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(71) Applicant: **BAYER CROPSCIENCE AKTIENGESELLSCHAFT** [DE/DE]; Alfred-Nobel-Str. 50, 40789 Monheim am Rhein (DE).

(72) Inventors: **LAMPRECHT, Sybille**; Am Arenzberg 29, 51381 Leverkusen (DE). **THIELERT, Wolfgang**; Buschweg 69, 51519 Odenthal (DE). **DAUCK, Hartwig**; Bechhausener Str. 6, 51399 Burscheid (DE). **JOHN, Marita**; An der Kommende 2b, 46238 Bottrop (DE). **LOZANO, Francisco, Leonel, Junior**; Rua Costa Rica No. 175, apt 61, Sao Paulo (BR).

(74) Agent: **BIP PATENTS**; Alfred-Nobel-Str. 10, 40789 Monheim am Rhein NRW (DE).

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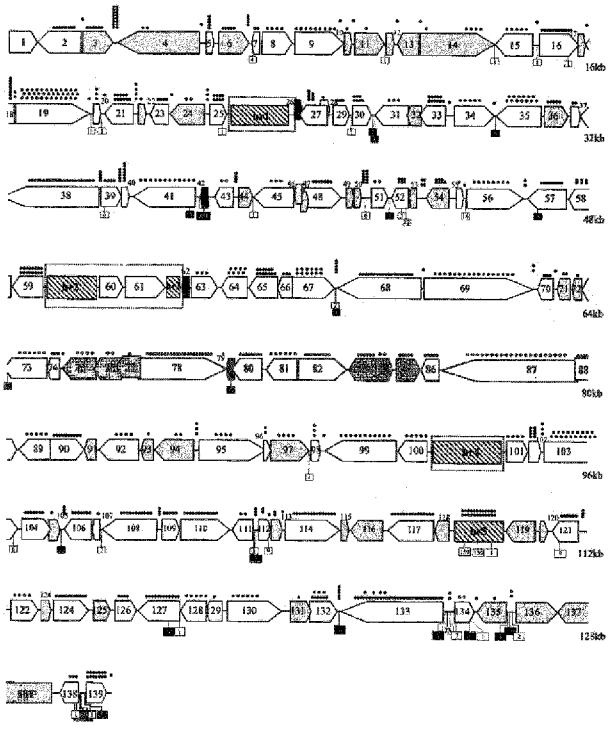
[Continued on next page]

(54) Title: COMBINATION OF NUCLEAR POLYHEDROSIS VIRUS AND DIAMIDES

Fig. 3:



(57) Abstract: The invention refers to combinations of nuclear polyhydrosis viruses and diamide compounds, especially Flubendiamide, their use and preparation.

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Combination of nuclear polyhedrosis virus and Diamides

[0001] The Baculoviridae are a family of viruses with circular, covalently closed, double-stranded DNA genomes that range in size from 100 to 180 kb. Members of the Baculoviridae are characterized by their presence in occlusion bodies (OBs) called polyhedra for NPVs and granules for GVs. Polyhedra are about 0.6–2 μm in diameter, whereas granules are oval-shaped with diameters of about 0.2–0.4 μm. Occlusion bodies are highly stable and can resist most normal environmental conditions thereby allowing virions to remain infectious indefinitely (Rohrmann, Baculovirus Molecular Biology, 2013).Within the family, there exist two types of Baculoviridae: Granulovirus (GV) and nuclear polyhedrosis virus (NPV). NPV is a virus type affecting insects, predominantly moths and butterflies. It has been used as a pesticide for crops infested by insects susceptible to virus infection. The polyhedral capsid of NPV is a highly stable protein crystal which protects the virus in the external environment. It dissolves in the alkaline midgut of lepidopterous larvae to release the virus particle and infect the larvae. NPVs are designated single (S) or multiple (M), depending on the number of virions packaged in a nucleocapsid.

[0002] A number of NPVs have been isolated worldwide from insect species belonging to the genus Helicoverpa (Lepidoptera: Noctuidae), which includes agricultural pest insects such as Helicoverpa zea (Hz), Helicoverpa virescens (Hv), Helicoverpa armigera (Ha) and Helicoverpa punctigera (Hp). NPVs affecting/isolated from Hz generally also affect closely related Helicoverpa species such as Ha. These species are major global pests that attack at least 30 different food and fibre crops and are, in many instances, resistant to chemical insecticides. Helicoverpa zea single-nucleocapsid nucleopolyhedrovirus (HzSNPV) was registered as one of the first commercial baculovirus pesticides (Virion-H, Biocontrol-VHZ, Elcar) in the 1970s and has been used extensively to control the cotton bollworm in the USA. HaSNPV, isolated in 1975 in Hubei province, People's Republic of China, has been used successfully in China for over 20 years to control H. armigera in cotton and vegetable crops in an area of about 100.000 hectares. Especially HzSNPV and HaSNPV are closely related to each other.

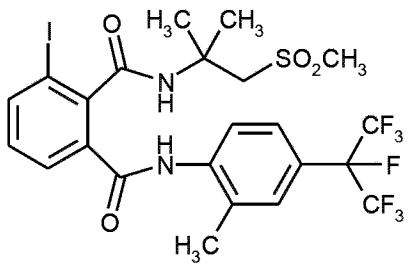
[0003] The complete nucleotide sequence of HzSNPV has been determined (130.869 bp) and compared to the nucleotide sequence of Helicoverpa armigera (Ha) SNPV (131.403 bp). These two genomes are very similar in their nucleotide (97% identity) and amino acid (99% identity) sequences. The coding regions are much more conserved than the non-coding regions. In HzSNPV/HaSNPV, the 63 open reading frames (ORFs) present in all baculoviruses sequenced so far are much more conserved than other ORFs (see Chen et al. 2002, J. of General Virology, 83, 673-684).

[0004] Sequence alignment of ORFs between HzSNPV and HaSNPV indicated that the mean level of sequence identity is 98.2% for amino acids and 99.1% for nucleotides. Putative functions of the various HzSNPV ORFs implied by their corresponding homologues are listed in Table 1. It can be seen that all 135 HaSNPV ORFs have homologues in HzSNPV except Ha17. This ORF appeared to be part of Hz16,

the AcMNPV me53 homologue in HzSNPV and HaSNPV. Resequencing of the pertinent region in HaSNPV confirmed that Ha16 and Ha17 form a single ORF homologous to Hz16. An Hz119 homologue, originally not detected in the HaSNPV genome analysis has been designated as Ha115a (Table 1). Forty-five of the 139 HzSNPV ORFs (32%) exhibited 100% identity in amino acid sequence to the corresponding HaSNPV ORFs, of which 21 (15% of 139 ORFs) are even identical in nucleotide sequence. Sixty-eight HzSNPV ORFs had amino acids replaced in the corresponding HaSNPV ORFs, twenty eight of which had only a single amino acid change. Due to deletion/insertion or to stop codon changes, only a total of 25 HzSNPV ORFs (15±8%) exhibited lower identity or had different sizes in HaSNPV (Table 1).

[0005] One example for an NPV is HzSNPV, the GenBank accession number of the HzSNPV genome sequence at the NCBI (National Center for Biotechnology Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA) is AF334030. Another example is strain AC53 (also known as A44WT) which is used in the biopesticides ViVUS and ViVUS Max (AgBiTech Pty. Ltd.). It was originally isolated from an unspecified Helicoverpa species cadaver from Brookstead, Southeast Queensland, Australia, in 1974 (Noune, Genome Announcements, Vol 3, Issue 5, e01083-15, 2015) and of which the accession number of the genome sequence at the NCBI is KJ909666. GemStar (Certis US) and VIVUS/CCAB (AgBi Tech, Australia) are examples of commercially available HzSNPVs.

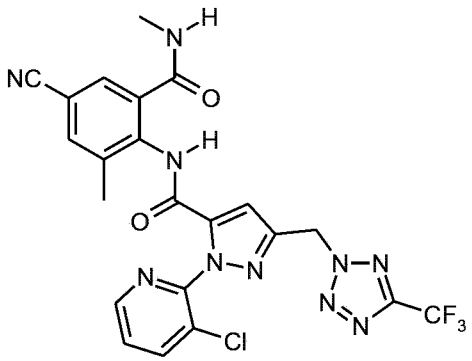
[0006] Flubendiamide (diamide compound (II-1)) is known from EP 1 006 107. The amount of Flubendiamide can be determined, e.g., by HPLC MS/MS-detection as described by Billian (Pflanzenschutznachrichten Bayer 60, 2007, 2, 263-296).



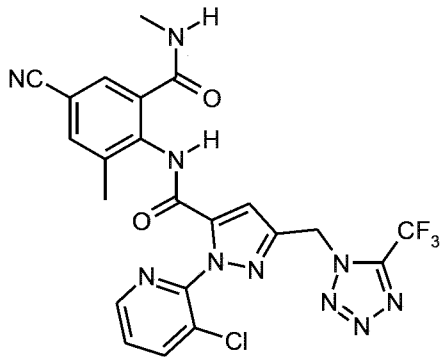
(II-1).

[0007] Tetraniliprole (diamide compound (II-2)) 1-(3-chloropyridin-2-yl)-N-[4-cyano-2-methyl-6-(methylcarbamoyl)phenyl]-3-{[5-(trifluoromethyl)-2H-tetrazol-2-yl]methyl}-1H-pyrazole-5-carboxamide which may be present as (II-2-a) or a regioisomeric mixture of (II-2-a) and (II-2-b) is known from WO 2007/144100.

[0008] Preferably, the mixing ratio of (II-2-a) to (II-2-b) is at least 70:30. More preferably, the mixing ratio of (II-2-a) to (II-2-b) is at least 80:20; 81:19; 82:18; 83:17; 84:16; 85:15, 86:14; 87:13; 88:12; 89:11; 90:10, 91:9; 92:8; 93:7; 96:6; 95:5 or higher.

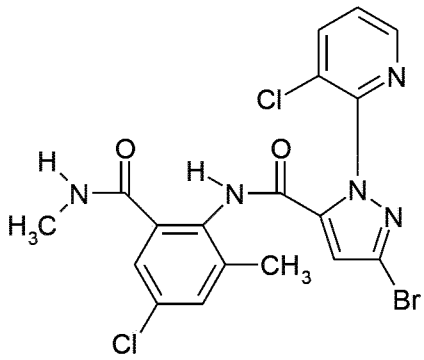


(II-2-a)



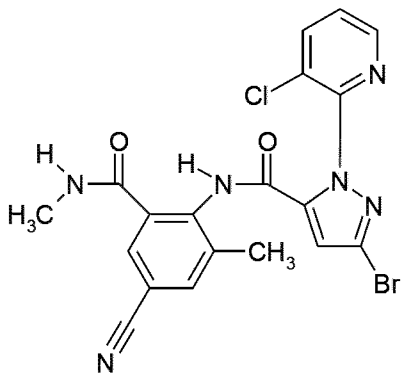
(II-2-b)

[0009] Chlorantraniliprole (Rynaxypyr – compound (II-3)) has the structure:



(II-3).

[0010] Cyantraniliprole (Cyacypyr – compound (II-4)) has the structure:



(II-4)

[0011] It has now been found that active compound combinations of NPV and diamide compounds, especially Flubendiamide or Tetraniliprole, are synergistically active and suitable for controlling insect pests, especially *Helicoverpa* pests.

[0012] Surprisingly, the insecticidal activity of the active compound combination according to the invention is considerably higher than the sum of the activities of the individual active compounds. An unforeseeable true synergistic effect is present, and not just an addition of activities.

Summary

[0013] The invention refers to combinations of a nuclear polyhedrosis virus (NPV) and a diamide compound, preferably Flubendiamide.

[0014] A preferred embodiment refers to a combination according to the invention, wherein the NPV is a Helicoverpa zea (Hz), Helicoverpa virescens (Hv), Helicoverpa armigera (Ha) or Helicoverpa punctigera (Hp) NPV (HzNPV, HvNPV, HaNPV, HpNPV).

[0015] A further preferred embodiment refers to a combination according to the invention, wherein the NPV is a HzNPV or a HaNPV.

[0016] A further preferred embodiment refers to a combination according to the invention, wherein the NPV is a HzSNPV.

[0017] A further preferred embodiment refers to a combination according to the invention, wherein the concentration of NPV is at least $5x10^7$ OB/l of combination, preferably is at least $1x10^8$ OB/l of combination.

[0018] A further preferred embodiment refers to a combination according to the invention, wherein the concentration of NPV is in the range from $5x10^7$ OB/l of the combination to $1,5x10^{10}$ OB/l of the combination, more preferably in the range from $1x10^8$ OB/l of the combination to $5x10^9$ OB/l of the combination, more preferably in the range from $1x10^8$ OB/l of the combination to $1,5x10^9$ OB/l of the combination.

[0019] A further preferred embodiment refers to a combination according to the invention, wherein the concentration of Flubendiamide is in the range from 0.01875 mg/l of the combination to 0.175 g/l of the combination.

[0020] A further preferred embodiment refers to a combination according to the invention, wherein the ratio between NPV and a diamide compound is in the range from $5x10^9$ OB per 1 mg Flubendiamide to $2x10^{10}$ OB per 1 mg Flubendiamide.

[0021] A further aspect of the invention refers to a method for combating pests on plants comprising the step of applying NPV and a diamide compound in a combination according to the invention to at least parts of a plant.

[0022] One preferred embodiment refers to said method, wherein NPV and Flubendiamide are simultaneously applied to at least parts of a plant, preferably in form of a tank mix.

[0023] Another embodiment refers to said method, wherein NPV and a diamide compound are separately applied to at least parts of a plant, wherein the time difference between the application of a diamide compound and the NPV is between more than 1 min and 7 days, preferably between more than 1 min and 1 day, such as 12 hours, 6 hours, 3 hours, 2 hours or 1 hour.

Detailed description

[0024] The indefinite article "a" as used herein is understood by the skilled person as "one or more".

[0025] The term "%(w/w)" as used herein refers to percent by weight (e.g., 1 %(w/w) = 1 g Flubendiamide / 100g solution).

[0026] SEQ ID No.: 1 refers to the nucleotide sequence of the NPV having the accession number AF334030 at the NCBI.

[0027] SEQ ID NO.: 2 refers to the nucleotide sequence of the NPV strain AC53 (also known as A44WT; originally isolated from an unspecified Helicoverpa species from a cadaver from Brookstead, Southeast Queensland, Australia, in 1974) having the accession number KJ909666.

[0028] Fig. 1 shows the schematic view of a counting chamber of a hemocytometer with a sample introduction point (1), a cover glass (2), counting chambers (3), cover glass mounting support (4) and a sample depth of 0,1 mm (5) (see also Caprette, 2006).

[0029] Fig. 2 shows the schematic view of a counting grid for evaluating the amount of OBs. In this example, the small squares with 1/400 sq. mm (6), 1/25 sq. mm (7) and the counting grid central area.

[0030] Fig. 3 shows the Open Reading Frames in the nucleotide sequence of SEQ ID NO.: 1.

[0031] The term occlusion body (OB) refers to viral occlusion bodies. OBs of baculoviridae are produced in the nucleus of infected cells and confer resistance to adverse environmental conditions on viruses. They are made from polyhedrin and protect infectious virus particles after release into the environment. OBs are dissolved by the alkaline pH in the insect gut, thus resulting in the release of infectious virus particles.

[0032] A NPV and a diamide compound of the combinations, mixtures or compositions according to the present invention can be combined in any specific ratio between these two mandatory active ingredients. Preferably in ratio ranges wherein the combination has a synergistic effect. Moreover, further active ingredients in form of, e.g., further insecticides, nematicides or fungicides can be present in such a combination, mixture or composition according to the present invention.

Diamide compound

[0033] A diamide compound according to the invention is a compound having insecticidal activity based on its ability to act as a Ryanodine Receptor Modulator (IRAC class 28). Preferred diamide compounds are Rynaxypyr, Cyazypyr, Flubendiamide, Cyhalodiamide (ZJ 4042), Cyclaniliprole, Broflanilide, and Tetraniliprole, more preferred Flubendiamide and Tetraniliprole, even more preferred Flubendiamide.

[0034] Thus, one preferred embodiment refers to combinations of a NPV with Flubendiamide and to methods to combat insects comprising providing Flubendiamide and NPV at least to a part of a plant. Another preferred embodiment refers to combinations of an NPV with Tetraniliprole and methods to combat insects comprising providing Tetraniliprole and NPV at least to a part of a plant.

[0035] In one preferred embodiment, the amount of Flubendiamide in a combination according to the invention is at least $1x10^{-7}$ %(w/w) (0,0000001 %(w/w)), such as at least $1,875x10^{-7}$ %(w/w). For example, if the combination is a liquid combination, the amount of Flubendiamide in the combination is at least 0,01 mg/l, such as at least 0,01875 mg/l.

[0036] In another preferred embodiment, the amount of Flubendiamide in a combination of NPV and Flubendaimide is in the range from $1x10^{-5}$ %(w/w) to $2x10^{-2}$ %(w/w) (0,02 %(w/w)) such as from $1,875x10^{-5}$ %(w/w) to $1,75x10^{-2}$ %(w/w).

[0037] The amount of Flubendiamide can be determined by HPLC MS/MS-detection as described by Billian (2007).

NPV

[0038] The NPV is generally provided in form of occlusion bodies (OBs) in a carrier such as a solution or powder or suspension.

[0039] The concentration of OBs (e.g., in OBs/ml) can be determined by using the method of D.R. Caprette (Experimental Bioscience, Rice University Jan 27, 2006, updated Aug 10, 2012: http://www.ruf.rice.edu/~bioslabs/methods/microscopy/cellcounting.html). The enumeration of OBs in a viral suspension can be done with the help of Neubauer's hemocytometer, which comprises a glass slide carrying calibrations. A haemocytometer is named after its first use: it was originally designed for performing blood cell counts. To enumerate, virus suspension can be diluted, if necessary, and put in the groove of a hemocytometer. After allowing OBs to settle down, e.g. for one, two, three, four, five 10 or even more minutes, the OB count takes place in five squares of the haemocytometer area at random under, e.g. a stereomicroscope (see, e.g., Fig 1 and 2).

[0040] The mirror-like polished surface of the counting chamber should be carefully cleaned, e.g., with lens paper. The coverslip should also be cleaned. The coverslip is placed over the counting surface prior

to putting on the cell suspension (Fig. 1). The suspension is introduced into one of the V-shaped wells with a Pasteur or other type of pipet. The area under the coverslip fills by capillary action. Sufficient liquid must be introduced so that the mirrored surface is just covered. The charged counting chamber is then placed on the microscope stage and the counting grid is brought into focus.

[0041] For example, one entire grid on standard haemocytometers with Neubauer rulings can be seen at 40x (4x objective). The main divisions separate the grid into 9 large squares (see, e.g., Fig 2). Each square has a surface area of one square mm, and the depth of the chamber is 0.1 mm. Thus the entire counting grid lies under a volume of 0.9 mm-cubed.

[0042] Suspensions should be diluted sufficiently so that the cells or other particles do not overlap each other on the grid, and should be uniformly distributed. The OBs can be systematically counted in selected squares so that the total count is, e.g. 100 OBs, 200 OBs, 500 OBS or 1000 OBs. The total counts should be 100 OBs or more to ensure a statistically significant information. In general, a specific counting pattern should be determined to avoid bias. For example, for OBs that overlap a ruling, an OB is counted as "in" if it overlaps the top or right ruling, and "out" if it overlaps the bottom or left ruling.

[0043] Although the concentration of NPV in a combination with Flubendiamide can be lower, in one preferred embodiment the amount of OBs in a combination with Flubendiamide is at least $1x10^9$ OBs of NPV per 1 mg Flubendiamide, more preferably at least $2,5x10^9$ OBs of NPV per 1 mg Flubendiamide.

[0044] In a more preferred embodiment, the ratio of NPV to Flubendiamide in a combination according to the invention is in a range from $5x10^9$ OBs per 1 mg Flubendiamide to $2x10^{10}$ OBs per 1 mg Flubendiamide.

[0045] For example, the concentration of NPV in a combination with Flubendiamide according to the invention is at least $1x10^7$ OBs/l, more preferably $5x10^7$ OBs/l, even more preferably is at least $1x10^8$ OBs/l.

[0046] Preferably, the concentration of NPV in a combination with Flubendiamide is in the range from $1x10^7$ OBs/l to $5x10^{12}$ OBs/l such as from $1x10^7$ OBs/l to $1,5x10^{10}$ OBs/l, preferably $5x10^7$ OBs/l to $6x10^9$ OBs/l, more preferably in the range from $1x10^8$ OBs/l to $3x10^9$ OB/l, more preferably in the range from $1x10^8$ OBs/l to $1,5x10^9$ OBs/l.

[0047] In one preferred embodiment, the NPV is derived from Helicoverpa zea (Hz), Helicoverpa virescens (Hv), Helicoverpa armigera (Ha) or Helicoverpa punctigera (Hp) NPV (i.e. HzNPV, HvNPV, HaNPV, HpNPV). More preferred the NPV is derived from Helicoverpa zea (Hz) or Helicoverpa armigera (Ha), i.e. is a HzNPV or a HaNPV such as a HzSNPV or a HaSNPV.

[0048] In yet another preferred embodiment, the NPV comprises at least 5 of the following ORFs of FIG. 3: ORF 3, 4, 6, 10, 11, 12, 13, 14, 17, 22, 24, 32, 36, 44, 46, 47, 49, 50, 53, 54, 71, 72, 75, 76, 77,

83, 84, 85, 91, 93, 94, 97, 105, 113, 115, 116, 118, 119, 120, 125, 131, 135, 136 and 137, more preferably the NPV comprises at least ORFs 3 (encoding protein of SEQ ID NO:2), 11 (encoding protein of SEQ ID NO:2), 72 (encoding protein of SEQ ID NO:2), 93 (encoding protein of SEQ ID NO:2) and 125 (encoding protein of SEQ ID NO:2) of Figure 1. More preferably, the NPV comprises at least 10 of the following ORFs of Figure 1: ORF 3, 4, 6, 10, 11, 12, 13, 14, 17, 22, 24, 32, 36, 44, 46, 47, 49, 50, 53, 54, 71, 72, 75, 76, 77, 83, 84, 85, 91, 93, 94, 97, 105, 113, 115, 116, 118, 119, 120, 125, 131, 135, 136 and 137. More preferably, the NPV comprises at least 30 of the following ORFs of Figure 1: ORF 3, 4, 6, 10, 11, 12, 13, 14, 17, 22, 24, 32, 36, 44, 46, 47, 49, 50, 53, 54, 71, 72, 75, 76, 77, 83, 84, 85, 91, 93, 94, 97, 105, 113, 115, 116, 118, 119, 120, 125, 131, 135, 136 and 137. Even more preferably, the NPV comprises at least 40 of the following ORFs of Figure 1: ORF 3, 4, 6, 10, 11, 12, 13, 14, 17, 22, 24, 32, 36, 44, 46, 47, 49, 50, 53, 54, 71, 72, 75, 76, 77, 83, 84, 85, 91, 93, 94, 97, 105, 113, 115, 116, 118, 119, 120, 125, 131, 135, 136 and 137. Even more preferably, the NPV comprises the following ORFs of Figure 1: ORF 3, 4, 6, 10, 11, 12, 13, 14, 17, 22, 24, 32, 36, 44, 46, 47, 49, 50, 53, 54, 71, 72, 75, 76, 77, 83, 84, 85, 91, 93, 94, 97, 105, 113, 115, 116, 118, 119, 120, 125, 131, 135, 136 and 137.

[0049] The positions of the ORFs in the genome as disclosed in NCBI (National Center for Biotechnology Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA) number AF334030 (SEQ ID No:1) are summarized in the following Table 1 which can also be found in Chen et al. 2002, J. of gen. Vir., 83, 673-684.

Table 1: ORFs in the genome of HzSNPV (nucleotide level (nt) and amino acid level (aa)

					HaSNPV homologue			AcMNPV homologue*	
			Length			Identity (%)			Identity (%)
HzSNPV ORF	Name	Position	nt	aa	ORF	nt	aa	ORF	aa
1	*polyhedrin*	1 → 741	741	246	1	99·3	99·6	8	85
2	*orf1629*	738 ← 1979	1242	413	2	99·4	99·3	9	36
3	*pk-1*	1994 → 2797	804	267	3	99·4	100	10	41
4	*ksurt*	2922 ← 5192	2271	756	4	99·9	100	Se4	27
5		5388 → 5567	180	59	5	97·8	96·7		
6		5738 → 6595	858	285	6	99·4	100		
7		6807 ← 6962	156	51	7	98·7	86·5		
8	*ie-0*	6950 → 7807	858	285	8	99·5	99·3	141	31
9	*p49*	7824 → 9230	1407	468	9	99·4	99·8	142	52
10	*odv-e18*	9241 → 9486	246	81	10	99·4	100	143	62
11	*odv-ec27*	9501 → 10355	855	284	11	99·9	100	144	52
12		10399 → 10677	279	92	12	100	100	145	50
13		10704 ← 11315	612	203	13	100	100	146	32
14	*ie-1*	11357 → 13324	1968	655	14	99·8	100	147	30
15	*odv-e56*	13377 ← 14441	1065	354	15	99·6	99·7	148	49
16	*me53*	14591 → 15670	1080	359	16/17	99·0	98·2	139	26
17		15673 → 15840	168	55	18	100	100		
18		15893 ← 16174	282	93	19	97·2	93·6	Ld26	39
19	*p74*	16195 → 18261	2067	688	20	98·2	98·4	138	53
20	*p10*	18314 ← 18577	264	87	21	98·9	98·9	137	26
21	*p26*	18660 ← 19463	804	267	22	98·6	98·9	136	37
22		19576 → 19779	204	67	23	99·5	100	29	32
23	*lef-6*	19855 ← 20418	564	187	24	99·3	99·5	28	30
24	*dbp*	20432 ← 21403	972	323	25	99·8	100	25	36
25	*hr1*	21547 → 22023	477	158	26	98·3	98·5	26	35
26		23950 → 24102	153	50					
27		24045 ← 24812	768	255	27	99·1	98·8	34	31
28	*ubiquitin*	24652 → 24903	252	83	28	99·6	99·8	35	73
29		24967 → 25473	507	168	29	99·4	99·4		
30	*Lsel25‡*	25492 → 26064	573	190	30	98·8	97·9	La25	32
31	*39K/pp31*	26128 ← 27063	936	311	31	99·7	99·7	36	36
32	*lef-11*	27029 ← 27412	384	127	32	100	100	37	35
33		27381 ← 28097	717	238	33	98·5	99·1	38	54
34		28328 → 29407	1080	359	34	99·5	99·2		
35	*p47*	29475 ← 30713	1239	412	35	99·0	98·5	40	56
36		30786 → 31457	672	223	36	99·3	100	41	26
37		31543 → 31785	243	80	37	99·2	100	43	25
38	*lef-8*	31782 ← 34487	2706	901	38	99·2	99·4	50	64
39		34540 → 35118	579	192	39	99·3	99·0	51	25
40		35259 → 35411	153	50	40	95·4	90·2		
41	*chitinase*	35419 ← 37146	1728	575	41	99·3	99·1	126	67
42		37303 ← 37509	207	68					
43		37654 ← 38199	546	181	42	99·6	99·0	52	29
44		38315 → 38725	411	136	43	100	100	53	42
45		38732 ← 39868	1137	378	44	99·7	99·5	Se107	30
46		39876 ← 40103	228	75	45	100	100		
47	*lef-10*	40063 → 40278	216	71	46	100	100	53a	43
48	*vp1054*	40151 → 41206	1056	351	47	99·3	99·1	54	44
49		41326 → 41532	207	68	48	100	100	55	40
50		41533 → 41727	195	64	49	100	100	56	26
51		42007 → 42498	492	163	50	99·6	98·1	57	42
52		42577 ← 43044	468	155	51	98·7	97·4	59	39

					HaSNPV homologue			AcMNPV homologue*	
			Length			Identity (%)			Identity (%)
HzSNPV ORF	Name	Position	nt	aa	ORF	nt	aa	ORF	aa
53		43056 ← 43322	267	88	52	100	100	60	43
54	*fp*	43534 ← 44187	654	217	53	100	100	61	62
55		44359 → 44544	186	61	54	99·5	98·4		
56	*lef-9*	44670 → 46229	1560	519	55	99·5	99·6	62	65
57	*cathepsin*	46313 ← 47416	1104	367	56	99·3	99·5	127	47
58		47457 ← 48044	588	195	57	99·0	98·5	Xc83	33
59	*gp37* *hr2*	48115 ← 48954	840	279	58	98·1	98·2	64	57
60	*bro*	50494 → 51129	636	211	59		39·0	2	21
61	*bro* *hr3*	51240 → 52298	1059	352	60		71·0	2	20
62		52781 ← 52960	180	59					
63	*he65*	53027 → 53737	711	236	61	99·6	99·2	105	29
64	*iap-2*	53814 ← 54566	753	250	62	98·9	99·6	71	34
65		54614 ← 55438	825	274	63	98·4	98·9	69	42
66		55407 ← 55808	402	133	64	99·3	99·3	68	42
67	*lef-3*	55828 → 56967	1140	379	65	99·0	99·2	67	27
68		57074 ← 59431	2358	785	66	99·2	98·9	66	28
69	*DNA pol*	59462 → 62524	3063	1020	67	99·5	99·5	65	47
70		62601 ← 63059	459	152	68	99·4	98·7	74	26
71	*hzORF384*	63125 ← 63508	384	127	69	99·5	100	75	24
72		63514 ← 63771	258	85	70	99·6	100	76	43
73	*vlf-1*	63812 ← 65056	1245	414	71	99·5	99·5	77	70
74		65069 ← 65401	333	110	72	99·1	99·1	78	44
75	*gp41*	65470 ← 66438	969	322	73	99·6	100	80	58
76		66368 ← 67093	726	241	74	99·7	100	81	54
77		66966 ← 67643	678	225	75	99·9	100	82	31
78	*vp91capsid*	67573 → 70023	2451	816	76	99·1	98·6	83	43
79		70026 ← 70202	177	58					
80	*cg30*	70168 ← 71019	852	283	77	99·1	98·6	88	31
81	*vp39capsid*	71108 ← 71989	882	293	78	99·3	99·7	89	45
82	*lef-4*	71988 → 73373	1386	461	79	99·4	99·8	90	46
83		73426 ← 74190	765	254	80	99·4	100	92	55
84		74192 → 74680	489	162	81	99·6	100	93	54
85	*odv-e25*	74726 → 75418	693	230	82	99·3	100	94	44
86		75450 ← 75947	498	165	83	99·0	98·8	Se68	26
87	*helicase*	75966 ← 79727	3762	1253	84	99·4	99·7	95	44
88		79684 → 80205	522	173	85	99·2	98·9	96	49
89		80264 ← 81229	966	321	86	99·5	99·4	98	46
90	*lef-5*	81125 → 82072	948	315	87	99·0	99·1	99	52
91	*p6.9*	82066 ← 82395	330	109	88	100	100	100	44
92		82460 ← 83569	1110	369	89	99·6	99·7	101	43
93		83615 ← 83983	369	122	90	99·5	100	102	26
94		83983 ← 85116	1134	377	91	99·8	100	103	51
95	*vp80capsid*	85211 → 87028	1818	605	92	99·8	99·5	104	23
96		87025 → 87201	177	58	93	98·9	98·3	110	29
97		87216 → 88301	1086	361	94	99·6	100	109	58
98		88346 → 88630	285	94	95	99·0	98·9	108	41
99	*odv-e66*	88697 ← 90715	2019	672	96	99·5	99·7	46	43
100	*p13†* *hr4*	90736 ← 91566	831	276	97	99·4	98·9	Se56	60
101		93744 → 94343	600	199	98	99·3	99·0	115	40
102		94347 → 94703	357	118	99	97·8	95·0		

					HaSNPV homologue			AcMNPV homologue*	
			Length			Identity (%)			Identity (%)
HzSNPV ORF	Name	Position	nt	aa	ORF	nt	aa	ORF	aa
103		94798 → 96324	1527	508	100	98·8	98·8	Se52	24
104		96403 → 97164	762	253	101	99·1	99·6	106/107	47/32
105		97179 → 97511	333	110	102	99·7	100		
106	*iap-3*	97570 ← 98376	807	268	103	99·1	98·1	Se110	38
107		98373 ← 98528	156	51	104	99·4	98·1		
108	*bro*	98632 ← 100137	1506	501	105	99·3	99·4	Ld71	51
109	*sod*	100305 → 100784	480	159	106	99·0	98·1	31	74
110		100791 → 102164	1374	457	107	99·0	99·6		
111		102218 ← 102796	579	192	108	99·7	99·0		
112		102965 → 103312	348	115	109	99·4	99·1		
113		103290 → 103589	300	99	110	99·3	100	117	33
114		103657 → 105243	1587	528	111	99·1	99·1	119	48
115		105240 → 105476	237	78	112	100	100		
116	*fgf*	105499 ← 106404	906	301	113	100	100	32	29
117	*alk-exo*	106531 ← 107817	1287	428	114	98·8	98·6	133	44
118		107837 ← 108226	390	129	115	100	100	19	28
	hr5								
119		109615 ← 110541	927	308	115a	100	100		
120		110742 → 110957	216	71	116	100	100	111	36
121	*lef-2*	111073 ← 111789	717	238	117	99·2	99·7	6	43
122	*p24capsid*	112151 → 112897	747	248	118	99·5	99·2	129	37
123	*gp16*	112959 → 113243	285	94	119	100	100	130	25
124	*calyx/pep*	113295 → 114317	1023	340	120	98·9	99·7	131	36
125		114396 → 114860	465	154	121	100	100	63	29
126		114991 → 115581	591	196	122	99·3	98·5		
127	*38·7kd*	115625 ← 116803	1179	392	123	98·8	98·0	13	27
128	*lef-1*	116805 ← 117542	738	245	124	99·3	99·6	14	39
129		117517 ← 117951	435	144	125	99·8	99·3		
130	*egt*	118096 → 119643	1548	515	126	99·6	99·4	15	47
131		119843 → 120421	579	192	127	99·8	100		
132		120372 → 121172	801	266	128	98·9	97·5	17	24
133		121255 ← 124098	2844	947	129	98·8	98·1	Se30	29
134	*pktp-1*	124439 → 124948	510	169	130	99·6	97·1	24	23
135	*mtf-1*	125015 ← 125812	798	265	131	99·9	100	21	29
136		126074 → 127225	1152	383	132	100	100	22	60
137		127266 ← 129299	2034	677	133	100	100	23	24
138		129441 ← 129983	543	180	134	99·5	96·1		
139		130176 → 130763	588	195	135	97·6	95·4		

* Homologous ORFs from Baculoviruses other than AcMNPV are indicated by Ld (LdMNPV), Ls (Leucania separate NPV), Se (SeMNPV) and Xc (XcGV).

+ Taken from HzSNPV sequence available in GenBank

‡ LsNPV ORF name taken from Wang et al. (1995, Archives of Virology, 140, 2283-2291). Percentage amino acid identity is shown to Lsel25.

[0050] In one preferred embodiment, the NPV is a NPV with a genome sequence having the accession number AF334030 at the NCBI (SEQ ID NO:1).

[0051] In yet another preferred embodiment, the NPV is a NPV with a genome sequence having the accession number KJ909666 at the NCBI (SEQ ID NO:2).

[0052] In yet another preferred embodiment, the NPV is a NPV with a genome sequence which differs from SEQ ID NO:1 or SEQ ID NO:2 by at most 200 amendments, such as at most 150 amendments, at most 100 amendments or at most 50 amendments, such as deletions or exchanges of bases; or the NPV is a NPV with a genome sequence which comprises SEQ ID NO:1 or SEQ ID NO:2 or which comprises a sequence which differs from SEQ ID NO:1 or SEQ ID NO:2 by at most 200 amendments selected from deletions or exchanges of bases.

[0053] A base sequence which has not more than 200 amendments selected from deletions or exchanges of bases compared to SEQ ID NO:1 or SEQ ID NO:2 can be identified by techniques known in the art or combinations thereof, e.g., single-molecule real-time sequencing, pyrosequencing ion semiconductor (ion torrent sequencing, SOLiD sequencing (sequencing by ligation) or Sanger sequencing.

[0054] In another preferred embodiment, the NPV is a HzSNPV having the nucleotide sequence disclosed in NCBI accession number AF334030 (SEQ ID NO:1) or the nucleotide sequence disclosed in NCIMB accession number KJ909666 (SEQ ID NO:2).

Method

[0055] The present invention also refers to a method for combating insecticides, especially lepidopterous pests, comprising the step of treating at least part of a plant with a combination according to the invention.

[0056] The combination can be provided in that the NPV and Flubendiamide are provided simultaneously to at least a part of a plant, e.g. in form of a tank mix (i.e. the active ingredients NPV and Flubendiamide were mixed before applied to at least a part of a plant) or in form of two separated compositions which, however, are simultaneously applied to at least a part of a plant. In this context, "simultaneously" means in this context the time difference between the application of the first active ingredient and the second active ingredient is 1 minute (min) or less than 1 min (e.g., simultaneous application of both active ingredients by two different spray nozzles). Alternatively, Flubendiamide and a NPV are provided separately, whereas Flubendiamide is provided, e.g., as a first application and NPV as a second application to at least a part of a plant. Preferably, the time difference between the application of Flubendiamide (or one of the other diamide compounds) and the following application of the NPV is from more than 1 minute up to 7 days, preferably up to 1 day, such as up to 12 hours, up to 6 hours, up to 3 hours, up to 2 hours or up to 1 hour. Of course, the skilled person understands that

conditions such as heavy rain may reduce the time period between the two applications to still achieve a synergistically active combination on at least a part of a plant. In the latter case, the first active compound must still be present on the plant in an effective amount when delivering the second active compound. However, the amount of Flubendiamide or NPV can be determined by a skilled person by the methods described herein.

[0057] Preferably, the amount of NPV delivered per hectar is in the range from $1x10^{10}$ OBs/ha to $1,5x10^{13}$ OBs/ha, preferably $5x10^{10}$ OBs/ha to $6x10^{12}$ OBs/ha, more preferably in the range from $1x10^{11}$ OBs/ha to $3x10^{12}$ OBs/ha, more preferably in the range from $1x10^{11}$ OBs/ha to $1,5x10^{12}$ OBs/ha.

[0058] Preferably, the amount of Flubendiamide delivered per hectar is in the range from 0,01875 g/ha to 175 g/ha.

[0059] The skilled person understands that the distribution per hectar should be as uniform as possible. This can be achieved by, e.g. spray applications.

Combination

[0060] For the sake of clearness, a combination in the context of the present invention refers to the physical combination comprising the active ingredients NPV and a diamide compound, preferably Flubendiamide (mixture), e.g. on a plant (NPV and diamide compound can be provided at the same time or at different times as long as the first active compound is still present in the required amount when the second compound is provided) or a formulation (e.g. a tank mix). Optionally, a combination can comprise at least one further active ingredient (an insecticide and/or fungicide) and/or further compounds having no insecticidal or fungicidal activity. A mixture means a physical combination of NPV and one of the diamide compounds, especially Flubendiamide, whereas a formulation means a combination of the mixture together with further additives, such as surfactants, solvents, carriers, pigments, antifoams, thickeners and extenders, in a form as suitable for agrochemical application.

[0061] The final used formulation is usually prepared by mixing the NPV with a diamide compound, preferably Flubendiamide or Tetraniliprole, more preferably Flubendiamide, and an inert carrier, and if necessary, by adding a surfactant and/or another auxiliary for formulation, such as an extender, and by formulating the mixture into oil formulation, emulsifiable concentrate, flowable formulation, wettable powder, water dispersible granules, powder, granules, or the like. The formulation, which is used alone or by adding another inert component, can be used as a pesticide.

[0062] Specific further components of this final formulation are described later.

[0063] The "formulation" can be prepared by formulating the NPV and a diamide compound and then making the formulations or their diluents.

[0064] Accordingly, the present invention also relates to combinations, especially formulations, for controlling pests, especially harmful insects, mites, arachnids and nematodes, comprising an effective and non-phytotoxic amount of the inventive combinations, mixtures or formulations. These are preferably pesticidal formulations which comprise agriculturally suitable auxiliaries, solvents, carriers, surfactants or extenders.

[0065] In the context of the present invention, "control of pests" means a reduction in infestation by harmful pests, compared with the untreated plant measured as pesticidal efficacy, preferably a reduction by 25-50 %, compared with the untreated plant (100 %), more preferably a reduction by 50-80 %, compared with the untreated plant (100 %); even more preferably, the infection by pests is entirely suppressed (by 80-100 %). The control may be curative, i.e. for treatment of already infected plants, or protective, for protection of plants which have not yet been infected.

[0066] The present invention also relates to a method for controlling pests, comprising contacting said pests or their habitat with the above-described composition. Preferably, "habitat" means a field, a plantation or a wood.

[0067] The present invention also relates to a method for controlling pests, comprising contacting said pests or their habitat with the above-described formulation.

[0068] The present invention relates further to a method for treating seeds, comprising contacting said seeds with the above-described formulation.

[0069] In one embodiment, the invention refers to a seed coating comprising a NPV and a diamide compound.

[0070] Finally, the present invention also relates to seed treated with the above-mentioned composition.

Crop protection – types of treatment

[0071] The treatment of the plants and plant parts with the compounds of the formula (I) is carried out directly or by action on their surroundings, habitat or storage space using customary treatment methods, for example by dipping, spraying, atomizing, irrigating, evaporating, dusting, fogging, broadcasting, foaming, painting, spreading-on, injecting, watering (drenching), drip irrigating and, in the case of propagation material, in particular in the case of seed, furthermore as a powder for dry seed treatment, a solution for liquid seed treatment, a water-soluble powder for slurry treatment, by incrusting, by coating with one or more coats, etc. It is furthermore possible to apply the compounds of the formula (I) by the ultra-low volume method or to inject the application form or the compound of the formula (I) itself into the soil.

[0072] A preferred direct treatment of the plants is foliar application, i.e. the compounds of the formula (I) are applied to the foliage, where treatment frequency and the application rate should be adjusted according to the level of infestation with the pest in question.

[0073] In the case of systemically active compounds, the compounds of the formula (I) also access the plants via the root system. The plants are then treated by the action of the compounds of the formula (I) on the habitat of the plant. This may be done, for example, by drenching, or by mixing into the soil or the nutrient solution, i.e. the locus of the plant (e.g. soil or hydroponic systems) is impregnated with a liquid form of the compounds of the formula (I), or by soil application, i.e. the compounds of the formula (I) according to the invention are introduced in solid form (e.g. in the form of granules) into the locus of the plants. In the case of paddy rice crops, this can also be done by metering the compound of the formula (I) in a solid application form (for example as granules) into a flooded paddy field.

Formulations

[0074] Suitable organic solvents include all polar and non-polar organic solvents usually employed for formulation purposes. Preferable the solvents are selected from ketones, e.g. methyl-isobutyl-ketone and cyclohexanone, amides, e.g. dimethyl formamide and alkanecarboxylic acid amides, e.g. N,N-dimethyl decaneamide and N,N-dimethyl octanamide, furthermore cyclic solvents, e.g. N-methyl-pyrrolidone, N-octyl-pyrrolidone, N-dodecyl-pyrrolidone, N-octyl-caprolactame, N-dodecyl-caprolactame and butyrolactone, furthermore strong polar solvents, e.g. dimethylsulfoxide, and aromatic hydrocarbons, e.g. xylol, Solvesso™, mineral oils, e.g. white spirit, petroleum, alkyl benzenes and spindle oil, also esters, e.g. propyleneglycol-monomethylether acetate, adipic acid dibutylester, acetic acid hexylester, acetic acid heptylester, citric acid tri-*n*-butylester and phthalic acid di-*n*-butylester, and also alkohols, e.g. benzyl alcohol and 1-methoxy-2-propanol.

[0075] According to the invention, a carrier is a natural or synthetic, organic or inorganic substance with which the active ingredients are mixed or combined for better applicability, in particular for application to plants or plant parts or seed. The carrier, which may be solid or liquid, is generally inert and should be suitable for use in agriculture.

[0076] Useful solid or liquid carriers include: for example ammonium salts and natural rock dusts, such as kaolins, clays, talc, chalk, quartz, attapulgite, montmorillonite or diatomaceous earth, and synthetic rock dusts, such as finely divided silica, alumina and natural or synthetic silicates, resins, waxes, solid fertilizers, water, alcohols, especially butanol, organic solvents, mineral and vegetable oils, and derivatives thereof. Mixtures of such carriers can likewise be used.

[0077] Suitable solid filler and carrier include inorganic particles, e.g. carbonates, silikates, sulphates and oxides with an average particle size of between 0.005 and 20 µm, preferably of between 0.02 to 10 µm, for example ammonium sulphate, ammonium phosphate, urea, calcium carbonate, calcium sulphate, magnesium sulphate, magnesium oxide, aluminium oxide, silicium dioxide, so-called fine-particle silica,

silica gels, natural or synthetic silicates, and alumosilicates and plant products like cereal flour, wood powder/sawdust and cellulose powder.

[0078] Useful solid carriers for granules include: for example crushed and fractionated natural rocks such as calcite, marble, pumice, sepiolite, dolomite, and synthetic granules of inorganic and organic meals, and also granules of organic material such as sawdust, coconut shells, maize cobs and tobacco stalks.

[0079] Useful liquefied gaseous extenders or carriers are those liquids which are gaseous at standard temperature and under standard pressure, for example aerosol propellants such as halohydrocarbons, and also butane, propane, nitrogen and carbon dioxide.

[0080] In the formulations, it is possible to use tackifiers such as carboxymethylcellulose, and natural and synthetic polymers in the form of powders, granules or latices, such as gum arabic, polyvinyl alcohol and polyvinyl acetate, or else natural phospholipids, such as cephalins and lecithins, and synthetic phospholipids. Further additives may be mineral and vegetable oils.

[0081] If the extender used is water, it is also possible to employ, for example, organic solvents as auxiliary solvents. Useful liquid solvents are essentially: aromatics such as xylene, toluene or alkylnaphthalenes, chlorinated aromatics and chlorinated aliphatic hydrocarbons such as chlorobenzenes, chloroethylenes or dichloromethane, aliphatic hydrocarbons such as cyclohexane or paraffins, for example mineral oil fractions, mineral and vegetable oils, alcohols such as butanol or glycol and their ethers and esters, ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone or cyclohexanone, strongly polar solvents such as dimethylformamide and dimethyl sulphoxide, and also water.

[0082] The inventive compositions may additionally comprise further components, for example surfactants. Useful surfactants are emulsifiers and/or foam formers, dispersants or wetting agents having ionic or nonionic properties, or mixtures of these surfactants. Examples of these are salts of polyacrylic acid, salts of lignosulphonic acid, salts of phenolsulphonic acid or naphthalenesulphonic acid, polycondensates of ethylene oxide with fatty alcohols or with fatty acids or with fatty amines, substituted phenols (preferably alkylphenols or arylphenols), salts of sulphosuccinic esters, taurine derivatives (preferably alkyl taurates), phosphoric esters of polyethoxylated alcohols or phenols, fatty esters of polyols, and derivatives of the compounds containing sulphates, sulphonates and phosphates, for example alkylaryl polyglycol ethers, alkylsulphonates, alkylsulphates, arylsulphonates, protein hydrolysates, lignosulphite waste liquors and methylcellulose. The presence of a surfactant is necessary if one of the active ingredients and/or one of the inert carriers is insoluble in water and when application is effected in water. The proportion of surfactants is between 5 and 40 per cent by weight of the inventive composition.

[0083] Suitable surfactants (adjuvants, emulsifiers, dispersants, protective colloids, wetting agent and adhesive) include all common ionic and non-ionic substances, for example ethoxylated nonylphenols, polyalkyl glycolether of linear or branched alcohols, reaction products of alkyl phenols with ethylene oxide and/or propylene oxide, reaction products of fatty acid amines with ethylene oxide and/or propylene oxide, furthermore fattic acid esters, alkyl sulfonates, alkyl sulphates, alkyl ethersulphates, alkyl etherphosphates, arylsulphate, ethoxylated arylalkylphenols, e.g. tristyryl-phenol-ethoxylates, furthermore ethoxylated and propoxylated arylalkylphenols like sulphated or phosphated arylalkylphenol-ethoxylates and -ethoxy- and -propoxylates. Further examples are natural and synthetic, water soluble polymers, e.g. lignosulphonates, gelatine, gum arabic, phospholipides, starch, hydrophobic modified starch and cellulose derivatives, in particular cellulose ester and cellulose ether, further polyvinyl alcohol, polyvinyl acetate, polyvinyl pyrrolidone, polyacrylic acid, polymethacrylic acid and co-polymerisates of (meth)acrylic acid and (meth)acrylic acid esters, and further co-polymerisates of methacrylic acid and methacrylic acid esters which are neutralized with alkalimetal hydroxide and also condensation products of optionally substituted naphthalene sulfonic acid salts with formaldehyde.

[0084] It is possible to use dyes such as inorganic pigments, for example iron oxide, titanium oxide and Prussian Blue, and organic dyes such as alizarin dyes, azo dyes and metal phthalocyanine dyes, and trace nutrients such as salts of iron, manganese, boron, copper, cobalt, molybdenum and zinc.

[0085] Antifoams which may be present in the formulations include e.g. silicone emulsions, longchain alcohols, fattiy acids and their salts as well as fluoroorganic substances and mixtures therof.

[0086] Examples of thickeners are polysaccharides, e.g. xanthan gum or veegum, silicates, e.g. attapulgite, bentonite as well as fine-particle silica.

[0087] If appropriate, it is also possible for other additional components to be present, for example protective colloids, binders, adhesives, thickeners, thixotropic substances, penetrants, stabilizers, sequestrants, complexing agents. In general, the active ingredients can be combined with any solid or liquid additive commonly used for formulation purposes.

[0088] The inventive mixtures or compositions can be used as such or, depending on their particular physical and/or chemical properties, in the form of their formulations or the use forms prepared therefrom, such as aerosols, capsule suspensions, cold-fogging concentrates, warm-fogging concentrates, encapsulated granules, fine granules, flowable concentrates for the treatment of seed, ready-to-use solutions, dustable powders, emulsifiable concentrates, oil-in-water emulsions, water-in-oil emulsions, macrogranules, microgranules, oil-dispersible powders, oil-miscible flowable concentrates, oil-miscible liquids, gas (under pressure), gas generating product, foams, pastes, pesticide coated seed, suspension concentrates, suspoemulsion concentrates, soluble concentrates, suspensions, wettable powders, soluble powders, dusts and granules, water-soluble and water-dispersible granules or tablets, water-soluble and water-dispersible powders for the treatment of seed, wettable powders, natural

products and synthetic substances impregnated with active ingredient, and also microencapsulations in polymeric substances and in coating materials for seed, and also ULV cold-fogging and warm-fogging formulations.

[0089] The inventive compositions include not only formulations which are already ready for use and can be applied with a suitable apparatus to the plant or the seed, but also commercial concentrates which have to be diluted with water prior to use. Customary applications are for example dilution in water and subsequent spraying of the resulting spray liquor, application after dilution in oil, direct application without dilution, seed treatment or soil application of granules.

[0090] The inventive mixtures, compositions and formulations generally contain between 0.05 and 99 % by weight, 0.01 and 98 % by weight, preferably between 0.1 and 95 % by weight, more preferably between 0.5 and 90 % of active ingredient, most preferably between 10 and 70 % by weight. For special applications, e.g. for protection of wood and derived timber products the inventive mixtures, compositions and formulations generally contain between 0.0001 and 95 % by weight, preferably 0.001 to 60 % by weight of active ingredient.

[0091] The contents of active ingredient in the application forms prepared from the formulations may vary in a broad range. The concentration of the active ingredients in the application forms is generally between 0.000001 to 95 % by weight, preferably between 0.0001 and 2 % by weight.

[0092] The formulations mentioned can be prepared in a manner known per se, for example by mixing the active ingredients with at least one customary extender, solvent or diluent, adjuvant, emulsifier, dispersant, and/or binder or fixative, wetting agent, water repellent, if appropriate desiccants and UV stabilizers and, if appropriate, dyes and pigments, antifoams, preservatives, inorganic and organic thickeners, adhesives, gibberellins and also further processing auxiliaries and also water. Depending on the formulation type to be prepared further processing steps are necessary, e.g. wet grinding, dry grinding and granulation.

[0093] The inventive mixtures or compositions may be present as such or in their (commercial) formulations and in the use forms prepared from these formulations as a mixture with other (known) active ingredients, such as insecticides, attractants, sterilants, bactericides, acaricides, nematicides, fungicides, growth regulators, herbicides, fertilizers, safeners and/or semiochemicals.

[0094] The inventive treatment of the plants and plant parts with the mixtures or compositions is effected directly or by action on their surroundings, habitat or storage space by the customary treatment methods, for example by dipping, spraying, atomizing, irrigating, evaporating, dusting, fogging, broadcasting, foaming, painting, spreading-on, watering (drenching), drip irrigating and, in the case of propagation material, especially in the case of seeds, also by dry seed treatment, wet seed treatment, slurry treatment, incrustation, coating with one or more coats, etc. It is also possible to deploy the

mixtures or compositions by the ultra-low volume method or to inject the mixtures or compositions preparation or the mixtures or compositions itself into the soil.

[0095] The combinations according to the invention can preferably be used as pesticidal combinations. They are active against normally sensitive and resistant species and against all or some stages of development. The abovementioned pests include:

[0096] pests from the phylum of the Arthropoda, in particular from the class of the Arachnida, for example Acarus spp., for example Acarus siro, Aceria kuko, Aceria sheldoni, Aculops spp., Aculus spp., for example Aculus fockeui, Aculus schlechtendali, Amblyomma spp., Amphitetranychus viennensis, Argas spp., Boophilus spp., Brevipalpus spp., for example Brevipalpus phoenicis, Bryobia graminum, Bryobia praetiosa, Centruroides spp., Chorioptes spp., Dermanyssus gallinae, Dermatophagoides pteronyssinus, Dermatophagoides farinae, Dermacentor spp., Eotetranychus spp., for example Eotetranychus hicoriae, Epitrimerus pyri, Eutetranychus spp., for example Eutetranychus banksi, Eriophyes spp., for example Eriophyes pyri, Glycyphagus domesticus, Halotydeus destructor, Hemitarsonemus spp., for example Hemitarsonemus latus (=Polyphagotarsonemus latus), Hyalomma spp., Ixodes spp., Latrodectus spp., Loxosceles spp., Neutrombicula autumnalis, Nuphersa spp., Oligonychus spp., for example Oligonychus coffeae, Oligonychus coniferarum, Oligonychus ilicis, Oligonychus indicus, Oligonychus mangiferus, Oligonychus pratensis, Oligonychus punicae, Oligonychus yothersi, Ornithodorus spp., Ornithonyssus spp., Panonychus spp., for example Panonychus citri (=Metatetranychus citri), Panonychus ulmi (=Metatetranychus ulmi), Phyllocoptruta oleivora, Platytetranychus multidigituli, Polyphagotarsonemus latus, Psoroptes spp., Rhipicephalus spp., Rhizoglyphus spp., Sarcoptes spp., Scorpio maurus, Steneotarsonemus spp., Steneotarsonemus spinki, Tarsonemus spp., for example Tarsonemus confusus, Tarsonemus pallidus, Tetranychus spp., for example Tetranychus canadensis, Tetranychus cinnabarinus, Tetranychus turkestani, Tetranychus urticae, Trombicula alfreddugesi, Vaejovis spp., Vasates lycopersici;

[0097] from the class of the Chilopoda, for example Geophilus spp., Scutigera spp.;

[0098] from the order or the class of the Collembola, for example Onychiurus armatus; Sminthurus viridis;

[0099] from the class of the Diplopoda, for example Blaniulus guttulatus;

[0100] from the class of the Insecta, for example from the order of the Blattodea, for example Blatta orientalis, Blattella asahinai, Blattella germanica, Leucophaea maderae, Loboptera decipiens, Neostylopyga rhombifolia, Panchlora spp., Parcoblatta spp., Periplaneta spp., for example Periplaneta americana, Periplaneta australasiae, Pycnoscelus surinamensis, Supella longipalpa;

[0101] from the order of the Coleoptera, for example Acalymma vittatum, Acanthoscelides obtectus, Adoretus spp., Aethina tumida, Agelastica alni, Agrilus spp., for example Agrilus planipennis, Agrilus

coxalis, Agrilus bilineatus, Agrilus anxius, Agriotes spp., for example Agriotes linneatus, Agriotes mancus, Alphitobius diaperinus, Amphimallon solstitialis, Anobium punctatum, Anoplophora spp., for example Anoplophora glabripennis, Anthonomus spp., for example Anthonomus grandis, Anthrenus spp., Apion spp., Apogonia spp., Atomaria spp., for example Atomaria linearis, Attagenus spp., Baris caerulescens, Bruchidius obtectus, Bruchus spp., for example Bruchus pisorum, Bruchus rufimanus, Cassida spp., Cerotoma trifurcata, Ceutorrhynchus spp., for example Ceutorrhynchus assimilis, Ceutorrhynchus quadridens, Ceutorrhynchus rapae, Chaetocnema spp., for example Chaetocnema confinis, Chaetocnema denticulata, Chaetocnema ectypa, Cleonus mendicus, Conoderus spp., Cosmopolites spp., for example Cosmopolites sordidus, Costelytra zealandica, Ctenicera spp., Curculio spp., for example Curculio caryae, Curculio caryatrypes,Curculio obtusus, Curculio sayi, Cryptolestes ferrugineus, Cryptolestes pusillus, Cryptorhynchus lapathi, Cryptorhynchus mangiferae, Cylindrocopturus spp., Cylindrocopturus adspersus, Cylindrocopturus furnissi, Dendroctonus spp., for example Dendroctonus ponderosae, Dermestes spp., Diabrotica spp., for example Diabrotica balteata, Diabrotica barberi, Diabrotica undecimpunctata howardi, Diabrotica undecimpunctata undecimpunctata, Diabrotica virgifera virgifera, Diabrotica virgifera zeae, Dichocrocis spp., Dicladispa armigera, Diloboderus spp., Epicaerus spp., Epilachna spp., for example Epilachna borealis, Epilachna varivestis, Epitrix spp., for example Epitrix cucumeris, Epitrix fuscula, Epitrix hirtipennis, Epitrix subcrinita, Epitrix tuberis, Faustinus spp., Gibbium psylloides, Gnathocerus cornutus, Hellula undalis, Heteronychus arator, Heteronyx spp., Hylamorpha elegans, Hylotrupes bajulus, Hypera postica, Hypomeces squamosus, Hypothenemus spp., for example Hypothenemus hampei, Hypothenemus obscurus, Hypothenemus pubescens, Lachnosterna consanguinea, Lasioderma serricorne, Latheticus oryzae, Lathridius spp., Lema spp., Leptinotarsa decemlineata, Leucoptera spp., for example Leucoptera coffeella, Lissorhoptrus oryzophilus, Listronotus (= Hyperodes) spp., Lixus spp., Luperodes spp., Luperomorpha xanthodera, Lyctus spp., Megacyllene spp., for example Megacyllene robiniae, Megascelis spp., Melanotus spp., for example Melanotus longulus oregonensis, Meligethes aeneus, Melolontha spp., for example Melolontha melolontha, Migdolus spp., Monochamus spp., Naupactus xanthographus, Necrobia spp., Neogalerucella spp., Niptus hololeucus, Oryctes rhinoceros, Oryzaephilus surinamensis, Oryzaphagus oryzae, Otiorhynchus spp., for example Otiorhynchus cribricollis, Otiorhynchus ligustici, Otiorhynchus ovatus, Otiorhynchus rugosostriarus, Otiorhynchus sulcatus, Oulema spp., for example Oulema melanopus, Oulema oryzae, Oxycetonia jucunda, Phaedon cochleariae, Phyllophaga spp., Phyllophaga helleri, Phyllotreta spp., for example Phyllotreta armoraciae, Phyllotreta pusilla, Phyllotreta ramosa, Phyllotreta striolata, Popillia japonica, Premnotrypes spp., Prostephanus truncatus, Psylliodes spp., for example Psylliodes affinis, Psylliodes chrysocephala, Psylliodes punctulata, Ptinus spp., Rhizobius ventralis, Rhizopertha dominica, Rhynchophorus spp., Rhynchophorus ferrugineus, Rhynchophorus palmarum, Scolytus spp., for example Scolytus multistriatus, Sinoxylon perforans, Sitophilus spp., for example Sitophilus granarius, Sitophilus linearis, Sitophilus oryzae, Sitophilus zeamais, Sphenophorus spp., Stegobium paniceum, Sternechus spp., for example Sternechus paludatus, Symphyletes spp., Tanymecus spp., for example Tanymecus dilaticollis,

Tanymecus indicus, Tanymecus palliatus, Tenebrio molitor, Tenebrioides mauretanicus, Tribolium spp., for example Tribolium audax, Tribolium castaneum, Tribolium confusum, Trogoderma spp., Tychius spp., Xylotrechus spp., Zabrus spp., for example Zabrus tenebrioides;

[0102] from the order of the Dermaptera, for example Anisolabis maritime, Forficula auricularia, Labidura riparia;

[0103] from the order of the Diptera, for example Aedes spp., for example Aedes aegypti, Aedes albopictus, Aedes sticticus, Aedes vexans, Agromyza spp., for example Agromyza frontella, Agromyza parvicornis, Anastrepha spp., Anopheles spp., for example Anopheles quadrimaculatus, Anopheles gambiae, Asphondylia spp., Bactrocera spp., for example Bactrocera cucurbitae, Bactrocera dorsalis, Bactrocera oleae, Bibio hortulanus, Calliphora erythrocephala, Calliphora vicina, Ceratitis capitata, Chironomus spp., Chrysomya spp., Chrysops spp., Chrysozona pluvialis, Cochliomya spp., Contarinia spp., for example Contarinia johnsoni, Contarinia nasturtii, Contarinia pyrivora, Contarinia schulzi, Contarinia sorghicola, Contarinia tritici,Cordylobia anthropophaga, Cricotopus sylvestris, Culex spp., for example Culex pipiens, Culex quinquefasciatus, Culicoides spp., Culiseta spp., Cuterebra spp., Dacus oleae, Dasineura spp., for example Dasineura brassicae, Delia spp., for example Delia antiqua, Delia coarctata, Delia florilega, Delia platura, Delia radicum, Dermatobia hominis, Drosophila spp., for example Drosphila melanogaster, Drosophila suzukii, Echinocnemus spp., Euleia heraclei, Fannia spp., Gasterophilus spp., Glossina spp., Haematopota spp., Hydrellia spp., Hydrellia griseola, Hylemya spp., Hippobosca spp., Hypoderma spp., Liriomyza spp., for example Liriomyza brassicae, Liriomyza huidobrensis, Liriomyza sativae, Lucilia spp., for example Lucilia cuprina, Lutzomyia spp., Mansonia spp., Musca spp., for example Musca domestica, Musca domestica vicina, Oestrus spp., Oscinella frit, Paratanytarsus spp., Paralauterborniella subcincta, Pegomya or Pegomyia spp., for example Pegomya betae, Pegomya hyoscyami, Pegomya rubivora, Phlebotomus spp., Phorbia spp., Phormia spp., Piophila casei, Platyparea poeciloptera, Prodiplosis spp., Psila rosae, Rhagoletis spp., for example Rhagoletis cingulata, Rhagoletis completa, Rhagoletis fausta, Rhagoletis indifferens, Rhagoletis mendax, Rhagoletis pomonella, Sarcophaga spp., Simulium spp., for example Simulium meridionale, Stomoxys spp., Tabanus spp., Tetanops spp., Tipula spp., for example Tipula paludosa, Tipula simplex, Toxotrypana curvicauda;

[0104] from the order of the Hemiptera, for example Acizzia acaciaebaileyanae, Acizzia dodonaeae, Acizzia uncatoides, Acrida turrita, Acyrthosipon spp., for example Acyrthosiphon pisum, Acrogonia spp., Aeneolamia spp., Agonoscena spp., Aleurocanthus spp., Aleyrodes proletella, Aleurolobus barodensis, Aleurothrixus floccosus, Allocaridara malayensis, Amrasca spp., for example Amrasca bigutulla, Amrasca devastans, Anuraphis cardui, Aonidiella spp., for example Aonidiella aurantii, Aonidiella citrina, Aonidiella inornata, Aphanostigma piri, Aphis spp., for example Aphis citricola, Aphis craccivora, Aphis fabae, Aphis forbesi, Aphis glycines, Aphis gossypii, Aphis hederae, Aphis illinoisensis, Aphis middletoni, Aphis nasturtii, Aphis nerii, Aphis pomi, Aphis spiraecola, Aphis

viburniphila, Arboridia apicalis, Arytainilla spp., Aspidiella spp., Aspidiotus spp., for example Aspidiotus nerii, Atanus spp., Aulacorthum solani, Bemisia tabaci, Blastopsylla occidentalis, Boreioglycaspis melaleucae, Brachycaudus helichrysi, Brachycolus spp., Brevicoryne brassicae, Cacopsylla spp., for example Cacopsylla pyricola, Calligypona marginata, Capulinia spp., Carneocephala fulgida, Ceratovacuna lanigera, Cercopidae, Ceroplastes spp., Chaetosiphon fragaefolii, Chionaspis tegalensis, Chlorita onukii, Chondracris rosea, Chromaphis juglandicola, Chrysomphalus aonidum, Chrysomphalus ficus, Cicadulina mbila, Coccomytilus halli, Coccus spp., for example Coccus hesperidum, Coccus longulus, Coccus pseudomagnoliarum, Coccus viridis, Cryptomyzus ribis, Cryptoneossa spp., Ctenarytaina spp., Dalbulus spp., Dialeurodes chittendeni, Dialeurodes citri, Diaphorina citri, Diaspis spp., Diuraphis spp., Doralis spp., Drosicha spp., Dysaphis spp., for example Dysaphis apiifolia, Dysaphis plantaginea, Dysaphis tulipae, Dysmicoccus spp., Empoasca spp., for example Empoasca abrupta, Empoasca fabae, Empoasca maligna, Empoasca solana, Empoasca stevensi, Eriosoma spp., for example Eriosoma americanum, Eriosoma lanigerum, Eriosoma pyricola, Erythroneura spp., Eucalyptolyma spp., Euphyllura spp., Euscelis bilobatus, Ferrisia spp., Fiorinia spp., Furcaspis oceanica, Geococcus coffeae, Glycaspis spp., Heteropsylla cubana, Heteropsylla spinulosa, Homalodisca coagulata, Hyalopterus arundinis, Hyalopterus pruni, Icerya spp., for example Icerya purchasi, Idiocerus spp., Idioscopus spp., Laodelphax striatellus, Lecanium spp., for example Lecanium corni (=Parthenolecanium corni), Lepidosaphes spp., for example Lepidosaphes ulmi, Lipaphis erysimi, Lopholeucaspis japonica, Lycorma delicatula, Macrosiphum spp., for example Macrosiphum euphorbiae, Macrosiphum lilii, Macrosiphum rosae, Macrosteles facifrons, Mahanarva spp., Melanaphis sacchari, Metcalfiella spp., Metcalfa pruinosa, Metopolophium dirhodum, Monellia costalis, Monelliopsis pecanis, Myzus spp., for example Myzus ascalonicus, Myzus cerasi, Myzus ligustri, Myzus ornatus, Myzus persicae,. Myzus nicotianae, Nasonovia ribisnigri, Neomaskellia spp., Nephotettix spp., for example Nephotettix cincticeps,, Nephotettix nigropictus, Nettigoniclla spectra, Nilaparvata lugens, Oncometopia spp., Orthezia praelonga, Oxya chinensis, Pachypsylla spp., Parabemisia myricae, Paratrioza spp., for example Paratrioza cockerelli, Parlatoria spp., Pemphigus spp., for example Pemphigus bursarius, Pemphigus populivenae, Peregrinus maidis, Perkinsiella spp., Phenacoccus spp., for example Phenacoccus madeirensis, Phloeomyzus passerinii, Phorodon humuli, Phylloxera spp., for example Phylloxera devastatrix, Phylloxera notabilis, Pinnaspis aspidistrae, Planococcus spp., for example Planococcus citri, Prosopidopsylla flava, Protopulvinaria pyriformis, Pseudaulacaspis pentagona, Pseudococcus spp., for example Pseudococcus calceolariae, Pseudococcus comstocki, Pseudococcus longispinus, Pseudococcus maritimus, Pseudococcus viburni, Psyllopsis spp., Psylla spp., for example Psylla buxi, Psylla mali, Psylla pyri, Pteromalus spp., Pulvinaria spp., Pyrilla spp., Quadraspidiotus spp., for example Quadraspidiotus juglansregiae, Quadraspidiotus ostreaeformis, Quadraspidiotus perniciosus, Quesada gigas, Rastrococcus spp., Rhopalosiphum spp., for example Rhopalosiphum maidis, Rhopalosiphum oxyacanthae, Rhopalosiphum padi, Rhopalosiphum rufiabdominale, Saissetia spp., for example Saissetia coffeae, Saissetia miranda, Saissetia neglecta, Saissetia oleae, Scaphoideus titanus, Schizaphis graminum, Selenaspidus articulatus, Sipha flava,

Sitobion avenae, Sogata spp., Sogatella furcifera, Sogatodes spp., Stictocephala festina, Siphoninus phillyreae, Tenalaphara malayensis,Tetragonocephela spp., Tinocallis caryaefoliae, Tomaspis spp., Toxoptera spp., for example Toxoptera aurantii, Toxoptera citricidus, Trialeurodes vaporariorum, Trioza spp., for example Trioza diospyri, Typhlocyba spp., Unaspis spp., Viteus vitifolii, Zygina spp.;

[0105] from the suborder of the Heteroptera, for example Aelia spp., Anasa tristis, Antestiopsis spp., Boisea spp., Blissus spp., Calocoris spp., Campylomma livida, Cavelerius spp., Cimex spp., for example Cimex adjunctus, Cimex hemipterus, Cimex lectularius, Cimex pilosellus, Collaria spp., Creontiades dilutus, Dasynus piperis, Dichelops furcatus, Diconocoris hewetti, Dysdercus spp., Euschistus spp., for example Euschistus heros, Euschistus servus, Euschistus tristigmus, Euschistus variolarius, Eurydema spp., Eurygaster spp., Halyomorpha halys, Heliopeltis spp., Horcias nobilellus, Leptocorisa spp., Leptocorisa varicornis, Leptoglossus occidentalis, Leptoglossus phyllopus, Lygocoris spp., for example Lygocoris pabulinus, Lygus spp., for example Lygus elisus, Lygus hesperus, Lygus lineolaris, Macropes excavatus, Megacopta cribraria, Miridae, Monalonion atratum, Nezara spp., for example Nezara viridula, Nysius spp., Oebalus spp., Pentomidae, Piesma quadrata, Piezodorus spp., for example Piezodorus guildinii, Psallus spp., Pseudacysta persea, Rhodnius spp., Sahlbergella singularis, Scaptocoris castanea, Scotinophora spp., Stephanitis nashi, Tibraca spp., Triatoma spp.;

[0106] from the order of the Hymenoptera, for example Acromyrmex spp., Athalia spp., for example Athalia rosae, Atta spp., Camponotus spp., Dolichovespula spp., Diprion spp., for example Diprion similis, Hoplocampa spp., for example Hoplocampa cookei, Hoplocampa testudinea, Lasius spp., Linepithema (Iridiomyrmex) humile, Monomorium pharaonis, Paratrechina spp., Paravespula spp., Plagiolepis spp., Sirex spp., for example Sirex noctilio, Solenopsis invicta, Tapinoma spp., Technomyrmex albipes, Urocerus spp., Vespa spp., for example Vespa crabro, Wasmannia auropunctata, Xeris spp.;

[0107] from the order of the Isopoda, for example Armadillidium vulgare, Oniscus asellus, Porcellio scaber;

[0108] from the order of the Isoptera, for example Coptotermes spp., for example Coptotermes formosanus, Cornitermes cumulans, Cryptotermes spp., Incisitermes spp., Kalotermes spp., Microtermes obesi, Nasutitermes spp., Odontotermes spp., Porotermes spp., Reticulitermes spp., for example Reticulitermes flavipes, Reticulitermes hesperus;

[0109] from the order of the Lepidoptera, for example Achroia grisella, Acronicta major, Adoxophyes spp., for example Adoxophyes orana, Aedia leucomelas, Agrotis spp., for example Agrotis segetum, Agrotis ipsilon, Alabama spp., for example Alabama argillacea, Amyelois transitella, Anarsia spp., Anticarsia spp., for example Anticarsia gemmatalis, Argyroploce spp., Autographa spp., Barathra brassicae, Blastodacna atra, Borbo cinnara, Bucculatrix thurberiella, Bupalus piniarius, Busseola spp., Cacoecia spp., Caloptilia theivora, Capua reticulana, Carpocapsa pomonella, Carposina niponensis,

Cheimatobia brumata, Chilo spp., for example Chilo plejadellus, Chilo suppressalis, Choreutis pariana, Choristoneura spp., Chrysodeixis chalcites, Clysia ambiguella, Cnaphalocerus spp., Cnaphalocrocis medinalis, Cnephasia spp., Conopomorpha spp., Conotrachelus spp., Copitarsia spp., Cydia spp., for example Cydia nigricana, Cydia pomonella, Dalaca noctuides, Diaphania spp., Diparopsis spp., Diatraea saccharalis, Dioryctria spp., for example Dioryctria zimmermani, Earias spp., Ecdytolopha aurantium, Elasmopalpus lignosellus, Eldana saccharina, Ephestia spp., for example Ephestia elutella, Ephestia kuehniella, Epinotia spp., Epiphyas postvittana, Erannis spp., Erschoviella musculana, Etiella spp., Eudocima spp., Eulia spp., Eupoecilia ambiguella, Euproctis spp., for example Euproctis chrysorrhoea, Euxoa spp., Feltia spp., Galleria mellonella, Gracillaria spp., Grapholitha spp., for example Grapholita molesta, Grapholita prunivora, Hedylepta spp., Helicoverpa spp., for example Helicoverpa armigera, Helicoverpa zea, Heliothis spp., for example Heliothis virescens, Hofmannophila pseudospretella, Homoeosoma spp., Homona spp., Hyponomeuta padella, Kakivoria flavofasciata, Lampides spp., Laphygma spp., Laspeyresia molesta, Leucinodes orbonalis, Leucoptera spp., for example Leucoptera coffeella, Lithocolletis spp., for example Lithocolletis blancardella, Lithophane antennata, Lobesia spp., for example Lobesia botrana, Loxagrotis albicosta, Lymantria spp., for example Lymantria dispar, Lyonetia spp., for example Lyonetia clerkella, Malacosoma neustria, Maruca testulalis, Mamestra brassicae, Melanitis leda, Mocis spp., Monopis obviella, Mythimna separata, Nemapogon cloacellus, Nymphula spp., Oiketicus spp., Omphisa spp., Operophtera spp., Oria spp., Orthaga spp., Ostrinia spp., for example Ostrinia nubilalis, Panolis flammea, Parnara spp., Pectinophora spp., for example Pectinophora gossypiella, Perileucoptera spp., Phthorimaea spp., for example Phthorimaea operculella, Phyllocnistis citrella, Phyllonorycter spp., for example Phyllonorycter blancardella, Phyllonorycter crataegella, Pieris spp., for example Pieris rapae, Platynota stultana, Plodia interpunctella, Plusia spp., Plutella xylostella (=Plutella maculipennis), Podesia spp., for example Podesia syringae, Prays spp., Prodenia spp., Protoparce spp., Pseudaletia spp., for example Pseudaletia unipuncta, Pseudoplusia includens, Pyrausta nubilalis, Rachiplusia nu, Schoenobius spp., for example Schoenobius bipunctifer, Scirpophaga spp., for example Scirpophaga innotata, Scotia segetum, Sesamia spp., for example Sesamia inferens, Sparganothis spp., Spodoptera spp., for example Spodoptera eradiana, Spodoptera exigua, Spodoptera frugiperda, Spodoptera praefica, Stathmopoda spp., Stenoma spp., Stomopteryx subsecivella, Synanthedon spp., Tecia solanivora, Thaumetopoea spp., Thermesia gemmatalis, Tinea cloacella, Tinea pellionella, Tineola bisselliella, Tortrix spp., Trichophaga tapetzella, Trichoplusia spp., for example Trichoplusia ni, Tryporyza incertulas, Tuta absoluta, Virachola spp.;

[0110] from the order of the Orthoptera or Saltatoria, for example Acheta domesticus, Dichroplus spp., Gryllotalpa spp., for example Gryllotalpa gryllotalpa, Hieroglyphus spp., Locusta spp., for example Locusta migratoria, Melanoplus spp., for example Melanoplus devastator, Paratlanticus ussuriensis, Schistocerca gregaria;

[0111] from the order of the Phthiraptera, for example Damalinia spp., Haematopinus spp., Linognathus spp., Pediculus spp., Phylloxera vastatrix, Phthirus pubis, Trichodectes spp.;

[0112] from the order of the Psocoptera, for example Lepinotus spp., Liposcelis spp.;

[0113] from the order of the Siphonaptera, for example, Ceratophyllus spp., Ctenocephalides spp., for example Ctenocephalides canis, Ctenocephalides felis, Pulex irritans, Tunga penetrans, Xenopsylla cheopis;

[0114] from the order of the Thysanoptera, for example Anaphothrips obscurus, Baliothrips biformis, Chaetanaphothrips leeuweni, Drepanothrips reuteri, Enneothrips flavens, Frankliniella spp., for example Frankliniella fusca, Frankliniella occidentalis, Frankliniella schultzei, Frankliniella tritici, Frankliniella vaccinii, Frankliniella williamsi, Haplothrips spp., Heliothrips spp., Hercinothrips femoralis, Kakothrips spp., Rhipiphorothrips cruentatus, Scirtothrips spp., Taeniothrips cardamomi, Thrips spp., for example Thrips palmi, Thrips tabaci;

[0115] from the order of the Zygentoma (= Thysanura), for example Ctenolepisma spp., Lepisma saccharina, Lepismodes inquilinus, Thermobia domestica;

[0116] from the class of the Symphyla, for example Scutigerella spp., for example Scutigerella immaculata;

[0117] pests from the phylum of the Mollusca, for example from the class of the Bivalvia, for example Dreissena spp.,

[0118] and also from the class of the Gastropoda, for example Arion spp., for example Arion ater rufus, Biomphalaria spp., Bulinus spp., Deroceras spp., for example Deroceras laeve, Galba spp., Lymnaea spp., Oncomelania spp., Pomacea spp., Succinea spp.;

[0119] plant pests from the phylum of the Nematoda, i.e. phytoparasitic nematodes, in particular Aglenchus spp., for example Aglenchus agricola, Anguina spp., for example Anguina tritici, Aphelenchoides spp., for example Aphelenchoides arachidis, Aphelenchoides fragariae, Belonolaimus spp., for example Belonolaimus gracilis, Belonolaimus longicaudatus, Belonolaimus nortoni, Bursaphelenchus spp., for example Bursaphelenchus cocophilus, Bursaphelenchus eremus, Bursaphelenchus xylophilus, Cacopaurus spp., for example Cacopaurus pestis, Criconemella spp., for example Criconemella curvata, Criconemella onoensis, Criconemella ornata, Criconemella rusium, Criconemella xenoplax (= Mesocriconema xenoplax), Criconemoides spp., for example Criconemoides ferniae, Criconemoides onoense, Criconemoides ornatum, Ditylenchus spp., for example Ditylenchus dipsaci, Dolichodorus spp., Globodera spp., for example Globodera pallida, Globodera rostochiensis, Helicotylenchus spp., for example Helicotylenchus dihystera, Hemicriconemoides spp., Hemicycliophora spp., Heterodera spp., for example Heterodera avenae, Heterodera glycines, Heterodera schachtii, Hirschmaniella spp., Hoplolaimus spp., Longidorus spp., for example Longidorus africanus, Meloidogyne spp., for example Meloidogyne chitwoodi, Meloidogyne fallax, Meloidogyne hapla, Meloidogyne incognita, Meloinema spp., Nacobbus spp., Neotylenchus spp., .Paralongidorus

spp., Paraphelenchus spp., Paratrichodorus spp., for example Paratrichodorus minor, Paratylenchus spp., Pratylenchus spp., for example Pratylenchus penetrans, Pseudohalenchus spp., Psilenchus spp., Punctodera spp., Quinisulcius spp., Radopholus spp., for example Radopholus citrophilus, Radopholus similis, Rotylenchulus spp., Rotylenchus spp., Scutellonema spp., Subanguina spp., Trichodorus spp., for example Trichodorus obtusus, Trichodorus primitivus, Tylenchorhynchus spp., for example Tylenchorhynchus annulatus, Tylenchulus spp., for example Tylenchulus semipenetrans, Xiphinema spp., for example Xiphinema index.

[0120] Especially preferred, the combinations according to the invention can be used against pests from the order of the Lepidoptera, for example Achroia grisella, Acronicta major, Adoxophyes spp., for example Adoxophyes orana, Aedia leucomelas, Agrotis spp., for example Agrotis segetum, Agrotis ipsilon, Alabama spp., for example Alabama argillacea, Amyelois transitella, Anarsia spp., Anticarsia spp., for example Anticarsia gemmatalis, Argyroploce spp., Autographa spp., Barathra brassicae, Blastodacna atra, Borbo cinnara, Bucculatrix thurberiella, Bupalus piniarius, Busseola spp., Cacoecia spp., Caloptilia theivora, Capua reticulana, Carpocapsa pomonella, Carposina niponensis, Cheimatobia brumata, Chilo spp., for example Chilo plejadellus, Chilo suppressalis, Choreutis pariana, Choristoneura spp., Chrysodeixis chalcites, Clysia ambiguella, Cnaphalocerus spp., Cnaphalocrocis medinalis, Cnephasia spp., Conopomorpha spp., Conotrachelus spp., Copitarsia spp., Cydia spp., for example Cydia nigricana, Cydia pomonella, Dalaca noctuides, Diaphania spp., Diparopsis spp., Diatraea saccharalis, Dioryctria spp., for example Dioryctria zimmermani, Earias spp., Ecdytolopha aurantium, Elasmopalpus lignosellus, Eldana saccharina, Ephestia spp., for example Ephestia elutella, Ephestia kuehniella, Epinotia spp., Epiphyas postvittana, Erannis spp., Erschoviella musculana, Etiella spp., Eudocima spp., Eulia spp., Eupoecilia ambiguella, Euproctis spp., for example Euproctis chrysorrhoea, Euxoa spp., Feltia spp., Galleria mellonella, Gracillaria spp., Grapholitha spp., for example Grapholita molesta, Grapholita prunivora, Hedylepta spp., Helicoverpa spp., for example Helicoverpa armigera, Helicoverpa zea, Helicoverpa virescens, and Helicoverpa punctigera, Heliothis spp., for example Heliothis virescens, Hofmannophila pseudospretella, Homoeosoma spp., Homona spp., Hyponomeuta padella, Kakivoria flavofasciata, Lampides spp., Laphygma spp., Laspeyresia molesta, Leucinodes orbonalis, Leucoptera spp., for example Leucoptera coffeella, Lithocolletis spp., for example Lithocolletis blancardella, Lithophane antennata, Lobesia spp., for example Lobesia botrana, Loxagrotis albicosta, Lymantria spp., for example Lymantria dispar, Lyonetia spp., for example Lyonetia clerkella, Malacosoma neustria, Maruca testulalis, Mamestra brassicae, Melanitis leda, Mocis spp., Monopis obviella, Mythimna separata, Nemapogon cloacellus, Nymphula spp., Oiketicus spp., Omphisa spp., Operophtera spp., Oria spp., Orthaga spp., Ostrinia spp., for example Ostrinia nubilalis, Panolis flammea, Parnara spp., Pectinophora spp., for example Pectinophora gossypiella, Perileucoptera spp., Phthorimaea spp., for example Phthorimaea operculella, Phyllocnistis citrella, Phyllonorycter spp., for example Phyllonorycter blancardella, Phyllonorycter crataegella, Pieris spp., for example Pieris rapae, Platynota stultana, Plodia interpunctella, Plusia spp., Plutella xylostella (=Plutella maculipennis), Podesia spp., for example Podesia syringae, Prays spp., Prodenia spp., Protoparce spp., Pseudaletia spp.,

for example Pseudaletia unipuncta, Pseudoplusia includens, Pyrausta nubilalis, Rachiplusia nu, Schoenobius spp., for example Schoenobius bipunctifer, Scirpophaga spp., for example Scirpophaga innotata, Scotia segetum, Sesamia spp., for example Sesamia inferens, Sparganothis spp., Spodoptera spp., for example Spodoptera eradiana, Spodoptera exigua, Spodoptera frugiperda, Spodoptera praefica, Stathmopoda spp., Stenoma spp., Stomopteryx subsecivella, Synanthedon spp., Tecia solanivora, Thaumetopoea spp., Thermesia gemmatalis, Tinea cloacella, Tinea pellionella, Tineola bisselliella, Tortrix spp., Trichophaga tapetzella, Trichoplusia spp., for example Trichoplusia ni, Tryporyza incertulas, Tuta absoluta, Virachola spp.

[0121] Even more preferred, the combinations according to the invention can be used against Helicoverpa spp., for example Helicoverpa armigera, Helicoverpa zea, Helicoverpa virescens, and Helicoverpa punctigera, especially Helicoverpa armigera and Helicoverpa zea.

Plants and plant parts

[0122] All plants and plant parts can be treated in accordance with the invention. Here, plants are to be understood to mean all plants and plant parts such as wanted and unwanted wild plants or crop plants (including naturally occurring crop plants), for example cereals (wheat, rice, triticale, barley, rye, oats), maize, soya bean, potato, sugar beet, sugar cane, tomatoes, pepper, cucumber, melon, carrot, watermelon, onion, lettuce, spinach, leek, beans, Brassica oleracea (e.g. cabbage) and other vegetable species, cotton, tobacco, oilseed rape, and also fruit plants (with the fruits apples, pears, citrus fruits and grapevines). Crop plants can be plants which can be obtained by conventional breeding and optimization methods or by biotechnological and genetic engineering methods or combinations of these methods, including the transgenic plants and including the plant varieties which can or cannot be protected by varietal property rights. Plants should be understood to mean all developmental stages, such as seeds, seedlings, young (immature) plants up to mature plants. Plant parts should be understood to mean all parts and organs of the plants above and below ground, such as shoot, leaf, flower and root, examples given being leaves, needles, stalks, stems, flowers, fruit bodies, fruits and seeds, and also tubers, roots and rhizomes. Parts of plants also include harvested plants or harvested plant parts and vegetative and generative propagation material, for example seedlings, tubers, rhizomes, cuttings and seeds.

[0123] Treatment according to the invention of the plants and plant parts with the compounds of the formula (I) is carried out directly or by allowing the compounds to act on the surroundings, environment or storage space by the customary treatment methods, for example by immersion, spraying, evaporation, fogging, scattering, painting on, injection and, in the case of propagation material, in particular in the case of seeds, also by applying one or more coats.

[0124] As already mentioned above, it is possible to treat all plants and their parts according to the invention. In a preferred embodiment, wild plant species and plant cultivars, or those obtained by conventional biological breeding methods, such as crossing or protoplast fusion, and also parts thereof,

are treated. In a further preferred embodiment, transgenic plants and plant cultivars obtained by genetic engineering methods, if appropriate in combination with conventional methods (genetically modified organisms), and parts thereof are treated. The terms “parts” or “parts of plants” or “plant parts” have been explained above. The invention is used with particular preference to treat plants of the respective commercially customary cultivars or those that are in use. Plant cultivars are to be understood as meaning plants having new properties ("traits") and which have been obtained by conventional breeding, by mutagenesis or by recombinant DNA techniques. They can be cultivars, varieties, bio- or genotypes.

Genetically modified organisms

[0125] As already mentioned above, it is possible to treat all plants and their parts in accordance with the invention. In a preferred embodiment, wild plant species and plant cultivars, or those obtained by conventional biological breeding methods, such as crossing or protoplast fusion, and also parts thereof, are treated. In a further preferred embodiment, transgenic plants and plant cultivars obtained by genetic engineering methods, if appropriate in combination with conventional methods (Genetically Modified Organisms), and parts thereof are treated. The terms “parts” or “parts of plants” or “plant parts” have been explained above. More preferably, plants of the plant cultivars which are commercially available or are in use are treated in accordance with the invention. Plant cultivars are understood to mean plants which have new properties ("traits") and have been obtained by conventional breeding, by mutagenesis or by recombinant DNA techniques. They can be cultivars, varieties, bio- or genotypes.

[0126] The method of treatment according to the invention can be used in the treatment of genetically modified organisms (GMOs), e.g. plants or seeds. Genetically modified plants (or transgenic plants) are plants of which a heterologous gene has been stably integrated into genome. The expression “heterologous gene” essentially means a gene which is provided or assembled outside the plant and when introduced in the nuclear, chloroplastic or mitochondrial genome gives the transformed plant new or improved agronomic or other properties by expressing a protein or polypeptide of interest or by downregulating or silencing other gene(s) which are present in the plant (using for example, antisense technology, cosuppression technology, RNA interference – RNAi – technology or microRNA – miRNA - technology). A heterologous gene that is located in the genome is also called a transgene. A transgene that is defined by its particular location in the plant genome is called a transformation or transgenic event.

[0127] Depending on the plant species or plant cultivars, their location and growth conditions (soils, climate, vegetation period, diet), the treatment according to the invention may also result in superadditive (“synergistic”) effects. Thus, for example, reduced application rates and/or a widening of the activity spectrum and/or an increase in the activity of the active compounds and compositions which can be used according to the invention, better plant growth, increased tolerance to high or low temperatures, increased tolerance to drought or to water or soil salt content, increased flowering performance, easier harvesting, accelerated maturation, higher harvest yields, bigger fruits, larger plant

height, greener leaf color, earlier flowering, higher quality and/or a higher nutritional value of the harvested products, higher sugar concentration within the fruits, better storage stability and/or processability of the harvested products are possible, which exceed the effects which were actually to be expected.

[0128] At certain application rates, the mixtures or compositions according to the invention may also have a strengthening effect in plants. Accordingly, they are also suitable for mobilizing the defense system of the plant against attack by harmful microorganisms. This may, if appropriate, be one of the reasons of the enhanced activity of the mixtures or compositions according to the invention, for example against fungi. Plant-strengthening (resistance-inducing) substances are to be understood as meaning, in the present context, those substances or combinations of substances which are capable of stimulating the defense system of plants in such a way that, when subsequently inoculated with harmful microorganisms, the treated plants display a substantial degree of resistance to these microorganisms. In the present case, harmful microorganisms are to be understood as meaning phytopathogenic fungi, bacteria and viruses. Thus, the mixtures or compositions according to the invention can be employed for protecting plants against attack by the abovementioned pathogens within a certain period of time after the treatment. The period of time within which protection is effected generally extends from 1 to 10 days, preferably 1 to 7 days, after the treatment of the plants with the active compounds.

[0129] Plants and plant cultivars which are preferably to be treated according to the invention include all plants which have genetic material which impart particularly advantageous, useful traits to these plants (whether obtained by breeding and/or biotechnological means).

[0130] Plants and plant cultivars which are also preferably to be treated according to the invention are resistant against one or more biotic stresses, i.e. said plants show a better defense against animal and microbial pests, such as against nematodes, insects, mites, phytopathogenic fungi, bacteria, viruses and/or viroids.

[0131] Plants and plant cultivars which may also be treated according to the invention are those plants which are resistant to one or more abiotic stresses. Abiotic stress conditions may include, for example, drought, cold temperature exposure, heat exposure, osmotic stress, flooding, increased soil salinity, increased mineral exposure, ozone exposure, high light exposure, limited availability of nitrogen nutrients, limited availability of phosphorus nutrients, shade avoidance.

[0132] Plants and plant cultivars which may also be treated according to the invention, are those plants characterized by enhanced yield characteristics. Increased yield in said plants can be the result of, for example, improved plant physiology, growth and development, such as water use efficiency, water retention efficiency, improved nitrogen use, enhanced carbon assimilation, improved photosynthesis, increased germination efficiency and accelerated maturation. Yield can furthermore be affected by improved plant architecture (under stress and non-stress conditions), including but not limited to, early

flowering, flowering control for hybrid seed production, seedling vigor, plant size, internode number and distance, root growth, seed size, fruit size, pod size, pod or ear number, seed number per pod or ear, seed mass, enhanced seed filling, reduced seed dispersal, reduced pod dehiscence and lodging resistance. Further yield traits include seed composition, such as carbohydrate content, protein content, oil content and composition, nutritional value, reduction in anti-nutritional compounds, improved processability and better storage stability.

[0133] Plants that may be treated according to the invention are hybrid plants that already express the characteristic of heterosis or hybrid vigor which results in generally higher yield, vigor, health and resistance towards biotic and abiotic stresses). Such plants are typically made by crossing an inbred male-sterile parent line (the female parent) with another inbred male-fertile parent line (the male parent). Hybrid seed is typically harvested from the male sterile plants and sold to growers. Male sterile plants can sometimes (e.g. in corn) be produced by detasseling, i.e. the mechanical removal of the male reproductive organs (or males flowers) but, more typically, male sterility is the result of genetic determinants in the plant genome. In that case, and especially when seed is the desired product to be harvested from the hybrid plants it is typically useful to ensure that male fertility in the hybrid plants is fully restored. This can be accomplished by ensuring that the male parents have appropriate fertility restorer genes which are capable of restoring the male fertility in hybrid plants that contain the genetic determinants responsible for male-sterility. Genetic determinants for male sterility may be located in the cytoplasm. Examples of cytoplasmic male sterility (CMS) were for instance described in *Brassica* species (WO 92/05251, WO 95/09910, WO 98/27806, WO 05/002324, WO 06/021972 and US 6,229,072). However, genetic determinants for male sterility can also be located in the nuclear genome. Male sterile plants can also be obtained by plant biotechnology methods such as genetic engineering. A particularly useful means of obtaining male-sterile plants is described in WO 89/10396 in which, for example, a ribonuclease such as barnase is selectively expressed in the tapetum cells in the stamens. Fertility can then be restored by expression in the tapetum cells of a ribonuclease inhibitor such as barstar (e.g. WO 91/02069).

[0134] Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may be treated according to the invention are herbicide-tolerant plants, i.e. plants made tolerant to one or more given herbicides. Such plants can be obtained either by genetic transformation, or by selection of plants containing a mutation imparting such herbicide tolerance.

[0135] Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are insect-resistant transgenic plants, i.e. plants made resistant to attack by certain target insects. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation imparting such insect resistance.

[0136] An "insect-resistant transgenic plant", as used herein, includes any plant containing at least one transgene comprising a coding sequence encoding:

1) an insecticidal crystal protein from *Bacillus thuringiensis* or an insecticidal portion thereof, such as the insecticidal crystal proteins listed by Crickmore et al. (1998, Microbiology and Molecular Biology Reviews, 62: 807-813), updated by Crickmore et al. (2005) at the *Bacillus thuringiensis* toxin nomenclature, online at: http://www.lifesci.sussex.ac.uk/Home/Neil_Crickmore/Bt/), or insecticidal portions thereof, e.g., proteins of the Cry protein classes Cry1Ab, Cry1Ac, Cry1B, Cry1C, Cry1D, Cry1F, Cry2Ab, Cry3Aa, or Cry3Bb or insecticidal portions thereof (e.g. EP-A 1 999 141 and WO 2007/107302), or such proteins encoded by synthetic genes as e.g. described in and U.S. Patent Application 12/249,016 ; or

2) a crystal protein from *Bacillus thuringiensis* or a portion thereof which is insecticidal in the presence of a second other crystal protein from *Bacillus thuringiensis* or a portion thereof, such as the binary toxin made up of the Cry34 and Cry35 crystal proteins (*Nat. Biotechnol.* 2001, *19*, 668-72; *Applied Environm. Microbiol.* 2006, *71*, 1765-1774) or the binary toxin made up of the Cry1A or Cry1F proteins and the Cry2Aa or Cry2Ab or Cry2Ae proteins (U.S. Patent Application 12/214,022 and EP-A 2 300 618); or

3) a hybrid insecticidal protein comprising parts of different insecticidal crystal proteins from *Bacillus thuringiensis*, such as a hybrid of the proteins of 1) above or a hybrid of the proteins of 2) above, e.g., the Cry1A.105 protein produced by corn event MON89034 (WO 2007/027777); or

4) a protein of any one of 1) to 3) above wherein some, particularly 1 to 10, amino acids have been replaced by another amino acid to obtain a higher insecticidal activity to a target insect species, and/or to expand the range of target insect species affected, and/or because of changes introduced into the encoding DNA during cloning or transformation, such as the Cry3Bb1 protein in corn events MON863 or MON88017, or the Cry3A protein in corn event MIR604; or

5) an insecticidal secreted protein from *Bacillus thuringiensis* or *Bacillus cereus*, or an insecticidal portion thereof, such as the vegetative insecticidal (VIP) proteins listed at:

http://www.lifesci.sussex.ac.uk/home/Neil_Crickmore/Bt/vip.html, e.g., proteins from the VIP3Aa protein class; or

6) a secreted protein from *Bacillus thuringiensis* or *Bacillus cereus* which is insecticidal in the presence of a second secreted protein from *Bacillus thuringiensis* or *B. cereus*, such as the binary toxin made up of the VIP1A and VIP2A proteins (WO 94/21795); or

7) a hybrid insecticidal protein comprising parts from different secreted proteins from *Bacillus thuringiensis* or *Bacillus cereus*, such as a hybrid of the proteins in 1) above or a hybrid of the proteins in 2) above; or

8) a protein of any one of 5) to 7) above wherein some, particularly 1 to 10, amino acids have been replaced by another amino acid to obtain a higher insecticidal activity to a target insect species, and/or to expand the range of target insect species affected, and/or because of changes introduced into the encoding DNA during cloning or transformation (while still encoding an insecticidal protein), such as the VIP3Aa protein in cotton event COT102; or

9) a secreted protein from *Bacillus thuringiensis* or *Bacillus cereus* which is insecticidal in the presence of a crystal protein from *Bacillus thuringiensis*, such as the binary toxin made up of VIP3 and Cry1A or Cry1F (U.S. Patent Applications 61/126083 and 61/195019), or the binary toxin made up of the VIP3 protein and the Cry2Aa or Cry2Ab or Cry2Ae proteins (U.S. Patent Application 12/214,022 and EP-A 2 300 618).

10) a protein of 9) above wherein some, particularly 1 to 10, amino acids have been replaced by another amino acid to obtain a higher insecticidal activity to a target insect species, and/or to expand the range of target insect species affected, and/or because of changes introduced into the encoding DNA during cloning or transformation (while still encoding an insecticidal protein)

[0137] Of course, an insect-resistant transgenic plant, as used herein, also includes any plant comprising a combination of genes encoding the proteins of any one of the above classes 1 to 10. In one embodiment, an insect-resistant plant contains more than one transgene encoding a protein of any one of the above classes 1 to 10, to expand the range of target insect species affected when using different proteins directed at different target insect species, or to delay insect resistance development to the plants by using different proteins insecticidal to the same target insect species but having a different mode of action, such as binding to different receptor binding sites in the insect.

[0138] An "insect-resistant transgenic plant", as used herein, further includes any plant containing at least one transgene comprising a sequence producing upon expression a double-stranded RNA which upon ingestion by a plant insect pest inhibits the growth of this insect pest, as described e.g. in WO 2007/080126, WO 2006/129204, WO 2007/074405, WO 2007/080127 and WO 2007/035650.

[0139] Plants or plant cultivars (obtained by plant biotechnology methods such as genetic engineering) which may also be treated according to the invention are tolerant to abiotic stresses. Such plants can be obtained by genetic transformation, or by selection of plants containing a mutation imparting such stress resistance. Particularly useful stress tolerance plants include:

1) plants which contain a transgene capable of reducing the expression and/or the activity of poly(ADP-ribose) polymerase (PARP) gene in the plant cells or plants as described in WO 00/04173, WO 2006/045633, EP-A 1 807 519, or EP-A 2 018 431.

2) plants which contain a stress tolerance enhancing transgene capable of reducing the expression and/or the activity of the PARG encoding genes of the plants or plants cells, as described e.g. in WO 2004/090140.

3) plants which contain a stress tolerance enhancing transgene coding for a plant-functional enzyme of the nicotineamide adenine dinucleotide salvage synthesis pathway including nicotinamidase, nicotinate phosphoribosyltransferase, nicotinic acid mononucleotide adenyl transferase, nicotinamide adenine dinucleotide synthetase or nicotine amide phosphorybosyltransferase as described e.g. in EP-A 1 794 306, WO 2006/133827, WO 2007/107326, EP-A 1 999 263, or WO 2007/107326.

Resistance Induction / Plant Health and other effects

[0140] The mixtures or compositions according to the invention also exhibit a potent strengthening effect in plants. Accordingly, they can be used for mobilizing the defences of the plant against attack by undesirable microorganisms.

[0141] Plant-strengthening (resistance-inducing) substances are to be understood as meaning, in the present context, those substances which are capable of stimulating the defence system of plants in such a way that the treated plants, when subsequently inoculated with undesirable microorganisms, develop a high degree of resistance to these microorganisms.

[0142] The active compounds according to the invention are also suitable for increasing the yield of crops. In addition, they show reduced toxicity and are well tolerated by plants.

[0143] Further, in context with the present invention plant physiology effects comprise the following:

[0144] Abiotic stress tolerance, comprising temperature tolerance, drought tolerance and recovery after drought stress, water use efficiency (correlating to reduced water consumption), flood tolerance, ozone stress and UV tolerance, tolerance towards chemicals like heavy metals, salts, pesticides (safener) etc..

[0145] Biotic stress tolerance, comprising increased fungal resistance and increased resistance against nematodes, viruses and bacteria. In context with the present invention, biotic stress tolerance preferably comprises increased fungal resistance and increased resistance against nematodes

[0146] Increased plant vigor, comprising plant health / plant quality and seed vigor, reduced stand failure, improved appearance, increased recovery, improved greening effect and improved photosynthetic efficiency.

Effects on plant hormones and/or functional enzymes.

[0147] Effects on growth regulators (promoters), comprising earlier germination, better emergence, more developed root system and/or improved root growth, increased ability of tillering, more productive tillers, earlier flowering, increased plant height and/or biomass, shorting of stems, improvements in shoot growth, number of kernels/ear, number of ears/m^2, number of stolons and/or number of flowers, enhanced harvest index, bigger leaves, less dead basal leaves, improved phyllotaxy, earlier maturation / earlier fruit finish, homogenous riping, increased duration of grain filling, better fruit finish, bigger fruit/vegetable size, sprouting resistance and reduced lodging.

[0148] Increased yield, referring to total biomass per hectare, yield per hectare, kernel/fruit weight, seed size and/or hectolitre weight as well as to increased product quality, comprising:

[0149] improved processability relating to size distribution (kernel, fruit, etc.), homogenous riping, grain moisture, better milling, better vinification, better brewing, increased juice yield, harvestability, digestibility, sedimentation value, falling number, pod stability, storage stability, improved fiber length/strength/uniformity, increase of milk and/or meet quality of silage fed animals, adaption to cooking and frying;

[0150] further comprising improved marketability relating to improved fruit/grain quality, size distribution (kernel, fruit, etc.), increased storage / shelf-life, firmness / softness, taste (aroma, texture, etc.), grade (size, shape, number of berries, etc.), number of berries/fruits per bunch, crispness, freshness, coverage with wax, frequency of physiological disorders, colour, etc.;

[0151] further comprising increased desired ingredients such as e.g. protein content, fatty acids, oil content, oil quality, aminoacid composition, sugar content, acid content (pH), sugar/acid ratio (Brix), polyphenols, starch content, nutritional quality, gluten content/index, energy content, taste, etc.;

[0152] and further comprising decreased undesired ingredients such as e.g. less mycotoxines, less aflatoxines, geosmin level, phenolic aromas, lacchase, polyphenol oxidases and peroxidases, nitrate content etc.

[0153] Sustainable agriculture, comprising nutrient use efficiency, especially nitrogen (N)-use efficiency, phosphours (P)-use efficiency, water use efficiency, improved transpiration, respiration and/or CO_2 assimilation rate, better nodulation, improved Ca-metabolism etc..

[0154] Delayed senescence, comprising improvement of plant physiology which is manifested, for example, in a longer grain filling phase, leading to higher yield, a longer duration of green leaf colouration of the plant and thus comprising colour (greening), water content, dryness etc.. Accordingly, in the context of the present invention, it has been found that the specific inventive application of the active compound combination makes it possible to prolong the green leaf area duration, which delays

the maturation (senescence) of the plant. The main advantage to the farmer is a longer grain filling phase leading to higher yield. There is also an advantage to the farmer on the basis of greater flexibility in the harvesting time.

[0155] Therein "sedimentation value" is a measure for protein quality and describes according to Zeleny (Zeleny value) the degree of sedimentation of flour suspended in a lactic acid solution during a standard time interval. This is taken as a measure of the baking quality. Swelling of the gluten fraction of flour in lactic acid solution affects the rate of sedimentation of a flour suspension. Both a higher gluten content and a better gluten quality give rise to slower sedimentation and higher Zeleny test values. The sedimentation value of flour depends on the wheat protein composition and is mostly correlated to the protein content, the wheat hardness, and the volume of pan and hearth loaves. A stronger correlation between loaf volume and Zeleny sedimentation volume compared to SDS sedimentation volume could be due to the protein content influencing both the volume and Zeleny value (*Czech J. Food Sci. Vol. 21, No. 3: 91–96,* 2000).

[0156] Further the "falling number" as mentioned herein is a measure for the baking quality of cereals, especially of wheat. The falling number test indicates that sprout damage may have occurred. It means that changes to the physical properties of the starch portion of the wheat kernel have already happened. Therein, the falling number instrument analyzes viscosity by measuring the resistance of a flour and water paste to a falling plunger. The time (in seconds) for this to happen is known as the falling number. The falling number results are recorded as an index of enzyme activity in a wheat or flour sample and results are expressed in time as seconds. A high falling number (for example, above 300 seconds) indicates minimal enzyme activity and sound quality wheat or flour. A low falling number (for example, below 250 seconds) indicates substantial enzyme activity and sprout-damaged wheat or flour.

[0157] The term "more developed root system" / "improved root growth" refers to longer root system, deeper root growth, faster root growth, higher root dry/fresh weight, higher root volume, larger root surface area, bigger root diameter, higher root stability, more root branching, higher number of root hairs, and/or more root tips and can be measured by analyzing the root architecture with suitable methodologies and Image analysis programmes (e.g. WinRhizo).

[0158] The term "crop water use efficiency" refers technically to the mass of agriculture produce per unit water consumed and economically to the value of product(s) produced per unit water volume consumed and can e.g. be measured in terms of yield per ha, biomass of the plants, thousand-kernel mass, and the number of ears per m2.

[0159] The term "nitrogen-use efficiency" refers technically to the mass of agriculture produce per unit nitrogen consumed and economically to the value of product(s) produced per unit nitrogen consumed, reflecting uptake and utilization efficiency.

[0160] Improvement in greening / improved colour and improved photosynthetic efficiency as well as the delay of senescence can be measured with well-known techniques such as a HandyPea system (Hansatech). Fv/Fm is a parameter widely used to indicate the maximum quantum efficiency of photosystem II (PSII). This parameter is widely considered to be a selective indication of plant photosynthetic performance with healthy samples typically achieving a maximum Fv/Fm value of approx. 0.85. Values lower than this will be observed if a sample has been exposed to some type of biotic or abiotic stress factor which has reduced the capacity for photochemical quenching of energy within PSII. Fv/Fm is presented as a ratio of variable fluorescence (Fv) over the maximum fluorescence value (Fm). The Performance Index is essentially an indicator of sample vitality. (See e.g. *Advanced Techniques in Soil Microbiology*, 2007, *11*, 319-341; *Applied Soil Ecology*, 2000, *15*, 169-182.)

[0161] The improvement in greening / improved colour and improved photosynthetic efficiency as well as the delay of senescence can also be assessed by measurement of the net photosynthetic rate (Pn), measurement of the chlorophyll content, e.g. by the pigment extraction method of Ziegler and Ehle, measurement of the photochemical efficiency (Fv/Fm ratio), determination of shoot growth and final root and/or canopy biomass, determination of tiller density as well as of root mortality.

[0162] Within the context of the present invention preference is given to improving plant physiology effects which are selected from the group comprising: enhanced root growth / more developed root system, improved greening, improved water use efficiency (correlating to reduced water consumption), improved nutrient use efficiency, comprising especially improved nitrogen (N)-use efficiency, delayed senescence and enhanced yield.

[0163] Within the enhancement of yield preference is given as to an improvement in the sedimentation value and the falling number as well as to the improvement of the protein and sugar content – especially with plants selected from the group of cereals (preferably wheat).

Application Rates and Timing

[0164] When using the inventive mixtures or compositions, the application rates can be varied within a relatively wide range, depending on the kind of application. The application rate of the mixtures or compositions is

- in the case of treatment of plant parts, for example stems and leaves: the amount of Flubendiamide is from 0.001 to 10 000 g/ha, preferably from 0.01 to 1000 g/ha, more preferably from 5 to 500 g/ha, even more preferably from 50 to 250 g/ha (in the case of application by watering or dripping, it is even possible to reduce the application rate, especially when inert substrates such as rockwool or perlite are used) and the amount of NPV is from $5x10^9$ OBs/ha to $2x10^{16}$ OBs/ha, preferably from $5x10^{10}$ OBs/ha to $2x10^{15}$ OBs/ha, more preferably from $2,5x10^{13}$ OBs/ha to $2,5x10^{15}$ OBs/ha, even more preferably from $2,5x10^{14}$ OBs/ha to $1,25x10^{15}$ OBs/ha, wherein the ratio between NPV and Flubendiamide is from $5x10^9$ OBs to $2x10^{10}$ OBs per 1 mg Flubendiamid.

[0165] These application rates are merely by way of example and are not limiting for the purposes of the invention.

[0166] The inventive mixtures or compositions can thus be used to protect plants from attack by the pathogens mentioned for a certain period of time after treatment. The period for which protection is provided extends generally for 1 to 28 days, preferably for 1 to 14 days, more preferably for 1 to 10 days, most preferably for 1 to 7 days, after the treatment of the plants with the mixtures or compositions, or for up to 200 days after a seed treatment.

[0167] The method of treatment according to the invention also provides the use or application of NPV and a diamide compound as defined above in a simultaneous, separate or sequential manner. If the single active ingredients are applied in a sequential manner, i.e. at different times, they are applied one after the other within a reasonably short period, such as a few hours or days. Preferably the order of applying the compounds according to formula (I) and the biological control agent as defined above is not essential for working the present invention. However, it is preferred to first apply a diamide compound as defined above followed by applying a NPV. More preferably, the time difference between application of the diamide compound and applicaton of the NPV in a sequential manner is from more than 1 min to 7 days, to 5 days, to 4 days, to 3 days, to 2 days, to 1 day such as to 12 hours, to 6 hours or to 1 hour.

[0168] The plants listed can particularly advantageously be treated in accordance with the invention with the inventive mixtures or compositions. The preferred ranges stated above for the mixtures or compositions also apply to the treatment of these plants. Particular emphasis is given to the treatment of plants with the mixtures or compositions specifically mentioned in the present text.

[0169] According to another aspect of the present invention, in the combination or composition according to the invention, the compound ratio NPV and Flubendiamide or compound (II), respectively, may be advantageously chosen so as to produce a synergistic effect. The term synergistic effect is defined by Colby in an article entitled "Calculation of the synergistic and antagonistic responses of herbicide combinations" Weeds, (1967), 15, pages 20-22.

Formula for the efficacy of the combination of two compounds

[0170] The expected efficacy of a given combination of two compounds is calculated as follows (see Colby, S.R., „Calculating Synergistic and antagonistic Responses of Herbicide Combinations“, Weeds 15, pp. 20-22, 1967):

If

X is the efficacy expressed in % mortality of the untreated control for test compound A at a concentration of m ppm or m g/ha,

Y is the efficacy expressed in % mortality of the untreated control for test compound B at a concentration of n ppm or n g/ha,

E is the efficacy expressed in % mortality of the untreated control using the mixture of A and B at m and n ppm respectively m and n g/ha,

$$\text{then is} \qquad E = X + Y - \frac{X \times Y}{100}$$

[0171] If the observed insecticidal efficacy of the combination is higher than the one calculated as „E", then the combination of the two compounds is more than additive, i.e., there is a synergistic effect.

Formula for calculating OBs

[0172] The enumeration of OBs in a viral suspension can be done with the help of Neubauer's hemocytometer, which comprises a glass slide carrying calibrations. Virus suspension was diluted by a factor of 1000 and put in the groove of a haemocytometer. The mirror-like polished surface of the counting chamber was cleaned with lens paper. The coverslip was placed over the counting surface prior to putting on the cell suspension. After allowing OBs to settle down, the OBs were counted in a defined number of squares of the hemocytometer area at random under a stereomicroscope.

Example A

Heliothis armigera - spray test with Flubendiamide

Solvent: 7 parts by weight of dimethylformamide

Emulsifier: alkylaryl polyglycol ether

[0173] To produce a suitable preparation of compound (II-1), 1 part by weight of active compound (II-1) is mixed with the stated amount of solvent and is diluted with water, containing an emulsifier concentration of 1000 ppm, to the desired concentration. Further test concentrations are prepared by dilution with emulsifier containing water.

[0174] To produce a suitable preparation of NPV, Gemstar LC ($2x10^9$ OBs/ml liquid concentrate) is diluted with water containing an emulsifier concentration of 1000 ppm to the desired concentration.

[0175] Cotton plants (*Gossypium hirsutum*) are treated by being sprayed with the preparation of the active compound of the desired concentration and are infested with larvae of the cotton boll worm (*Heliothis armigera*).

[0176] After the specified period of time, the mortality in % is determined. 100 % means all caterpillars have been killed; 0 % means none of the caterpillars have been killed. The mortality values determined thus are recalculated using the Colby-formula (see paragraph 170).

[0177] According to the present application in this test e.g. the following combinations show a synergistic effect in comparison to the single compounds:

[0178] In Table A1, the foliar spray application rate on Heliothis armigera/cotton has been applied in a water volume equivalent to 1000l/ha containing a concentration of 0.075 g Flubendiamide/ha equivalent to 0.075 ppm Flubendiamide (= 0.075 mg Flubendiamide/l water) and 200 ml of Gemstar NPV/ha (original concentration of Gemstar $2x10^9$ OBs/ml) as active ingredients.

Table A-1: Heliothis armigera - spray test

Active Ingredient	Concentration	Efficacy in % after 2d
Flubendiamide	0.075 mg/l (0.075 ppm) = 0.075 g/ha	30
NPV (concentration of Gemstar: $2x10^9$ OBs/ml)	$4x10^8$ OBs/l = $4x10^{11}$ OBs/ha (= 200 ml Gemstar/ha)	0
Flubendiamide + NPV according to the invention	0.075 ppm + 200 ml/ha	obs.* cal.** 60 30

[0179] In Table A2, the foliar spray application rate on Heliothis armigera/cotton has been applied in a water volume equivalent to 1000l/ha containing a concentration of 0.0375 g Flubendiamide/ha equivalent to 0.0375 ppm Flubendiamide (= 0.0375 mg Flubendiamide/l water) and 100 ml NPV/ha.

Table A-2: Heliothis armigera - spray test

Active Ingredient	Concentration	Efficacy in % after 3d
Flubendiamide	0.0375 mg/l (0.0375 ppm) = 0.0375 g/ha	0
NPV (concentration of Gemstar: $2x10^9$ OBs/ml)	$2x10^8$ OBs/l = $2 x10^{11}$ OBs/ha (100 ml Gemstar/ha)	0
Flubendiamide + NPV according to the invention	0.0375 ppm + 100 ml/ha	obs.* cal.** 40 0

[0180] In Table A3, the foliar spray application rate on Heliothis armigera/cotton has been applied in a water volume equivalent to 1000l/ha containing a concentration of 0.0375 or 0.01875 g Flubendiamide/ha equivalent to 0.0375 or 0.01875 ppm Flubendiamide (= 0.0375 or 0.01875 g Flubendiamide/l water) and 100 or 50 ml NPV/ha.

Table A-3: Heliothis armigera - spray test

Active Ingredient	Concentration	Efficacy in % after 4d
Flubendiamide	0.0375 mg/l (0.0375 ppm) = 0.0375 g/ha	0
	0.01875 mg/l (0.01875 ppm) = 0.01875 g/ha	0
NPV (concentration of Gemstar: $2x10^9$ OBs/ml)	$2x10^8$ OBs/l = $2x10^{11}$ OBs/ha (100 ml Gemstar/ha)	0
	$1x10^8$ OBs/l =$1x10^{11}$ OBs/ha (50 ml Gemstar/ha)	0
Flubendiamide + NPV according to the invention		obs.* cal.**
	0.0375 ppm + 100ml/ha	50 0
	0.01875 ppm + 50ml/ha	30 0

[0181] In Table A4, the foliar spray application rate on Heliothis armigera/cotton has been applied in a water volume equivalent to 1000l/ha containing a concentration of 0.0375 g Flubendiamide/ha equivalent to 0.0375 ppm Flubendiamide (= 0.0375 g Flubendiamide/l water) and 100 ml NPV/ha.

Table A-4: Heliothis armigera - spray test

Active Ingredient	Concentration	Efficacy in % after 7d
Flubendiamide	0.0375 mg/l (0.0375 ppm) = 0.0375 g/ha	0
NPV (concentration of Gemstar: $2x10^9$ OBs/ml)	$2x10^8$ OBs/l = $2x10^{11}$ OBs/ha (100 ml Gemstar/ha)	30
Flubendiamide + NPV according to the invention		obs.* cal.**
	0.0375 ppm + 100 ml/ha	70 30

*obs. = observed insecticidal efficacy, ** cal. = efficacy calculated with Colby-formula

Example B

Heliothis armigera - spray test

Solvent: 7 parts by weight of dimethylformamide

Emulsifier: alkylaryl polyglycol ether

[0182] To produce a suitable preparation of active compound, 1 part by weight of active compound is mixed with the stated amount of solvent and is diluted with water, containing an emulsifier concentration of 1000ppm, to the desired concentration. Further test concentrations are prepared by dilution with emulsifier containing water.

[0183] To produce a suitable preparation of NPV, AC53 NPV ($2x10^9$ OBs/ml liquid concentrate) is diluted with water containing an emulsifier concentration of 1000 ppm to the desired concentration.

[0184] Cotton plants (*Gossypium hirsutum*) are treated by being sprayed with the preparation of the active compound of the desired concentration and are infested with larvae of the cotton boll worm (*Heliothis armigera*).

[0185] After the specified period of time, the mortality in % is determined. 100 % means all caterpillars have been killed; 0 % means none of the caterpillars have been killed. The mortality values determined thus are recalculated using the Colby-formula (see paragraph 170).

[0186] According to the present application in this test e.g. the following combinations show a synergistic effect in comparison to the single compounds:

Table A: Heliothis armigera - spray test

Active Ingredient	Concentration	Efficacy in % after 3d
Flubendiamide	0,075 mg/l (0.075 ppm) or 0,075 g/ha	50
Hz NPV (concentration of AC53: ($7.5x10^9$ OBs/ml)	$1,3x10^9$ OBs/l = $1,3x10^{12}$ OBs/ha (175,4 ml AC53/ha)	0
Flubendiamide + Hz NPV AC53 according to the invention	0.075 ppm + 175,4 ml/ha	obs.* cal.** 90 50

*obs. = observed insecticidal efficacy, ** cal. = efficacy calculated with Colby-formula

Claims:

1. Combination of a nuclear polyhedrosis virus (NPV) and Flubendiamide.

2. The combination according to claim 1, wherein the NPV is a Helicoverpa zea (Hz), Helicoverpa virescens (Hv), Helicoverpa armigera (Ha) or Helicoverpa punctigera (Hp) NPV (HzNPV, HvNPV, HaNPV, HpNPV).

3. The combination according to claim 2, wherein the NPV is a HzNPV or a HaNPV.

4. The combination according to claim 3, wherein the NPV is a HzSNPV.

5. The combination according to any one of the preceding claims, wherein the concentration of NPV is at least $5x10^7$ OBs/l, preferably is at least $1x10^8$ OBs/l.

6. The combination according to any one of the preceding claims, wherein the concentration of NPV is in the range from $5x10^7$ OBs/l to $1,5x10^{10}$ OBs/l , more preferably in the range from $1x10^8$ OBs/l to $5x10^9$ OBs/l, more preferably in the range from $1x10^8$ OBs/l to $1,5x10^9$ OBs/l.

7. The combination according to any one of the preceding claims, wherein the concentration of Flubendiamide is in the range from 0.01875 mg/l to 0.175 g/l.

8. The combination according to any one of the preceding claims, wherein the ratio between NPV and a diamide compound is in the range from $5x10^9$ OBs per 1 mg Flubendiamide to $2x10^{10}$ OBs per 1 mg Flubendiamide.

9. Method for combating pests on plants comprising the step of applying NPV and Flubendiamide in a combination according to any one of claims 1 to 8 to at least parts of a plant.

10. The method according to claim 9, wherein NPV and Flubendiamide are simultaneously applied to at least parts of a plant, preferably in form of a tank mix.

11. The method according to claim 9, wherein NPV and Flubendiamide are separately applied to at least parts of a plant, wherein the time difference between the application of Flubendiamide and the NPV is 7 days or less, preferably 1 day or less, such as 12 hours or less, 6 hours or less, 3 hours or less, 2 hours or less or 1 hour or less.

Fig 1:

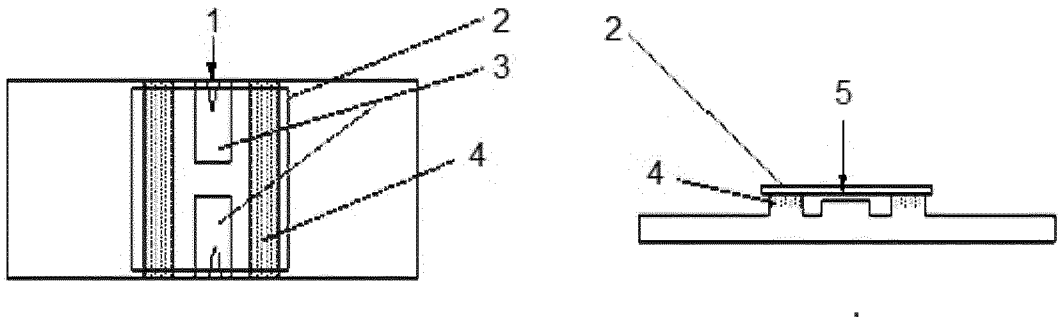


Fig. 2:

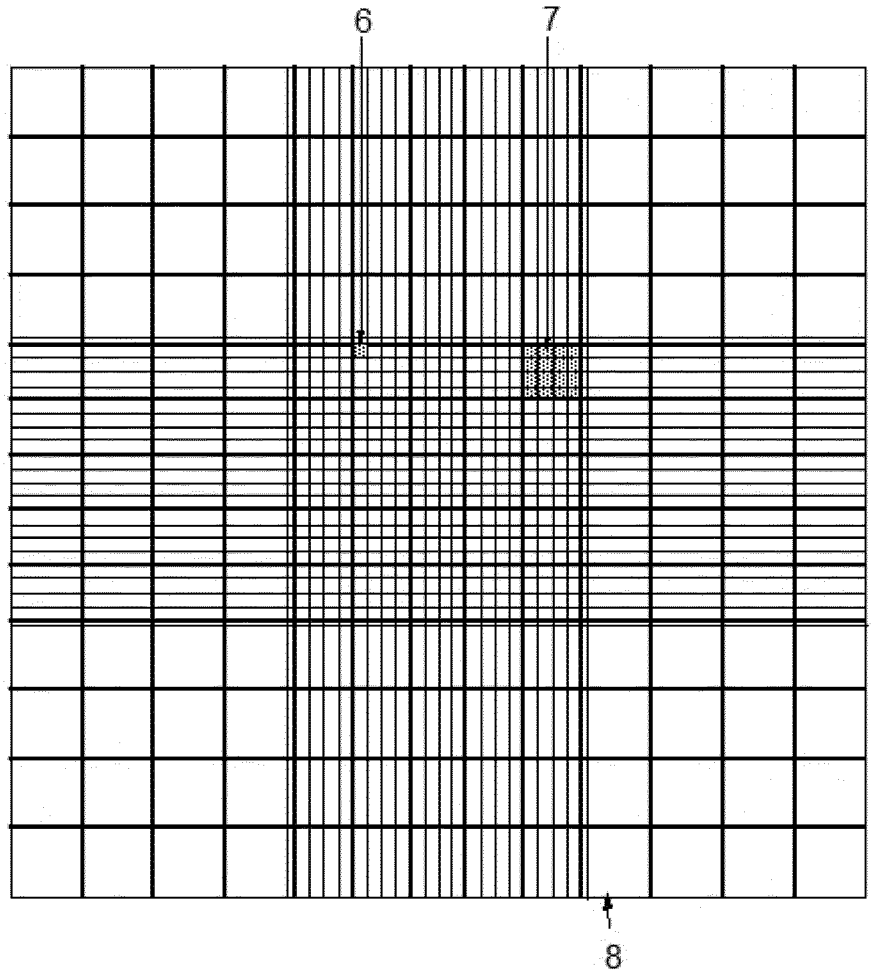
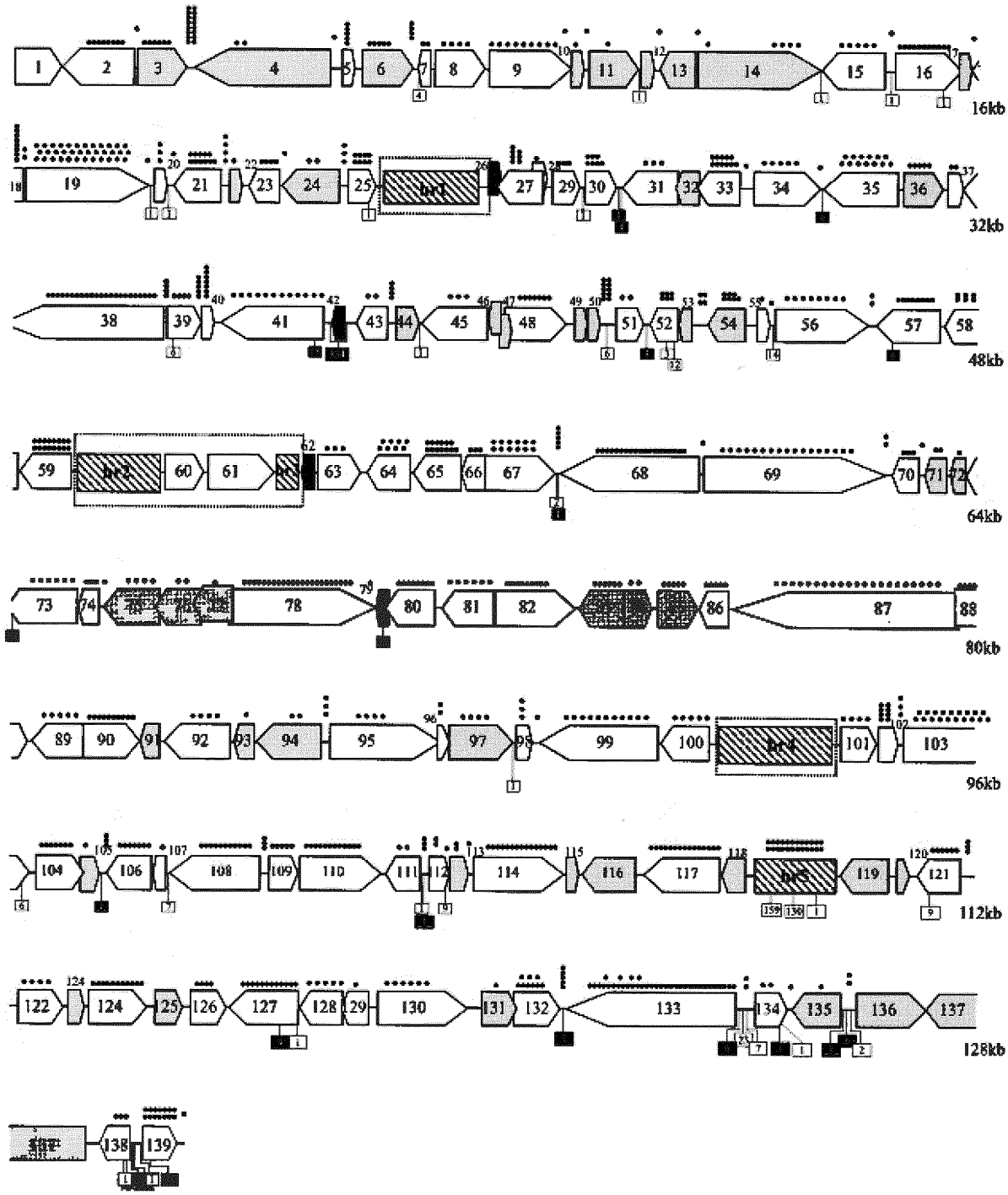


Fig. 3:



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/057528

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01N41/10 A01N63/00 A01P7/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 April 2017	11/05/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hateley, Martin

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 2013/315873 A1 (HSU JU-CHUN [TW] ET AL) 28 November 2013 (2013-11-28) abstract paragraphs [0001], [0009], [0013] - [0014] paragraphs [0017], [0019], [0022] - [0023], [0025] - [0026] examples 1-4 claims 1, 4, 8-9	1,5,7, 9-11
A	WO 2014/170364 A1 (BAYER CROPSCIENCE AG [DE]) 23 October 2014 (2014-10-23) paragraphs [0003] - [0013]; compounds I-1 paragraph [0043]	1-11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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