

Notat vedr. anvendelsen af pyrethroider til bekæmpelse af insekter; Biocid PT18.

Rådgivningsnotat fra DCA – Nationalt Center for Fødevarer og Jordbrug

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Baggrund

Miljøstyrelsen har bedt Institut for Agroøkologi (AGRO) om en redegørelse for hvilke pyrethroider der anses som egnede til bekæmpelse af insekter, hvilke der er uegnede på grund af risikoen for udvikling af resistens, og hvordan denne problemstilling har været reguleret ved godkendelser i Danmark. Herunder ønskes redegjort for, hvilke steder pyrethroider er uegnede at bruge, og hvilke målorganismer der er i risiko for at udvikle resistens ved bekæmpelse med pyrethroider. AGRO er bedt om at forklare, hvilke pyrethroider der anses som persistente i denne sammenhæng og hvilke betingelser der øger risikoen for udvikling af resistens. Endvidere er AGRO bedt om at vurdere, om der er yderligere omstændigheder MST skal tage højde for i deres vurdering af pyrethroidholdige produkter til bekæmpelse af insekter.

Resume

Det anbefales, at der ikke anvendes pyrethroider med langtidsvirkning i stalde, fjerkræhuse, væksthuse og lignende, idet dette vil føre til en kraftig og hurtig selektion af pyrethroidresistens hos stuefluer, som vil gøre det umuligt at anvende de korttidsvirkende pyrethroider til hurtigt og effektivt bekæmpelse af en stuefluepopulation. Dette har medført, at der i Danmark ikke har været anvendt pyrethroider med langtidsvirkning i stalde, fjerkræhuse, væksthuse og lignende. I Danmark har vi således stuefluepopulationer, som stadig kan bekæmpes med pyrethrum eller ikke-persistente pyrethroider, som det eneste land vi kender til.

Besvarelse

Besvarelsen omhandler biocider til skadedyrsbekæmpelse og omfatter ikke plantebeskyttelsesmidler. Vi har i Danmark i omkring 40 år haft en politik vedr. anvendelsen af pyrethroider indendøre i stalde, fjerkræhuse, væksthuse og lignende. Det primære fokus har været at fastholde følsomheden hos stuefluer over for de midler som ikke havde en langtidsvirkning, idet disse er meget effektive og anses for at være de mest skånsomme i forhold til toksikologiske og miljømæssige problematikker.

Baggrunden for denne politik, hvor pyrethroider med langtidsvirkning (høj persistens) ikke må anvendes i stalde, fjerkræhuse, væksthuse og lignende, skal findes i en række erfaringer der blev gjort i forbindelse med feltundersøgelser af pyrethroid produkters effektivitet over for stuefluen.

Insektmidler indeholdende pyrethrum, som er et botanisk insekticid ekstraheret fra planten *Tanacetum cinerariifolium*, har været anvendt siden 1950 i form af spray eller aerosoler. Aktivstofferne i pyrethrum kaldes pyrethriner og er en blanding af primært pyrethrin I og II, men også cinerin I, cinerin II, jasmolin I, and jasmolin II (Casida, 1973). Pyrethrum-midlerne har ingen langtidsvirkning (residual effekt), idet de meget nemt nedbrydes biologisk eller ved UV-lys. Pyrethrum midlerne giver således et beskeden selektionstryk for udviklingen af resistens og man så således også først pyrethrumresistens i Danmark i 1971-73 på enkelte gårde med intensiv pyrethrum-sprøjtning.

Pyrethroider er syntetiske insekticider baseret på strukturen af naturlige pyrethriner. Nogle syntetiske pyrethroider har stadig den egenskab, at de nedbrydes hurtigt; f.eks. resmethrin, d-phenothrin, bioresmethrin og bioallethrin. Hovedparten af pyrethroiderne er dog fremstillet med henblik på at være langtidsvirkende; f.eks. permethrin, deltamethrin og lambda-cyhalothrin (Davies et al., 2007; Gajendiran og Abraham, 2018). Lad os præsentere et par eksempler i) resmethrin i vandig opløsning har en halveringstid på mindre end 1 time (Rand 2002) og resmethrin har en halveringstid på 20-90 minutter på en udendørs overflade som udsættes for sollys. Undersøgelser af resmethrin indendøre viste at resmethrin blev nedbrudt i løbet af få timer (National Pesticide Information Center, <http://npic.orst.edu/factsheets/ResGen.html#env>), ii) i luften nedbrydes d-phenothrin hurtigt med en halveringstid på 38-72 minutter. På planteoverflader har d-phenothrin en halveringstid på mindre end 1 dag (National Pesticide Information Center <http://npic.orst.edu/factsheets/archive/dphentech.html>) iii) permethrin er et typisk persistent pyrethroid. Permethrin blev påført indendørs i nærheden af en vindue i et forsøg, hvor det blev udsat for dagslys. Efter 20 dage var 60 % af den påførte permethrin stadig på overfladen (National Pesticide Information Center, <http://npic.orst.edu/factsheets/PermGen.html>).

Stuefluerne på en gård er en afgrænset population med lille tilførsel af nyt genetisk materiale, hvilket begunstiger selektionen og er et perfekt scenarium for hurtig udvikling af insekticidresistens. Feltundersøgelser foretaget i 1973 med pyrethroider viste en markant udvikling af resistens efter én sæson med hyppig brug, f. eks. to gange om ugen af pyrethroidspray, der kunne forårsage et stærkt selektionstryk over 3-5 måneder, hvorimod lejlighedsvis eller sjældnere anvendelse i flere på hinanden følgende år (10 eller mere) ikke gav anledning til alvorlige resistensproblemer. Det konkluderedes, at hyppig og langvarig brug af pyrethroider bør undgås på danske gårde (Keiding, 1976; 1977; 1986).

Senere noteres det, at så længe fluepopulationerne er rimeligt følsomme over for pyrethroid, er påføring med spray på alle fluernes hvilepladser i staldene langt den mest effektive og bekvemme måde at bekæmpe fluer på gårdene, MEN også er en meget effektiv måde at udvikle resistens på (Keiding og Jespersen, 1986).

Efterfølgende er det blevet anbefalet kun at anvende pyrethrum eller ikke-persistente pyrethroider en gang om ugen, som supplement til anden bekæmpelse, f.eks. med ædegifte. Dette har medført, at vi i Danmark stadig har fluepopulationer, som kan bekæmpes med pyrethrum eller ikke-persistente pyrethroider (Keiding, 1999; Kristensen et al., 2001), hvorimod det mange andre steder i Europa er nytteløst at anvende selv persistente pyrethroider på grund af pyrethroidresistens.

Et eksempel på et ikke-persistent godkendt produkt vil være AquaPy (reg.nr. 18-499), hvor aktivstoffet er pyrethrin I+II, som anvendes til bekæmpelse af fluer i stalde som en tågebehandling. En anden type godkendte produkter er spray indeholdende pyrethrum eller pyrethriner; Chok Fluespray (reg.nr. 386-22), Flue Spray Pyre C (reg.nr. 671-4,) FlueFri Spray (reg.nr. 364-19), Insektspray (reg.nr. 730-21), Kvit fluespray PY (reg.nr. 671-3), Kvit Staldchok Fluespray D (reg.nr. 25-41), Prima Fluespray (reg.nr. 386-23), Stald chok fluespray D (reg.nr. 25-11), Tanaco Flue Chok (reg.nr. 179-149), Trinol Nr. 810 (reg.nr. 730-10), Trinol Turbo-Jet mod Fluer (reg.nr. 25-19) hvor man hurtigt ville kunne dræbe en stor del af den voksne fluepopulation. Dette vil ikke være muligt i fremtiden hvis man anvender produkter med persistente pyrethroider.

Eksempler på persistente godkendte biocid produkter indeholdende permethrin er Perma Forte B (reg.nr. 730-11), Tanaco Hvepsespray (reg.nr. 179-200) og Garden Fluer og Hvepse (reg.nr. 179-235). Disse produkter har følgende anmærkning "Må ikke anvendes i stalde, fjerkræhuse, væksthuse og lignende."

Dokumentation

Keiding J (1976) Development of resistance to pyrethroids in field populations of Danish houseflies. *Pesticide Science* 7: 283-291.

"The 1973 investigations have shown that moderate to high pyrethroid resistance can develop in housefly populations on a high proportion of Danish trial farms, when intensive use of pyrethroid aerosols or space sprays (pyrethrins/pb, bioresmethrin, bioresmethrin/pb, tetramethrin/pb or tetramethrin/resmethin) takes place and hence the populations are submitted to strong selection pressure with pyrethroids for several months."

"However, we believe that the kind and intensity of selection pressure applied by the regular treatments on the trial farms, with semi-isolated fly populations mainly concentrated in the treated stables and often breeding in them, is a decisive part of the reason why pyrethroid resistance has developed on several Danish farms 1971-73 This is supported by the fact that resistance to other insecticides also very often has developed earlier or more quickly on the Danish trial farms than elsewhere and that Danish fly populations with occasional pyrethroid pressure in most cases have remained relatively susceptible to pyrethroids.

As a consequence of these results and considerations we think that frequent and long-term use of pyrethroids, which may exert an effective selection pressure on the treated fly populations, should be avoided, at least in situations similar to those found on Danish farms."

Keiding J (1977) Resistance in the housefly in Denmark and elsewhere, in *Pesticide Management and Insecticide Resistance*, ed. by Watson DL and Brown AWA, Academic Press, New York, pp. 261-302.

"It is important to note that pyrethroid resistance only developed after a season of frequent use, e.g. twice a week, of pyrethroid sprays that could cause a strong selection pressure over 3-5 months, whereas occasional or less frequent use in several successive years (10 or more) did not give rise to serious resistance problems, as shown with farms outside the pyrethroid trial areas."

Keiding J, Jespersen JB (1986) Effect of different control strategies on the development of insecticide resistance by houseflies: experience from Danish farms, in *Proc Brighton Crop Prot Conf, Pests and Diseases, BCPC, Farnham, Surrey, UK*, pp. 623-630.

"As long as the fly population is reasonable susceptible to the insecticide, application of residual spray to all fly resting sites in the animal units is by far the most effective and convenient means of controlling flies on traditional Danish farms. We soon learned, however, that this is also a very efficient of developing resistance ..."

"Space sprays and aerosols containing pyrethrum+ piperonyl butoxide (PY-PB) were widely used on Danish farms 1950-70 without serious problems of resistance to PY-PB. For many years these sprays were used to supplement other control methods, but from about 1970 they were increasingly used as the main fly control method. Trials in 1971 showed that spraying twice a week

with PY-PB in the fly season was necessary to obtain satisfactory fly control where the fly breeding potential was high, but such frequent application might induce moderate to high resistance PY-PB and other pyrethroids. This development of resistance to pyrethroids by frequent application was demonstrated on many farms in 1973 (Keiding, 1976) and later. However, on farms with aerosol treatments at a week's interval or more low resistance to pyrethroids did not increase generally and the aerosol treatments continue to be effective. However, once a fly population had developed pyrethroid resistance this would in many cases remain high the following year(s) even if the frequency of the aerosol treatments was reduced. If other insecticides were used, pyrethroid resistance might reverse. Based on these results we recommended that the frequency and extent of using pyrethroid aerosols or space sprays should be reduced to decrease the selection pressure by allowing more unexposed flies to reproduce. Moreover, based on the long experience with residual sprays, we persuaded the authorities and companies not to register residual pyrethroid formulations for fly control on farms. The result is that aerosols are still effective on most Danish farms in spite of the general high potential for development of pyrethroid resistance."

Keiding J (1986) Prediction or resistance risk assessment, in Pesticide Resistance: Strategies and tactics for management, National Academy Press, Washington, DC, pp. 279-297.

"The most striking example of resistance risk assessment was that of pyrethroid resistance. Investigations from 1970 to 1973 showed that house flies on Danish farms had a common potential for developing high resistance to pyrethroids when the selection pressure with pyrethroids was strong, for example, by frequent use of pyrethroid aerosols (Keiding 1976). If aerosols were used less frequently, however, once a week or less, allowing some unexposed flies to reproduce, the resistance might remain low and the aerosols would remain effective. Knowing that treatments with residual sprays give a strong selection pressure, DPIL advised some companies and the authorities not to introduce residual sprays with pyrethroids for fly control on farms. The advice was followed, even though there was no proper legal basis for banning residual pyrethroids for fly control until 1980.* In the meantime DPIL received further support for this decision.

In 1977 and 1978 DPIL found The predicted rapid development of general pyrethroid resistance when residual pyrethroids was confirmed in Switzerland, in Germany, and England. In Denmark we continue to avoid the residual pyrethroids for fly control. The aerosols with pyrethrum, and the like, are still effective, and pyrethroid resistance is low to moderate."

Keiding J (1999) Review of the global status and recent development of insecticide resistance in field populations of the housefly, *Musca domestica* (Diptera: Muscidae). Bulletin of Entomological Research 89: S7-S67.

"It is important to note that pyrethroid resistance only developed after a season of frequent use, e.g. a twice weekly application of pyrethroid sprays resulting in strong selection pressure over a period of three to five months, whereas occasional or less frequent use did not give rise to serious resistance problems over ten or more successive years."

"Subsequently it was recommended that synergized pyrethrum or non-persistent pyrethroids should be used only at a reduced rate, as supplement to other fly control measures and never more frequently than once a week in order to reduce selection of r pyrethroid resistance. As mentioned on p.26 space sprays remained effective on most farms, and annual surveys for resistance to bioresmethrin/pbo (1977-1989) did not show a general increase in resistance."

Kristensen M, Spencer AG, Jespersen JB (2001). The status and development of insecticide resistance in Danish populations of the housefly *Musca domestica* (L.). Pest Management Science 57: 82-89.

"In general, though, the results show low to moderate resistance to pyrethrum and bioresmethrin, confirming that resistance to pyrethroids can be kept at a low level and that spacesprays remain effective if they are not used frequently and if residual pyrethroids are not permitted, as is the case in Denmark.

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National Pesticide Information Center, <http://npic.orst.edu/factsheets/ResGen.html#env>, besøgt 01-12-2022

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