Short Note

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100 ‘Genetic Zipper’ Technology-Based Oligonucleotide Insecticides Generated in 15 Minutes Using DNAInsector Algorithm (dnainsector.com): Fast and Potent Tool for Pest Control

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100 'Genetic Zipper' Technology-Based Oligonucleotide Insecticides Generated in 15 Minutes Using DNAInsector Algorithm (dnainsector.com): Fast and Potent Tool for Pest Control

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Abstract

The article provides basic knowledge on how to calculate selectivity of oligonucleotide pesticides when 'genetic zipper' ('GZ') technology is used to provide safety for non-target organisms. Also here we represent 100 'GZ' technology-based oligonucleotide insecticides generated in 15 minutes using DNAInsector algorithm (dnainsector.com) to show that 'GZ' technology is amazing approach transferring us to a new oligo era of development of potent and selective oligonucleotide pesticides based on new principles prompted by nature.

Keywords: DNA insecticides; oligonucleotide pesticides; olinscides; rRNA

Introduction

Today, in plant protection, there is an understanding that it is necessary to create genus- and species-specific pesticides that could solve problems with globally important pests being safe for non-target organisms [1]. Oligonucleotide pesticides based on 'genetic zipper' ('GZ') technology have an easily adaptable structure and a selective DNA containment mechanism of action, which opens up the possibility of effective and well-tailored pest control with minimal side effects [2,3]. Oligonucleotide pesticides can be designed very quickly using DNAInsector program (available at dnainsector.com) or manually, based on pre-rRNA and mature rRNA sequences retrieved from the GenBank database [4]. In practical terms, this means that individuals with basic sequence knowledge can quickly design an oligonucleotide pesticide complementary to the pre-rRNA or mature rRNA of a susceptible to this approach pest with a high probability of success. In this article we represent 100 'GZ' technology-based oligonucleotide insecticides generated in 15 minutes using DNAInsector algorithm (dnainsector.com) to show that 'GZ' technology is amazing approach transferring us to a new oligo era of development of potent and selective oligonucleotide pesticides based on new principles prompted by nature (Table 1). Already today, the 'GZ' technology is potentially capable of controlling 20% of all invertebrate pests with a simple and flexible algorithm [3]. However, to ensure species specificity, it is essential to compare homologous target sites of pre-rRNA and mature rRNA in non-target organisms to prevent off-target effects [3,4].

How to Calculate Selectivity of Oligonucleotide Pesticides?

A very important preoperative recommendation is how to calculate the safety of a specific oligonucleotide pesticide in an ecosystem for a range of non-target organisms [4]. To do this, select a target rRNA region (for example, 500 nt long fragment of 28S rRNA) of a pest and corresponding regions of non-target organisms. This requires knowing, after DNA sequencing, the target rRNA sequence (in our case it is 500 nt long fragment of 28S rRNA) of all invertebrates of a given ecosystem (other animals and plants will not be susceptible to 'GZ' technology due to physiological barriers). Next, align target 500 nt long fragment of 28S rRNA of all invertebrates of a given ecosystem, select the most differing part of the sequence that belongs to pest (it can be ~100 nt long sequence out of 500 nt long fragment of 28S rRNA), and then upload it to the DNAInsector web tool. Generate unique oligonucleotide pesticide 11 nt long and check one more time, adjust manually if required, that it is not complementary elsewhere to the target 500 nt long fragment of 28S rRNA of non-target invertebrates. Mathematically, with a high probability (>99.9%), this oligonucleotide pesticide will also not be complementary to other rRNAs of non-target invertebrates in a given ecosystem. Therefore, information on total rRNA (which includes 5S, 5.8S, 12S, 16S, 18S, 28S, ETS and ITS regions and comprising ca. 10,000 nt in each non-target invertebrate) is not required, what significantly simplifies the selection of potent and selective oligonucleotide pesticides [4].

Beginning from 2008, in our research work we found that pre-rRNA and mature rRNA is a convenient target for oligonucleotide pesticides, while mRNA, due to much lower concentration, will be much less susceptible to them, even if oligonucleotide pesticides will possess perfect complementarity to it. Pest rRNA comprises 80-85% of all RNA in the cell [5] and its use as a target for 'GZ' technology helps making this approach very efficient and selective at the same time [2,4]. Thousands of different mRNAs make up only 5% of all RNA and use of mature rRNA and pre-rRNA for targeting substantially increases signal-to-noise ratio, ca. 10^5:1 (rRNA vs. random mRNA) [6].

Importantly, for 'GZ' technology it would be easy to create algorithms (plans) of designing potent and selective oligonucleotide pesticides for other cases, such as when an ecosystem contains two major pests and a dozen non-target organisms or when one species is pest and closely related species is beneficial, and many other scenarios of pest control [4]. The algorithm of 'GZ' technology is very simple and efficient, fundamentally different from all modern approaches to plant protection, including RNAi and CRISPR/Cas [3]. In a sense, 'GZ' technology is an oligo universe for the scientific exploration by a biologist or a plant protection specialist. And if they enter this oligo universe, it will enrich their capabilities.

Table 1. 100 'genetic zipper' technology-based oligonucleotide insecticides generated in 15 minutes using DNAInsector algorithm (dnainsector.com).

№	Reference	Latin name	GenBank ID	Target rRNA	Sequence of oligonucleotide insecticide (5′..3′)
1	https://doi.org/10.1603/008.103.0105	*Abgrallaspis aguacatae*	GQ478401.1	28S	TGTTAGACTCC
2	https://doi.org/10.1080/095831500750016389	*Abgrallaspis cyanophylli*	JQ651301.1	28S	CACCATCTTCC
3	https://doi.org/10.1111/j.1440-6055.1976.tb01714.x	*Acizzia dodonaeae*	MG195297.1	18S	CTAATAAAAGC
4	https://doi.org/10.1371/journal.pone.0214220	*Acizzia errabunda*	MG195288.1	18S	CTAGAATTACC

5	https://doi.org/10.13140/RG.2.2.22942.72008	*Acizzia sasakii*	MK039563.1	16S	ATTTCTCTTCC
6	https://doi.org/10.1093/jisesa/ieae032.	*Acutaspis scutiformis*	KY219127.1	28S	TTCATTACGCC
7	https://doi.org/10.1371/journal.pone.0251663	*Adelges laricis*	AF275215.1	12S	AATAAAATACC
8	https://doi.org/10.1111/syen.12033	*Affirmaspis cederbergensis*	MH934019.1	28S	CCATCTTCCCC
9	https://doi.org/10.1111/epp.12760.	*Aleurocanthus camelliae*	OQ180914.1	16S	TTTACTGCAGC
10	https://doi.org/10.3390/insects11010042	*Aleurocanthus spiniferus*	OQ180915.1	16S	TAATTTACTGC
11	https://doi.org/10.1080/21658005.2013.795042	*Aleurochiton aceris*	AY521267.1	16S	ATTGTTGTACC
12	https://doi.org/10.61310/mndjstea.1015.23	*Aleurodicus dispersus*	JQ305695.1	16S	TTTCATTGAGC
13	https://doi.org/10.1016/S0305-0491(99)00054-1	*Aleurodicus dugesii*	U06474.1	18S	TTAGAACTAGG
14	https://doi.org/10.3956/2010-05.1	*Aleuroplatus coronata*	EU441164.1	16S	TGTTAAACAGG
15	https://doi.org/10.3956/2010-05.1	*Aleuroplatus gelatinosus*	EU441163.1	16S	AAATTTAAGCC
16	https://doi.org/10.1079/cabicompendium.4538	*Aleurothrixus floccosus*	HG810135.1	16S	TCTGTTCGACC
17	https://doi.org/10.1093/jisesa/ieu136	*Aleurotrachelus camelliae*	OQ180920.1	28S	TTATTACAACC
18	https://doi.org/10.1007/s41348-020-00319-9	*Aleyrodes proletella*	MW644572.1	16S	ATTTACTGCGG
19	http://dx.doi.org/10.3733/ca.v054n06p26	*Aphis gossypii*	HG810150.1	16S	TAAATATTAGG
20	https://doi.org/10.12681/eh.13916	*Anapulvinaria pistaciae*	OR074914.1	5.8S	GTTTGTACAGC
21	https://doi.org/10.11646/zootaxa.4117.1.4	*Ancepaspis edentata*	KY220051.1	28S	ACCTACTGTCC
22	https://doi.org/10.21608/sjas.2024.322627.1461	*Aonidiella pini*	MK886648.1	28S	ATCAAACAACC
23	https://doi.org/10.1080/00222939100770791	*Aphalaroida inermis*	MG988580.1	18S	CACAGTTATCC

24	https://doi.org/10.1080/00779962.2007.9722151	*Arytainilla spartiophila*	MG988581.1	18S	AACCCTAATCC
25	https://doi.org/10.3897/zookeys.867.34937	*Aspidaspis florenciae*	KY219598.1	28S	ACCATCTTCCC
26	https://doi.org/10.1079/cabicompendium.7490	*Aspidiella hartii*	KY219906.1	28S	TCCTGAATACC
27	https://doi.org/10.1079/cabicompendium.7506	*Aspidiella sacchari*	DQ145368.2	28S	TCCCGTTTACC
28	https://doi.org/10.1079/cabicompendium.7415	*Aspidiotus destructor*	DQ145293.2	28S	CATAGTTCACC
29	https://doi.org/10.3897/zookeys.1047.68409.	*Aspidiotus fularum*	MH934073.1	28S	TTTCATTACGC
30	https://doi.org/10.1603/AN10060	*Aspidiotus nerii*	DQ145297.2	28S	TTCATCCTGGC
31	https://doi.org/10.1016/j.aspen.2020.02.002	*Aspidiotus rigidus*	OL437057.1	28S	TCTTTCGCCCC
32	https://doi.org/10.3897/zookeys.1174.105851	*Aulacaspis difficilis*	DQ145298.2	28S	ATATCAAACGG
33	https://doi.org/10.3897/zookeys.1174.105851	*Aulacaspis distylii*	DQ145299.2	28S	AGTCTTTCGCC
34	https://doi.org/10.1111/epp.12778	*Aulacaspis rosae*	KY219387.1	28S	GCTTACTGTCC
35	https://doi.org/10.1016/S1226-8615(08)60379-9	*Aulacaspis spinosa*	DQ145367.2	28S	GCAATTCCTCC
36	https://doi.org/10.11646/zootaxa.4272.1.6	*Austrolecanium cryptocaryae*	KY816393.1	18S	TTTAATGAGCC
37	https://doi.org/10.11646/zootaxa.4272.1.6	*Austrolecanium sassafras*	KY816397.1	18S	CAAGTCTTTGC
38	https://doi.org/10.11646/zootaxa.4508.1.6	*Austrolichtensia hakearum*	MH844461.1	18S	TTTCACCGTGC
39	https://doi.org/10.1007/978-3-030-28683-5_8	*Bemisia afer*	GQ867747.1	16S	AATCATTGAGC
40	https://doi.org/10.1093/jee/99.3.691	*Bemisia argentifolii*	AY521257.1	28S	TTTGTATCAGG
41	https://doi.org/10.1007/s13205-021-02831-7	*Bemisia breyniae*	GQ867745.1	16S	TGTCATTGAGC
42	https://doi.org/10.1038/s41598-017-00528-7	*Bemisia emiliae*	GQ867744.1	16S	ATTCATTGAGC
43	https://doi.org/10.1007/s13205-021-02831-7	*Bemisia euphorbiae*	GQ867743.1	16S	ATTATGCTACC

44	https://doi.org/10.1007/s10340-020-01210-0	*Bemisia tabaci*	AF110722.3	16S	ATTTATTACGC
45	https://doi.org/10.1007/s10886-012-0121-y	*Brachycaudus helichrysi*	JX965980.1	12S	ACTAAAATACC
46	https://doi.org/10.11646/zootaxa.4362.1.4	*Cacopsylla bidens*	MK039580.1	16S	TCATACAAGCC
47	https://doi.org/10.3897/BDJ.10.e85094	*Cacopsylla burckhardti*	MK039571.1	16S	ATAAAACACGC
48	https://doi.org/10.11646/zootaxa.4362.1.4	*Cacopsylla chinensis*	LC513963.1	16S	TCTTATCGTCC
49	https://doi.org/10.1080/23802359.2021.1875908	*Cacopsylla citrisuga*	MH053225.1	16S	ACTATCACCCC
50	https://doi.org/10.1186/s12866-020-01895-4	*Cacopsylla heterogena*	MH053234.1	16S	AAAAATTATGC
51	https://doi.org/10.11646/zootaxa.4362.1.4	*Cacopsylla jukyungi*	LC513968.1	16S	AATTCTATAGG
52	https://doi.org/10.5281/zenodo.14578	*Cacopsylla mali*	AF367822.1	12S	GATAAAATACC
53	https://doi.org/10.5281/zenodo.14578	*Cacopsylla peregrina*	MT038953.1	28S	TGCTTAAATCC
54	https://doi.org/10.34101/actaagrar/74/1660	*Cacopsylla pruni*	DQ778635.1	18S	GTACTCATTCC
55	https://doi.org/10.5281/zenodo.5806004	*Cacopsylla pulchra*	MT038955.1	28S	TATTAATATGC
56	https://doi.org/10.3390/agronomy14040668.	*Cacopsylla pyri*	MK039584.1	16S	AAATTATAAGG
57	https://doi.org/10.11646/zootaxa.4362.1.4	*Cacopsylla pyricola*	MK039589.1	16S	TCTGTTCAACC
58	https://doi.org/10.11646/zootaxa.4362.1.4	*Cacopsylla pyrisuga*	AB721006.1	16S	ACATTTTCCCC
59	https://doi.org/10.5281/zenodo.14578	*Cacopsylla ulmi*	MT038960.1	28S	TTAAATCCACC
60	https://doi.org/10.61310/mjst.v23i1.2370	*Ceroplastes floridensis*	JQ795604.1	28S	TCCTGAATTCC
61	https://doi.org/10.1007/s13744-016-0480-0	*Ceroplastes glomeratus*	KX670822.1	28S	TTCAACTTTCC
62	https://doi.org/10.11646/zootaxa.4701.6.2	*Ceroplastes kunmingensis*	MT316993.1	28S	CTTCATCCTGG
63	https://doi.org/10.11646/zootaxa.4701.6.2	*Ceroplastes murrayi*	MT316994.1	28S	ACTTTCATTGC
64	https://doi.org/10.1079/pwkb.species.12351	*Ceroplastes rubens*	MT317009.1	28S	TTCATTGCGCC

	https://doi.org/10.2903/j.efsa.2024.8888				
65	https://doi.org/10.11609/jott.7419.14.2.20606-20614	*Ceroplastes rusci*	PV762166.1	28S	CATCTTCCCCC
66	https://doi.org/10.1079/cabicompendium.12353	*Ceroplastes sinensis*	KY085826.1	28S	GTCCGTTTACC
67	https://doi.org/10.1079/cabicompendium.120372	*Ceroplastes stellifer*	MK533217.1	28S	TCCGTTTACCC
68	https://doi.org/10.5281/zenodo.14578	*Chamaepsylla hartigii*	MT038961.1	5.8S	TAATCTTGCCC
69	https://doi.org/10.1111/j.1095-8312.2011.01716.x	*Chionaspis americana*	KY220045.1	28S	TTGAATTCCGC
70	https://doi.org/10.1111/epp.12287	*Chionaspis etrusca*	DQ145397.2	28S	GATCGATTTGC
71	https://doi.org/10.1590/S1519-566X2010000300013	*Coccus alpinus*	JX499976.1	28S	AAATTCATCGC
72	https://doi.org/10.1079/cabicompendium.14663	*Coccus celatus*	MT317016.1	28S	AACTGAATTCC
73	https://doi.org/10.3897/zookeys.734.22774	*Coccus ficicola*	MK533218.1	28S	TTACTCCTCGG
74	https://doi.org/10.3897/zookeys.244.4045	*Coccus formicarii*	MZ782004.1	28S	CCTCGATTACC
75	https://doi.org/10.1017/S0007485300010919	*Coccus longulus*	MT317024.1	28S	TGACTTCATCC
76	https://doi.org/10.11646/zootaxa.3646.2.2	*Cornopsylla rotundiconis*	MH758086.1	28S	TGCCCTTTTGC
77	https://doi.org/10.11646/zootaxa.4508.1.6	*Cryptes baccatus*	MZ782005.1	28S	TATATCGTCGG
78	https://doi.org/10.11646/zootaxa.4508.1.6	*Cryptes utzoni*	MH886632.1	28S	GTTTCGTTCGC
79	https://doi.org/10.1111/jen.12937	*Diaphorina communis*	MH042733.1	16S	GCTGTTATCCC
80	https://doi.org/10.1080/23802359.2021.1906175	*Didesmococcus koreanus*	MH844459.1	18S	CATGTATTAGC
81	https://doi.org/10.1093/gigascience/giz113	*Ericerus pela*	KX380986.1	18S	CCAATTGATCC
82	https://doi.org/10.1093/jipm/pmv016	*Eriopeltis festucae*	MT317080.1	28S	CCATCTTTCGG
83	https://doi.org/10.1042/bj0660289	*Eucallipterus tiliae*	KX631489.1	16S	CATTCTAGTCC
84	https://doi.org/10.1603/0022-0493-98.4.1202	*Eulecanium cerasorum*	MK533231.1	28S	TAGTCTTTCGC

85	https://doi.org/37. 10.5281/zenodo.5806004.	*Livilla horvathi*	AF367826.1	12S	CTTTTAAATCC
86	http://dx.doi.org/10.5252/z2015n1a13	*Livilla pyrenaea*	AF367832.1	12S	TTAATAATTCC
87	https://doi.org/10.4289/0013-8797.119.1.162	*Livilla variegata*	AF367837.1	12S	ATCCTATTTCC
88	https://doi.org/10.1093/jee/toae041	*Myzus cerasi*	KX631445.1	16S	CATACAAGTCC
89	https://doi.org/10.1007/s12600-023-01059-w	*Paraleyrodes bondari*	GQ867760.1	16S	TCTCATTGAGC
90	https://doi.org/10.1093/jisesa/ieu136	*Pealius mori*	HG810145.1	16S	TTGGATTAAGC
91	https://doi.org/10.5656/KSAE.2012.04.1.83	*Pealius rhododendri*	GQ867752.1	16S	GTTCATTGAGC
92	https://doi.org/10.13140/RG.2.2.14711.39848	*Psylla alni*	MG988605.1	18S	ACTTTGCTTGC
93	https://doi.org/10.13140/RG.2.2.14711.39848	*Psylla alniformosanaesuga*	MH758107.1	28S	GGTATTTCACC
94	https://doi.org/10.1111/epp.12636	*Psylla buxi*	MG988606.1	18S	CTTTTACTTCC
95	https://doi.org/37. 10.5281/zenodo.5806004.	*Psylla foersteri*	MG988583.1	18S	AATACGAATGC
96	https://doi.org/10.1673/031.010.12001	*Siphoninus phillyreae*	Z15053.1	18S	GTTAGCTTTGG
97	https://doi.org/10.3897/travaux.66.e98619	*Spanioneura fonscolombii*	MG988609.1	18S	ATCAAGTTTGG
98	https://doi.org/10.5958/0974-8172.2018.00158.X	*Tetraleurodes acaciae*	ON311124.1	18S	CCTATAAAAGG
99	https://doi.org/10.1111/j.1365-2311.2004.00586.x	*Tetraleurodes mori*	AY521263.1	16S	TTAGTTAATGG
100	https://doi.org/10.1038/s41598-024-84958-0	*Trialeurodes ricini*	HG810146.1	16S	ATAAGATTAGG

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