Supporting information

A new, efficient and recyclable [Ce(*L*-Pro)]$_2$(Oxa) as a heterogeneous catalyst used in Kabachnik-Fields reaction.

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1. Experiment Details

1. 1. General Procedure

The catalyst preparation was carried out using dry starting material under pressure. All other reactions were carried out using chemical reagents and solvents without any specific treatment. The respective reactions were monitored by Thin Layer Chromatography (TLC) MACHEREY-NAGEL (SIL G / UV_{254}) and were visualized by fluorescence quenching with UV light at 254 nm. The purification of the compounds was performed by recrystallization solvent using Chloroform / Hexane to 65°C. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ on Bruker (300 MHz and 75 MHz respectively) spectrometer. ^{1}H NMR data are reported as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, q =quartet, m = multiplet), coupling constants (*J*) and assignment. The infrared spectra were recorded on FT/IR 4100 type A spectrometer of Jasco. The melting point was measured using DF-3600 of Instrutherm. It is important to mention that all spectral data matched with literature data.

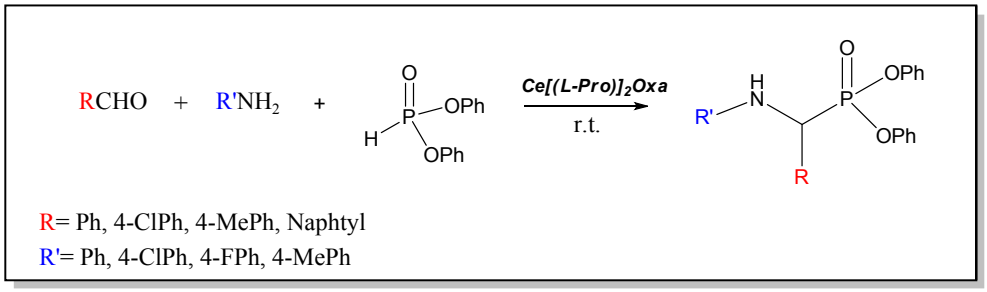
1.2. Catalyst -Procedure of [Ce(*L*-Pro)]$_2$(Oxa)

The cerium catalyst was prepared using *L*-proline (2.7 mmol) and sodium hydroxide (2.7 mmol) in methanol (10 mL) at room temperature, after 10 minutes then cerium (III) chloride (1.4 mmol) was added. The mixture was stirred at room temperature for 45 minutes, then was added a solution of sodium oxalate (0.1g/mL) as precipitate agent. After completion the reaction was centrifuged, washed with methanol and dried overnight at 40 °C and a pale yellow semi-solid was obtained. The infrared spectra were recorded on FT/IR 4100 type A spectrometer of Jasco. The X-Ray powder diffraction were done at room temperature with CuK_{α} in a conventional diffractometer.The analysis of Scanning electron microscopy (SEM), were done by a Phenom Pro X model of Anacom Científica brand, with an enlargement of 80 to 130,000 times, resolution ≤ 14 nm, CCD camera with a zoom of 20 to 135 times.

1.3 General Procedure of α-aminophosphonates

In a 50 mL round bottle flask was added cerium catalyst (0.02 mmol), benzaldehyde (2.2 mmol), aniline (2.0 mmol) and diphenyl phosphite (2.0 mmol), the mixture was magnetic stirred in toluene (10 mL) at room temperature. The progress of the reaction was monitored by TLC (eluent: EtOAc/hexane, 10:90), until the phosphite and aniline was completely consumed. After the reaction was completed a white solid was formed and then purified by recrystallization (chloroform/hexane) to obtain α-aminophosphontes, the catalyst was separated by filtration. All compounds were characterized by ^{1}H NMR, ^{13}C NMR, FT / IR and melting point; all data are summarized as follow.

2. Reaction Optimization



2.1. Effects of catalyst

Table 1 Influence of catalyst loading over the Kabachnik-Fields reaction.[a]

Cat (%mol)[b]	Yeld(%)[b]
0	[c]
1	96
2	97

[a] Reaction conditions: benzaldehyde (2.2 mmol), aniline (2.0 mmol) and diphneylphosphite (2.0 mmol) at room temperature [b] Yields by recrystallization [c] No reaction.

2.2. Solvents effects for the Kabachnik-Fields reaction.

Table 2 Solvents and yields for the Kabachnik-Fields reaction.[a]

Solvent [a]	Time (min)	Yeld (%) [b]
Toluene	10	96
DCM	10	90
CH_3CN	10	55
THF	60	80
No solvent	60	-

[a] Reaction conditions: benzaldehyde (2.2 mmol), aniline (2.0 mmol) and diphneyl phosphite (2.0 mmol) and 1 % mol catalyst at room temperature. [b] Yield of isolated product.

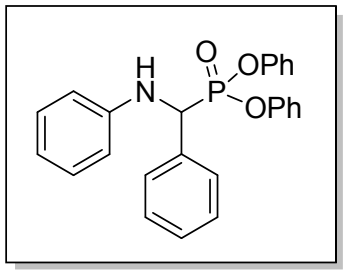
Table 3. Kabachnik-Fields reactions using [Ce(*L*-Pro)]$_2$(Oxa) recyclability.

Cycle	*Yield[a] (%)*	*ΔYield (per cycle)*
#1	94	-
#2	80	14
#3	65	15

[a.] Yields by recrystallization.

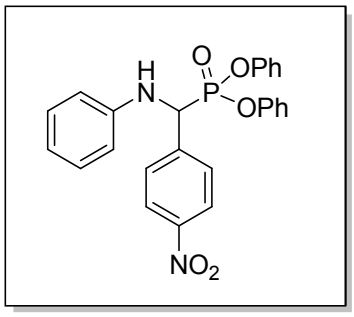
3. Characterization of the Kabachnik-Fields reaction.

Diphenyl (phenyl(phenylamino)methyl) phosphonate:



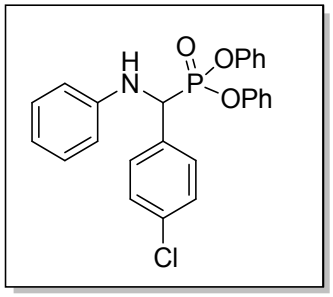
White solid, PM: 415.13 g/mol. $C_{25}H_{22}NO_3P$. M.p.:159 °C. IR (KBr) ($\nu_{máx}$ cm^{-1}): 3343 (N-H), 1186.01 (P=O), 762.70 (C-P). ^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 2.14-2.22 (d, J_{H-P}= 24.6 Hz, 1H, N-C**H**-P), 3.67-3.89 (m, 4H), 4.10-4.40 (m, 14H), 4.57-4.60 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 55.01 and 57.06 (d, J_{C-P}= *153.3* Hz), 76.66, 77.51, 114.08, 118.918, 120.34, 120.40, 120.70, 120.75, 125.29, 125.46, 125.47, 128.20, 128.28, 128.41, 128.45, 128.85, 128.89, 129.32, 129.68, 129.78, 134.82, 145.97, 150.29.

Diphenyl ((4-nitrophenyl)(phenylamino)methyl) phosphonate



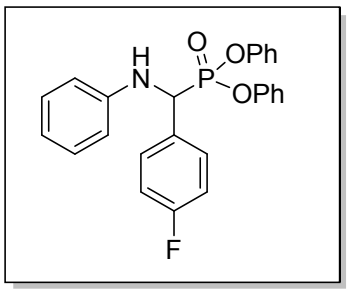
Yellow solid, MW: 460.12 g/mol. $C_{25}H_{21}N_2O_5P$. M.p.: 153-155 °C. IR (KBr) ($\nu_{máx}$ cm^{-1}): 3305.39(N-H), 1182.15 (P=O), 772 (C-P). ^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.25-5.36 (d, *J* = 25,38 Hz, 1H, N-C**H**-P), 6.60-6.68 (m, 2H), 6.75-6.86 (m, 3H), 6.89-7.05 (m, 12H), 7.47-8.50 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.88 and 56.10 (d, J_{C-P} = 153.0 Hz), 114.03, 115.41, 119.58, 120.12, 120.16, 120.32, 120.51, 120.54, 123.18, 123.22, 123.48, 123.50, 125.75, 125.87, 129.53, 129.58, 129.96, 129.98, 134.11, 137.53, 137.54, 145.09, 145.21.

Diphenyl ((4-chlorophenyl)(phenylamino)methyl) phosphonate:



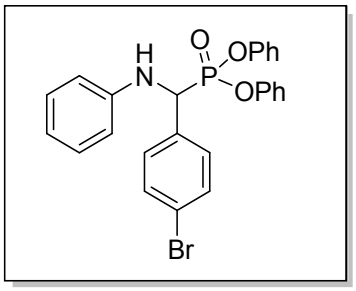
Green solid, PM: 449.09 g/mol. $C_{25}H_{21}ClNO_3P$. M.p:131-132 ^oC. IR KBr ($\nu_{máx}$ cm^{-1}): 3299 (N-H), 1182.15 (P-O), 765.60 (C-P). ^1H NMR (300 MHz, DMSO): δ ppm 5.12-5.20 (d, *J* = 24.9 Hz, 1H, N-C**H**-P), 6.64-6.99 (m, 3H), 7.11-7.38 (m, 15H), 7.51-7.57 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.40 and 56.45 (d, J_{P-C} = 153.0 Hz), 76.57, 77.42, 113.98, 119.11, 120.20, 120.26, 120.53, 120.58, 125.39, 125.50, 128.97, 129.01, 129.31, 129.39, 129.46, 129.72, 129.77, 133.46, 134.23, 145.43, 145.61, 150.10, 150.12.

Diphenyl ((4-fluorophenyl)(phenylamino)methyl) phosphonate:



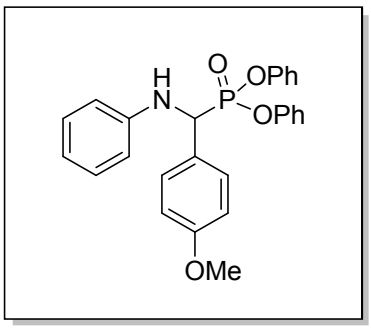
Blue solid, PM: 433.12 g/mol. $C_{25}H_{21}FNO_3P$. M.p.:104-105 ^oC. IR KBr ($\nu_{máx}$ cm^{-1}): 3453.29 (N-H), 1284.63 (P-O), 776.80 (C-O).^1H NMR (300 MHz, $CDCl_3$): δ ppm 5.19-5.11 (d J_{H-P} = 24,3 Hz, 1H, N-C**H**-P), 6.63-6.94 (m, 6H), 7.03-7.33 (m, 12H), 7.52-7.58 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.27 and 56.32 (d, J_{P-C} = 153.7 Hz) 76.57, 77.42, 113.98, 115.65, 115.68, 115.94, 115.97, 119.04, 120.19, 120.25, 120.55, 120.60, 125.33, 125.47, 129.30, 129.70, 129.77, 129.81, 129.89, 145.51, 145.71, 150.14, 150.17.

Diphenyl ((4-bromophenyl)(phenylamino)methyl) phosphonate:



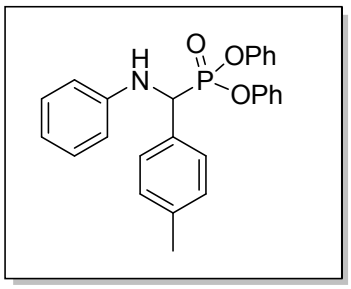
Green solid, MW:493.04 g/mol. $C_{25}H_{11}BrNO_3P$. M.p.:138-140 ^oC. IR KBr ($\nu_{máx}$ cm^{-1}): 3322.75(N-H), 1029.63 (P-O), 765.60 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.05-5.24 (d, *J* = 24.9 Hz, 1H, N-C**H**-P), 6.59-6.72 (m, 2H), 6.72-6.86 (m, 2H), 6.87-7.00 (m, 2H), 7.06-7.39 (m, 10H), 7.40-7.56 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.55 and 56.59 (d, J_{P-C} = 153.55 Hz), 114.07, 115.40, 119.13, 119.22, 120.28, 120.34, 120.62, 120.67, 122.51, 122.56, 125.54, 125.66, 129.40, 129.57, 129.87, 132.01, 132.04, 134.04, 145.50, 145.63, 150.12, 150.18, 150.30.

Diphenyl ((4-methoxyphenyl)(phenylamino)methyl) phosphonate:



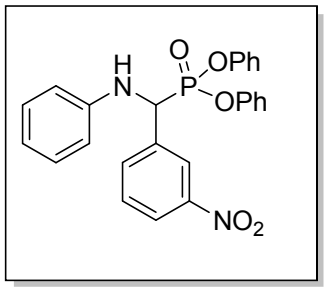
Yellow solid, MW:445.14 g/mol. $C_{26}H_{24}NO_4P$. M.p.:141-142 ^oC. IR KBr ($\nu_{máx}$ cm^{-1}): 3329.0 (N-H), 1252.0 (P-O), 770.4 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 3.80 (s, 3H), 5.08-5.16 (d, *J* = 24.6 Hz, 1H, N-C**H**-P), 6.66-6.92 (m, 6H), 7.09-7.33 (m, 11H), 7.45-7.51 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.19, 55.16 and 56.26 (d, J_{P-C} =73.52 Hz), 76.57, 77.42, 113.98, 114.17, 114.20, 118.68, 120.25, 120.31, 120.58, 120.64, 125.11, 125.27, 126.45, 126.47, 129.14, 129.23, 129.31, 129.53, 129.63, 145.76, 145.96, 150.21, 150.23.

Diphenyl ((phenylamino)(*p*-tolyl)methyl) phosphonate:



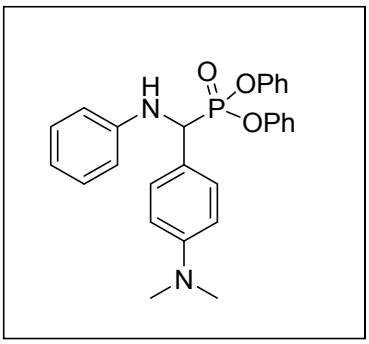
Yellow solid, MW: 429.15 g/mol. $C_{26}H_{24}NO_3P$. Mp: 120-125 °C. IR KBr ($v_{máx}$ cm^{-1}): 3345.01 (N-H), 1215.14 (P=O), 764.63 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 2.34 (s, 3H), 5.09-5.17 (d, J_{H-P}= 24.6 Hz, 1H, N-C**H**-P), 6.64-6.92 (m, 5H), 7.08-7.32 (m, 12H), 7.42-7.40 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 55.33 and 57.28 (d, J_{P-C} =147.36 Hz), 113.28, 114.25, 115.46, 120.27, 120.31, 120.42, 120.66, 120.78, 125.36, 125.52, 128.20, 128.28, 128.32, 128.45, 128.65, 128.82, 128.86, 129.60, 129.68, 129.77, 129.81, 134.92, 143.48, 143.60.

Diphenyl ((3-nitrophenyl)(phenylamino)methyl) phosphonate:



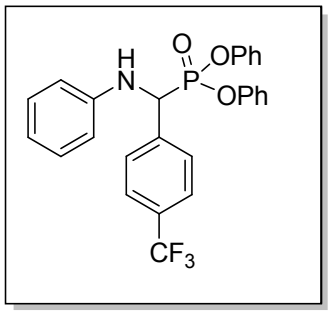
Red solid, MW: 460.12 g/mol. $C_{25}H_{21}N_2O_5P$. M.p.: 124-126 °C. ^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.21 and 5.38 (d, J_{H-P}= 25.9 Hz, 1H, N-C**H**-P), 6.52-6.69 (m, 2H), 6.75-6.94 (m, 3H), 6.96-7.05 (m, 2H), 7.06-7.37 (m, 11H), 7.73-7.83 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.83 and 56.83 (d, J_{P-C} =151.22Hz), 113.92, 114.02, 115.43, 119.25, 119.57, 120.19, 120.25, 120.51, 120.56, 123.97, 124.01, 125.79, 125.88, 128.66, 128.80, 129.06, 129.13, 129.45, 129.51, 129.55, 129.97, 145.23, 145.39.

Diphenyl ((4-(dimethylamino)phenyl)(phenylamino)methyl) phosphonate:



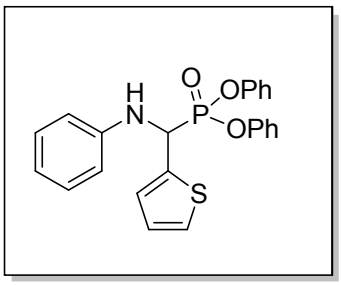
Orange solid MW: 458.18 g/mol. $C_{27}H_{27}N_2O_3P$. M.p: 97-98 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3399.12(N-H), 1188.9 (P=O), 772.3 (C-P). ^1H NMR (300 MHz, $CDCl_3$): δ ppm 2.94 (s, 1H), 3.09 (s, 3H), 5.06-5.13 (d, *J* = 23.7, 1H, N-C**H**-P), 6.66-6.94 (m, 6H), 7.10-7.32 (m, 12H), 7.39-7.79 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 40.54, 54.83 and 56.08 (d, J_{P-C} = 93.7 Hz), 76.82, 77.33, 111.03, 112.75, 112.77, 114.16, 115.52, 118.68, 119.83, 120.52, 120.55, 120.78, 120.82, 125.29, 128.98, 129.03, 129.70, 146.12, 146.24, 150.32, 150.40, 150.47, 150.55, 150.56.

Diphenyl ((phenylamino)(4-(trifluoromethyl) phenyl)methyl) phosphonate:



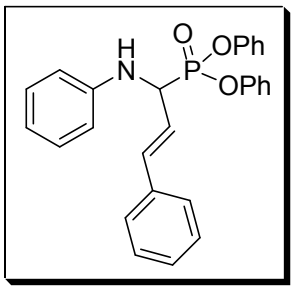
Green solid. MW: 483.12 g/mol. $C_{26}H_{21}F_3NO_3P$. Mp: 118-120 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3326.12 (N-H), 1209.63 (P=O), 752.1 (C-P). ^1H NMR (300 MHz, $CDCl_3$): δ ppm 5.18-5.26 (d, *J* = 24.6, 1H, N-C**H**-P), 6.62-6.95 (m, 6H), 7.08-7.33 (m, 10H), 7.55-7.73 (m, 4H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 55.08 and 56.30 (d, J_{P-C} = 153.17 Hz), 76.74, 77.25, 113.955, 115.31, 119.27, 120.12, 120.16, 120.28, 120.50, 120.53, 125.54, 125.55, 125.66, 125.67, 128.47, 128.51, 129.37, 129.50, 129.76, 129.77, 129.82, 139.03, 145.40, 150.02.

Diphenyl ((phenylamino)(thiophen-2-yl)methyl) phosphate:



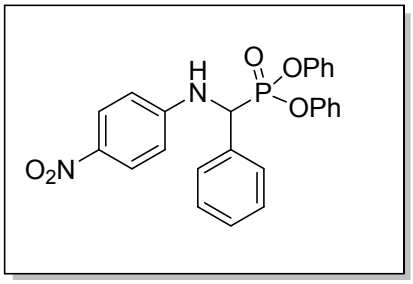
Brown solid. MW: 421.09 g/mol. $C_{23}H_{20}NO_3PS$. Mp. 93-95°C. IR KBr ($\nu_{máx}$ cm^{-1}): 3365.1 (N-H), 1277.1 (P=O), 773.3 (C-P). ^1H NMR (300 MHz, $CDCl_3$): δ ppm 5.41-5.49 (d, *J* = 24.4, 1H, N-C**H**-P), 6.73-6.84 (m, 6H), 6.99-7.33 (m, 16H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 55.08-56.30 (d, J_{P-C} = 153.17 Hz), 76.745, 77.254, 113.955, 115.318, 119.278, 120.126, 120.160, 120.289, 120.504, 120.537, 125.543, 125.553, 125.665, 125.676, 128.470, 128.515, 129.373, 129.500, 129.767, 129.774, 129.829, 139.039, 145.406, 150.023.

(3-Phenyl-1-phenylamino-allyl)-phosphonic acid diphenyl ester:



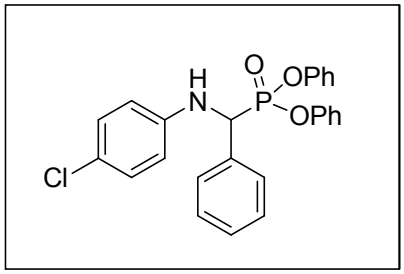
Brown solid. MW: 427.13 g/mol. $C_{26}H_{22}NO_3P$. Mp: 84-85 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3295.75 (N-H), 1213.01 (P=O), 741.97 (C-P). ^1H NMR (300 MHz, $CDCl_3$): δ ppm 5.15-5.23 (d, J_{H-P}= *14.1* Hz, 1H, N-C**H**-P), 5.67 (s, N-H), 6.80-6.89 (m, 5H), 7.08-7.37 (m, 10H), 8.14-8.34 (m, 5H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 76.63 and 77.48 (d, J_{P-C} = 63.90 Hz), 113.21, 115.33, 117.31, 117.70, 119.16, 119.98, 120.73, 121.20, 126.97, 129.45, 129.68, 132.26, 133.25, 133.86, 135.56, 137.21, 137.56, 146.02, 148.43, 155.62.

Diphenyl (((4-nitrophenyl)amino)(phenyl)methyl) phosphonate:



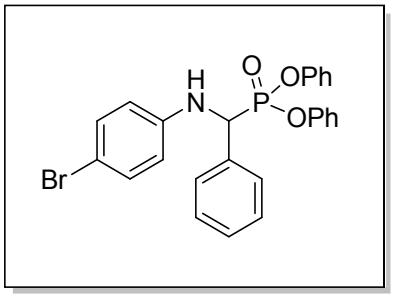
Yellow solid. PM: 460.12 g/mol. $C_{25}H_{21}N_2O_5P$. Mp.: 143-145 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3328.7 (N-H), 1257.9 (P-O), 770.4 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.18-5.26 (d, J_{H-P}= 24,5 Hz, 1H, N-C**H**-P), 6.59-6.77 (m, 4H), 7.10-7.39 (m, 11H), 7.55-7.58 (m, 3H), 7.98-8.03 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 53.45 and 55.51 (d, J_{C-P}= *154.5* Hz), 112.98, 113.10, 115.834, 120.82, 120.87, 121.04, 121.09, 125.91, 125.94, 126.37, 126.97, 128.90, 128.94, 129.10, 129.18, 129.26, 130.40, 135.09, 137.92, 150.30, 150.44, 153.76, 153.91.

Diphenyl (((4-Chlorophenyl) amino)(phenyl)methyl) phosphonate:



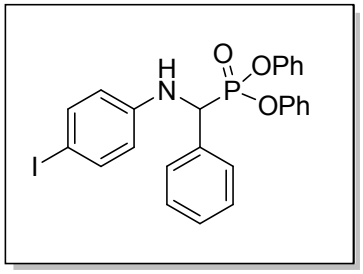
White solid, PM: 449.09. $C_{25}H_{21}ClNO_3P$. Mp:151-152 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3336.25 (N-H), 1185.53 (P=O), 775.72 (C-P). ^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 3.82-3.90 (d, J_{H-P}= 24,6 Hz, 1H, N-C**H**-P), 5.32-5.64 (m, 4H), 5.84-6.17 (m, 14H), 6.28-6.33 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 53.77 and 55.84 (d, J_{C-P}= 156.3 Hz), 115.65, 120.75, 120.81, 121.05, 121.11, 121.18, 125.69, 125.75, 128.48, 128.52, 128.78, 128.81, 128.96, 129.12, 129.20, 130.26, 135.80, 146.33, 146.53, 150.30, 150.43, 150.51, 150.65.

Dipheny (((4-bromophenyl)amino)(phenyl)methyl) phosphonate:



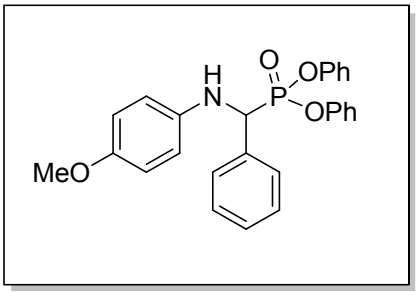
White solid. PM: 493.04 g/mol. $C_{25}H_{21}BrNO_3P$. Mp:165-167 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3336.25 (N-H), 1185.53 (P=O), 775.72 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.09-5.18 (d, J_{H-P}= 24,6 Hz, 1H, N-C**H**-P), 6.55-6.90 (m, 4H), 7.13-7.45 (m, 14H), 7.55-7.60 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 55.50 and 57.56 (d, J_{C-P}= 154.12 Hz), 76.57, 77.42, 115.02, 115.12, 115.35, 115.55, 115.84, 120.01, 120.20, 120.26, 120.59, 120.64, 125.32, 125.51, 125.51, 128.19, 128.50, 128.86, 129.62, 129.73, 134.37, 142.12,150.02.

Diphenyl (((4-iodophenyl)amino)(phenyl)methyl) phosphosnate:



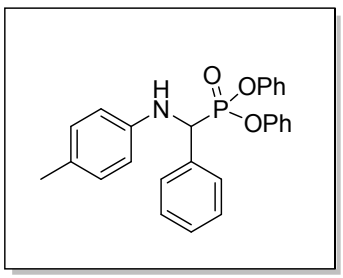
Yellow solid. PM: 541.03. $C_{25}H_{21}INO_3P$. Mp.: 154-155 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3339.62 (N-H), 1188.90 (P=O), 775.726 (C-P). ^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 5.05-5.14 (d, J_{H-P}= 24.9 Hz, 1H, N-C**H**-P), 6.43-6.46 (m, 2H), 5.82-6.85 (m, 4H), 7.08-7.42 (m, 12H), 7.52-7.55 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 54.82 and 56.86 (d, J_{C-P}= 153.50 Hz), 115.37, 116.27, 117.39, 120.28, 120.35, 120.64, 120.75, 125.43, 125.63, 128.14, 128.21, 128.61, 128.67, 128.96, 129.06, 129.59, 129.66, 129.89, 134.30, 134.34, 137.88, 145.60.

Diphenyl (((4-methoxyphenyl)amino)(phenyl)methyl) phosphonate:



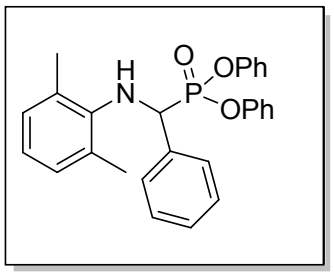
Light brown solid. PM: 445.14 g/mol. $C_{26}H_{24}NO_4P$. IR KBr ($\nu_{máx}$ cm^{-1}): 3454.8 (N-H), 1186.0 (P=O), 776.2 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 3.73 (s, 3H), 5.04-5.12 (d , J_{H-P}= 24.3 Hz , 1H, N-C**H**-P), 6.61-6.89 (m, 6H), 7.10-7.40 (m, 12H), 7.54-7.58 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 39.43, 54.15 and 56.22 (d, J_{C-P}= 155.7 Hz), 114.27, 115.01, 120.22, 120.27 120.56, 120.62, 125.06, 125.11, 127.75, 127.79, 128.13, 128.15, 128.62, 128.70, 129.67, 135.74, 140.57, 140.79, 149.82, 149.96, 150.092, 150.22, 151.63.

Diphenyl (phenyl(*p*-tolylamino)methyl) phosphonate:



White solid. PM: 429.15 g/mol. $C_{26}H_{24}NO_3P$. Mp: 165-168 ^oC. IR KBr ($\nu_{máx}$ cm^{-1}): 3336.2 (N-H), 1185.5 (P=O), 775.7 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 3.06 (s, 3H), 5.77-5.85 (d, J_{H-P}= 25.2 Hz, 1H, N-C**H**-P), 6.79-7.43 (m, 18H), 7.65-7.68 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 34.82, 61.26 and 63.41(d, J_{C-P}= 161.4 Hz), 76.57, 77.42, 114.37, 115.36, 118.66, 119.67, 120.46, 120.52, 120.59, 120.65, 125.11, 125.27, 128.35, 128.68, 128.95, 129.07, 129.23, 129.28, 129.54, 129.63, 133.02, 149.86, 149.98.

Diphenyl (((2,6-dimethylphenyl)amino)(phenyl) methyl) phosphonate:



Blue solid. PM: 443.17 g/mol. $C_{27}H_{26}NO_3P$. Mp.: 98-100 °C. IR KBr ($\nu_{máx}$ cm^{-1}): 3343.4 (N-H), 1213.0 (P=O), 755.4 (C-P).^{1}H NMR (300 MHz, $CDCl_3$): δ ppm 2.27 (s, 6H), 4.84-4.92 (d, J_{H-P}= 22,6 Hz, 1H, N-C**H**-P), 6.72-6.88 (m, 4H), 6.96-7.38 (m, 13H), 7.51-7.55 (m, 2H).^{13}C NMR (75 MHz, $CDCl_3$): δ ppm 18.73, 57.98 and 59.96 (d, J_{C-P}= 161.4 Hz), 76.57, 77.42, 115.33, 119.83, 120.24, 120.55, 122.29, 122.78, 125.16, 125.34, 128.25, 128.37, 128.60, 129.05, 129.31, 129.47, 129.68, 131.58, 134.50, 135.397, 135.43, 143.40, 150.01, 156.13.

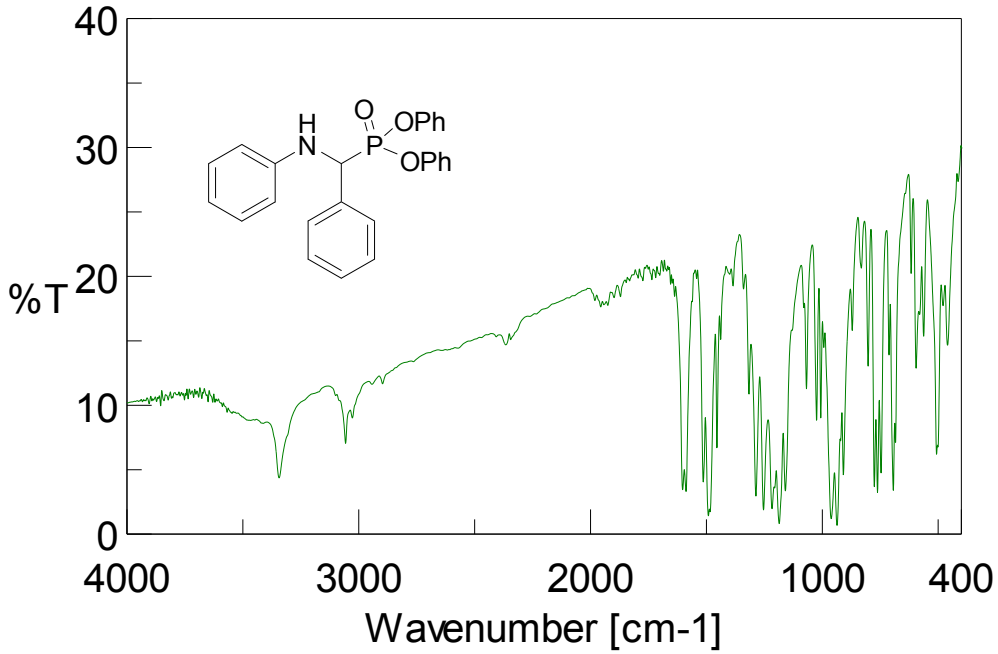


Figure 1. FTIR spectra for the **Diphenyl (phenyl(phenylamino)methyl) phosphonate [A1]** in KBr.

4. ^{1}H and ^{13}C NMR spectra analysis

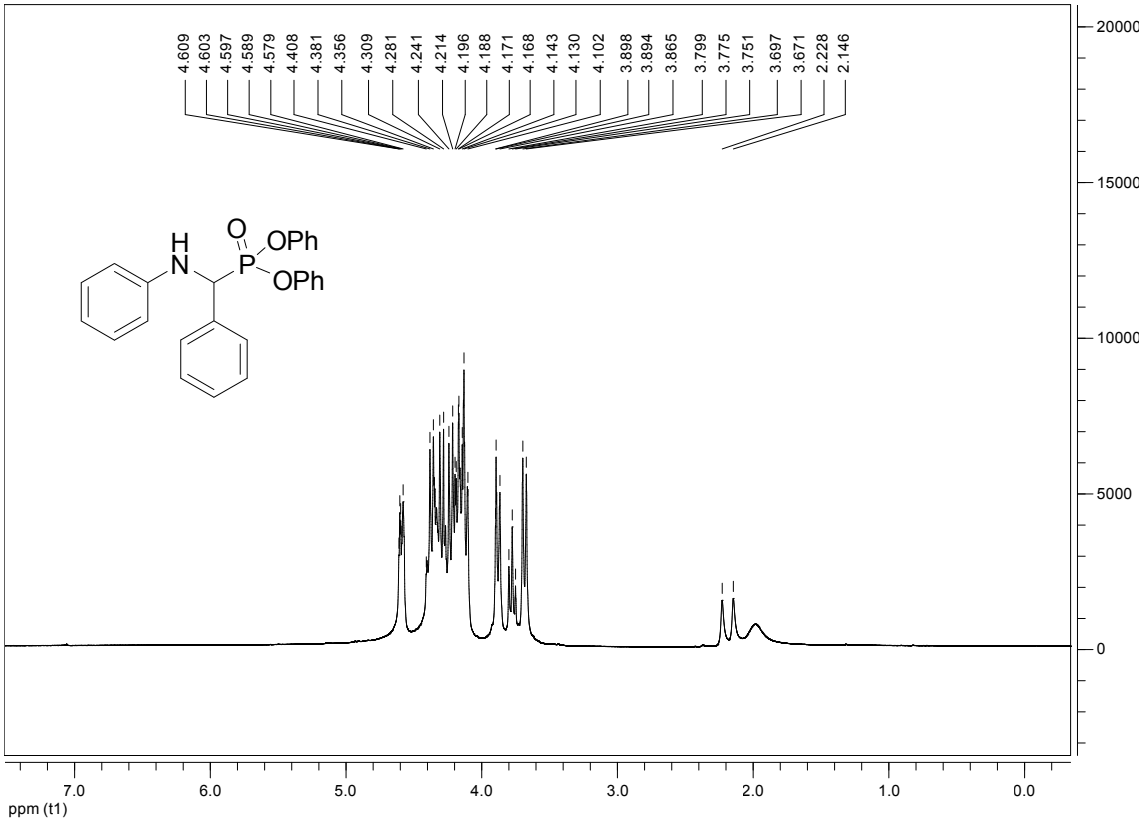


Figure 2. ^{1}H NMR spectra for the **Diphenyl (phenyl(phenylamino)methyl) phosphonate** in $CDCl_3$.

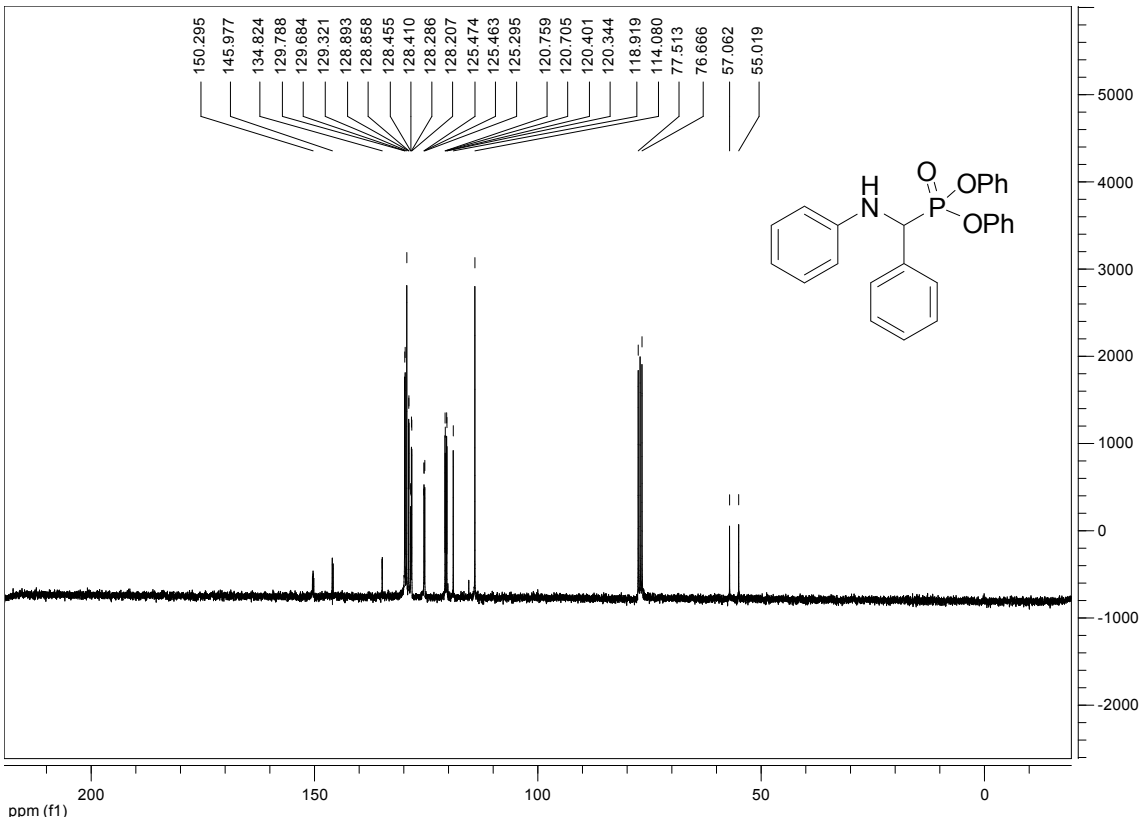


Figure 3. ^{1}H NMR spectra for the **Diphenyl (phenyl(phenylamino)methyl) phosphonate** in $CDCl_3$.

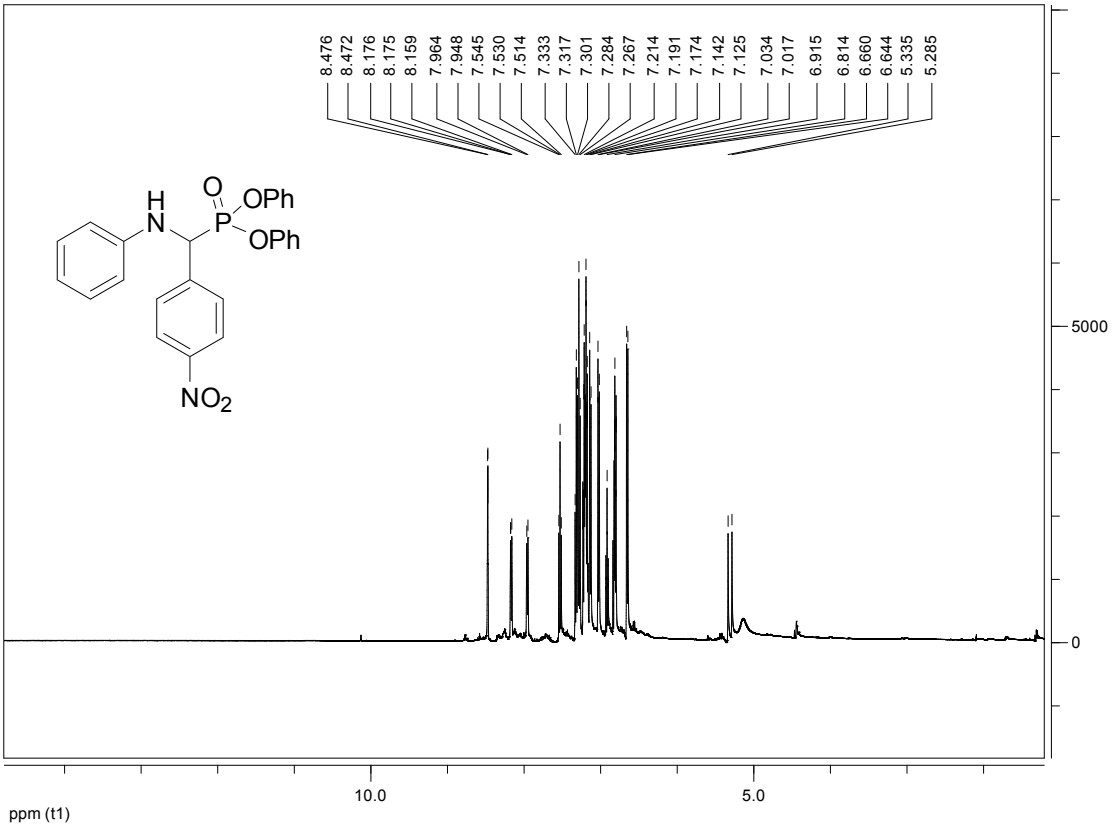


Figure 4. ^{1}H NMR spectra for the **Diphenyl ((4-nitrophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

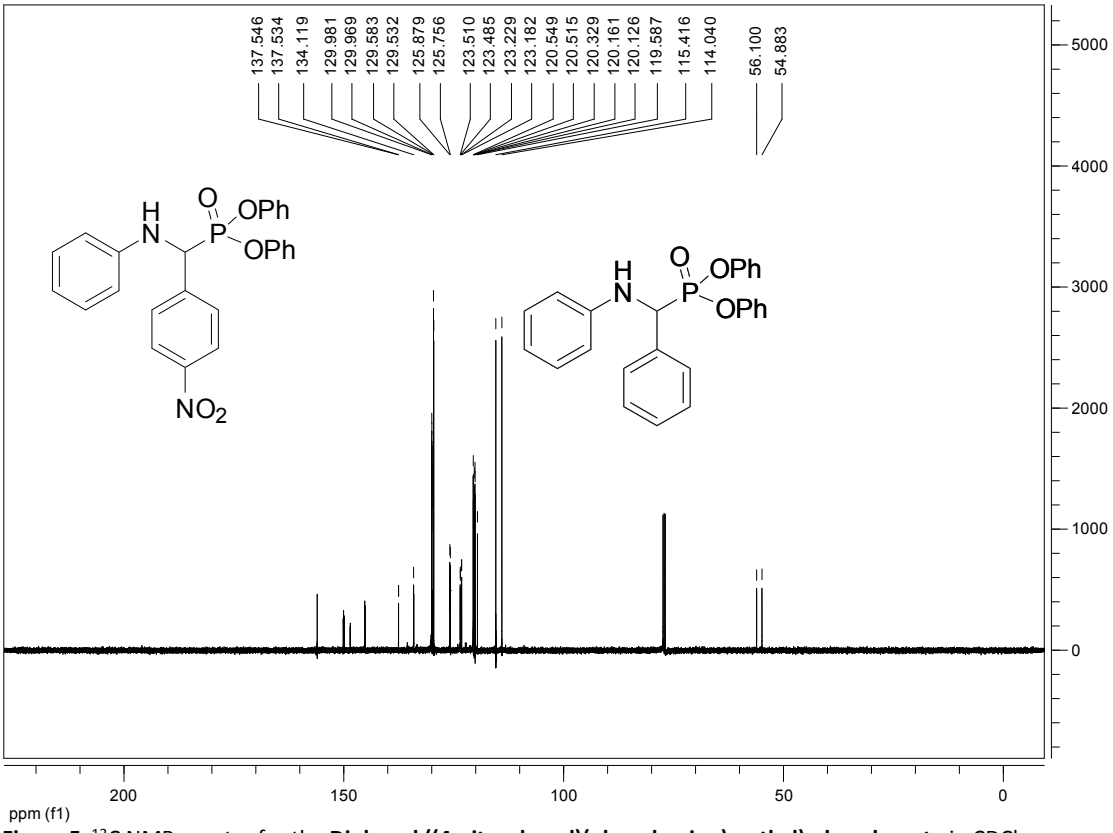


Figure 5. ^{13}C NMR spectra for the **Diphenyl ((4-nitrophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

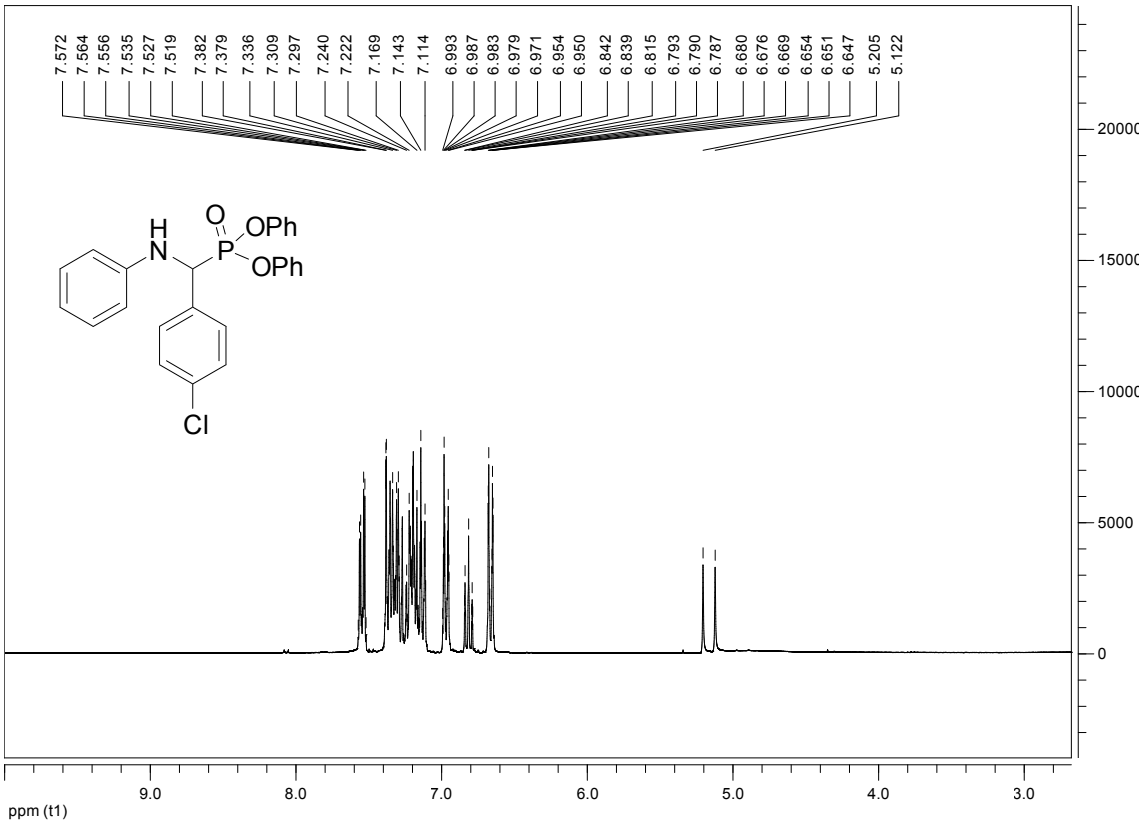


Figure 6. ^{1}H NMR spectra for the **Diphenyl ((4-chlorophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

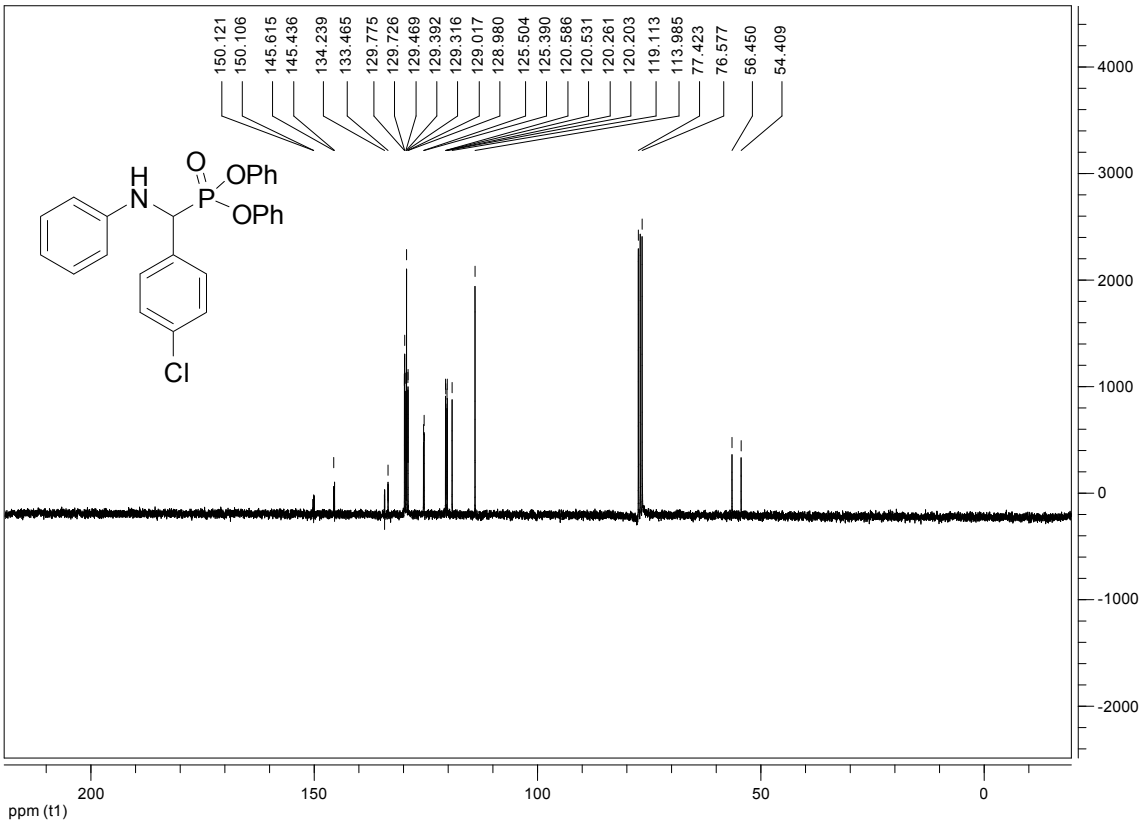


Figure 7. ^{1}H NMR spectra for the **Diphenyl ((4-chlorophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

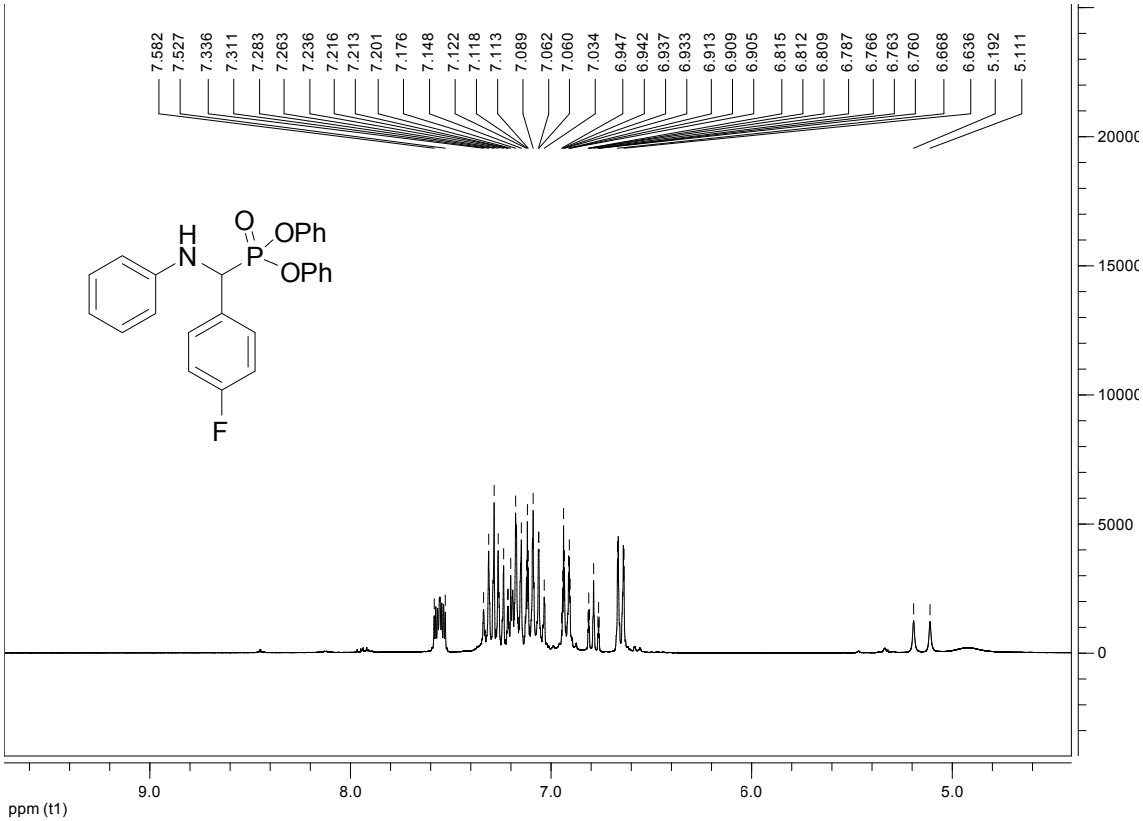


Figure 8. ^{1}H NMR spectra for the **Diphenyl ((4-fluorophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

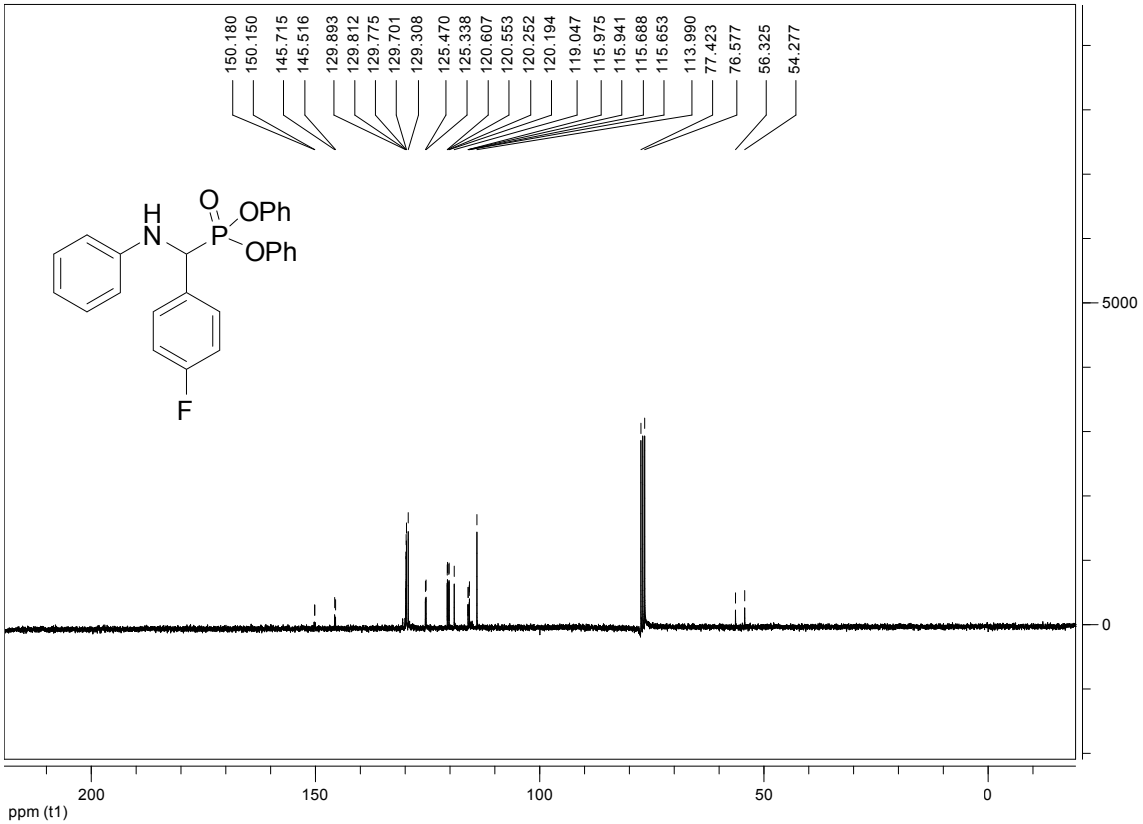


Figure 9. ^{1}H NMR spectra for the **Diphenyl ((4-fluorophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

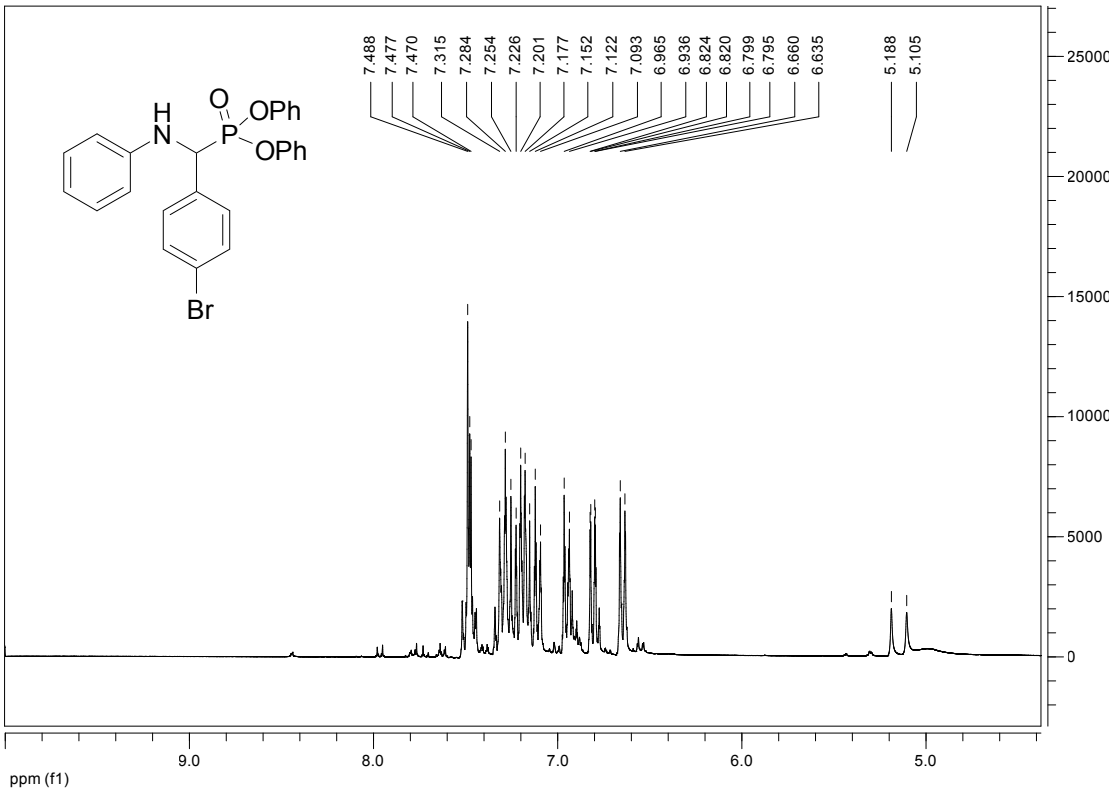


Figure 10. ^{1}H NMR spectra for the **Diphenyl ((4-bromophenyl)(phenylamino)methyl) phosphonate [A5]** in $CDCl_3$.

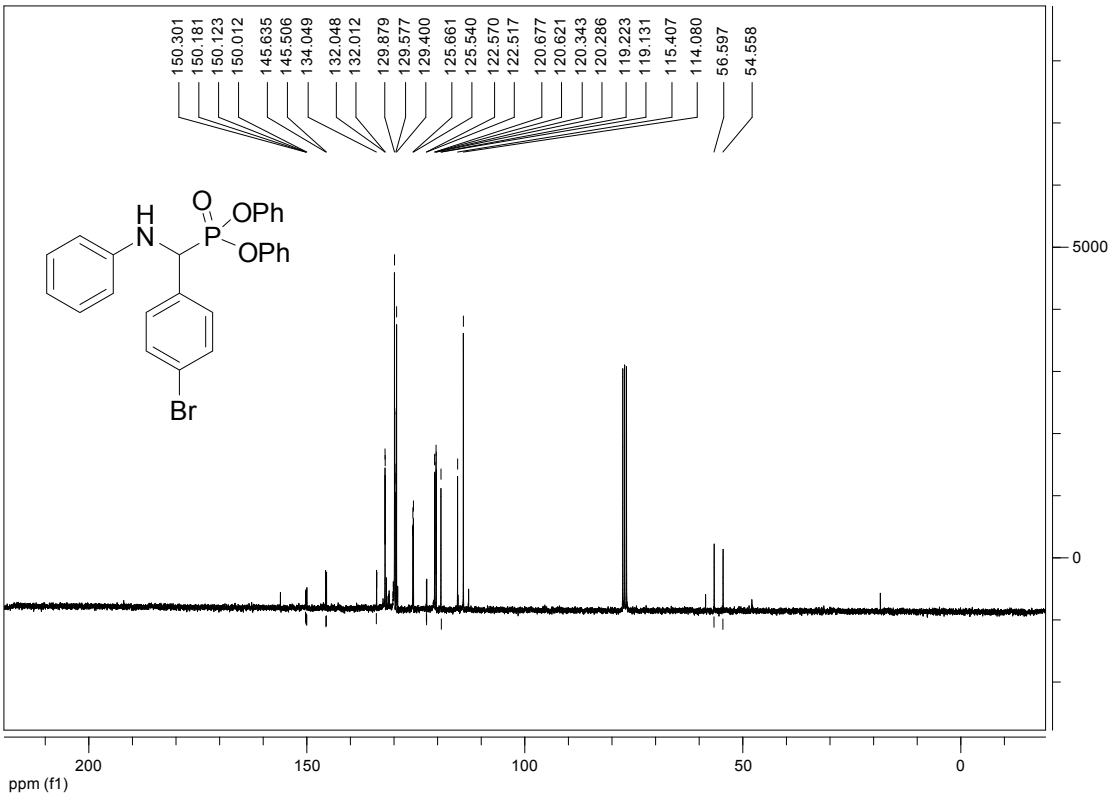


Figure 11. ^{13}C NMR spectra for the **Diphenyl ((4-bromophenyl)(phenylamino)methyl) phosphonate [A5]** in $CDCl_3$.

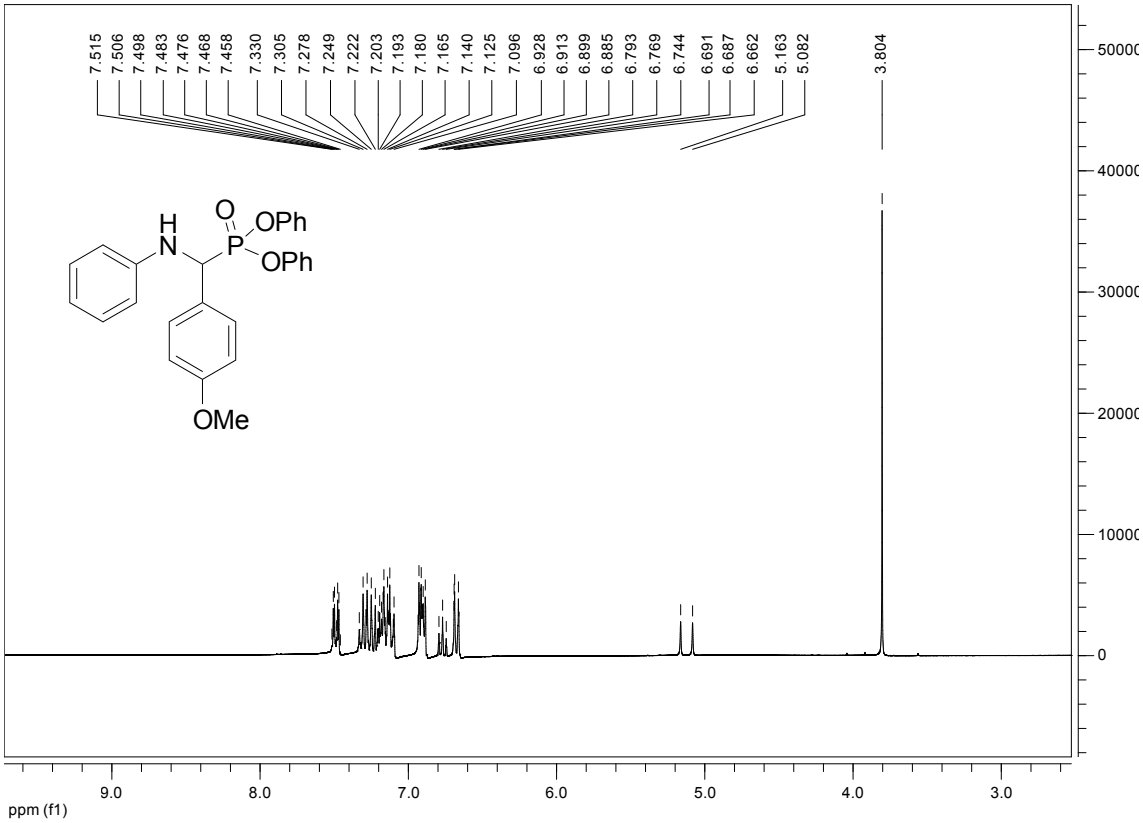


Figure 12. ^{1}H NMR spectra for the **Diphenyl ((4-methoxyphenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

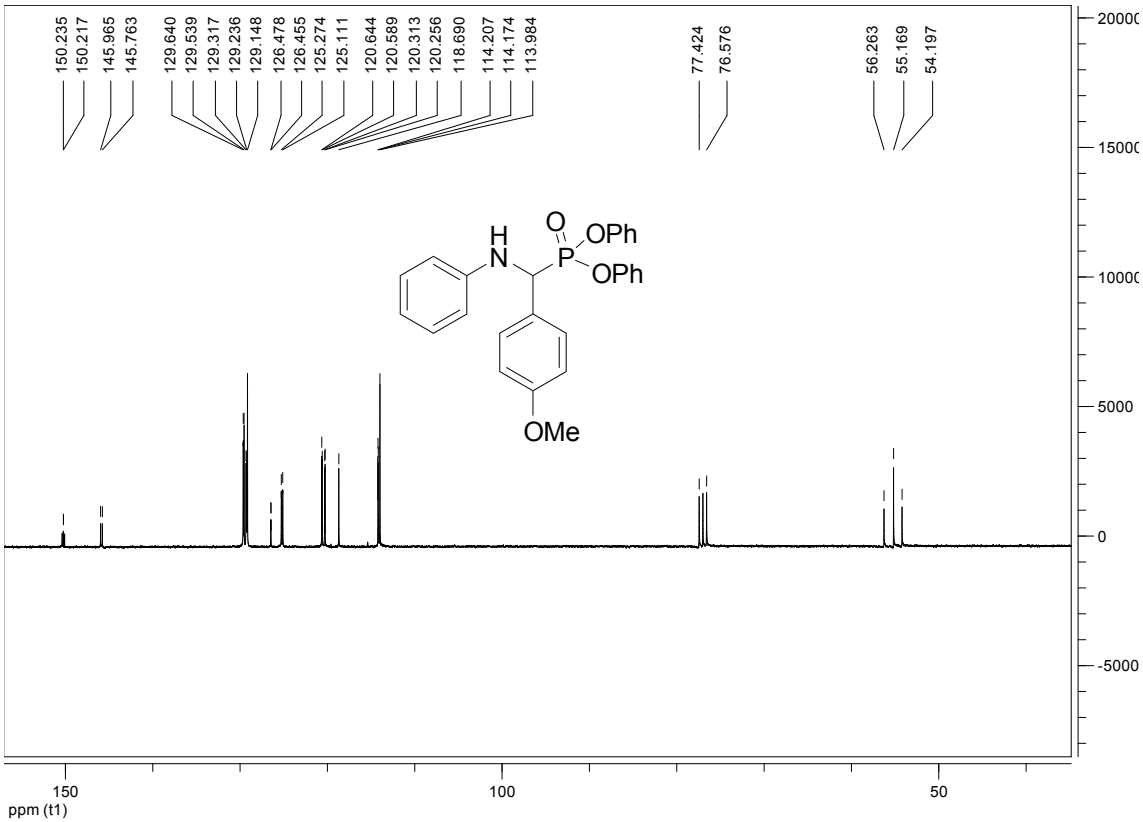


Figure 13. ^{13}C NMR spectra for the **Diphenyl ((4-methoxyphenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

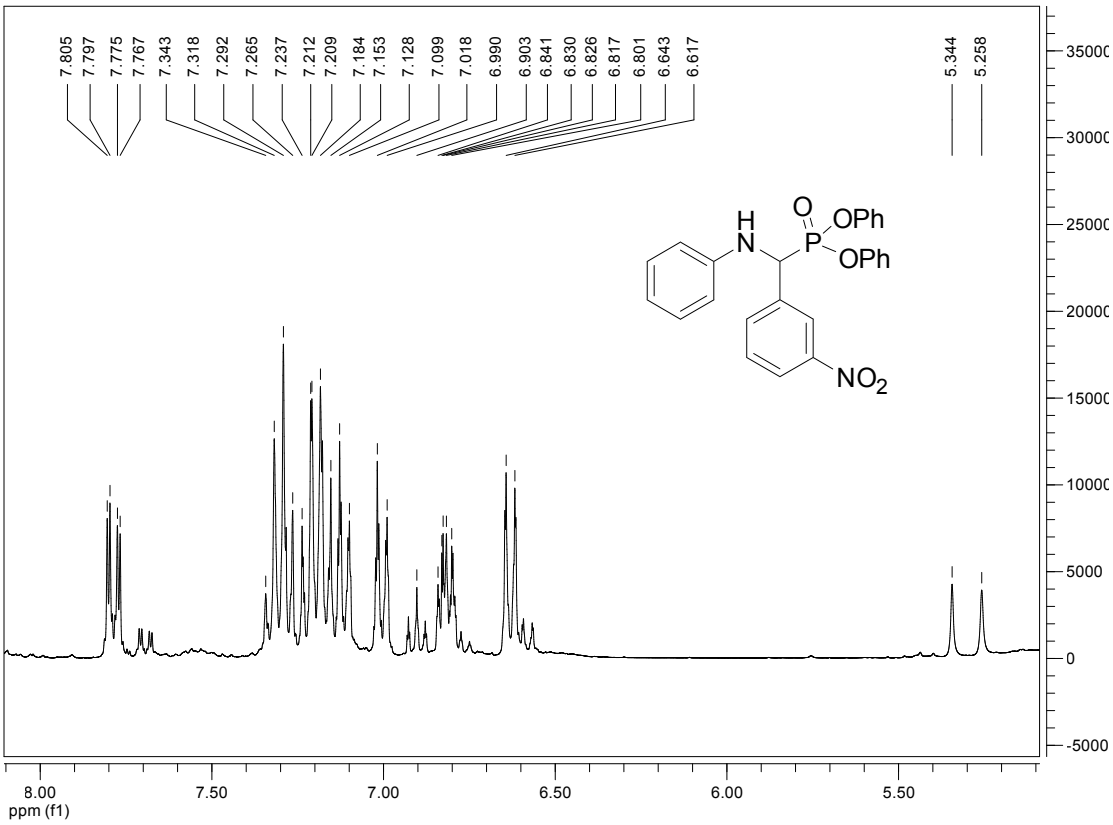


Figure 14. ^{1}H NMR spectra for the **Diphenyl ((3-nitrophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

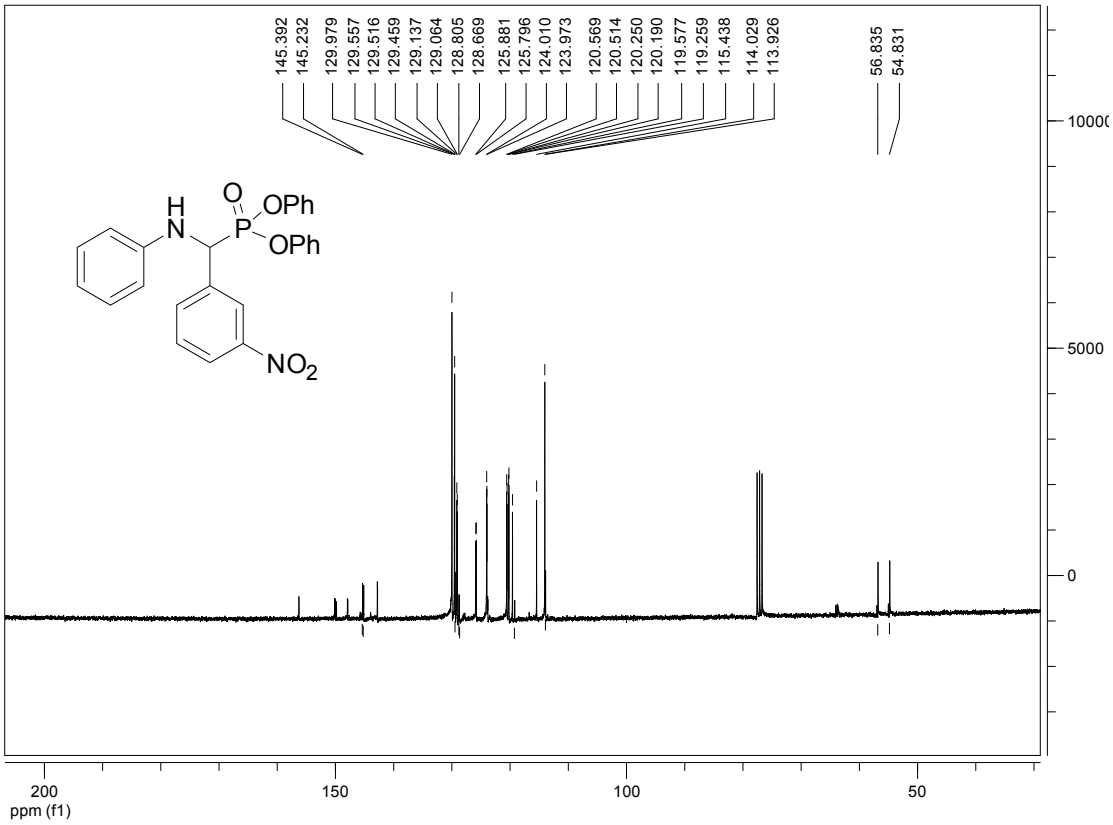


Figure 15. ^{13}C NMR spectra for the **Diphenyl ((3-nitrophenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

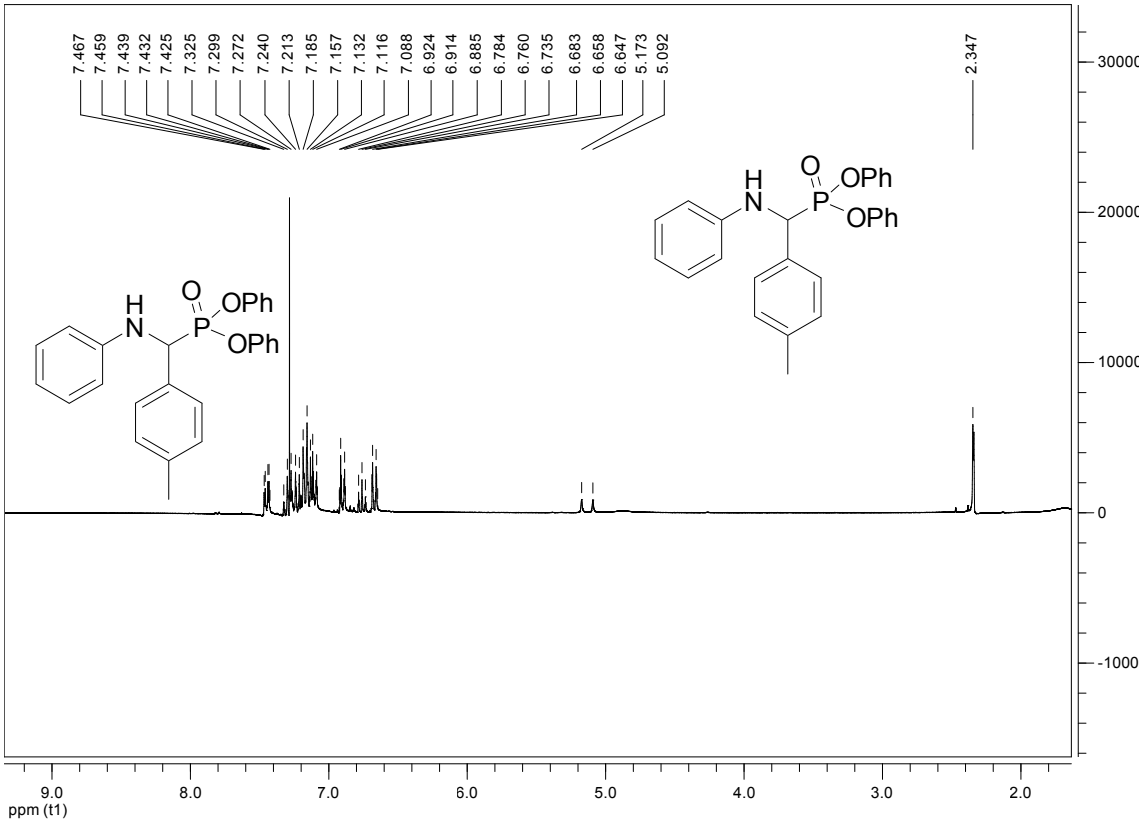


Figure 16. ^{1}H NMR spectra for the **Diphenyl ((phenylamino)(*p*-tolyl)methyl) phosphonate** in $CDCl_3$.

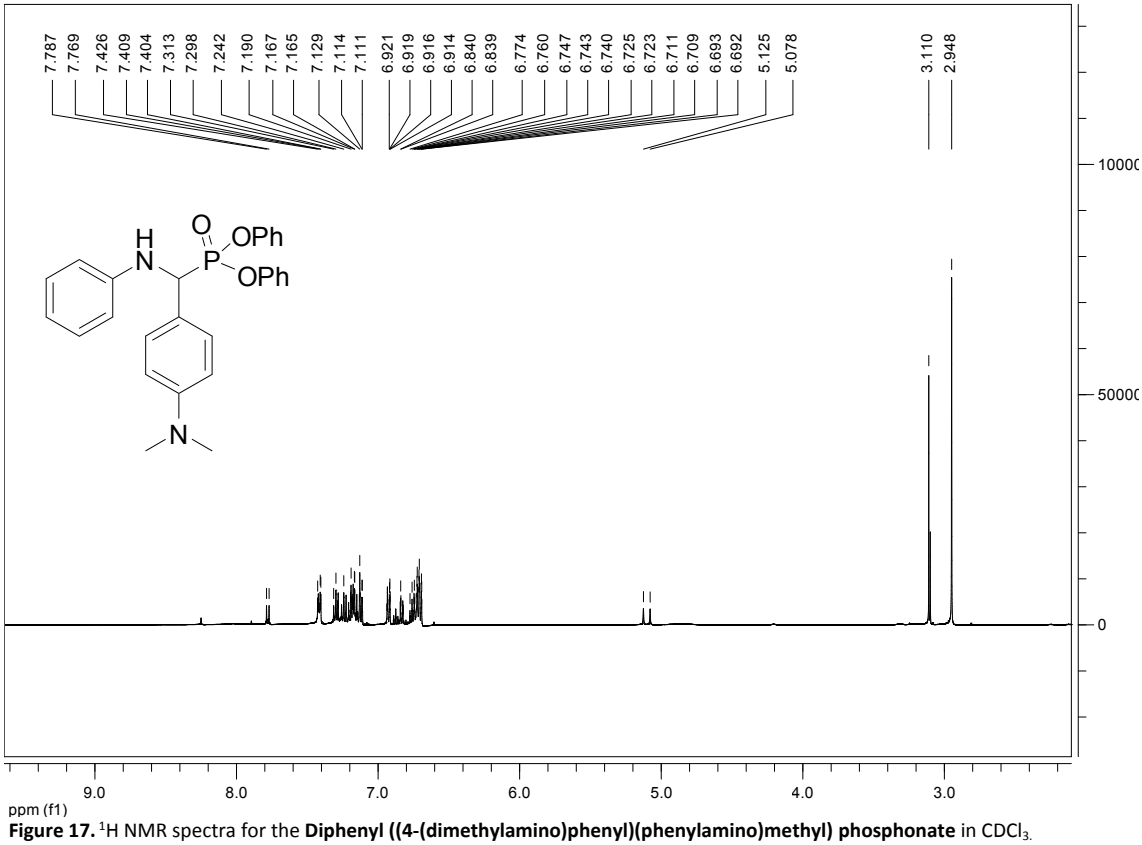


Figure 17. ^{1}H NMR spectra for the **Diphenyl ((4-(dimethylamino)phenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

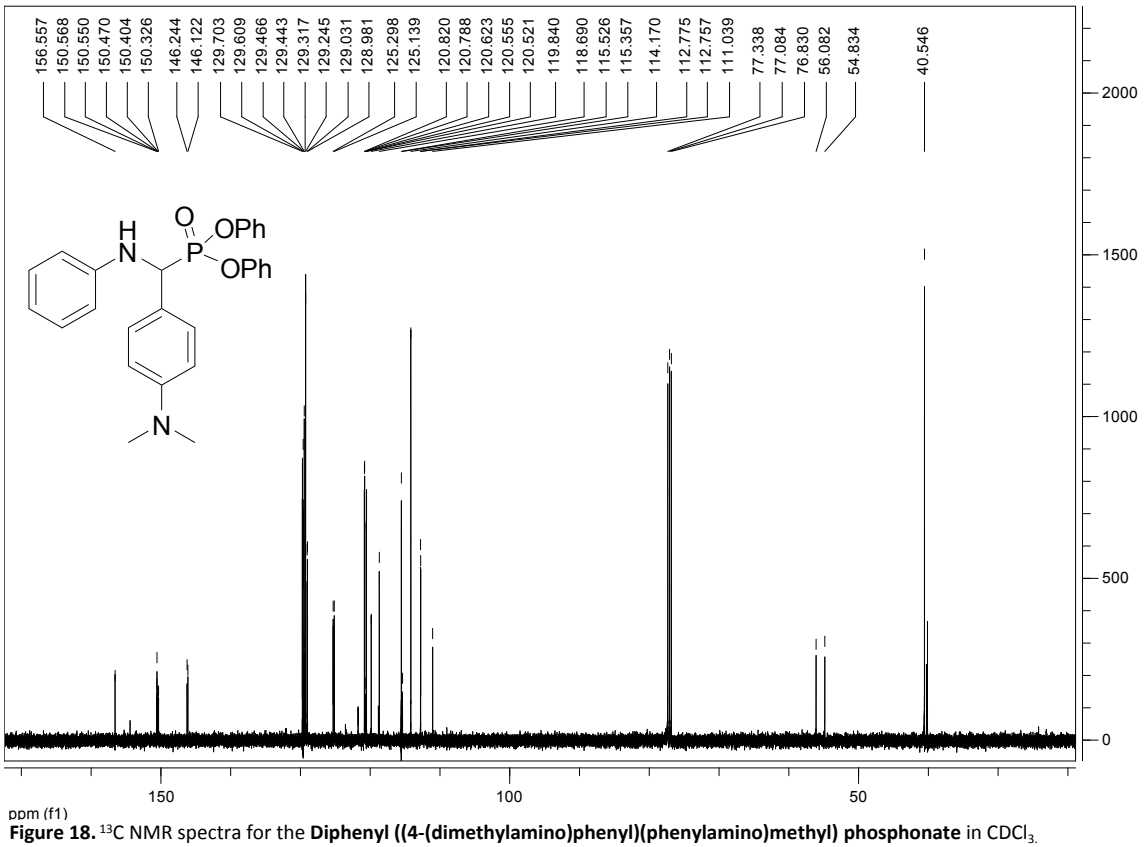


Figure 18. ^{13}C NMR spectra for the **Diphenyl ((4-(dimethylamino)phenyl)(phenylamino)methyl) phosphonate** in $CDCl_3$.

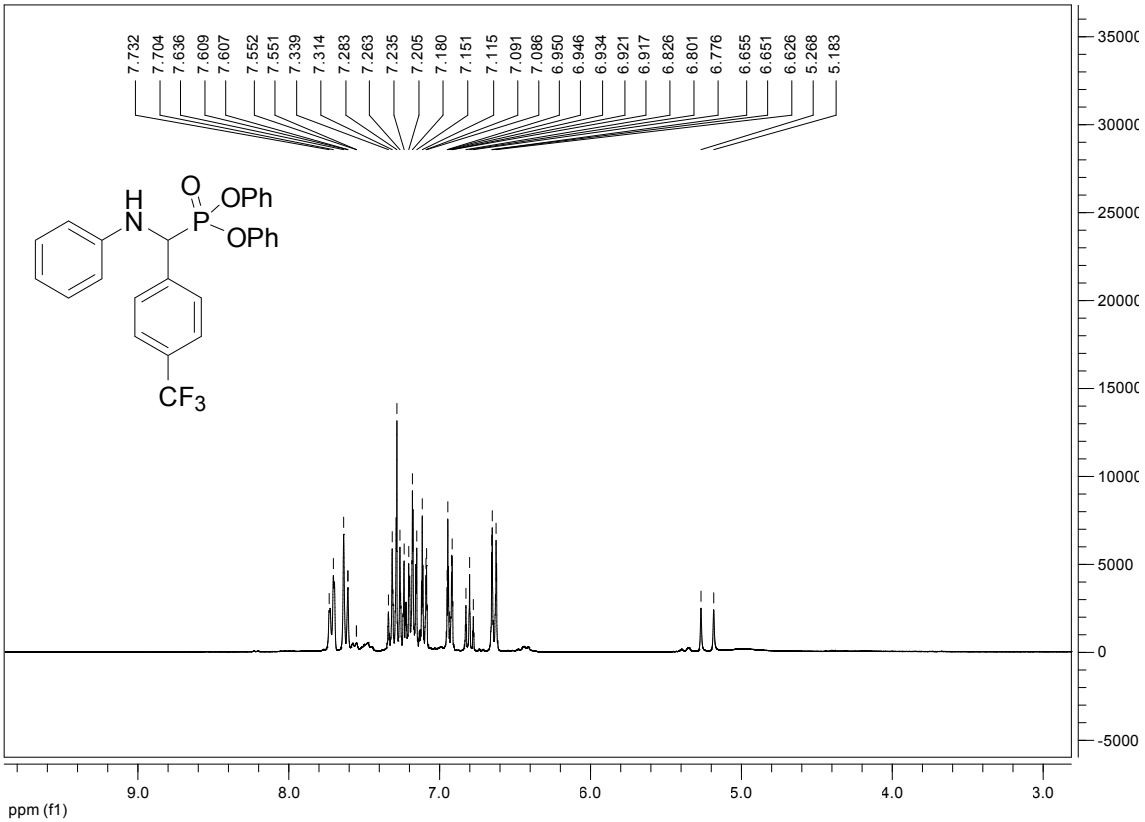


Figure 19. ^{1}H NMR spectra for the **Diphenyl ((phenylamino)(4-(trifluoromethyl) phenyl)methyl) phosphonate** in $CDCl_3$.

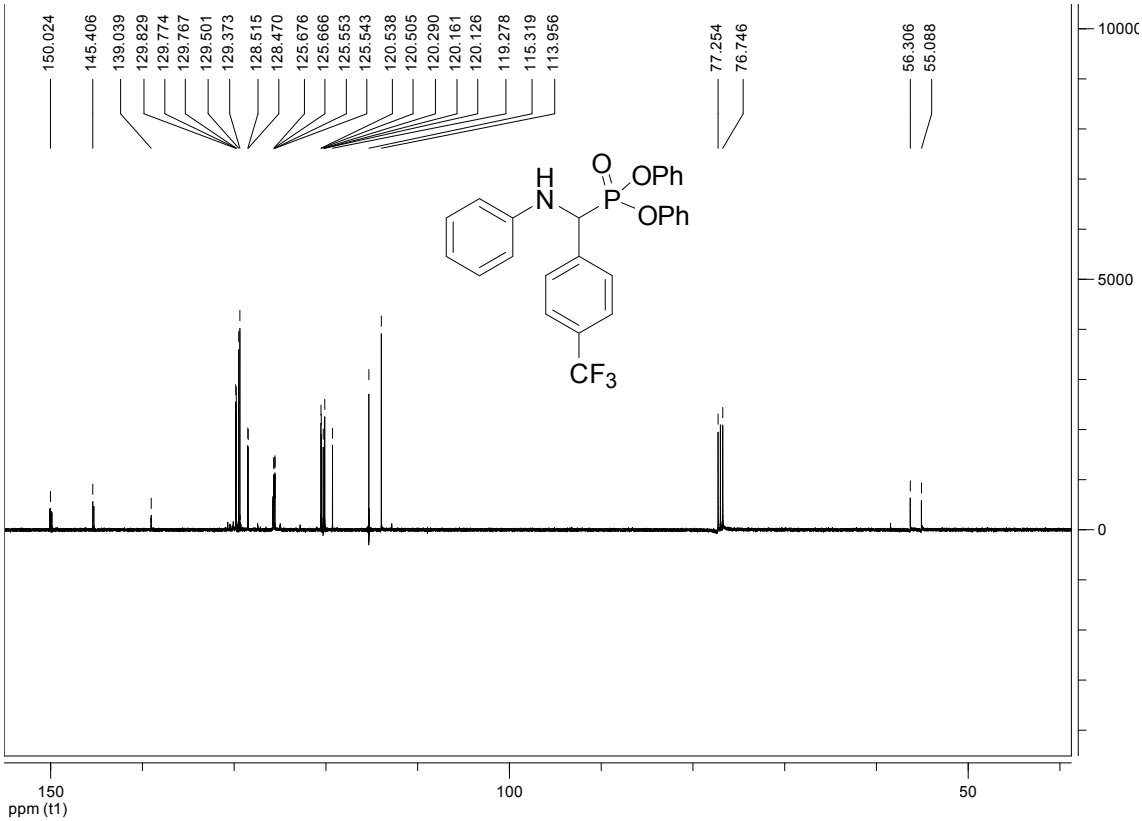


Figure 20. ^{13}C NMR spectra for the **Diphenyl ((phenylamino)(4-(trifluoromethyl) phenyl)methyl) phosphonate** in $CDCl_3$.

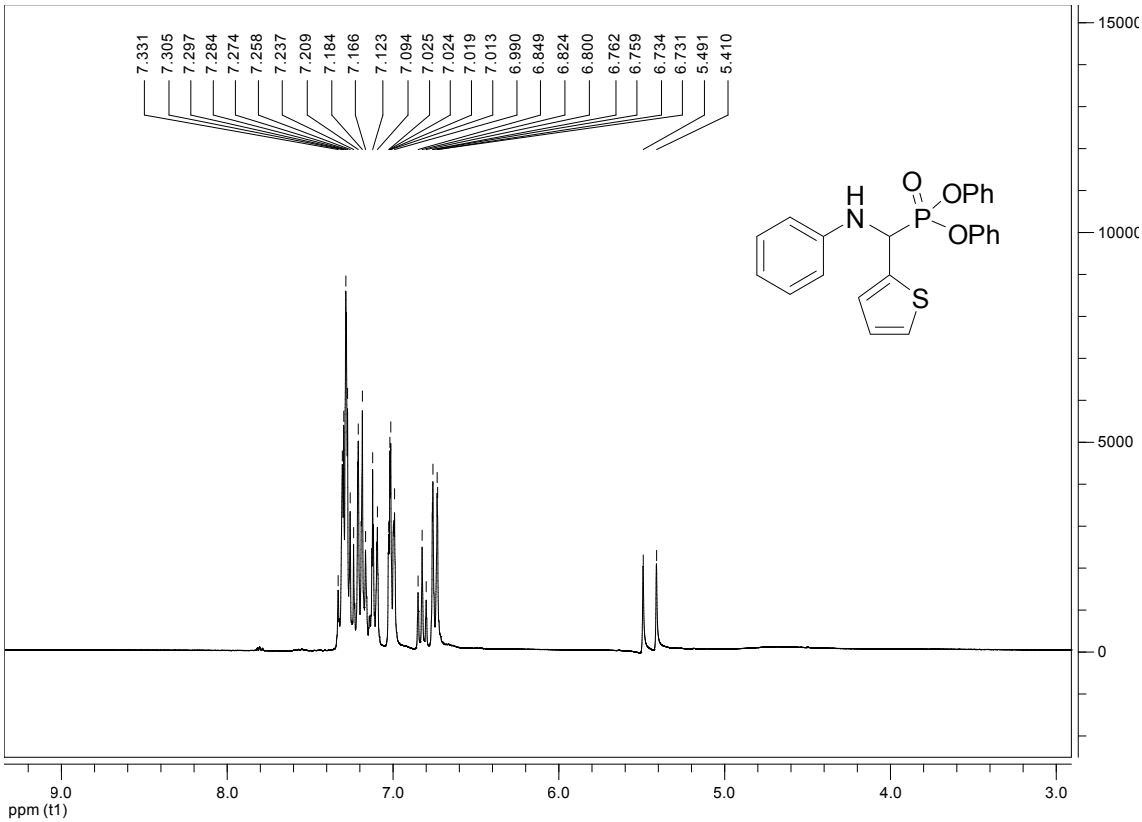


Figure 21. ^{1}H NMR spectra for the **Diphenyl ((phenylamino)(thiophen-2-yl)methyl) phosphate** in $CDCl_3$.

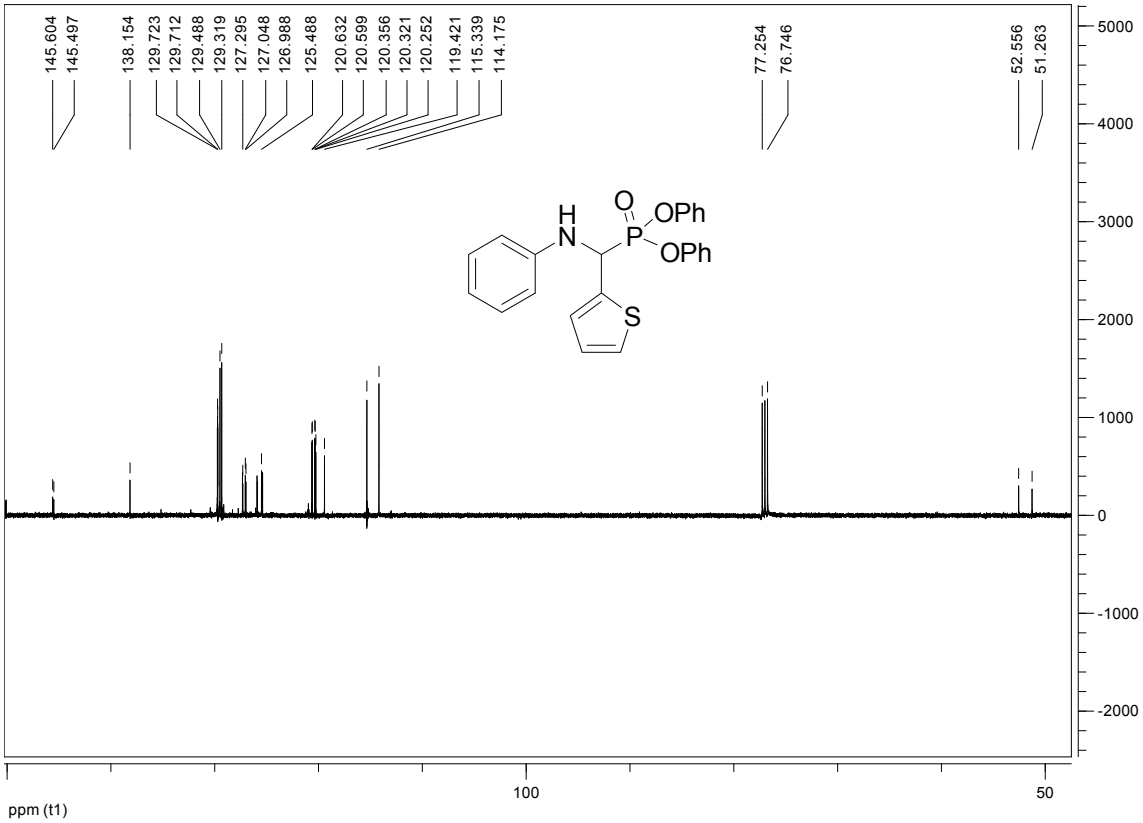


Figure 22. ^{13}C NMR spectra for the **Diphenyl ((phenylamino)(thiophen-2-yl)methyl) phosphate** in $CDCl_3$.

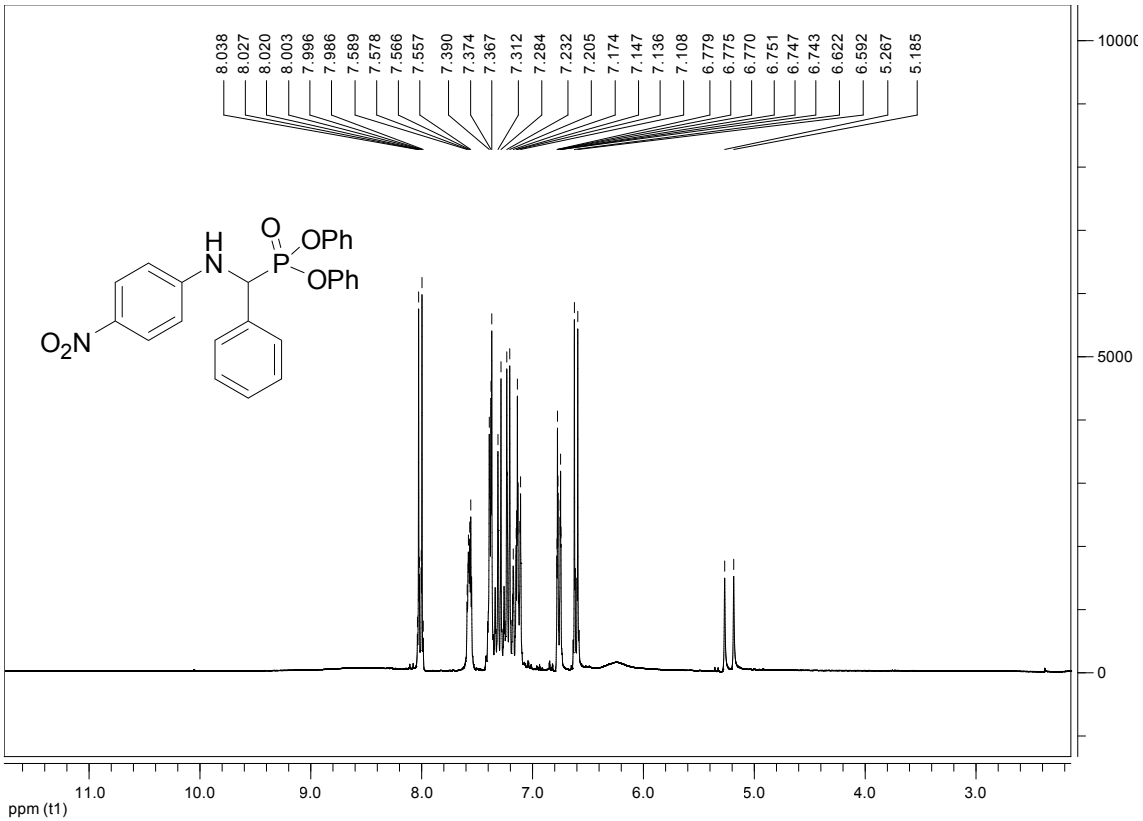


Figure 23. ^{1}H NMR spectra for the **Diphenyl (((4-nitrophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

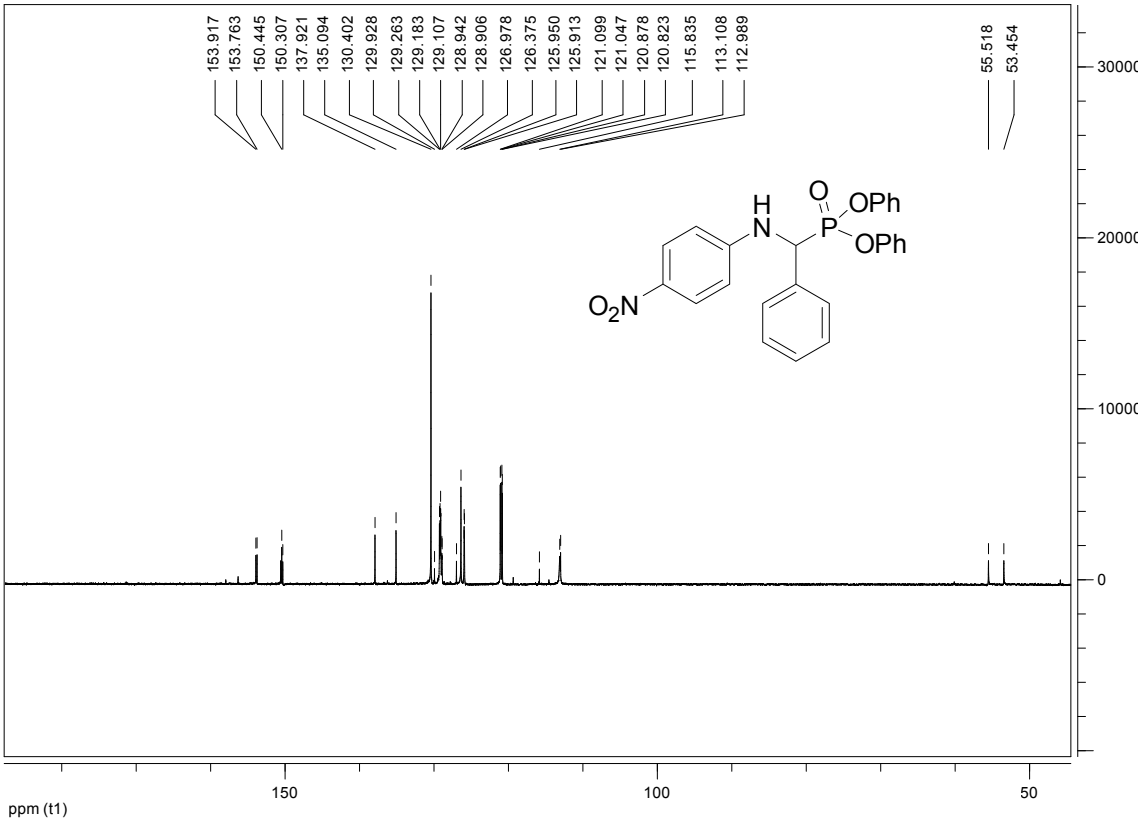


Figure 24. ^{13}C NMR spectra for the **Diphenyl (((4-nitrophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

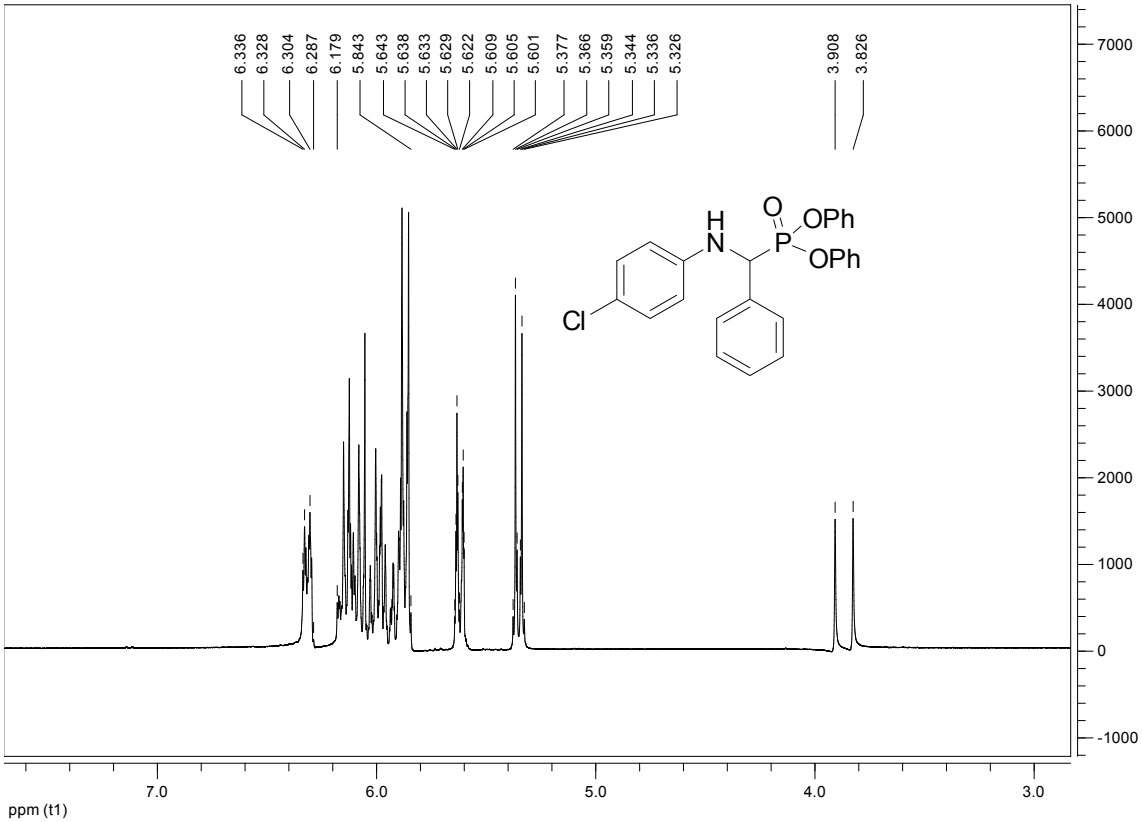


Figure 25. ^{1}H NMR spectra for the **Diphenyl (((4-Chlorophenyl) amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

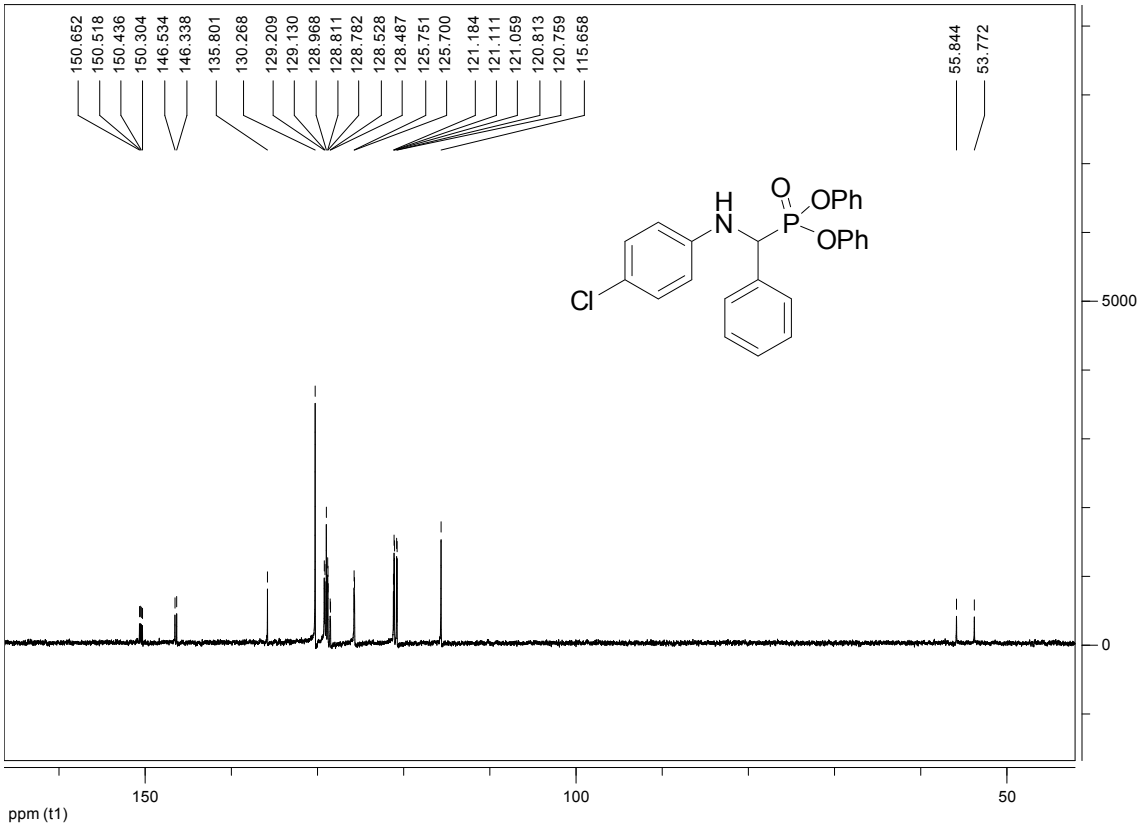


Figure 26. ^{13}C NMR spectra for the **Diphenyl (((4-Chlorophenyl) amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

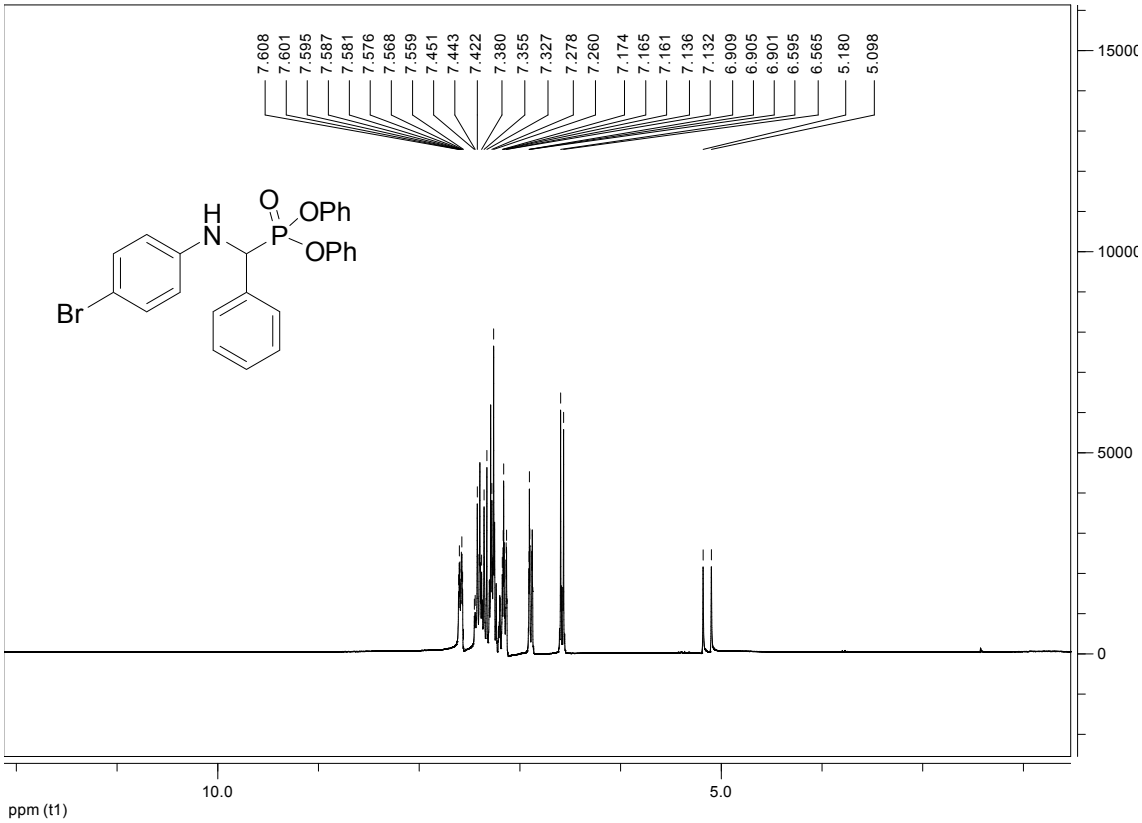


Figure 27. ^{1}H NMR spectra for the **Dipheny (((4-bromophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

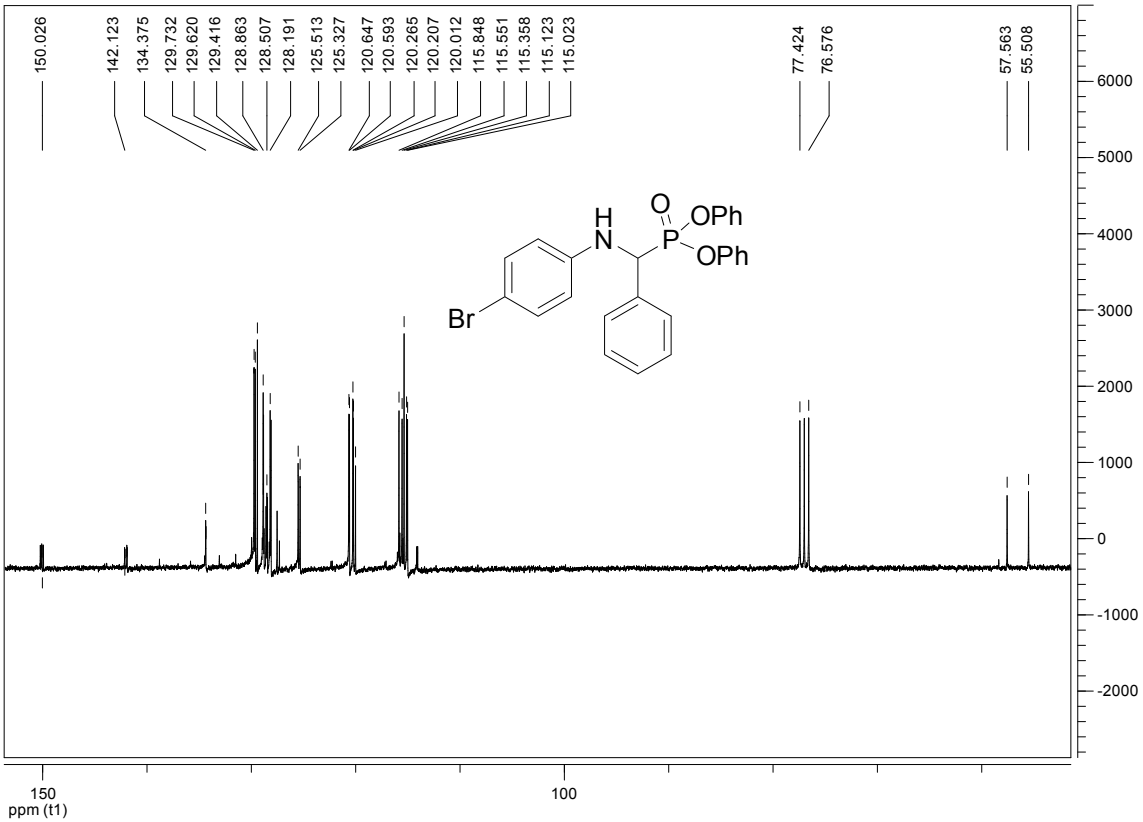


Figure 28. ^{13}C NMR spectra for the **Dipheny (((4-bromophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

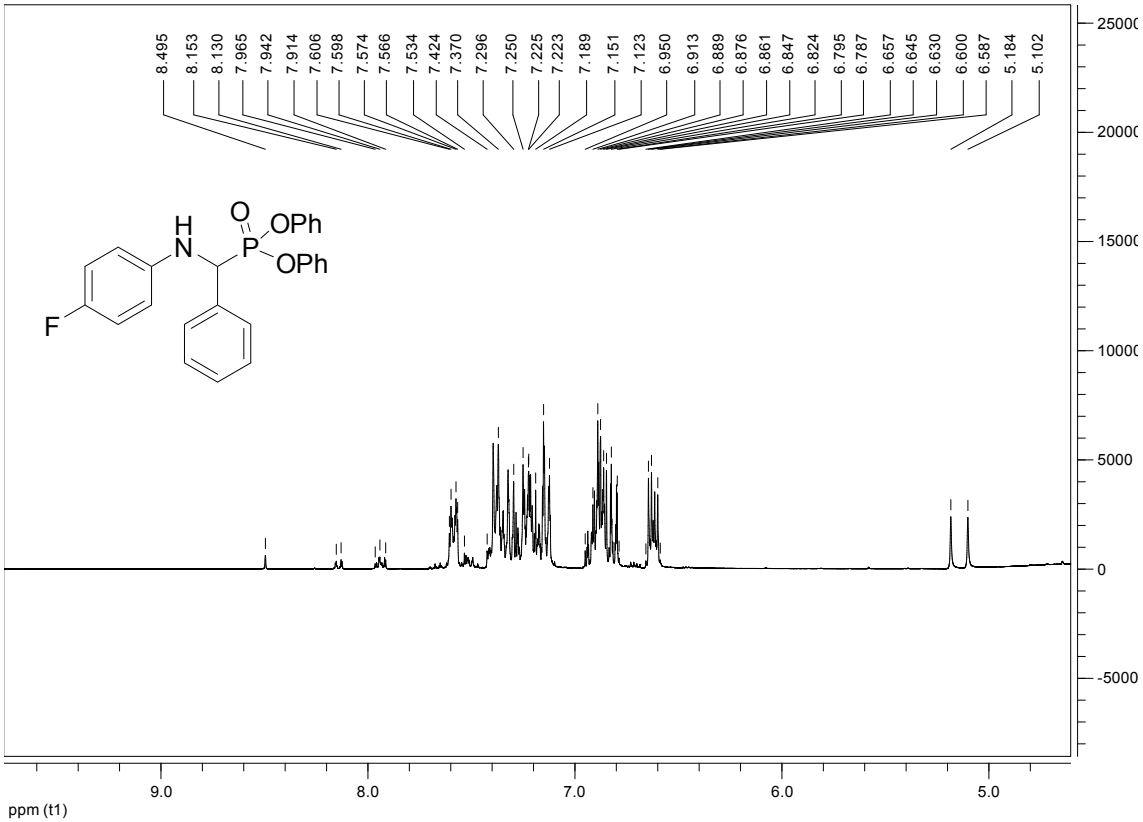


Figure 29. ^{1}H NMR spectra for the **Diphenyl (((4-fluorophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

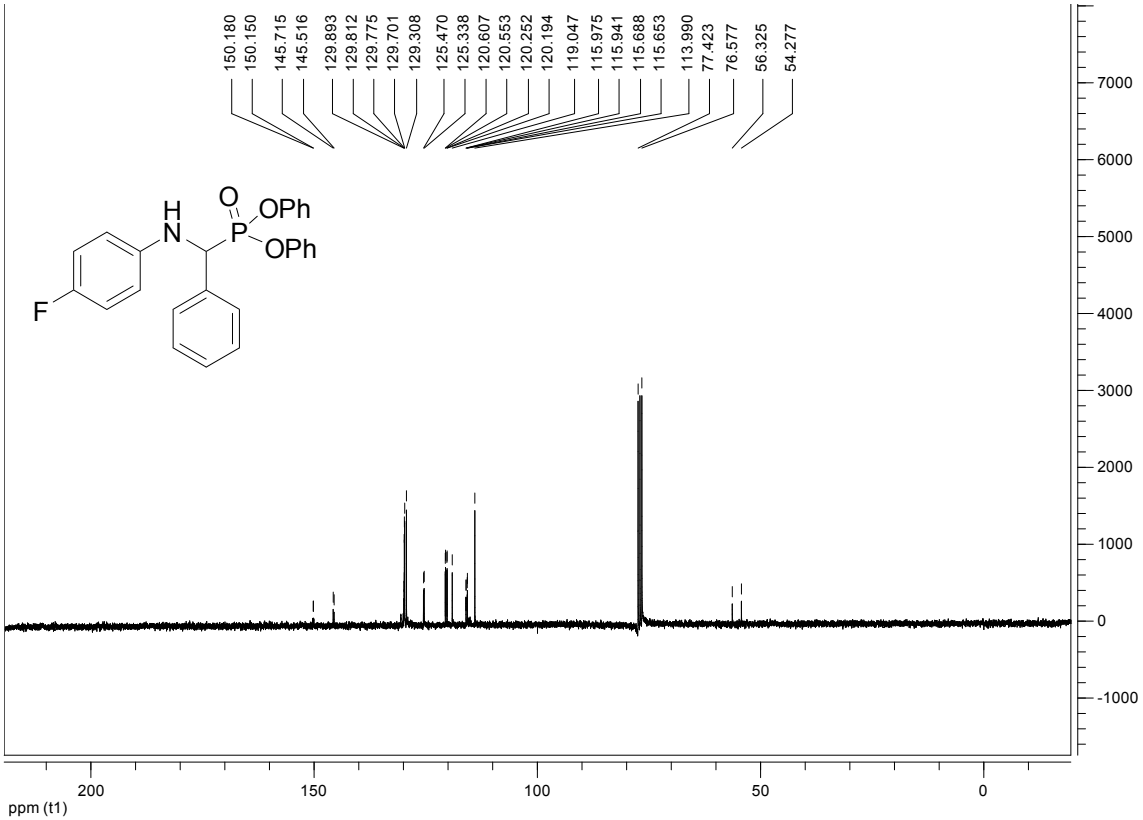


Figure 30. ^{13}C NMR spectra for the **Diphenyl (((4-fluorophenyl)amino)(phenyl)methyl) phosphonate** in $CDCl_3$.

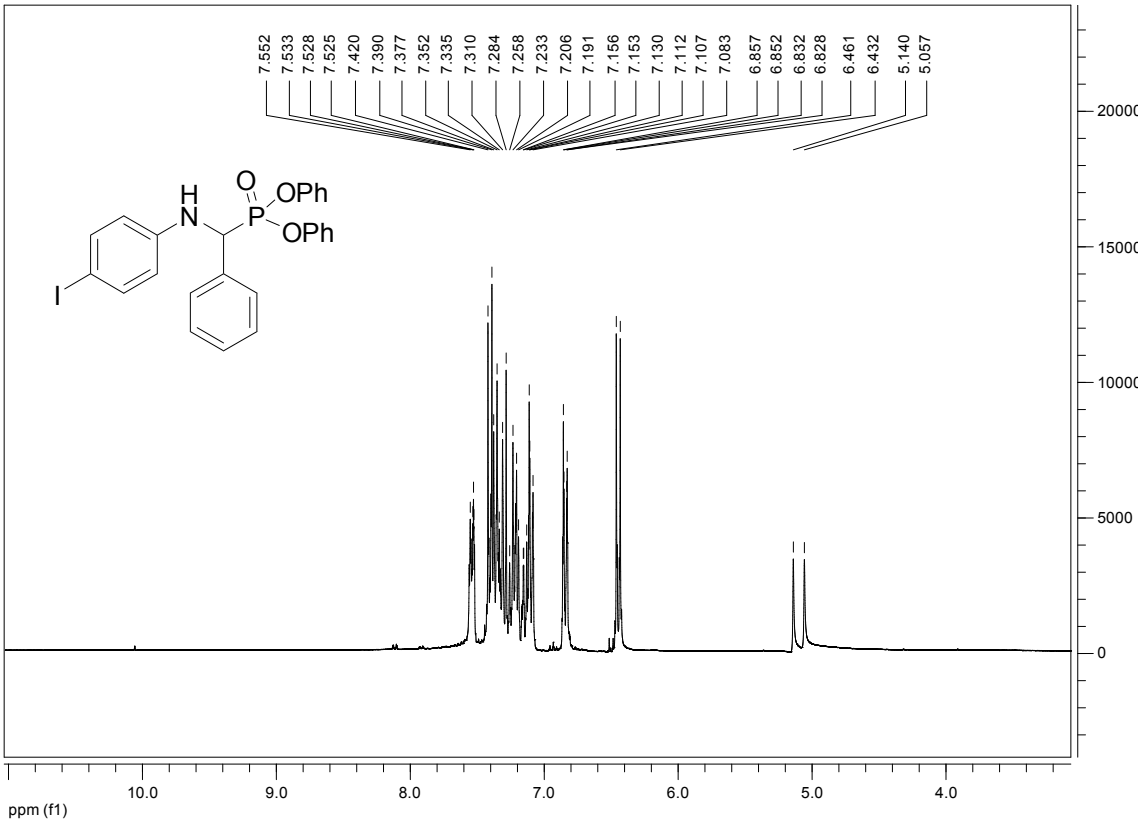


Figure 31. ^{1}H NMR spectra for the **Diphenyl (((4-iodophenyl)amino)(phenyl)methyl) phosphosnate** in $CDCl_3$.

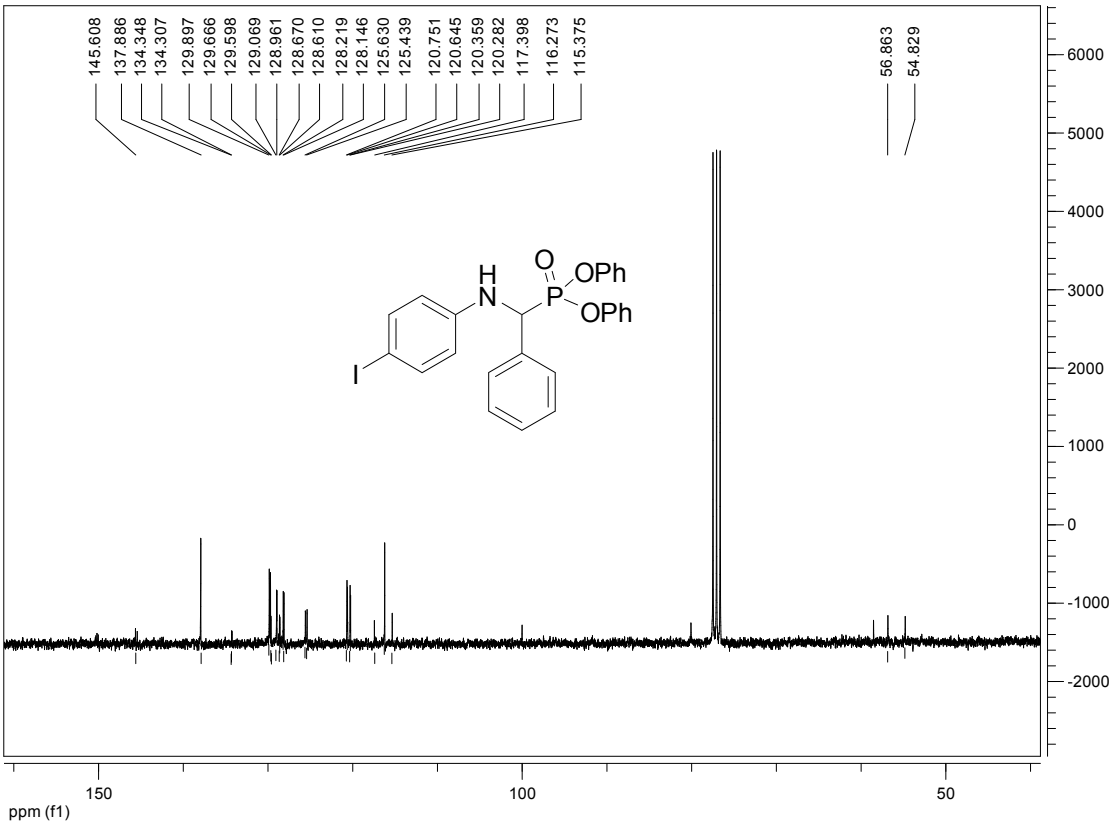


Figure 32. ^{13}C NMR spectra for the **Diphenyl (((4-iodophenyl)amino)(phenyl)methyl) phosphosnate** in $CDCl_3$.

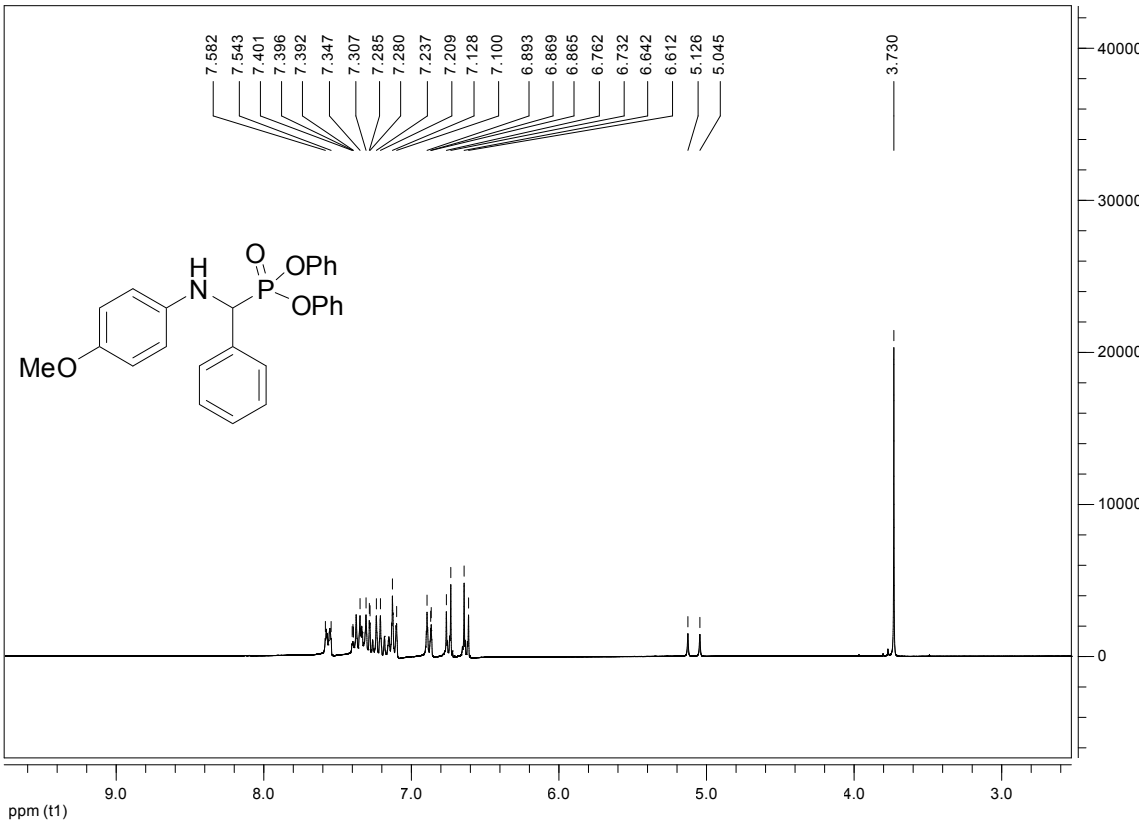


Figure 33. ^{1}H NMR spectra for the **Diphenyl (((4-methoxyphenyl)amino)(phenyl)methyl) phosphonate** in DMSO.

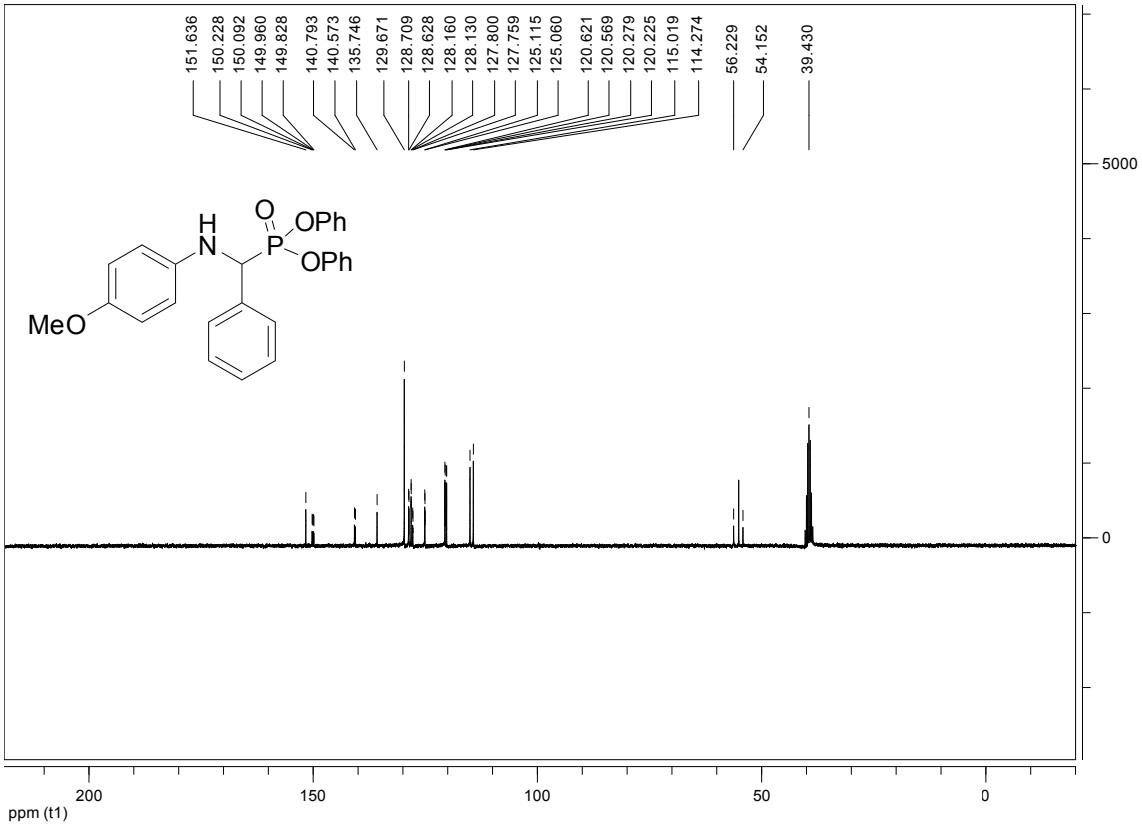


Figure 34. ^{13}C NMR spectra for the **Diphenyl (((4-methoxyphenyl)amino)(phenyl)methyl) phosphonate** in DMSO.

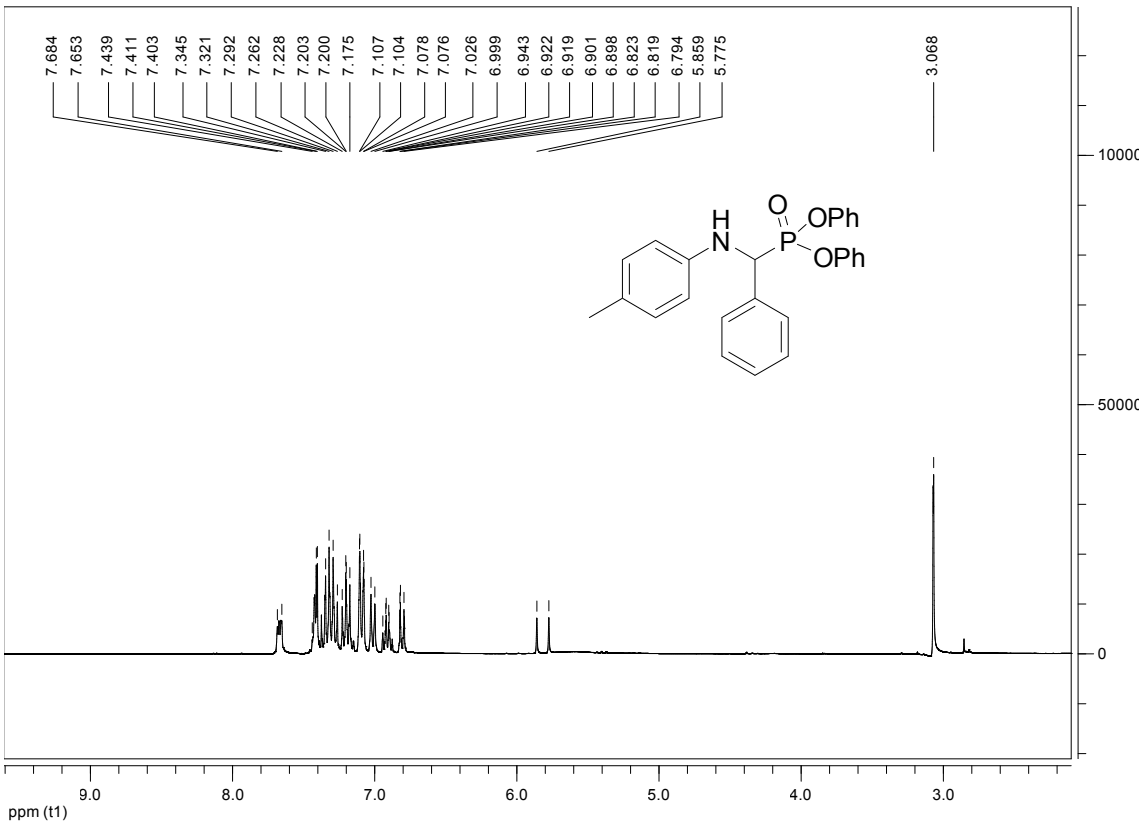


Figure 35. ^{1}H NMR spectra for the **Diphenyl (phenyl(*p*-tolylamino)methyl) phosphonate** in $CDCl_3$.

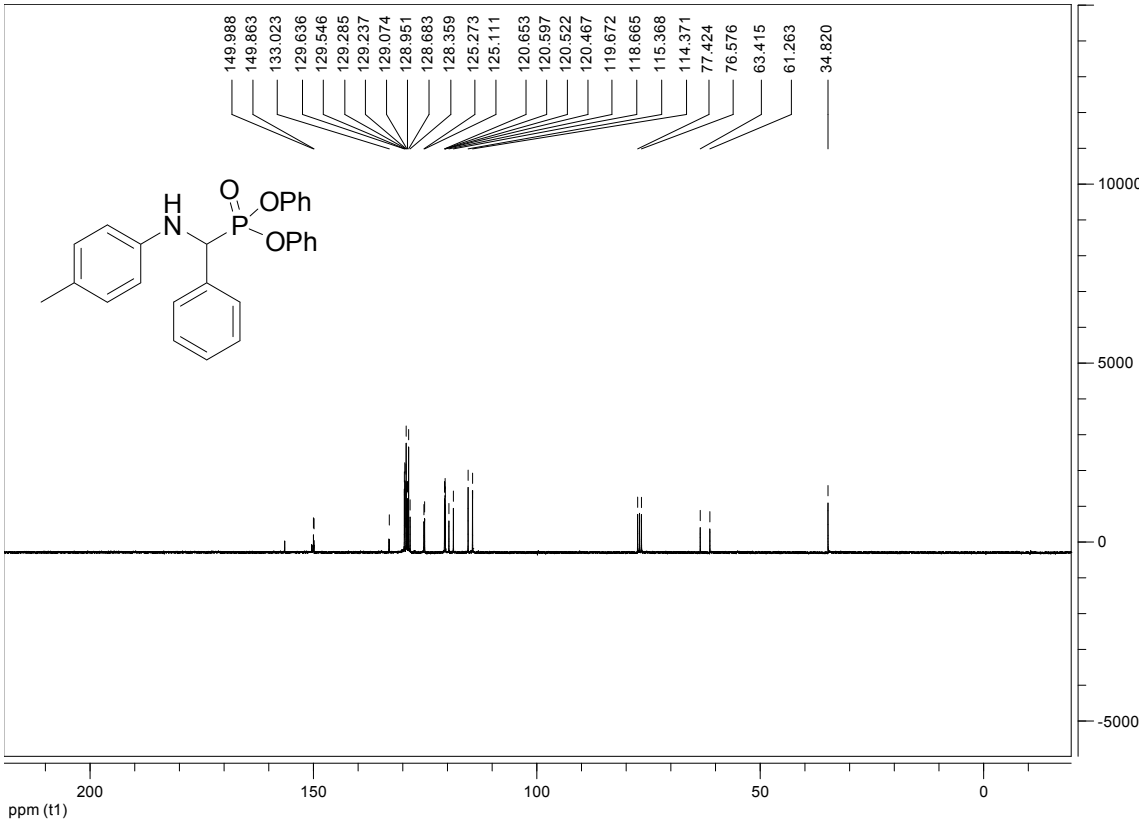


Figure 36. ^{13}C NMR spectra for the **Diphenyl (phenyl(*p*-tolylamino)methyl) phosphonate** in $CDCl_3$.

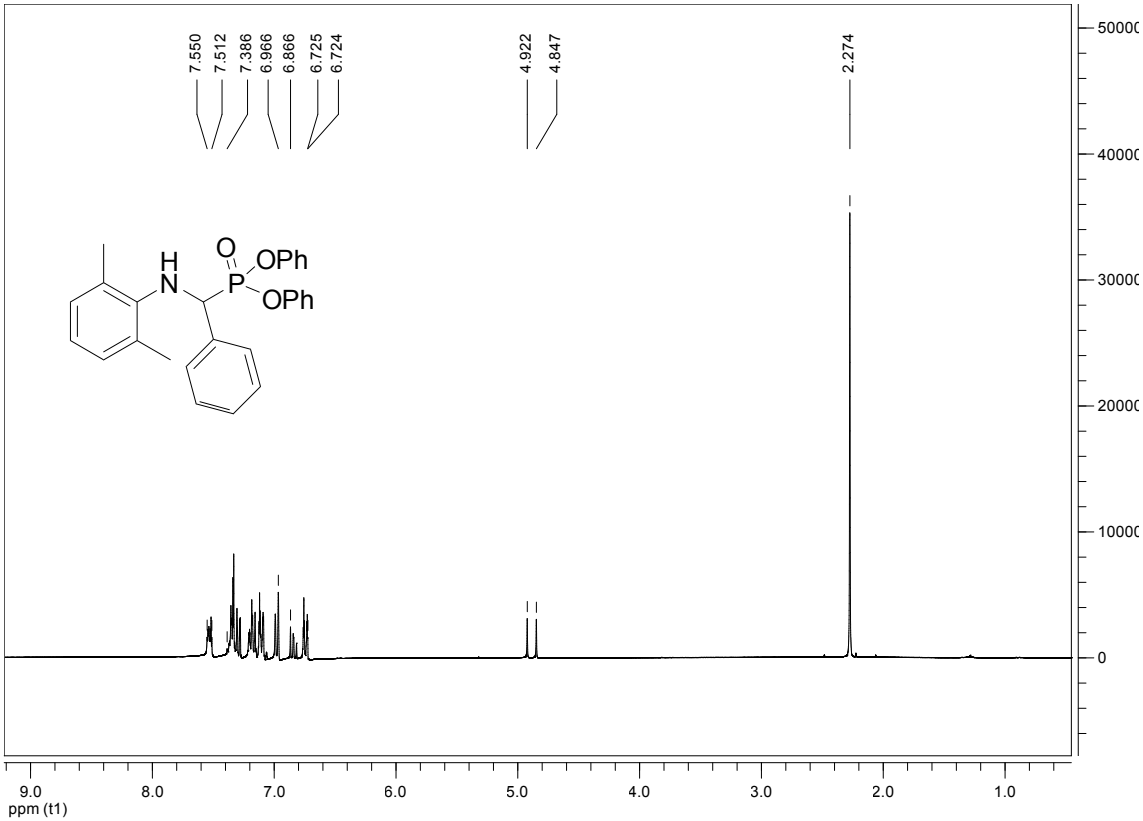


Figure 37. ^{1}H NMR spectra for the **Diphenyl (((2,6-dimethylphenyl)amino)(phenyl) methyl) phosphonate** in $CDCl_3$.

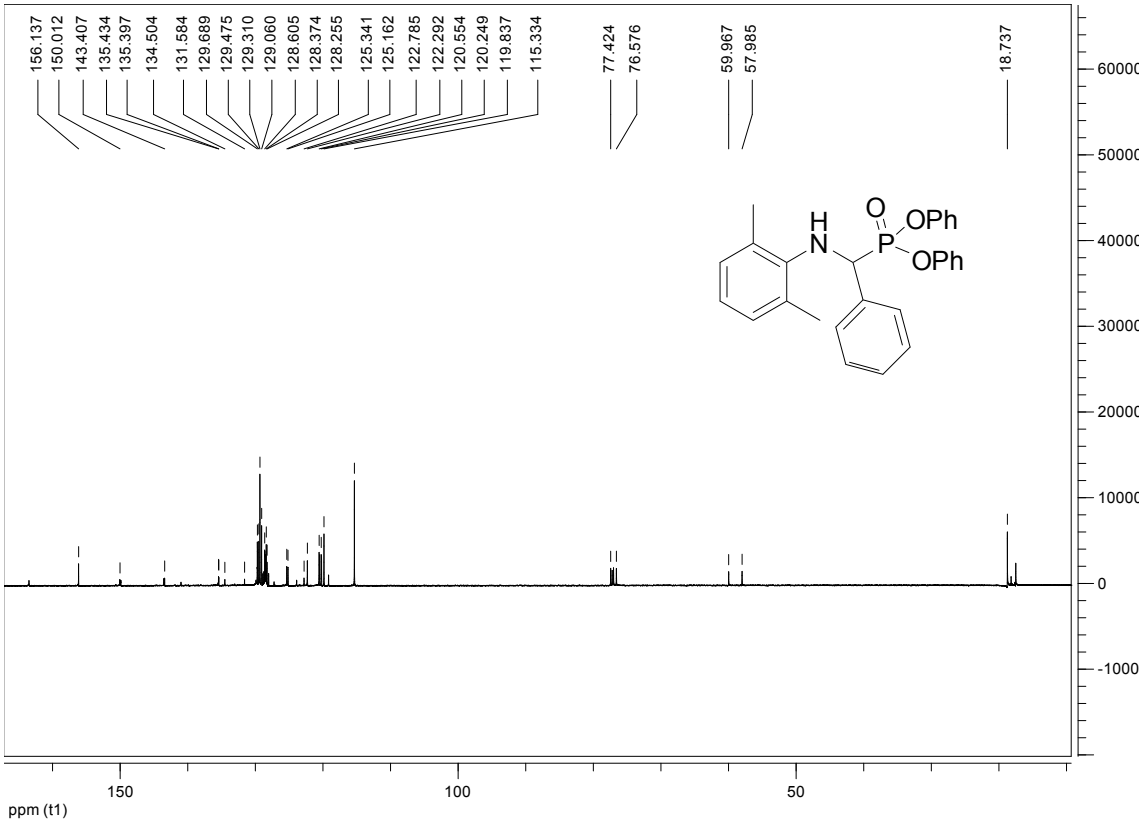


Figure 38. ^{13}C NMR spectra for the **Diphenyl (((2,6-dimethylphenyl)amino)(phenyl) methyl) phosphonate** in $CDCl_3$.

5. Characterization of Ce[(*L*-Pro)$_2$(Oxa)]

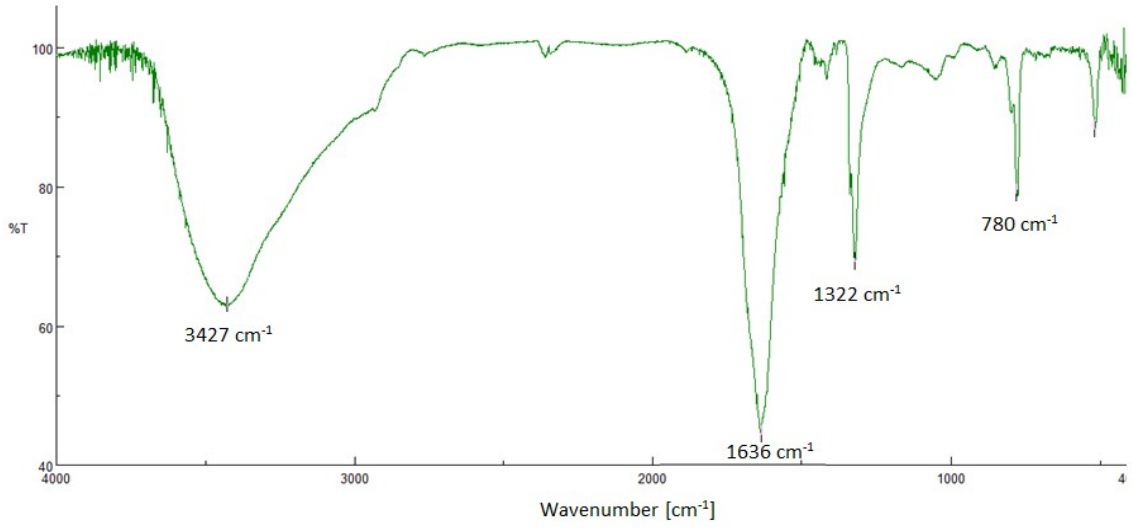


Figure 39. IR for Ce[(*L*-Pro)$_2$(Oxa)] in KBr spectroscopic.

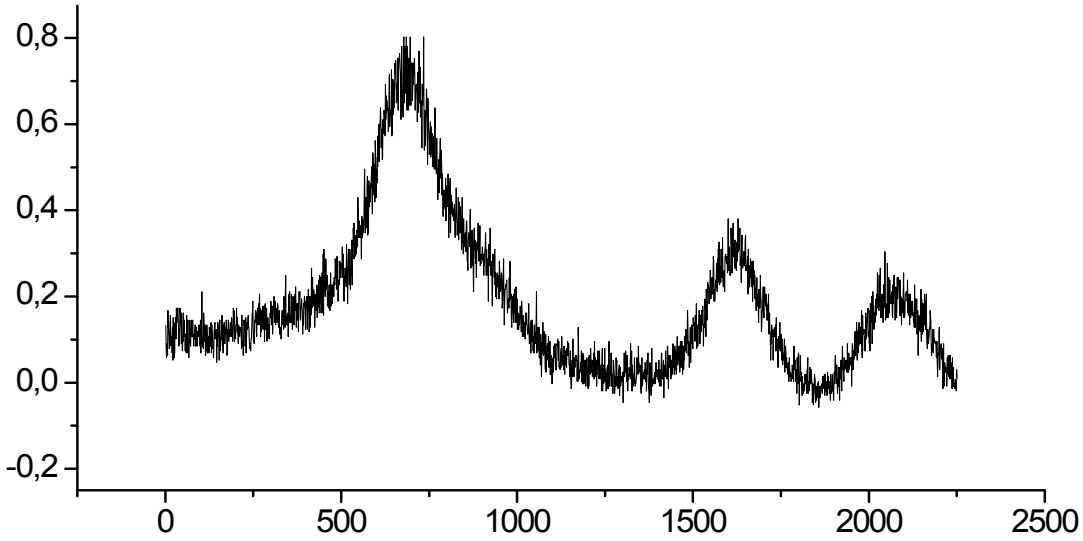


Figure 40. X-Ray diffraction patterns of [Ce(*L*-Pro)]$_2$(Oxa).