – and two dicots – *Papaver rhoeas* (1998) and *Sinapis arvensis* (2006). Most grass populations are resistant to ACCase-inhibitors (by altered target site or enhanced metabolism) and some are multiple resistant to ALS-inhibitors. The two dicots show target site resistance to ALS inhibitors: some *P. rhoeas* populations are multiple resistant to ALS-inhibitors and auxin-like herbicides and some only to the latter group. The two worst situations involve *Lolium* spp. and *P. rhoeas*. In the situation described above, management of herbicide resistant populations is problematic as a limited number of anti-resistance agronomic techniques are applicable. Most farmers manage resistance by rotating herbicide mode of action. The increasing use of graminicide sulfonylureas is becoming a threat, so farmers and stakeholders need to be aware that a more cautious and responsible use of herbicides is crucial. The Italian herbicide resistance working group (GIRE) is strongly committed to this aim.

Key words: Herbicide resistance, ACCase-inhibitors, ALS-inhibitors, wheat, IWM.

(53) The successes or failure of soil solarization for weed control – a review

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Soil solarization (SH) can be an effective non-chemical method to control weeds.. However, weeds differ in their response to SH: some exhibit high tolerance and some are very sensitive. The success of SH is determined by the inherent properties of the plant propagules accumulated in the soil (seedbank), and their interaction with the exogenous factors triggered by the solarization process. Based on the reported response of 167 weed species to SH, we identified the main factors involved in the successes or failure of SH. The main exogenous factor that determines SH success is the thermal killing mechanism. The rise in soil temperature caused by SH affects directly or indirectly the weed seeds by exposing them to sub-lethal temperature. However, biological and chemical processes are also involved in the weed seedbank deterioration. For example, organic matter decomposition could advance the seedbank deterioration process by facilitating thermophilic microbial activities known as biofumigation. Seeds of perennial weeds are more susceptible to SH than propagules. In addition, winter annual weeds are more sensitive than summer annuals and dormant and non-dormant seeds respond differently to SH. Physical dormancy is a common factor that determines the tolerance of weeds to SH. Compact seeds (small, smooth and globular seeds) tend to penetrate to the deeper soil layer outside the reach of the heat. Thus, soil disturbance after SH may exhume these seeds and thereby reducing the effect of SH. However, large seeds that are deeply buried are able to emerge without soil disturbance.

Keywords: Seed dormancy, seedbank, soil solarization, weeds

(54) First results on chemical weed control in olive oil orchard of Southern Italy optimizing the use of flazasulfuron

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Results on chemical weed control in an olive orchard located in Savelletri (Apulia – Southern Italy) are reported. Trial was aimed to optimize the use of flazasulfuron (commercial name in Italy: Chikara 25 WG®), an active ingredient belonging to Sulfonylurea chemical class with pre and post activity on weeds. Particularly, its efficacy and persistence of action were evaluated when used alone or mixed with glyphosate and compared to that of oxyfluorfen. Thesis compared were: a) flazasulfuron + glyphosate (100 g + 3 l ha^{-1}); b) flazasulfuron + glyphosate (60 g + 3 l ha^{-1}); c) flazasulfuron (160 g ha^{-1}); oxyfluorfen + glyphosate (2 l + 3 l ha^{-1}); d) weedy control. Flazasulfuron showed high and lasting level of efficacy, both alone and mixed with glyphosate. In this last case its activity was good also at the lowest application rate and provided high and lasting suppression of important weeds such as *Oxalis pes-caprae* L. and *Conyza canadensis* (L.) Cronquist. First results suggest that the application rate of 60 g ha^{-1} mixed to glyphosate (3 l ha^{-1}) seems to be a good chemical weed control strategy in order to optimize affects and costs.

Key words: Olive orchards, chemical control, flazasulfuron

(55) The role of water resources management in weed control- a case study of cotton crop in Greece

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In Greece the cotton crop producers, according to cross-compliance in EU Common Agricultural Policy among other constituents, orientate towards water resources management. Particularly in the Mediterranean Basin, given the degree of water scarcity, the Deficit Irrigation might be a potential solution to the increasing demand for water. Studies carried out in Karditsa (central Greece) during the period 2004-2006, indicated that applying a "Drip Irrigation System" – DIS- and reducing the water use at 60-70%, we obtain little impact on the quality and quantity of the harvested yield. Actually, by this strategy the water use is improved, allowing a better weed control as well. In observations, conducted in several cotton fields, we obtained the ranking of weeds based on the relative abundance method. The following weed species were dominant in the surveyed crops; *Solanum nigrum, Convolvulus arvensis, Cyperus rotundus, Xanthium strumarium, , Cynodon dactylon and Sorghum halepense.* Assessing the effect of two irrigation systems (Sprinkler and DIS) we observed the weed populations superiority in the fields irrigated by sprinklers, with mean values of 5.41 and 3.33 weeds/m^2, respectively. Although, weeds ranking remained unchanged in both irrigation systems, *C. rotundus* and *C. arvensis* were significantly decreased in the case of the DIS, while *C. dactylon* was not influenced by the type of irrigation system. These data support the concept of "reducing irrigation in semi arid agriculture" and orientate the water resources management to meet weed control resulting in optimal effects on yield.

Key words: Deficit irrigation, weed control, cotton

(56) Factors affecting the efficacy of *Orobanche cumana* control in sunflower

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Broomrape (*Orobanche* spp.) is a root parasite, causing severe damage to vegetable and field crops. Its early *in-situ* detection and control are crucial, but difficult because of its subsurface development. minirhizotron technology enables the *in-situ* observation of host-parasite interactions. We studied the factors affecting *O. cumana* control in sunflower (*Helianthus annuus* L.) under controlled and field conditions, to optimize its chemical control. We detected the initial underground development of *O. cumana* on sunflower roots, evaluated the control efficacy of *O. cumana* with Imazapic studied the relations between *O. cumana* parasitism at different buried-seed depths, its development, and the efficacy of the chemical control. *Orobanche cumana* parasitism- attachments and meristem initiation- was observed with the minirhizotron. The number of vital attachments on roots of the chemical treated sunflower plants decreased to zero under both controlled and field growth conditions while new attachments continued to develop in the untreated controls. Broomrape shoot emergence was correlated to growing degree days under both conditions. Excellent *O. cumana* control was achieved in the herbicide treated sunflower. Control efficacy was affected by attachment depth and density: it was highest in the topmost layer,but decreased with depth and attachment density.

Key words: Chemical control, minirhyzotron, model, *Orobanche cumana*

(57) Effect of glyphosate on *Orobanche aegyptiaca* parasitism in tomato *(Lycopersicon esculentum Mill.)*

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Glyphosate blocks the biosynthesis of the aromatic amino acids by inhibition of EPSP synthase in sensitive plants. This trial was initiated to identify the appropriate time of glyphosate application on tomato to control *O. aegyptiaca* and to examine the ability of *O. aegyptiaca* to synthesize aromatic amino acids using shikimate analysis. Glyphosate susceptible and resistant tomatoes were grown in a greenhouse and transplanted to the polyethylene bags at the second leaf stage. The parasite seeds were sterilized and preconditioned in polyethylene bags for two weeks prior to tomato transplanting. 1.08 kg a.e./ha glyphosate was applied to host leaves at five growth stages in 50, 57, 64, 71 and 78 days from planting. Glyphosate killed all parasites without killing the resistance tomatoes two weeks after treatment (WAT) in 50 day old tomatoes while it took three weeks in 57, 64, 71 day old and more than three weeks in 78 day old tomatoes. Glyhposate was found effective against *O. aegyptiaca* before it creates an attachment to resistance tomato. There was no significant difference ($p > 0.05$) in the parasite in shikimate content at the tubercle stage while later on the parasite accumulates shikimate indicating presence of EPSP synthase in the late growth stages for synthesizing aromatic amino acids. There was no significant difference ($p > 0.05$) for shikimate content in the resistant tomato leaves indicating resistance to glyphosate.

Key words: *Orobanche aegyptiaca*, glyphosate, tomato, EPSP Synthase

(58) Differences in sensitivity to glyphosate of common weeds in maize in temperate zone

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Several weed species are inherently (naturally) more tolerant to herbicides than other ones. Many of these weeds become at present more problematic in herbicide tolerant crops as they replace the niches vacated by other weed species and cause the shift in weed communities. Latest reports from the countries with long-term experience with GM crops refer about number of weed species naturally tolerant or resistant to glyphosate; most of them are important also under European conditions. To describe expected differences in sensitivity to glyphosate among for Central Europe typical weeds of maize, the sensitivity to glyphosate was tested on *Amaranthus retroflexus*, *Chenopodium album*, *Echinochloa crus-galli* and *Polygonum lapathifolium.* The doses ranging between 0.019 – 19.2 kg ha^{-1} of a.i. glyphosate (Roundup Klasik) were applied in pot trial in growth stage BBCH 12-14 of weeds. Dose-response curves were drawn and the values of ED_{50} and ED_{90} were calculated separately for both experimental years 2006, 2007. Obtained ED_{90} values for individual species varied between 129.6 -1741 g.ha^{-1} a.i. glyphosate. The most sensitive was *A. retroflexus* (129.6; 131.6 g ha^{-1} a.i. in 2006; 2007) followed by *Ch. album* (440.1; 336.3 g ha^{-1} a.i.) and *E. crus-galli* (1255.4, 455.9). Highest level of tolerance was found in *P. lapathifolium* (1741.0; 1070.4 g.ha^{-1} a.i). The most sensitive species required threefold higher dose to increase the efficacy from 50% to 90% while at the most tolerant *P. lapathifolium* was 6.3 fold necessary. Weather conditions in individual years influenced the efficacy very high in more tolerant species, especially *E. crus-galli.* Obtained values of ED_{90} for the most tolerant species correspond with the recommended dose of glyphosate 1080 g.ha^{-1} a.i. what is 3.0 lt ha^{-1} of Roundup. Usually, it is recommended to repeat this dose in split application or to combine Roundup with other herbicides. The differences in sensitivity of weed species refer to necessity of adjusting the glyphosate dose according to weed spectrum to prevent the failures in weed control and the shift in weed communities if HT crops will be widespread introduced. On the other hand, many weeds (e.g. *A. retroflexus*) are very sensitive to glyphosate and the Roundup dose of 0.5-1.0 lt ha^{-1} is sufficient for their control. Therefore, it creates a space for economic (environmental) optimisation of weed control and rational use of glyphosate.

Key words: Dose-response, efficacy, glyphosate, weed sensitivity

(59) Fat-hen (*Chenopodium album* L.) resistant to metamitron: monitoring methods

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Fat-hen (*Chenopodium album* L.) is becoming more difficult to control in sugar beet. So far, in metamitron-resistant (Rm) fat-hen collected from sugar beet fields two *psbA* mutations have been identified*: a Ser264 to Gly mutation in Belgian and French Rm-biotypes with cross-resistance to atrazine and metribuzin and an Ala251 to Val mutation in a Swedish Rm-biotype cross-resistant to metribuzin but sensitive to atrazine. The triazinones metamitron (a key herbicide in sugar beet) and metribuzin (selective to a variety of crops) are inhibitors of photosynthesis at Photosystem II and belong, like the triazine atrazine, to HRAC Group C_1. In bio-assays and chlorophyll fluorescence measurements the response of Rm fat-hen to metamitron can be investigated. However, this response is not always clear-cut. Therefore, monitoring for metamitron-resistance using only metamitron is rather complicated. This problem might be solved by using other herbicides. The fact that Rm-biotypes are all cross-resistant to metribuzin and the better distinction between sensitive and resistant biotypes by this triazinone justifies the use of metribuzin for Rm monitoring purposes. Further, a good indication about the kind of mutation present can be obtained by using atrazine (or terbuthylazine, another triazine). Rm-biotypes resistant to atrazine have the Ser264 to Gly mutation whereas the Rm-biotype sensitive to atrazine has the Ala251 to Val mutation.

* See abstract 49 in this proceedings: Triazinone-resistant *Chenopodium album* due to two different *psb*A mutations.

Key words: Fat-hen, triazinones, resistance, Photosystem II, monitoring

(60) Clay-polycation composites as bases for imazapyr controlled release formulations

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Interest has grown in designing materials for herbicide controlled release formulations (CRFs). Such formulations are designed to reduce herbicide leaching for reduced soil and water contamination. We present a novel CRF for the anionic herbicide imazapyr (IMP) based on its binding to poly dimethyl-diallylammonium chloride (PDADMAC), adsorbed on a clay-mineral, montmorillonite. PDADMAC adsorption on montmorillonite reached a high loading and charge reversal was reached at low polymer loadings enabling IMP binding. IMP binding as a function of PDADMAC loading on the clay showed a maximum at a loading of 0.16g/g clay. IMP binding reached 66% active ingredient. IMP release from the CRFs applied on a thin layer of soil was substantially slower than its release from the commercial formulation. After two irrigations (equivalent to 10 mm of rain) 100% of the IMP from the commercial formulation (25% a.i.) leached through the thin soil layer, whereas only 25 % leached from the PDADMAC-montmorillonite formulation with 40% active ingredient. A bioassay in soil columns showed that the polycation-clay CRF as well as the commercial formulation (applied at a rate of 500 g/ha) exhibited 80% growth inhibition of the test plant at the top of the column this indicates that the CRFs herbicidal activity is as good as the commercial one. However the CRF, in comparison to the commercial formulation, showed considerably lower herbicidal activity at depths of 5-20 cm indicating that the CRF can reduce imazapyr leaching which makes the new formulations promising from an environmental and economical point of view.

Key words: Controlled Release Formulations, Imazapyr, polycation-clay composites

(61) Herbicide controlled release formulations based on solubilization in micelles adsorbed on clay

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Controlled release formulations (CRFs) are developed to reduce herbicide leaching which can result in soil and water contamination. We designed new CRFs for sulfentrazone (anionic) and metolachlor (hydrophobic) based on their solubilization in cationic micelles and adsorption of the mixed micelles on a clay-mineral. The adsorption isotherms of sulfentrazone and metolachlor were of an L and C shape, respectively, which was attributed to the herbicide charge and hydrophobicity. In both cases the herbicide loading was high and the release showed hysteresis. Sulfentrazone and metolachlor release from the CRFs applied on a thin layer of soil was substantially slower than their release from the commercial formulations. After five irrigations (equivalent to 25 mm of rain) 100% of sulfentrazone from the commercial formulation leached through the thin soil layer, whereas only 20% leached from the micelle-clay formulation. Metolachlor release from the commercial formulation was not complete but after ten irrigations 80% was washed which is twice the amount released from the micelle-clay formulation. In a soil pot bioassay, sulfentrazone CRFs yielded 40% growth inhibition of maize while the commercial formulation yielded only 17% inhibition. These results indicate that applying the CRFs will decrease sulfentrazone and metolachlor leaching and increase the herbicidal activity.

Key-word: Metolachlor, sulfentrazone, controlled-release formulations, surfactant, clay

(62) Controlled release of bromoxynil: influence of pH

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This study aimed to develop controlled release formulations of bromoxynil formulation and to test its release under various pH values. Bentonite clay was activated toward the adsorption of bromoxynil by ion exchange reaction using quaternary ammonium or phosphonium organic salts. The resultant organo-bentonites were used as adsorbent materials for bromoxynil at various pH values and temperatures. Organo-bentonite formulation was prepared and their release was tested under pH solution. Release of bromoxynil to the solution was determined by HPLC. Results showed that bromoxynil was best adsorbed on bentonite surfaces modified with NCP, or HDTBP at various loadings. The adsorption of bromoxynil was further enhanced by lowering the pH of the adsorption solution and/or optimizing the temperature or the adsorption reaction. Release of bromoxynil from NCP-, or HDTBP-bentonite was significantly slower than from raw bentonite and release at acidic solution (pH 3) was significantly slower that at solution of pH 5.5 or distilled water. The application of organo-bentonite formulations may be advantageous in acidic soil, and provide effective controlled release formulations of bromoxynil.

Key words: Benzonitrile herbicide, organ-clay, formulation

(63) *Solanum eleagnifolium*, a serious threat for the Greek agroecosystems.

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In Greece, especially in Thessaloniki and Chalkidiki counties (Northern Greece) almost all fields with arable and horticultural crops, such as cotton, tomatoes, peppers, eggplants, olive orchards, vineyards, pastures, rangeland as well as forest openings, waste places and roadsides have been infested by *Solanum eleagnifolium*. This troublesome weed is a perennial herb, with creeping roots and prickles on the stems. Foliage and berries contain variable amounts of several glycoalkaloids and can be toxic when ingested by livestock or people. Mature berries of this weed also contain high levels of solanine and solanosine, which are toxic to livestock. Large infestations can reduce harvest yields and the carrying capacities of pastures by competing with desirable plants of nutrients and soil moisture. *S. eleagnifolium* appears to have allelopathic properties especially in cotton fields. Plants develop colonies from extensive systems of creeping horizontal and deep vertical roots, both of which produce new shoots. Colonies of *S. eleagnifolium* are difficult to control or eliminate by mechanical methods neither by biological means because there are no currently registered biocontrol agents for use on this plant. On the other hand, few phloem-mobile herbicides such as glyphosate, dicamba, 2,4-D, and triclopyr that have been tested for this purpose, were quite effective against the weed. However, being non-selective to most irrigated summer-crops, limits their use in cultivated annual crops. The combination of this weed growth characteristics and the safe use of these herbicides should be considered when designing management practices.

Key words: *Solanum eleagnifolium; troublesome weeds; phloem-mobile*

(64) The influence of soil type and nutrition intensity to herbicides breakdown

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Submitted work summarizes investigation concerning total number of micro organisms content in soil as well as the herbicidal residues under differentiated mineral nutrition condition at two soil types Eutric Fluvisol and Gleyic Fluvisol. Duration of pot trial 120 days. There were four nourishment variants, including control without mineral nutrition. We tested seven herbicides active compounds. The observed parameters were expressive different according soil types, herbicides and nourishment variants. The better herbicides breakdown we observed at Eutric Fluvisol (residues in total at 78% of average) in comparing with Gleyic Fluvisol (122 %). We confirm the very positive effect of soil activators Condit (75 % of residues average in total) and EcoCondit (125 %) on solved herbicides breakdown, especially suitable for the dicamba, metribuzin and clopyralid breakdown. Residues of terbuthylazine and S-metolachlor was various. All measured acetochlor and sulfosulfuron residues values were under detection limit. The very important is the finding, that at the variant with NPK fertilisers using it was the highest amount of residues in total (126 %), and the least amount was finded at controll variant without nutrition (75 %). The increasing of nourishment intensity means the higher amount of herbicides residues, but the suitable effective nutrition system (Condit and EcoCondit) caused the increasing of soil activity, which take part at the pesticide degradation in soil. This general trend was not valid for both soil types.

Key words: Herbicides, residues, mineral nutrition, soil activators

(65) The influence of bacterial preparates to herbicides breakdown

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Submitted work summarizes investigation concerning five different bacterial preparates influence on the seven herbicides breakdown as well as on the total number of micro organisms content in the soil. The task was solved on soil type Eutric Fluvisol. Duration of pot trial 120 days. We confirm the good general breakdown effect of solved microbial preparates on herbicides residues. The most important is the fact, that each of microbial preparates can improve the breakdown of other herbicide. Dicamba – the best effect was found on variants with EM as well as PHYLAZOL using (both achieved the same value 3,3 % of residues in comparing to dicamba average of nourishment variants), AZOTER (9 %), no threated controll (35 %), BACTOFIL B (303 %), BACTOFIL A (428 %). Metribuzin – EM (20 %), AZOTER (28 %), both PHYLAZOL and controll (33,2%), BACTOFIL B (51,1 %), BACTOFIL A (64%). S-metolachlor – EM (7 %), BACTOFIL A (93 %), both AZOTER and PHYLAZOL (97 %), controll (120 %), BACTOFIL B (221 %). Terbuthylazine – EM (46 %), BACTOFIL B (65 %), AZOTER (82 %), PHYLAZOL (96 %), BACTOFIL A (105 %), controll (106%). Clopyralid – both BACTOFIL A and PHYLAZOL (17 %), AZOTER (28%), EM (37%), both controll and BACTOFIL B (39%). Residues content of sulfosulfuron and acetochlor was under detection limit. In general we find, that the more microorganisms means the less residues, what confirm the importance of microorganisms activity role in the herbicides breakdown.

Key words: Herbicides, residues, microbial degradation, microbial preparates

(66) Factors effecting bromoxynil application in sweet corn (*Zea mais* L.)

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The post-emergence herbicide bromoxynil effectively controls troublesome broadleaf weeds in sweet corn. However, it was found that the herbicide causes damage to sweet corn when applied at the early growth stages, and under extreme temperature or radiation conditions. The study was conducted under field, greenhouse, laboratory and controlled conditions. Two bromoxynil formulations of either Emulsifiable Concentrate (EC) or Suspension Concentrate (SC) were applied to sweet corn cultivar 'Jubilee' at the 4th to 5th leaf stage. The SC formulation did not cause any damage to corn, whereas corn was injured when treated with EC formulation. Bromoxynil effectively controlled *Solanum nigrum*, *Amaranthus* spp. and *Abutilon theophrasti*, *whereas Ipomoea purpurea* seedlings were only partially controlled and *Portulaca oleracea* was not controlled at all by any of the herbicide rates tested. The amount of bromoxynil retention on 'Jubilee' corn leaves was 10% higher than that retained on the leaves of var 'Oropesa'. There were no significant differences in the amount of epicuticular wax between the two examined varieties. The effect of bromoxynil on the PSII apparatus as estimated by recording the kinetics of chlorophyll fluorescence was used as a parameter of bromoxynil detoxification in corn plants. The data clearly indicate that the response of corn to bromoxynil is strongly affected by environmental conditions (temperatures and radiation), growth stage, variety and herbicide formulation. It may be concluded that the differences in susceptibility between corn varieties are due to differences in retention, penetration and detoxification of bromoxynil.

Key words: Herbicides, PSII, temperatures, chemical control

(67) The side-looking spectral signature of Maize (*Zea Mays*); a preliminary study

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The main goal of precise agriculture is to increase the yield while reducing the use of resources and cost. Monitoring the crop is a major component in the process of increasing the yield. Hence, if by close monitoring one can provide inputs only when and where they are needed, the use of resources will be reduced, hence, the goal is achieved. The most effective way for precise monitoring of agricultural fields is by the use of spectroscopic imaging of the crop. Vegetation absorbs light in specific wavelengths and reflects in others. The difference between the amounts absorbed and reflected and the location along the stem at which it is absorbed can characterize the plant phenology and status. Commonly remote sensing is done from above and represents the top canopy layer reflectance. In this project which was part of a workshop looking at the use of remote sensing practice to reduce herbicides, corn plants were measured from the side and from the near range. This practice has not been shown before. The overall shape of the reflectance signature from 30 to 2500 nm was maintained no matter which part of the plant was observed. However, differences at specific wavelengths especially in relation to other wavelengths were clearly noticeable as a function of height. Obviously the phenology and the plant structure are the cause for these differences. However, these differences can be used to monitor variability within a field which is not always observed from nadir looking spectroscopy. This is a preliminary study and further work is still needed to determine how and where this can be utilized.

Key words: Remote sensing, green, detection, precision agriculture

(68) Field dodder extracts obtain significant antioxidant activity

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Despite its negative effects on world agriculture, field dodder has features that may prove useful in the fight against different pathologies in the human body, what was earlier shown by alternative medicine for another dodder species, namely Cuscuta *chinensis* Lam. and Cuscuta *europaea* L. In this connection, it has proven significant to study its protective properties against lipid peroxidation (LPO) in rat liver microsomes (RLM). Dried samples of field dodder were ground to a final size of 1-3 mm. According to our previous phytochemical studies, the optimal extragents were 50% ethanol and dimethyl sulfoxide (DMSO). Membranes from liver tissues were obtained according to the method of Kon' et al. /1986/. Thiobarbituric acid reactive substances (TBARS) were measured using the method of Ohkawa et al. /1979/. LPO was induced for 60 minutes with the Fe^{2+} + ascorbat system. Field dodder extracts were preliminary incubated with RLM for 15 minutes at 37^0C. Extracts do not influence accumulation of TBARS without the induction of LPO. Significant decline in TBARS is observed in presence of DMSO extracts in comparison with ethanol extracts under concentration of 20 µg of extract/mg of protein (3.3 and 6.3 nmol for DMSO and ethanol extracts), which is evidently connected with more thorough extraction of phenol compounds fraction with DMSO. Comparative study of the protective activities of the studied extracts with such of a-tocopherol showed that their efficacies against LPO in RLM are almost equal. Thus, our research has shown that both extracts can be used for inhibition of LPO processes in RLM and that their protective efficacies are comparable with such of a- tocopherol, a universally recognized antioxidant present in the human body.

Key words: Field dodder, extracts, antioxidant activity

(69) The influence of different agrotechniques on herbicide breakdown

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This work represents one – year results of testing herbicidal residues in field conditions under different agro techniques. Herbicidal active compounds were chosen from the point of view of their risk effect considering accumulation in the soil and additional effect on cultural crops as well as water resources contamination. The task was solved in exact field trials and laboratory residual analyses were used. Tested herbicidal active compounds were acetochlor, S-metolachlor, metribuzin, terbuthylazine, dicamba. Herbicides were applied in accordance with registered application practices. Observed factors were: two soil subtypes (Eutric Fluvisol, gleyic Fluvisol), differentiated agrotechniques (one conventional, two soil protecting practices) and two soil layer (topsoil, subsoil). Our results confirmed that observed residues were expressive differently according to the soil subtypes, herbicidal and agrotechnical variants as well as soil depth. Our results can beapplied for herbicidal plant protection and drawing soil protecting systems. It was found that the higher content of herbicidal residues was in the gleyic Fluvisol rather than in the Eutric Fluvisol. According to depth of soil profile the higher herbicide content was found in the topsoil rather than in the subsoil and lower intensity of soil cultivation resulted at lower content of herbicidal residues. The work presents results of APVV project *27-035504 „Parametric risc asessment of herbicides using in agroenvironmental conditions of Slovakia“*

Key words: Herbicides, agrotechnic, residues, residual effect

(70) Weed dispersal in wheat fields by sheep stubble grazing

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Under Mediterranean semi-arid conditions, sheep graze in marginal lands during the green season and are turned to cereal fields after harvest in summer. Farmers frequently claim that this practice results in large input of weed seeds through faeces and fleece. The aim of this study was to investigate the potential of weed contamination in wheat fields by seasonal sheep grazing by estimating: i) the potential of seed dispersal from marginal lands in faeces and fleece; and ii) the influence of stubble grazing on the size and composition of the weed seed-bank and vegetation in a wheat crop system. The potential for weed contamination from marginal land through sheep faeces and fleece decreased from late spring to summer, since the sheep were turned to the fields after plants dry out and shed seeds. Therefore, no correspondence was found between faeces contents and the weed species in the field. Stubble grazing increased seed-bank and frequency of weed mainly due to small grasses. However these species were not present in the faeces or fleece. Moreover, since they are weak competitors, they did not affect wheat yield. The total seed density and relative proportion of annual forbs in the seed-bank were small and not affected by stubble grazing. One year rotation with garden pea strongly reduced the total seed bank in the wheat field. Adequate agrotechnical practices, delaying stubble grazing into summer and shearing the sheep before turning them into the fields can reduce weed contamination and create a sustainable rainfed wheat-sheep farming system.

Key words: Seed dispersal, seed-bank, semi-arid, wheat-sheep farming system

(71) Effect of herbicides on different categories of weeds in Japanese mint (*Mentha arvensis*) in Eastern India

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A field experiment on different herbicides on Japanese mint (*Mentha arvensis*) was conducted in the university farm during rainy and summer seasons of 2003-2004 and 2004-2005 in West Bengal, India. The treatments consisted of oxyfluorfen at a rate of 176 ga.i/ha, oxyfluorfen at a rate of 206ga.i./ha, oxyfluorfen at a rate of 235ga.i/ha, oxyfluorfen at a rate of 470ga.i/ha, fluchloralin at a rate of 540ga.i/ha, pendimethalin at a rate of 450ga.i/ha, hand weeding20 and 40DAPand unweeded control. The experiment was conducted in factorial randomized block with four replications. Number and dry weight of grassy weeds at20 and 40days after planting were lower with application of oxyfluorfen at a rate of 470ga.i/hand it was comparable with hand weeding twice. Lower doses of oxyfluorfen and fluchloralin and pendimethalin were not much effective so far as grassy weeds concerned. In case of sedges lowest number of weeds were found with hand weeding twice at20 and 40 day after sowing followed by application of oxyfluorfen at a rate of 470ga.i/ha. Other herbicides were not much effective. Dry weight of sedges also followed similar trend. The broadleaf weeds were also effectively controlled with application of oxyfluorfen at a rate of 470ga.i/ha. Dry weight of broadleaf weeds were significantly lower in hand weeding twice followed by application of oxyfluorfen at a rate of 470ga.i/ha. Similar trend of result was noticed in both rainy and winter seasons. Oxyfluorfen at a rate of 470ga.i/ha was more effective in controlling weeds in Japanese mint over conventional herbicides fluchloralin and pendimethalin.

Key words: Japanese mint, herbicide, oxyfluorfen, pendimethalin, fluchloralin

(72) Rotation: a key factor in weed management in Israeli semi-arid and arid wheat fields

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No tillage (NT) practices facilitate non-irrigated agriculture, but weed management has become the major limiting factor preventing adoption of no tillage practices in Israel. We evaluated the relative impact of crop rotation, under different tillage, fertilization and irrigation managements on weed density dynamics. A rotation-tillage-fertilization long-term study was conducted at Gilat Research Center in southern Israel from 1998 to 2007 to determine weed infestation levels in wheat fields grown under various crop management systems: non-irrigated vs. irrigated; wheat monoculture (CW) vs. rotation (WF), conventional tillage (CT) vs. minimum (MT) and NT; and fertilization (non-fertilized and fertilized plots). Total rainfall varied from 72 mm to 334 mm annually, and significantly interacted with all experiment factors. There was a correlation between weed infestation and the previous year's rainfall. Severe drought (less than 200 mm) reduced weed density during the following year, while rainy years caused a significant increase in weed density up to about 2000 seedlings m^{-2} in the next year. In both rotation schemes, total weed densities were often greater in NT than in either MT or CT. Crop rotation significantly reduced grass and broadleaf weeds density. Clean fallow generally reduced weed densities in subsequent crops to a reasonable level, independent of soil management. The dependence on herbicides in NT management lead to the selection of ACCase-resistant ryegrass (*Lolium rigidum*), and ALS-resistant hairy fleaben (*Conyza bonariensis*). It was concluded that crop rotation is the key for growing wheat successfully in arid regions, and adopting reduced and NT management without reasonable crop rotation would increase weed problems.

Key words: Crop rotation, herbicide rotation, fallow, no tillage, reduce tillage, wheat