Analytical method for the determination of relevant impurities in pirimiphos-methyl TC and EC (Syngenta analytical method SD-876/2)

Outline of method

The sample of pirimiphos-methyl technical material or EC formulation is dissolved in deuterated chloroform and the impurities determined as percentage w/w, relative to the pirimiphos-methyl content, by quantitative ^{31}P NMR.

Reagents

d-chloroform ($CDCl_3$). Solutions used in this method are stable at room temperature for at least 22 hours.

Apparatus

NMR equipped with ^{31}P probe, Varian Inova 400, or equivalent, with 5mm HFCP liquid probe.

Electronic integrator or *data system.*

Method

NMR operating conditions (typical)

Pulse programme: standard one X-pulse experiment with inverse gated decoupling; relaxation delay - 90°-X-pulse - acquisition (with proton decoupling).

Observed nucleus: ^{31}P.

Relaxation delay: >50s.

Pulse width: 90°.

Decoupler nucleus: ^{1}H.

Decoupler mode: inverse gated.

Decoupler modulation mode: broadband WALTZ decoupling.

Transmitter Offset: 48ppm.

Number of points in FID: 256k total points (real + imaginary).

Number of scans: 64.

Spectral width: 150ppm.

Temperature: ambient.

Data acquisition and integration

Conduct the NMR experiment in accordance with the instrument manufacturer's recommendations and local practice. Typical data processing would be 1Hz Lorentzian line broadening and zero filling to at least 512k total points. Careful phasing and baseline correction are essential. It is important to ensure each sample is correctly shimmed during data acquisition (e.g. by examination of the pirimiphos-methyl line shape), to ensure reliable curve-fitting. Re-analyze the sample if necessary.

Integral regions should be set using peak deconvolution. If necessary, they may be set manually but peak deconvolution provided best accuracy in the validation study.

Normalize the integral of pirimiphos-methyl to a value of 100. Plot the spectrum and integral list.

Preparation of sample solutions

Prepare two test solutions (A and B) from each sample to be tested, as follows.

Technical material (TC). Shake the TC thoroughly to ensure homogeneity. Transfer approximately 125 mg to a 4 ml sample bottle. Add 0.75 ml $CDCl_3$ and mix well on a mixer. Transfer approximately 0.7 ml solution to a 5mm NMR-tube.

EC formulation. Shake the EC thoroughly to ensure homogeneity. Transfer a volume of EC, corresponding to approximately 125mg pirimiphos-methyl, to a 4ml sample bottle. Add 0.5 ml $CDCl_3$ and mix well on a mixer. Transfer approximately 0.7ml of the solution to a 5mm NMR-tube.

Assignment

Reference the spectra according to local practice, or set the pirimiphos-methyl signal to 64 ppm, whichever is more convenient.

Table of shifts relative to 85% H_3PO_4

Compound	Chemical shift, ppm
pirimiphos-methyl	64
O,O,S-trimethylphosphorothioate (MeOOSPO)	32
O,O-dimethylphosphorochloridothioate (DMPCT)	72.8
O,O,O-trimethylphosphorothioate (MeOOOPS)	73.2
O-2-diethylamino-6-methylpyrimidin-4-yl-*O,S*-dimethylphosphorothioate (*iso*-pirimiphos-methyl)	93
O,O,S-trimethylphosphorodithioate (MeOOSPS)	100

Calculation

Using the integral obtained from the impurity and pirimiphos-methyl, the % w/w of impurity, relative to pirimiphos-methyl, should be calculated using the appropriate equation below.

If the pirimiphos-methyl NMR integral was set to 100:

impurity % w/w (relative to pirimiphos-methyl) = impurity NMR integral x impurity m.w. ratio*.

If the pirimiphos-methyl NMR integral was not set to 100:

$$\text{impurity \% w/w (relative to pirimiphos-methyl)} = \frac{\text{impurity NMR integral} \times \text{impurity m.w. ratio*} \times 100}{\text{pirimiphos-methyl NMR integral}}$$

* m.w. ratio – ratio of molecular weight relative to pirimiphos-methyl, as indicated in the table below.

compound	m.w. ratio
pirimiphos-methyl	1.00
O,O,S-trimethylphosphorothioate (MeOOSPO)	0.51
O,O-dimethylphosphorochloridothioate (DMPCT)	0.53
O,O,O-trimethylphosphorothioate (MeOOOPS)	0.51
O-2-diethylamino-6-methylpyrimidin-4-yl-*O,S*-dimethylphosphorothioate (*iso*-pirimiphos-methyl)	1.00
O,O,S-trimethylphosphorodithioate (MeOOSPS)	0.56

To calculate the impurity concentration in TC as g/kg:

$$\text{impurity, g/kg} = \frac{\text{impurity \% w/w (relative)} \times \text{pirimiphos-methyl content of TC (g/kg)}}{100}$$

Typical spectra

Figure 1. Full spectral range

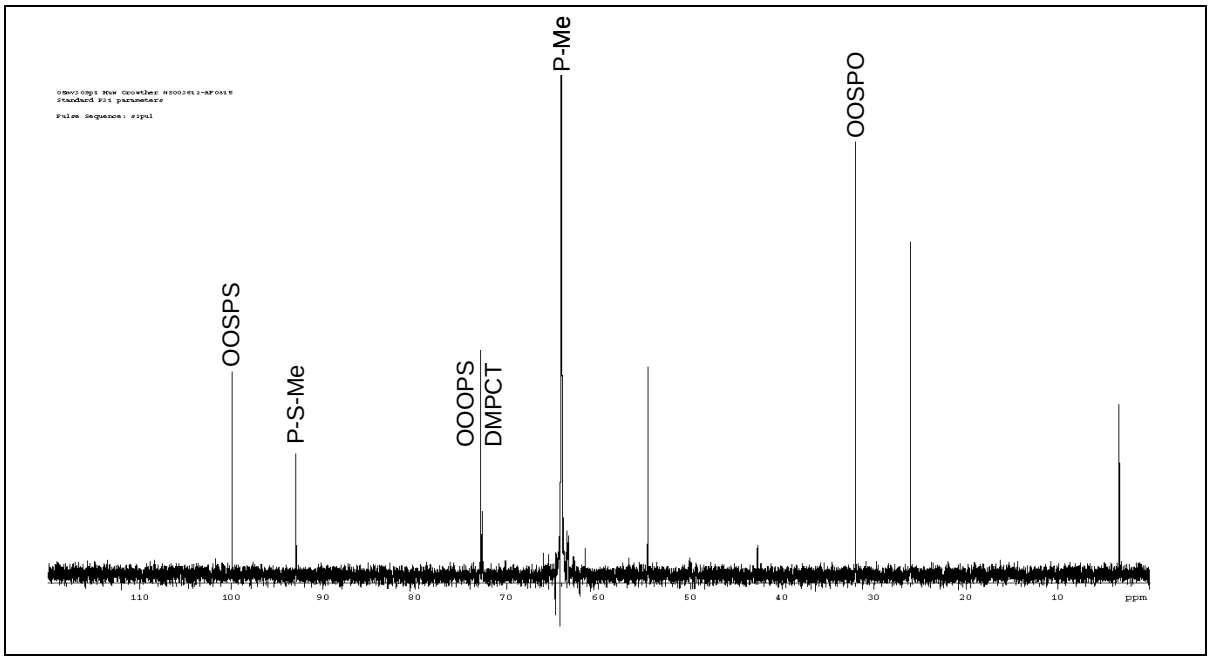

Figure 2. Expanded around 73ppm, showing resolution of MeOOOPS from DMPCT