



国際農薬規制シンポジウム
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ネオニコチノイド： 花粉媒介者、EUにおける反対と規制



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概要



花粉媒介者(ポリネーター)の魅力と奉仕

花粉媒介者(ポリネーター)の危険状況



ネオニコチノイドの問題点は何か？

毒性、環境中での作用



EUおよび一部加盟国(MS)における法的措置





花粉媒介者(ポリネーター) —魅力と奉仕

魅力



生物多様性を維持するための奉仕...

- 生態系における主な受粉機能
- およそ300,000の動物種が受粉に関与
- 花粉媒介者は野生の花や植物の繁殖と多様性を確保する
- 世界中の植物の16%以上が蜂により受粉されている



...さらに食料も安全保障に

- 世界の食糧生産の35%が花粉媒介者に左右される (FAO)
- 受粉により収穫物の質と量が決まる

果実収穫

受粉なし



+ 62 %

受粉あり



+ 63 %



+ 89 %



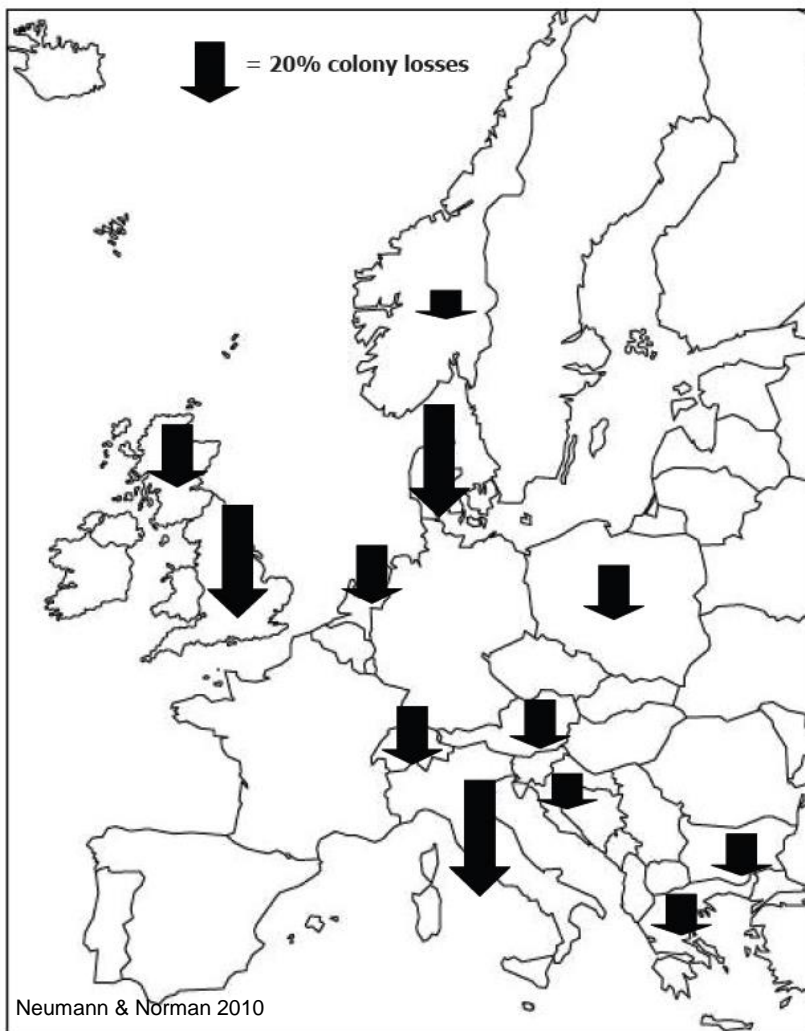


花粉媒介者—危險狀況



野生蜂と飼育蜂の減少

- ヨーロッパでは1960年代から飼育蜂が減少しているが、1998年以降減少が加速している
(BE, F, D, I, NL, ES, UK) (UNレポート2010)
- 日本、米国、中国では蜂群の喪失が報告されている
- 英国では、野生蜂の25%がレッドデータブックリストに絶滅危惧種や希少種として登録されている
- 特殊化された蜂の減少: 1980年以降英国で52%、オランダで67%減少 (ALARMプロジェクト)



なぜか？

近年ヨーロッパでは蜂群が減少している

影響する要因： 花粉媒介者に悪影響を及ぼしているのは何か？

気候
天候条件

食料調達
入手可能性
多様性
質

生息地の質
巣材

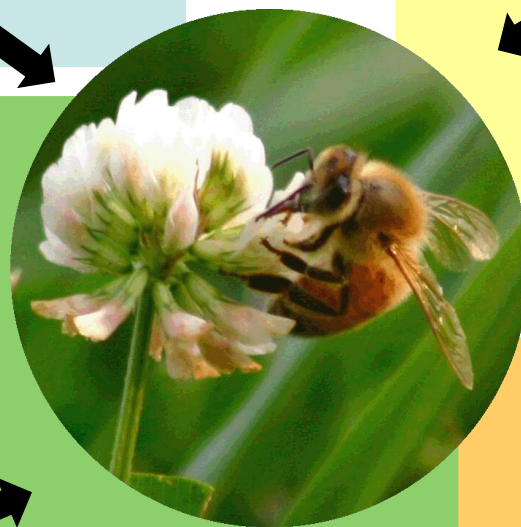
植物保護と農薬

遺伝的多様性

衛生性と手入れ





開発

病気
ウイルス
細菌
寄生虫





化学合成農薬は

- 直接および間接的に害を与える
 - 急性影響と慢性影響
 - 生息地や餌資源を減少させ巣材を破壊する
 - 短周期輪作と単作による集約的農業を可能にし、
単調な景観にした
- 
- 
- 
- 

観測される農薬の影響...

単独蜂に対する影響

■ 致命的影響

急性

慢性

■ 亜致命的影響

記憶

機動性および

配向性

社会的行動

■ 寿命(採餌!)

■ 幼虫の成長



写真: Noa Simon

蜂群に対する影響

■ ハチミツ収穫量の低下

■ 冬季死亡率の上昇

■ 女王蜂の再生産の問題

■ ウイルスや細菌への感染性の上昇



写真: 蜂の巣における蜂の活動

EUにおける蜂に急性毒性のある農薬成分36品目

アバメクチン
α-シペルメトリン
リン化アルミニウム
β-シフルトリン
クロルピリホス
クロルピリホスメチル
クロチアニジン
シフルトリン
シペルメトリン
デルタメトリン

ジメトエート
エスフェンバレレート
エトフェンプロックス
フェナミホス
フィプロニル
ホルメタネート
ホスチアゼート
γシハロトリン
イミダクロプリド
インドキサカルブ
λシハロトリン
マラチオン



メチオカルブ
ミルベメクチン
オキサミル
ホスメット
ピリミホスメチル
ヨウ化カリウム
ピレトリン
ピリダベン
キノクラミン
スピノサド
チアメトキサム
εシペルメトリン



ネオニコチノイドの問題点は何か？



ネオニコチノイド




イミダクロプリド
クロチアニジン
チアメトキサム

蜂に対する高度の急性毒性




チアクロプリド
アセタミプリド

蜂に対する中程度の急性毒性



...トウモロコシやその他のシリアル類、ヒマワリ、菜種、飼料用ビート、およびサトウダイコン用のハリガネムシ、ヨトウムシ、ウリハムシの幼虫、アブラムシ、およびヨコバイに対する**種子処理**として



...果樹園(リンゴ、桃)、ブトウおよび野菜(ジャガイモ、タマネギ、キャベツ、ネギ、ザラート”salat”など)の中や、観賞植物や鉢植え上のアブラムシおよびその他吸汁害虫に対して**散布**される



ネオニコチノイドの性質の作用



環境中

- ✓ 高い水溶性
- ✓ 高い浸透性
- ✓ 土壌への残留性




植物中

- ✓ 浸透性: 植物が成長するにつれて全組織にわたって拡散し、最終的には花蜜や花粉まで汚染する



昆虫中

- 
- ✓ 神経毒性: ニコチン性アセチルコリン受容体(神経伝達物質)に影響を与えることで中枢神経に影響
 - ✓ 致死量以下のネオニコチノイドの影響の可能性:
例) 異常な採餌活動、嗅覚記憶および学習能力の低下、配向性の障害

影響は可逆的かどうかについて現在議論が進行中。

ネオニコチノイド — 蜂の曝露

排水/浸出

表流水

露

粉塵

土壤

蜜

花蜜 / 花粉



ネオニコチノイドによる中毒はヨーロッパの全土
で見られる





EUおよび一部加盟国における法的措置





ネオニコチノイドが引き起こす急性中毒の結果



EU当局が行った技術的措置

- 種子処理に関する技術要件の増加
- 播種機の技術基準を上げ、粉塵の発生を減少



各加盟国が行った法的措置

国内禁止：スロベニア、フランス、ドイツ、およびイタリアの4つの加盟国が蜂に有害な数種類の農薬を一時「禁止」の措置



ドイツ



写真: Christoph Koch 養蜂者の抗議デモ

- BAYER CropScienceのクロチアニジンで種子処理した、スイートコーン種子から生じる粉塵によって12,500の蜂群に中毒(2008)
- ネオニコチノイドによるトウモロコシの種子処理を一時中止。(Poncho・Faibel・Cruiserの3つの農薬が影響を受ける)
- ただしネオニコチノイドを原料とする76種の農薬製品が依然として使用されている

フランス



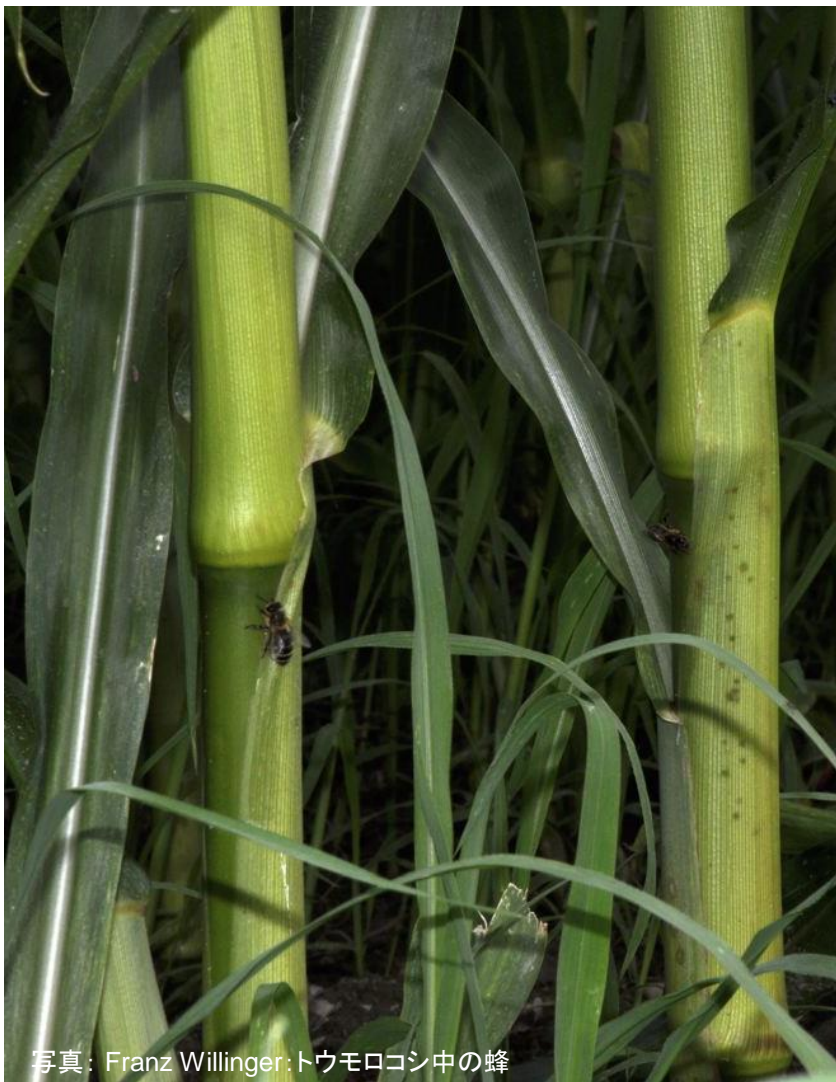
- 過去10年間で9000万匹の蜂が死亡
- 1999年：イミダクロプリドによるヒマワリの種子処理を禁止
- 2004年：Gaucho(イミダクロプリド)によるトウモロコシの処理を禁止
- 2012年：チアメトキサムによるアブラナの処理を禁止
- 「環境の利益のために」

スロベニア共和国



- 2011年：以下の農薬の使用および販売を禁止
 - RED PONCHO FS 600(クロチアニジン)によるトウモロコシ種とサトウダイコンの処理
 - CRUISER 350 FS(チアメキサム)によるトウモロコシ種の処理
 - CRUISER 70 FS(チアメキサム)によるサトウダイコンの処理
 - Biscayaによるアブラナ種子の開花期
 - クロチアニジン、イミダクロプリド、またはチアメキサムを含有する農薬のトウモロコシとアブラナの種子処理

イタリア



写真： Franz Willinger: トウモロコシ中の蜂

- 2008年：農業省が予防原則を適用し、クロチアニジン、チアメトキサム、イミダクロプリド、およびフィプロニルによるトウモロコシの種子処理を中止。
- 禁止に伴い監視が施行された
- 結果：農薬処理された種子を使用しなくても害虫による大きな被害はなく、蜂の損失は37,5%(2007～2008年)からおよそ15%(2010～2011年)に減少した

亜致死および複合影響に関する 科学的根拠についての法的措置は？

Scienceexpress EMBARGOED UNTIL 2:00 PM US ET THURSDAY, 29 MARCH 2012 Report Neonicotinoid Pesticide Reduces Bumble Bee Colony Growth and Queen Production

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Growing evidence for declines in bee populations in the valuable ecosystem services they have provided has been implicated in these declines as they pollinate crop plants. We exposed colonies to field-realistic levels of the neonicotinoid pesticide imidacloprid in the lab to develop naturally under field conditions. Control colonies reared on reduced food rates and suffered an 8% decline in queen production compared to control colonies. Given that they may be having a considerable impact on the developed world's

Bees in agroecosystems survive by feeding in field margins and patches of semi-natural habitat. The brief glims of flowers provided by many of the most important crops, such as oilseed rape and sunflower (1, 2). Many crops with neonicotinoid insecticides as a seed dressing, migrating in the sap to all parts of the plant, protect against insect herbivores. The neonicotinoid imidacloprid, which is found in rapeseed, oilseed rape, corn, cotton, soybean and many other crops (3). Being systemic, imidacloprid spreads throughout the plant, protecting it from flowering crops, typically at concentrations of 0.1–1.0 mg/kg (4, 5). Thus bees are exposed to neonicotinoid insecticides through pollen and nectar.

It is unclear what impact this exposure has on bees. A recent meta-analysis found that consumption of residue from laboratory and semi-field conditions reduced colony growth by 4 to 20% (7), but had no effect on queen production (8). Fewer studies have been carried out on bumble bees and queen production (9–11). There is some evidence that low doses of neonicotinoids may reduce foraging ability (12), which is likely to have significant impacts under natural conditions. Although recent studies (13, 14) have shown some evidence that neonicotinoids reduce forager success under field conditions, no studies have examined their impacts on colonies foraging naturally in the field. Here we present an experiment using 75 *Bombus terrestris* colonies designed to simulate the likely effects

Report
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of exposure of a wild bumble bee colony to neonicotinoids present on the flowers of a nearby crop. The colonies were randomly allocated to one of three treatments. Control colonies received no insecticide and a natural period of 14 days in the laboratory.

Naturwissenschaften
DOI 10.1007/s00114-011-0881-4
ORIGINAL PAPER

Pesticide exposure in honey bees results in increased levels of the gut pathogen *Nosema*

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Abstract Global pollinator declines have been attributed to habitat destruction, pesticide use, and climate change or some combination of these factors, and managed honey bees, *Apis mellifera*, are part of worldwide pollinator declines. Here we exposed honey bee colonies during three brood generations to sub-lethal doses of a widely used pesticide, imidacloprid, and then subsequently challenged newly emerged bees with the gut parasite, *Nosema* spp. The pesticide dosages used were below levels demonstrated to cause effects on longevity or foraging in adult honey bees. *Nosema* infections increased significantly in the bees from pesticide-treated hives when compared to bees from control hives demonstrating an indirect effect of pesticides on pathogen growth in honey bees. We clearly demonstrate an increase in pathogen growth within individual bees reared in colonies exposed to one of the most widely used pesticides worldwide, imidacloprid, at below levels considered harmful to bees. The finding that individual bees with undetectable levels of the target pesticide, after being reared in a sub-lethal pesticide environment within the

colony, had between pesticides to increased mortality.

Keywords

Sub-lethal ·

Introduction

The honey bee (*Apis mellifera*) is one of the most important pollinators of many of our food crops. While world-wide increases in honey bee mortality and declines in colony health have been reported in many countries, the reasons for these declines are still unclear. Factors such as habitat loss, parasitism, and disease have all been suggested as potential causes (1–3). Pesticide use is also a likely factor, as many pesticides are known to be toxic to bees (4–6). In particular, neonicotinoid insecticides, which are widely used in agriculture, have been shown to be highly toxic to bees (7–10). Neonicotinoids are systemic pesticides that are taken up by the plant and move through the plant's vascular system to all parts of the plant, including the nectar and pollen. This means that bees are exposed to neonicotinoids when they visit treated plants. Neonicotinoids have been shown to affect bee navigation, learning, and memory (11–13). They have also been shown to affect bee immune systems (14–16). In particular, neonicotinoids have been shown to increase the susceptibility of bees to the gut parasite *Nosema* (17–19). *Nosema* is a common gut pathogen of honey bees that causes a range of symptoms, including reduced longevity, reduced fecundity, and reduced foraging ability (20–22). The fact that neonicotinoids increase the susceptibility of bees to *Nosema* suggests that they may be having a significant impact on the health of honey bee colonies. In this study, we investigated the effects of sub-lethal doses of imidacloprid on the growth of *Nosema* in honey bee colonies. We found that colonies exposed to imidacloprid had significantly higher levels of *Nosema* than control colonies. This increase in *Nosema* levels was observed in bees from all three brood generations, suggesting that the effects of imidacloprid are persistent. Our findings suggest that neonicotinoids may be having a significant impact on the health of honey bee colonies, and that this impact may be mediated through the gut pathogen *Nosema*.

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Scienceexpress EMBARGOED UNTIL 2:00 PM US ET THURSDAY, 29 MARCH 2012 Report A Common Pesticide Decreases Foraging Success and Survival in Honey Bees

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Non-lethal exposure of honey bees to thiamethoxam (neonicotinoid systemic pesticide) causes high mortality due to homing failure at levels that could put at risk of colony collapse. Simulated exposure events on free-ranging foragers labeled with an RFID tag suggest that homing is impaired by thiamethoxam intoxication. These experiments offer new insights into the consequences of common neonicotinoid pesticides used worldwide.

Colony collapse disorder (CCD) is a recent, pervasive syndrome affecting honey bee (*Apis mellifera*) colonies in the Northern Hemisphere which is characterized by a sudden disappearance of honey bees from hives (1). Multiple causes of CCD have been proposed, such as pesticides, parasites, and natural habitat degradation (2–4). However, the relative contribution of these stressors in CCD events remains unknown. Some scientists and beekeepers suspect that pesticides are readily exposed to pesticides because they rely heavily on insecticides to protect their crops (5, 6). In modern cereal farming systems, honey bees are exposed to pesticides because they rely heavily on insecticides to protect their crops (5, 6). In particular, neonicotinoid insecticides, which are widely used in agriculture, have been shown to be highly toxic to bees (7–10). Neonicotinoids are systemic pesticides that are taken up by the plant and move through the plant's vascular system to all parts of the plant, including the nectar and pollen. This means that bees are exposed to neonicotinoids when they visit treated plants. Neonicotinoids have been shown to affect bee navigation, learning, and memory (11–13). They have also been shown to affect bee immune systems (14–16). In particular, neonicotinoids have been shown to increase the susceptibility of bees to the gut parasite *Nosema* (17–19). *Nosema* is a common gut pathogen of honey bees that causes a range of symptoms, including reduced longevity, reduced fecundity, and reduced foraging ability (20–22). The fact that neonicotinoids increase the susceptibility of bees to *Nosema* suggests that they may be having a significant impact on the health of honey bee colonies. In this study, we investigated the effects of sub-lethal doses of imidacloprid on the growth of *Nosema* in honey bee colonies. We found that colonies exposed to imidacloprid had significantly higher levels of *Nosema* than control colonies. This increase in *Nosema* levels was observed in bees from all three brood generations, suggesting that the effects of imidacloprid are persistent. Our findings suggest that neonicotinoids may be having a significant impact on the health of honey bee colonies, and that this impact may be mediated through the gut pathogen *Nosema*.

of such behavioral difficulties on colony dynamics are extremely difficult to assess in the field and non-invasive approaches are needed. In this study, we tested the hypothesis that a sub-lethal exposure to a common neonicotinoid insecticide, thiamethoxam, causes high mortality due to homing failure at levels that could put at risk of colony collapse. Simulated exposure events on free-ranging foragers labeled with an RFID tag suggest that homing is impaired by thiamethoxam intoxication. These experiments offer new insights into the consequences of common neonicotinoid pesticides used worldwide.



Fig. 1. Honey bee RFID monitoring equipment. (A) A pollen forager honey bee fitted with a 3mg RFID tag. (B) A hive entrance equipped with RFID readers for detecting returning marked foragers.

Scienceexpress

<http://www.sciencemag.org/content/early/2012/03/29/10.1126/science.1215109>



なすべきことは多く残っている:



リスク管理の改善

— 複合影響、長期的影響、種の性質などを考慮に入れた、
蜂毒性に関するリスク評価の改善



被害予防の強化

- 農業のやり方の変更
- 化学合成農薬に対する依存率の低下
- 輪作システムの支援
- 作物多様性の上昇



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ありがとうございました