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Innovative crop protection for 21st century food security

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Review

*In Focus***Innovative crop protection for 21st century food security**Jonathan Gressel^a and Robert Edwards^b^aPlant and Environmental Sciences, Weizmann Institute of Science, Rehovot, Israel^bSchool of Natural and Environmental Sciences, Newcastle University, Newcastle Upon-Tyne, NE1 7RU, UK

There are ever-so-many problems in crop protection that conventional agronomy, breeding and chemistry have not been able to solve, yet rather than out-of-the-box thinking so many symposia stick to the traditional ways of working. The pressing issue of providing stable food security to a growing world population is increasingly now exacerbated by an unstable, erratically changing climate and confounded by new problems of protecting crops from weeds, insects and pathogens, as well as abiotic stresses. Set against this background, the theme of the meeting was about thinking about new solutions and how to implement them in the shortening time scales as we head toward the trilemma. A long standing mutual interest in innovation in crop protection stimulated the two of us to invite a group of nine senior British scientists together with four UK post-doctoral fellows to join a similar group of Israeli scientists at the David Lopatie Convention Center at the Weizmann Institute of Science to discuss innovative solutions. The meeting's logo set the scene for our discussions; how to develop non-conventional solutions to currently intractable problems (Fig. 1). The presentations, briefly described below, dealt with concepts and ongoing research that provided an excellent basis for discussion by the nearly 200 attendees. Confidentiality of discussions was a condition for registration, resulting in active and intense discussion following each paper. By nature, most of the results presented were of a preliminary nature and thus not yet ripe for publication. Thus, only a few papers follow in this "in focus" section.

The opening charge by Jonathan Gressel (Weizmann Inst.) summarized some of the seemingly intractable problems facing crop protection and why new out of the box concepts are needed. In his charge, he accentuated ex-President of Israel Shimon Peres enlightened politician's views on why food security is necessary for geo-political global security. Basically, populations with a full stomachs do not go to war.

The presentations were divided into three major topics considered over two very long days:

- Protection through improved plants
- New concepts in chemical control
- Facilitated biological control

In the first section, Anne Osbourn (John Innes Ctr) described how synthetic biology could be used to deliver new traits. Rafi Perl-Treves (Bar-Ilan U) then discussed the possible implication of utilizing clustered resistance genes to control disparate pathogens. He was followed by Ari Sadanandom (Durham U) who showed how protein modification systems can be used as part of novel protection strategies. Dudy Bar-Zvi (Ben-Gurion U) then demonstrated how modulating protein degradation can facilitate plant adaptation to abiotic stresses. Amit Gal-On (Volcani Cte) described how novel CRISPR gene editing systems can be used to preclude viral attack. The session ended

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3 with Adi Avni (Tel-Aviv U) demonstrating how internal plant defenses can be turned on
4 under the mediation of the “MAMP EIX” system.

5 The session on New Concepts in Chemical Control was opened by Elena
6 Poverenov¹ (Volcani Ctr) who described the novel edible nanotech coatings her group is
7 developing to preclude rot during fruit and vegetable shipping and storage.¹ She was
8 followed by Renier van der Hoorn (Oxford U) with a presentation on how new
9 proteomic approaches are being used in his lab to study the interface between plants
10 and their pathogens. Zvi Hayouka described how seemingly random peptide mixtures
11 could be used to confound pathogenic bacteria. Using the enigmatic title “Chemical
12 Control of Chemical Control” Rob Edwards (Newcastle U) described how mixtures of
13 crop protection chemicals could be used to modulate each others’ activity, vastly
14 improving efficacy.² Oren Ostersetzer (Hebrew U) followed showing data on the
15 unexpected activity of analogues of the natural amino acid phenylalanine on weed
16 growth. Asaph Aharoni (Weizmann Inst) then described discovering how the natural
17 colored plant metabolite betalain actually controls pathogens and how this finding could
18 be used. Moving on to control insects, Shireen Davies (Glasgow U) fascinated the
19 participants with the neuroendocrinological approaches her group is using.³
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23 The session of facilitated biocontrol was opened by Robert Jackson (Reading U),
24 who described the novel approaches he is developing, followed by Eyal Emmanuel
25 (Evogene), outlining approaches his company is taking to find a new generation of insect
26 killing toxins from bacteria for application in transgenic crops. Neil Brown
27 (Rothamsted) described the innovative approaches his group is taking to control the
28 fungi that produce mycotoxins that affect consumers of stored products.⁴ Jurrian Ton
29 (Sheffield U) discussed how the plants own acquired “immune” system could be
30 exploited to counter pathogens. Elisa Korenblum (Weizmann Inst) detailed her research
31 on how the bacteria surrounding crop roots affect plant metabolism. Phil Poole (Oxford
32 U) discussed his work on the ecology of root colonizing organisms and how the
33 community is selected, and what implications this has on the plants. Einat Zchori-Fein
34 (Newe-Yaar Res. Ctr.) described her group’s research on the insects that symbiotically
35 control pathogens inside plant tissue.⁵ The scientific program was concluded with a
36 lively illuminating exposition by Raymond St. Leger, a British scientist at U. Maryland
37 (USA) on how transgenic fungi can both kill insects and promote growth.⁶
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40 Feedback from the attendees was universally positive and will result in new
41 collaborations, friendship and the initiation of just the kind of innovative thinking and
42 projects the organisers were hoping for.
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46 the UK Academic Study Group and The Chorafas Institute for Scientific Exchange, as well
47 as contributions from Israeli companies involved in crop protection: FuturaGene,
48 Kaiima, Adama and Evogene.
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Figure Legend

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48 Figure 1. Logo accentuating the concept that the bilateral workshop was meant
49 primarily for novel, untried new and innovative solutions for problems in crop
50 protection.
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Figure 1. Logo accentuating the concept that the bilateral workshop was meant primarily for novel, untried new and innovative solutions for problems in crop protection.

68x100mm (150 x 150 DPI)