France, difficulties to manage insect pests of winter oilseed rape (*Brassica napus* var. *oleifera*): resistances to insecticides

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Abstract

In France, these last years, pest management had become more and more uneasy in relation with increased damage due to animal pests, lists of available chemical tools shortened and resistances to insecticides. The Green peach aphid (*Myzus persicae* L) met on rape expresses resistance to pyrethroids (target mutation). In autumn, to contain aphid presence and avoid virus transmissions, an adapted aphicid product is needed as in the same time only a pyrethroid is usable to control any other pests. Such a spray may help aphid establishment. Pollen beetle (*Meligethes aeneus* FABRICIUS) also expresses resistance (metabolic type) to pyrethroids. Thus this situation posed problems till 1999, on winter oilseed rape. Till 8 years, any new chemical had been registered. So, all the still registered products have been tested again. By chance, today, in spring, farmers can choose between three remaining – with similar, but not so high, efficacies – solutions: tau-fluvalinate and bifenthrin, two exceptions among the pyrethroid family; and malathion (organophosphate), a chemical alternative. Despite near 30 years of quite exclusive use of pyrethroids for field sprays and registered alternatives less and less numerous, this chemical family seems to be still satisfactory working against the numerous others damaging (i. e. *Ceutorhynchus spp*) or potentially damaging pests of rape.

Key words: Pyrethroid, organophosphate, neonicotinoid, pollen beetle, *Meligethes aeneus*, green peach aphid, *Myzus persicae*, *Ceutorhynchus*, flea beetle, *Phyllotreta*

Introduction

Traditional major crop in France (2006: 1.300.000 ha), winter oilseed rape (WOSR) is promised to new developments (demand of bio fuel). Unluckily, these last years, pest management had become more and more uneasy in relation with: (1) Increased damage due to animal pests – For a long time (second half part of the XX th century) WOSR pest control only needed to consider a rather short list (4-6 species) of major difficulties. More, at the end of this period, above insect pests, slugs have often taken the first place. Today, farmers have to deal with something like may be 10 insect species. Wireworms (COLEOPTERA: ELATERIDAE) constitute one last example (autumn 2006); (2) European re-registration – All pesticides are submitted to new examination (Directive 91/414/ CEE). A part of them, not proposed again, is automatically radiated. Another part of them, defended but not considered positive risk-benefit by our authorities, is not registered again. The remaining part leaves lots of usages without chemical solutions; (3) Resistances to insecticides – To day, such difficulties especially affect glasshouse or fruit trees pests, for instance, and large crops are not so concerned else – it is the case for WOSR - for largely polyphagous insects, as green peach aphids (GPA), scarcely for oliphagous insects, as pollen beetles (PB).

Material and methods

(1) Farmers – Chemical companies, technical institutes and Administration act in straight relation with farmers. Insufficient efficacy reports of field treatments constituted a first alert that induced resistance investigations. (2) Laboratory - Glass-vial tests have been adopted for PB and most of the other considered species. Submitting insects to different toxic concentrations allow LD50 (lethal dose 50) evaluation expressed as FD (field registered dose) parts. Cypermethrin was chosen as pyrethroid model (FD = 25 g a.i./ha). Other strategic active ingredients or synergists have also such been involved (Delorme et al., 2002; Ballanger et al., 2003). Another method, insects set upon foliar disks before been sprayed, have been retained for GPA to determine LC50 (lethal concentration 50) (Ballanger & Delorme, 1997). If we have the possibility to compare aphids coming from the field to susceptible laboratory aphid strains (resistance ratio), it is not the case with other insects as PB without well known laboratory populations and no breeding possibilities. (3) Field tests – New experiments are performed and results are confronted with previous data. Usually trials are based on 4 replication disposals, small plots (i.e.: 3 meters×10 meters), that allow diverse modalities (one date of spray, several insecticides compared and untreated plots) (Rivière et al., 2002; Ballanger & Delorme, 2005).

Results

Interest for GPA first came from virus diseases (Deverchère & Maisonneuve, 1994, a, b). At this occasion, early 1990's, lots of field tests did not revealed lacks of efficacies from treatments, based on pyrethroids. This problem was detected later (autumn 1997), when farmers appeared unable to control severe attacks may be more frequent in previously pyrethroid treated fields (to control another pest). In spring 1999, unusual high levels of PB populations revealed poor efficacies of the applied products (especially pyrethroids until mid-1970's). Before that some questions have already been asked by farmers but not acutely considered (low populations).

GPA - Green peach aphids (*Myzus persicae* L) - The GPA met on rape, expressed resistance to pyrethroids (target mutation) (Ballanger & Delorme, 1998; Ballanger, 1999). Recent laboratory tests have shown increased resistance levels (Table 1). Based on previous data first tests (tests 1 to 5) did not fit well and higher toxic concentrations were required (tests 6 and 7). Empirically, we consider that insufficient field efficacies can occur as soon as FC/LC50 < 20 (for LC50 =0.4, FC/LC50 = 1.48).

Table 1: 2005 – LC50 "Lambda-cyhalothrin (Karaté Xpress)", g active ingredient / hl [FD: 7,5 g SA/ha or FC: 0,75g SA/hl] / Inra Versailles / SUS = laboratory susceptible strain (from R.M.SAWICKI Harpenden, Great Britain), LYON = laboratory highly resistant strain (from peach tree) / Inra Versailles.

	1	2	3	4	5	6	7	SUS	LYON
Origine	18	54	51	51	89	54	55	Lab.	Lab.
LC50	> 0.4	-	> 0.4	> 0.4	> 0.4	1.48	1.67	0.0051	142

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PB - Pollen beetle (*Meligethes aeneus* FABRICIUS) – After the 1999 events, a working group (Chemical societies, technical institutes and administration) acts every year beside farmers to provide PB to the laboratories and to realize field tests. Cypermethrin LD50 may be less than FD/64 or FD/125 (< lower toxic concentrations applied). Most of the LD50 values evolve between FD/64 and DE (Fig. 1). At last we have to consider that resistance to pyrethroids concern most of the areas where WOSR is a major crop. It is not always the case in all the other areas (Détourné et al., 2002, 2005).

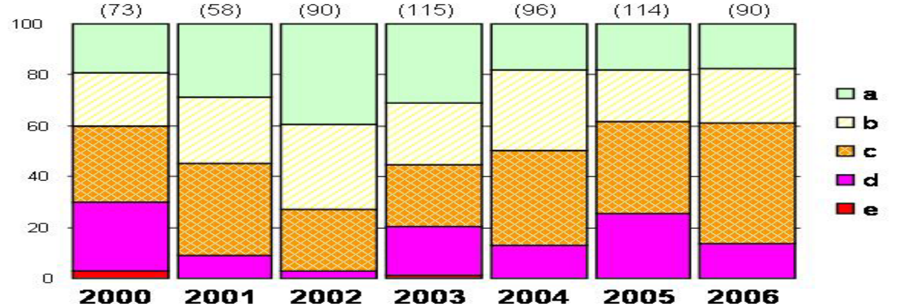

Figure 1. Pollen beetle resistance monitoring (laboratory glass-vial bioassays) over 7 years (2000 - 2006): LD50 "cypermethrin" (class %). a < 1/64 FD< b < 1/16 FD < c < ¼ FD < d < 1 FD < e < 4 FD (FD: field dose: 25 g a.i./ha). (n): total tests / Srpv Loos-en-Gohelle, Inra Versailles, Cetiom Grignon.

Before 2000, PB control was achieved with pyrethroid (lambda-cyhalothrin, deltamethrin, alphamethrin and cypermethrin) field sprays and partly with an organophosphate, methyl-parathion (no resistance). After that, from year to year, field tests have allowed us to distinguish tau-fluvalinate and bifenthrin, two pyrethroids structurally rather different from most of the other pyrethroid products (resistance). These two active ingredients show – confirming previous tau-fluvalinate results (Delorme et al., 2002) - a crossed resistance with cypermethrin but in the relation "y = ax + b", "a" is not so high (Fig. 2). As parathion use has become forbidden (2003), all the old - but still usable - registered products (before 1970) have been reviewed. By this way, it had been possible to qualify again and recommend malathion (organo-phosphorous) (Ballanger et al., 2003; Ballanger & Delorme, 2005).

Others pests – At present, pyrethroids seem to be still satisfactory working against the numerous other damaging or potentially damaging pests of WOSR. Difficulties to manage flea beetles *(Phyllotreta sp*p) at crop emergence only suggest interrogations. As it is less easy to bring sufficient large numbers of – i.e. - weevils (*Ceutorhynchus spp)* or flea beetles from the field than aphids or pollen beetles, not so many tests have been still achieved. Without true sensible references again, all the LD50 values are low, standing under FD/100 (Fig. 3).

Discussion

In autumn, as a more efficacious vector than *Brevicoryne brassicae* L. or *Lypaphis erysimi* KALTENBACH, GPA transmits TuYV, Turnip Yellows Virus (=BWYV, Beet Western Yellows Virus) and/or TuMV (Turnip Mosaic Virus) and/or CaMV (Cauliflower Mosaic Virus) and induces regular yield losses (From 1990 to 1994: insecticide protected – untreated > 2 qx/ha - up to 10 qx/ha – for 40 % of 254 field trials / MAISONNEUVE C. et al., 1993). More, from year to year, severe swarming can occur and conduct to plant losses and destroyed crops. To contain aphid presence (threshold: 20% plants with aphids during the 6 first weeks after emergence / REGNAULT Y. et al., 1993) and avoid virus transmissions, an aphicid - that means with poor efficacies against other pests if not association like pyrethroid + pyrimicarb – is needed. Another way, as in the same time to control the other pests only a pyrethroid is usable, such a spray may help GPA establishment (unintentional effects on beneficial organisms)?

In spring, PB resistance to pyrethroids and bad efficacies of foliar sprays combine with high level infestations to make - from a previously considered poorly noxious pest - a major pest. Thus the phenomenon occurred in 1999 and till 8 years, any new chemical had been registered. To day, at last, in spring, to try to preserve their crops, farmers can choose between three remaining – with similar, but not so high, efficacies – solutions ; tau-fluvalinate, bifenthrin and malathion. Some questions are asked concerning tau-fluvalinate and bifenthrin status (poor field efficacies). Among new possibilities, etofenprox seems to be a good candidate to registration. But, would it be a robust new solution as it is also a pyrethroid ? Malathion is promised to interdiction (Rejected by the ad hoc European committee / September 2006).

Promised to new developments, WOSR interests chemical society again and we can expect new products registration and alternative to pyrethroids. But the challenge is not won, especially in France, as hazards to bees are a major preoccupation. In France oleaginous crops, WOSR and sunflower, are essential to honey production. After the relegations of imidacloprid-fipronil seed treatments (supposed adverse to bees) on sunflower, neonicotinoids products (i.e. imidacloprid, thiamethoxam / highly toxic against bees) – good aphicids - have not still been registered on WOSR as autumnal seed crop protection tools. Concerning spring and PB, solutions could also come from neonicotinoids products (i.e. thiacloprid, acetamiprid / poorly toxic against bees) but first field test results do not appear so convincing and may be it would not be so easy to get a good bee keepers acceptance of such products.

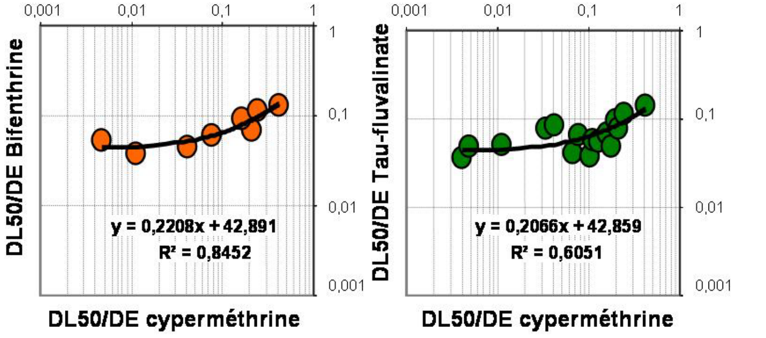

Figure 2 – 2006: Relation between LD50/FD (tau-fluvalinate or bifenthrine) and LD50/FD (cypermethrin) / Cetiom Grignon.

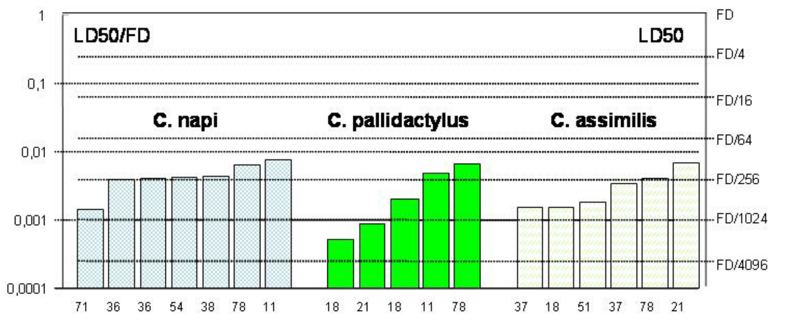

Figure 3 – 2006: LD50/FD (cypermethrin) for rape stem weevil (*C. napi*), cabbage stem weevil (*C. pallidactylus*) and seed pod weevil (*C. assimilis*) / Cetiom Grignon.

Conclusions

It is obvious that what concern GPA and PB can develop for others WOSR pests (after more than 30 years of quite exclusive use). It does not seem to be the case in France. But, laboratory tests performed in Germany showed that bad responses can be obtained with Ceutorhynchus spp, stem weevils (C. napi GYLLENHAL and C. pallidactylus PAYKUL / 2005-2006) and seed weevil (C. assimilis PAYKUL / 2006), not with *Phyllotreta spp. 2005)* (Heimbach et al., 2005, pers. comm. 2006).

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