# EFFECT OF AN ORGANOPHOSPHATE INSECTICIDE COMBINED WITH A LIQUID FERTILISER (UAN) ON SOME PESTS (APHIDOIDEA, CHRYSOMELIDAE) AND BENEFICIAL ARTHROPODS (ARANEAE, OPILIONES) IN WINTER WHEAT STANDS*

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The effect of the organophosphate insecticide (pirimiphos-methyl) combined with the liquid fertiliser (urea and ammonium nitrate solution) at lower rates, and the effect of the liquid fertiliser at standard rate on pests and beneficial arthropods of winter wheat were studied. All chemicals were applied at ear emergence. The number of aphids per ear and damage caused by cereal leaf beetles on 3 upper leaves were assessed. The ground surface arthropods were collected by pitfall traps. Combinations of fertiliser with insecticide was effective against cereal leaf beetles but increased aphid numbers. By contrast, application of liquid fertiliser suppressed aphid numbers. Populations of spiders and harvestmen were affected a little by the treatments. The results suggest that such a mixture of the organophosphate insecticide and UAN could be possibly used in the control of winter wheat pests despite it causes phytotoxicity when applied at ear emergence and might subsequently decrease the yield.

fertiliser; organophosphate; combination; aphids; cereal leaf beetles; Araneae; Opiliones

## INTRODUCTION

Winter wheat is the most important crop in the Czech Republic. Its demand is expected to increase while the crop area will probably decrease. Therefore, current research is focused on maximizing yield mainly by optimizing plant nutrition and reducing the effect of pests. A liquid fertiliser (solution of urea

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+ ammonium nitrate, UAN) has an insecticidal activity against *Meligethes aeneus* and *Leptinotarsa decemlineata* (Veverka, Oliberius, 1985, 1987, 1988) but it is nearly harmless to spiders and carabid beetles (Pekár, 1997a). Promising results in the regulation of pests were obtained after application of UAN combined with some insecticides (Oliberius et al., 1987). The combination was efficient against pests and less harmful to beneficial arthropods than a pyrethroid insecticide alone (Pekár, 1997b). Moreover, both chemical compounds were mixed together at lower doses than when used alone what is of considerable economic importance.

Here we report the results of UAN combined with the organophosphate insecticide, pirimiphos-methyl. This insecticide has not been registered for a control of winter wheat pests in the Czech Republic yet (Kužma et al., 1997). We tested lower insecticide doses than recommended (1 l/ha) because the standard rate caused significant reductions in pest and predator numbers (e.g. Heimbach, 1991) were tested. The effect of UAN + pirimiphos-methyl combination on cereal leaf beetles (*Oulema gallaeciana* /Heyden/ and *Oulema melanopus* L.), grain aphids (*Sitobion avenae* /F./), and their natural enemies, spiders and harvestmen, was surveyed.

## MATERIAL AND METHODS

The experiment was carried out in a 11.7 ha winter wheat field in Prague-Ruzyně in 1995 where five 0.08 ha plots (40 x 20 m) along the field margin were established. Two plots (termed FERT) were sprayed with 100 l/ha solution of UAN, one plot (COMB 1) with a mixture of 75 l/ha of UAN + 200 ml/ha of pirimiphos-methyl, the other (COMB 2) with a mixture 75 l/ha of UAN + 400 ml/ha of pirimiphos-methyl, and the two remaining plots were the control (CTRL). The spraying was made on June 8, 1995 at ear emergence of winter wheat.

UAN was a commercial product, DAM 390, consisting of 430 g $NH_4NO_3$ and 320 g $CO(NH_2)_2$ per 1 kg of a solution, with pH = 7.5–8.5. Pirimiphos-methyl was ACTELIC 50EC with a half-life $DT_{50}$ = 7.5–35 days, most stable at pH = 7.0 (pH range 5.8–8.5). It is hydrolysed only by concentrated acids and alkalis (Tomlin, 1994) and the mixture is thus supposed to be stable enough for the field trials.

Abundance of aphids and cereal leaf beetles was evaluated on each experimental plot in weekly intervals, between June 15 and July 13 (Fig. 1). Aphids were counted on tillers at 1 $m^2$ per plot. Their abundance was ranked into four categories: (1) a few of alatae, (2) several apterae, (3) aphid colony



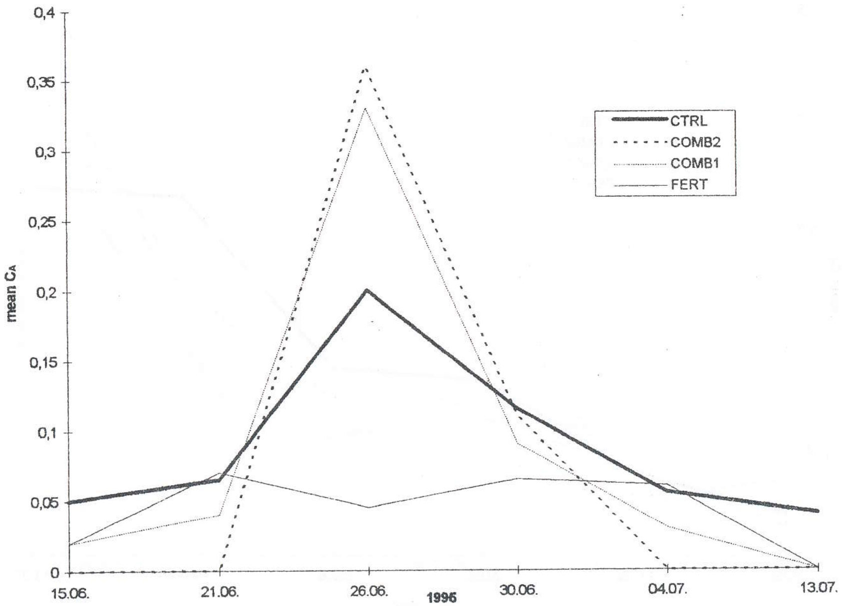
(< 10 inds.), (4) aphid colony (> 11 inds.) Coefficients of aphid presence ($C_A$) were calculated as

$$C_{A,\,B} = \frac{1x_1 + 2x_2 + 3x_3 + x_4}{n}$$

where: $n$ – total number of tillers per $m^2$
$x_1$–$x_4$ – number of tillers of the respective category

Damage to three upper leaves caused by cereal leaf beetles was ranked into four categories: (1) scarce spots (up to 5%), (2) separated spots (10%), (3) fused spots (25%), (4) eaten leaf (more than 40%). The coefficients of damage by cereal leaf beetles ($C_B$) were calculated using the equation above.

Spiders and harvestmen were collected by pitfall traps (7 cm diameter, 0.2 l volume, 4% formaldehyde fluid) emptied in 1–2 week intervals, between May 23 and July 10. Due to this irregularity the abundance was expressed as a number of spiders/day (Fig. 2). There were nine traps placed in 3 rows parallel to the field on each plot.



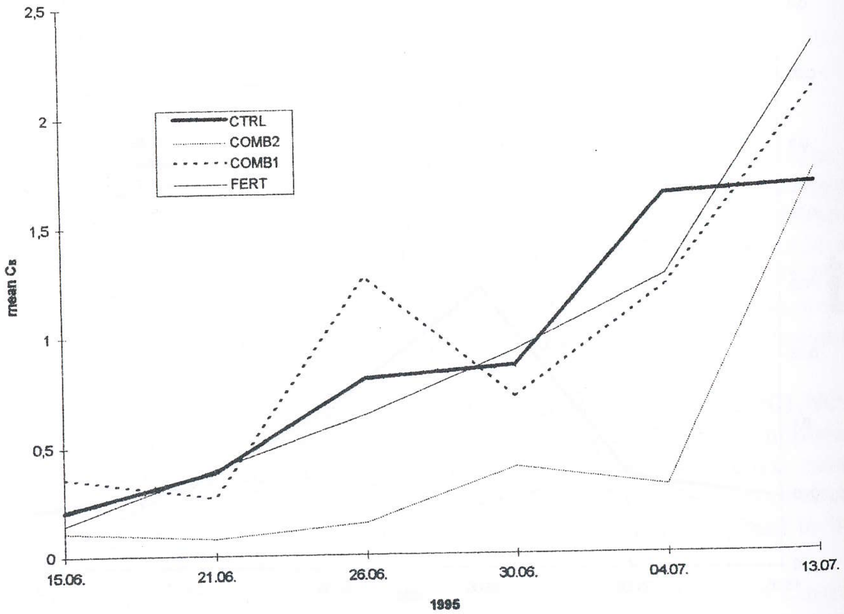

1. Comparison of aphid abundance (mean value of the coefficient of abundance – $C_A$) on studied plots one week after application

## RESULTS

### The effect on pests

The average abundances of aphids ($C_A$) was lowest on the FERT plot. On all plots, the maximum was 3 weeks after application (Fig. 1). At this time, the lowest abundance was recorded on the FERT plot, whereas the highest on the COMB plots. Both mixtures of insecticide + fertiliser (COMB 1 and COMB 2) significantly augmented aphid numbers in comparison with the FERT plot treated with UAN only ($P = 0.023$, 1-way ANOVA). The aphid numbers on CTRL plot were lower than on COMB and higher than on FERT, though not significantly. Later on, the difference in abundance of aphids between plots was negligible.

The damage caused by cereal leaf beetles ($C_B$) is displayed in Fig. 2. The lowest damage was found on COMB 2 (higher concentration of pirimiphos--methyl) for 5 weeks (June 15–July 4) after application but the differences



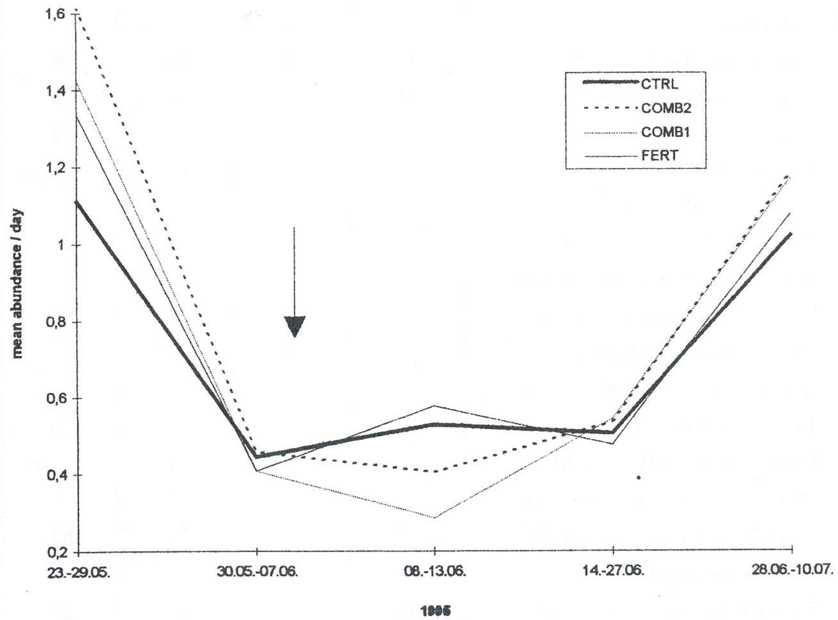

2. Comparison of damage to leaf by cereal beetles (mean value of the coefficient of abundance – $C_B$) on the studied plots one week after application



between this plot and the remaining ones were significant ($P < 0.05$, 1-way ANOVA) only 2, 3 and 5 weeks after application. Six weeks after spraying (July 13), either damage on COMB 2 increased so the plots were not differing significantly from each other. Application of the lower insecticide concentration on COMB 1 as well as application of UAN on FERT did not decrease abundance of cereal leaf beetles.

### The effect on beneficial arthropods

In total, 2486 individuals of spiders and 16 individuals of harvestmen were collected (Tab. I). Total abundance of spiders decreased between May 30 and June 7, i.e. before application, and then gradually increased with maximum in June 28–July 10 (Fig. 3). However, immediately after application, the abundance of spiders even more decreased on both COMB plots to 77 % (COMB 2) and 38% (COMB 1) of the abundance on CTRL. The difference




3. Abundance of spiders + harvestmen (mean value of 18 traps per 1 day) on studied plots. The arrow mark the date of application

I. Numbers (total capture of 9 pitfall traps per plot) of harvestmen and spiders collected in the study

| | COMB 1 | COMB 2 | FERT | CTRL |
|---|---|---|---|---|
| **Opiliones** | | | | |
| *Phalangium opilio* Linnaeus | 3 | 1 | 2 | 2 |
| *Platybunus triangularis* (Herbst) | | | 1 | |
| **Araneae** | | | | |
| *Aculepeira ceropegia* (Walckenaer) | | | | 1 |
| *Alopecosa cuneata* (Clerck) | | 2 | 1 | |
| *Alopecosa pulverulenta* (Clerck) | 5 | 3 | 2 | 1 |
| *Araeoncus humilis* (Blackwall) | 3 | 4 | 5 | 2 |
| *Bathyphantes gracilis* (Blackwall) | | | 1 | |
| *Bianor aurocinctus* (Ohlert) | | 1 | | |
| *Dicymbium nigrum* (Blackwall) | 1 | 1 | | |
| *Diplostyla concolor* (Wider) | | 2 | | |
| *Drassodes* sp. | | | 1 | |
| *Enoplognatha thoracica* (Hahn) | | 1 | 3 | |
| *Erigone atra* (Backwall)* | 49 | 41 | 45 | 46 |
| *Erigone dentipalpis* (Wider)* | 53 | 26 | 26 | 28 |
| *Erigonella hiemalis* (Blackwall) | | | | 1 |
| *Ero furcata* (Villers) | | | 1 | |
| *Euophrys frontalis* (Walckwall) | | | 1 | |
| *Gongylidiellum vivum* (O.P.-C.) | 2 | | | |
| *Haplodrassus signifer* (C.L.Koch) | | | 1 | |
| *Lepthyphantes alutacius* Simon | | | 1 | |
| *Linyphia hortensis* Sundevall | | 1 | | |
| *Mangora acalypha* (Walckenaer) | | | 1 | |
| *Meioneta rurestris* (C.L.K.) | 8 | 6 | 7 | 6 |
| *Micaria pulicaria* (Sundevall) | | | 1 | |
| *Micrargus subaequalis* (Westring) | 6 | 4 | 7 | 1 |
| *Oedothorax apicatus* (Backwall)* | 54 | 82 | 71 | 63 |
| *Oxyptila simplex* (O.P.-C.) | | 2 | 1 | 3 |
| *Pachygnatha degeeri* Sundevall | 34 | 20 | 23 | 23 |
| *Pardosa agrestis* (Westring)* | 42 | 76 | 66 | 51 |
| *Pardosa lugubris* (Walckenaer) | 2 | 1 | | |



Continuation of Tab. I

| | COMB 1 | COMB 2 | FERT | CTRL |
|---|---|---|---|---|
| *Pardosa palustris* (Linnaeus)* | 53 | 79 | 62 | 73 |
| *Pardosa prativaga* (L.Koch)* | 61 | 40 | 63 | 58 |
| *Pardosa pullata* (Clerck) | 14 | 3 | 8 | 11 |
| *Phrurolithus festivus* (C.L.Koch) | 2 | | | |
| *Pisaura mirabilis* (Clerck) | | 1 | | 1 |
| *Porhomma microphthalmum* (O.P.-C.) | 2 | | 1 | 1 |
| *Robertus arundineti* (O.P.-C.) | 5 | 1 | 3 | 2 |
| *Tetragnatha pinicola* (L.Koch) | | | 1 | |
| *Theridion bimaculatum* (Linnaeus) | 2 | 2 | 2 | 3 |
| *Theridion impressum* (L.Koch) | 1 | | 1 | |
| *Trochosa ruricola* (De Geer) | 18 | 15 | 14 | 14 |
| *Walckenaeria capito* (Westring) | | | 1 | |
| *Xerolycosa miniata* (C.L.Koch) | 3 | 1 | 1 | 1 |
| *Xysticus cristatus* (Clerck) | | | 1 | |
| *Xysticus kochi* Thorell | 1 | | 3 | |
| *Zelotes lutetianus* (L.Koch) | 2 | 2 | 4 | 4 |
| *Zelotes pusillus* (C.L.Koch) | 4 | 1 | 1 | 3 |
| *Zora spinimana* (Sundevall) | | | 1 | 1 |
| Total | 430 | 419 | 435 | 400 |

* indicate species included in the statistical analysis

was significant on COMB 1 ($P$ = 0.02, Kruskal-Wallis ANOVA). A week after application, the difference between plots diminished.

Analysing the effect on abundance of the principal spider species it turned out that most of them (*Pardosa agrestis, Pardosa palustris, Pardosa prativaga, Oedothorax apicatus* and *Erigone atra*) were similarly abundant on all studied plots. Only *Erigone dentipalpis* was significantly ($P$ = 0.019, Kruskal-Wallis ANOVA) more abundant on COMB 1 than on the remaining plots. This might be due to high aphid numbers on this plot.

## DISCUSSION

This study was centered upon the effect of the organophosphate insecticide (pirimiphos-methyl) combined with the liquid fertiliser (UAN) on winter wheat pests and their natural enemies. Since applications of organophosphate insecticides (pirimiphos-methyl, methamidophos, azinphos-methyl, and parathion) at recommended rates were not only harmful to pests (Heimbach, 1991; Al Hussein, Wetzel, 1989, 1990) but also to their predators, such as *Chrysopa carnea, Syrphus vitripennis*, and spiders (Albert, Bogenschütz, 1984; Hassan et al., 1987; Al Hussein et al., 1991), we decided to use low doses of the insecticide in the combination with the liquid fertiliser (UAN). The combination of the 0.2% pirimiphos-methyl was effective against cereal beetles. The 0.1% concentration was not effective. The population of aphids increased significantly after application of both mixtures, while it was suppressed after the application of UAN solution. Solid nitrogen fertilisers often increase aphid numbers (Baran, 1971; Persin, 1976). Similar increase was observed at low rates of UAN. With high UAN rate (100 l/ha), the number of aphids was reduced whereas beneficial arthropods were little affected (Pekár, 1997a). In this study the abundance of spiders and harvestmen was only slightly affected by application of the mixtures.

Majority species of spiders occurring in crop fields feed on aphids (Sunderland, 1987). According to Nyffeler and Benz (1982), lycosid and linyphiid spiders were the most important predators of grain aphids. Fraser (1982) estimated that linyphiid spiders reduced population of aphids (*Sitobion avenae*) in a field of winter wheat by 37%. It seems that greater aphid numbers on both COMB plots attracted spiders, such as *Erigone dentipalpis*. Therefore higher abundance of spiders was recorded on these plots than on the remaining ones in the end of June.

Study of the effect of the organophosphate + fertiliser mixture revealed that pimimiphos-methyl combined with UAN, at reduced rates, can be used in the control of winter wheat pests. The insecticide should be used at least at 400 ml/ha rate. Lower concentrations are not efficient against cereal leaf beetles. If the control of aphid population is required as well, the concentration of UAN should be about 100 l/ha. Though the populations of beneficial arthropods are only a little affected at these rates, such combination causes phytotoxicity when applied at ear emergence and might subsequently decrease the yield.

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**Vliv směsi kapalného hnojiva (DAM 390) s organofosfátovým insekticidem (Actelic) na škůdce ozimé pšenice (Aphidoidea, Chrysomelidae) a přirozené nepřátele (Araneae, Opiliones).**

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DAM 390 není jenom dusíkatým hnojivem, ale má také insekticidní účinnost, jak ukázaly pokusy s blýskáčkem řepkovým a mandelinkou bramborovou (Veverka, Oliberius, 1987, 1988). Lepších výsledků v regulaci škůdců obilovin se dosáhlo aplikacemi směsi DAM 390 s insekticidy, především pyretroidy (Pekár, 1997b). Cílem této práce bylo zjistit účinnost směsi DAM s modelovým organofosfátovým insekticidem (v nižší dávce, než je doporučená) na škůdce ozimé pšenice (kohoutci a mšice) a jejich přirozené nepřátele. Za tímto účelem byly v 11,7ha poli ozimé pšenice (Praha-Ruzyně), v roce 1995 vyměřeny parcely 40 x 20 m. Na jedné parcele (nazvané COMB 1) byla aplikována směs DAM (75 l/ha) + ACTELIC (200 ml/ha), na druhé parcele (COMB 2) směs DAM (75 l/ha) + ACTELIC (400 ml/ha), na dalších dvou parcelách (FERT) byl aplikován pouze postřik směsí DAM (100 l/ha) a poslední dvě parcely byly kontrolní (CTRL), bez ošetření. Přípravky byly aplikovány na počátku metání. Množství mšic bylo stanoveno podle velikosti kolonií na klasech. Početnost kohoutků byla hodnocena na základě požeru na prvních 3 listech.

Výskyt mšic byl v průměru nejnižší na ploše ošetřené pouze směsí DAM, což se nejvýrazněji projevilo 3 týdny po aplikaci (obr. 1). Na plochách COMB 1 a 2 došlo po postřiku k výraznému namnožení mšic. Požer od kohoutků se postupně zvyšoval (obr. 2). Největší poškození bylo zaznamenáno po aplikaci směsi s vyšší dávkou insekticidu. Aplikace samotného přípravku DAM ani směsi s nižší dávkou insekticidu výskyt kohoutků nijak neovlivnily. Počty zaznamenaných pavouků a sekáčů jsou uvedeny v tab. I. Výskyt těchto predátorů poklesl významně pouze po aplikaci směsi na ploše COMB 1. Týden po aplikaci se rozdíl vyrovnal. Výskyt nejhojnějších druhů pavouků se statisticky nelišil mezi variantami, s výjimkou druhu *Erigone dentipalpis*, jenž byl hojnější na ploše COMB 1, pravděpodobně v důsledku vyššího výskytu mšic.

Studium směsi modelového organofosfátu se směsí DAM 390 odhalilo, že ACTELIC i v nižší dávce, než je doporučená, může být použit proti škůdcům ozimé pšenice. Minimální koncentrace insekticidu ve směsi by neměla být nižší než 400 ml/ha, poněvadž nižší dávky nejsou dostatečně účinné proti kohoutkům. Aby se dosáhlo účinného zásahu proti mšicím, dávka přípravku DAM by měla být 100 l/ha. Přestože



při těchto dávkách jsou přirození nepřátelé ohroženi pouze zanedbatelně, aplikace tak vysoké dávky směsi DAM v době metání způsobuje fytotoxicitu a následně i snížení výnosů.

DAM 390; Actelic; směs; mšice; kohoutci; pavouci; sekáči

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