Transition metal free synthesis of 2,4,6-trisubstituted pyrimidines *via* Cope-type hydroamination of 1,4-diarylbuta-1,3-diynes

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Supplimentary Data

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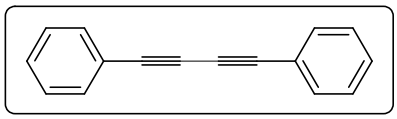
Experimental section:

General methods: High quality reagents (different alkynes and amidines) were purchased from Sigma Aldrich. Analytical grade commercial reagents and solvents were purified by standard procedures prior to use. Chromatographic purification was done with 60-120 mesh silica gel (Merck). For reaction monitoring, pre-coated silica gel 60 F254 sheets (Merck) were used. ^{1}H NMR (200 MHz) spectra were recorded on a BRUCKER-AC 200 MHz spectrometer. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard (deuterochloroform: 7.26 ppm). Data are reported as follows: chemical shifts, multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet), coupling constant (Hz). ^{13}C NMR (50 MHz) spectra were recorded on a BRUKER-AC 200 MHz. Spectrometer with complete proton decoupling. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard (deuterochloroform: 77.23 ppm). 19F NMR spectra were recorded on a BRUKER 400 MHz spectrometer. IR spectra were recorded on Perkin-Elmer IR73713 spectrophotometer. HRMS (ESI) spectra were taken using Waters Xevo G2 QTof mass spectrometer.

General procedure for the synthesis of 1,4-diarylbuta-1,3-diynes:

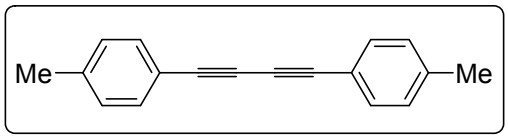
Arylacetylene (1.0 mmol), TMEDA (10 mol %), CuI (5 mol %) and Et_3N (3 mmol) were taken in round bottomed flask. Then 5 mL of acetone was added and the reaction mixture was stirred at room temperature under an air balloon for 24 h. After completion of the reaction, solvent was removed under reduced pressure and the crude product was purified by column chromatography using silica gel (60-120 mesh) and petroleum ether / ethylacetate as eluent.

1,4-diphenylbuta-1,3-diyne (1a):



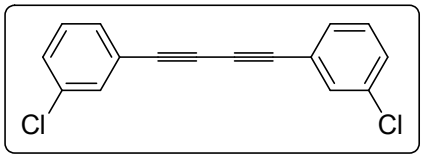
White solid; MP 88-89 °C; Yield 88%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 7.29-7.39 (6H, m), 7.52-7.57 (4H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 76.6, 81.8, 121.9, 128.6, 129.4, 132.7. This compound has been reported in the literature.[1]

1,4-di*p*-tolylbuta-1,3-diyne (1b):



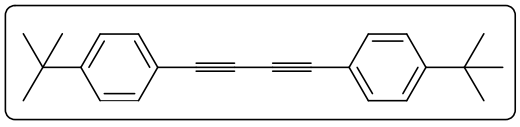
White solid; MP 183-184 °C; Yield 91%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.37 (6H, s), 7.14 (4H, d, J = 7.8 Hz), 7.42 (4H, d, J = 7.8 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.8 (2C), 73.7 (2C), 81.8 (2C), 119.0 (2C), 129.4 (4C), 132.6 (4C), 139.7 (2C). This compound has been reported in the literature.[1]

1,4-bis(3-chlorophenyl)buta-1,3-diyne (1c):



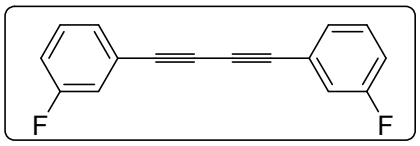
White solid; MP 73-74 °C; Yield 85%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 7.23-7.44 (6H, m), 7.50-7.51 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 74.9 (2 x C), 80.7 (2 x C), 123.5 (2 x C), 129.9 (4 x CH), 130.8 (2 x CH), 132.4 (2 x CH), 134.5 (2 x C). This compound has been reported in the literature.[2]

1,4-bis(4-*tert*-butylphenyl)buta-1,3-diyne (1d):



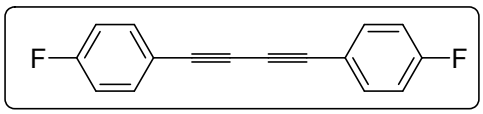
White solid; MP 195-196 °C; Yield 92%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 1.35 (18H, s), 7.37-7.41 (4H, m), 7.49-7.53 (4H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 31.3 (6 x CH_3), 35.1 (2 x C), 73.7 (2 x C), 81.7 (2 x C), 119.0 (2 x C), 125.6 (4 x CH), 132.4 (4 x CH), 152.7 (2 x C). This compound has been reported in the literature.[2]

1,4-bis(3-fluorophenyl)buta-1,3-diyne (1e):



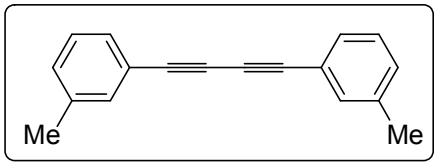
White solid; MP 121-122 °C; Yield 93%; **^{1}H NMR** in $CDCl_3$ (200 MHz) δ: 7.05-7.34 (8H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ : 74.6 (2 x C), 80.8 (2 x C, d, *J* = 3.5 Hz), 117.1 (2 x CH, d, *J* = 21.0 Hz), 119.4 (2 x CH, d, *J* = 23.0 Hz), 123.6 (2 x C, d, *J* = 9.5 Hz), 128.6 (2 x CH, d, *J* = 3.0 Hz), 130.3 (2 x CH, d, *J* = 8.5 Hz), 162.4 (2 x C, d, *J* = 246.0 Hz). This compound has been reported in the literature.[3]

1,4-bis(4-fluorophenyl)buta-1,3-diyne (1f):



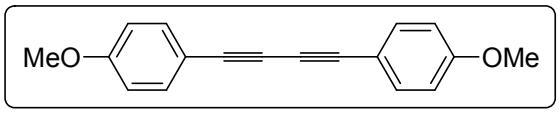
White solid; MP 194-195°C; Yield 94%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 6.99-7.08 (4H, m), 7.48-7.55 (4H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 73.7 (2 x C), 80.6 (2 x C), 116.1 (4 x CH, d, *J* = 22.0 Hz), 118.0 (2 x C), 134.7 (4 x CH, d, *J* = 8.5 Hz), 163.3 (2 x CF, d, *J* = 250.0 Hz). This compound has been reported in the literature.[1]

1,4-di*m*-tolylbuta-1,3-diyne (1g):



White solid; MP 68-69 °C; Yield 92%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.43 (6H, s), 7.24-7.28 (4H, m), 7.43 (4H, s); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.4 (2 x CH_3), 73.9 (2 x C), 81.8 (2 x C), 121.8 (2 x C), 128.5 (2 x CH), 129.8 (2 x CH), 130.3 (2 x CH), 133.2 (2 x CH), 138.3 (2 x C). This compound has been reported in the literature.[2]

1,4-bis(4-methoxyphenyl)buta-1,3-diyne (1h):

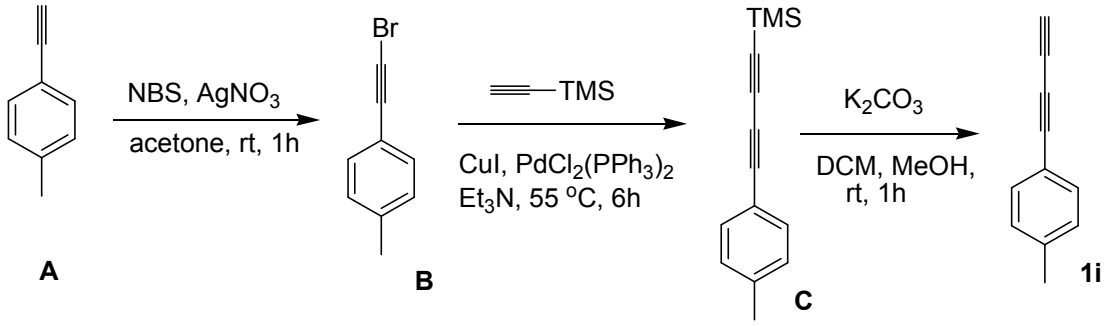


Yellow solid; MP 141-142°C; Yield 93%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 3.82 (6H, s), 7.46 (4H, d, *J* = 8.8 Hz), 8.85 (4H, d, *J* = 8.8 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 55.4 (2 x C), 73.0 (2 x C), 81.3 (2 x C), 113.9, 114.2, 134.1, 160.3. This compound has been reported in the literature.[1]

General procedure for the synthesis of 1-(buta-1,3-diynyl)-4-methylbenzene (1i):

The compound (1i) was synthesized according to the literature reported procedure as in ref 4.

The 1-ethynyl-4-methylbenzene (A) (2 mmol) was taken in a round bottomed flask and then 10 mL of acetone was added to it. Then NBS (1.1 equiv.) and $AgNO_3$ (0.1 equiv.) were added to the solution and the reaction mixture was stirred at room temperature for 1h. After completion of the reaction, the solvent was removed under reduced pressure and then passed through a pad of silica-gel with n-hexane as eluent. The filtrate was collected and evaporated under reduced pressure to afford the compound 1-(2-bromoethynyl)-4-methylbenzene (B) as colourless liquid in 94% yield.



Then the compound B, CuI (5 mol %) and $PdCl_2(PPh_3)_2$ (5 mol%) were taken in a two-neck round bottomed flask and the flask was filled with argon. Then 15 mL of Et_3N was added and the mixture was degassed with argon for 10 min. Then trimethylsilylacetyline (2 equiv.) was added through a syringe and the reaction mixture was stirred at 55 °C for 6h. After completion of the reaction, the solvent was removed under reduced pressure and the residue was purified by a column chromatography using hexane as eluent to afford the compound C as yellowish liquid.

Then the compound **C** and K_2CO_3 (6 equiv.) were taken in a round bottomed flask. Then 20 mL of MeOH and 20 mL of DCM were added and the reaction mixture was stirred at room temperature for 1h. After completion of the reaction, the solvent was removed under reduced

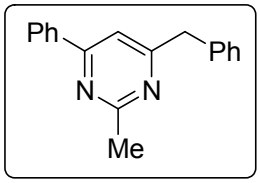
pressure and the crude product was purified by column chromatography using hexane as eluent to get the compound 1-(buta-1,3-diynyl)-4-methylbenzene (1i) as colourless liquid in 96% yield.; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.41 (3H, s), 2.51 (1H, s), 7.18 (2H, d, *J* = 8.2 Hz), 7.46 (2H, d, *J* = 8.2 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.8 (CH_3), 68.5 (C), 71.2 (CH), 73.1 (C), 75.8 (C), 118.0 (C), 129.4 (2 x CH), 132.9 (2 x CH), 140.1 (C).

General procedure for the synthesis of 2,4,6-trisubstitued pyrimidines:

The 1,4-diarylbuta-1,3-diyne (0.5 mmol), acetamidine/benzamidine hydrochloride (1.5 mmol) were taken in a round bottomed flask fitted with a condenser and then triethyl amine (1.5 mmol) and dimethyl sulfoxide (5 mL) were added. Then the reaction mixture was heated at 160 °C under air balloon for 24 h. Then the reaction mixture was cooled to room temperature, diluted with water and extracted with ethyl acetate (3 × 20 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and then evaporated under reduced pressure. The crude product was then purified by column chromatography using silica gel (60-120 mesh) and petroleum ether/ethylacetate as eluent.

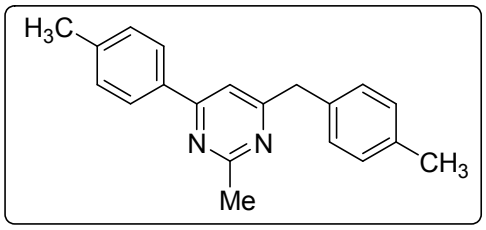
Characterization data for the compounds 2a-2n:

4-benzyl-2-methyl-6-phenylpyrimidine (2a):



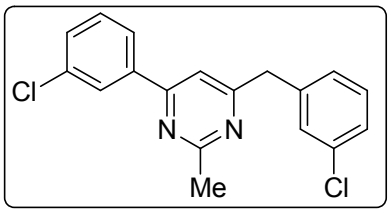
Yellow liquid; Yield 65%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.81 (3H, s), 4.16 (2H, s), 7.30-7.35 (5H, m), 7.44-7.47 (4H, m), 7.94-7.99 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 26.3 (CH_3), 44.3 (CH_2), 113.3 (CH), 127.1 (CH), 127.5 (2 x CH), 129.0 (2 x CH), 129.1 (2 x CH), 129.5 (2 x CH), 130.9 (CH), 137.2 (C), 137.7 (C), 164.9 (C), 168.0 (C), 169.7 (C); **HRMS** (ESI) calculated for $C_{18}H_{17}N_2$ $[M + H]^+$: 261.1386; found: 261.1381.

2-methyl-4-(4-methylbenzyl)-6-*p*-tolylpyrimidine (2b):



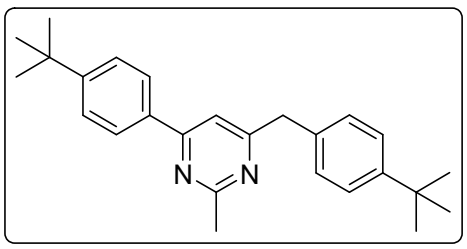
Yellow liquid; Yield 62%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.34 (3H, s), 2.39 (3H, s), 2.79 (3H, s), 4.11 (2H, s), 7.12-7.18 (4H, m), 7.23-7.27 (3H, m), 7.88 (2H, d, *J* = 8.2 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.3 (CH_3), 21.6 (CH_3), 26.2 (CH_3), 43.8 (CH_2), 112.9 (CH), 127.4 (2 x CH), 129.4 (2 x CH), 129.7 (2 x CH), 129.8 (2 x CH), 134.4 (C), 134.7 (C), 136.7 (C), 141.4 (C), 164.9 (C), 167.8 (C), 169.7 (C). **HRMS** (ESI) calculated for $C_{20}H_{21}N_2$ $[M + H]^+$: 289.1699; found: 289.1702.

4-(3-chlorobrnzyl)-6-(3-chlorophenyl)-2-methylpyrimidine (2c):



Yellow solid; MP 88-90 °C; Yield 78%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.80 (3H, s), 4.09 (2H, s), 7.16-7.28 (5H, m), 7.33-7.45 (2H, m), 7.81-7.88 (1H, m), 8.01 (1H, d, *J* = 1.4 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 26.4 (CH_3), 44.1 (CH_2), 113.2 (CH), 125.4 (CH), 127.3 (CH), 127.5 (2 x CH), 129.5 (CH), 130.2 (CH), 130.3 (CH), 130.8 (CH), 134.7 (C), 135.2 (C), 139.0 (C), 139.7 (C), 163.2 (C), 168.6 (C), 169.3 (C); **IR** (KBr): 3061, 3013, 2959, 2927, 1570, 1542 cm $^{-1}$; **HRMS** (ESI) calculated for $C_{18}H_{15}Cl_2N_2$ $[M + H]^+$: 329.0607; found: 329.0601; **Crystal data**: CCDC no 990434; Formula $C_{18}H_{14}Cl_2N_2$; Space group P212121; Unit cell parameters a 4.2028(7) b 11.833(2) c 31.589(5), α 90 β 90 γ 90.

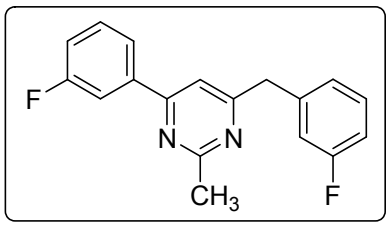
4-(4-*tert*-butylbenzyl)-6-(4-*tert*-butylphenyl)-2-methylpyrimidine (2d):



Yellow liquid; Yield 54%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 1.32 (9H, s), 1.34 (9H, s), 2.81 (3H, s), 4.13 (2H, s), 7.22-7.28 (3H, m), 7.36 (2H, d, *J* = 8.4 Hz), 7.48 (2H, d, *J* = 8.6 Hz), 7.91 (2H, d, *J* = 8.6 Hz); **^{13}C**

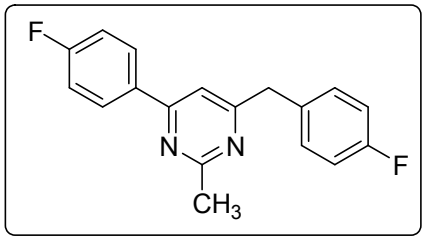
NMR ($CDCl_3$, 50 MHz) δ: 26.2 (CH_3), 31.4 (3 x CH_3), 31.6 (3 x CH_3), 34.7 (C), 35.1 (C), 43.7 (CH_2), 113.2 (CH), 125.9 (2 x CH), 126.1 (2 x CH), 127.3 (2 x CH), 129.1 (2 x CH), 134.5 (C), 134.7 (C), 149.9 (C), 154.5 (C), 164.9 (C), 167.8 (C), 169.6 (C); **HRMS** (ESI) calculated for $C_{26}H_{33}N_2$ $[M + H]^+$: 373.2638; found: 373.2641.

4-(3-fluorobenzyl)-6-(3-fluorophenyl)-2-methylpyrimidine (2e):



Yellow solid, MP 66-67 °C; Yield 81 %; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.80 (3H, s), 4.14 (2H, s), 6.93-7.17 (4H, m), 7.20-7.48 (3H, m), 7.73-7.77 (2H, m); **^{13}C NMR** in $CDCl_3$ (50 MHz) δ: 26.4 (CH_3), 44.1 (CH_2, d, *J* = 1.5 Hz), 113.2 (CH), 114.1 (CH, d, *J* = 20.9 Hz), 114.4 (CH, d, *J* = 15.5 Hz), 116.37 (CH, d, *J* = 21.2 Hz), 117.8 (CH, d, *J* = 21.2 Hz), 123.0 (CH, d, *J* = 3.0 Hz), 125.1 (CH, d, *J* = 3.0 Hz), 130.5 (CH), 130.6 (CH, d, *J* = 15.0 Hz), 139.5 (C, d, *J* = 7.5 Hz), 140.2 (C, d, *J* = 7.0 Hz), 163.2 (CF, d, *J* = 245.0 Hz), 163.4 (C), 163.5 (CF, d, *J* = 245.0 Hz), 168.6 (C), 169.5 (C); **^{19}F NMR** (CDCl3, 376 MHz) δ: -112.2, -112.7; **HRMS** (ESI) calculated for $C_{18}H_{15}F_2N_2$ $[M + H]^+$: 297.1198; found: 297.1187.

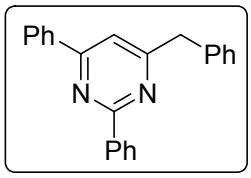
4-(4-fluorobenzyl)-6-(4-fluorophenyl)-2-methylpyrimidine(2f):



Yellow solid; MP 52-53 °C; Yield 75 %; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.78 (3H, s), 4.10 (2H, s), 6.98-7.30 (7H, m), 7.96-8.03 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 26.4 (CH_3), 43.7 (CH_2), 112.7 (CH), 115.8 (2 x CH, d, *J* = 21.0 Hz), 116.1 (2 x CH, d, *J* = 21.5 Hz), 129.4 (2 x CH, d, *J* = 9.0 Hz), 130.9 (2 x CH, d, *J* = 8.0 Hz), 133.4 (C, d, *J* = 3.0 Hz), 133.6 (C, d, *J* = 3.0 Hz), 162.0 (CF, d, *J* = 244.0 Hz), 163.5 (C), 164.7 (CF, d, *J* = 249.0 Hz), 168.4 (C), 169.8 (C); **^{19}F NMR** (CDCl3, 376 MHz) δ:

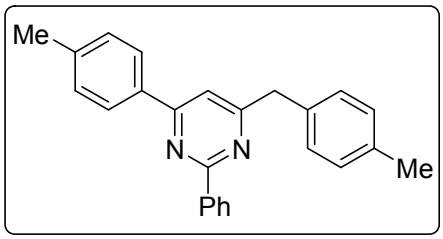
-109.9, -115.9; **HRMS** (ESI) calculated for $C_{18}H_{15}F_2N_2$ $[M + H]^+$: 297.1198; found: 297.1188.

4-benzyl-2,6-diphenylpyrimidine (2g):



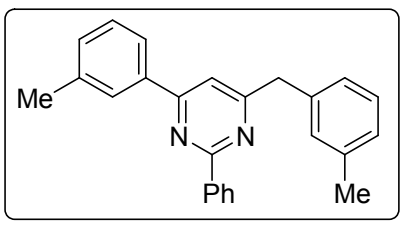
Yellow liquid; Yield 63%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 4.25 (2H, s), 7.30-7.38 (6H, m), 7.48-7.57 (6H, m), 8.12-8.17 (2H, m), 8.60-8.67 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 44.7 (CH_2), 113.8 (CH), 127.0 (CH), 127.5 (2 x CH), 128.7 (4 x CH), 128.9 (2 x CH), 129.0 (2 x CH), 129.6 (2 x CH), 130.8 (CH), 130.9 (CH), 137.5 (C), 138.2 (2 x C), 164.5 (2 x C), 170.2 (C); **HRMS** (ESI) calculated for $C_{23}H_{19}N_2$ $[M + H]^+$: 323.1543; found: 323.1536.

4-(4-methylbenzyl)-2-phenyl-6-*p*-tolylpyrimidine (2h):



Yellow liquid; Yield 60%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.35 (3H, s), 2.42 (3H, s), 4.19 (2H, s), 7.14-7.18 (1H, m), 7.27-7.35 (4H, m), 7.49-7.52 (5H, m), 8.05 (2H, d, *J* = 8.2 Hz), 8.59-8.68 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.3 (CH_3), 21.6 (CH_3), 44.4 (CH_2), 113.4 (CH), 127.4 (2 x CH), 128.6 (4 x CH), 129.4 (2 x CH), 129.6 (2 x CH), 129.7 (2 x CH), 130.7 (CH), 134.7 (C), 135.2 (C), 136.5 (C), 138.4 (C), 141.2 (C), 164.3 (C), 164.4 (C), 170.3 (C); **HRMS** (ESI) calculated for $C_{25}H_{23}N_2$ $[M + H]^+$: 351.1856; found: 351.1853.

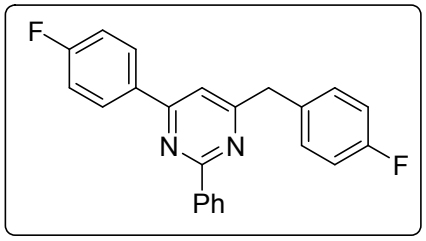
4-(3-methylbenzyl)-2-phenyl-6-*m*-tolylpyrimidine (2i):



Yellow liquid; Yield 61%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.35 (3H, s), 2.46 (3H, s), 4.23 (2H, s), 7.07-7.22 (3H, m), 7.29-7.42 (3H, m), 7.50-7.62 (4H, m), 7.89-7.98 (2H, m), 8.60-8.68 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.6 (CH_3), 21.8 (CH_3), 44.6 (CH_2), 114.0

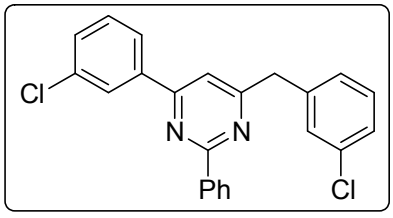
(CH), 124.7 (CH), 126.6 (CH), 127.8 (CH), 128.1 (CH), 128.7 (2 x CH), 128.8 (2 x CH), 128.9 (CH), 129.1 (CH), 130.3 (CH), 130.8 (CH), 131.8 (CH), 133.0 (C), 137.4 (C), 138.1 (C), 138.6 (C), 138.8 (C), 164.3 (C), 164.7 (C), 170.2 (C); **HRMS** (ESI) calculated for $C_{25}H_{23}N_2$ $[M + H]^+$: 351.1856; found: 351.1852.

4-(4-fluorobenzyl)-6-(4-fluorophenyl)-2-phenylpyrimidine (2j):



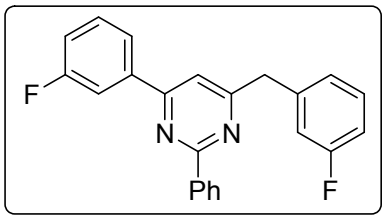
Yellow solid; MP 58-59 °C; Yield 82%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 4.20 (2H, s), 7.03-7.24 (4H, m), 7.31-7.40 (3H, m), 7.53-7.56 (3H, m), 8.13-8.23 (2H, m), 8.60-8.71 (2H, m); **^{13}C NMR** in $CDCl_3$ (50 MHz) δ: 43.8 (CH_2), 113.1 (CH), 115.7 (2 x CH, d, *J* = 21.5 Hz), 116.0 (2 x CH, d, J = 21.5 Hz), 128.6 (2 x CH), 128.7 (2 x CH), 129.4 (2 x CH, d, *J* = 9.0 Hz), 130.9 (CH), 131.0 (2 x CH, d, *J* = 8.5 Hz), 133.4 (C, d, *J* = 3.0 Hz), 133.8 (C, d, *J* = 3.5 Hz), 138.0 (C), 162.0 (CF, d, *J* = 245.0 Hz), 163.3 (C), 164.5(C), 164.7 (CF, d, *J* = 249.5 Hz), 170.1 (C); **^{19}F NMR** (CDCl3, 376 MHz) δ: -110.7, -116.9; **IR** (KBr): 3067, 3037, 2959, 2929, 1579, 1539 cm^{-1}; **HRMS** (ESI) calculated for $C_{23}H_{17}F_2N_2$ $[M + H]^+$: 359.1354 ; found: 359.1348.

4-(3-chlorobenzyl)-6-(3-chlorophenyl)-2-phenylpyrimidine (2k):



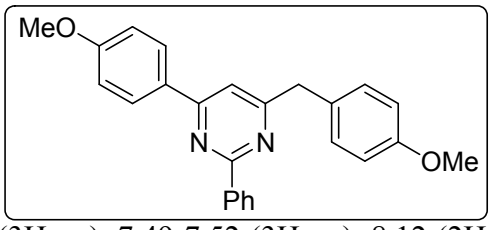
Yellow solid, MP 62-64 °C; Yield 80%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 4.25 (2H, s), 7.30-7.32 (3H, m), 7.39-7.64 (7H, m), 8.02-8.07 (1H, m), 8.22 (1H, d, *J* = 1.8 Hz), 8.63-8.67 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 44.3 (CH_2), 113.8 (CH), 125.5 (CH), 127.3 (CH), 127.6 (CH), 127.7 (CH), 128.7 (2 x CH), 128.8 (2 x CH), 129.6 (CH), 130.2 (CH), 130.3 (CH), 131.0 (CH), 131.1 (CH), 134.7 (C), 135.3 (C), 137.8 (C), 139.1 (C), 140.0 (C), 163.2 (C), 164.7 (C), 169.7 (C). **IR** (KBr): 3066, 3037, 2959, 2934, 1567, 1536 cm^{-1}; **HRMS** (ESI) calculated for $C_{23}H_{17}Cl_2N_2$ $[M + H]^+$: 391.0763; found: 391.0758.

4-(3-fluorobenzyl)-6-(3-fluorophenyl)-2-phenylpyrimidine (2l):



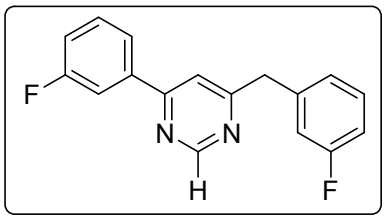
Yellow solid; MP 62-63 °C; Yield 88 %; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 4.23 (2H, s), 6.97-7.01 (1H, m), 7.11-7.26 (3H, m), 7.29-7.40 (2H, m), 7.45-7.57 (4H, m), 7.89-7.98 (2H, m), 8.63-8.68 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ : 44.3 (CH_2, d, *J* = 1.5 Hz), 113.66 (CH), 114.0 (CH, d, *J* = 20.7 Hz), 114.3 (CH, d, *J* = 22.8 Hz), 116.4 (CH, d, *J* = 21.0 Hz), 117.8 (CH, d, *J* = 21.5 Hz), 122.9 (CH, d, *J* = 2.7 Hz), 125.1 (CH, d, *J* = 2.8 Hz), 128.6 (2 x CH), 128.7 (2 x CH), 130.4 (CH), 130.5 (CH, d, *J* = 15.5 Hz), 130.9 (CH), 137.9 (C), 139.6 (C, d, *J* = 7.5 Hz), 140.4 (C, d, *J* = 7.0 Hz), 163.1 (C, d, *J* = 2.5 Hz), 163.2 (CF, d, *J* = 244.5 Hz), 163.4 (CF, d, *J* = 244.5 Hz), 164.6 (C), 169.7 (C); **IR** (KBr): 3061, 3031, 2965, 2935, 1570, 1542 cm^{-1}; **HRMS** (ESI) calculated for $C_{23}H_{17}F_2N_2$ $[M + H]^+$: 359.1354 ; found: 359.1346.

4-(4-methoxybenzyl)-6-(4-methoxyphenyl)-2-phenylpyrimidine (2m):



Semi solid; Yield 46%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 3.81 (3H, s), 3.88 (3H, s), 4.18 (2H, s), 6.89 (2H, d, *J* = 8.6 Hz), 7.00 (2H, d, *J* = 8.8 Hz), 7.27-7.32 (3H, m), 7.49-7.52 (3H, m), 8.12 (2H, d, *J* = 8.8 Hz), 8.58-8.63 (2H, m); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 43.7 (CH_2), 55.5 (CH_3), 55.6 (CH_3), 112.8 (CH), 114.4 (4 x CH), 128.7 (4 x CH), 129.0 (2 x CH), 129.8 (C), 130.3 (C), 130.6 (2 x CH), 130.7 (CH), 138.2 (C), 158.7 (C), 162.1 (C), 164.0 (C), 164.2 (C), 170.3 (C); **HRMS** (ESI) calculated for $C_{25}H_{23}N_2O_2$ $[M + H]^+$: 383.1754; found: 383.1751.

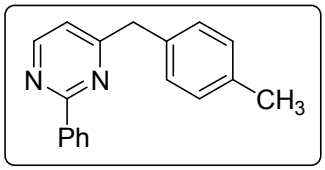
4-(3-fluorobenzyl)-6-(3-fluorophenyl)pyrimidine (2n):



Yellow liquid; Yield 62 %; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 4.17 (2H, s), 6.93-7.24 (4H, m), 7.29-7.51 (3H, s), 7.74-7.80

(2H, m), 9.20 (1H, d, J = 1.2 Hz); **^{13}C NMR** in $CDCl_3$ (50 MHz) δ : 44.2 (CH_2), 114.1 (CH, d, J = 5.5 Hz), 114.5 (CH, d, J = 7.5 Hz), 116.3 (CH),116.4 (CH, d, J = 21.5 Hz), 118.1 (CH, d, J = 21.0 Hz), 122.9 (CH, d, J = 3.0 Hz), 125.1 (CH, d, J = 3.0 Hz), 130.6 (CH), 130.7 (CH, d, J = 17.0 Hz), 139.1 (C, d, J = 7.5 Hz), 140.0 (C, d, J = 7.5 Hz), 159.2 (CH), 163.2 (CF, d, J = 245.0 Hz), 163.3 (C, d, J = 3.0 Hz), 163.5 (CF, d, J = 245.0 Hz), 169.6 (C); **^{19}F NMR** (CDCl3, 376 MHz) δ: -113.0, -113.5; **HRMS** (ESI) calculated for $C_{17}H_{13}F_2N_2$ $[M + H]^+$: 283.1041 ; found: 283.1048.

4-(4-methylbenzyl)-2-phenylpyrimidine (2o):

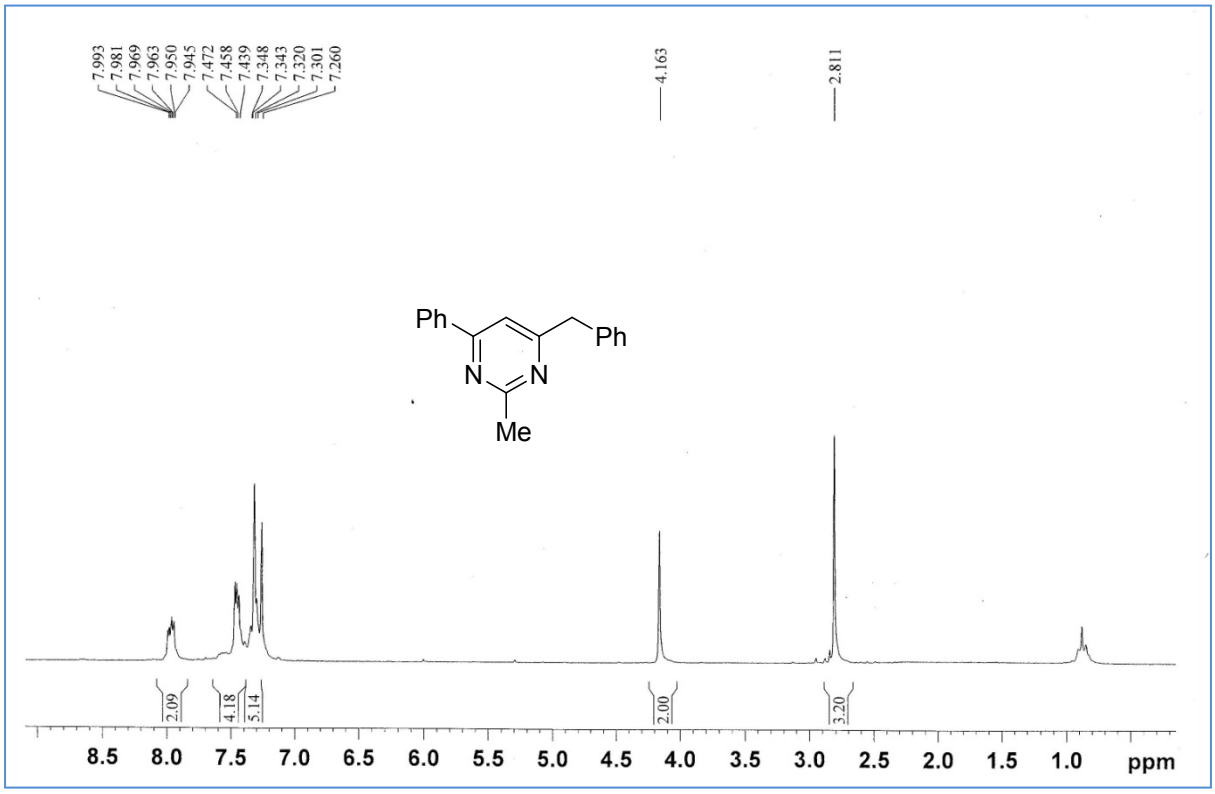


Yellow liquid; Yield 76%; **^{1}H NMR** ($CDCl_3$, 200 MHz) δ: 2.36 (3H, s), 4.15 (2H, s), 6.94 (1H, d, J = 5.0 Hz), 7.14-7.26 (4H, m), 7.49-7.53 (3H, m), 8.49-8.53 (2H, m), 8.64 (1H, d, J = 5.0 Hz); **^{13}C NMR** ($CDCl_3$, 50 MHz) δ: 21.2 (CH_3), 44.2 (CH_2), 118.2 (CH), 128.4 (2 x CH), 128.7 (2 x CH), 129.4 (2 x CH), 129.6 (2 x CH), 130.7 (CH), 134.8 (C), 136.6 (C), 138.0 (C), 157.4 (CH), 164.5 (C), 170.0 (C). **HRMS** (ESI) calculated for $C_{18}H_{17}N_2$ $[M + H]^+$: 261.1386; found: 261.1378.

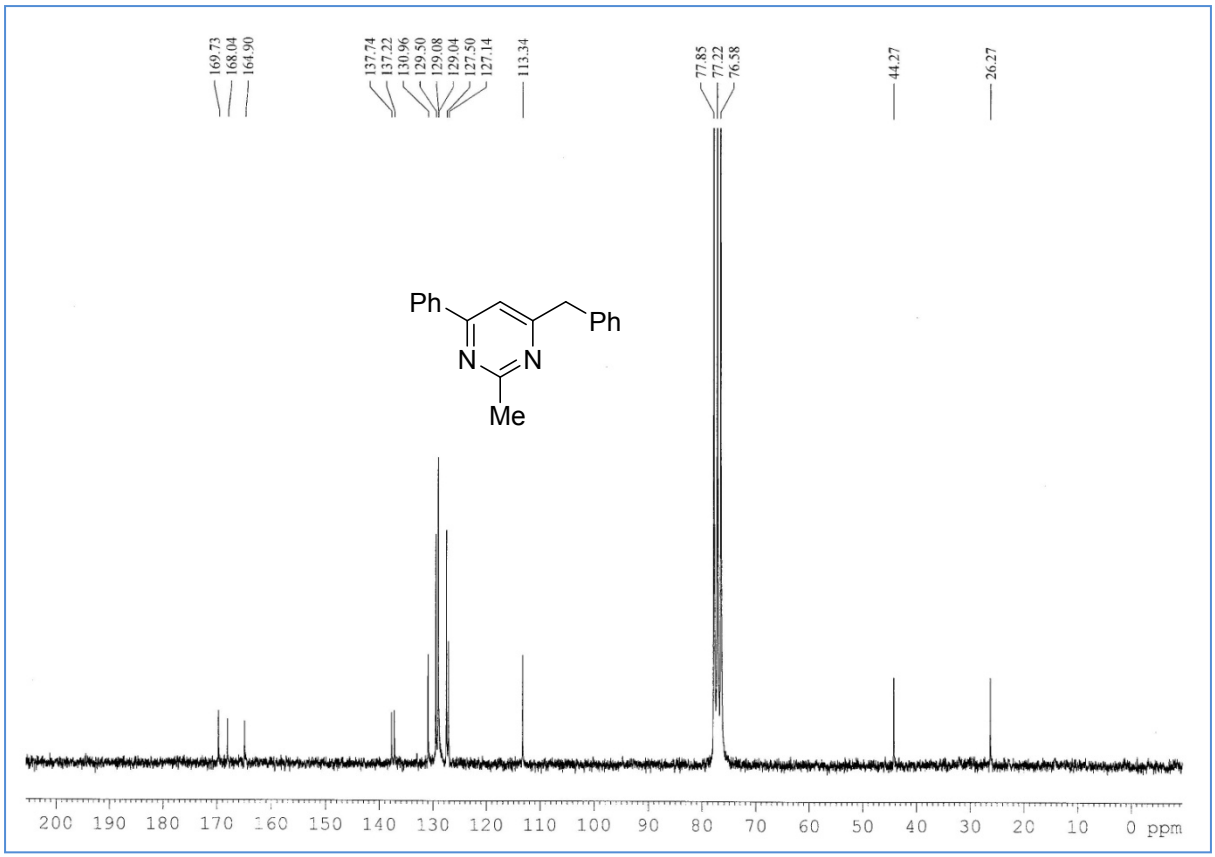
References:

1. S. Zhang, X. Liu and T. Wang, *Adv. Synth. Catal.* 2011, **353**, 1463.
2. Z. Chen, H. Jiang, A. Wang and S. Yang, *J. Org. Chem.* 2010, **75**, 6700.
3. X. Ruian, Y. Ruiya, C. Mingzhong, *Eurr. J. Org. Chem.* 2012, **22**, 4178.
4. Y. X. Xue, Y. Y. Zhu, L. M. Gao, X. Y. He, N. Liu, W. Y. Zhang, J. Yin, Y. Ding, H. Zhou, and Z. Q. Wu, *J. Am. Chem. Soc.*, 2014, **136**, 4706.

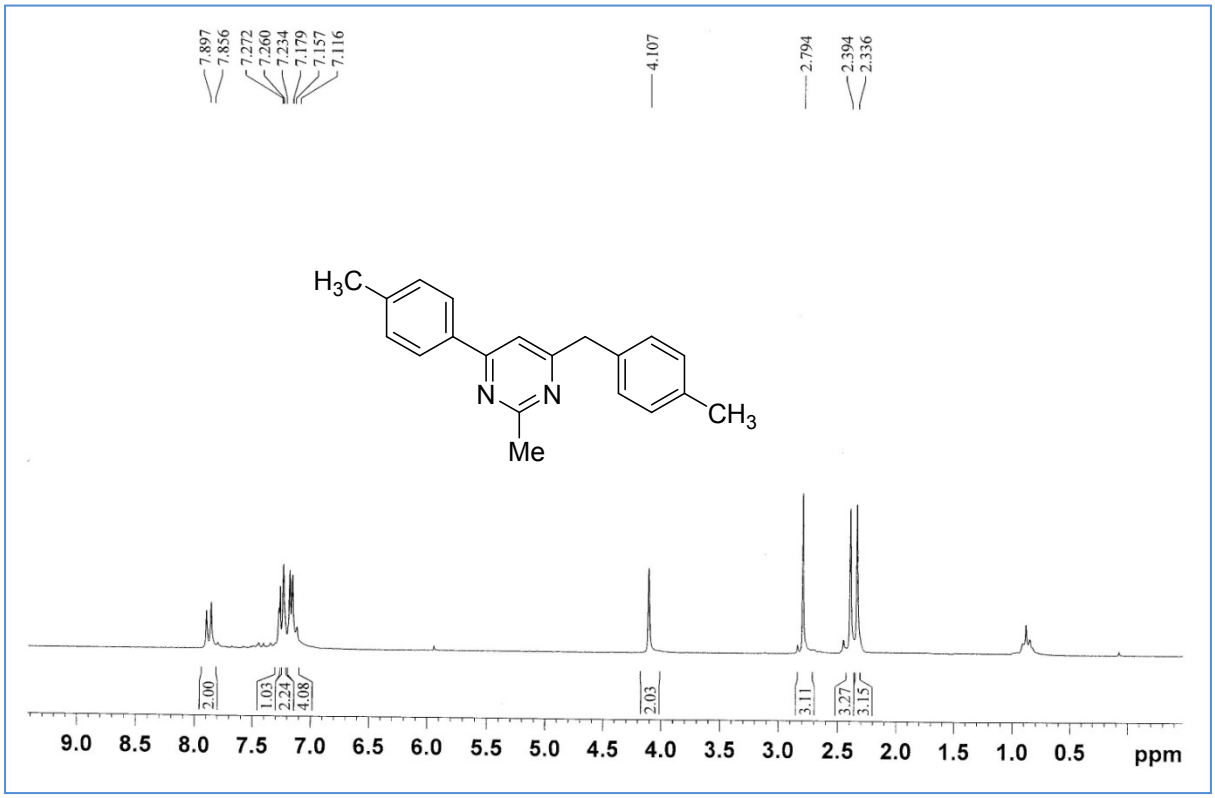
[1]H NMR of compound 2a



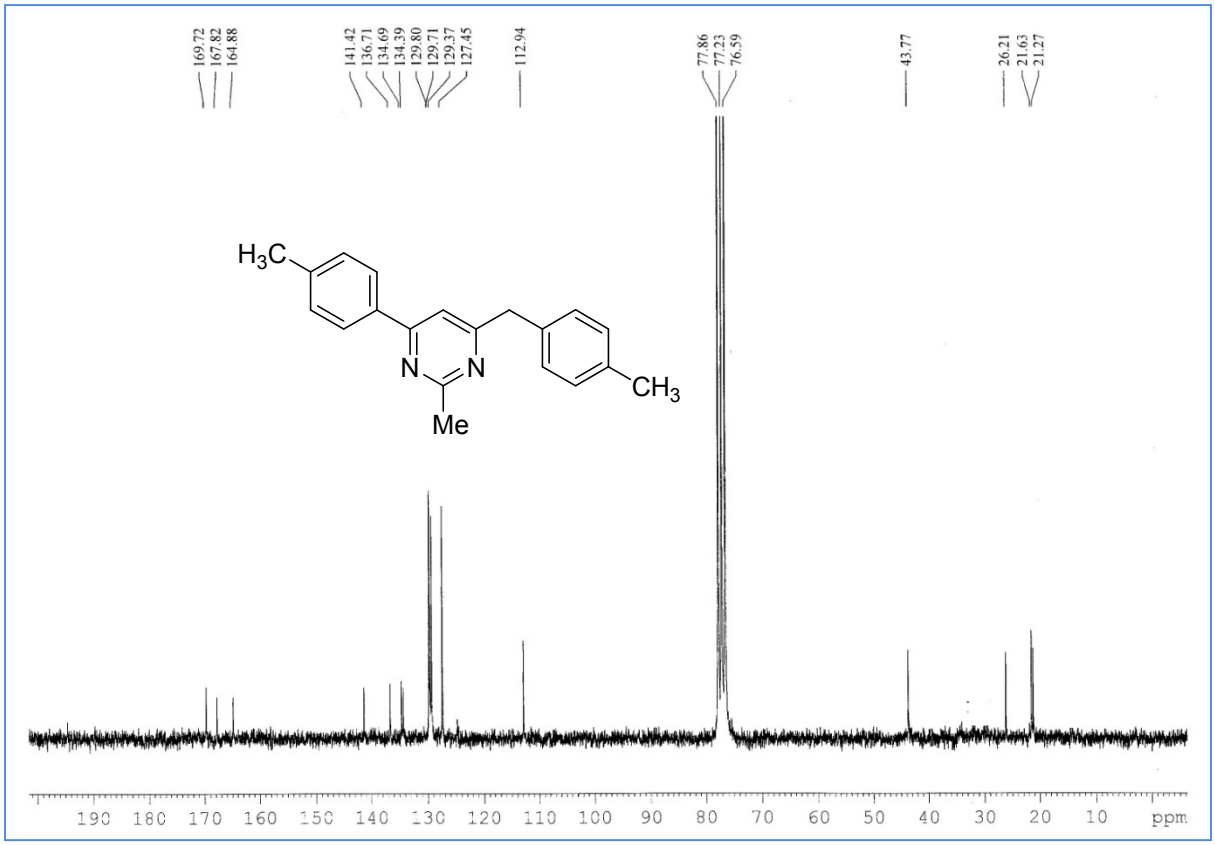
[13]C NMR of compound 2a



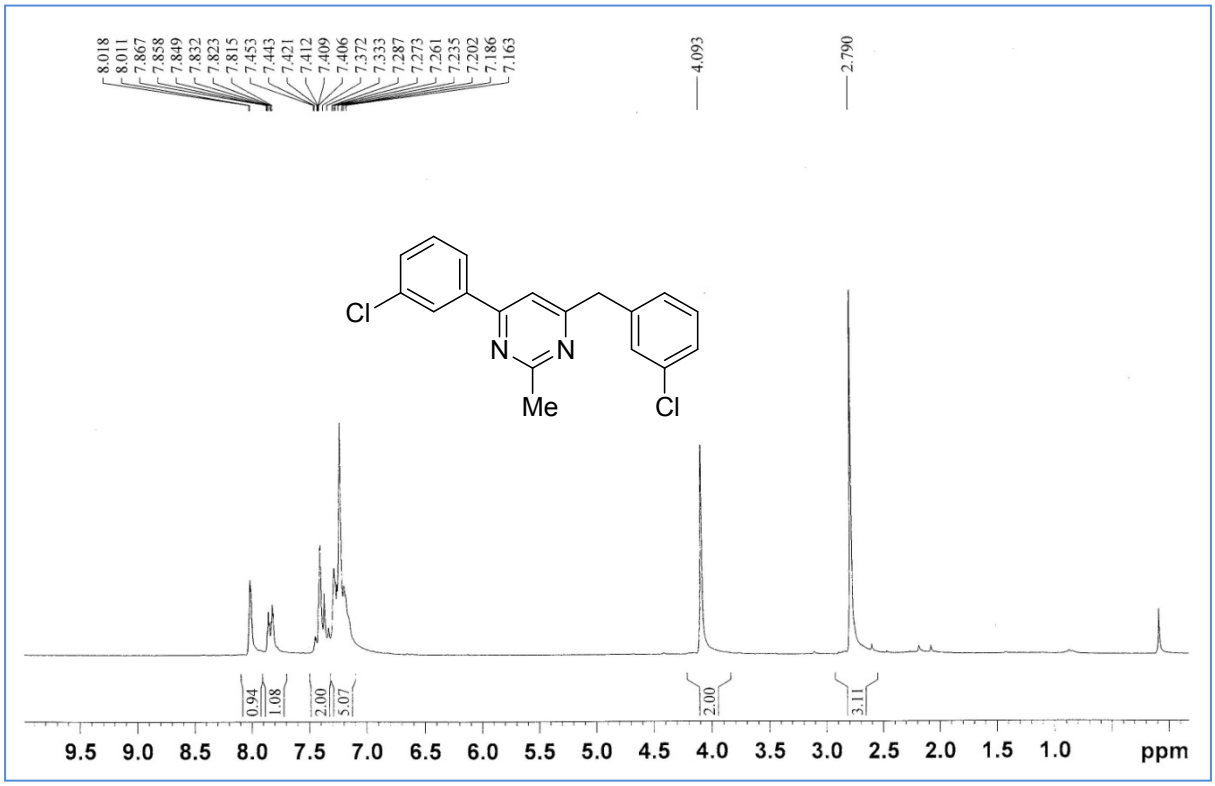
^{1}H NMR of compound 2b



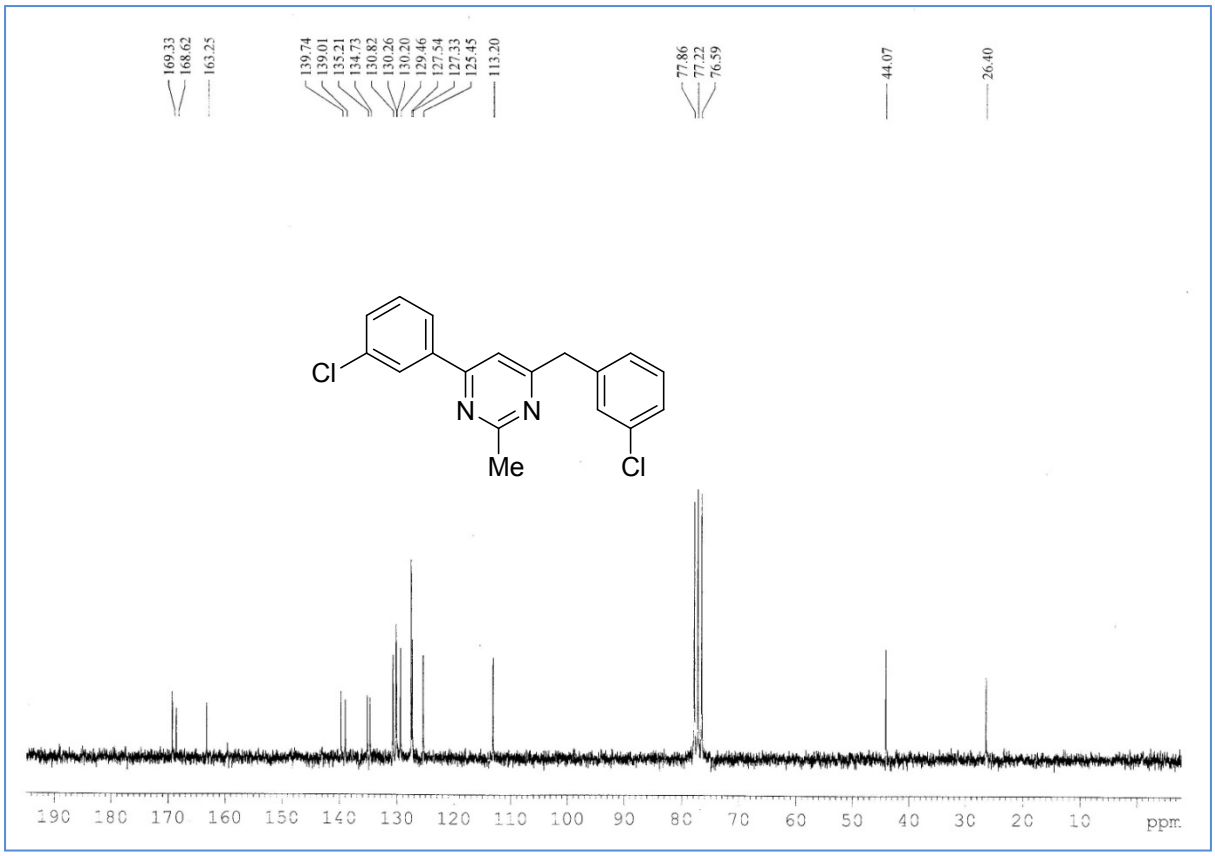
^{13}C NMR of compound 2b



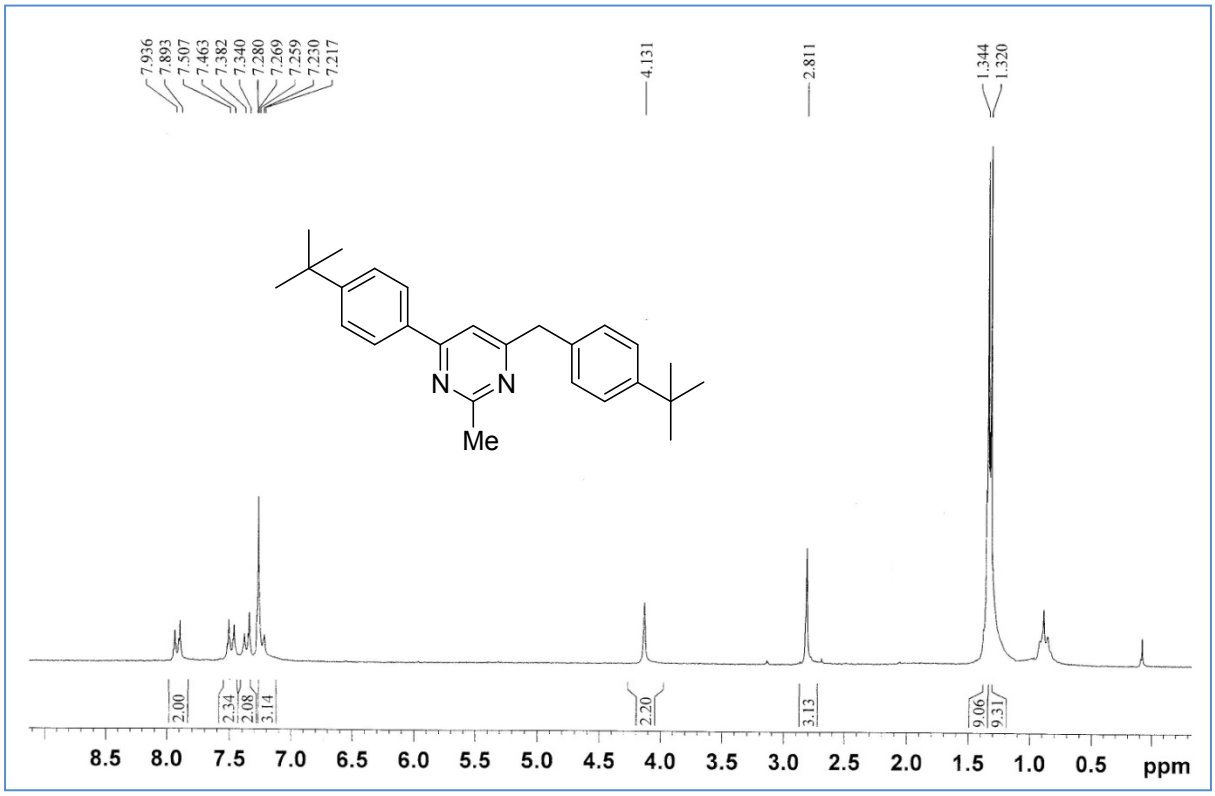
[1]H NMR of compound 2c



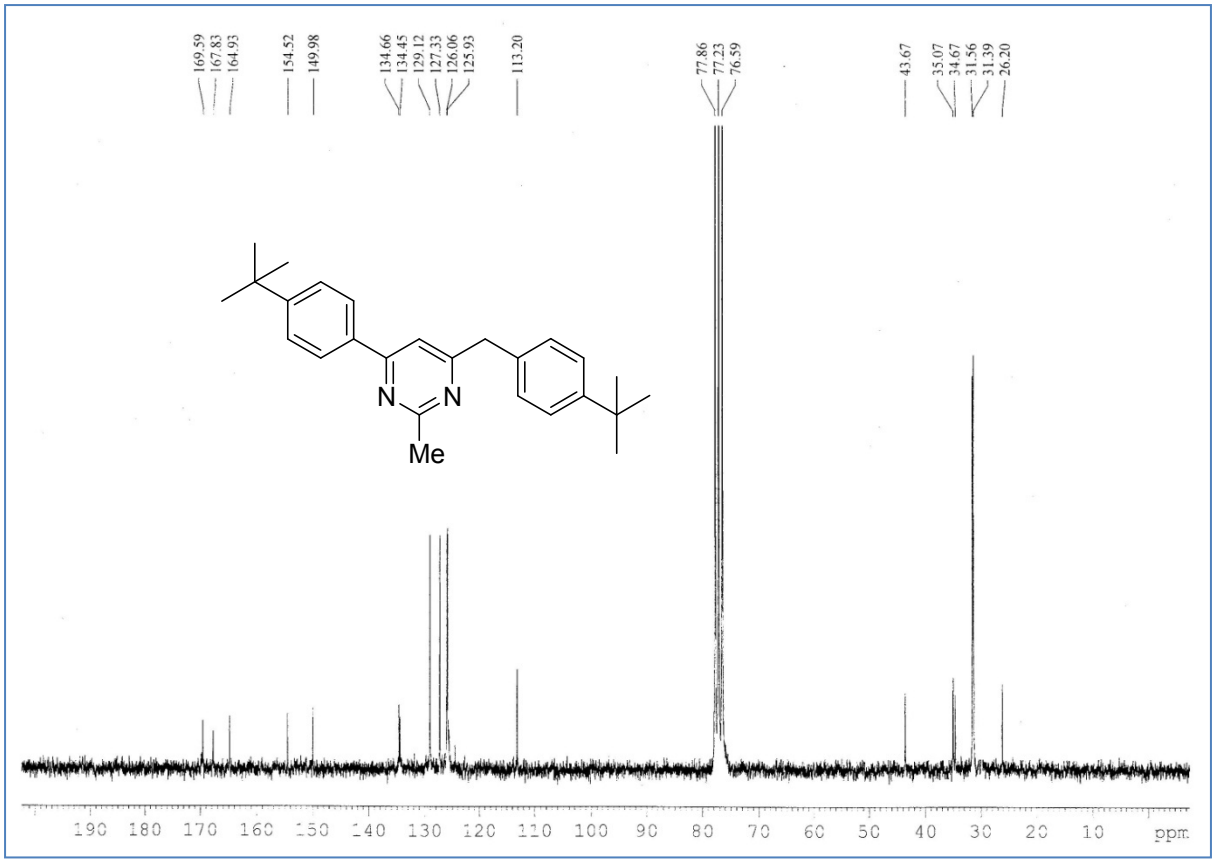
[13]C NMR of compound 2c



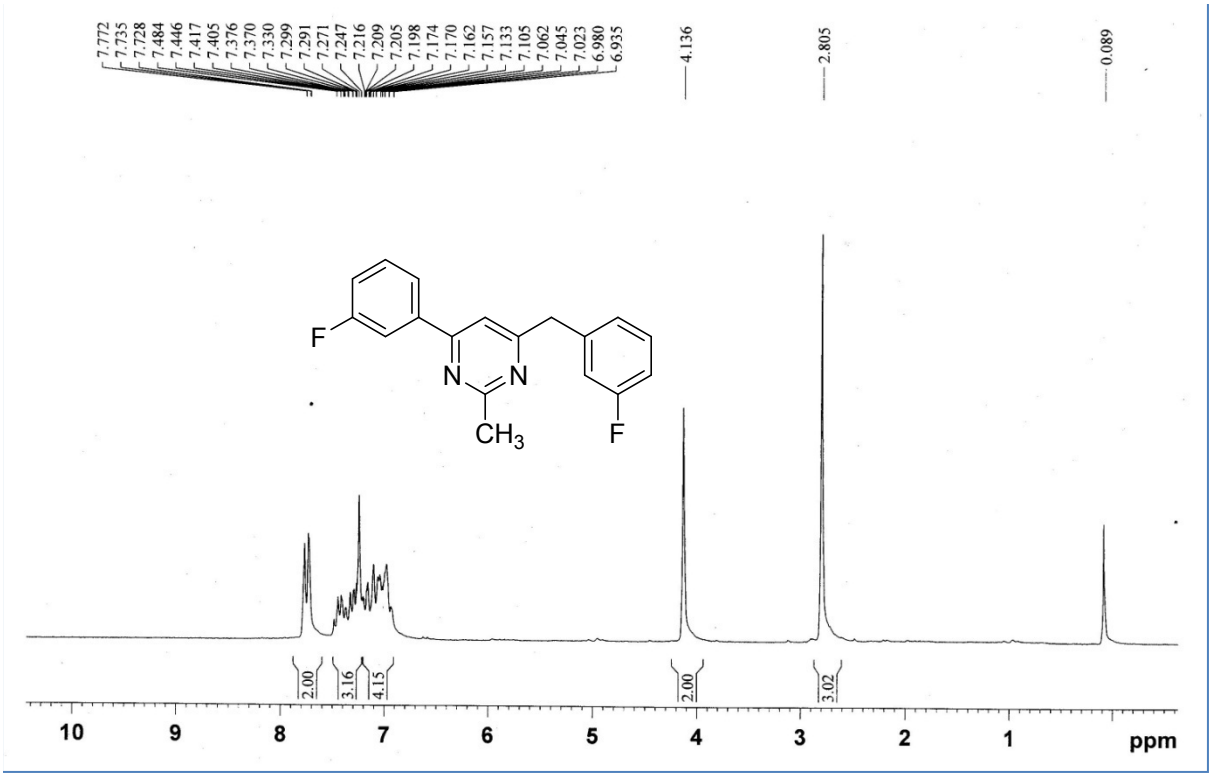
[1]H NMR of compound 2d



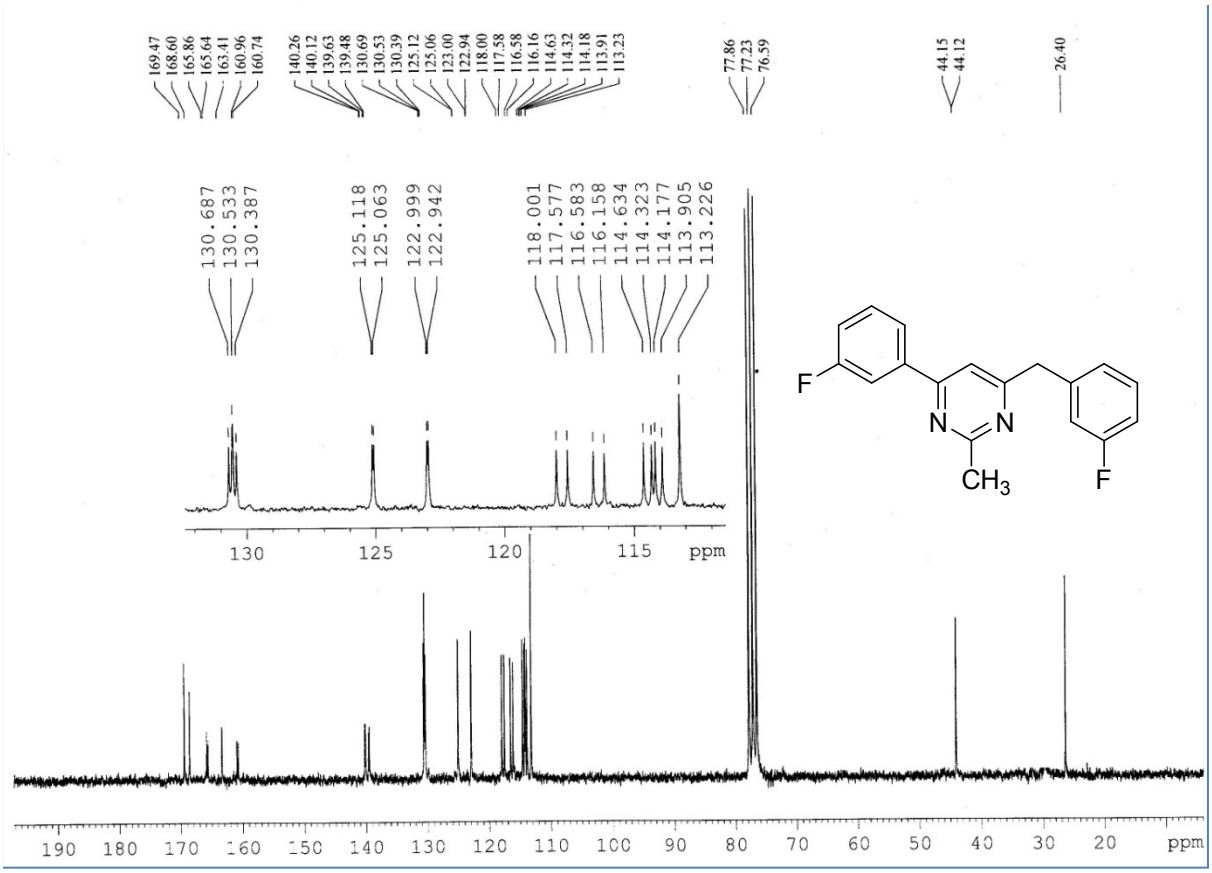
[13]C NMR of compound 2d



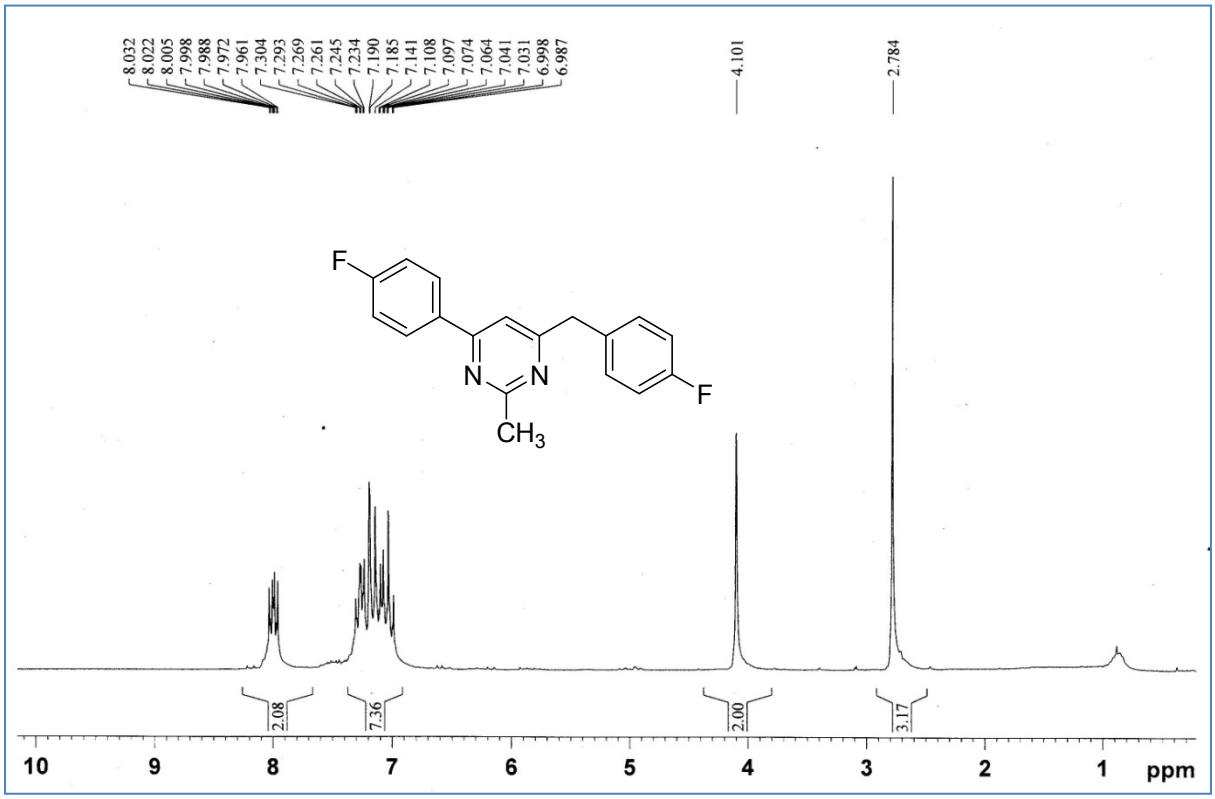
^{1}H NMR of compound 2e



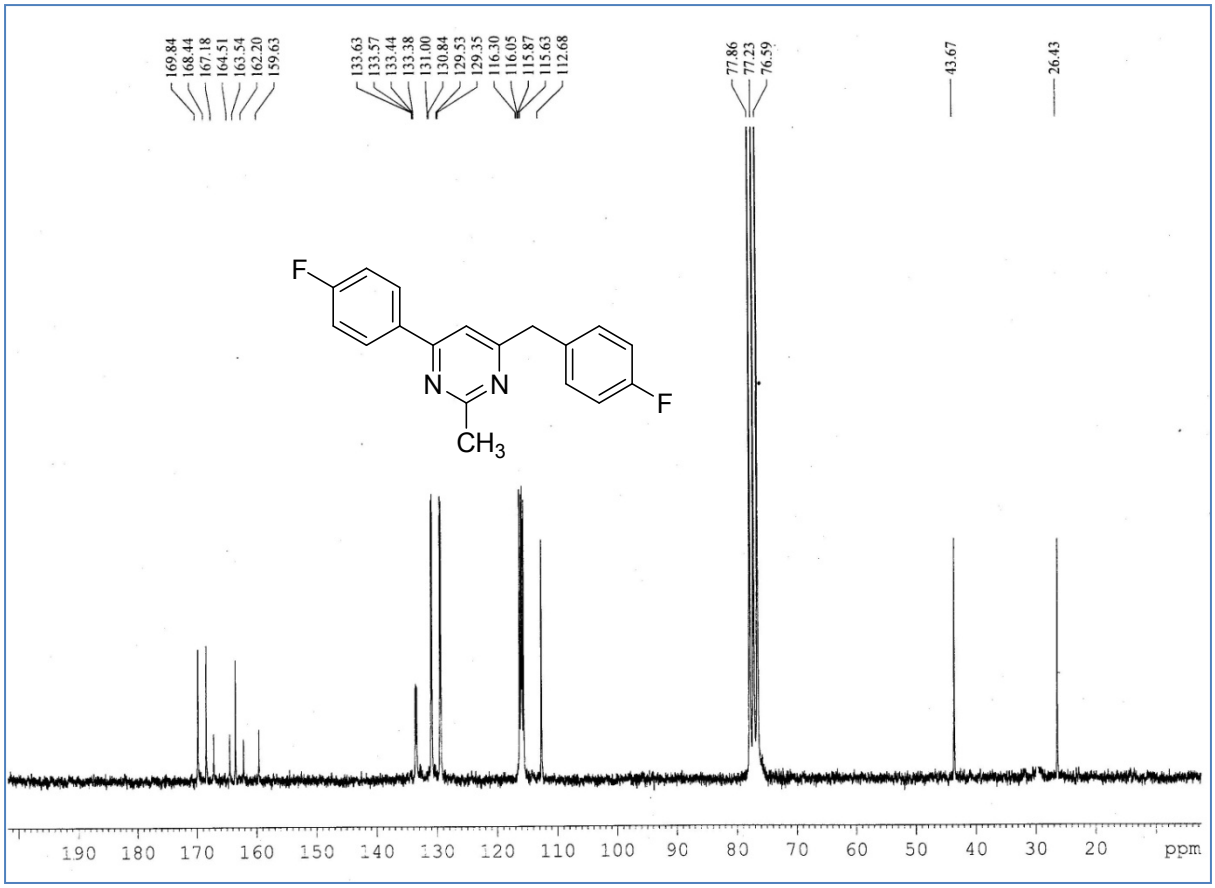
^{13}C NMR of compound 2e



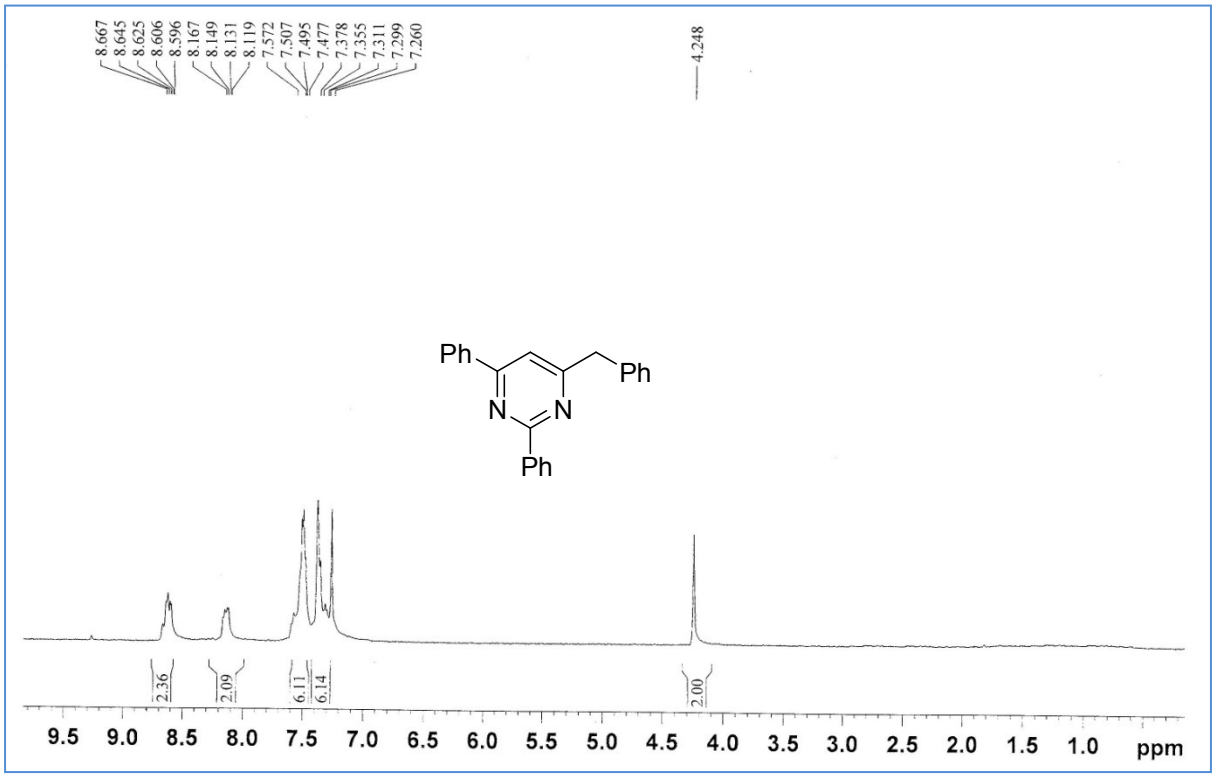
^{1}H NMR of compound 2f



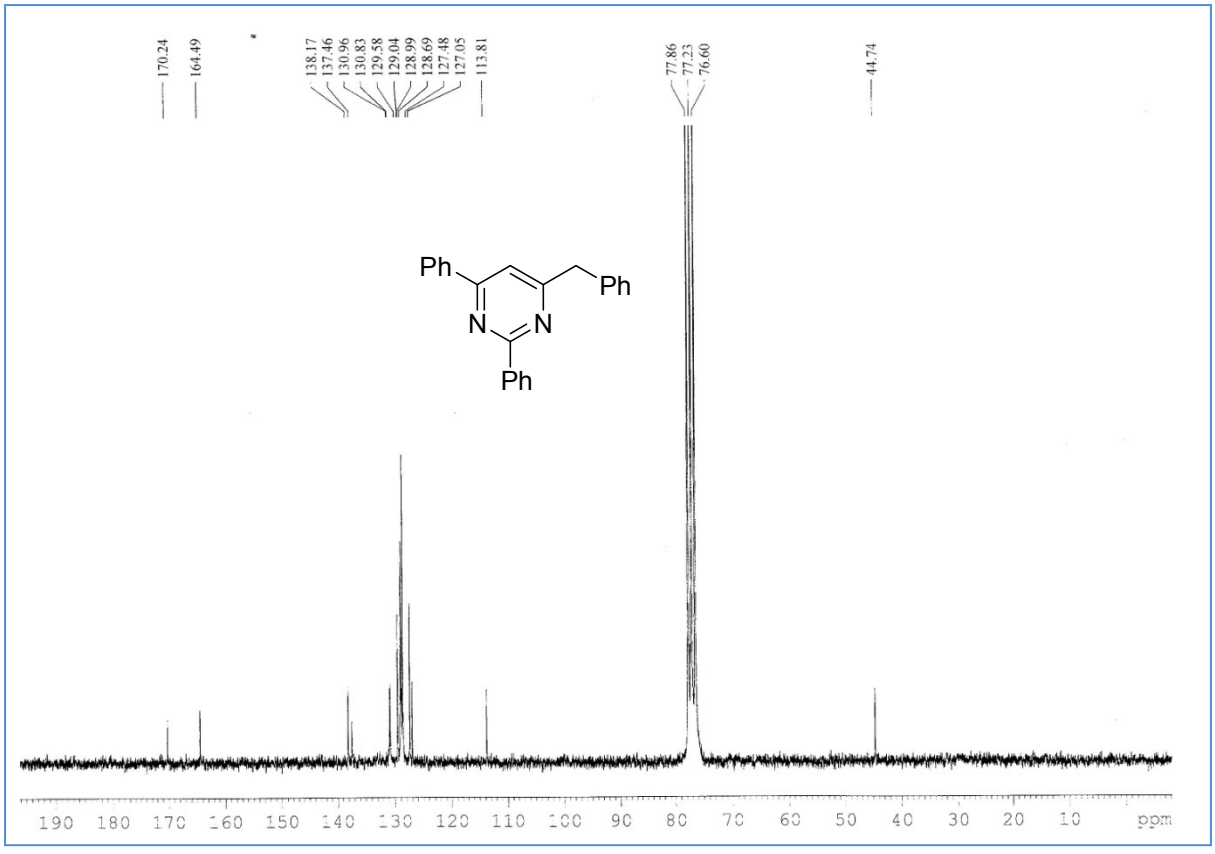
^{13}C NMR of compound 2f



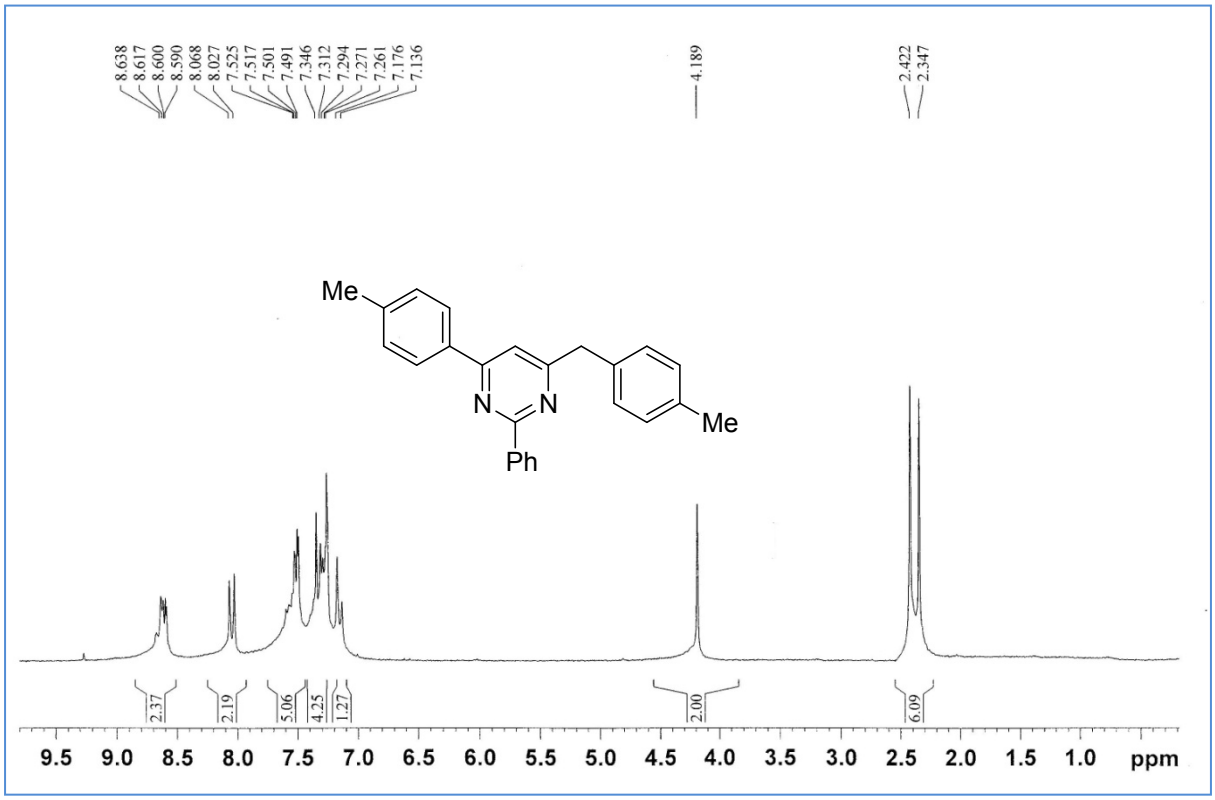
^{1}H NMR of compound 2g



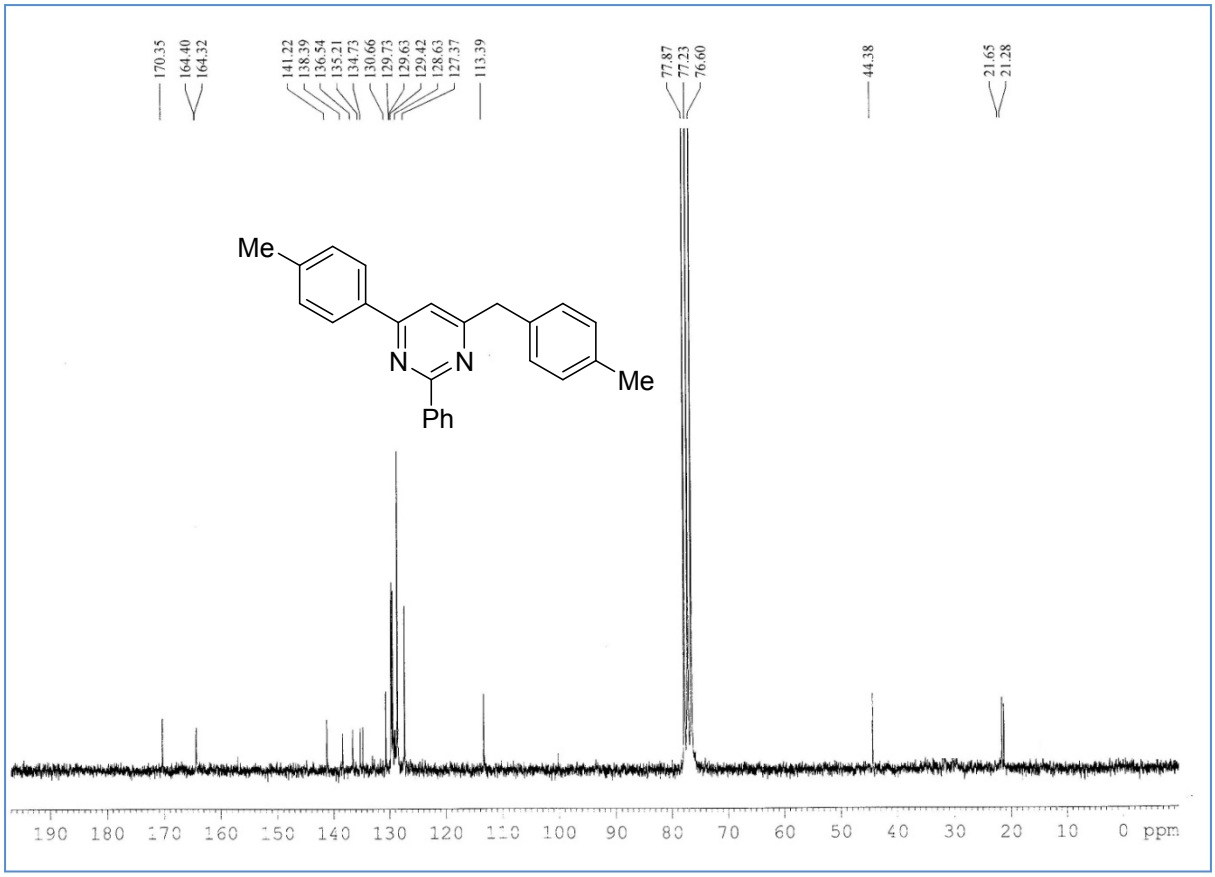
^{13}C NMR of compound 2g



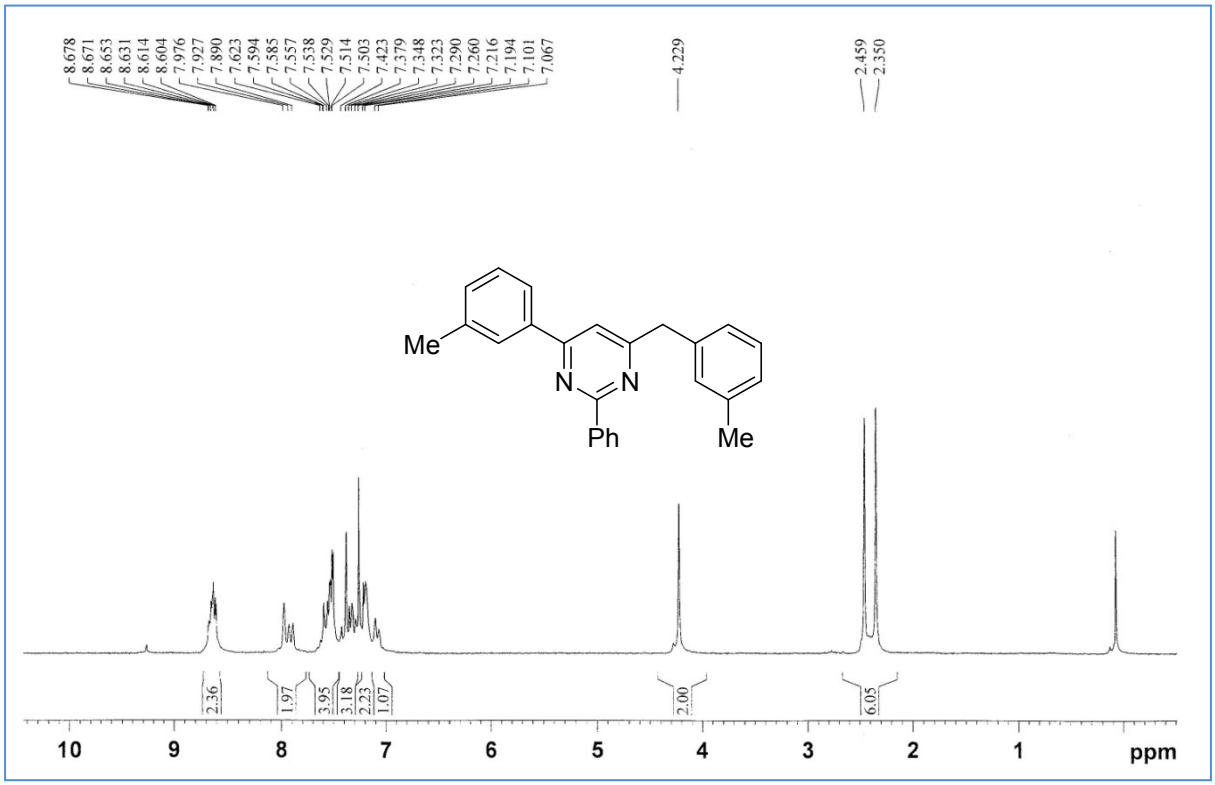
[1]H NMR of compound 2h



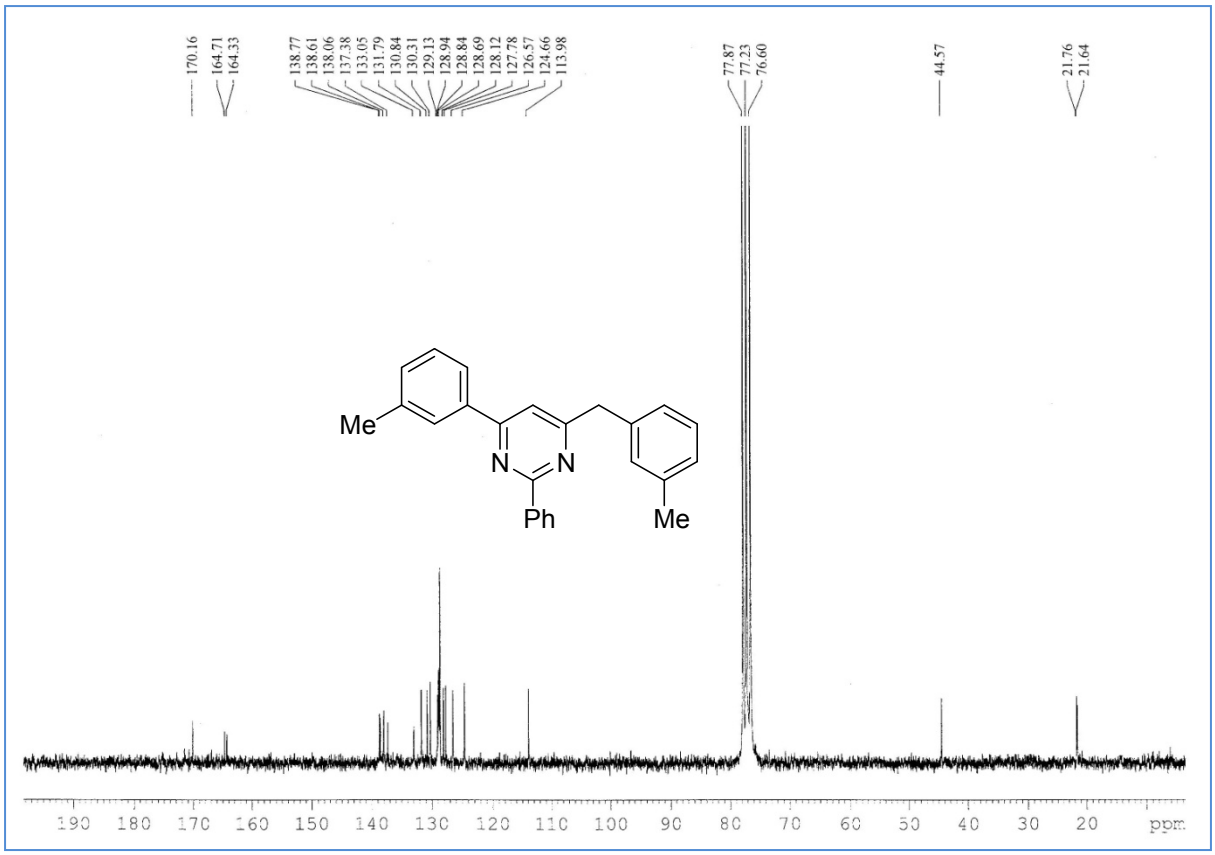
[13]C NMR of compound 2h



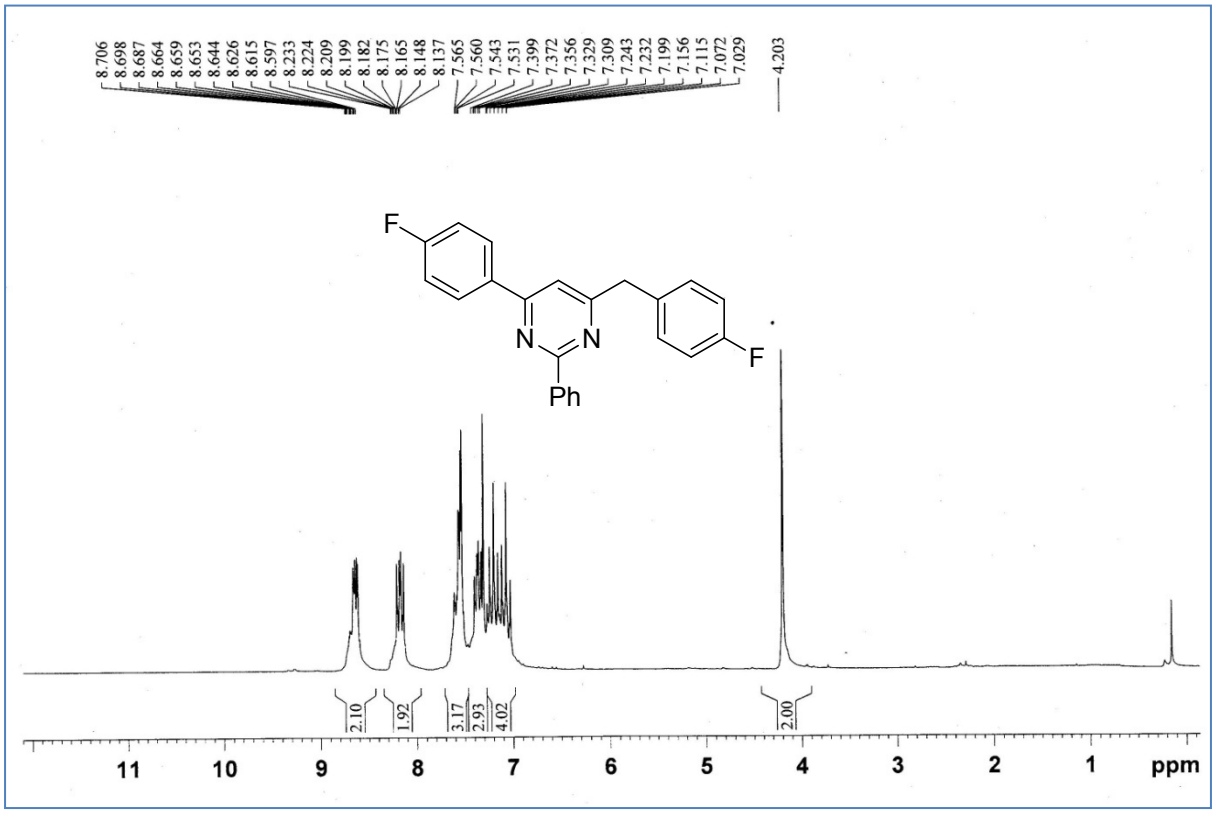
^{1}H NMR of compound 2i



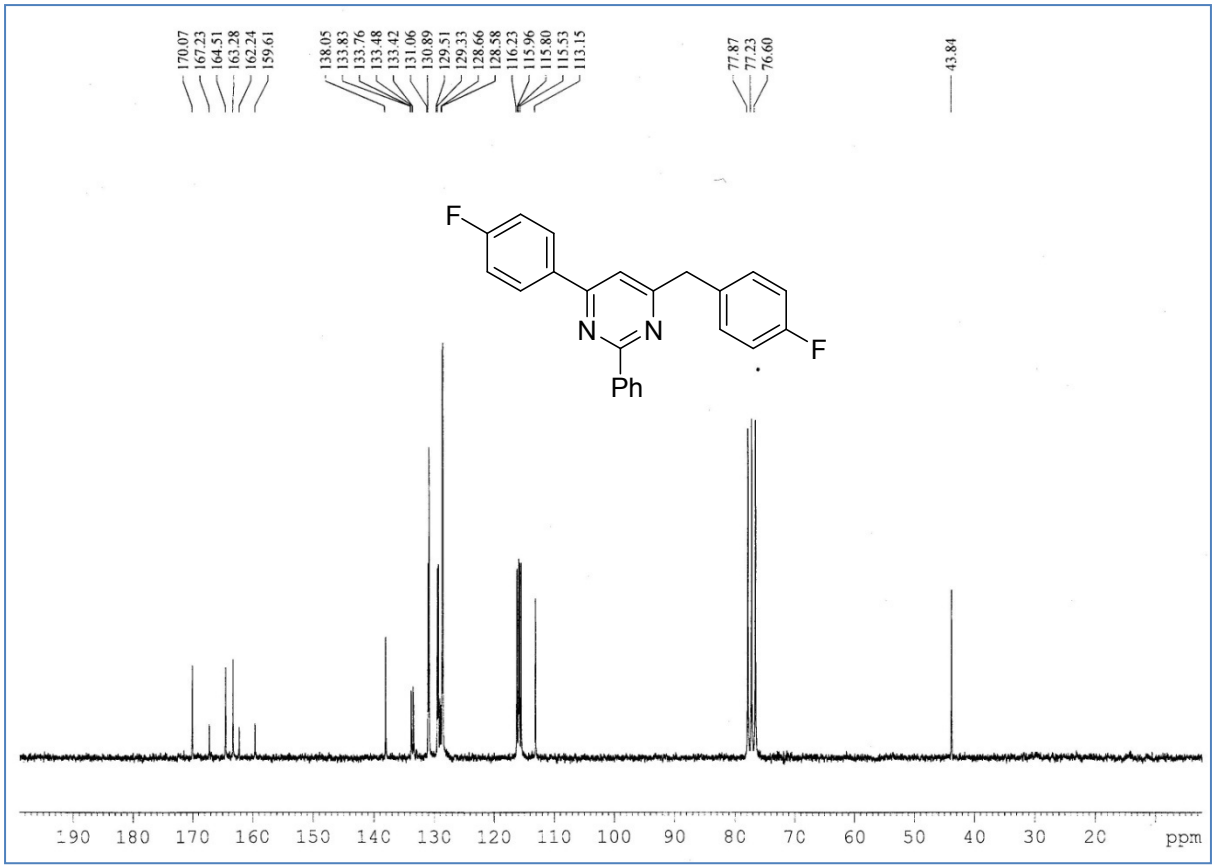
^{13}C NMR of compound 2i



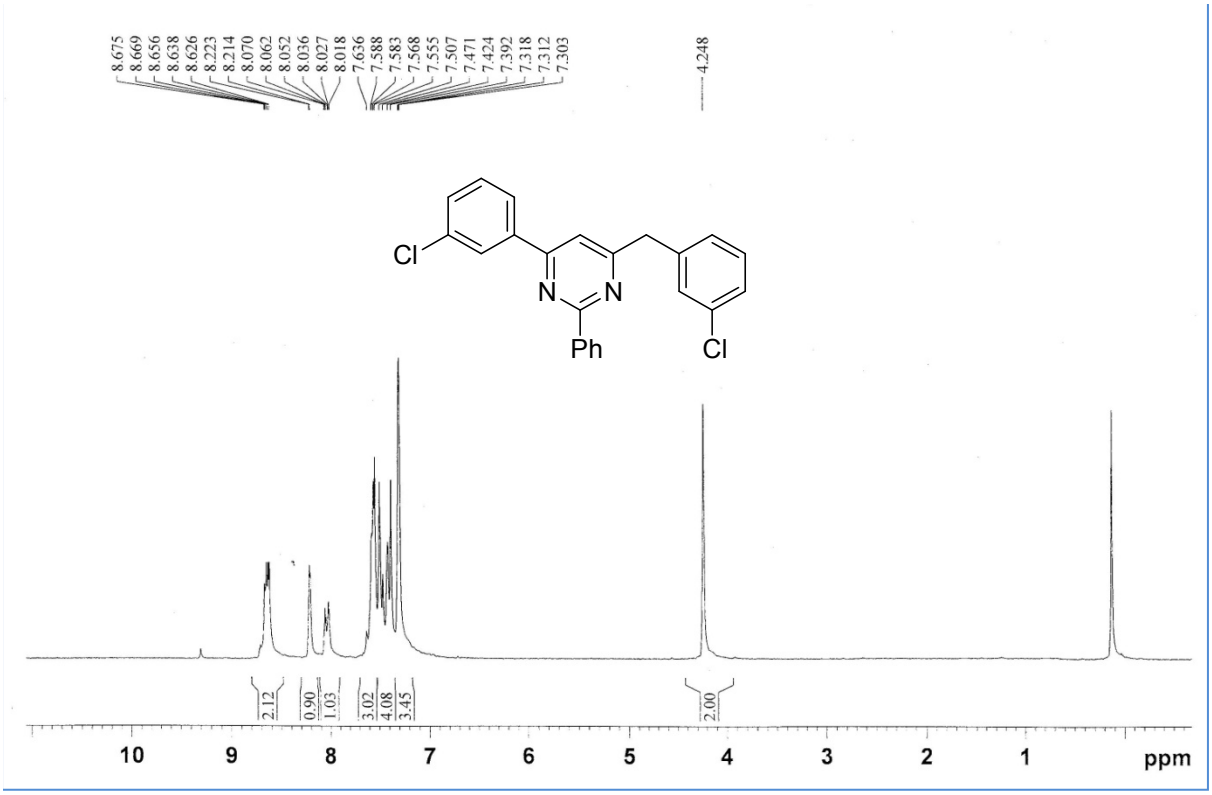
^{1}H NMR of compound 2j



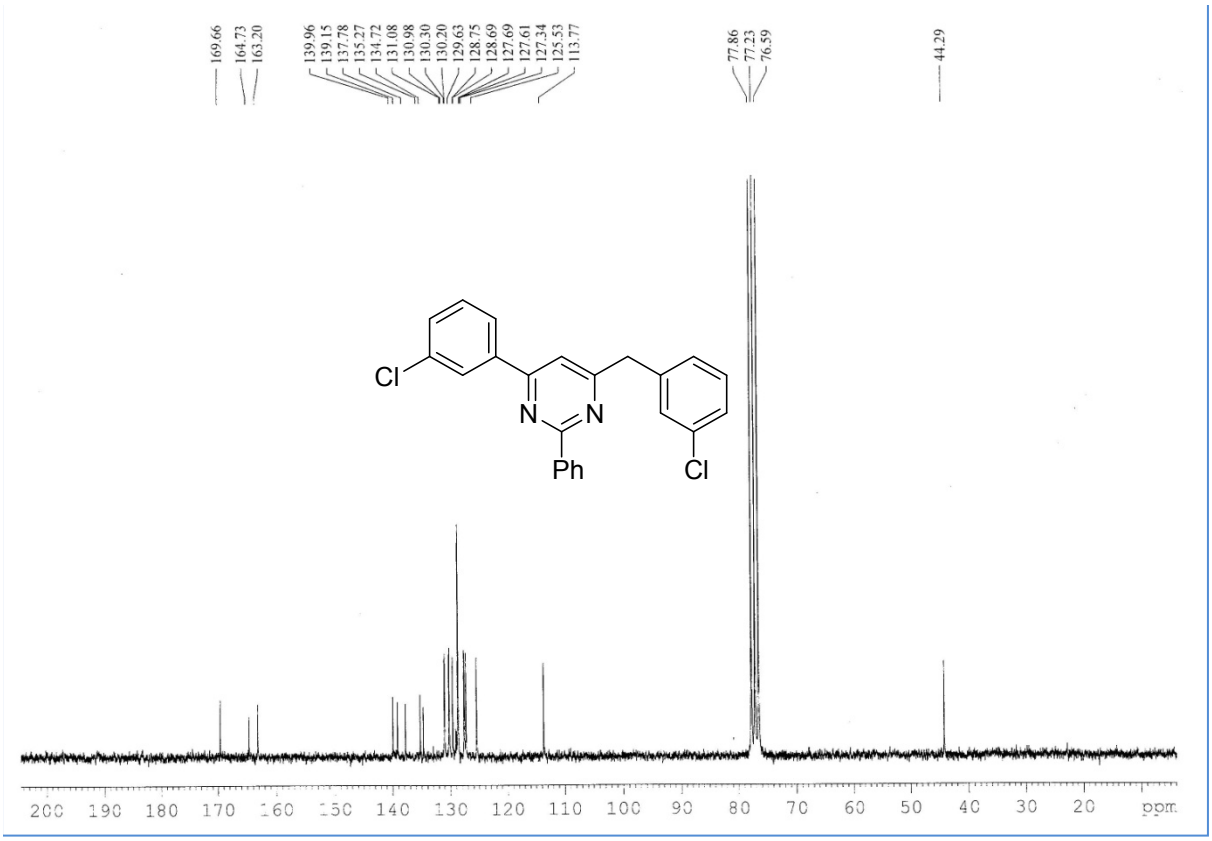
^{13}C NMR of compound 2j



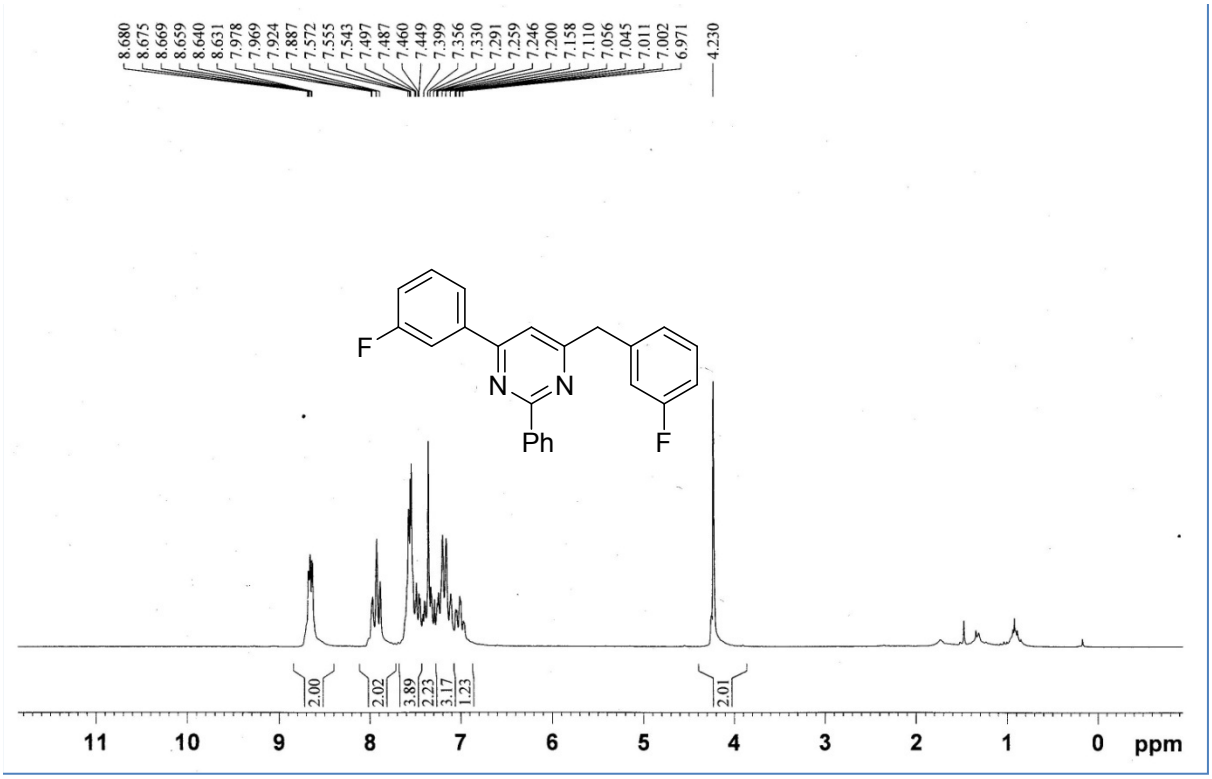
^{1}H NMR of compound 2k



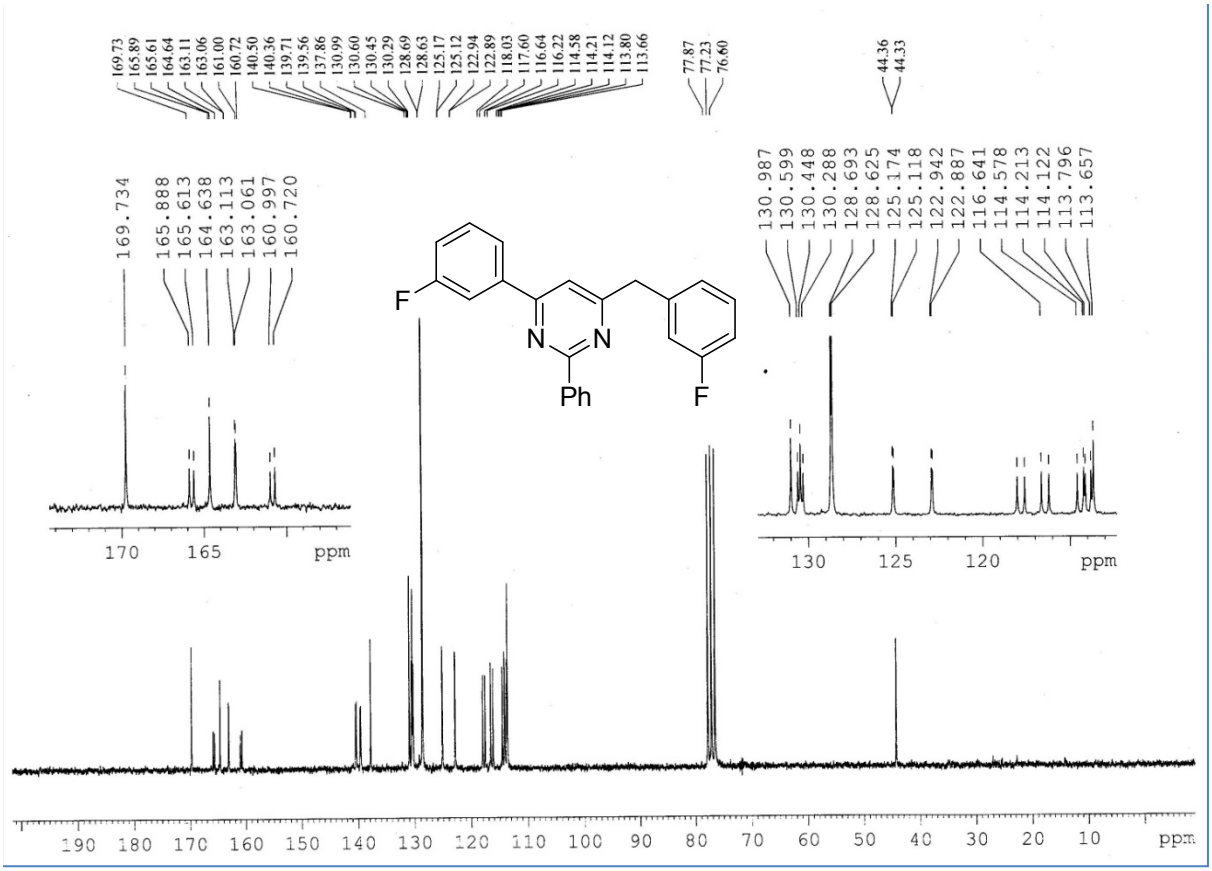
^{13}C NMR of compound 2k



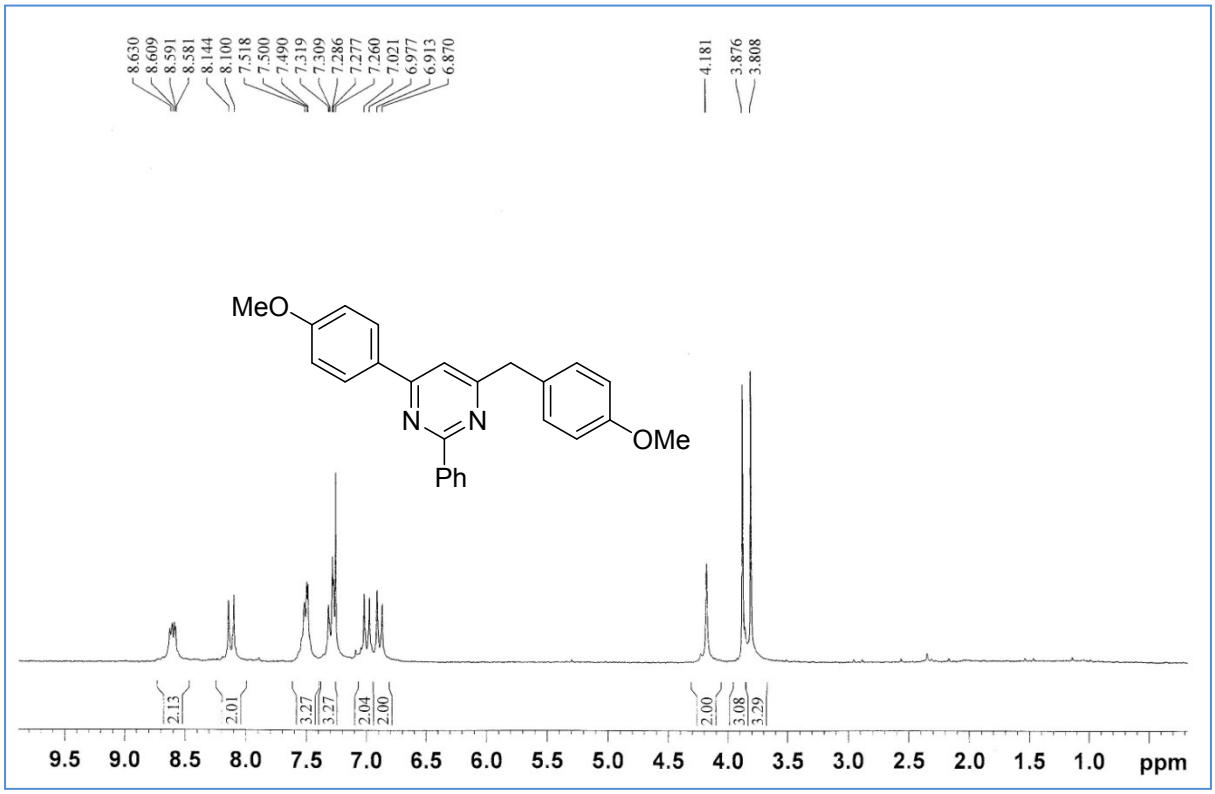
^{1}H NMR of compound 2l



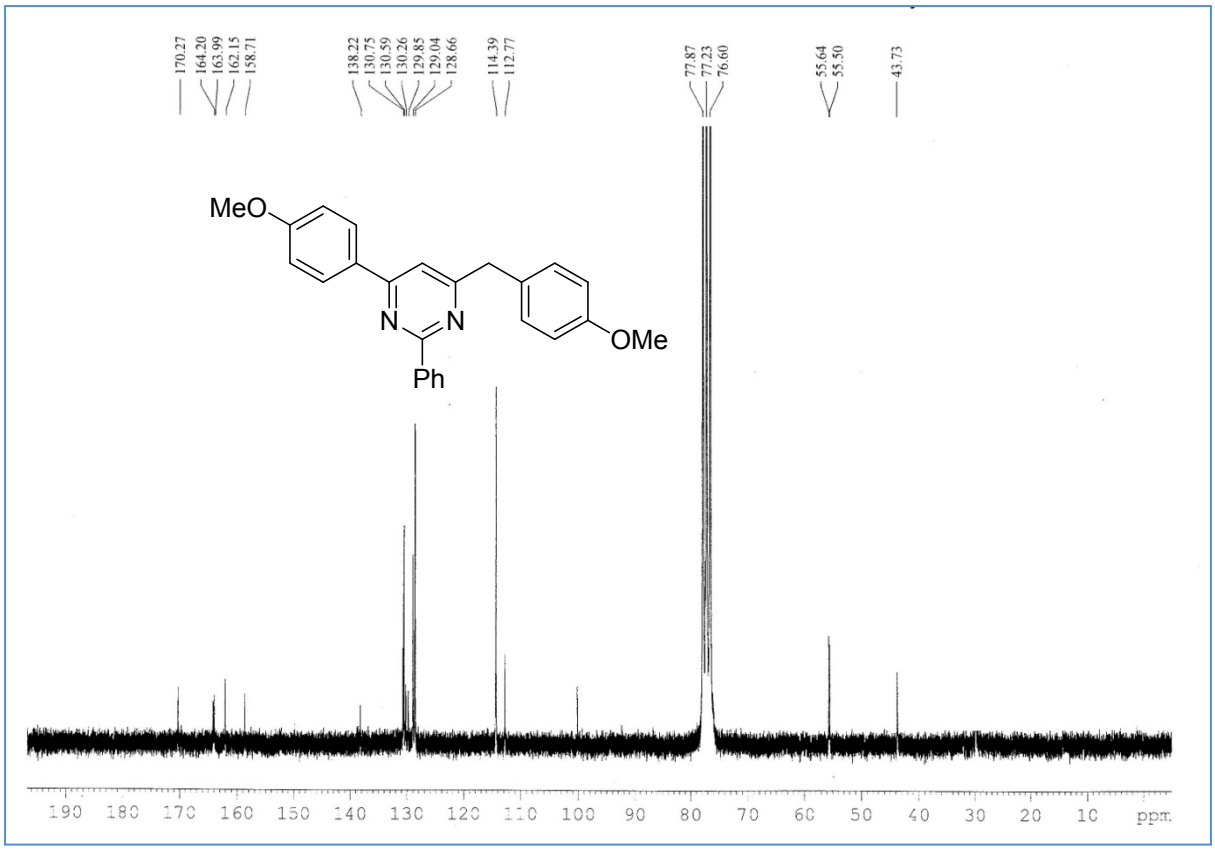
^{13}C NMR of compound 2l



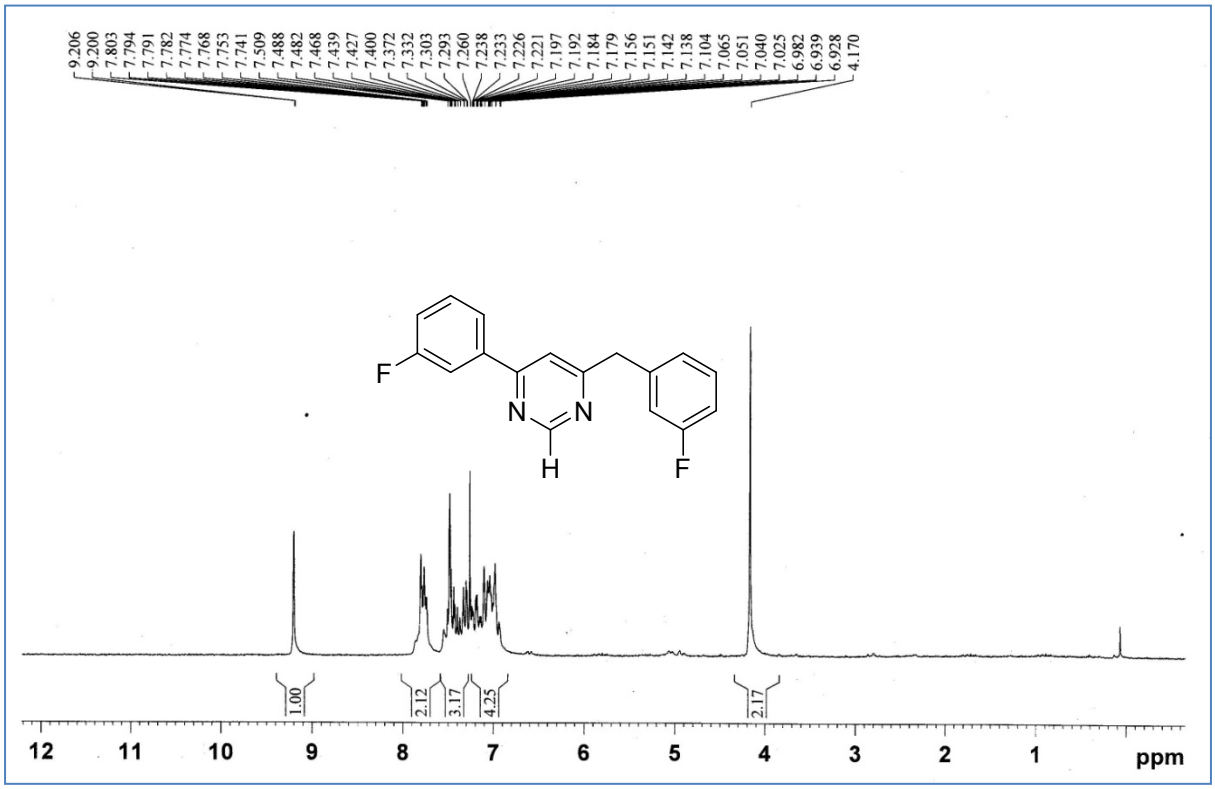
^{1}H NMR of compound 2m



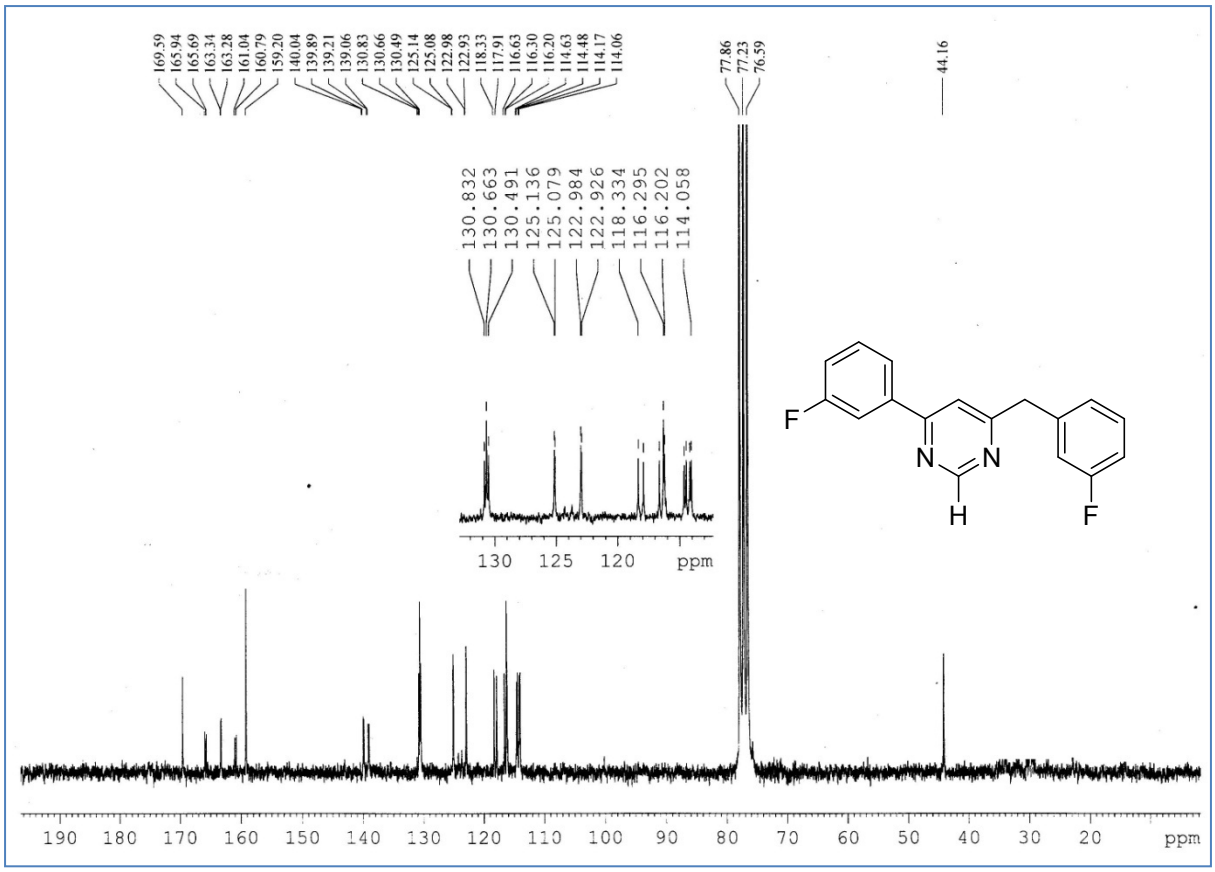
^{13}C NMR of compound 2m



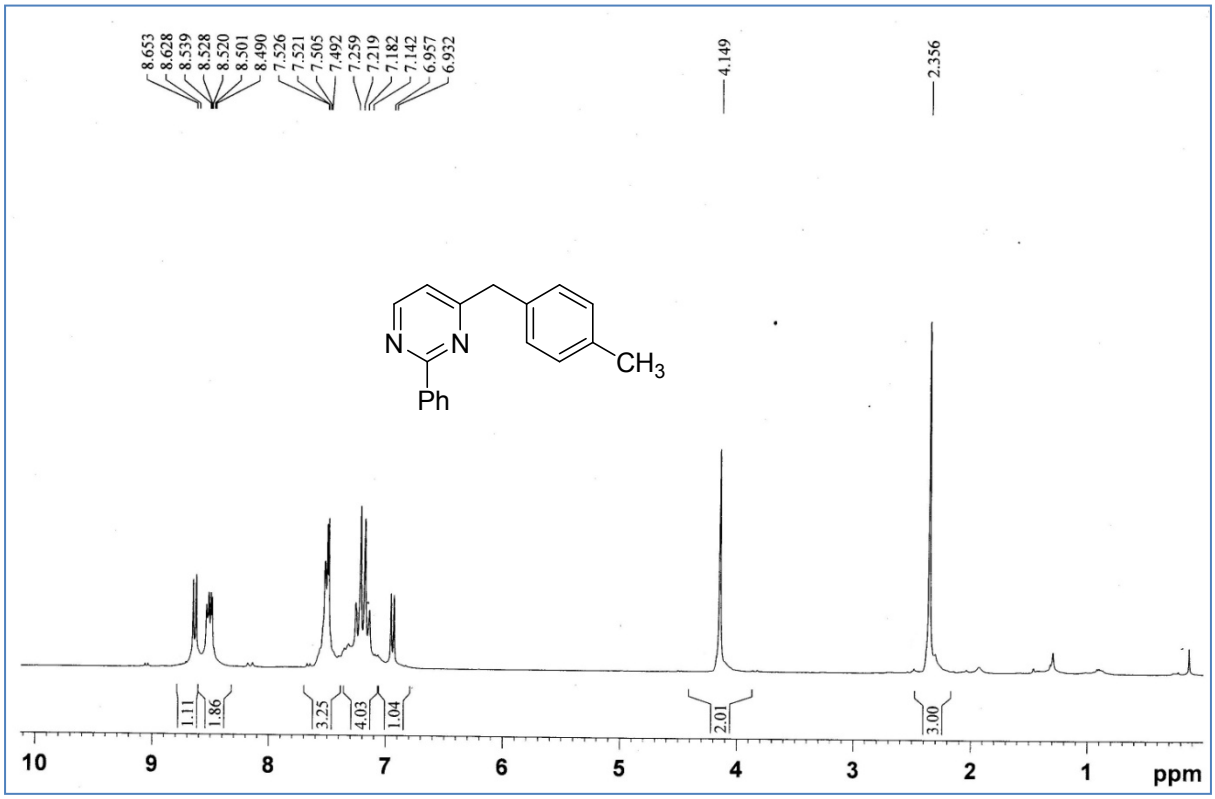
^{1}H NMR of compound 2n



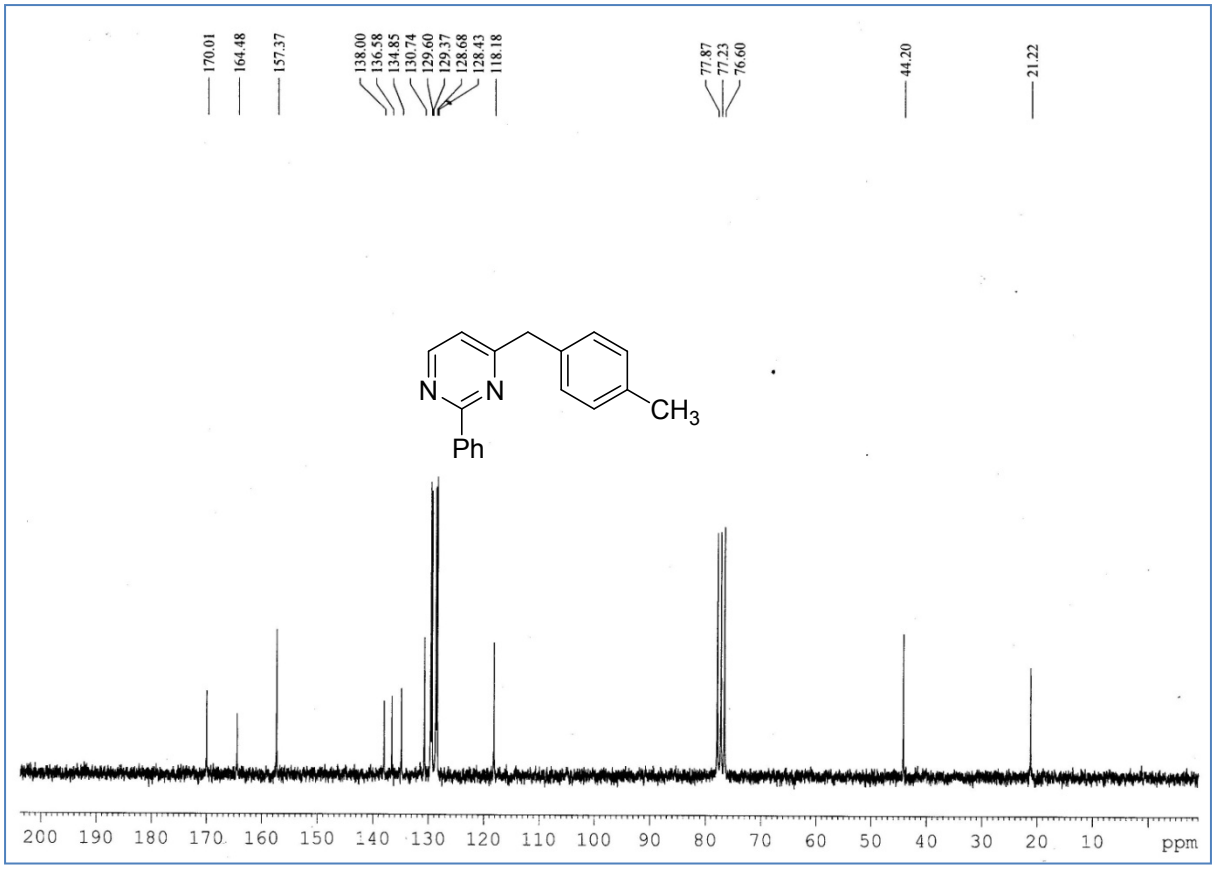
^{13}C NMR of compound 2m



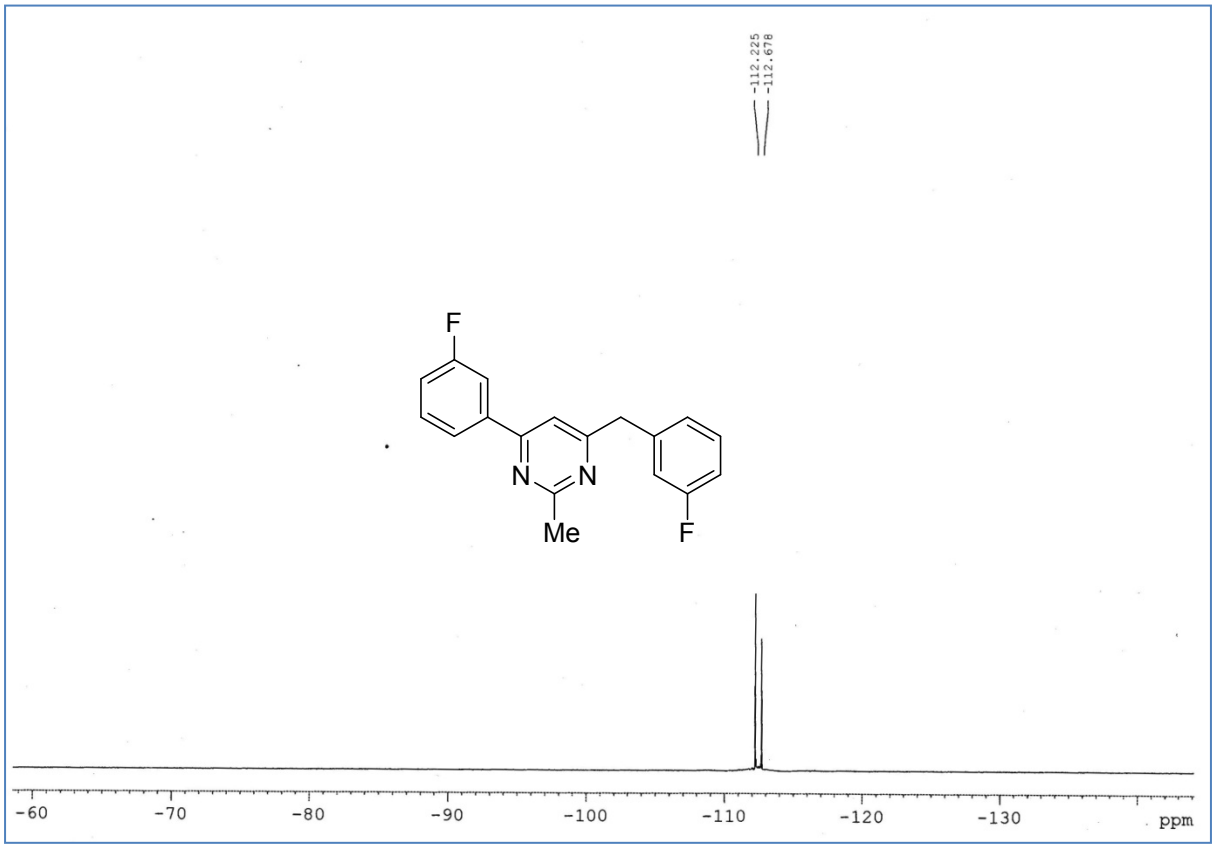
^{1}H NMR of compound 2o



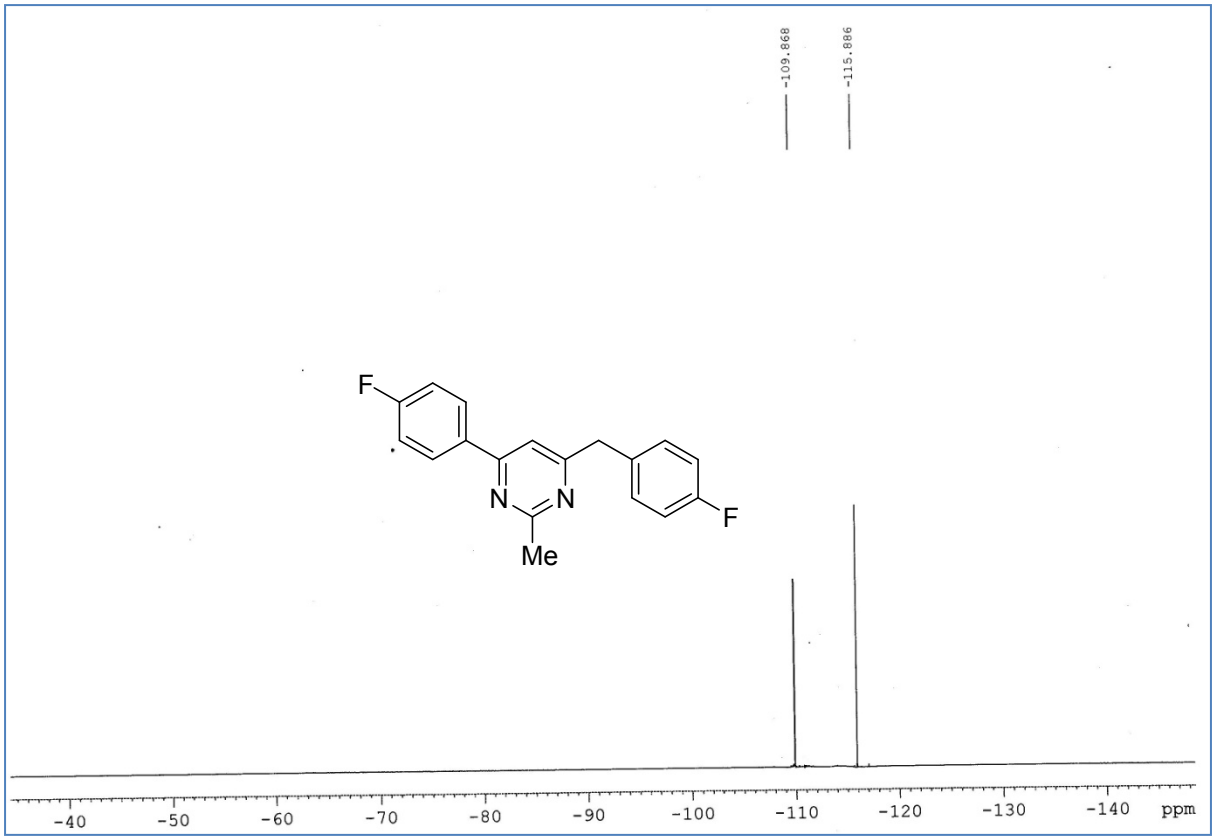
^{13}C NMR of compound 2o



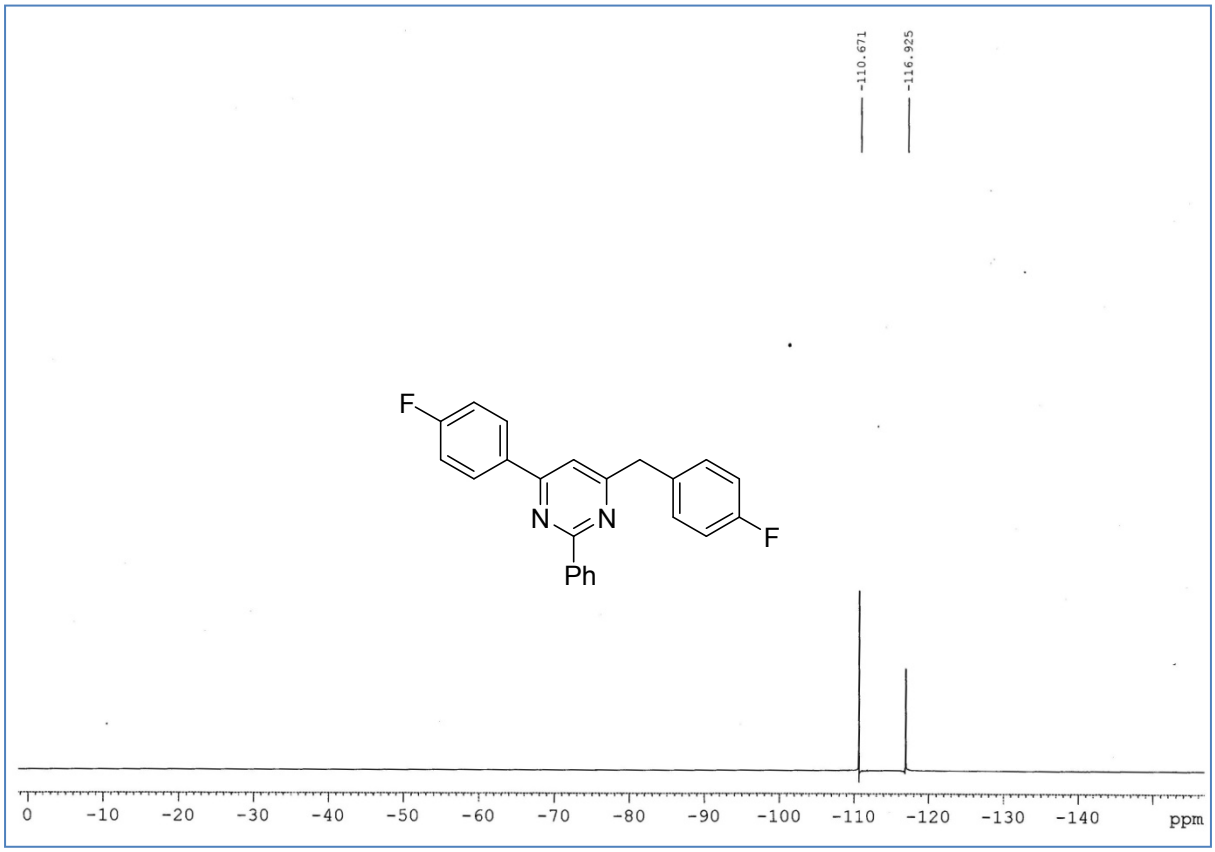
^{19}F NMR of compound 2e



^{19}F NMR of compound 2f



^{19}F NMR of compound 2j



^{19}F NMR of compound 2n