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## **Biorational control of arthropod pests with emphasis on the use of the chitin synthesis inhibitor novaluron**

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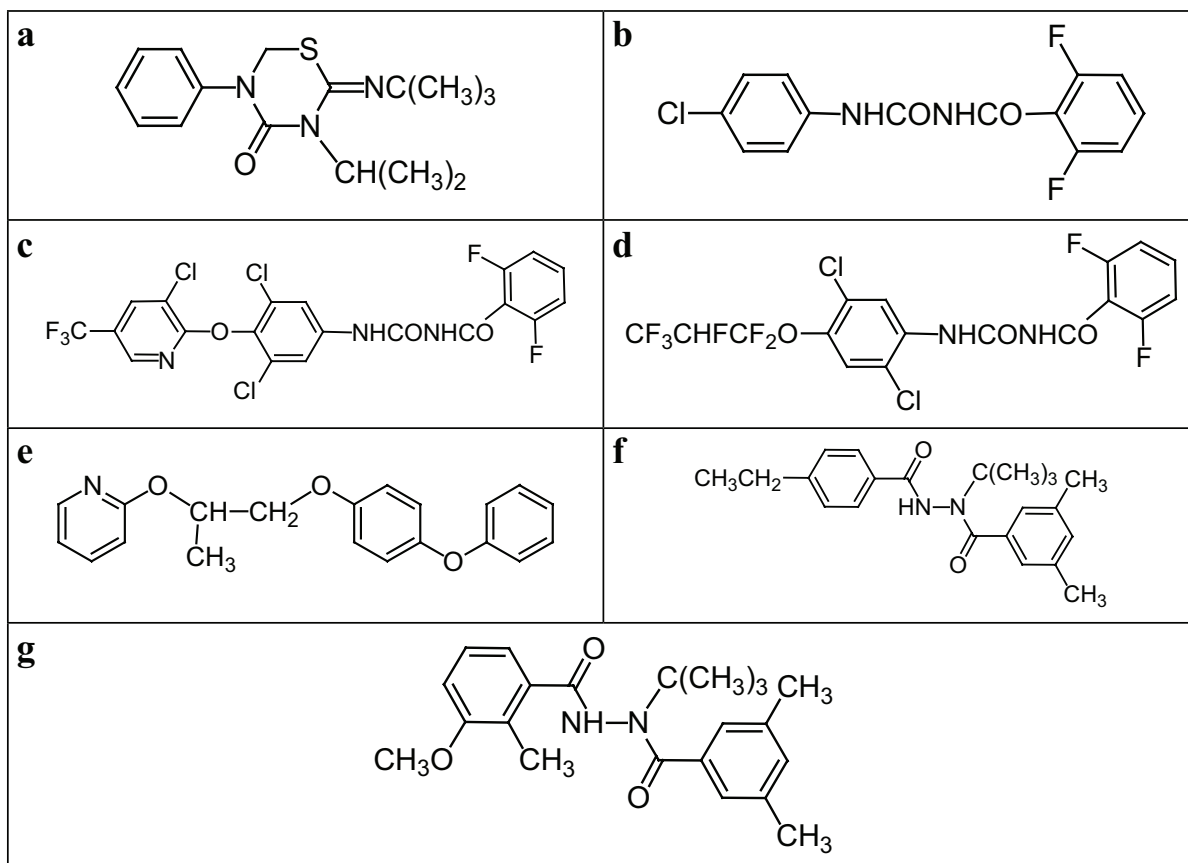
**Abstract:** Efforts have been made during the past three decades to develop insecticides with selective properties that act specifically on biochemical sites present in a particular insect group, but whose properties differ from those present in mammals. This approach has led to the discovery of compounds that affect the hormonal regulation of molting and developmental processes in insects such as ecdysone agonists, juvenile hormone (JH) mimics and chitin synthesis inhibitors. The search for potent acylureas has led to the development of novaluron (Rimon) developed by Makhteshim Chemical Works. The LC-50 value of novaluron on 3<sup>rd</sup>-instar *Spodoptera littoralis* fed on treated leaves is approximately 0.1 mg a.i./liter. This value resembles that of chlorfluazuron and is tenfold lower than that of teflubenzuron. Novaluron affects nymphs of *Bemisia tabaci* more than chlorfluazuron and teflubenzuron. Artificial rain, at a rate of 40 mm/h applied 5 and 24 h after treatment in a cotton field had no appreciable effect on the potency of novaluron on both *S. littoralis* larvae and *B. tabaci* nymphs. Hence, novaluron can be used in tropical areas and during rainy seasons. In general, benzoylphenyl ureas had no direct effect on parasitoids and phytoseiids and are considered mildly affect other natural enemies. Novaluron has no cross-resistance with conventional insecticides, the JH mimics pyriproxyfen and neonicotinoids. As such, it is considered an important compound in pest management programs.

**Keywords:** novel insecticides, insect growth regulators, buprofezin, diflubenzuron, chlorfluazuron, novaluron, pyriproxyfen, ecdysone agonists, tebufenozide, methoxyfenozide, neonicotinoids, imidacloprid, acetamiprid, thiamethoxam, GABA and glutamate receptors, abamectin, emamectin and spinosad

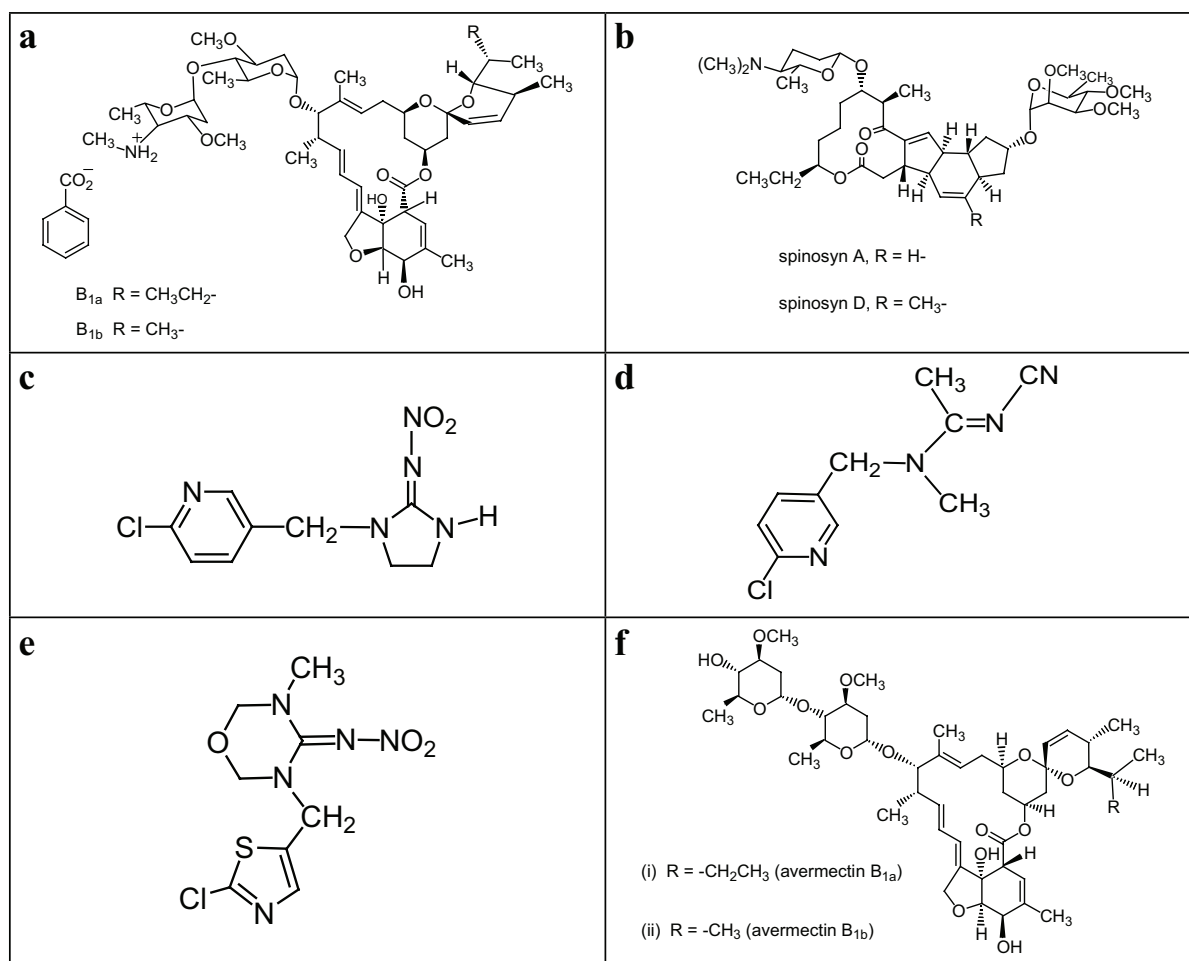
## NOVEL INSECTICIDES WITH SELECTIVE PROPERTIES

Novel approaches for biorational control of arthropod pests are the development of new compounds that specifically affect developmental processes in insects but not in mammals, such as, chitin synthesis inhibitors [1-3], juvenile hormone mimic pyriproxyfen [4, 5] and ecdysone agonists [6-7] (Figure 1).

In addition, compounds which interact with nicotine acetylcholine receptors with a higher affinity in insects than in mammals such as imidacloprid, acetamiprid and thiamethoxam have been introduced for the control of aphids and whiteflies [8, 9]. Compound originating from natural products such as abamectin, emamectin benzoate and spinosad which act on GABA and glutamate receptors and chloride channels have been used for controlling various agricultural pests [10, 11]. Furthermore, other products originating from bacteria (e.g. *Bacillus thuringiensis*) or other sources (e.g. plant extracts) have been used for controlling diversity of insect pests (Figure 2).



**Figure 1.** Insect growth regulators: the chitin synthesis inhibitors [buprofezin (a), diflubenzuron (b), chlorfluazuron (c) and novaluron (d)]; the juvenile hormone mimic pyriproxyfen (e) and the ecdysone agonists: tebufenozide (f) and methoxyfenozide (g).



**Figure 2.** Novel insecticides with selective properties: neonicotinoids such as imidacloprid (c), acetamiprid (d) and thiamethoxam (e), compounds that act on GABA and glutamate receptors such as abamectin (f), emamectin benzoate (a) and spinosad (b).

## CHITIN SYNTHESIS INHIBITORS WITH EMPHASIS ON NOVALURON

Over the past four decades, two groups of compounds, the benzoylphenyl ureas and buprofezin have been developed (Figure 1). While buprofezin acts on whiteflies and leafhoppers [12], benzoylphenyl ureas act on the larval stages of diversity of insect species [2]. The first commercial compound, diflubenzuron (Dimilin) acts on insects of various orders by inhibiting chitin formation [13, 14], thereby causing abnormal endocuticular deposition and abortive molting [15]. The reduced level of chitin in the cuticle seems to result from inhibition of biochemical processes leading to chitin formation [14, 16, 17]. The search for potent acylureas has led to the development of new compounds such as

chlorfluazuron [18], teflubenzuron [19] and hexaflumuron [20] which are far more potent than diflubenzuron on various agricultural insect pests [2]. The most recent benzoylphenyl urea which has been developed is novaluron {Rimon EC-10, 1-[chloro-4-(1,1,2-trifluoromethoxyethoxy)phenyl]-3-(2,6-difluorobenzoyl) urea} (Figure 1). Our studies indicate that the LC-50 value of Rimon on third instar *S. littoralis* fed on treated leaves is 0.1 mg a.i./l. This value resembles that of chlorfluazuron and is over tenfold lower than that of teflubenzuron (Table 1). Novaluron affects larvae of *B. tabaci* to a greater extent than chlorfluazuron and teflubenzuron [21, 22]. Artificial rain at a rate of 40 mm/h applied 5 and 24 h after treatment in a cotton field had no appreciable effect on the potency of novaluron on *S. littoralis* larvae 5 and 24 h after application (Table 2). Hence novaluron can be used in tropical areas and in rainy seasons. Pyriproxyfen resistant strain of *B. tabaci* (>2000-fold) showed no cross-resistance to novaluron [23, 24]. In addition, novaluron has no appreciable effect on the phytoseiid mites and the parasitoid *Encarsia Formosa* [25, 26]. Hence it can be considered an important addition in pest management programs.

**Table 1.** Comparative toxicity of novaluron, chlorfluazuron and teflubenzuron on 3<sup>rd</sup>-instars *Spodoptera littoralis* under standard laboratory conditions [21]

Compound	No.	Slope	LC values in mg a.i./liter	
		±SEM	LC-50	LC-90
Novaluron	520	2.9 ±0.2	0.16 a	0.43a
Chlorfluazuron	380	2.1 ±0.1	0.15 a	0.62a
Teflubenzuron	290	2.9±0.4	2.43 b	7.64b

Within columns, means followed by the same letter do not differ significantly at P = 0.05.

**Table 2.** Effect of artificial rain on the potency of novaluron (Rimon EC-10) under field conditions on 3<sup>rd</sup>-instar *Spodoptera littoralis* [25]

Novaluron in mg a.i./liter	Without rain	Rain (40 mm/h) applied at various hours after treatment		
		1	5	24
0	1±1	1±1	3±3	2±2
5	100a	45±7c	76±9b	90±3b
0	1±1	-	-	1±1
5	97±3a	-	93±4a	93±5a

Within columns, means followed by the same letter do not differ significantly at P = 0.05.

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