Supplementary Information

Visible-light promoted radical cascade cyclization of 3-allyl-2-arylquinazolinones for the synthesis of phosphorylated dihydroisoquinolino[1,2-b]quinazolinones

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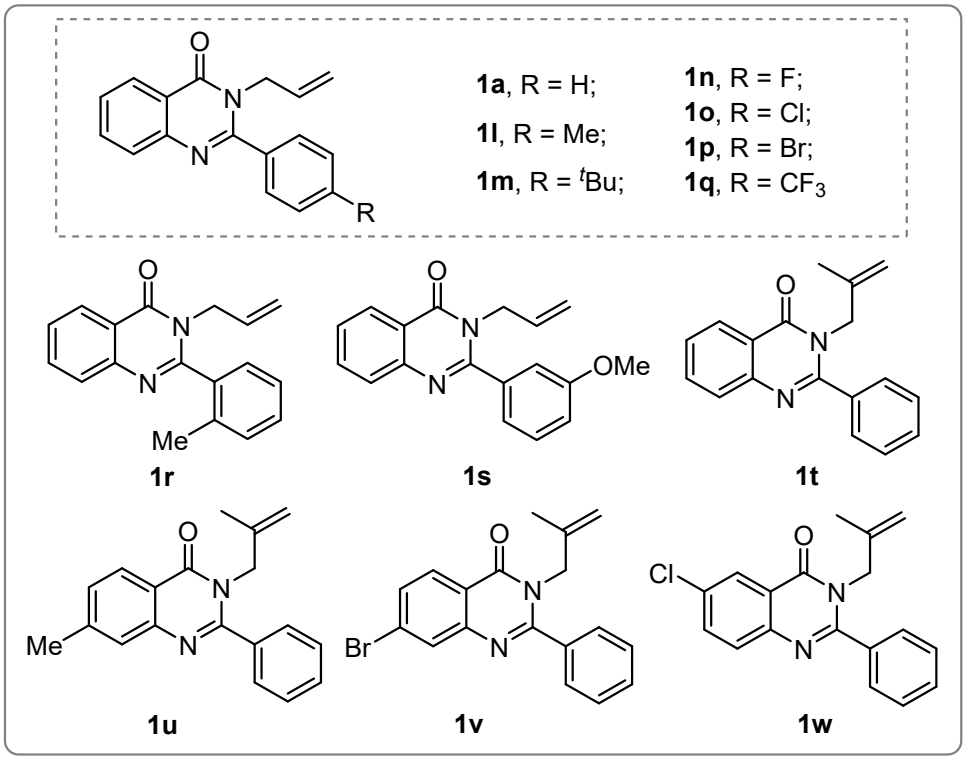
Contents

1. General information

The reactions involved in this article were performed in 10 mL tube or 100 mL round-bottom flask. Unless otherwise noted, all solvents and reagents were obtained from commercial sources. For chromatography, 200-300 mesh silica gel (Qingdao, China) was used. Melting points (mp) were taken on a JH30-Jiahang apparatus and were uncorrected. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectras were measured recorded on 400 M spectrometer in $CDCl_3$ solution. HRMS was measured in ESI mode and the mass analyzer of the HRMS was TOF. Chemical shifts (δ) were given in ppm, referenced to the residual proton resonance of $CDCl_3$ (7.26), to the carbon resonance of $CDCl_3$ (77.16). Coupling constants (J) were given in Hertz (Hz). The term m, q, t, d, s referred to multiplet, quartet, triplet, doublet, singlet. Single Crystal X-Ray Diffraction was performed on a Bruker Single Crystal X-Ray Diffractometer (model of the instrument–AXS D8 Quest System). All luminescence spectra were surveyed on a F-4600 FL Spectrophotometer and equipped with a 1 cm quartz cell.

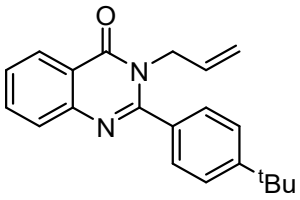
2. Preparation of 3-allyl-2-arylquinazolinones



Scheme S1 The structure of synthesized substrates.

All 3-allyl-2-arylquinazolinones were prepared according to the literature procedures.[1] And the characterization data of new compounds are given below:

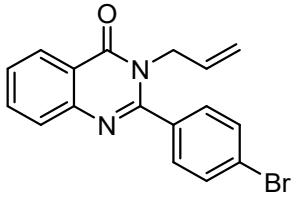
3-allyl-2-(4-(tert-butyl)phenyl)quinazolin-4(3H)-one (1m)



White solid (eluent: petroleum ether/ethyl acetate = 5/1); mp 143 - 144 ^{o}C; ^{1}H NMR (400 MHz,

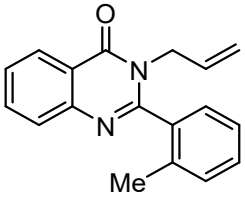
$CDCl_3$) δ 8.32 (d, *J* = 7.8 Hz, 1H), 7.73 (s, 2H), 7.49 (s, 5H), 5.96 – 5.82 (m, 1H), 5.17 (d, *J* = 10.3 Hz, 1H), 4.96 (d, *J* = 17.2 Hz, 1H), 4.62 (d, J = 4.7 Hz, 2H), 1.35 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.2, 156.6, 153.4, 147.4, 134.5, 132.5, 127.8, 127.6, 127.0, 126.9, 125.7, 120.8, 117.4, 48.3, 35.0, 31.3. HRMS(ESI) calcd. for $C_{21}H_{22}N_2O$ [$(M+H)^+$] 319.1805, found: 319.1815.

3-allyl-2-(4-bromophenyl)quinazolin-4(3H)-one (1p)



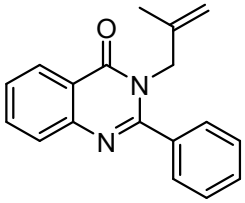
White solid (eluent: petroleum ether/ethyl acetate = 10/1); mp 90 - 91 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.75 – 7.67 (m, 2H), 7.63 – 7.58 (m, 2H), 7.51 – 7.39 (m, 3H), 5.89 – 5.80 (m, 1H), 5.16 (dd, *J* = 10.4, 0.9 Hz, 1H), 4.92 (dd, *J* = 17.2, 0.8 Hz, 1H), 4.55 (dt, *J* = 4.9, 1.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 155.4, 147.2, 134.7, 134.2, 132.3, 132.0, 129.8, 127.7, 127.5, 127.1, 124.6, 120.9, 117.7, 48.3; HRMS(ESI) calcd. for $C_{17}H_{13}BrN_2O$ [$(M+H)^+$] 341.0284, found: 341.0299.

3-allyl-2-(o-tolyl)quinazolin-4(3H)-one (1r)



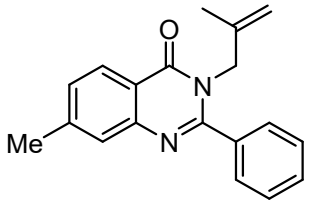
White solid (eluent: petroleum ether/ethyl acetate = 5/1); mp 71 - 72 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 7.5 Hz, 1H), 7.83 – 7.69 (m, 2H), 7.58 – 7.46 (m, 1H), 7.45 – 7.24 (m, 4H), 5.90 – 5.68 (m, 1H), 5.10 (d, *J* = 9.9 Hz, 1H), 4.84 (d, *J* = 17.1 Hz, 1H), 4.74 (dd, *J* = 14.6, 3.9 Hz, 1H), 4.27 – 4.17 (m, 1H), 2.24 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.8, 155.7, 147.3, 135.4, 134.6, 134.4, 131.5, 130.6, 129.8, 127.9, 127.5, 127.1, 126.8, 126.0, 120.9, 118.1, 47.6, 19.4; HRMS(ESI) calcd. for $C_{18}H_{16}N_2O$ [$(M+H)^+$] 277.1336 , found: 277.1350.

3-(2-methylallyl)-2-phenylquinazolin-4(3H)-one (1t)



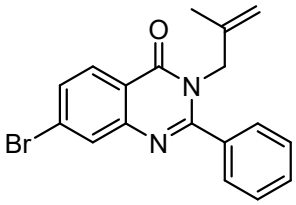
White solid (eluent: petroleum ether/ethyl acetate = 5/1); mp 108 - 109 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 – 8.31 (m, 1H), 7.82 – 7.72 (m, 2H), 7.61 – 7.42 (m, 6H), 4.89 – 4.83 (m, 1H), 4.55 – 4.45 (m, 3H), 1.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 156.5, 147.4, 140.1, 135.4, 134.6, 130.0, 128.7, 127.8, 127.7, 127.2 (d, *J* = 5.1 Hz), 120.8, 110.7, 50.6, 20.6; HRMS(ESI) calcd. for $C_{18}H_{16}N_2O$ [$(M+H)^+$] 277.1336, found: 277.1350.

7-methyl-3-(2-methylallyl)-2-phenylquinazolin-4(3H)-one (1u)



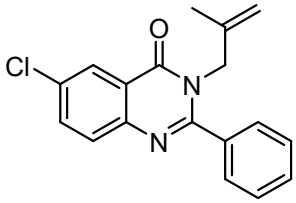
White solid (eluent: petroleum ether/ethyl acetate = 5/1); mp 80 - 81 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 (d, *J* = 8.1 Hz, 1H), 7.60 – 7.41 (m, 6H), 7.33 (d, *J* = 8.0 Hz, 1H), 4.85 (s, 1H), 4.52 – 4.44 (m, 3H), 2.50 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 156.6, 147.5, 145.6, 140.3, 135.5, 130.0, 128.8, 128.6, 127.9, 127.4, 127.0, 118.4, 110.7, 50.5, 22.1, 20.6; HRMS(ESI) calcd. for $C_{19}H_{18}N_2O$ [(M+H)$^+$] 291.1492, found: 291.1507.

7-bromo-3-(2-methylallyl)-2-phenylquinazolin-4(3H)-one (1v)



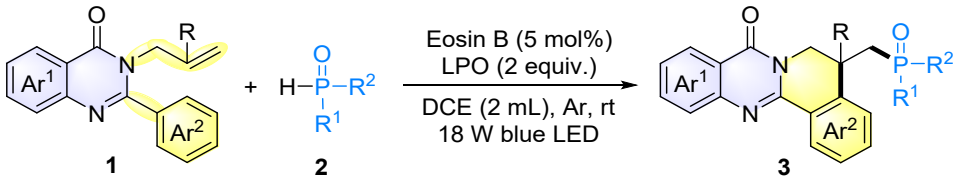
White solid (eluent: petroleum ether/ethyl acetate = 5/1); mp 112 - 113 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 – 8.14 (m, 1H), 7.94 – 7.89 (m, 1H), 7.61 – 7.57 (m, 1H), 7.56 – 7.52 (m, 2H), 7.50 – 7.43 (m, 3H), 4.88 – 4.84 (m, 1H),4.49 – 4.43 (m, 3H), 1.61 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.5, 157.7, 148.3, 139.9, 135.0, 130.4 (t, *J* = 13.1 Hz), 129.2, 128.6 (d, *J* = 8.1 Hz), 127.7, 119.5, 110.8, 50.6, 20.5; HRMS(ESI) calcd. for $C_{18}H_{15}BrN_2O$ [(M+H)$^+$] 355.0441, found: 355.0455.

6-chloro-3-(2-methylallyl)-2-phenylquinazolin-4(3H)-one (1w)



Pale yellow oil (eluent: petroleum ether/ethyl acetate = 5/1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (t, *J* = 1.5 Hz, 1H), 7.67 (d, *J* = 1.4 Hz, 2H), 7.56 – 7.52 (m, 2H), 7.50 – 7.42 (m, 3H), 4.86 (d, *J* = 0.7 Hz, 1H), 4.48 (s, 2H), 4.44 (s, 1H), 1.60 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.0, 156.7, 145.8, 139.9, 135.0, 134.9, 132.9, 130.2, 129.3, 128.6, 127.8, 126.4, 121.7, 110.8, 50.7, 20.5; HRMS(ESI) calcd. for $C_{18}H_{15}ClN_2O$ [(M+H)$^+$] 311.0946, found: 311.0960.

3. General procedure for visible-light promoted metal-free radical cascade cyclization of 3-allyl-2-arylquinazolinones



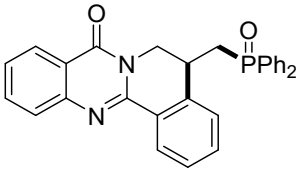
1 **2** **3**

A 10 mL tube was charged with 3-allyl-2-arylquinazolinones **1** (0.2 mmol), P(O)–H compounds

2 (0.4 mmol), LPO (0.4 mmol) and Eosin B (5 mol%), DCE (2 mL) was added via a syringe under argon. The resulting solution was stirred at room temperature with the irradiation of an 18 W blue LED for 12 h. After the reaction was completed, the volatile compounds were removed in vacuo and the residue was purified by column chromatography to give the targeted phosphorylated dihydroisoquinolino[1,2-b]quinazolinones **3**.

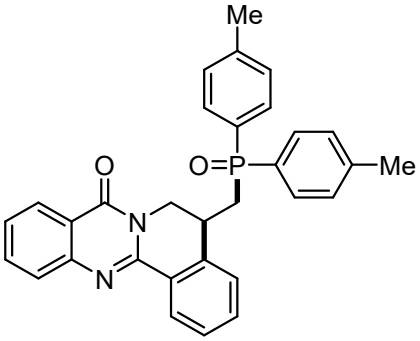
4. Characterization of dihydroisoquinolino[1,2-b]quinazolinones 3

5-((diphenylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3a)



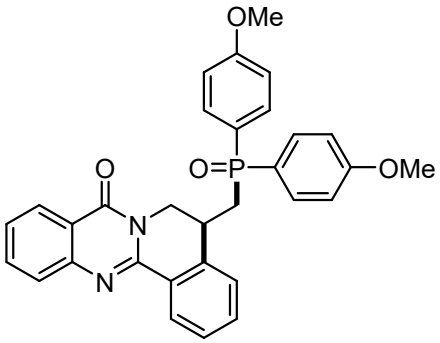
White solid (76%, 70.2 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 198.5 – 200.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (d, *J* = 7.8 Hz, 1H), 8.27 (d, *J* = 7.8 Hz, 1H), 7.80 – 7.74 (m, 2H), 7.65 (dd, *J* = 11.6, 7.3 Hz, 2H), 7.55 – 7.45 (m, 4H), 7.44 – 7.37 (m, 3H), 7.33 – 7.27 (m, 3H), 7.23 – 7.17 (m, 2H), 5.06 (dd, *J* = 13.7, 2.0 Hz, 1H), 3.93 – 3.85 (m, 1H), 3.77 – 3.70 (m, 1H), 2.56 – 2.38 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 149.1, 147.9, 139.8(d, *J* = 5.7 Hz), 134.5, 133.7, 132.8 (d, *J* = 23.0 Hz), 132.1 (d, *J* = 2.7 Hz), 132.0, 131.8, 131.7 (d, *J* = 2.5 Hz), 130.6 (dd, *J* = 11.1, 9.4 Hz), 128.8 (dd, *J* = 29.4, 11.8 Hz), 128.4, 128.1, 128.0 (d, *J* = 41.3 Hz), 126.9 (d, *J* = 31.5 Hz), 120.9, 45.5(d, *J* = 8.9 Hz), 33.6 (d, *J* = 70.3 Hz), 31.4 (d, *J* = 2.8 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.39 (s). HRMS(ESI) calcd. for $C_{29}H_{23}N_2O_2P$ [$(M+H)^+$] 463.1570, found: 463.1582.

5-((di-p-tolylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3b)



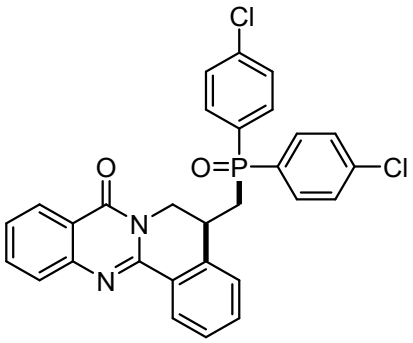
White solid (46%, 45.1 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 63.4 – 65.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 7.9 Hz, 1H), 8.22 (d, *J* = 7.9 Hz, 1H), 7.77 – 7.69 (m, 2H), 7.54 – 7.48(m , 2H), 7.45 – 7.36 (m, 3H), 7.32 – 7.27 (m, 1H), 7.23 – 7.15 (m, 4H), 7.13 – 7.08 (m, 2H), 5.03 (dd, *J* = 13.7, 2.0 Hz, 1H), 3.85 – 3.76 (m, 1H), 3.75 – 3.66 (m, 1H), 2.52 – 2.34 (m, 2H), 2.32 (s, 3H), 2.30 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.8, 149.0, 147.7, 142.3 (dd, *J* = 34.4, 2.6 Hz), 140.0 (d, *J* = 6.1 Hz), 134.3, 131.8, 130.5 (t, *J* = 10.1 Hz), 130.2, 129.6, 129.4 (d, *J* = 14.1 Hz), 129.2, 128.6, 128.3, 127.9, 127.8 (d, *J* = 42.6 Hz), 126.8 (d, *J* = 31.7 Hz), 120.8, 45.2 (d, *J* = 8.1 Hz), 33.5 (d, *J* = 70.2 Hz), 31.4 (d, *J* = 2.6 Hz), 21.5 (d, *J* = 6.5 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.97 (s). HRMS(ESI) calcd. for $C_{31}H_{27}N_2O_2P$ [$(M+H)^+$] 491.1883, found: 491.1892.

5-((bis(4-methoxyphenyl)phosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3c)



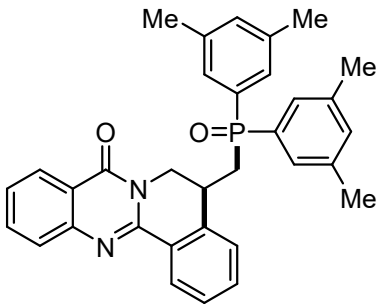
White solid (80%, 83.6 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 77.0 – 78.9 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, *J* = 7.6 Hz, 1H), 8.24 (d, *J* = 7.6 Hz, 1H), 7.79 – 7.71 (m, 2H), 7.58 – 7.50 (m, 2H), 7.48 – 7.38 (m, 3H), 7.34 – 7.29 (m, 1H), 7.25 – 7.18 (m, 2H), 6.92 – 6.87 (m, 2H), 6.84 – 6.78 (m, 2H), 5.04 (dd, *J* = 13.7, 2.4 Hz, 1H), 3.88 – 3.81 (m, 1H), 3.80 (s, 3H), 3.78 (s, 3H), 3.76 – 3.69 (m, 1H), 2.50 – 2.29 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.5 (d, *J* = 2.8 Hz), 162.3 (d, *J* = 2.8 Hz), 161.9, 149.1, 147.8, 140.2 (d, *J* = 5.9 Hz), 134.4, 132.5 (dd, *J* = 10.6, 8.5 Hz), 131.8, 128.4, 128.1 (d, *J* = 12.4 Hz), 128.0, 127.7, 126.9 (d, J = 31.5 Hz), 125.0, 124.1 (d, *J* = 35.7 Hz), 123.3, 120.9, 114.4 (dd, *J* = 25.4, 12.7 Hz), 55.4, 45.4 (d, *J* = 8.5 Hz), 34.0 (d, *J* = 70.7 Hz), 31.5 (d, *J* = 2.6 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.95 (s). HRMS(ESI) calcd. for $C_{31}H_{27}N_2O_4P$ [$(M+H)^+$] 523.1781, found: 523.1791.

5-((bis(4-chlorophenyl)phosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3d)



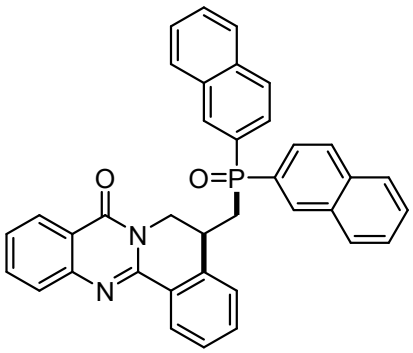
White solid (66%, 70.0 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 239.2 – 240.5 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 7.8 Hz, 1H), 8.17 (d, *J* = 7.8 Hz, 1H), 7.72 – 7.66 (m, 2H), 7.50 – 7.43 (m, 2H), 7.42 – 7.37 (m, 1H), 7.36 – 7.24 (m, 5H), 7.23 – 7.18 (m, 2H), 7.17 – 7.10 (m, 2H), 5.00 (dd, *J* = 13.8, 2.1 Hz, 1H), 3.85 – 3.76 (m, 1H), 3.68 – 3.61 (m , 1H), 2.48 – 2.27 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.8, 148.8, 147.7, 139.3 (d, *J* = 6.0 Hz), 138.9 (d, *J* = 3.3 Hz), 138.5 (d, *J* = 3.4 Hz), 134.5, 131.9 (d, *J* = 6.7 Hz), 131.8, 137.7, 130.9 (d, J = 34.1 Hz), 130.1, 129.2 (dd, J = 33.4, 12.4 Hz), 128.4, 128.3 (d, *J* = 2.0 Hz), 127.9 (d, J = 31.3 Hz), 126.9 (d, *J* = 14.7 Hz), 120.8, 45.1 (d, *J* = 9.2 Hz), 33.4 (d, *J* = 71.3 Hz), 31.5 (d, *J* = 2.8 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 28.22 (s). HRMS(ESI) calcd. for $C_{29}H_{21}Cl_2N_2O_2P$ [$(M+H)^+$] 531.0791, found: 531.0792.

5-((bis(3,5-dimethylphenyl)phosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3e)



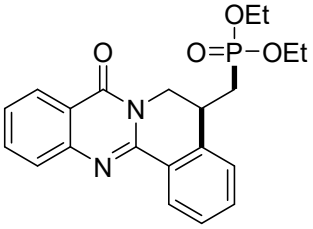
White solid (78%, 80.8 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 61.0 – 63.0 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (d, *J* = 7.7 Hz, 1H), 8.27 (d, *J* = 8.0 Hz, 1H), 7.81 – 7.71 (m, 2H), 7.49 – 7.42 (m, 1H), 7.34 – 7.20 (m, 5H), 7.12 (s, 1H), 7.09 (s, 2H), 7.02 (s, 1H), 5.05 (d, *J* = 13.8 Hz, 1H), 3.91 – 3.83 (m, 1H), 3.75 – 3.66 (m, 1H), 2.55 – 2.45 (m, 1H), 2.43 – 2.33 (m, 1H), 2.27 (s, 6H), 2.24 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 149.0, 147.8, 140.0 (d, *J* = 6.2 Hz), 138.6 (d, *J* = 12.4 Hz), 138.2 (d, *J* = 12.5 Hz), 134.3, 133.7 (d, *J* = 2.7 Hz), 133.4 (d, *J* = 2.7 Hz), 133.2, 132.4 (d, *J* = 42.0 Hz), 131.7, 128.4, 128.1 (d, *J* = 9.2 Hz) 127.95 (t, *J* = 3.1 Hz), 126. 8 (d, *J* = 35.0 Hz), 120.8, 45.1 (d, *J* = 8.3 Hz), 33.3 (d, *J* = 69.6 Hz), 31.3 (d, *J* = 2.7 Hz), 21.3 (d, *J* = 7.0 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 30.00(s). HRMS(ESI) calcd. for $C_{33}H_{31}N_2O_2P$ [$(M+H)^+$] 519.2196, found: 519.2202.

5-((di(naphthalen-2-yl)phosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3f)



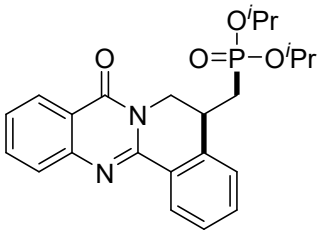
White solid (65%, 73.1 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 194.7 – 196.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 – 8.31 (m, 2H), 8.25 (d, *J* = 13.4 Hz, 1H), 8.16 (dd, *J* = 7.9, 0.8 Hz, 1H), 7.86 – 7.72 (m, 8H), 7.65 – 7.59 (m, 1H), 7.57 – 7.40 (m, 6H), 7.28 – 7.17 (m, 2H), 7.11 – 7.04 (m, 1H), 5.16 (dd, *J* = 13.8, 2.2 Hz, 1H), 3.99 – 3.91(m, 1H), 3.77 – 3.69 (m, 1H), 2.78 – 2.57(m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 148.9, 147.7, 139.7(d, *J* = 6.4 Hz), 134.7 (d, *J* = 2.2 Hz), 134.4 (d, *J* = 2.1 Hz), 134.3, 132.8 (d, *J* = 8.3 Hz), 132.6 (d, J = 4.4 Hz), 132.5, 132.4 (d, J = 13.2 Hz), 130.3, 129.5 (d, *J* = 41.3 Hz), 129.0 – 128.7 (m), 128.5 (d, *J* = 11.7 Hz), 128.3, 128.2, 128.1, 128.0 (d, *J* = 1.9 Hz), 127.8, 127.7 (d, *J* = 12.6 Hz), 127.0 (t, *J* = 5.0 Hz), 126.6, 125.2 (d, *J* = 10.6 Hz), 120.7, 45.1 (d, *J* = 8.3 Hz), 33.2 (d, *J* = 70.2 Hz), 31.5 (d, *J* = 2.6 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 30.30 (s). HRMS(ESI) calcd. for $C_{37}H_{27}N_2O_2P$ [$(M+H)^+$] 563.1883, found: 563.1893.

diethyl ((8-oxo-5,8-dihydro-6H-isoquinolino[1,2-b]quinazolin-5-yl)methyl)phosphonate (3g)



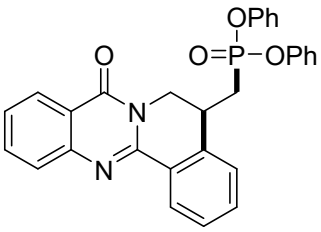
Pale yellow oil (38%, 31.2 mg, eluent: petroleum ether/ethyl acetate = 1/2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 – 8.42 (m, 1H), 8.28 (d, *J* = 7.7 Hz, 1H), 7.77– 7.70 (m, 2H), 7.51 – 7.38 (m, 4H), 5.13 (dd, *J* = 13.8, 2.9 Hz, 1H), 4.15 – 4.02(m, 2H), 4.01 – 3.90 (m, 2H), 3.86 – 3.79(m, 1H), 3.67 – 3.57 (m, 1H), 2.03 – 1.84 (m, 2H), 1.29 (t, *J* = 7.1 Hz, 3H), 1.19 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 148.9, 147.8, 140.1 (d, *J* = 11.1 Hz), 134.4, 132.0, 128.5, 128.2, 128.1, 127.7, 127.5, 127.0, 126.7, 120.8, 61.9 (d, *J* = 6.1 Hz), 44.1 (d, *J* = 9.1 Hz), 32.3 (d, *J* = 3.0 Hz), 29.5 (d, *J* = 141.4 Hz), 16.4 (dd, *J* = 9.7, 6.1 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 27.80 (s). HRMS(ESI) calcd. for $C_{21}H_{23}N_2O_4P$ [$(M+H)^+$] 399.1468, found: 399.1479.

diisopropyl ((8-oxo-5,8-dihydro-6H-isoquinolino[1,2-b]quinazolin-5-yl)methyl)phosphonate (3h)



Pale yellow oil (40%, 34.2 mg, eluent: petroleum ether/ethyl acetate = 1/2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 – 8.42 (m, 1H), 8.31 – 8.27 (m, 1H), 7.77 – 7.70 (m, 2H), 7.51 – 7.39 (m, 4H), 5.10 (dd, *J* = 13.7, 3.2 Hz, 1H), 4.76 – 4.55 (m, 2H), 3.90 – 3.84 (m, 1H), 3.66 – 3.55 (m 1H), 2.00 – 1.81 (m, 2H), 1.30 (dd, *J* = 6.1, 4.5 Hz, 6H), 1.25 (d, *J* = 6.2 Hz, 3H), 1.18 (d, *J* = 6.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 149.0, 147.8, 140.4 (d, J = 10.8 Hz), 134.3, 132.0, 128.6, 128.2, 128.1, 127.7, 127.5, 127.0, 126.7, 120.9, 70.7 (dd, *J* = 6.8, 4.0 Hz), 44.3 (d, *J* = 8.7 Hz), 32.5 (d, *J* = 3.6 Hz), 31.0 (d , *J* = 142.5 Hz), 24.2 – 23.8 (m). ^{31}P NMR (162 MHz, $CDCl_3$) δ 25.78 (s). HRMS(ESI) calcd. for $C_{23}H_{27}N_2O_4P$ [$(M+H)^+$] 427.1781, found: 427.1795.

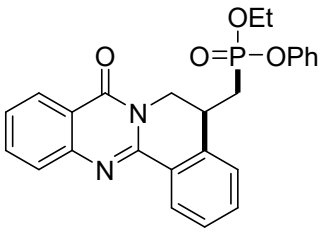
diphenyl ((8-oxo-5,8-dihydro-6H-isoquinolino[1,2-b]quinazolin-5-yl)methyl)phosphonate (3i)



Pale yellow oil (42%, 41.5 mg, eluent: petroleum ether/ethyl acetate = 1/2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.47 (m, 1H), 8.35 – 8.29 (m, 1H), 7.83 – 7.68 (m, 2H), 7.52 – 7.42 (m, 4H), 7.32 – 7.27 (m, 2H), 7.26 – 7.21 (m, 2H), 7.20 – 7.16 (m, 2H), 7.15 – 7.09 (m, 2H), 7.04 – 6.99 (m, 2H), 5.30 (dd, *J* = 13.7, 2.6 Hz, 1H), 3.95 – 3.80 (m, 2H), 2.42-2.22 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 150.1 (t, *J* = 8.8 Hz), 148.8, 147.8, 139.4 (d, *J* = 10.0 Hz), 134.6, 132.3, 129.9 (d, *J* = 12.4 Hz),

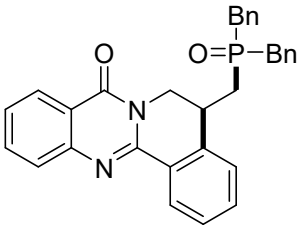
128.7, 128.6, 128.5, 127.8, 127.1, 126.9, 125.4 (d, J = 10.7 Hz), 120.9, 120.5 (dd, J = 7.1, 4.6 Hz), 44.5 (d, J = 10.9 Hz), 32.3 (d, J = 3.4 Hz), 29.9 (d, J = 142.0 Hz).^{31}P NMR (162 MHz, $CDCl_3$) δ 21.36 (s). HRMS(ESI) calcd. for $C_{29}H_{23}N_2O_4P$ [$(M+H)^+$] 495.1468, found: 495.1481.

ethyl phenyl((8-oxo-5,8-dihydro-6H-isoquinolino[1,2-b]quinazolin-5yl)methyl)phosphonate (3j)



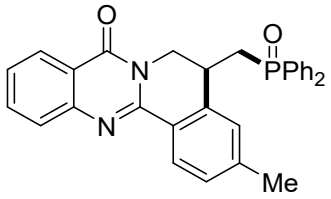
White solid (57%, 50.5 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 60.5 – 61.7 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 – 8.43 (m, 0.47H), 8.42 – 8.37 (m, 0.50H), 8.35 – 8.31 (m, 0.50H), 8.26 – 8.21 (m, 0.48H), 7.79 – 7.61 (m, 4H), 7.57 – 7.42 (m, 4.53H), 7.41 – 7.32 (m, 2H), 7.26 – 7.22 (m, 0.51H), 5.32 (dd, J = 13.7, 2.7 Hz, 0.51H), 4.92 (dd, J = 13.6, 2.8 Hz, 0.48H), 4.15 – 4.07 (m, 0.56H), 4.01 – 3.90 (m, 0.52H), 3. 89 – 3.67 (m, 3H), 2.23 – 2.04 (m, 2H), 1.29 (t, J = 7.1 Hz, 1.54H), 1.13 (t, J = 7.1 Hz, 1.46H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 161.8, 149.1, 149.0, 147.9, 147.8, 140.4 (d, J = 8.7 Hz), 140.3 (d, J = 5.7 Hz), 134.4 (d, J = 4.0 Hz), 132.7 (d, J = 2.7 Hz), 132.5 (d, J = 2.8 Hz), 132.0, 131.9, 131.6, 131.5, 131.3, 130.1, 129.0 (d, J = 12.5 Hz), 128.8 (d, J = 12.7 Hz), 128.6, 128.5, 128.2 (d, J = 2.1 Hz), 128.1 (d, J = 5.1 Hz), 127.7 (d, J = 3.3 Hz), 127.3, 127.0 (d, J = 4.0 Hz), 126.7, 121.0, 120.8, 61.2 (d, J = 6.5 Hz), 60.8 (d, J = 6.4 Hz), 45.0 (d, J = 10.2 Hz), 44.4 (d, J = 6.5 Hz), 34.1 (d, J = 27.3 Hz), 33.1 (d, J = 27.3 Hz), 31.6 (d, J = 2.9 Hz), 31.5 (d, J = 3.0 Hz), 16.5 (d, J = 6.6 Hz), 16.3 (d, J = 6.7 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 41.27 (s), 41.00 (s). HRMS(ESI) calcd. for $C_{25}H_{23}N_2O_4P$ [$(M+Na)^+$] 469.1288, found: 469.1287.

5-((di-p-tolylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3k)



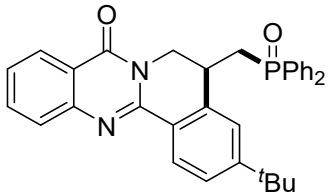
White solid (75%, 73.1 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 155.1 – 156.9 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.5 (dd, J = 7.6, 1.6 Hz, 1H), 8.31 (d, J = 7.5 Hz, 1H), 7.84 – 7.77 (m, 2H), 7.56 – 7.45 (m, 4H), 7.29 – 7.24 (m, 2H), 7.23 – 7.12 (m, 6H), 6.93 – 6.87 (m, 2H), 5.06 (dd, J = 13.7, 2.1 Hz, 1H), 3.74 – 3.68 (m, 1H), 3.66 – 3.58 (m, 1H), 3.12 – 2.63 (m, 4H), 1.90 – 1.66 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.1, 149.0, 147.9, 139.9 (d, J = 4.9 Hz), 134.6, 132.2, 131.7 (d, J = 7.1 Hz), 131.2 (d, J = 7.4 Hz), 130.0 (d, J = 5.2 Hz), 129.8 (d, J = 5.1 Hz)., 129.0 (t, J = 2.1 Hz), 128.7 (d, J = 13.1 Hz), 128.5, 127.8, 127.3 (d, J = 2.7 Hz), 127.1 (d, J = 4.1 Hz), 126.9, 120.9, 45.5 (d, J = 9.8 Hz), 37.6 (d, J = 41.4 Hz), 37.0 (d, J = 43.4 Hz), 31.6 (d, J = 3.3 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 41.15 (s). HRMS(ESI) calcd. for $C_{31}H_{27}N_2O_2P$ [$(M+H)^+$] 491.1883, found: 491.1893.

5-((diphenylphosphoryl)methyl)-3-methyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3l)



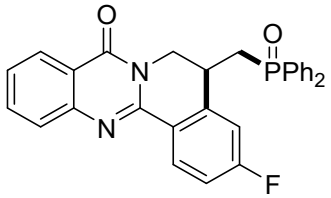
White solid (63%, 60.0 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 162.8 – 164.8 °C. ^{1}H NMR (400 MHz, $CDCl_3$)δ 8.26 (dd, *J* = 7.9, 3.9 Hz, 2H), 7.79 – 7.72 (m, 2H), 7.66 –7.58 (m, 2H), 7.55 – 7.35 (m, 7H), 7.34 – 7.27 (m, 2H), 7.06 (d, *J* = 8.0 Hz, 1H), 6.96 (s, 1H), 5.08 (dd, *J* = 13.7, 2.1 Hz, 1H), 3.92 – 3.82 (m, 1H), 3.76 – 3.65 (m, 1H), 2.56 – 2.39 (m, 2H), 2.15 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.0, 149.2, 147.9, 142.5, 139.4 (d, *J* = 5.0 Hz), 134.4, 133.8, 132.7 (d, *J* = 12.3 Hz), 132.0 (d, *J* = 2.6 Hz), 131.7, 131.6 (d, *J* = 2.0 Hz), 130.5 (dd, *J* = 15.3, 9.4 Hz), 128.9 (dd, *J* = 10.2, 8.8 Hz), 128.5 (d, *J* = 11.8 Hz), 127.9 (d, *J* = 58.4 Hz), 126.8 (d, *J* = 49.4 Hz), 125.5, 120.7, 45.7 (d, *J* = 9.8 Hz), 33.5 (d, *J* = 70.7 Hz), 31.2 (d, *J* = 2.8 Hz), 21.5. ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.44 (s). HRMS(ESI) calcd. for $C_{30}H_{25}N_2O_2P$ [$(M+H)^+$] 477.1727, found: 477.1735.

3-(tert-butyl)-5-((diphenylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3m)



White solid (88%, 91.2 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 84.2 – 86.1 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 8.3 Hz, 1H), 8.23 (dd, *J* = 8.0, 0.9 Hz, 1H), 7.78 – 7.69 (m, 2H), 7.63 – 7.55 (m, 2H), 7.53 – 7.24 (m, 11H), 5.07 (dd, *J* = 13.8, 2.1 Hz, 1H), 3.96 – 3.85 (m, 1H), 3.74 – 3.64 (m, 1H), 2.56 – 2.41 (m, 2H), 1.19 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 155.7, 149.1, 147.9, 139.5 (d, *J* = 5.8 Hz), 134.3, 133.9, 132.9 (d, *J* = 6.3 Hz), 132.0, 131.9 (d, *J* = 2.4 Hz), 131.6 (d, *J* = 2.5 Hz), 130.4 (dd, *J* = 16.3, 9.5 Hz), 128.7 (dd, *J* = 22.9, 11.8 Hz), 127.8 (d, *J* = 43.9 Hz), 126.7 (d, *J* = 51.2 Hz), 125.6 (d, *J* = 12.1 Hz), 124.9, 120.7, 45.4 (d, *J* = 8.8 Hz), 35.0, 33.1 (d, *J* = 70.2 Hz), 31.6 (d, *J* = 2.8 Hz), 31.0. ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.66 (s). HRMS(ESI) calcd. for $C_{33}H_{31}N_2O_2P$ [$(M+H)^+$] 519.2196, found: 519.2203.

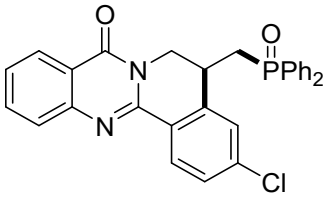
5-((diphenylphosphoryl)methyl)-3-fluoro-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3n)



White solid (47%, 45.2 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 215.3 – 217.2 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (dd, *J* = 8.2, 5.8 Hz, 1H), 8.24 (d, *J* = 7.8 Hz, 1H), 7.77 – 7.71 (m, 2H), 7.64 (dd, *J* = 11.0, 7.9 Hz, 2H), 7.53 (dd, *J* = 10.9, 8.1 Hz, 2H), 7.48 – 7.37 (m, 5H), 7.33 (d, *J* = 5.8

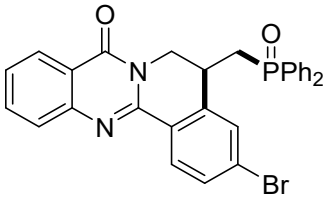
Hz, 2H), 6.96 – 6.87 (m, 2H), 5.05 (d, *J* = 13.4 Hz, 1H), 3.90 – 3.80 (m, 1H), 3.73 (d, *J* = 13.6 Hz, 1H), 2.57 – 2.36 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.7, 163.2, 161.8, 148.2, 147.7, 142.2 (dd, *J* = 8.7, 5.3 Hz), 134.5, 132.5 (t, *J* = 99.2 Hz), 132.2 (d, *J* = 2.7 Hz), 131.9 (d, *J* = 2.7 Hz), 130.9 (d, *J* = 9.1 Hz), 130.5 (dd, *J* = 11.9, 9.6 Hz), 128.8 (dd, *J* = 25.5, 12.0 Hz), 127.6, 126.9 (d, *J* = 27.6 Hz), 124.6 (d, *J* = 2.9 Hz), 120.7, 115.4 (dd, J = 39.6, 22.3 Hz), 45.4 (d, *J* = 9.5 Hz), 33.3 (d, *J* = 70.40 Hz), 31.5 (d, *J* = 3.0 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.05 (s). ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.73 (s). HRMS(ESI) calcd. for $C_{29}H_{22}FN_2O_2P$ [$(M+H)^+$] 481.1476, found: 481.1488.

3-chloro-5-((diphenylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3o)



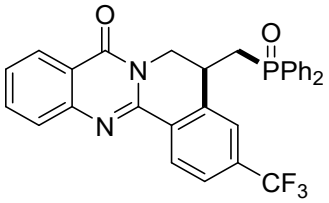
White solid (75%, 74.4 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 126.2 – 128.0 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 8.5 Hz, 2H), 7.85 – 7.35 (m, 15H), 5.15 (d, *J* = 13.1 Hz, 1H), 4.02 – 3.88 (m, 1H), 3.80 (d, *J* = 12.7 Hz, 1H), 2.70 – 2.44 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.7, 148.2, 147.6, 140.9 (d, *J* = 4.9 Hz), 137.9, 134.5, 133.6, 132.4 (d, *J* = 34.1 Hz), 132.1 (d, *J* = 3.0 Hz), 131.9 (d, *J* = 3.0 Hz), 131.3, 130.8 (d, *J* = 11.5 Hz), 130.5 (dd, *J* = 12.1 , 9.1 Hz), 129.6, 128.8 (dd, *J* = 21.1, 12.1 Hz), 128.5, 127.7, 127.0 (d, *J* = 12.1 Hz), 126.8, 120.8, 45.5 (d, *J* = 9.8 Hz), 33.4 (d, *J* = 70.7 Hz), 31.3 (d, *J* = 2.7 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 28.98 (s). HRMS(ESI) calcd. for $C_{29}H_{22}ClN_2O_2P$ [$(M+H)^+$] 497.118, found: 497.1184.

3-bromo-5-((diphenylphosphoryl)methyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3p)



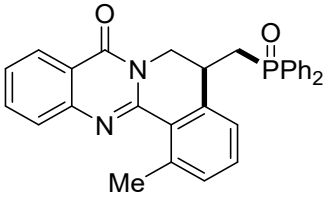
White solid (65%, 70.2 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 122.4 – 124.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25 (dt, *J* = 8.1, 1.1 Hz, 1H), 8.20 (d, *J* = 8.4 Hz, 1H), 7.79 – 7.73 (m, 2H), 7.66 – 7.58 (m, 2H), 7.56 – 7.50 (m, 2H), 7.49 – 7.44 (m, 2H), 7.43 – 7.30 (m, 7H), 5.07 (dd, *J* = 13.8, 2.3 Hz, 1H), 3.91 – 3.80 (m, 1H), 3.76 – 3.68 (m, 1H), 2.57 – 2.35 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 148.3, 147.7, 141.1 (d, *J* = 4.9 Hz), 134.6, 133.7, 132.5 (d, *J* = 43.4 Hz), 132.1 (d, *J* = 2.5 Hz), 132.0 (d, *J* = 2.7 Hz), 131.5 (d, *J* = 5.3 Hz), 131.3, 130.5 (dd, *J* = 13.6, 9.4 Hz), 129.7, 128.9 (dd, *J* = 16.1, 11.9 Hz), 127.8, 127.1 (d, *J* = 9.4 Hz), 127.0 (d, *J* = 67.4 Hz), 120.9, 45.6 (d, *J* = 9.9 Hz), 33.4 (d, *J* = 70.5 Hz), 31.3 (d, *J* = 2.8 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.08 (s). HRMS(ESI) calcd. for $C_{29}H_{22}BrN_2O_2P$ [$(M+Na)^+$] 563.0494, found: 563.0507.

5-((diphenylphosphoryl)methyl)-3-(trifluoromethyl)-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3q)



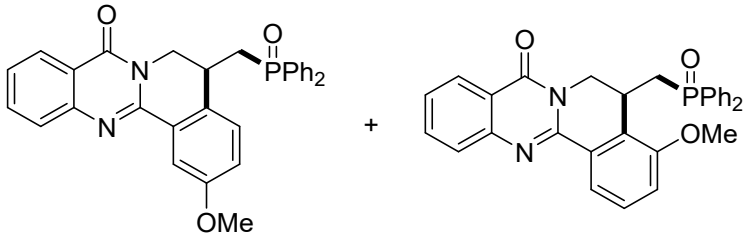
White solid (79%, 83.8 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 174.2 – 175.8 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, *J* = 8.0 Hz, 1H), 8.29 – 8.23(m, 1H), 7.81 – 7.73 (m, 2H), 7.61 (dd, *J* = 11.6, 7.6 Hz, 2H), 7.51-7.43 (m, 6H), 7.41 – 7.35 (m, 3H), 7.32 – 7.25 (m, 2H), 5.11 (dd, *J* = 13.8, 1.8 Hz, 1H), 4.04 – 3.93 (m, 1H), 3.73 (dd, *J* = 13.8, 1.6 Hz, 1H), 2.59 – 2.39 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.6, 147.6 (d, *J* = 19.1 Hz), 140.0 (d, *J* = 4.8 Hz), 134.6, 133.7, 133.0 (q, *J* = 32.9 Hz), 132.7, 132.0 (dd, *J* = 25.9, 2.8 Hz), 131.6, 131.1, 130.5 (dd, *J* = 13.6, 9.4 Hz), 128.8 (dd, *J* = 20.3, 11.9 Hz), 127.9, 127.2 (d, J = 27.9 Hz), 125.4 (q, *J* = 3.9 Hz), 124.9 (q, *J* = 3.6 Hz), 124.7, 122.0, 121.0, 45.5 (d, *J* = 9.8 Hz), 33.0 (d, *J* = 70.7 Hz), 31.5 (d, *J* = 2.7 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 28.74 (s). ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.73 (s). HRMS(ESI) calcd. for $C_{30}H_{22}F_3N_2O_2P$ [$(M+H)^+$] 531.1444, found: 531.1451.

5-((diphenylphosphoryl)methyl)-1-methyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3r)



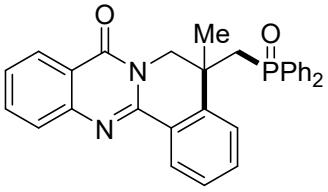
White solid (20%, 19.1 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 55.4 – 55.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (dt, J = 8.0, 1.1 Hz, 1H), 7.79 – 7.72 (m, 2H), 7.65 – 7.58 (m, 2H), 7.55 – 7.44 (m, 5H), 7.42 – 7.35 (m, 3H), 7.34 – 7.28 (m, 2H), 7.16 – 7.00 (m, 3H), 5.03 (dd, *J* = 13.7, 2.3 Hz, 1H), 3.84 – 3.74 (m, 1H), 3.65 – 3.58 (m, 1H), 2.80 (s, 3H), 2.48-2.35 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 149.3, 147.3, 141.5 (d, *J* = 5.9 Hz), 140.6, 134.3, 133.1 (d, *J* = 66.4 Hz), 132.1, 132.0 (d, *J* = 66.5 Hz), 131.9 (dd, *J* = 34.5, 2.7 Hz), 130.7, 130.6 (dd, *J* = 15.3, 9.4 Hz), 128.7 (dd, *J* = 34.6, 11.9 Hz), 127.8, 127.1, 126.9 (d, *J* = 13.1 Hz), 125.9, 120.5, 45.1 (d, *J* = 8.3 Hz), 32.6 (d, *J* = 2.7 Hz), 32.5 (d, *J* = 70.7 Hz), 23.7. ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.73 (s). HRMS(ESI) calcd. for $C_{30}H_{25}N_2O_2P$ [$(M+H)^+$] 477.1727, found: 477.1736.

5-((diphenylphosphoryl)methyl)-2-methoxy-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3s) and 5-((diphenylphosphoryl)methyl)-4-methoxy-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3s')



White solid (80%, 78.8 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 67.6 – 69.4 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 – 8.20 (m, 1H), 8.04 (d, *J* = 7.9 Hz, 0.7H), 7.88 (d, *J* = 2.70 Hz, 0.30H), 7.80 – 7.37 (m, 11H), 7.36 – 7.27 (m, 2.70H), 7.10 (d, *J* = 8.4 Hz, 0.30H), 6.85 (d, *J* = 8.1 Hz, 0.69H), 6.71 (dd, *J* = 8.4, 2.8 Hz, 0.30H), 5.46 (dd, *J* = 14.0, 1.1 Hz, 0.69H), 5.04 (dd, *J* = 13.7, 2.3 Hz, 0.30H), 4.15 – 4.06 (m, 0.7H), 3.87 – 3.78 (m, 1.22H), 3.75 – 3.60 (m, 2.40H), 3.51 (dd, *J* = 14.0, 4.1 Hz, 0.68H), 2.55 – 2.27 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.9, 161.7, 159.3, 155.0, 149.0, 148.9, 147.7, 134.0, 134.2, 134.1, 133.7, 133.2, 132.8 (d, *J* = 9.6 Hz), 132.1 (d, *J* = 8.0 Hz), 132.0, 131.8 (d, *J* = 2.5 Hz), 131.7 (d, *J* = 2.5 Hz), 131.6 (d, *J* = 2.7 Hz), 131.0 (d, *J* = 9.3 Hz), 130.7 (d, *J* = 9.3 Hz), 130.5 (d, *J* = 9.5 Hz), 130.4 (d, *J* = 9.4 Hz), 129.7, 129.4, 129.3 (d, *J* = 2.6 Hz), 129.0, 128.9 (d, *J* = 11.7 Hz), 128.8, 128.7 (d, *J* = 1.5 Hz), 128.6, 128.5 (d, *J* = 11.8 Hz), 127.7, 127.4 (d, *J* = 41.2 Hz), 126.9 (d, *J* = 25.9 Hz), 121.0, 120.9, 120.0, 118.8, 113.1, 111.7, 55.7, 55.3, 45.7 (d, *J* = 9.3 Hz), 43.8 (d, *J* = 3.8 Hz), 33.7 (d, *J* = 70.7Hz), 31.5 (d, *J* = 68.7 Hz), 30.7(d, *J* = 3.0 Hz), 25.2 (d, *J* = 2.4 Hz). ^{31}P NMR (162 MHz, $CDCl_3$) δ 29.85 (s, 0.30P), 29.69 (s, 0.70P). HRMS(ESI) calcd. for $C_{30}H_{25}N_2O_3P$ [$(M+H)^+$] 493.1676, found: 493.1684.

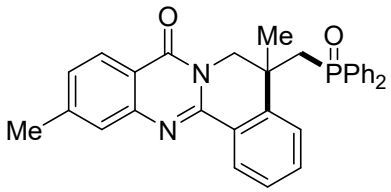
5-((diphenylphosphoryl)methyl)-5-methyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3t)



White solid (96%, 91.4 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 176.8 – 178.6 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 – 8.20 (m, 2H), 7.80 – 7.71 (m, 2H), 7.55 – 7.40 (m, 4H), 7.36 – 7.23 (m, 6H), 7.21 – 7.09 (m, 4H), 4.96 (d, *J* = 13.7 Hz, 1H), 3.46 (dd, *J* = 13.7, 4.3 Hz, 1H), 2.61 – 2.40 (m, 2H), 1.93 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 149.0, 147.9, 141.8 (d, *J* = 4.9 Hz), 135.1, 134.3, 134.1, 132.4, 131.8, 131.4, 131.2 (dd, *J* = 60.4, 2.6 Hz), 130.1 (dd, *J* = 22.4, 9.2 Hz), 128.5 (d, *J* = 11.6 Hz), 128.1 (dd, *J* = 14.1, 11.7 Hz), 127.7, 126.7 (d, *J* = 45.8 Hz), 125.9, 120.6, 51.5 (d, *J* = 11.2 Hz), 37.3 (d, *J* = 70.7 Hz), 36.4 (d, *J* = 3.5 Hz), 23.72. HRMS(ESI) calcd. for $C_{30}H_{25}N_2O_2P$ [$(M+H)^+$] 477.1727, found: 477.1736.

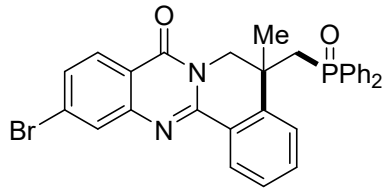
5-((diphenylphosphoryl)methyl)-5,11-dimethyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-

one (3u)



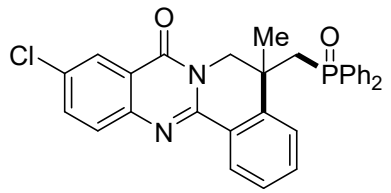
White solid (80%, 78.4 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 197.1 – 199.0 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (dd, *J* = 7.7, 1.2 Hz, 1H), 8.15 (d, *J* = 8.1 Hz, 1H), 7.59 (s, 1H), 7.54 – 7.46 (m, 3H), 7.38 – 7.32 (m, 1H), 7.31 – 7.23 (m, 6H), 7.21 – 7.08 (m, 4H), 4.95 (d, *J* = 13.7 Hz, 1H), 3.44 (dd, *J* = 13.7, 4.5 Hz, 1H), 2.56 (dd, *J* = 15.2, 8.2 Hz, 1H), 2.52 (s, 3H), 2.48 – 2.40 (m, 1H), 1.94 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.6, 149.1, 148.0, 145.3, 141.7 (d, *J* = 4.7 Hz), 134.7 (d, *J* = 99.8 Hz), 131.8 (d, *J* = 99.3 Hz), 131.7, 131.3, 131.2 (dd, *J* = 63.0, 2.6 Hz), 130.2 (dd, *J* = 24.4, 9.1 Hz), 128.6 (d, *J* = 11.6 Hz), 128.2 (d, *J* = 3.0 Hz), 128.1, 127.9, 127.6 (d, *J* = 26.7 Hz), 126.9, 126.0, 118.2, 51.6 (d, *J* = 11.6 Hz), 37.2(d, *J* = 71.4 Hz), 36.4 (d, *J* = 3.3 Hz), 23.7, 21.9. ^{31}P NMR (162 MHz, $CDCl_3$) δ 27.67 (s). HRMS(ESI) calcd. for $C_{31}H_{27}N_2O_2P$ [$(M+H)^+$] 491.1883, found: 491.1897.

11-bromo-5-((diphenylphosphoryl)methyl)-5-methyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3v)



White solid (78%, 86.4 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 200.7 – 201.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.14 (dd, *J* = 39.9, 6.7 Hz, 2H), 7.96 (s, 1H), 7.58 – 7.43 (m, 4H), 7.38 – 7.10 (m, 10H), 4.94 (d, *J* = 13.3 Hz, 1H), 3.46 (d, *J* = 12.1 Hz, 1H), 2.57 – 2.41 (m, 2H), 1.93 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 150.2, 149.0, 142.0 (d, *J* = 5.0 Hz), 134.6 (d, J = 99.7 Hz), 132.3, 132.0 (d, *J* = 99.4 Hz), 131.4 (dd, *J* = 59.7, 2.7 Hz), 130.3 (dd, *J* = 28.4, 8.0 Hz), 130.1 (d, *J* = 38.6 Hz), 129.1, 128.7, 128.6 (d, *J* = 4.0 Hz), 128.4, 128.3 (d, *J* = 2.0 Hz), 127.9 (d, *J* = 5.3 Hz), 126.0, 119.4, 51.5 (d, *J* = 11.1 Hz), 37. 5 (d, *J* = 71.7 Hz), 36.4 (d, *J* = 3.3 Hz), 23.8. ^{31}P NMR (162 MHz, $CDCl_3$) δ 27.28 (s). HRMS(ESI) calcd. for $C_{30}H_{24}BrN_2O_2P$ [$(M+Na)^+$] 577.0651, found: 577.0663.

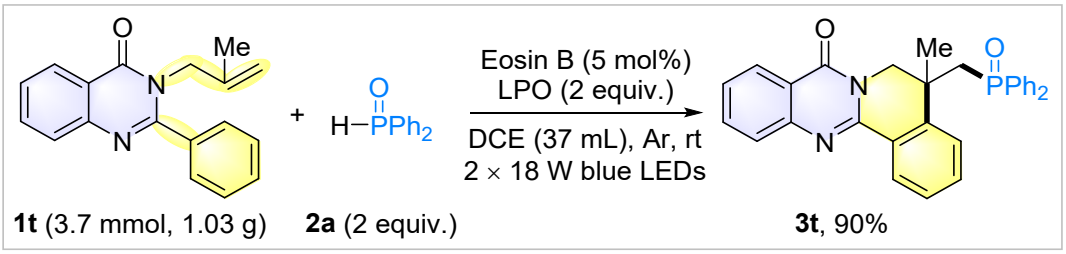
10-chloro-5-((diphenylphosphoryl)methyl)-5-methyl-5,6-dihydro-8H-isoquinolino[1,2-b]quinazolin-8-one (3w)



White solid (81%, 82.6 mg, eluent: petroleum ether/ethyl acetate = 1/2); mp 230.5 – 232.3 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 – 8.10 (m, 2H), 7.74 – 7.67 (m, 2H), 7.56 – 7.46 (m, 4H), 7.34 – 7.15 (m, 9H), 4.95 (dd, *J* = 13.6, 5.6 Hz, 1H), 3.48 (dd, *J* = 8.3, 5.3 Hz, 1H), 2.58 – 2,41 (m, 2H), 1.93 (d, *J* = 4.8 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.7, 149.4, 146.5, 142.1 (d, *J* = 5.1 Hz), 134.8, 134.6 (d, *J* = 99.6 Hz), 132.3 (d, *J* = 99.3 Hz), 132.2 (d, *J* = 18.1 Hz), 131.7, 131.4 (d, *J* = 58.1 Hz), 130.8 (d,

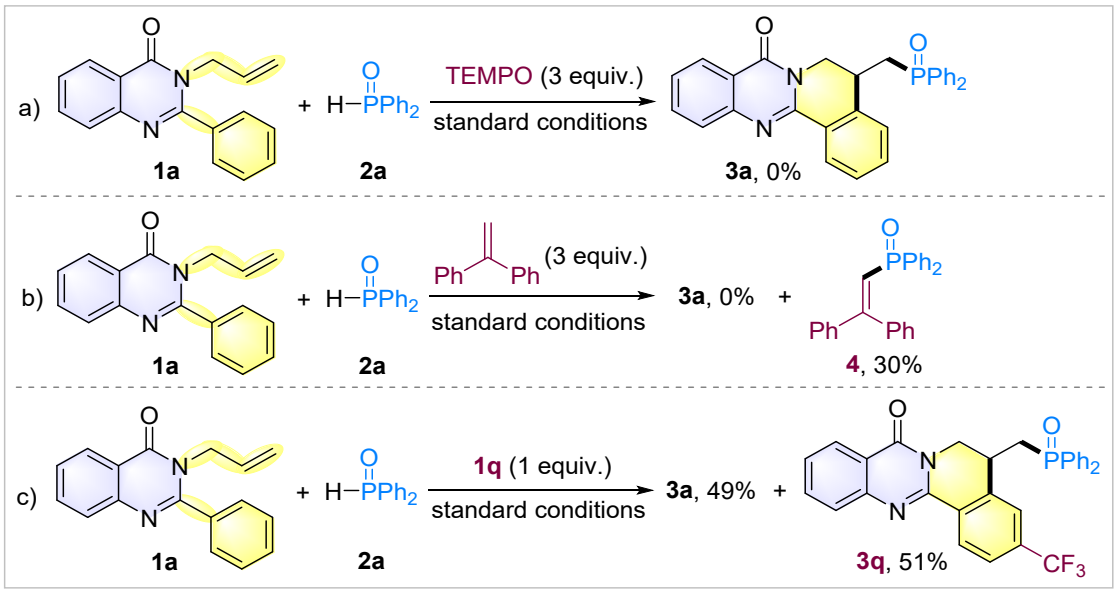
J = 11.4 Hz), 130.2 (dd, J = 17.2, 9.1 Hz), 129.4, 129.0 (d, J = 13.0 Hz), 128.5 (dd, J = 34.9, 11.7 Hz), 128.2, 127.9 (d, J = 5.2 Hz), 126.2 (d, J = 45.7 Hz), 121.7, 51.6 (d, J = 10.8 Hz), 37.6 (d, J = 70.7 Hz) , 36.5 (d, J = 3.2 Hz), 23.9. ^{31}P NMR (162 MHz, $CDCl_3$) δ 27.06 (s). HRMS(ESI) calcd. for $C_{30}H_{24}ClN_2O_2P$ [(M+H)$^+$] 511.1337, found: 511.1347.

5. Gram-scale preparation



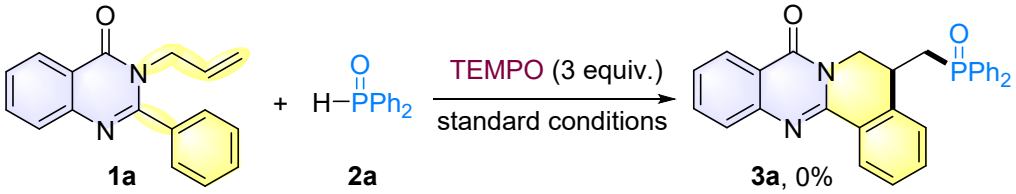
To a 100 mL oven-dried round bottom flask equipped with a magnetic stirring bar was added **1t** (3.7 mmol, 1.02 g), diphenylphosphine oxide **2a** (2 equiv.), LPO (2 equiv.), Eosin B (5 mol%) and DCE (37 mL) under argon. The reaction flask was stirred at room temperature with the irradiation of 2 × 18 W blue LEDs for 16 h. After the reaction was completed, the volatile compounds were removed in vacuo and the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 1/2) to give the desired product **3t** (1.60 g) as white solid in 90% yield.

6. Mechanistic Studies



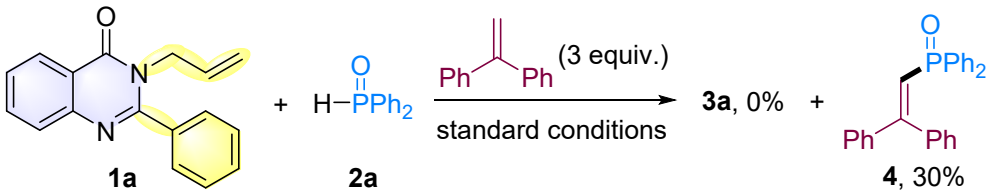
Scheme S2 Control experiments

(1) Control experiment with respect to TEMPO[2,3]



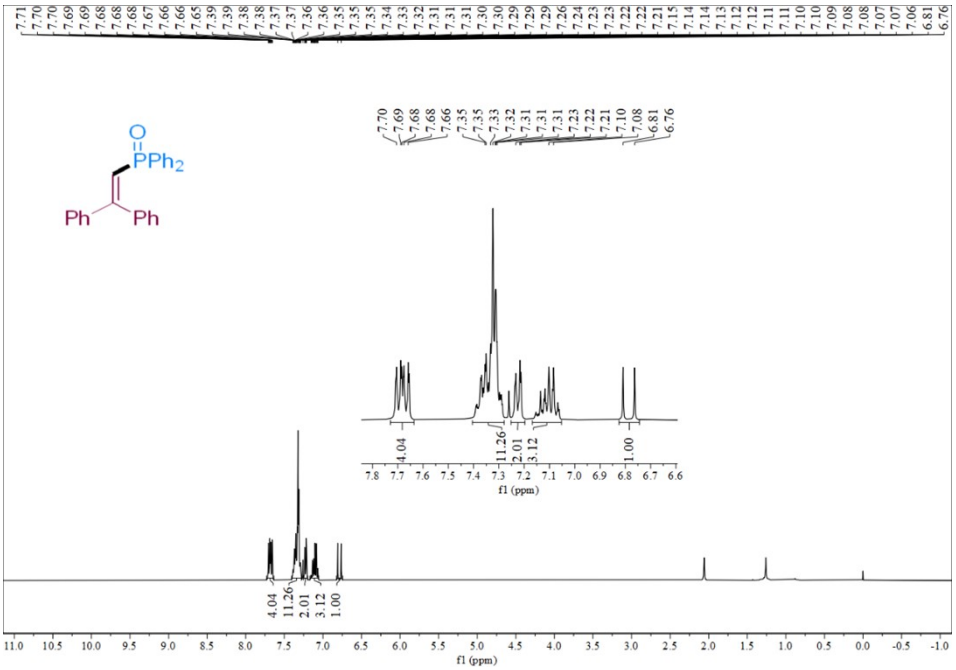
A 10 mL tube was charged with **1a** (0.2 mmol, 52.4 mg), **2a** (0.4 mmol, 80.8 mg), Eosin B (5 mol%, 6.2 mg), LPO (0.4 mmol, 159.4 mg), TEMPO (0.6 mmol, 93.7 mg) and DCE (2 mL) under argon. The resulting solution was stirred at room temperature with the irradiation of an 18 W blue LED. After the specified time, no corresponding product **3a** was detected by TLC analysis, suggesting that this visible light promoted phosphorylation/cyclization protocol might proceed through a radical-based mechanism.

(2) Control experiment with 1,1-diphenylethylene as the radical-trapping reagent[2,3]

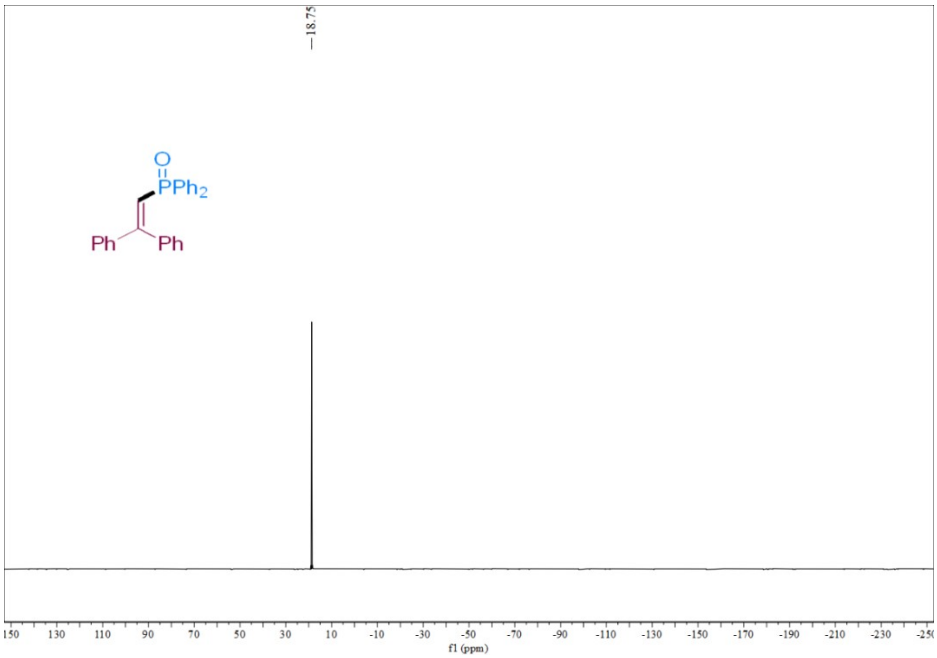


A 10 mL tube was charged with **1a** (0.2 mmol, 52.4 mg), **2a** (0.4 mmol, 80.8 mg), Eosin B (5 mol%, 6.2 mg), LPO (0.4 mmol, 159.4 mg), 1,1-diphenylethylene (0.6 mmol, 108.2 mg) and DCE (2 mL) under argon. The resulting solution was stirred at room temperature with the irradiation of an 18 W blue LED. The product **3a** was not detected and the heck-type product **4** (45.0 mg) was detected and isolated in 30% yield, indicating that phosphoryl radicals might be involved in this radical cascade cyclization reaction. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.64 (m, 4H), 7.40 – 7.28 (m, 11H), 7.25 – 7.20 (m, 2H), 7.17 – 7.05 (m, 3H), 6.79 (d, J = 18.2 Hz, 1H). ^{31}P NMR (162 MHz, $CDCl_3$) δ 18.75 (s).

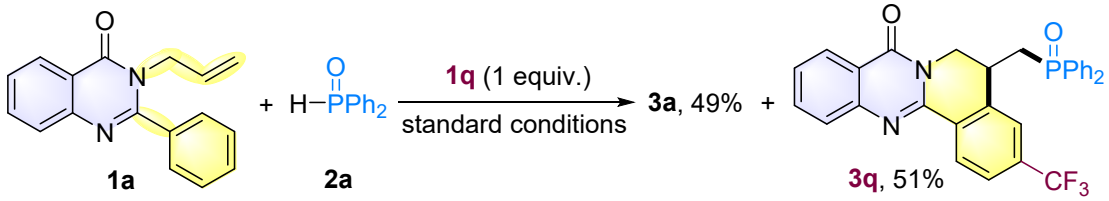
^{1}H NMR of **4** (400 MHz, $CDCl_3$):



^{31}P NMR of **4** (162 MHz, $CDCl_3$):



(3) Competitive reaction experiment with two substrates (1a and 1q) in one-pot



A 10 mL tube was charged with **1a** (0.2 mmol, 52.4 mg), **1q** (0.2 mmol, 66.1 mg), **2a** (0.4 mmol, 80.8 mg), Eosin B (5 mol%, 6.2 mg), LPO (0.4 mmol, 159.4 mg) and DCE (2 mL) under argon. The resulting solution was stirred at room temperature with the irradiation of an 18 W blue LED for 12 h. The volatile compounds were removed in vacuo and the residue was purified by column chromatography to give the targeted phosphorylated dihydroisoquinolino[1,2-b]quinazolinones **3a** and **3q** in 49% and 51% yield respectively. The result indicated that the presence or absence of strong electron-withdrawing group on the 2-aryl ring has no significant effect on the reaction efficiency.

(4) Procedure for emission quenching experiments[4]

All the Eosin B and substrates were dissolved in ethanol. The solutions were excited at 525 nm and fluorescence was measured from 500 nm to 700 nm. In a typical experiment, the emission spectrum of a 5×10^{-6} M solution of Eosin B and different concentration of 3-allyl-2-phenylquinazolinone **1a**, phosphine oxides **2a** and LPO in 10 mm path length quartz cuvette was collected.

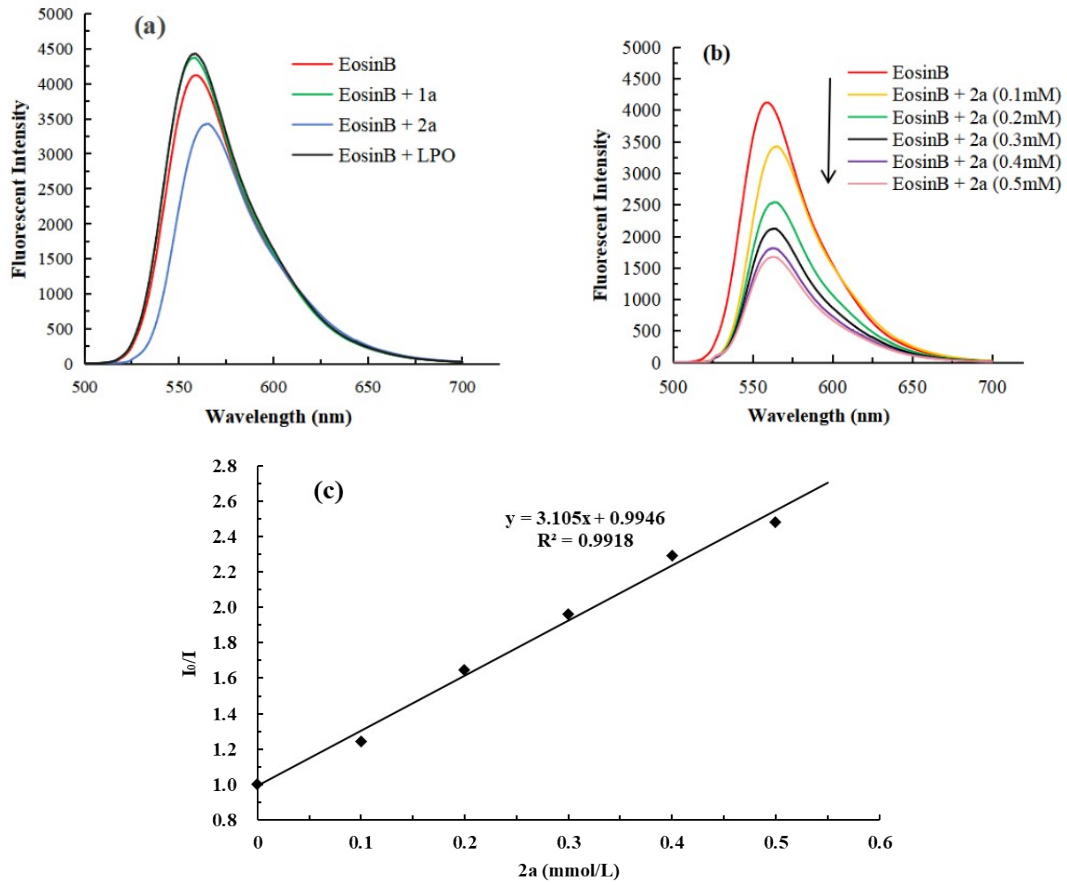
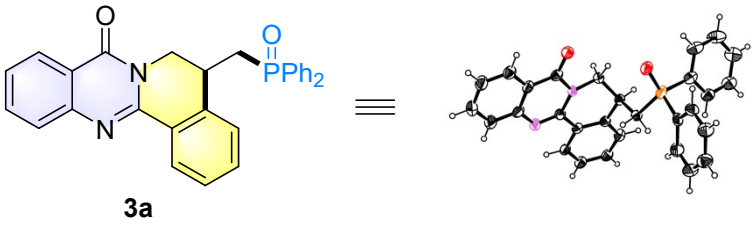


Figure S1 (a) The emission spectra of a 5 × 10^{-6} M solution of Eosin B with various reactants (0.1 mM) in ethanol excited at 525 nm; (b) The emission spectra of a 5 × 10^{-6} M solution of Eosin B with various concentrations of **2a** in ethanol excited at 525 nm; (c) The linear relationship between I_0/I (I_0 and I are the fluorescence intensities before and after the increasing the concentration of **2a**, respectively) and the increasing concentration of **2a**.

7. X-ray structure of 3a[5]



3a

Figure S2 Representative ortep diagram of compound **3a** (CCDC 2363078). Thermal ellipsoids are set at 30% probability level.

The crystals of **3a** were obtained from a solution of dichloromethane and n-hexane upon slow volatilization. The structure of a derivative of product **3a** ($C_{29}H_{23}N_2O_2P$) was determined by X-ray diffraction. The crystal was kept at 150.00 K during data collection. The X-ray data has been deposited at the Cambridge Crystallographic Data Center (CCDC 2363078).

Table S1 Crystal data and structure refinement for **3a**

Empirical formula	$C_{29}H_{23}N_2O_2P$
Formula weight	462.46
Temperature/K	150.00
Crystal system	monoclinic
Space group	P 1 21/c 1
a/Å	14.8254(6)
b/Å	13.4214(5)
c/Å	11.2282(5)
α/°	90
β/°	93.113(1)
γ/°	90
Volume/Å^3	2230.86(16)
Z	4
Dx g/cm^3	1.377
μ/mm^{-1}	0.155
F (000)	968.0
Crystal size/mm^3	0.2 × 0.15 × 0.1
Radiation	MoK\a (λ = 0.71073)
h, k, l max	18, 16, 14
Nref	4544
Tmin, Tmax	0.011, 0.028
Theta (max)	26.417
R (reflections)	0.0687(3587)
wR2 (reflections)	0.1585(4544)
S	1.136
Npar	464

8. References

(1) J. D. Palem, G. R. Alugubelli, R. Bantu, L. Nagarapu, S. Polepalli, S. N. Jain, R. Bathini and V. Manga, *Bioorg. Med. Chem. Lett.*, 2016, **26**, 3014.

(2) B. Mu, L. Zhang, G. Lv, K. Chen, T. Wang, J. Chen, T. Huang, L. Guo, Z. Yang and Y. Wu, *J. Org. Chem.*, 2022, **87**, 10146.

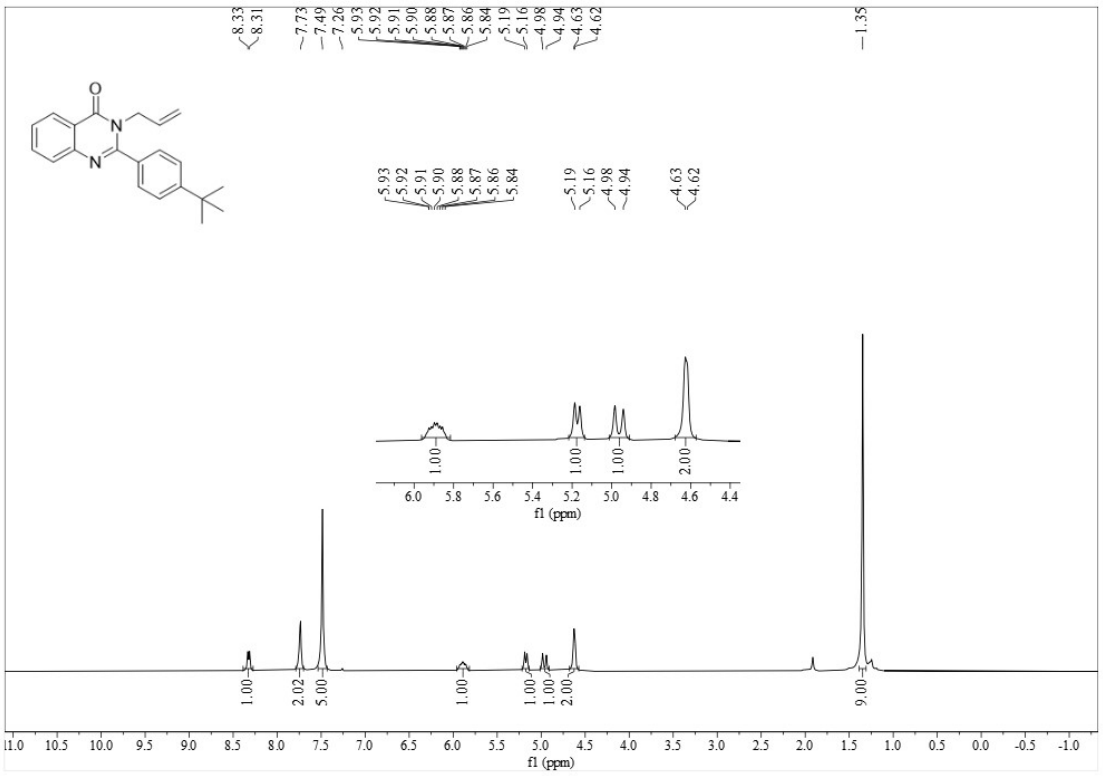
(3) Q.-W. Gui, F. Teng, P. Yu, Y.-F. Wu, Z.-B. Nong, L.-X. Yang, X. Chen, T.-B. Yang and W.-M. He, *Chinese J. Catal.*, 2023, **44**, 111.

(4) (a) X.-Y. Yuan, F.-L.n Zeng, H.-L. Zhu, Y. Liu, Q.-Y Lv, X.-L. Chen, L. Peng and B. Yu, *Org. Chem. Front.*, 2020, **7**, 1884; (b) P. Sun, D. Yang, W. Wei, M. Jiang, Z. Wang, L. Zhang, H. Zhang, Z. Zhang, Y. Wang and H. Wang, *Green Chem.*, 2017, **19**, 4785.

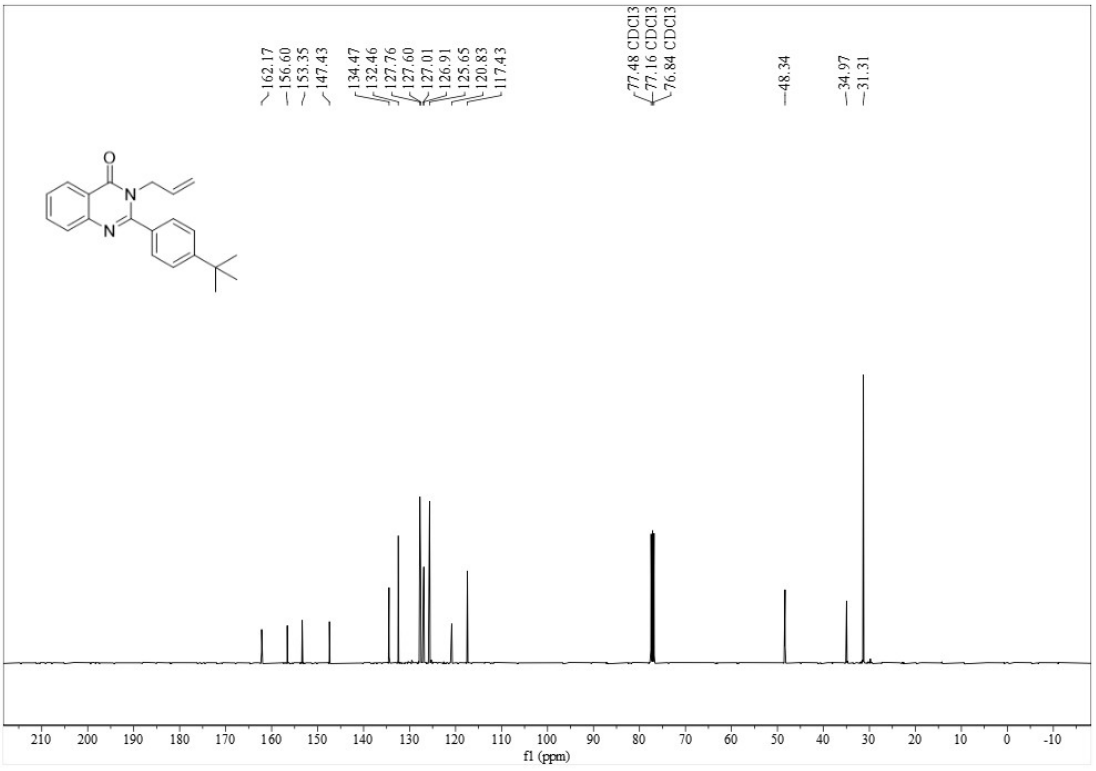
(5) O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A. K. Howard and H. Puschmann, *J. Appl. Cryst.*, 2009, **42**, 339.

9. NMR spectra

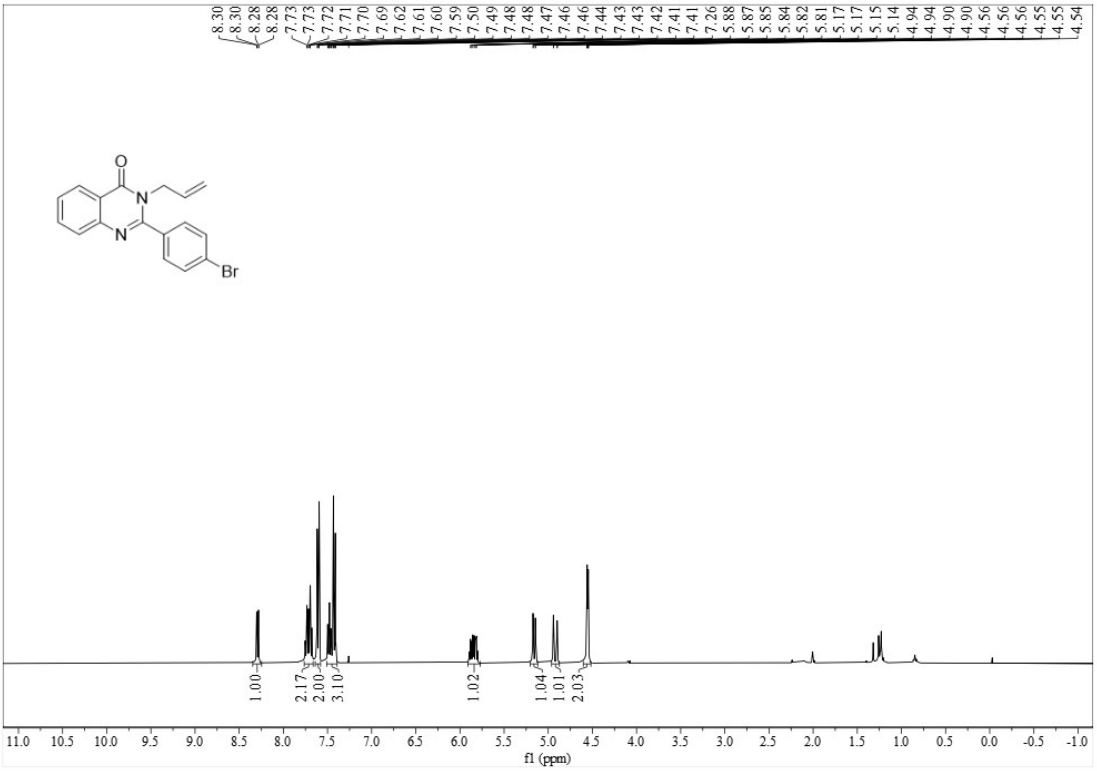
^{1}H NMR of **1m** (400 MHz, $CDCl_3$):



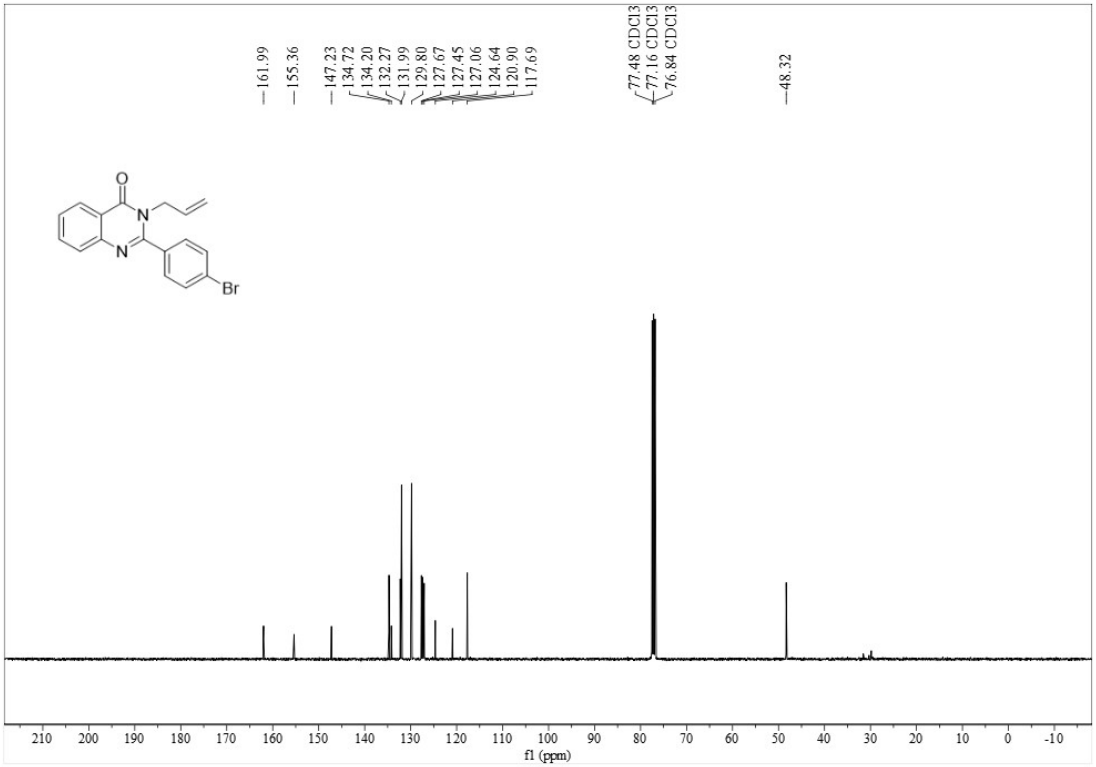
^{13}C NMR of **1m** (100 MHz, $CDCl_3$):



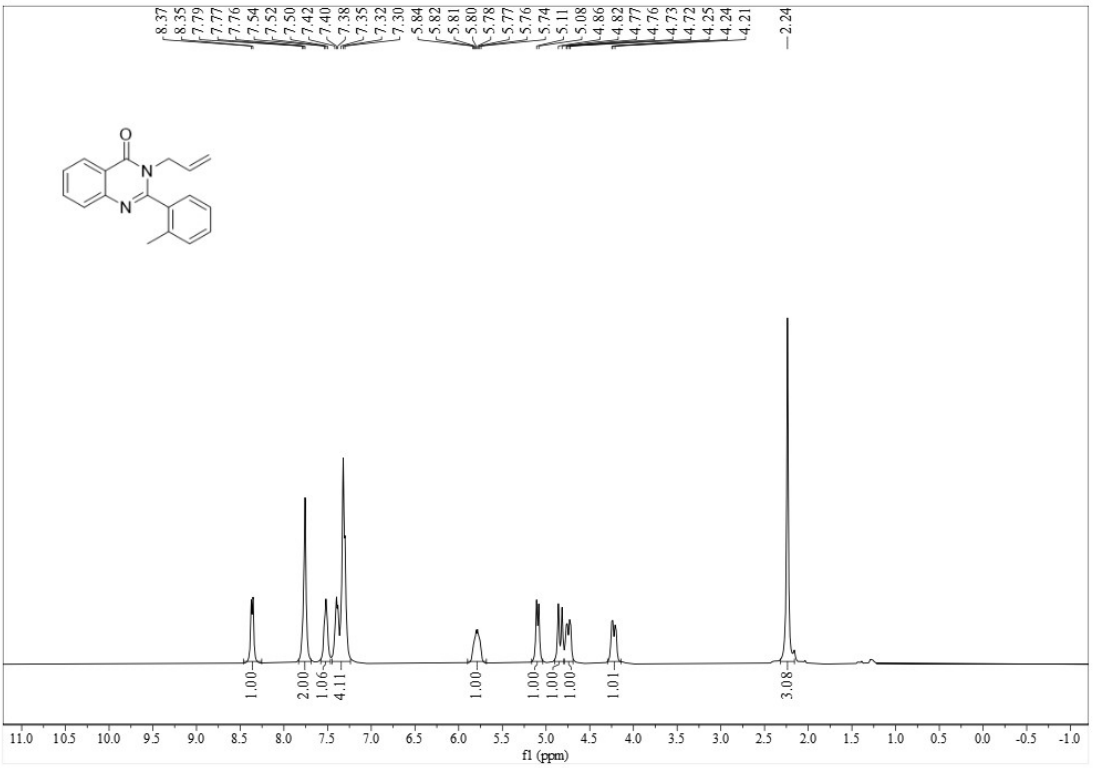
^{1}H NMR of **1p** (400 MHz, $CDCl_3$):



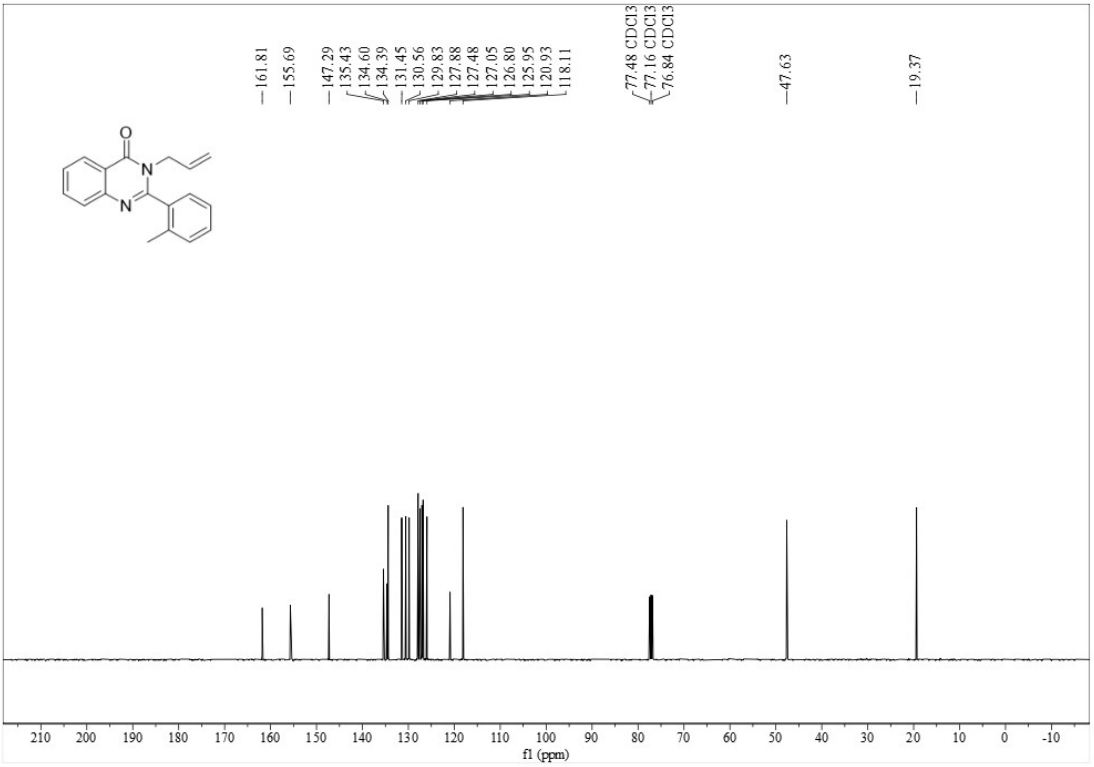
^{13}C NMR of **1p** (100 MHz, $CDCl_3$):



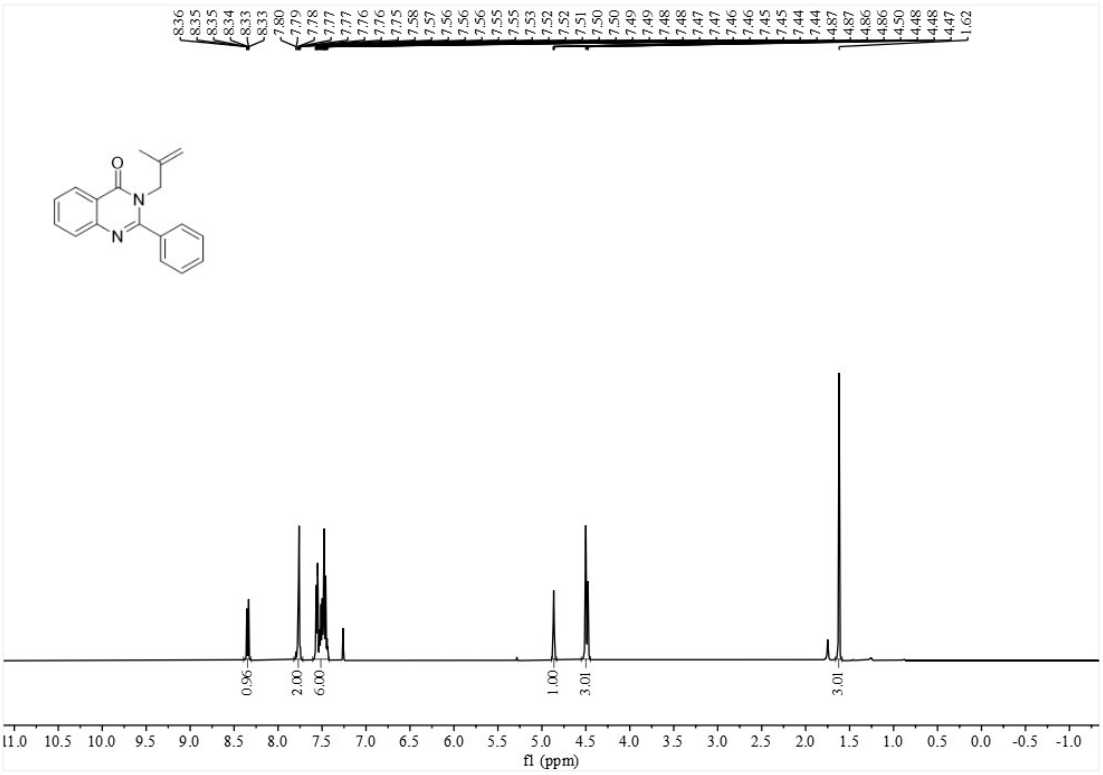
^{1}H NMR of **1r** (400 MHz, $CDCl_3$):



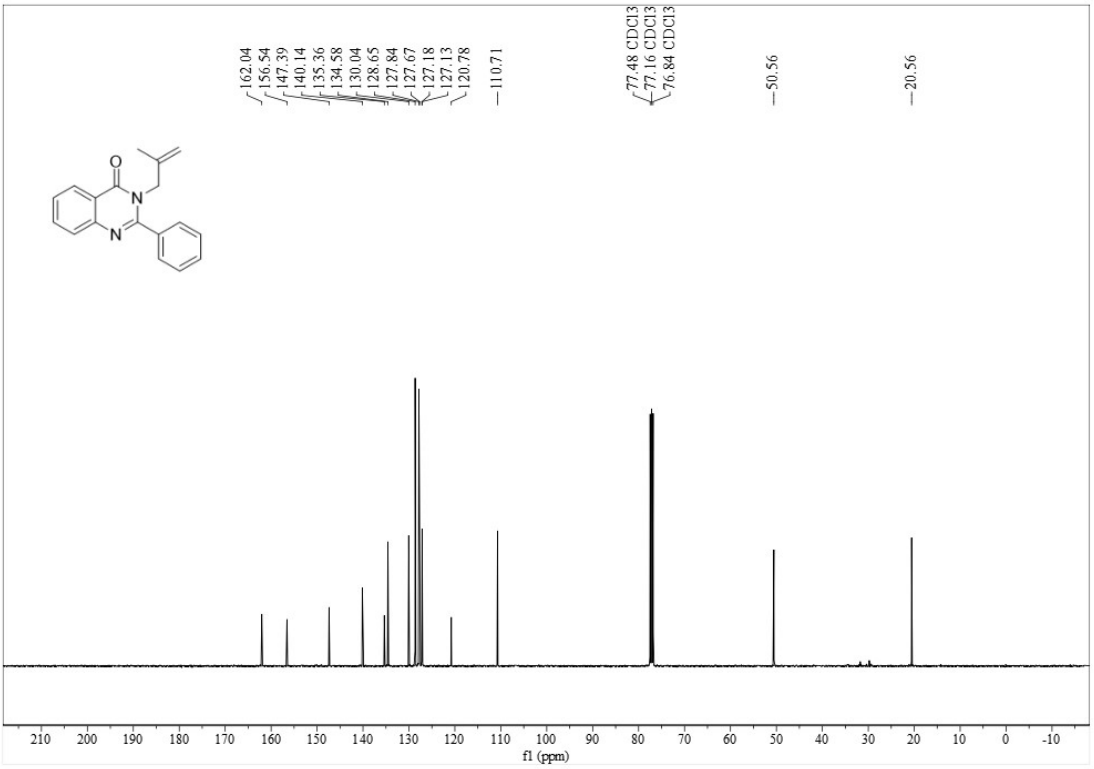
^{13}C NMR of **1r** (100 MHz, $CDCl_3$):



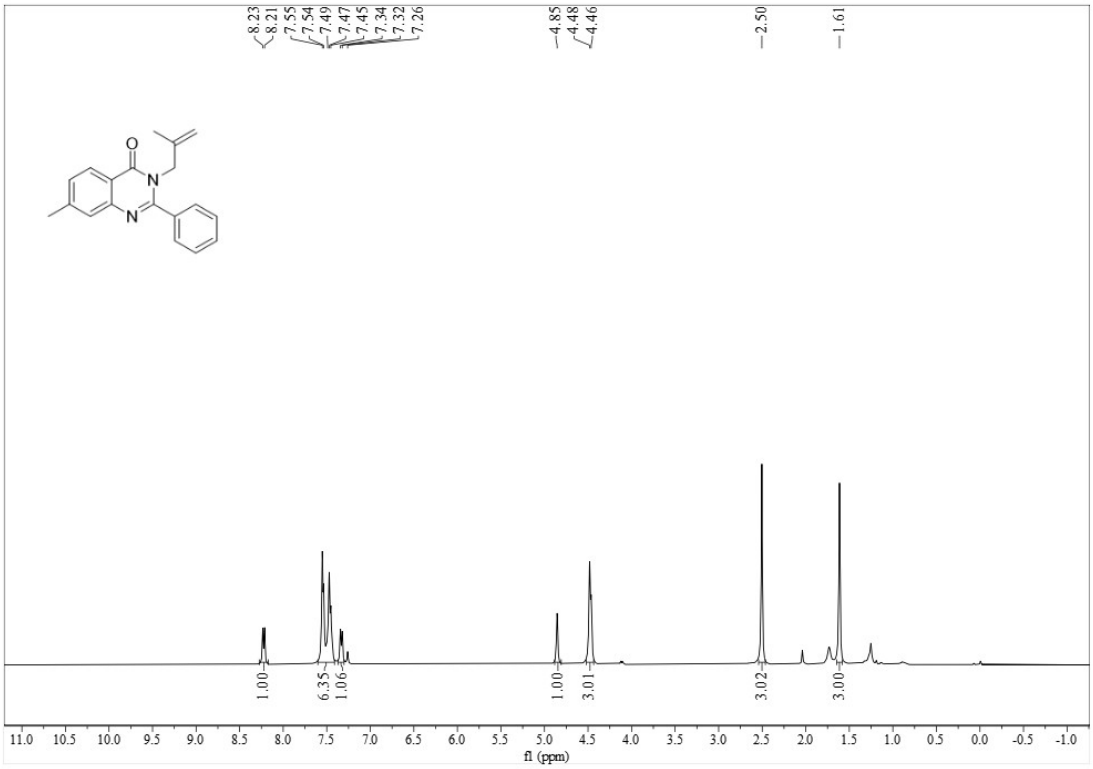
^{1}H NMR of **1t** (400 MHz, $CDCl_3$):



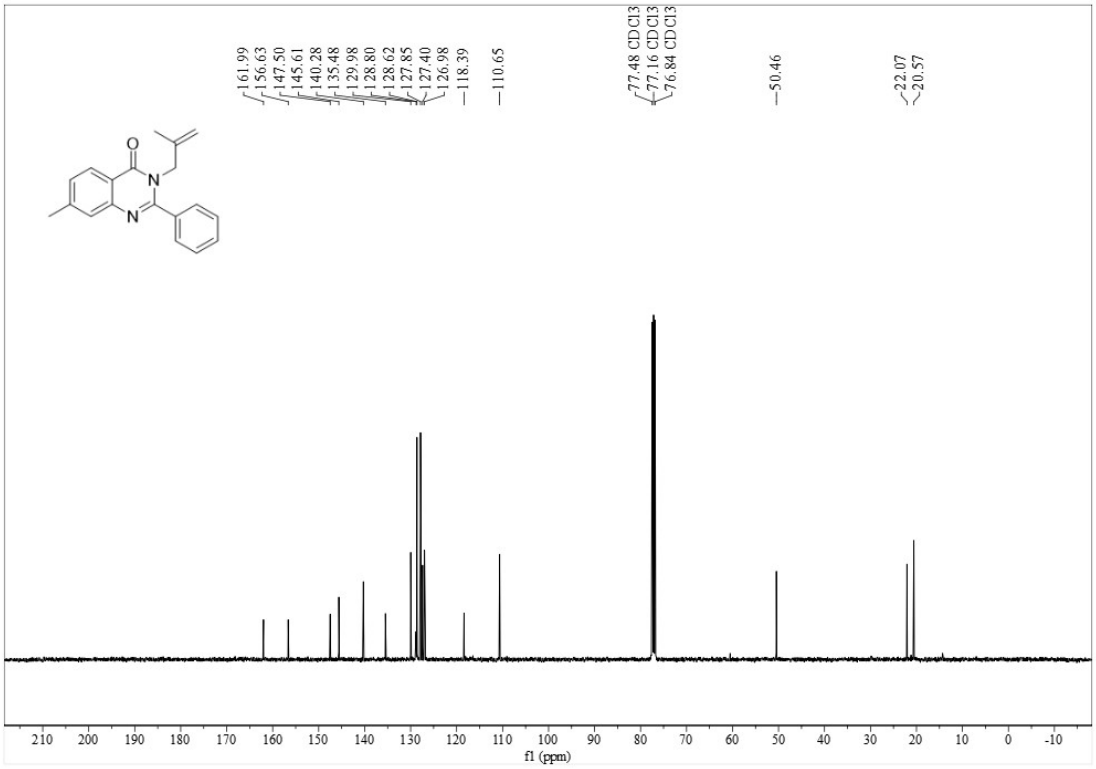
^{13}C NMR of **1t** (100 MHz, $CDCl_3$):



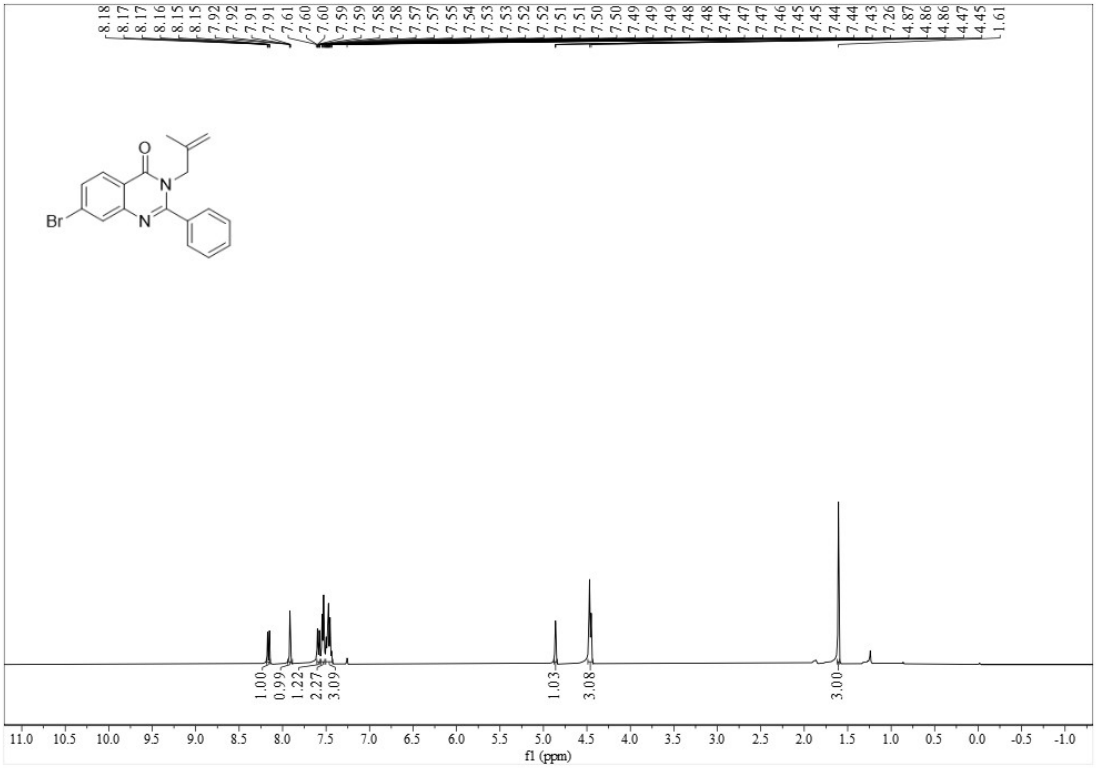
^{1}H NMR of **1u** (400 MHz, $CDCl_3$):



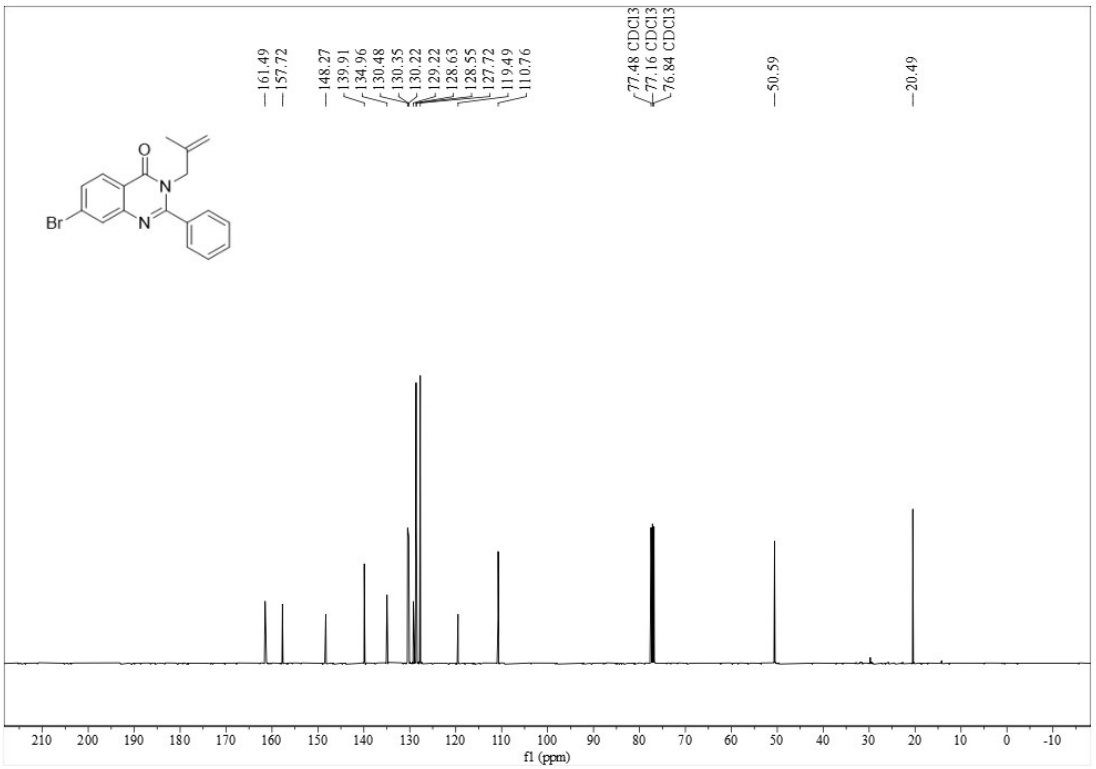
^{13}C NMR of **1u** (100 MHz, $CDCl_3$):



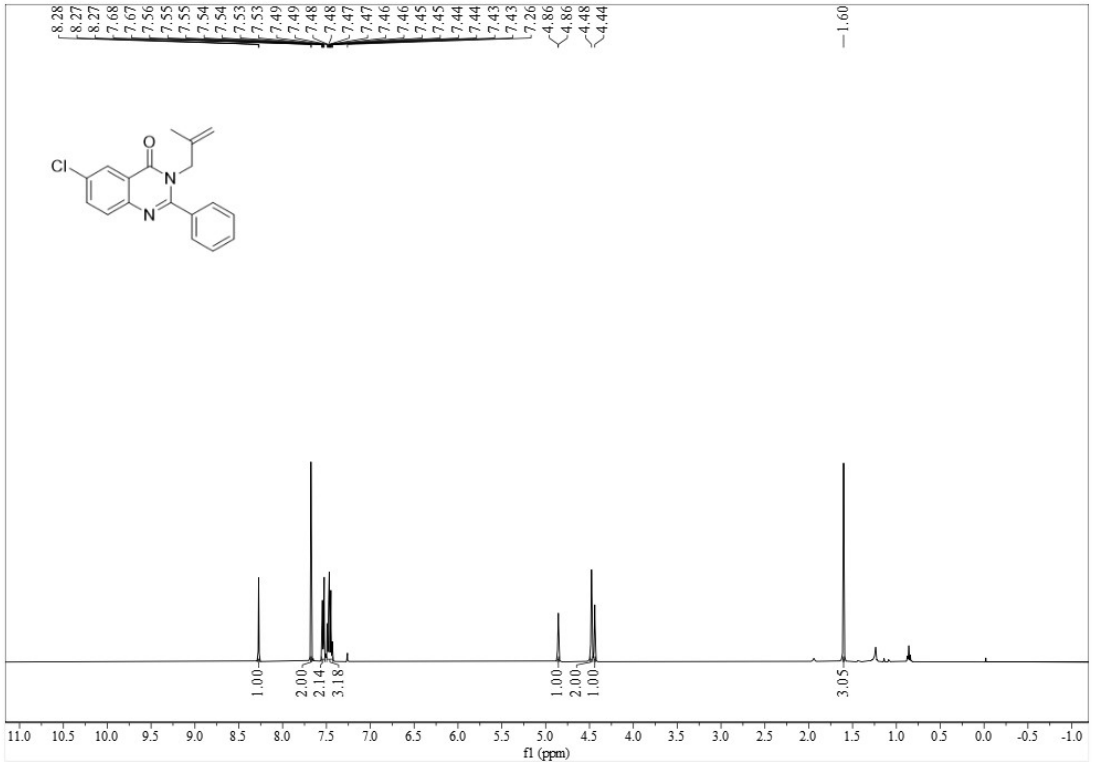
^{1}H NMR of **1v** (400 MHz, $CDCl_3$):



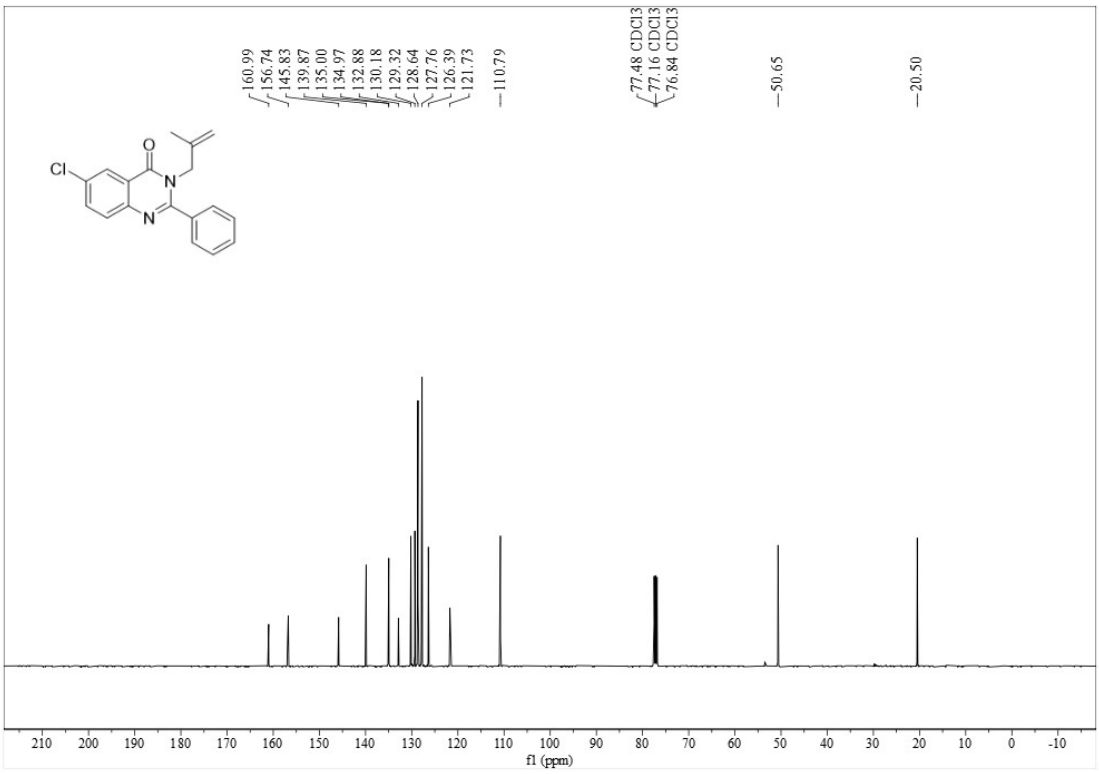
^{13}C NMR of **1v** (100 MHz, $CDCl_3$):



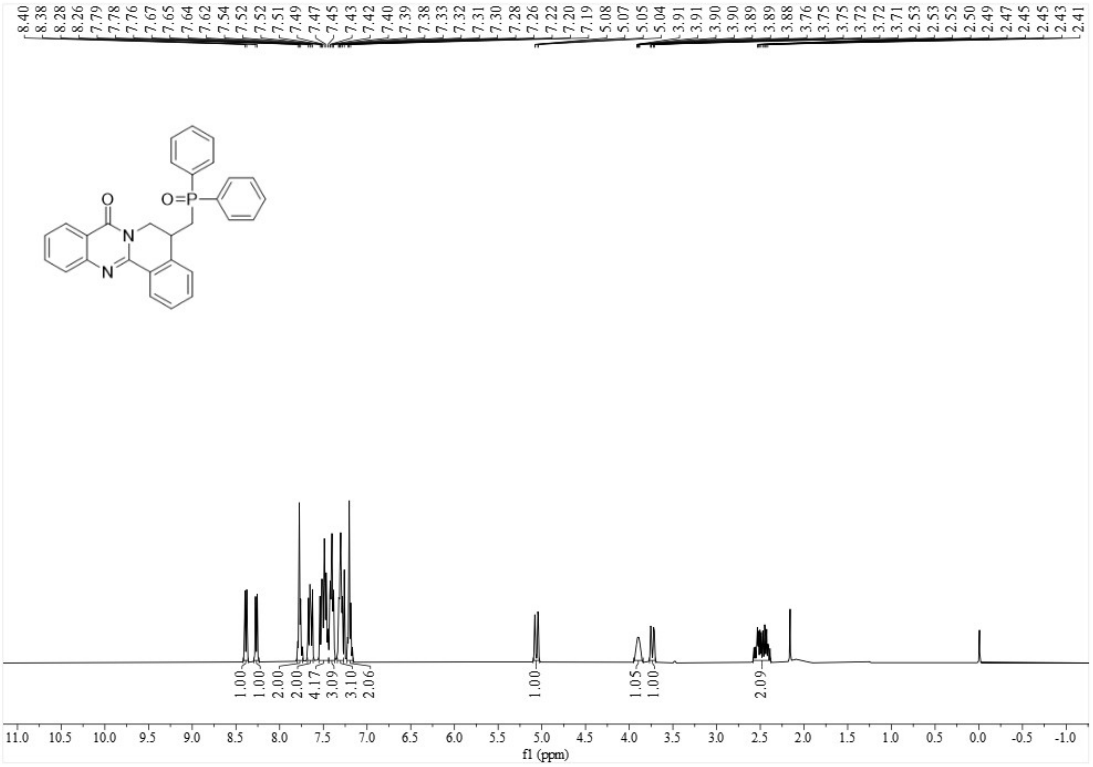
^{1}H NMR of **1w** (400 MHz, $CDCl_3$):



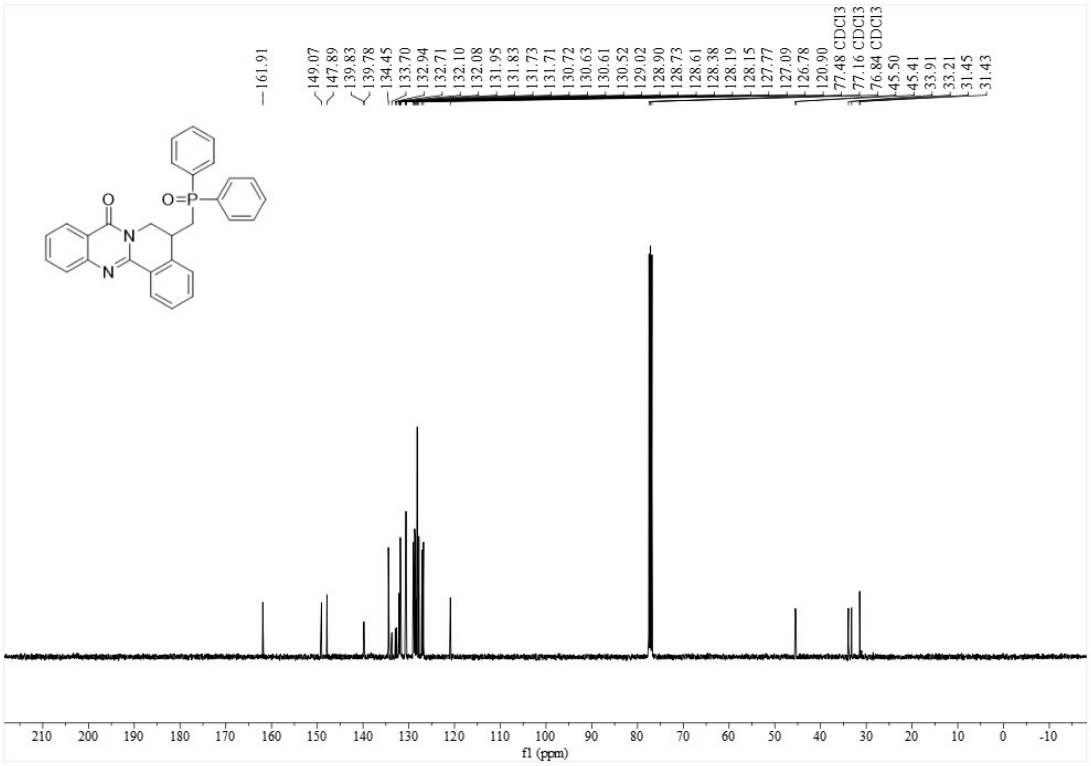
^{13}C NMR of **1w** (100 MHz, $CDCl_3$):



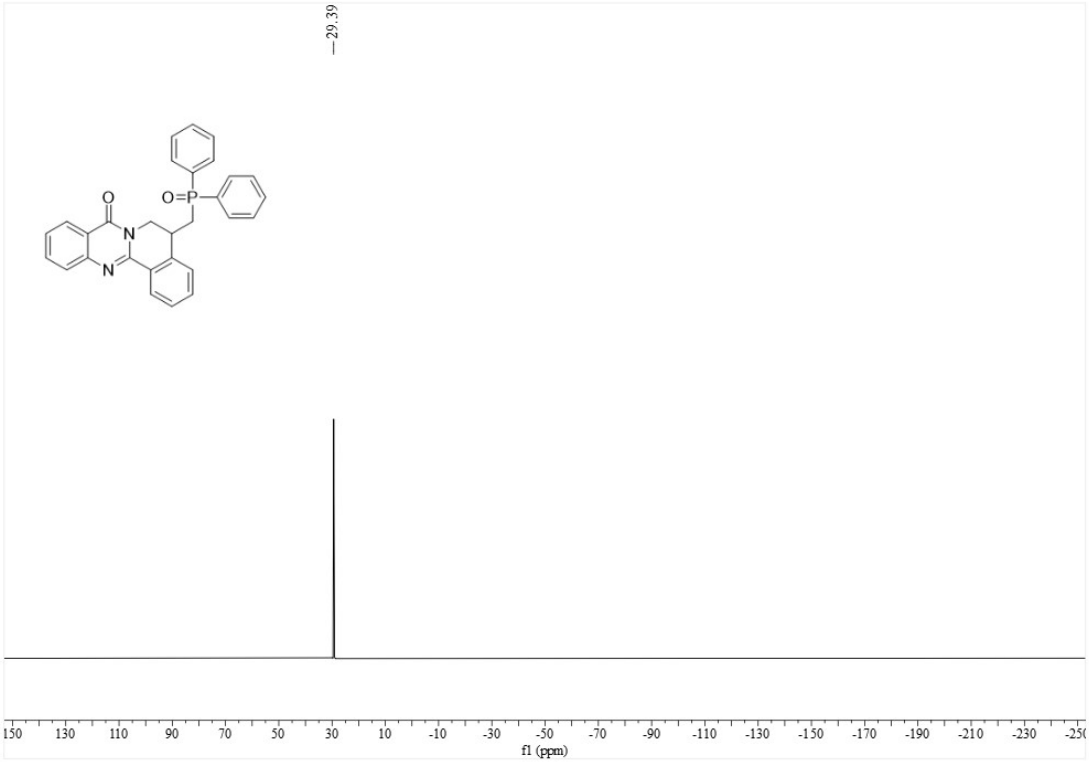
^{1}H NMR of **3a** (400 MHz, $CDCl_3$):



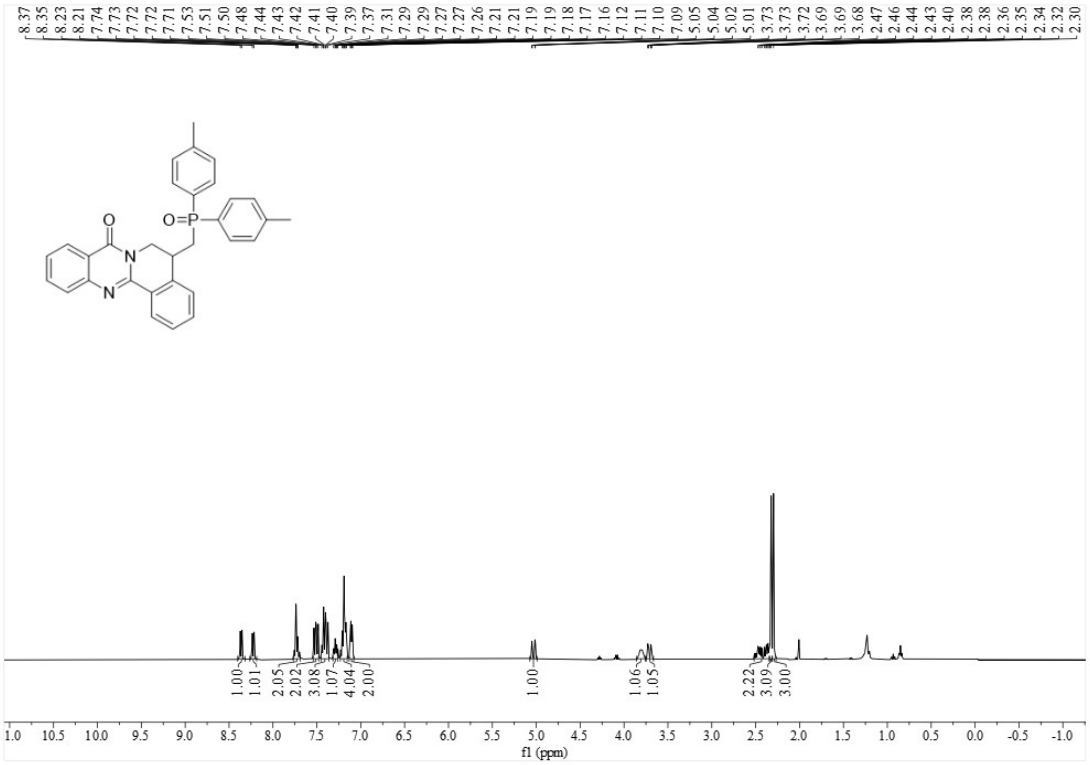
^{13}C NMR of **3a** (100 MHz, $CDCl_3$):



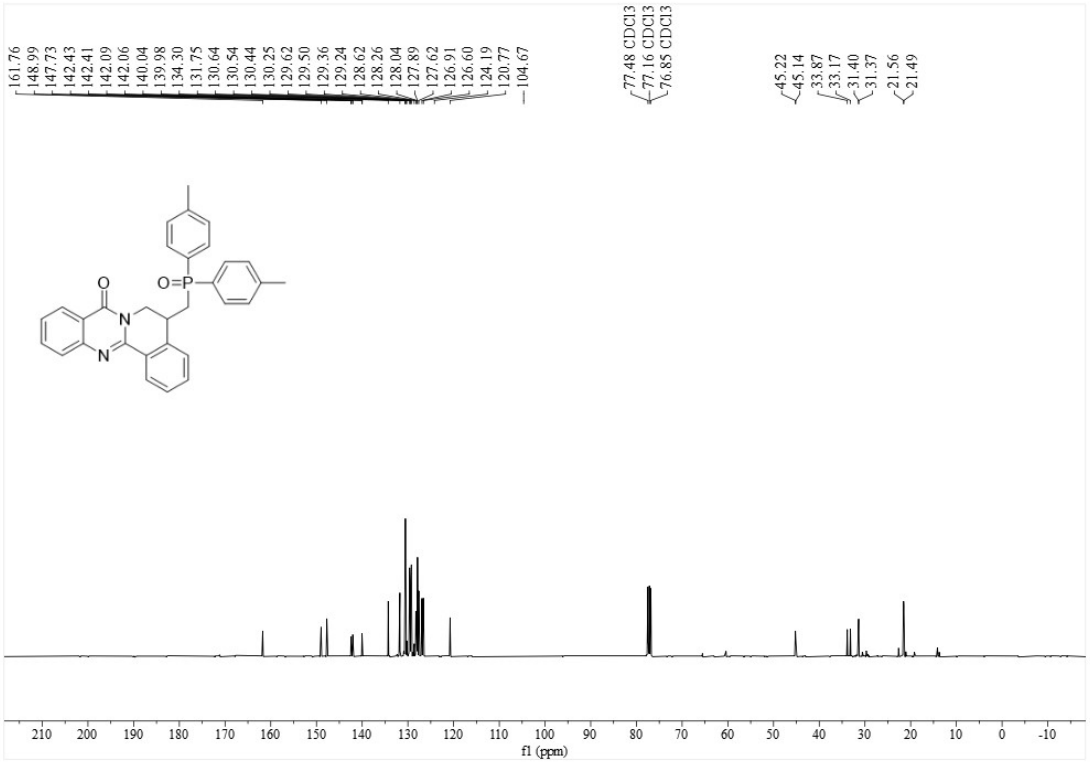
^{31}P NMR of **3a** (162 MHz, $CDCl_3$):



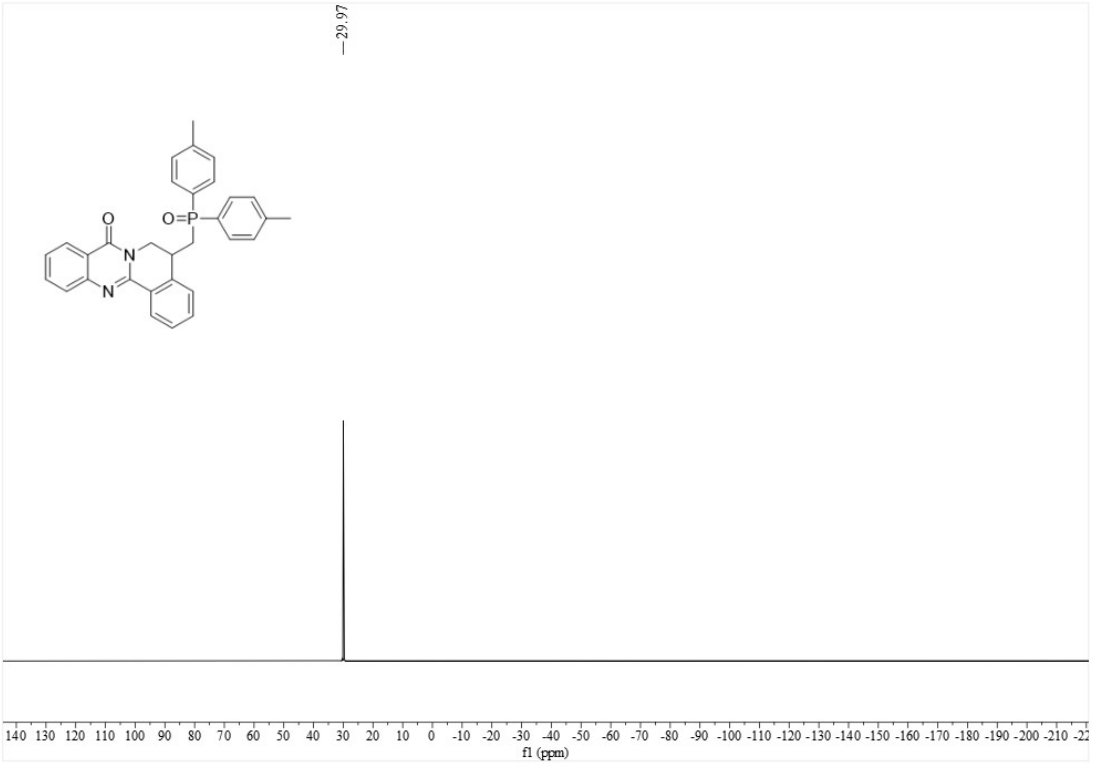
^{1}H NMR of **3b** (400 MHz, $CDCl_3$):



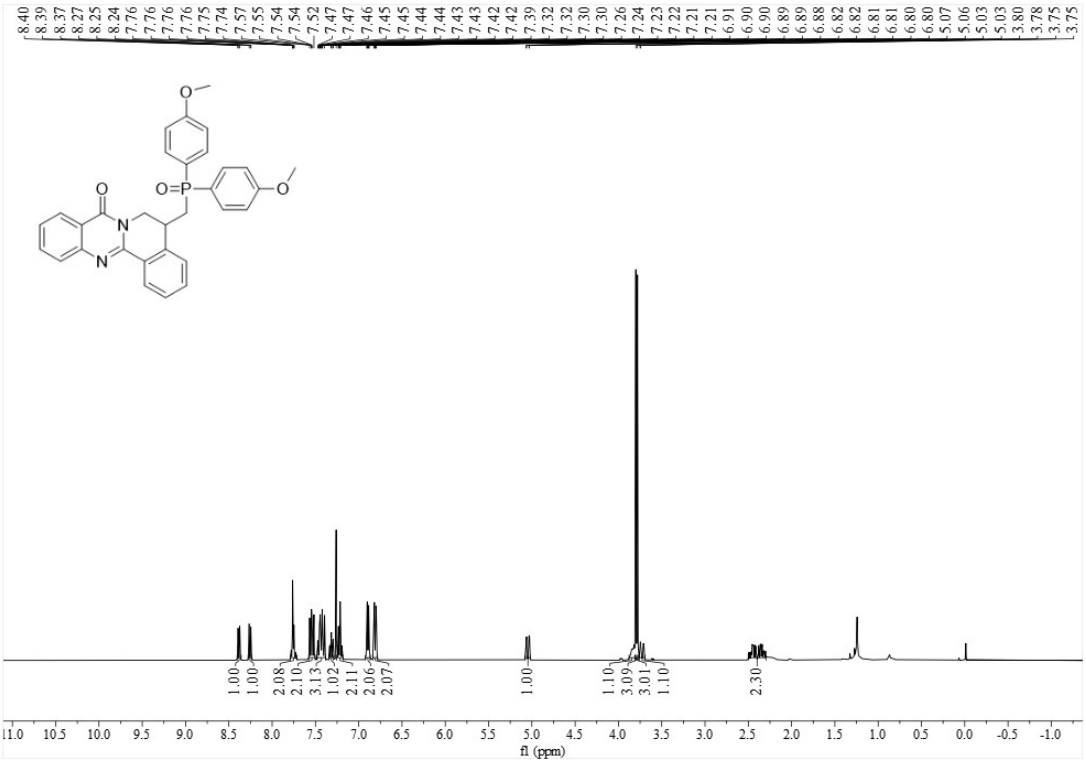
^{13}C NMR of **3b** (100 MHz, $CDCl_3$):



^{31}P NMR of **3b** (162 MHz, $CDCl_3$):



^{1}H NMR of **3c** (400 MHz, $CDCl_3$):



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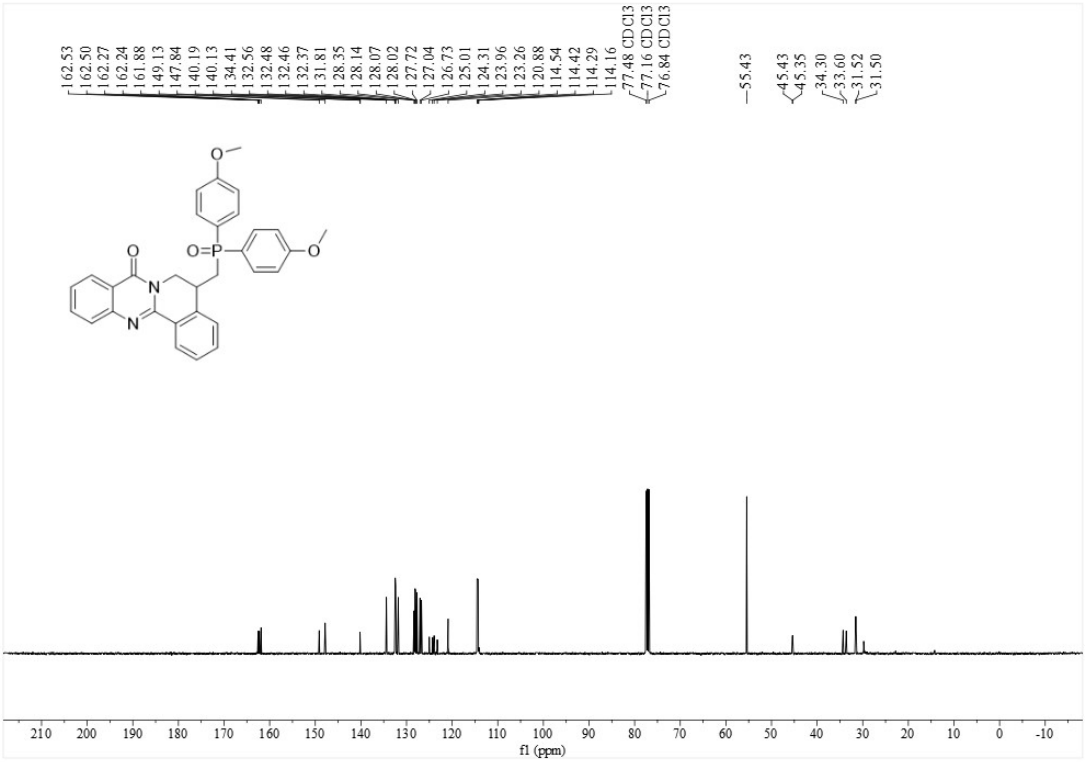
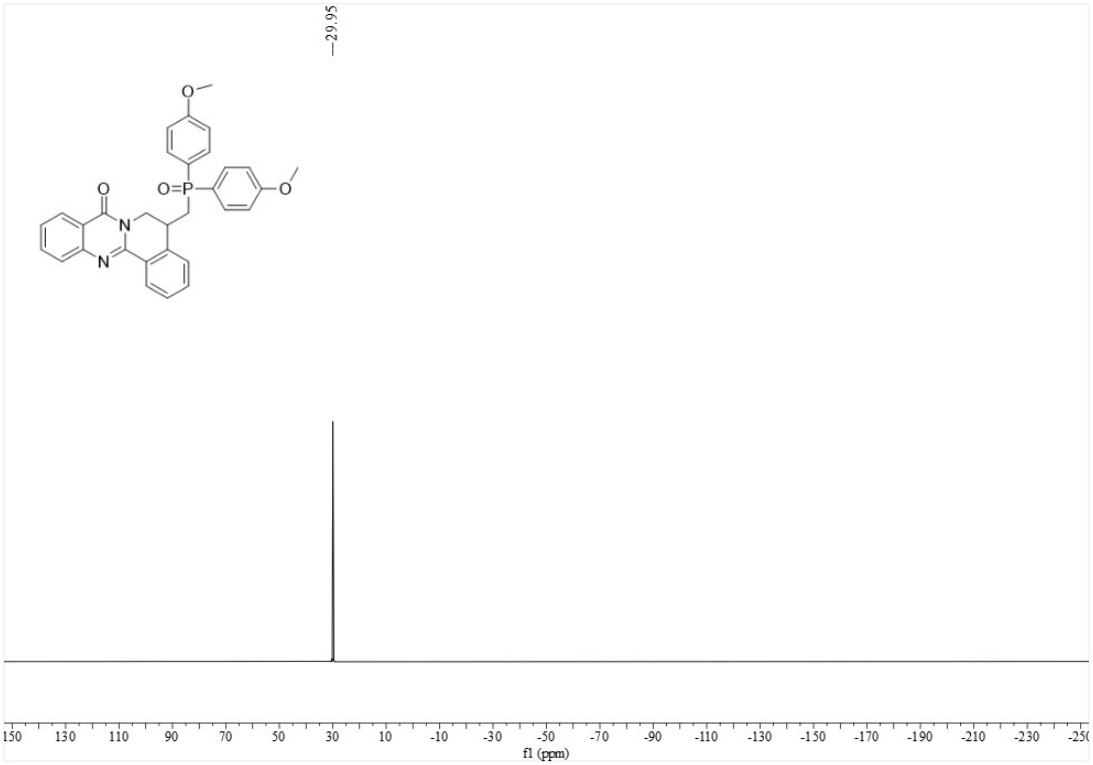
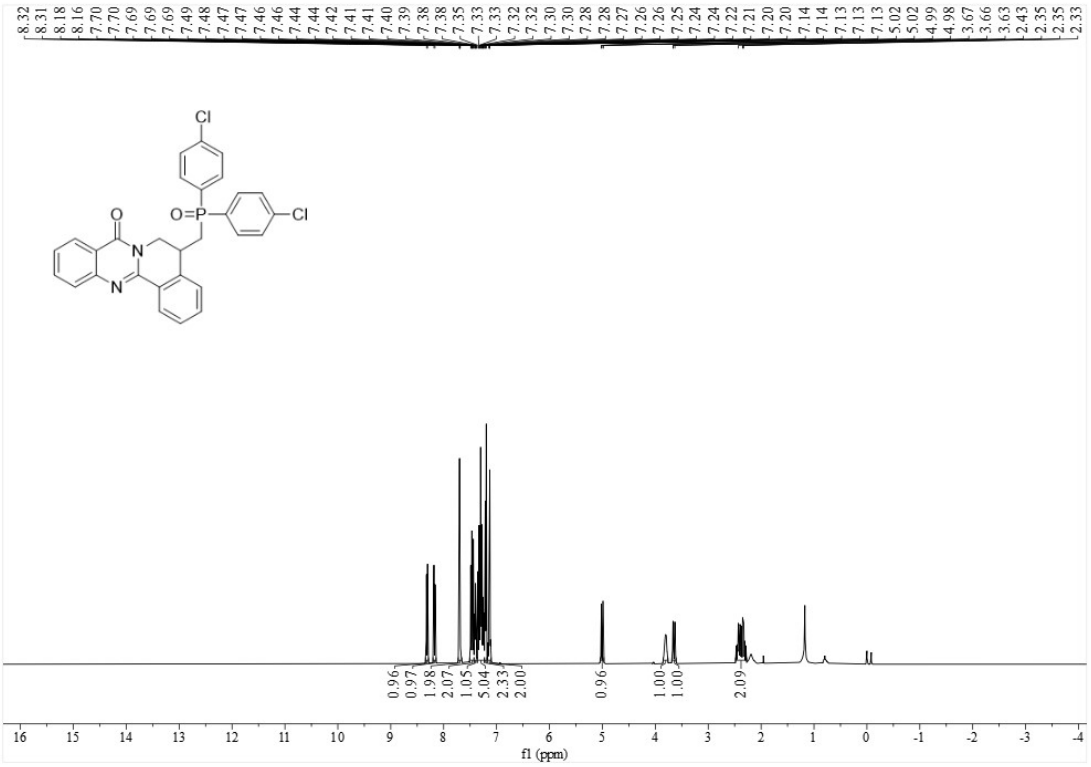


^{31}P NMR of **3c** (162 MHz, $CDCl_3$):



^{1}H NMR of **3d** (400 MHz, $CDCl_3$):



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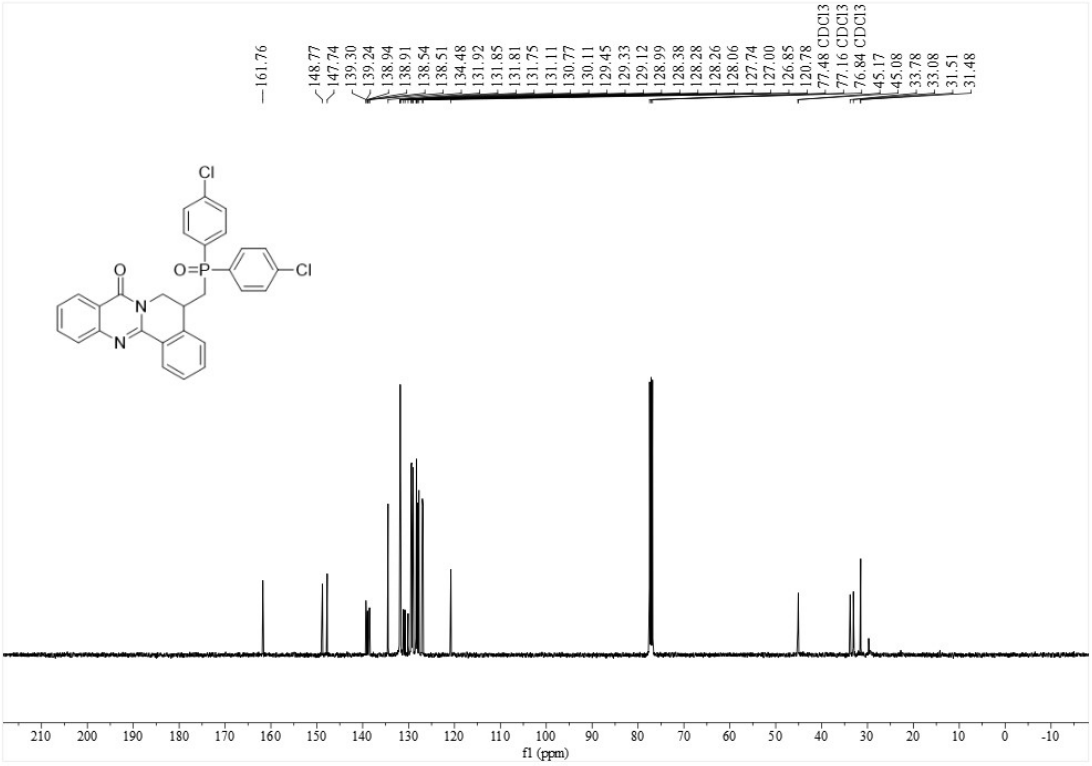

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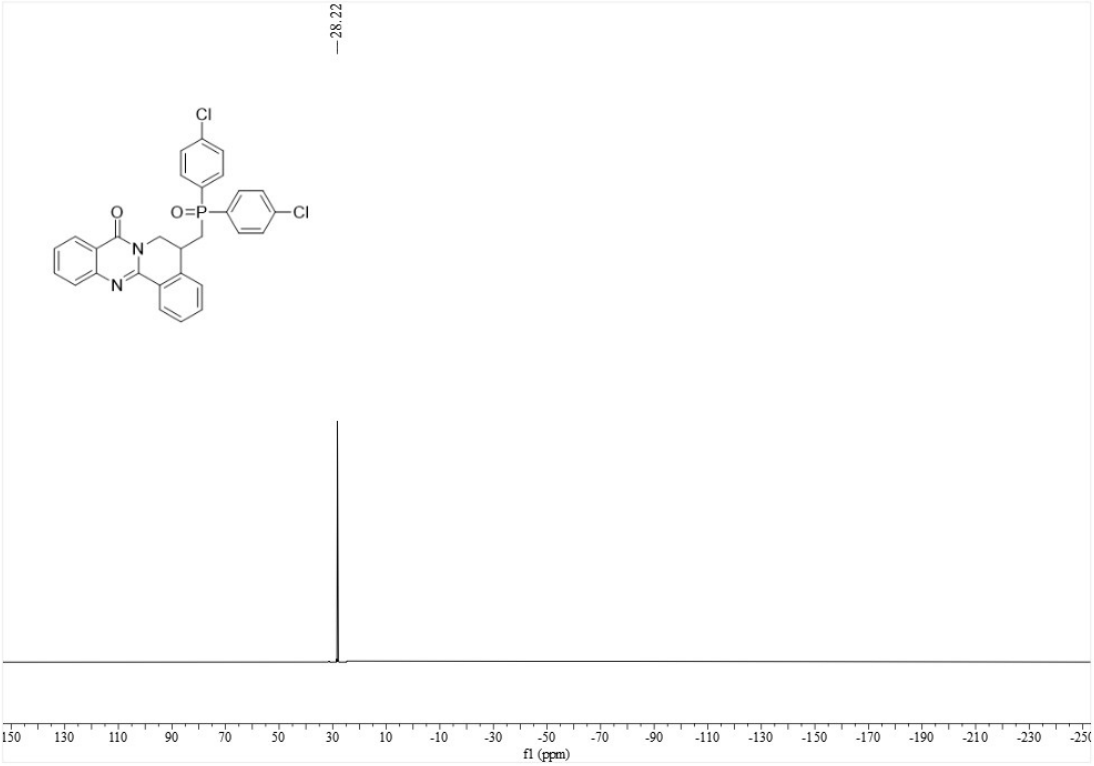

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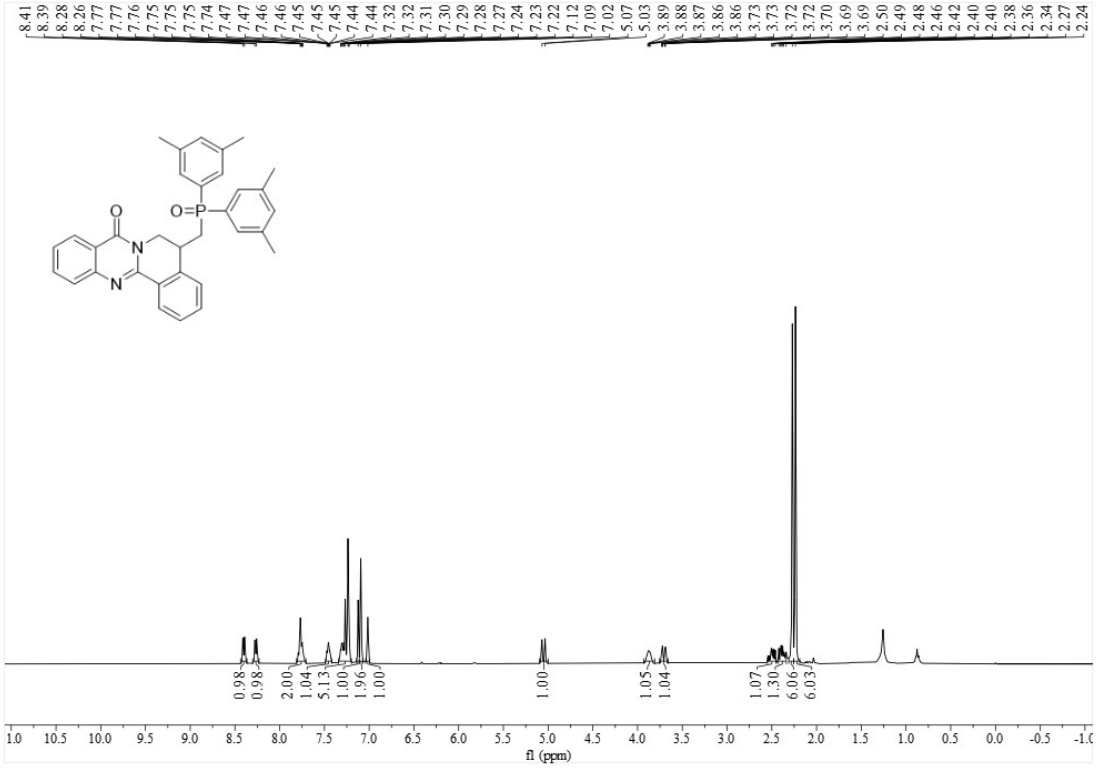

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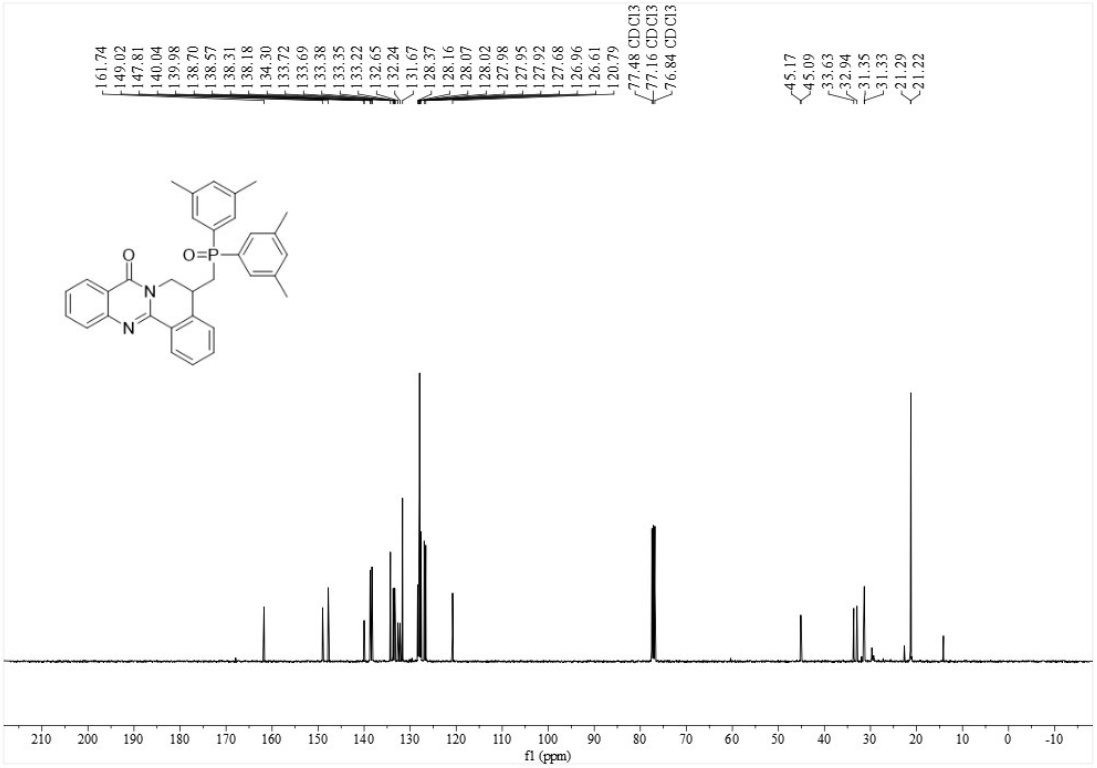
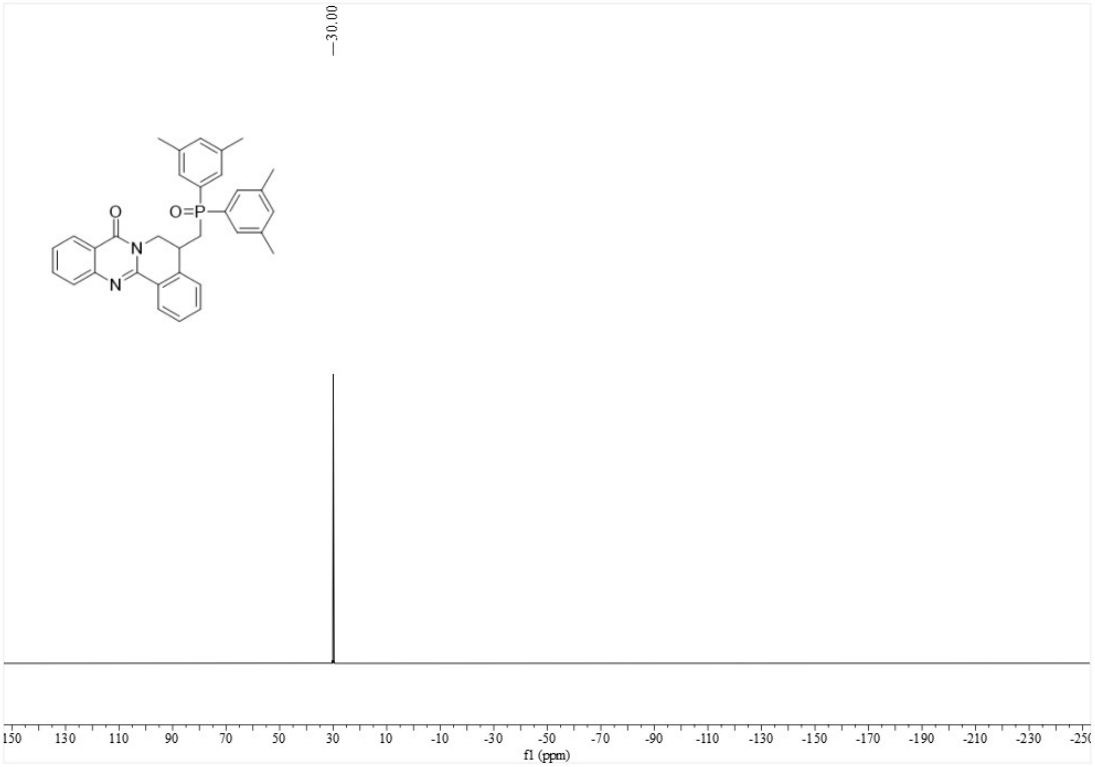


^{31}P NMR of **3e** (162 MHz, $CDCl_3$):



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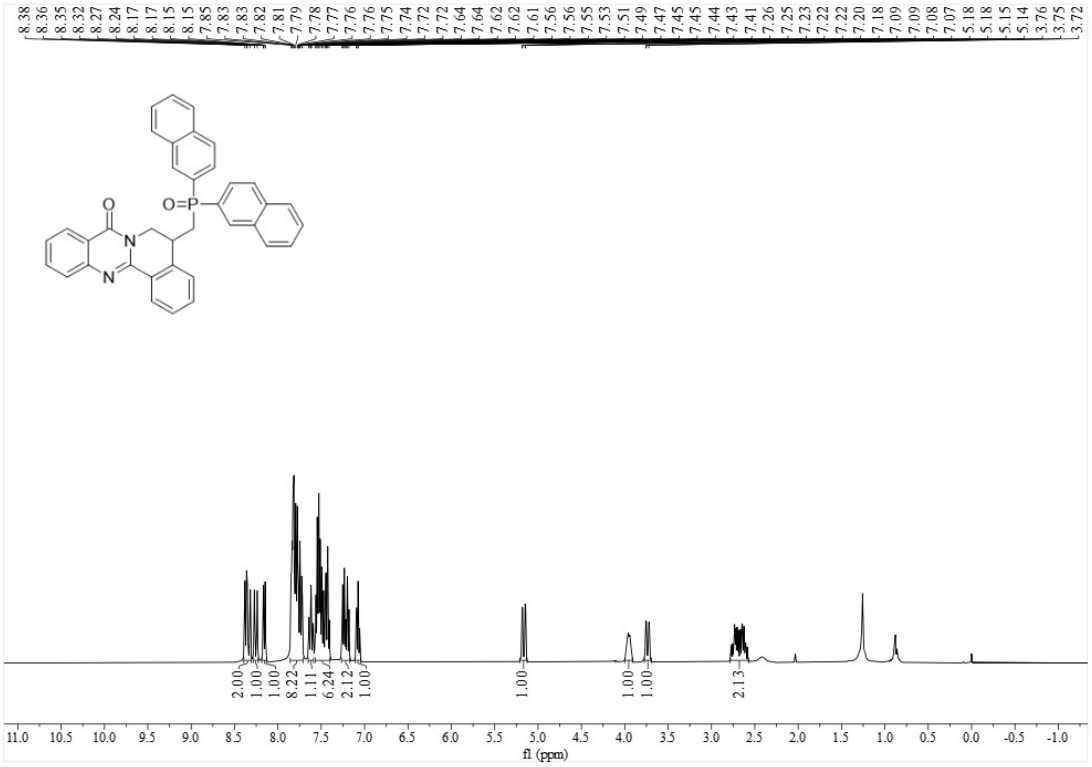
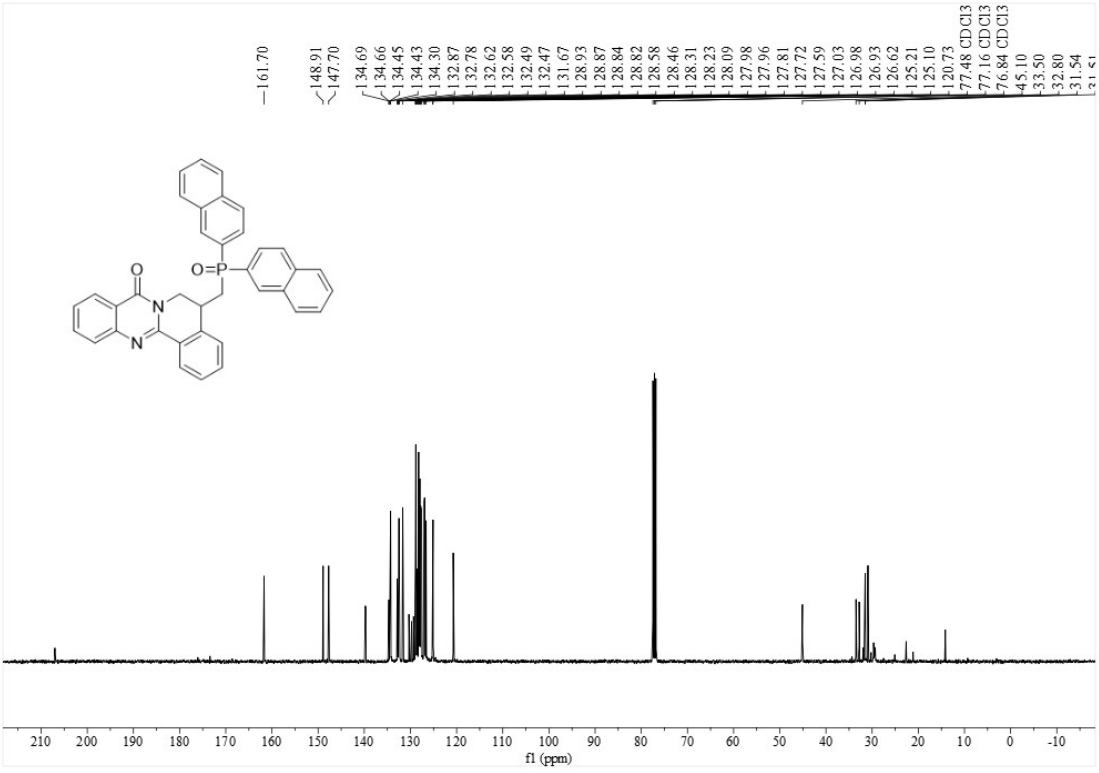


^{13}C NMR of **3f** (100 MHz, $CDCl_3$):



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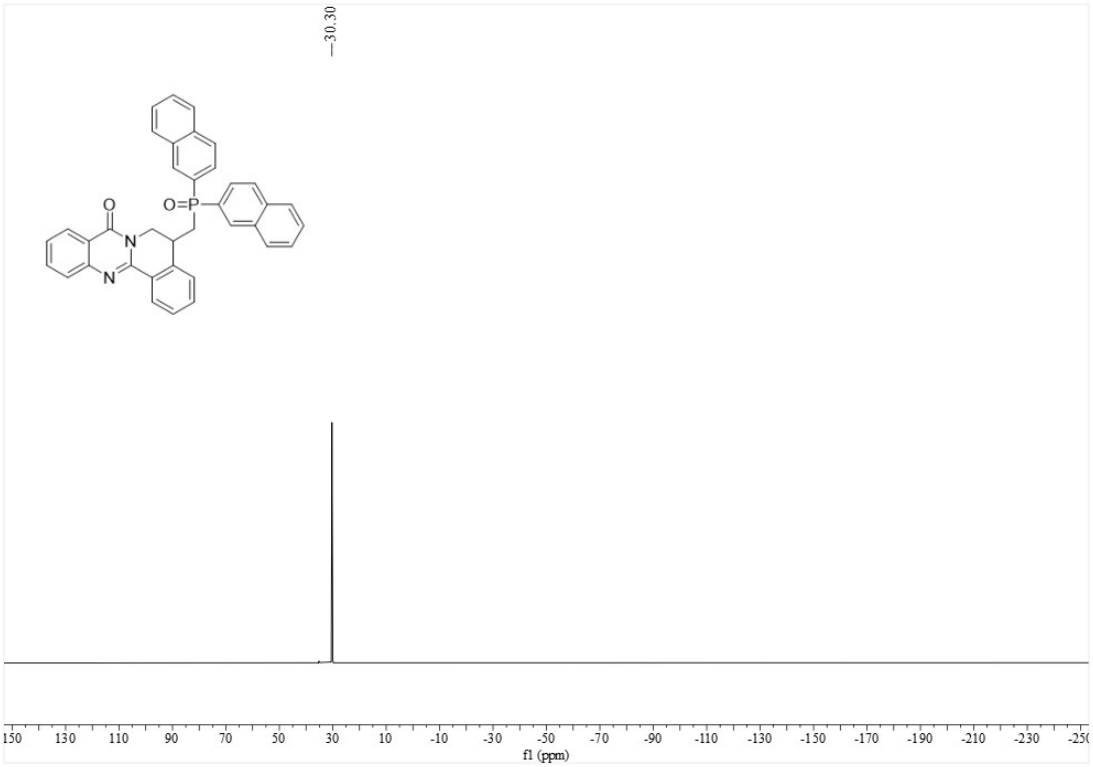
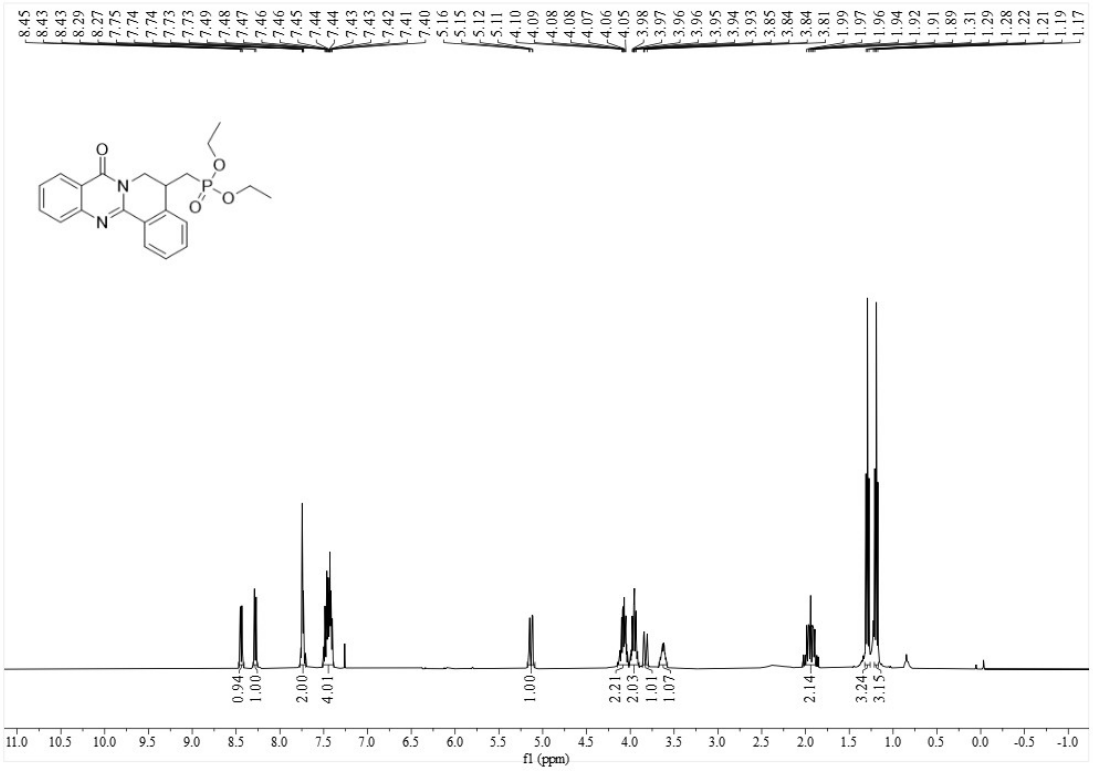


^{1}H NMR of **3g** (400 MHz, $CDCl_3$):



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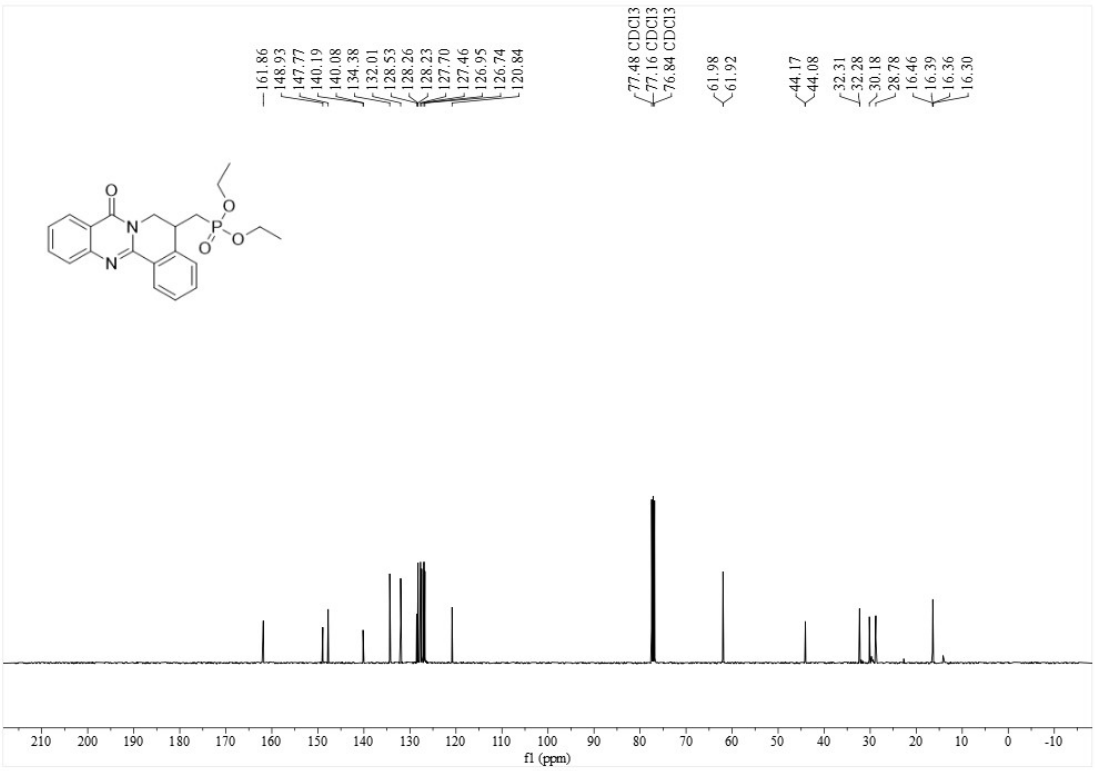
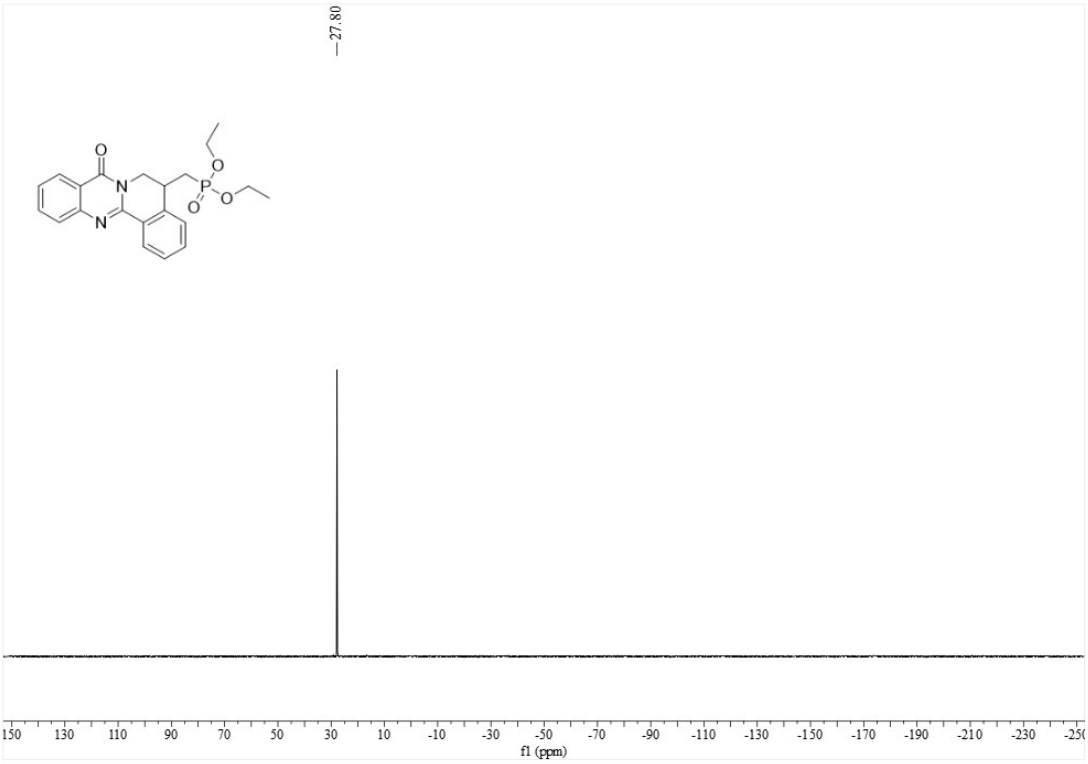
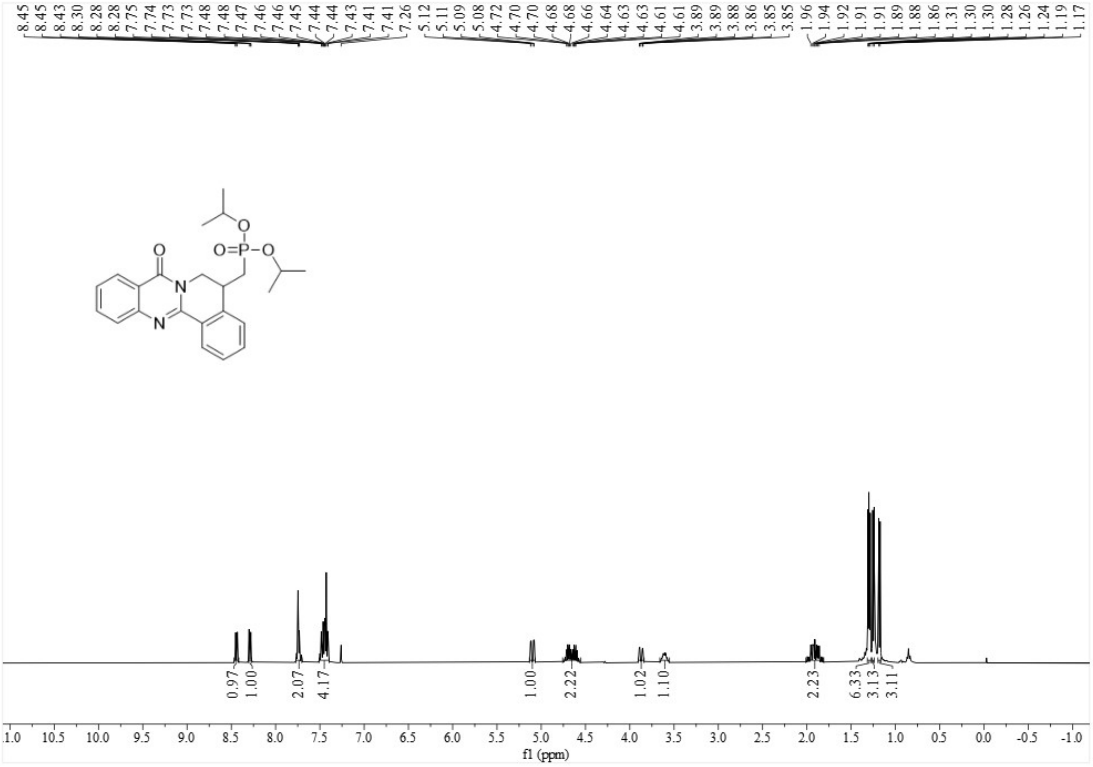


^{31}P NMR of **3g** (162 MHz, $CDCl_3$):



^{1}H NMR of **3h** (400 MHz, $CDCl_3$):



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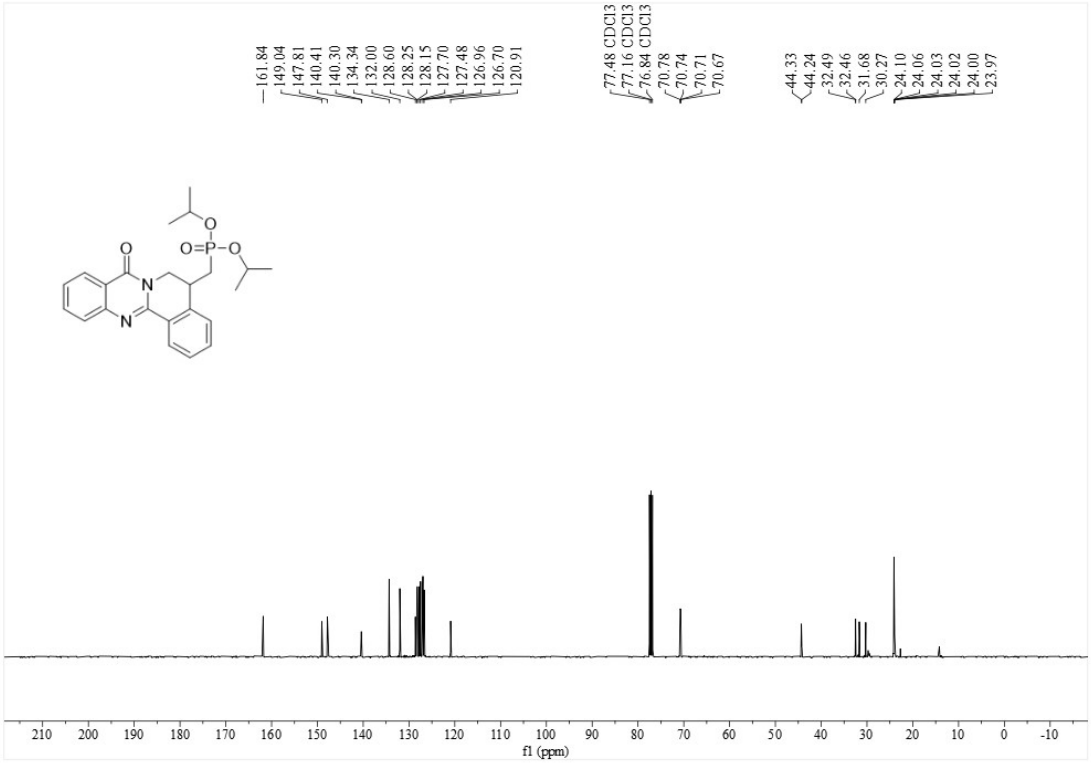
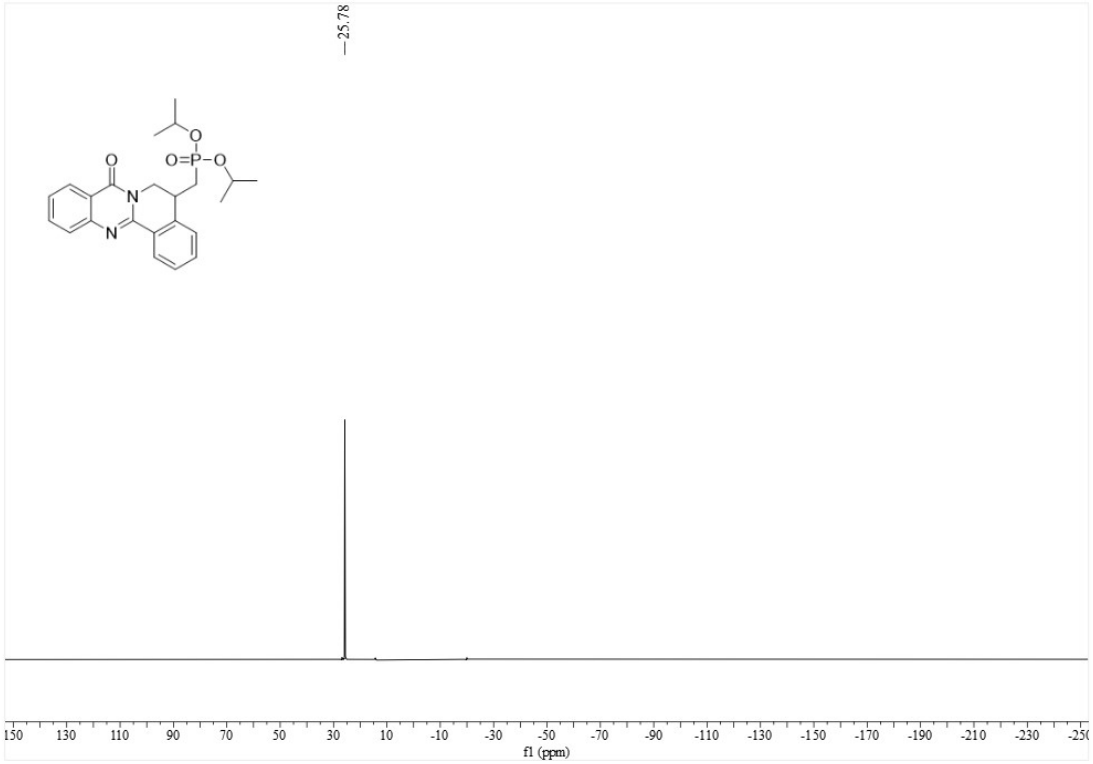


^{31}P NMR of **3h** (162 MHz, $CDCl_3$):



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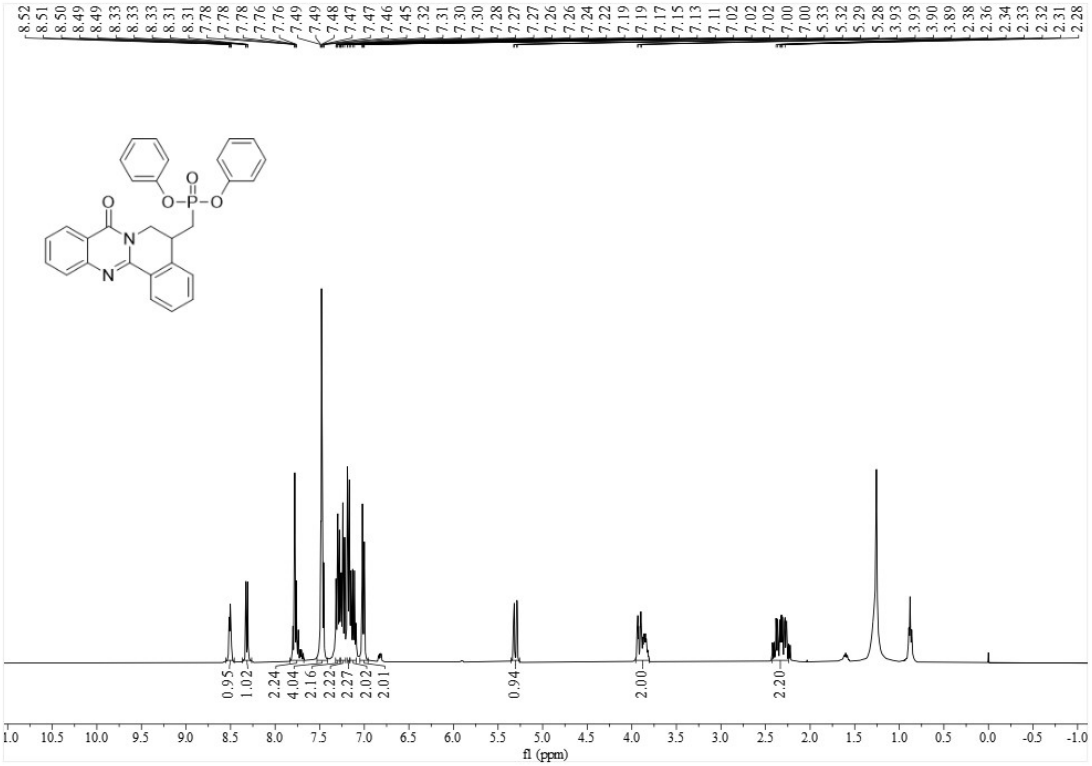

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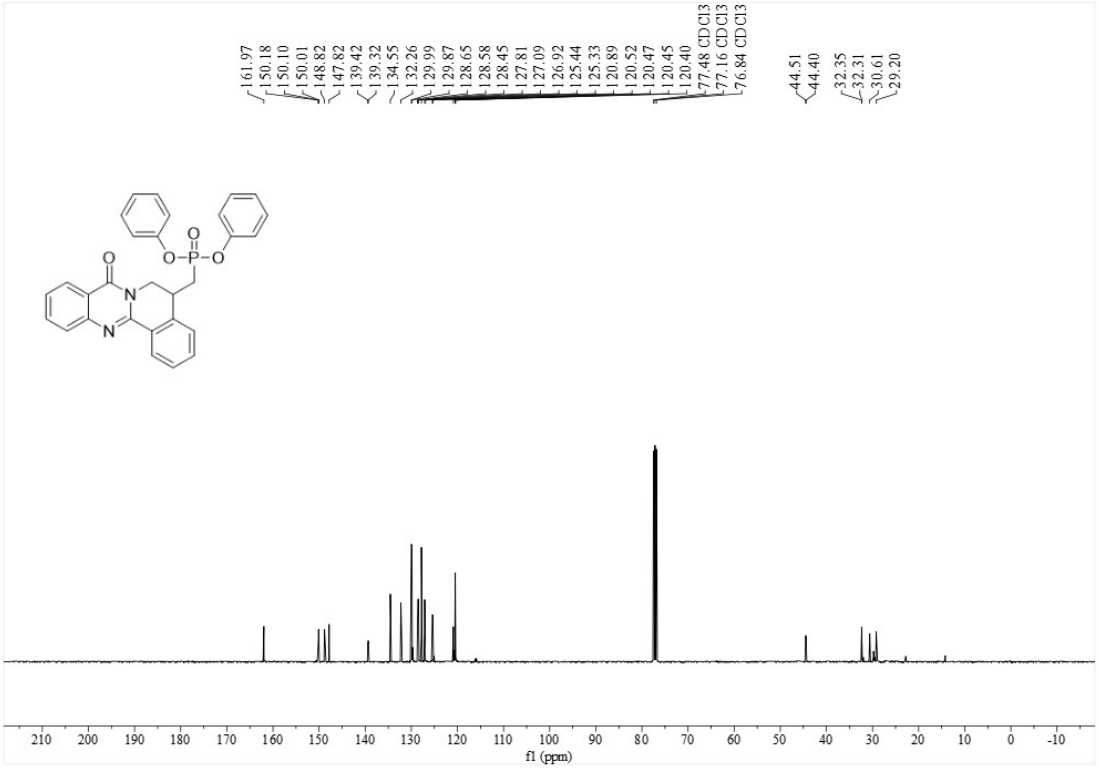

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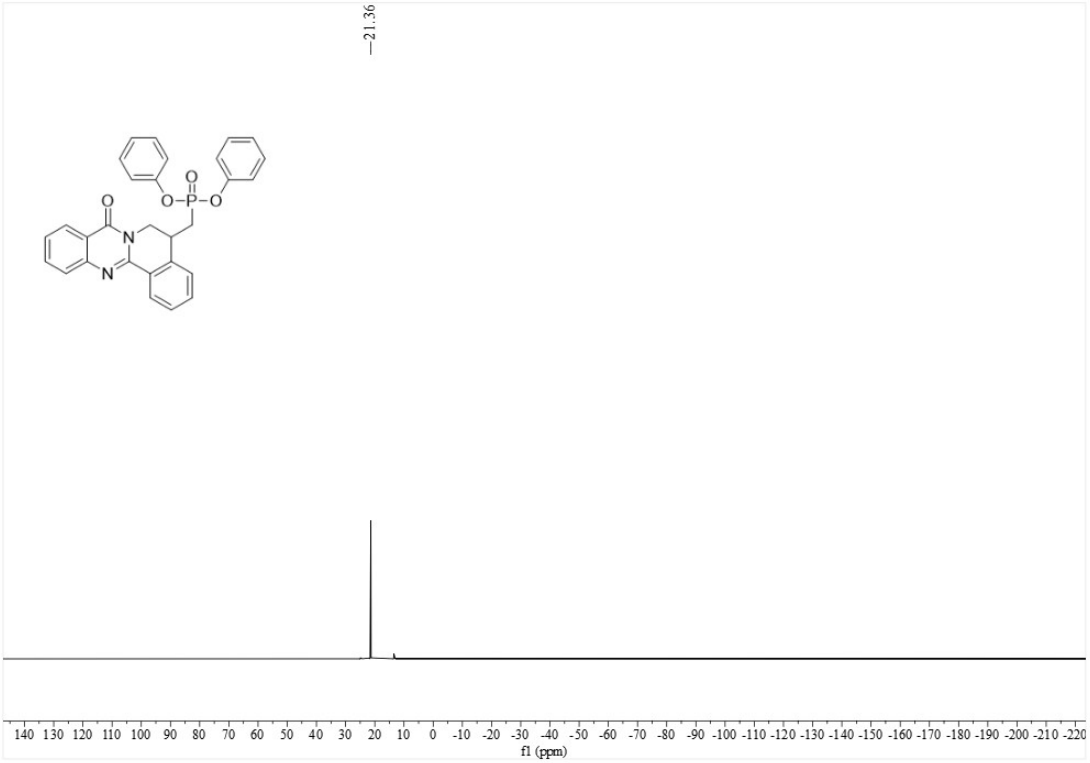

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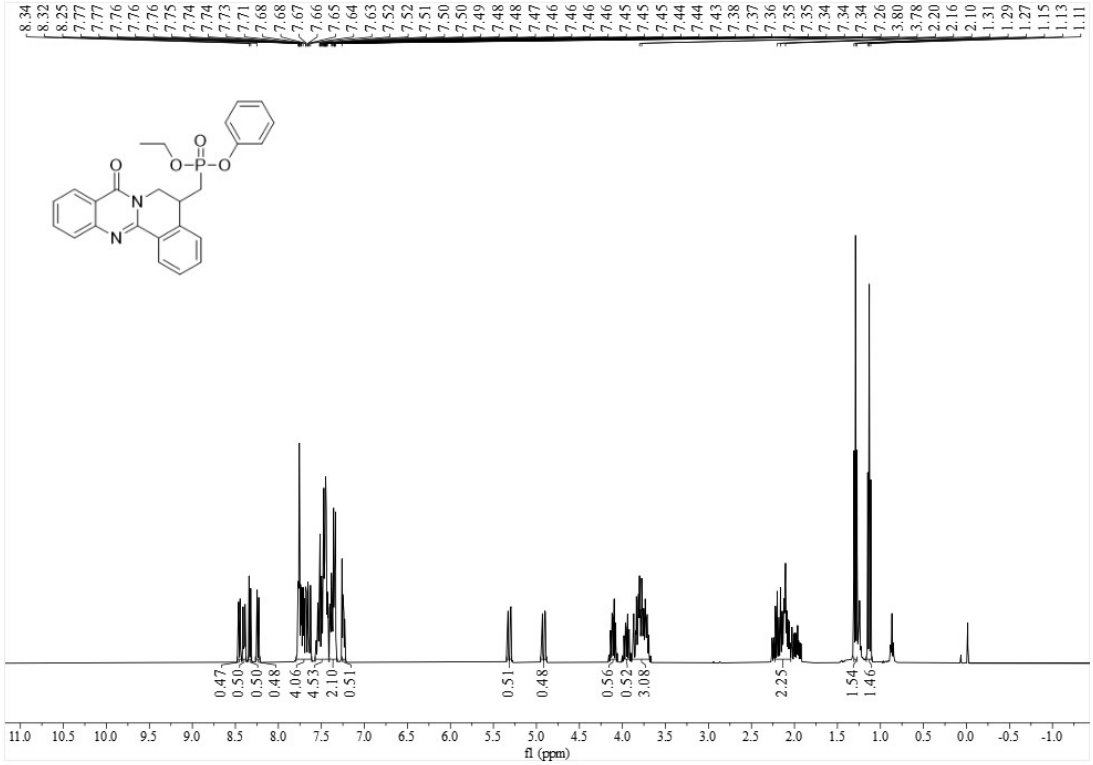

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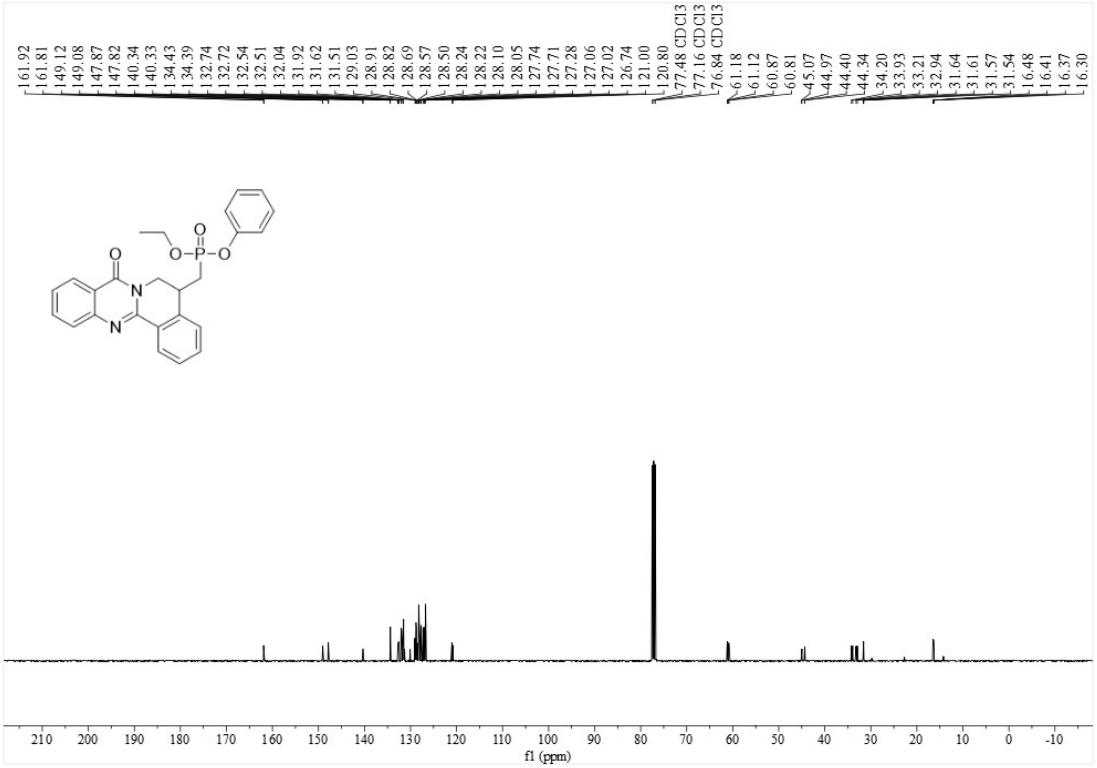
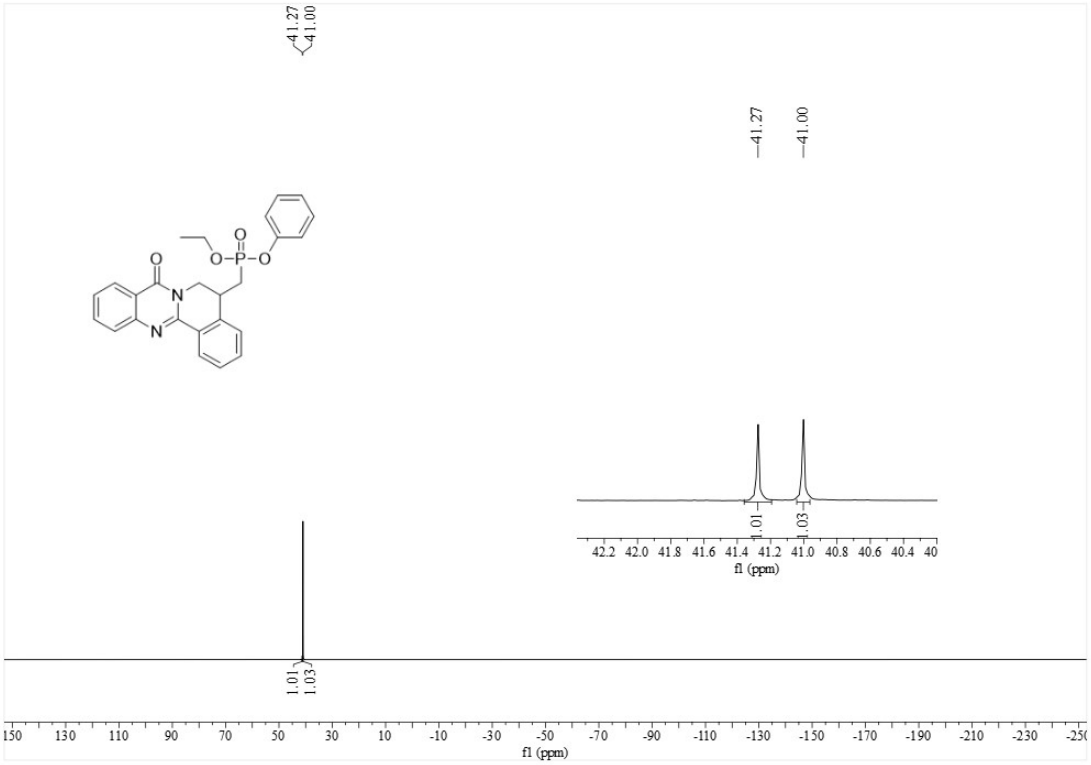


^{31}P NMR of **3j** (162 MHz, $CDCl_3$):



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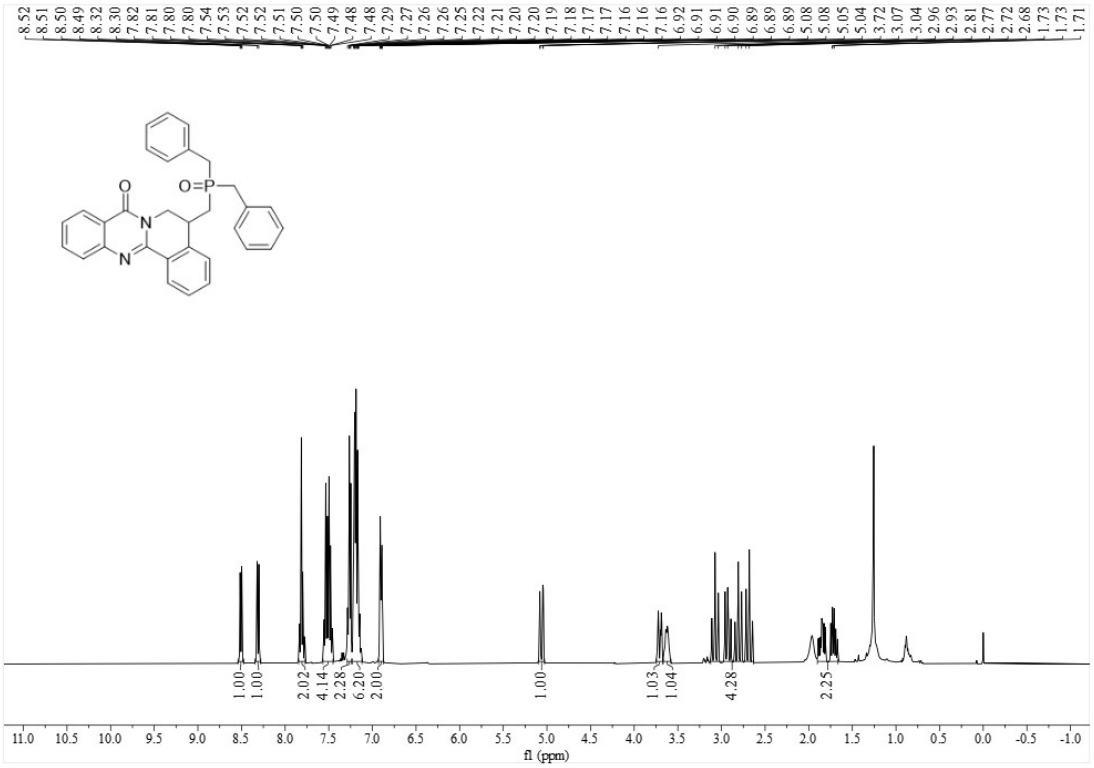

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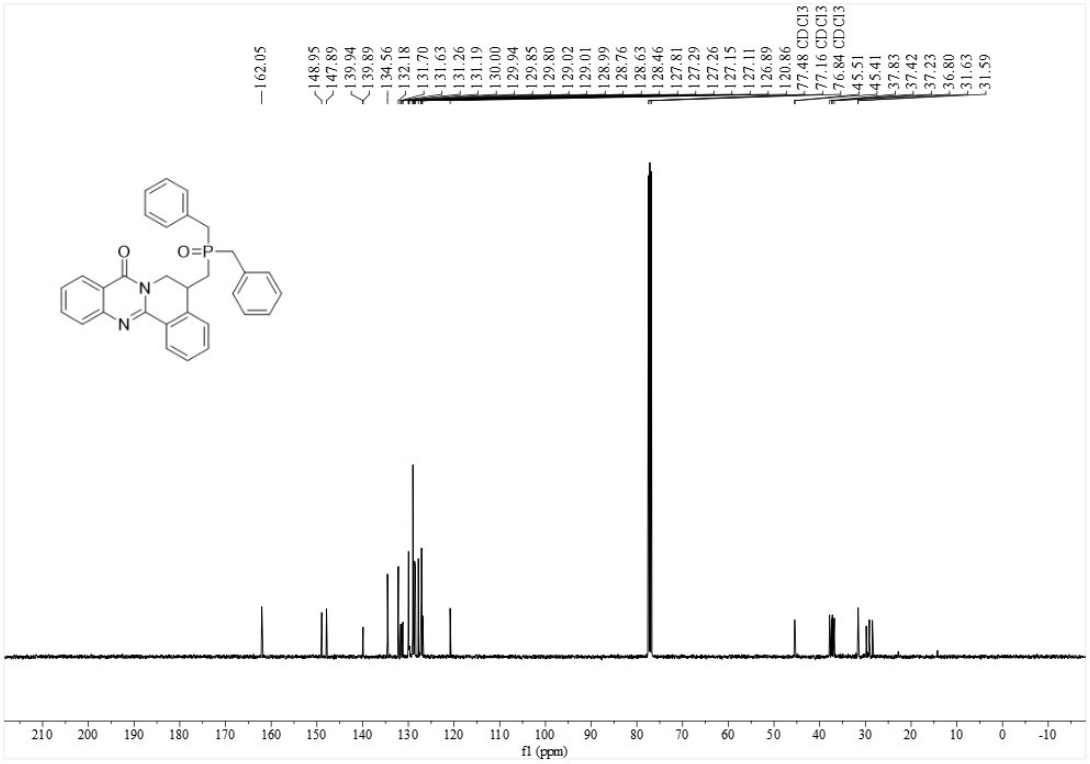

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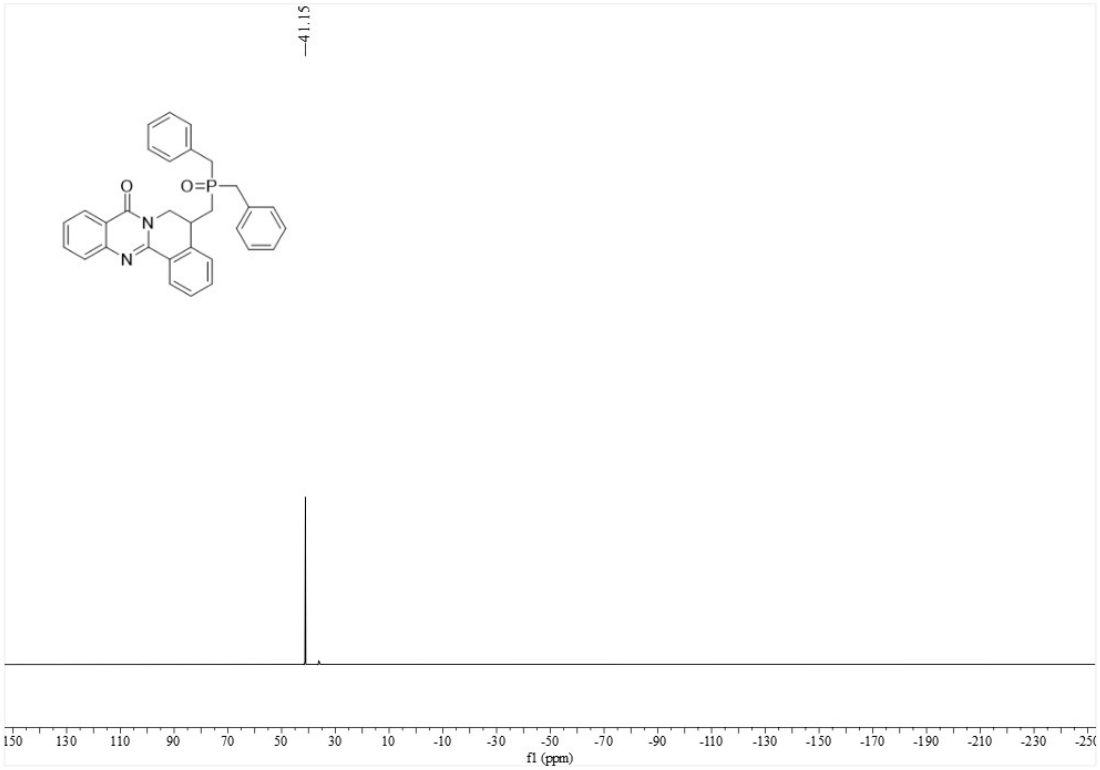
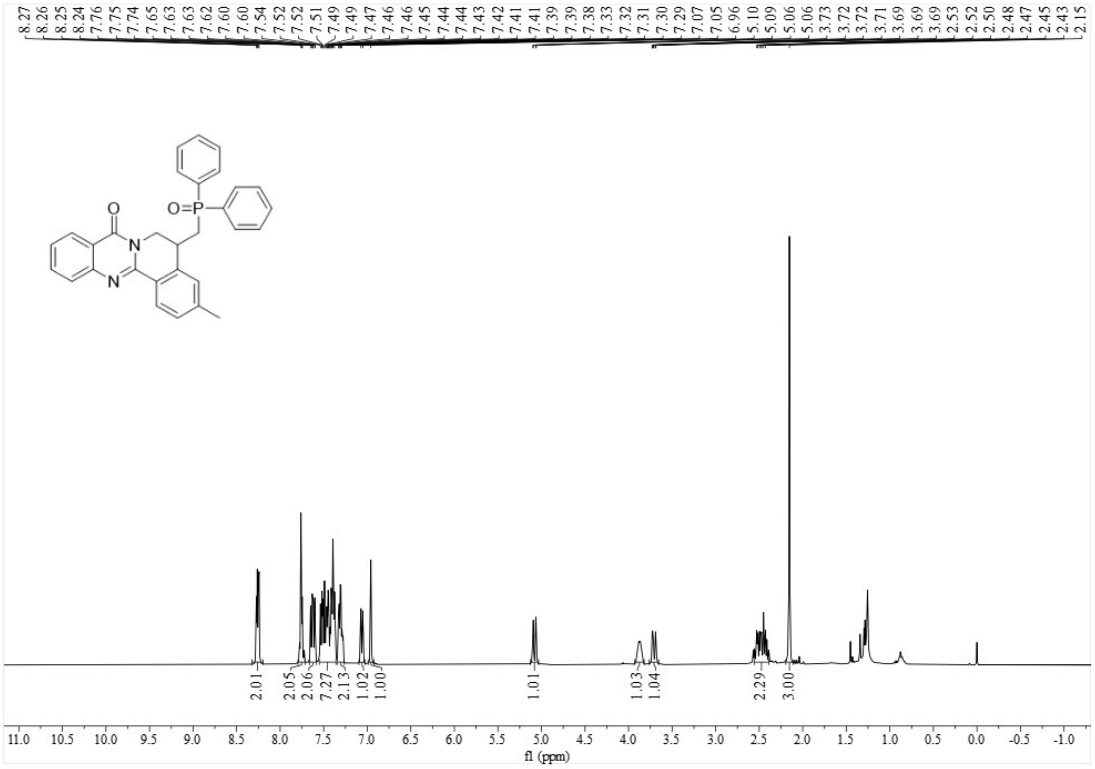


^{1}H NMR of **3l** (400 MHz, $CDCl_3$):



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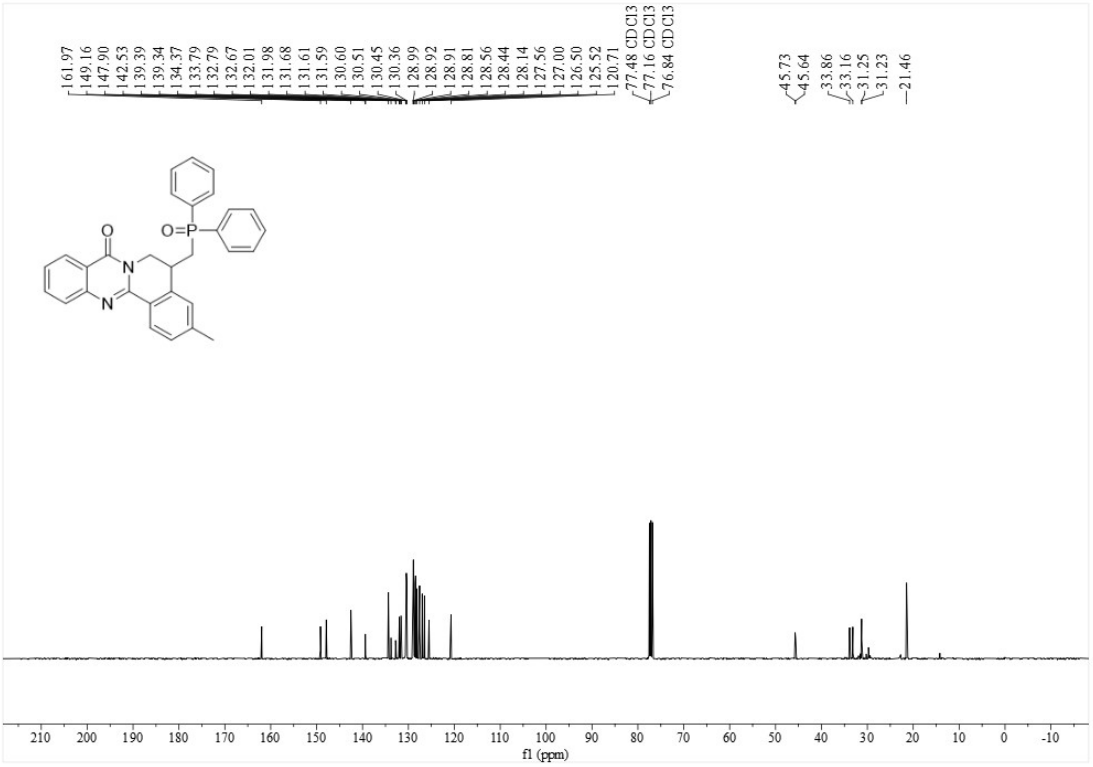
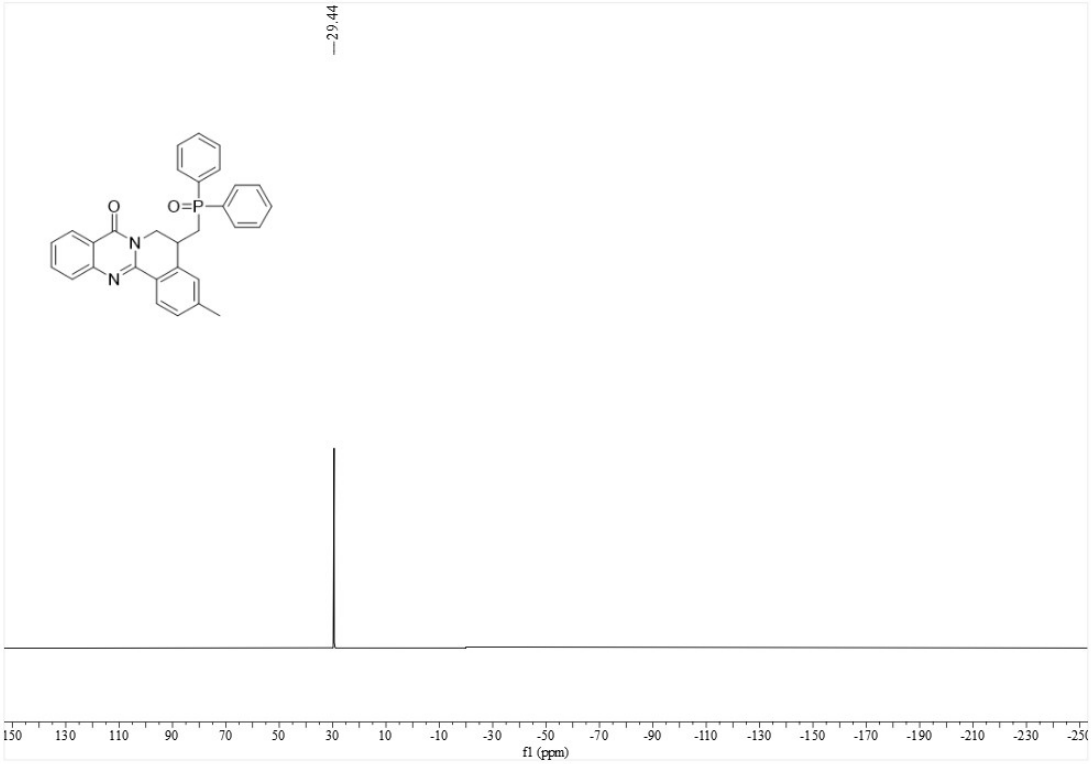
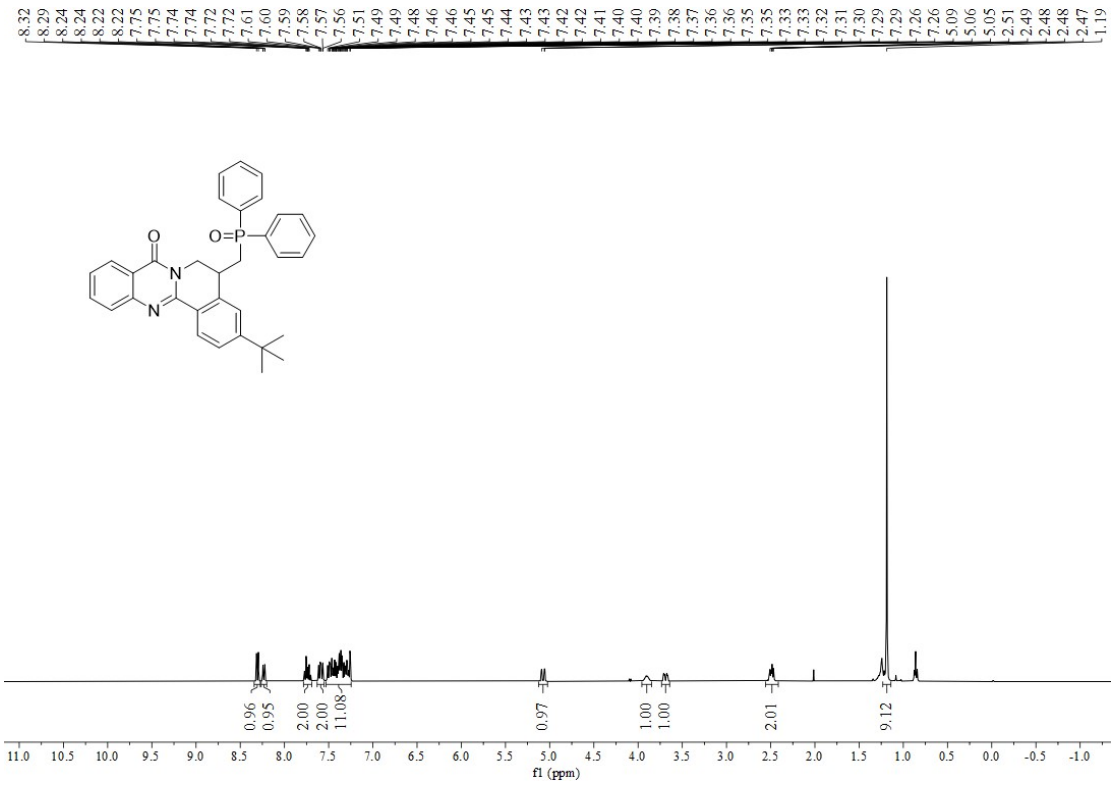


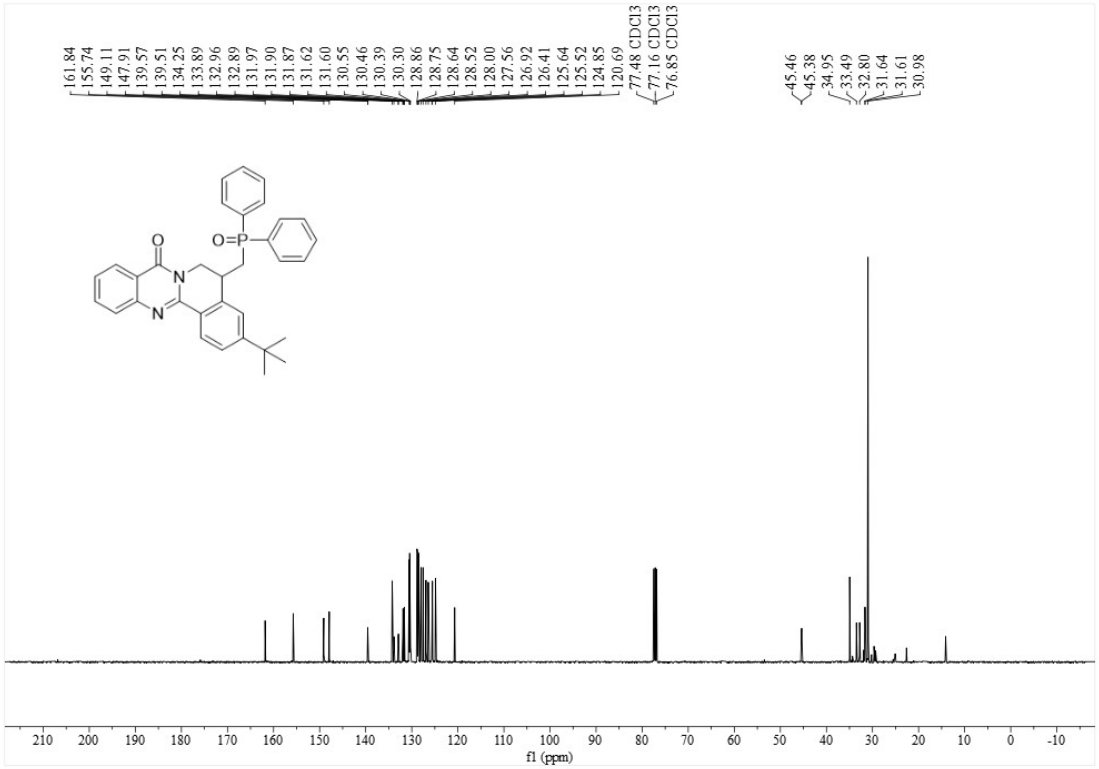
^{31}P NMR of **3l** (162 MHz, $CDCl_3$):



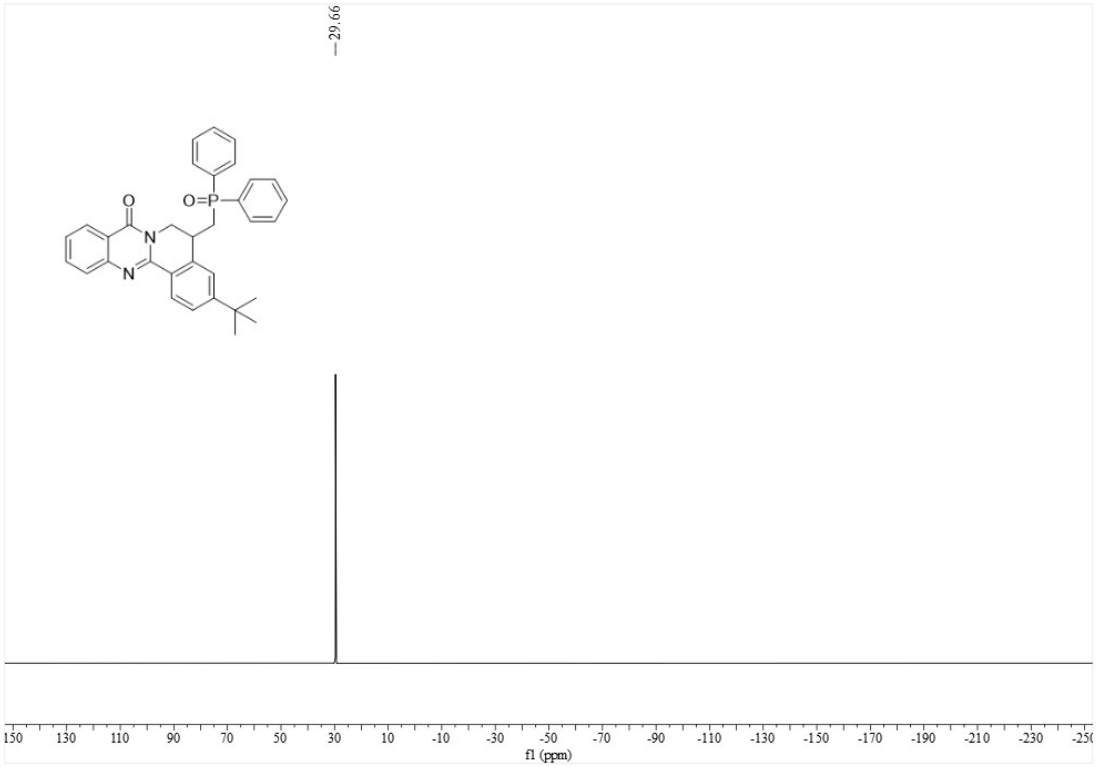
^{1}H NMR of **3m** (400 MHz, $CDCl_3$):



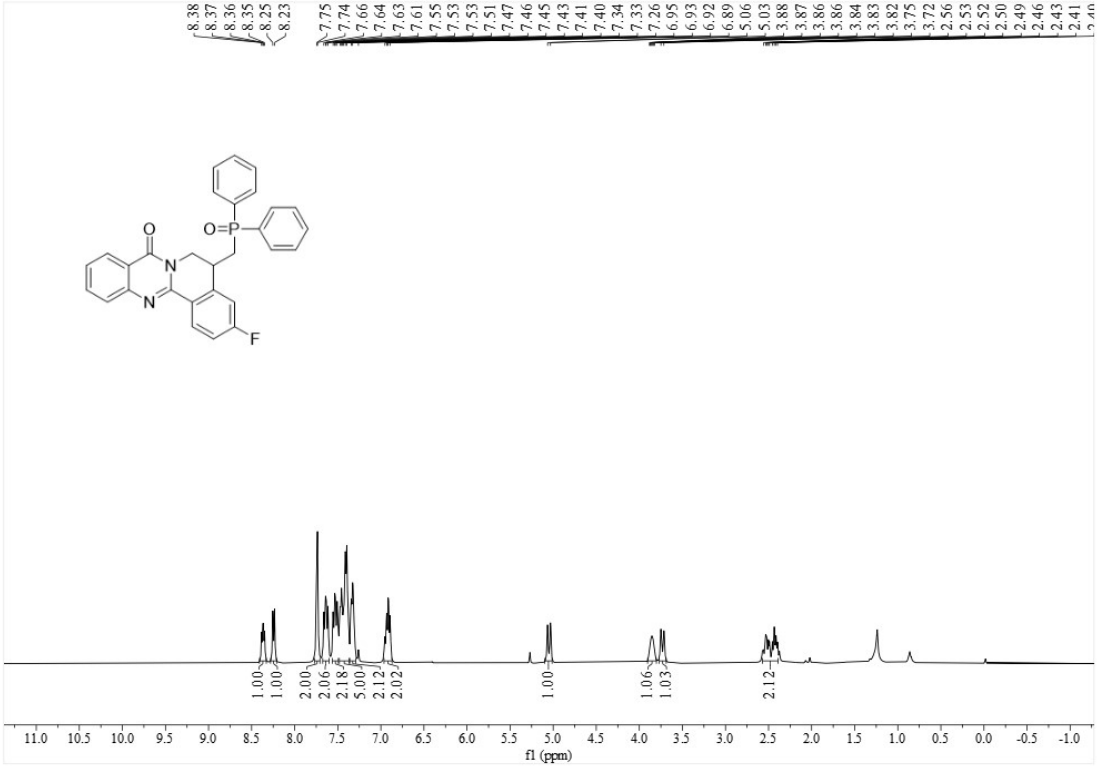
^{13}C NMR of **3m** (100 MHz, $CDCl_3$):



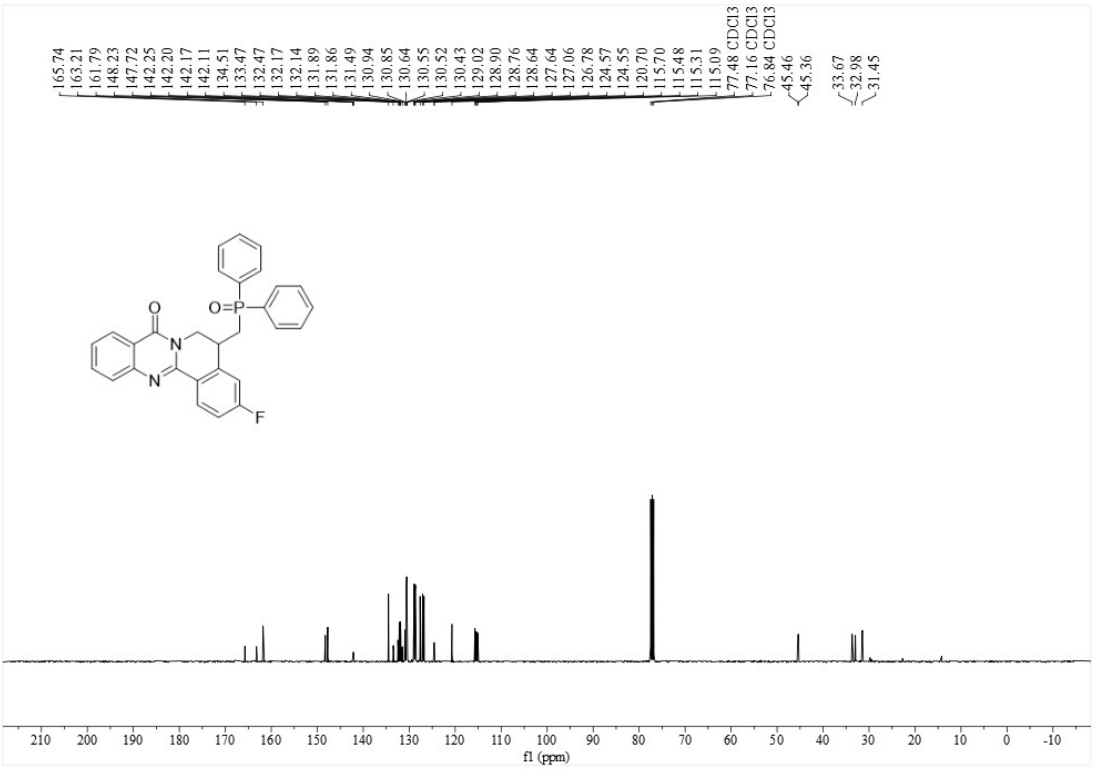
^{31}P NMR of **3m** (162 MHz, $CDCl_3$):



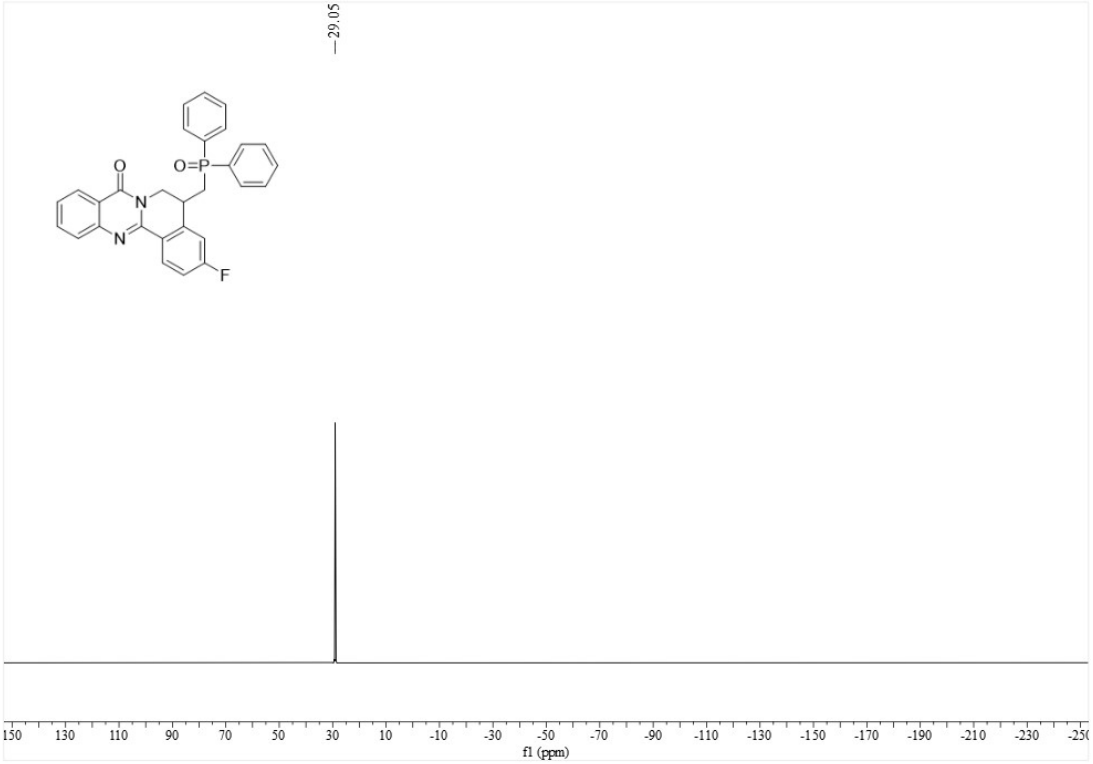
^{1}H NMR of **3n** (400 MHz, $CDCl_3$):



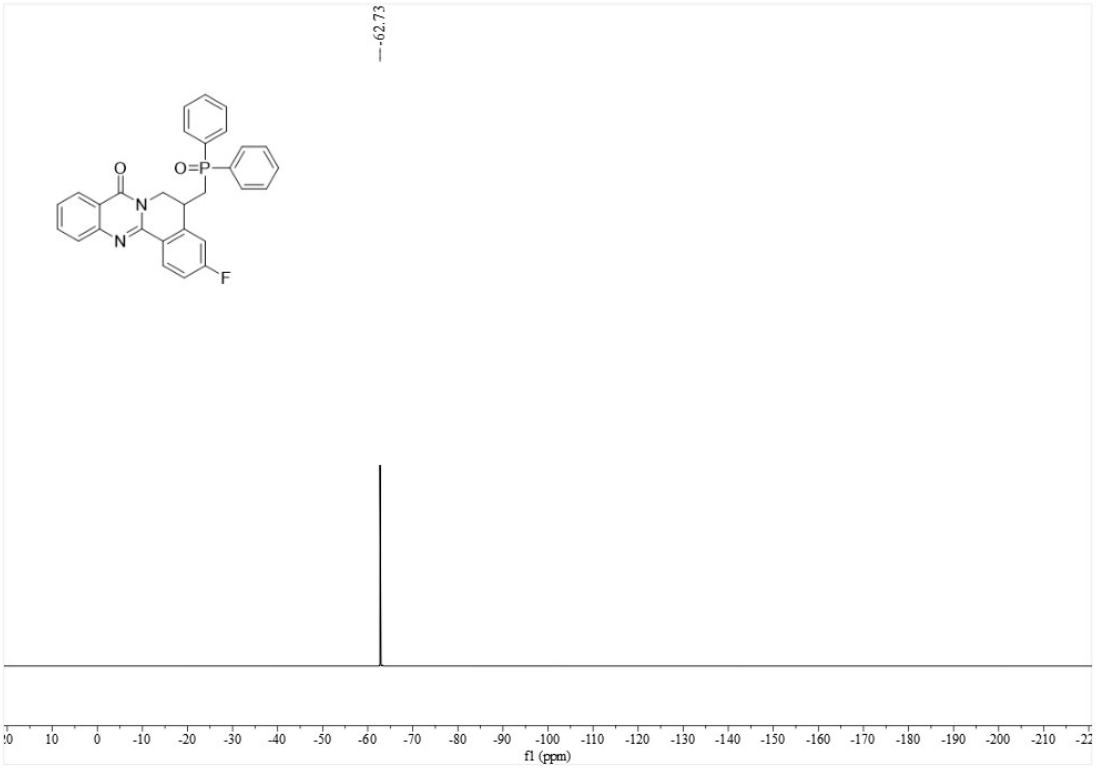
^{13}C NMR of **3n** (100 MHz, $CDCl_3$):



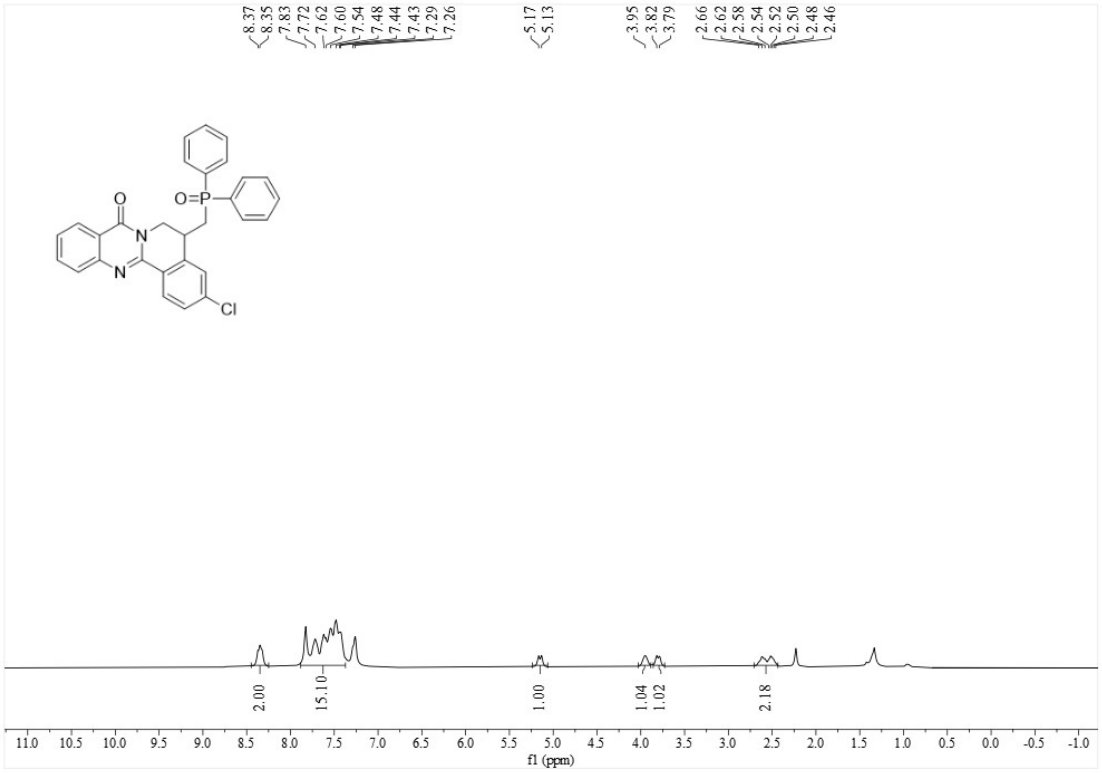
^{31}P NMR of **3n** (162 MHz, $CDCl_3$):



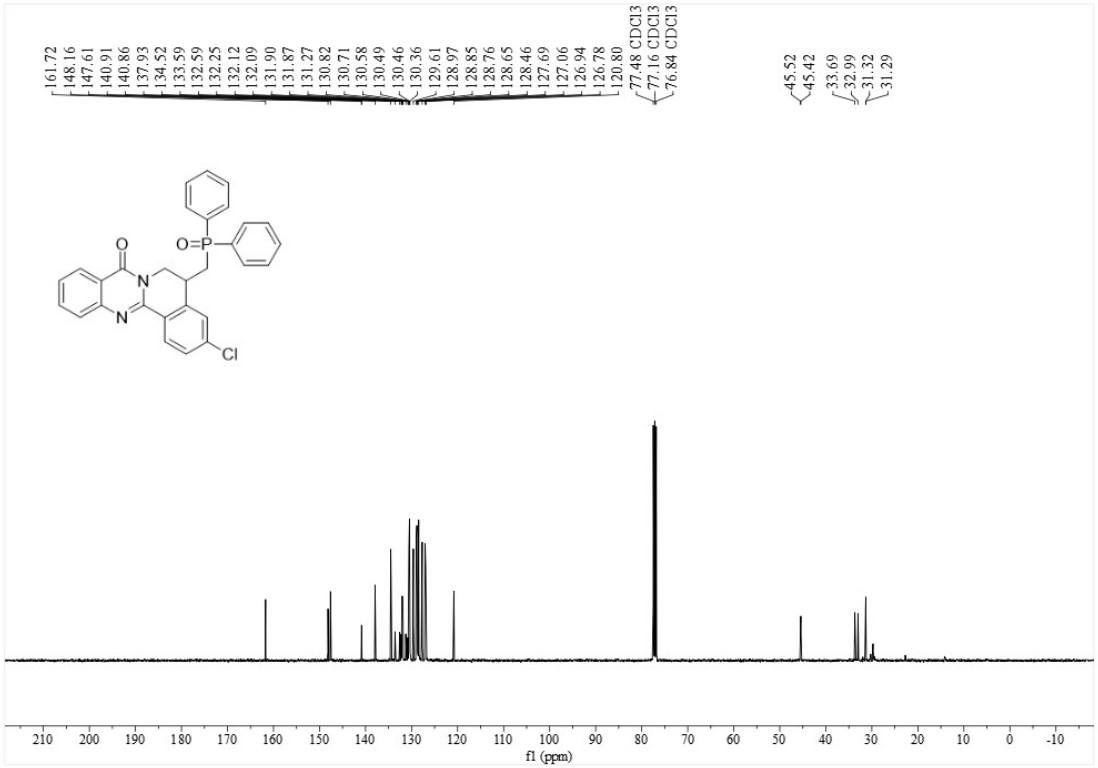
^{19}F NMR of **3n** (376 MHz, $CDCl_3$):



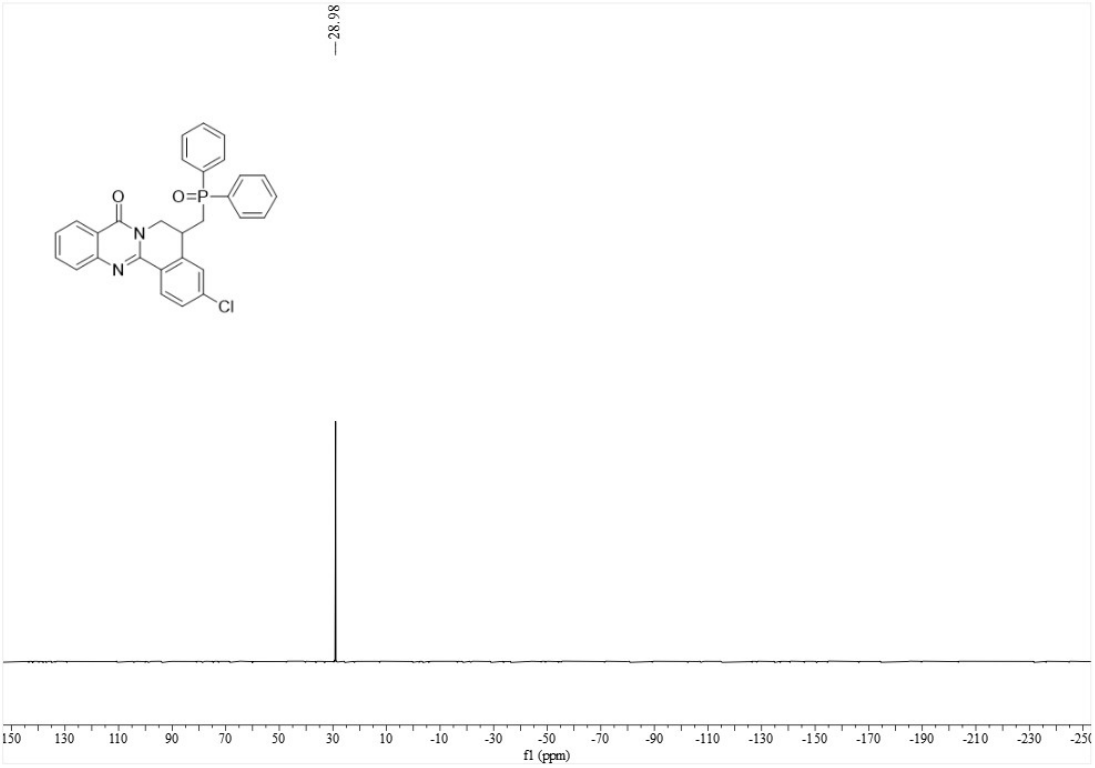
^{1}H NMR of **3o** (400 MHz, $CDCl_3$):



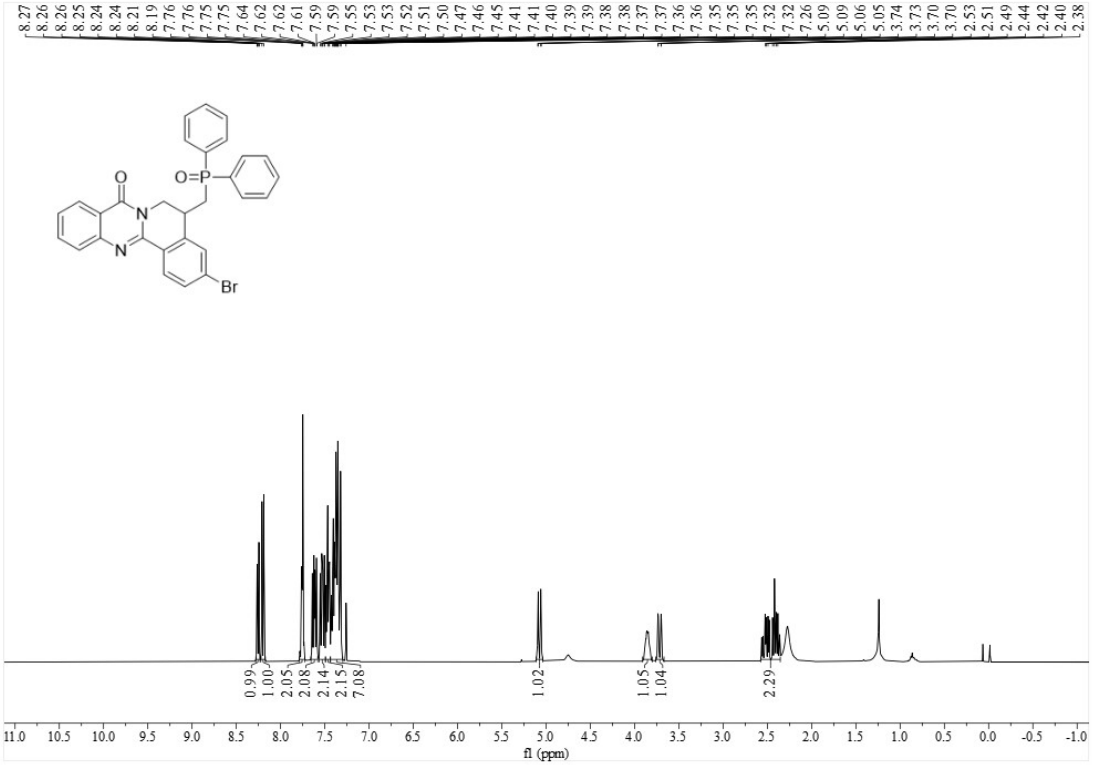
^{13}C NMR of **3o** (100 MHz, $CDCl_3$):



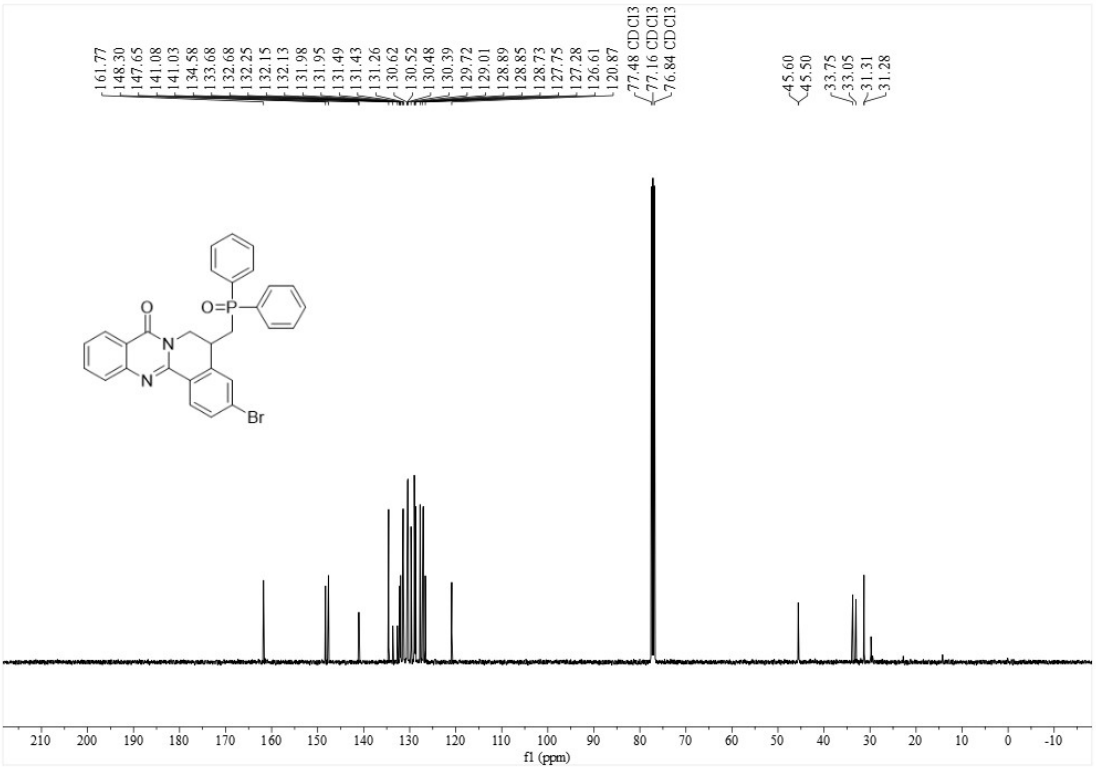
^{31}P NMR of **3o** (162 MHz, $CDCl_3$):



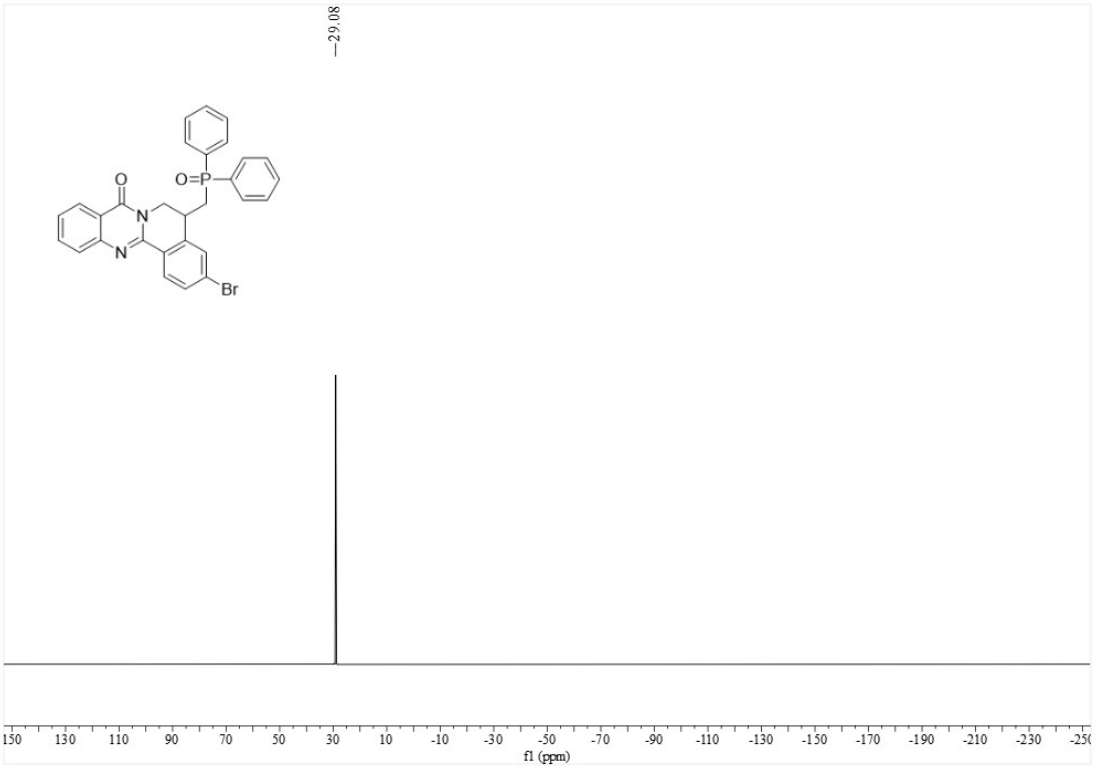
^{1}H NMR of **3p** (400 MHz, $CDCl_3$):



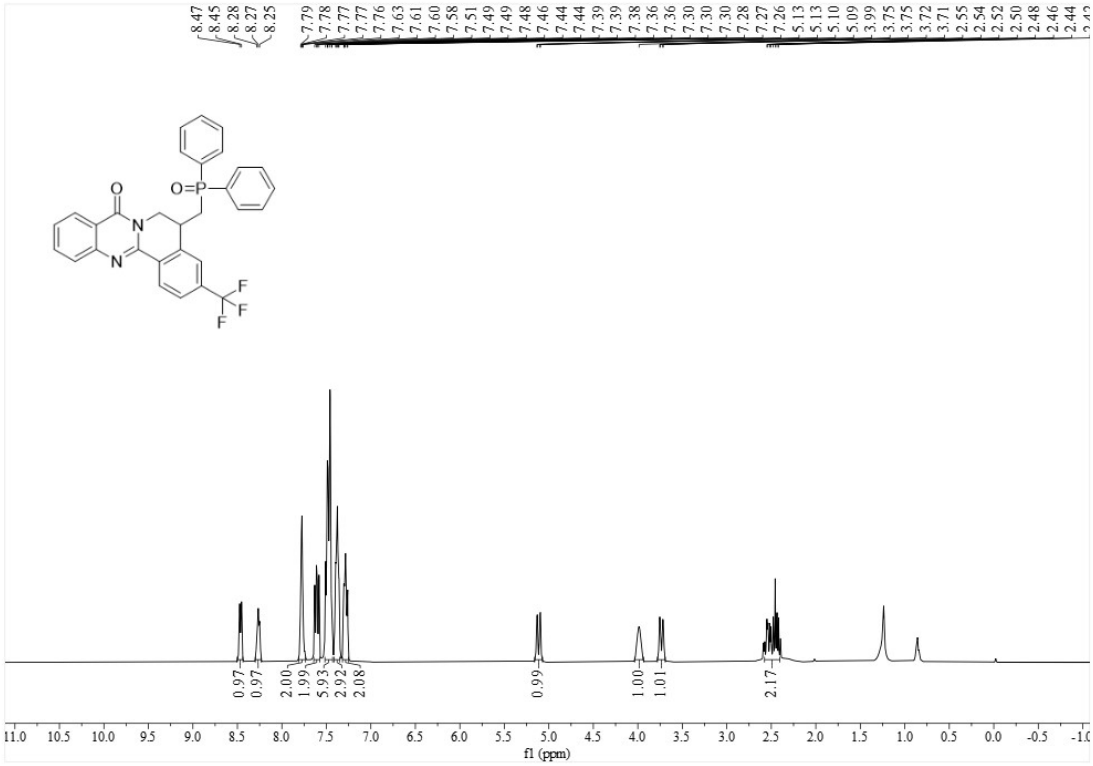
^{13}C NMR of **3p** (100 MHz, $CDCl_3$):



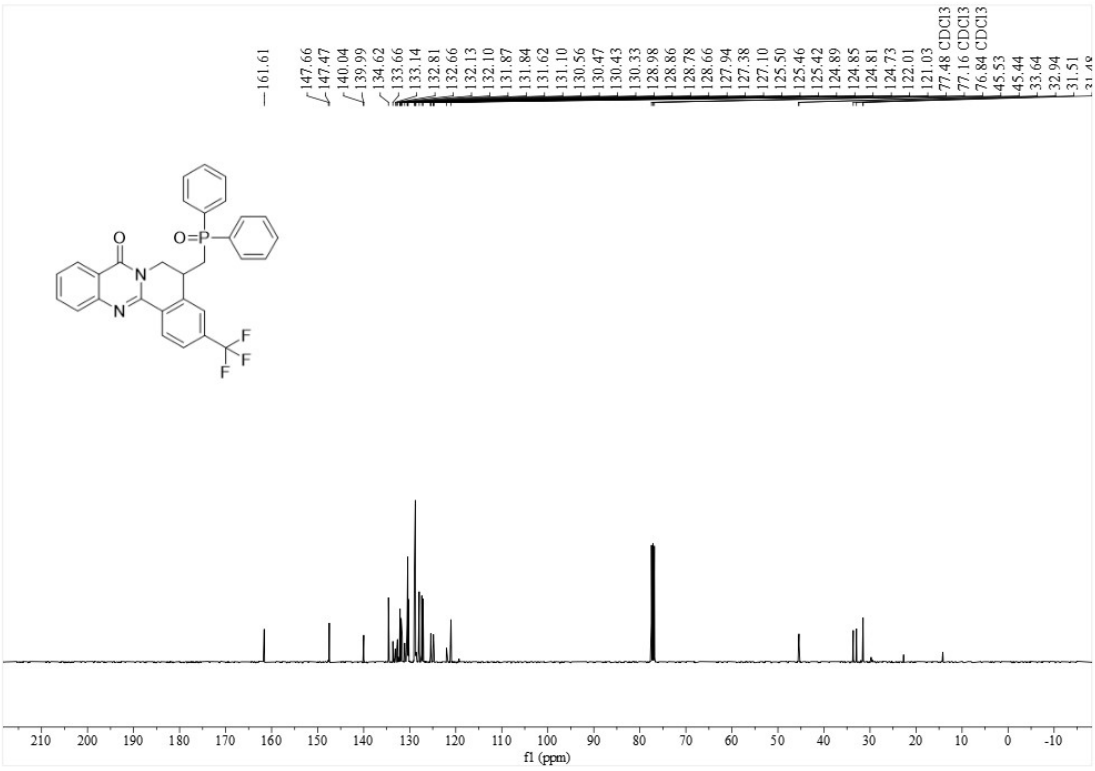
^{31}P NMR of **3p** (162 MHz, $CDCl_3$):



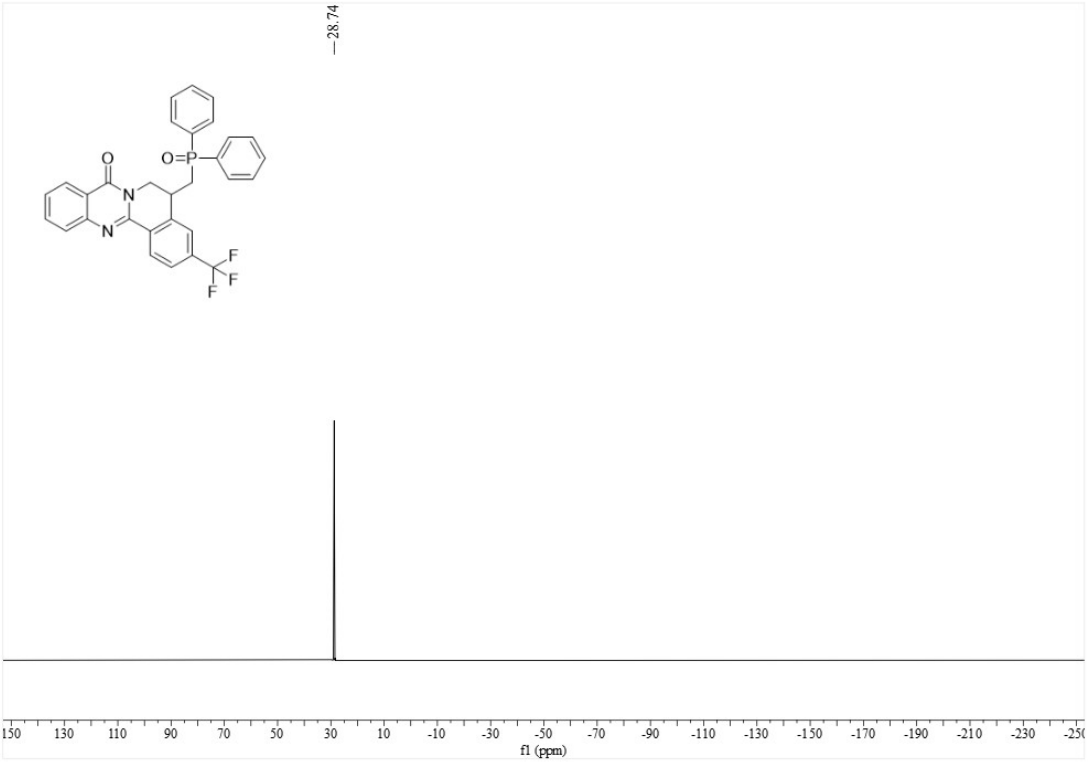
^{1}H NMR of **3q** (400 MHz, $CDCl_3$):



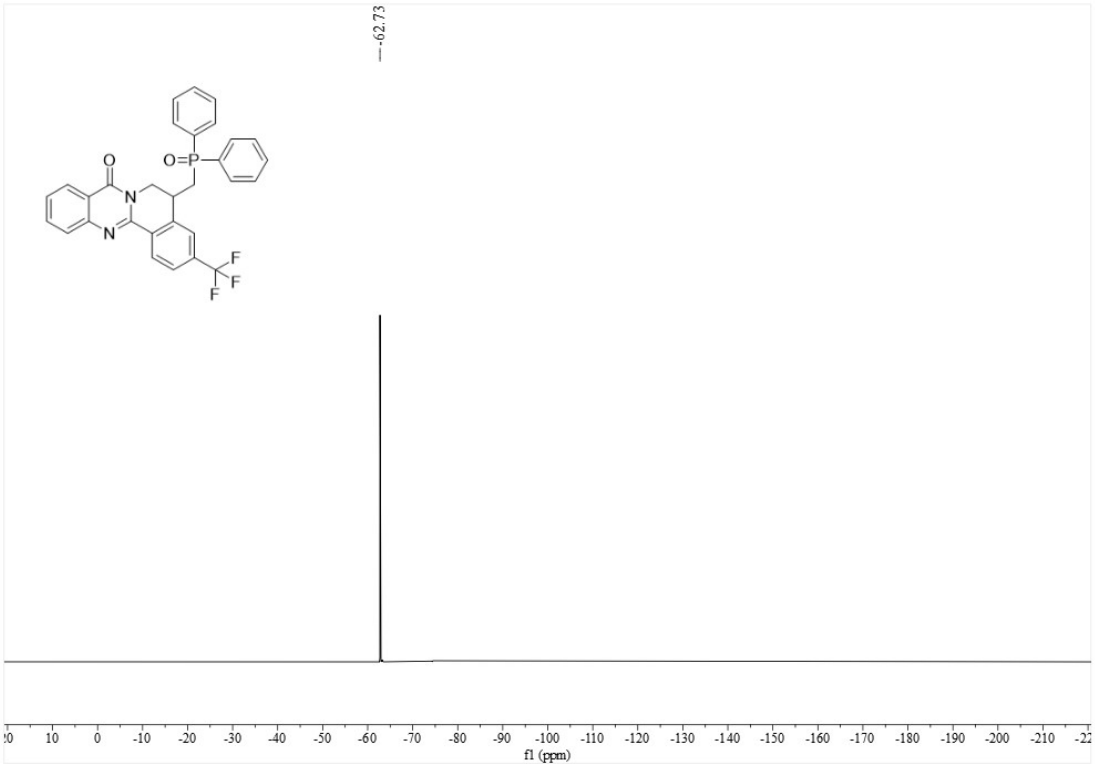
^{13}C NMR of **3q** (100 MHz, $CDCl_3$):



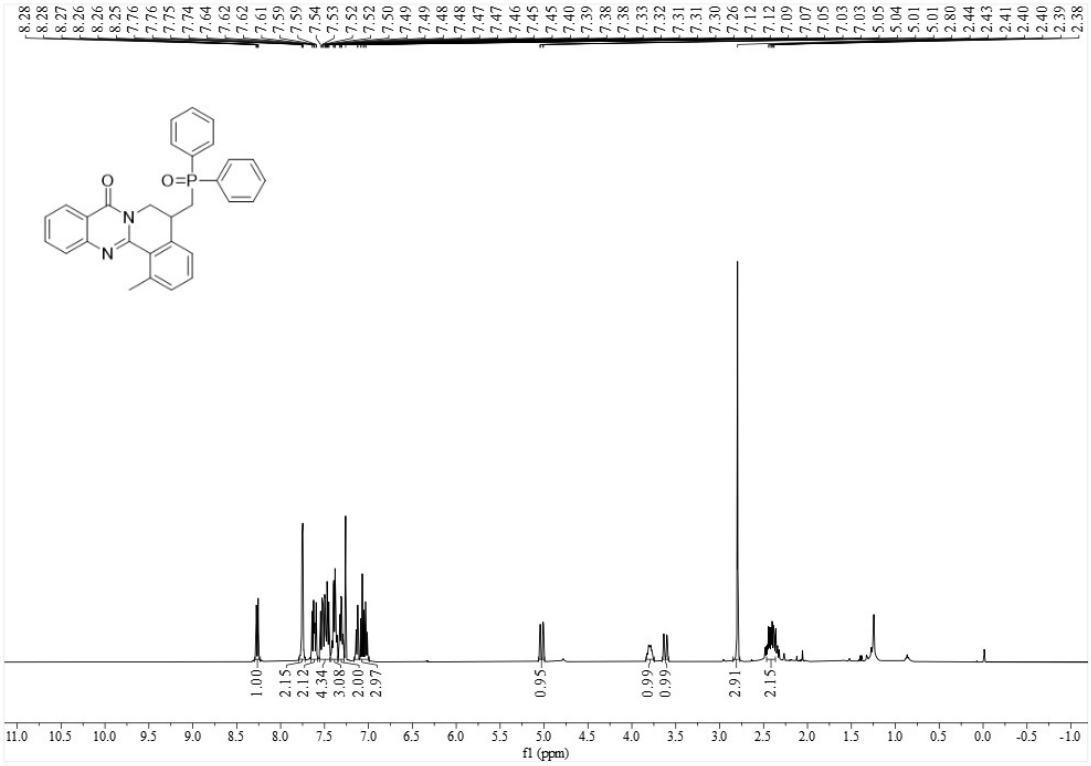
^{31}P NMR of **3q** (162 MHz, $CDCl_3$):



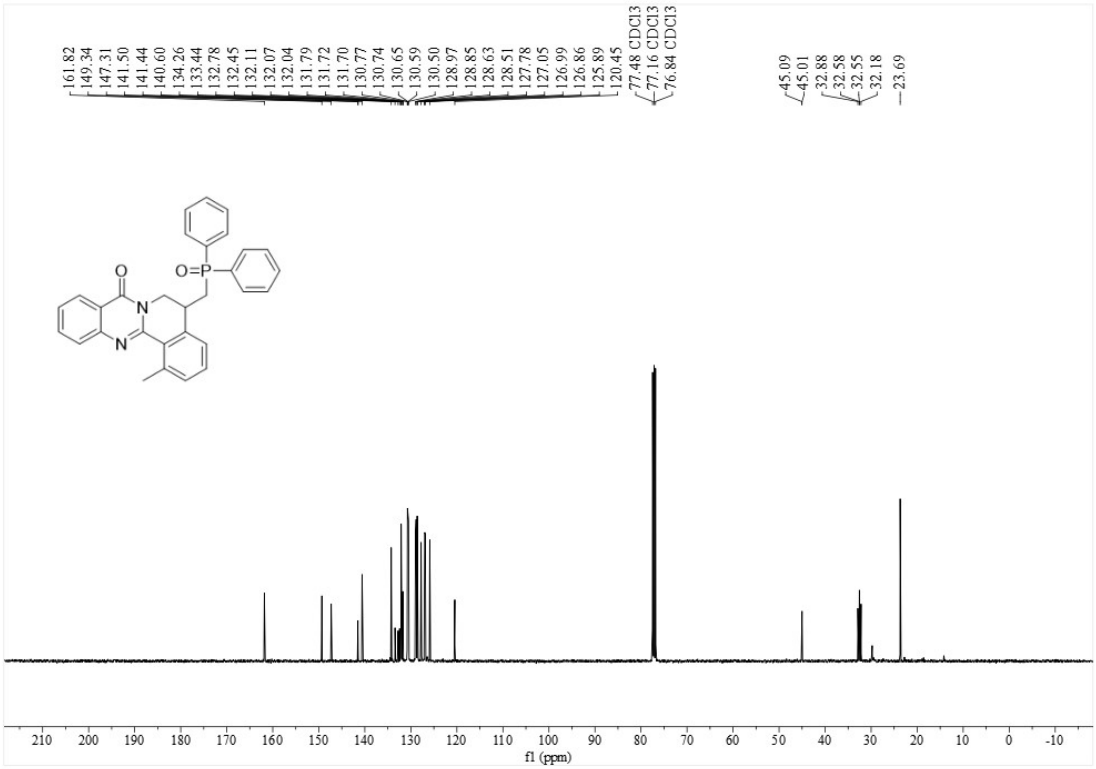
^{19}F NMR of **3q** (376 MHz, $CDCl_3$):



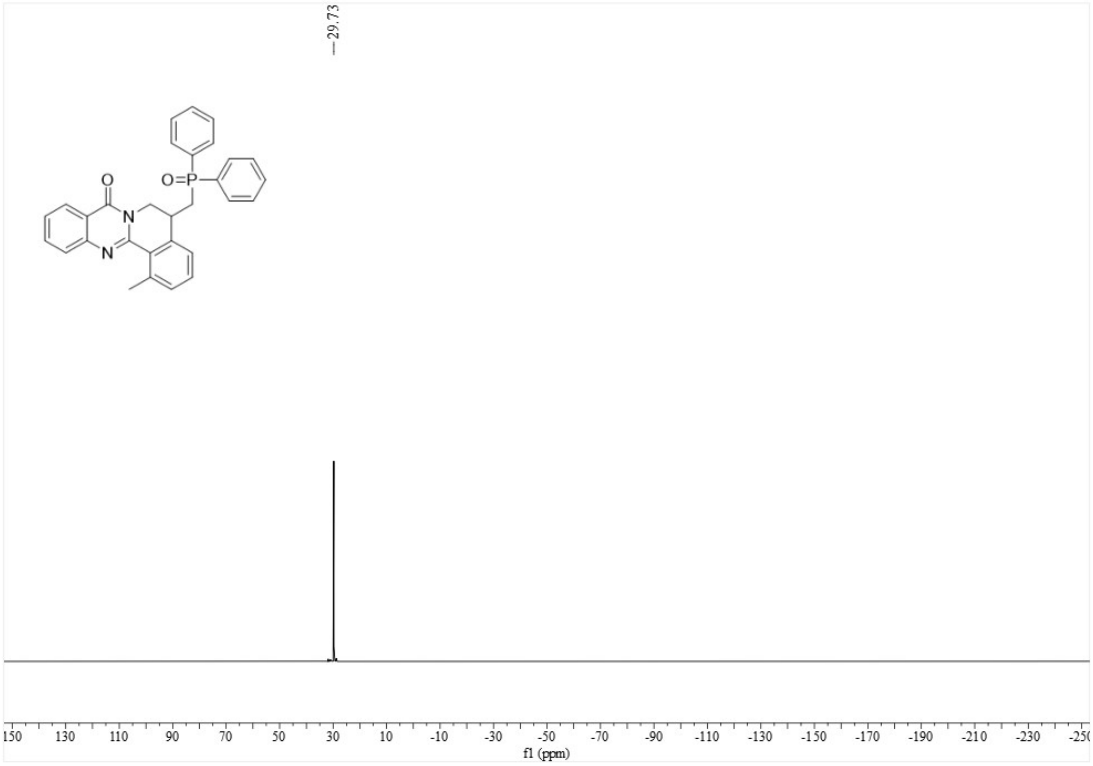
^{1}H NMR of **3r** (400 MHz, $CDCl_3$):



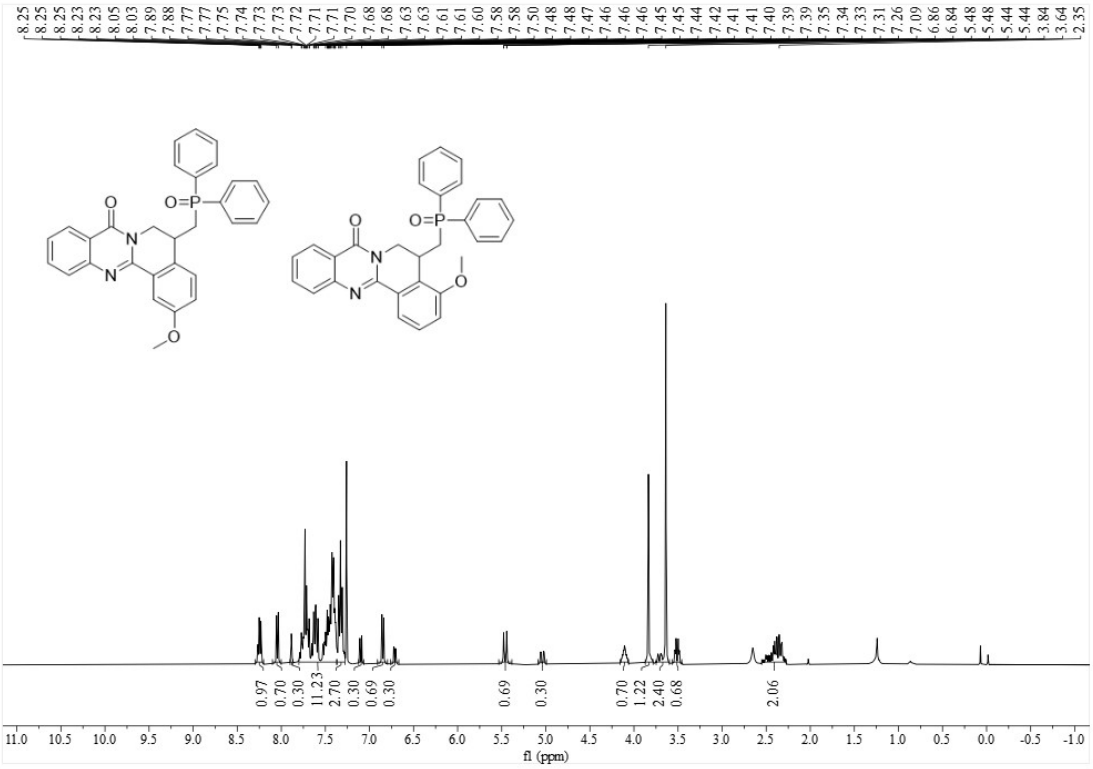
^{13}C NMR of **3r** (100 MHz, $CDCl_3$):



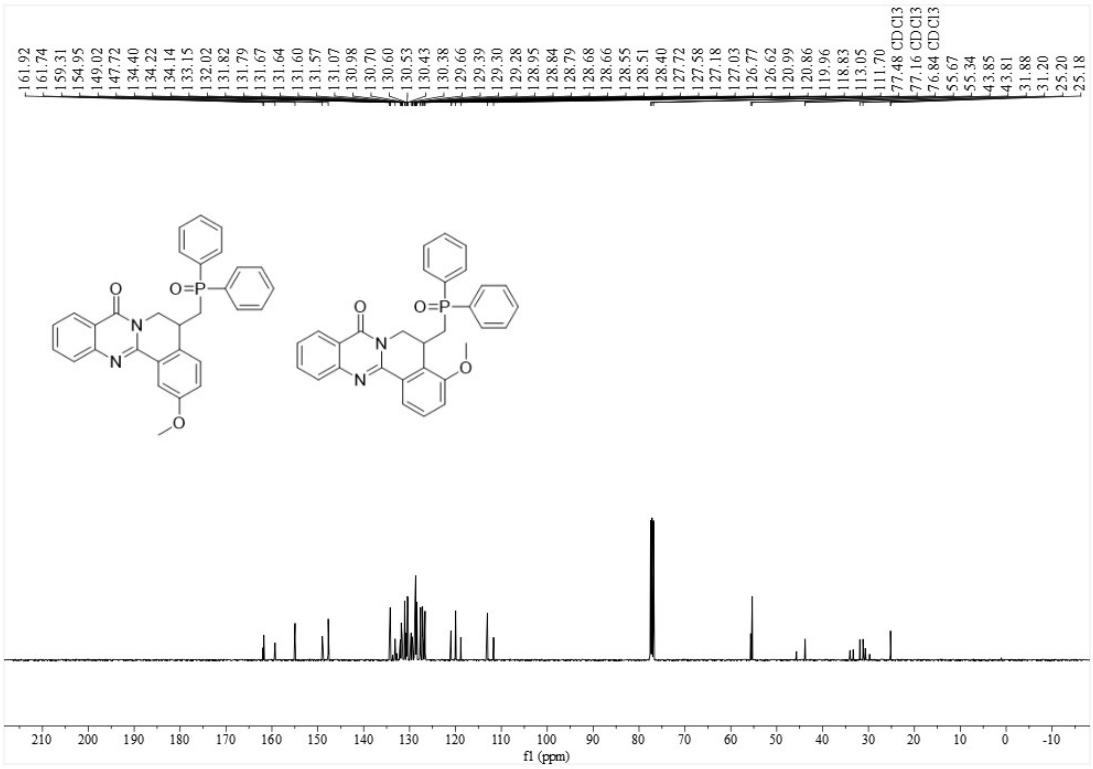
^{31}P NMR of **3r** (162 MHz, $CDCl_3$):



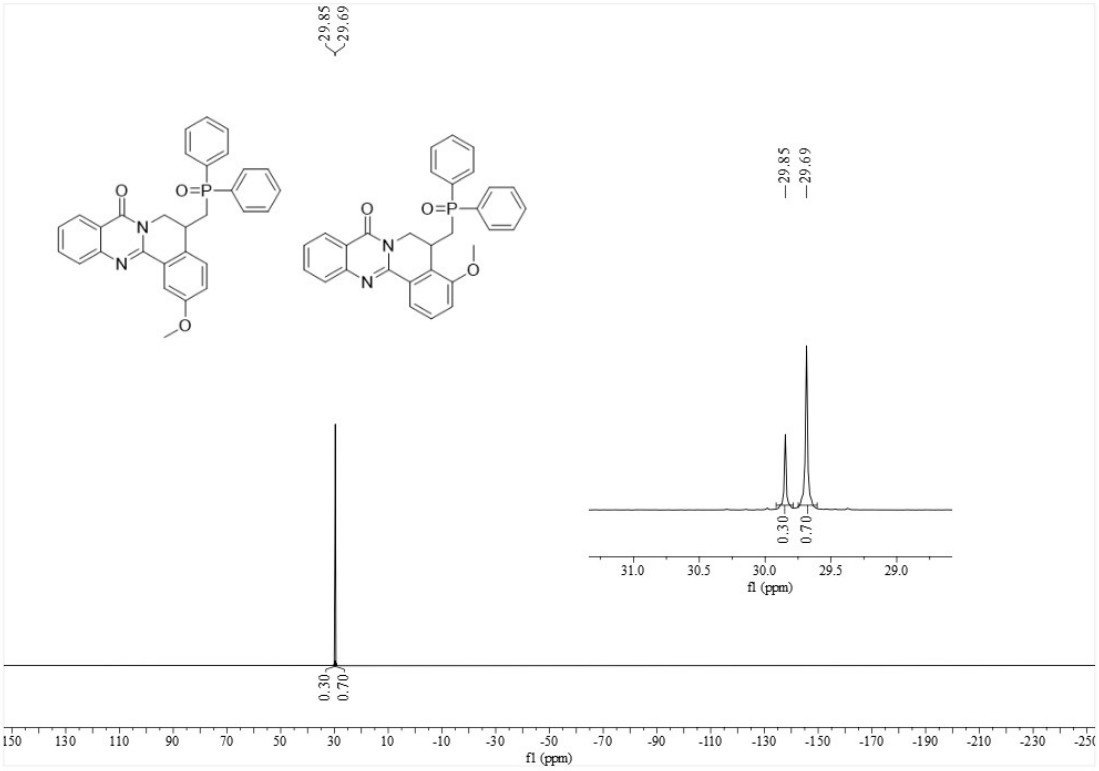
^{1}H NMR of **3s** (400 MHz, $CDCl_3$):



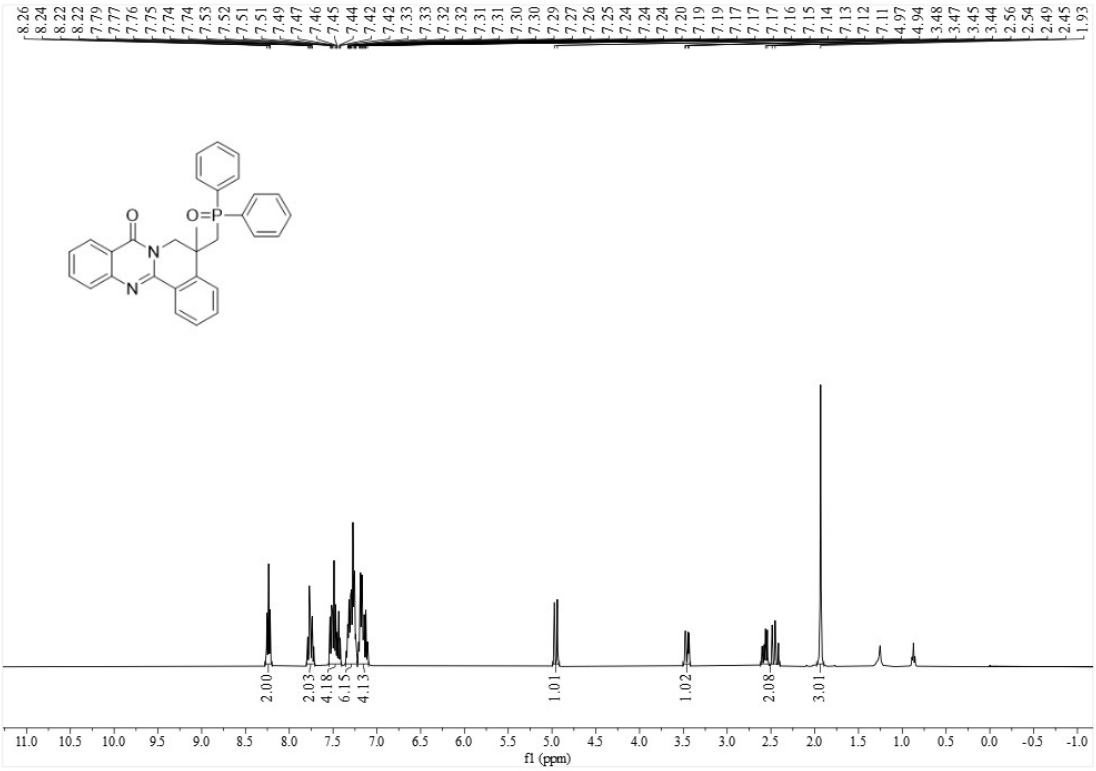
^{13}C NMR of **3s** (100 MHz, $CDCl_3$):



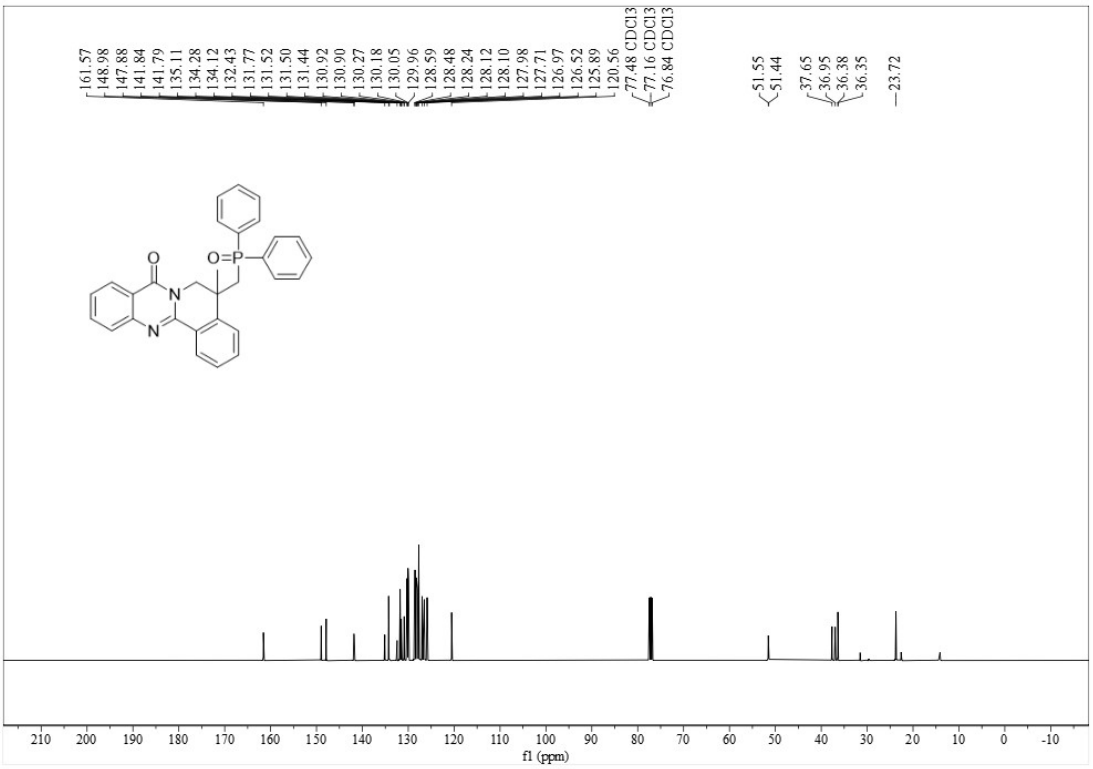
^{31}P NMR of **3s** (162 MHz, $CDCl_3$):



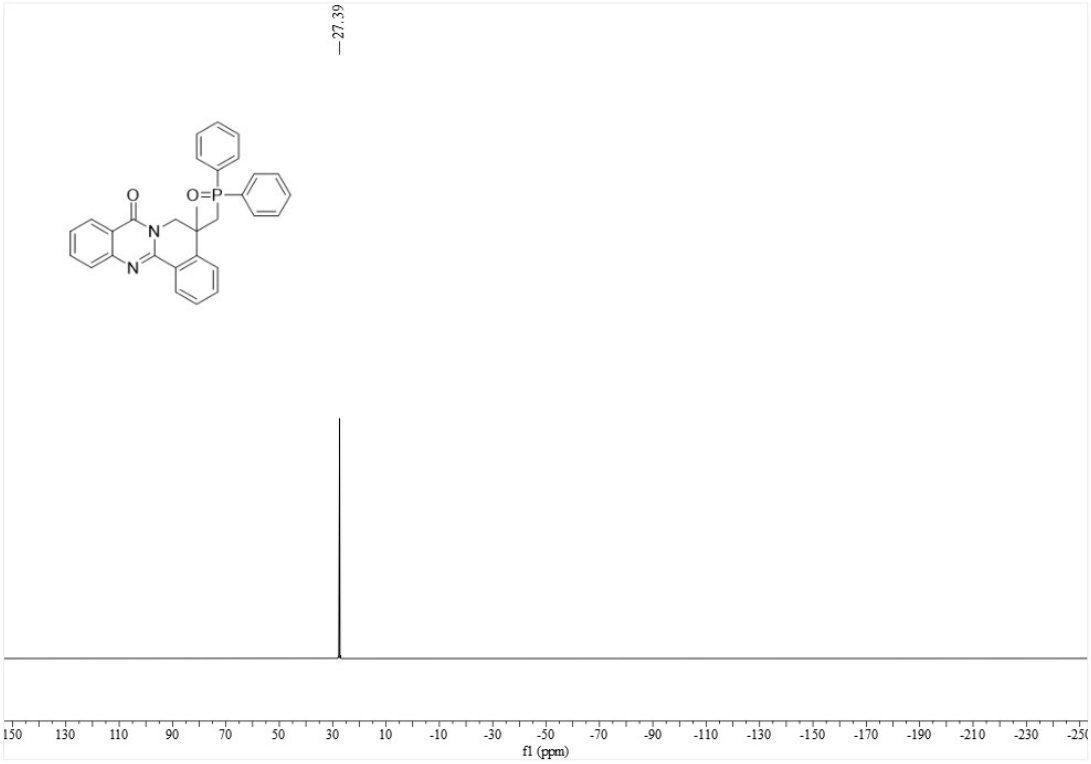
^{1}H NMR of **3t** (400 MHz, $CDCl_3$):



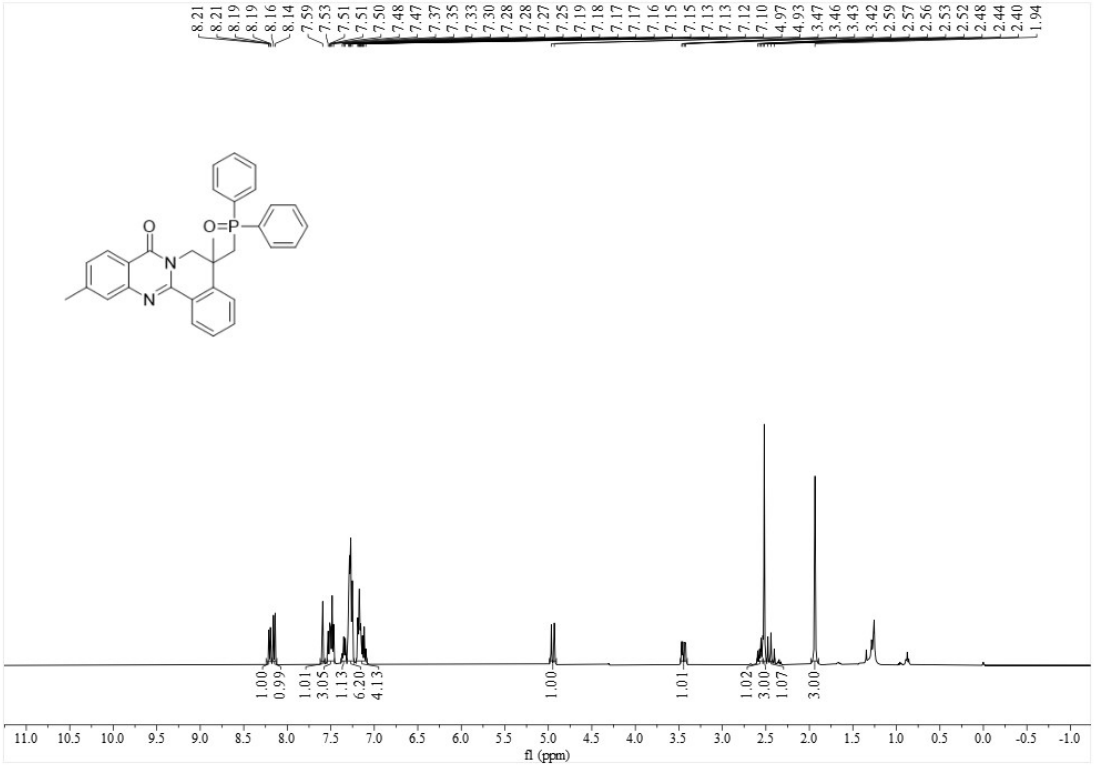
^{13}C NMR of **3t** (100 MHz, $CDCl_3$):



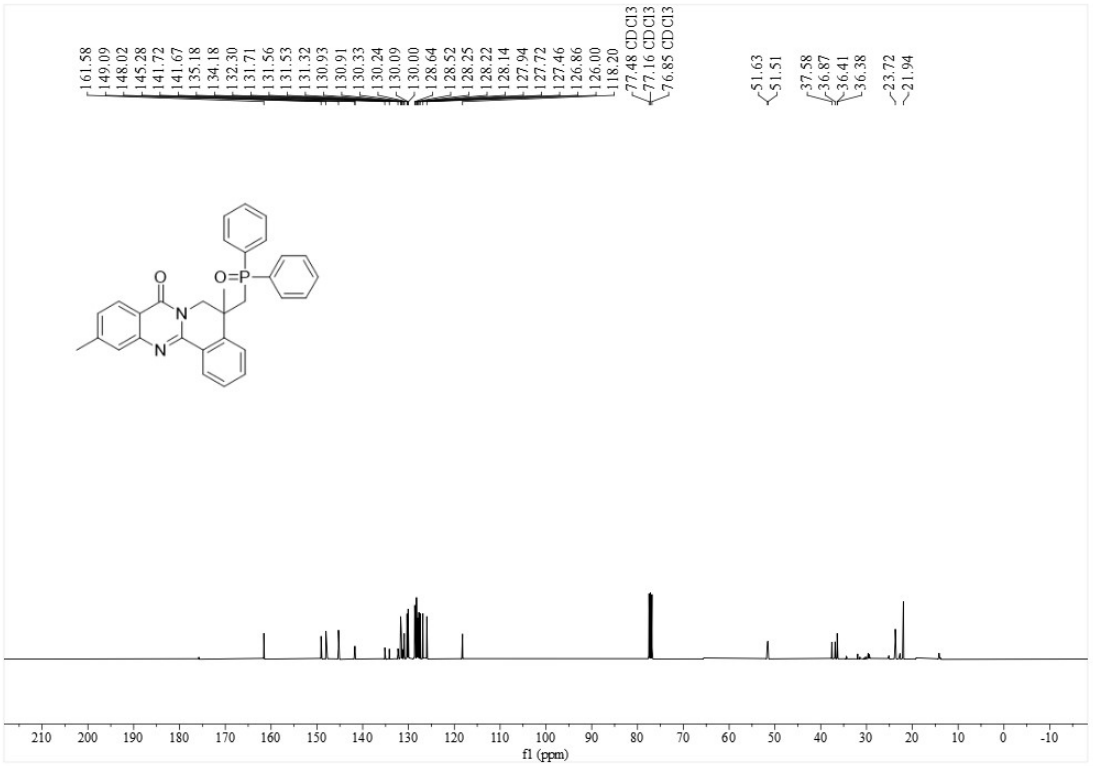
^{31}P NMR of **3t** (162 MHz, $CDCl_3$):



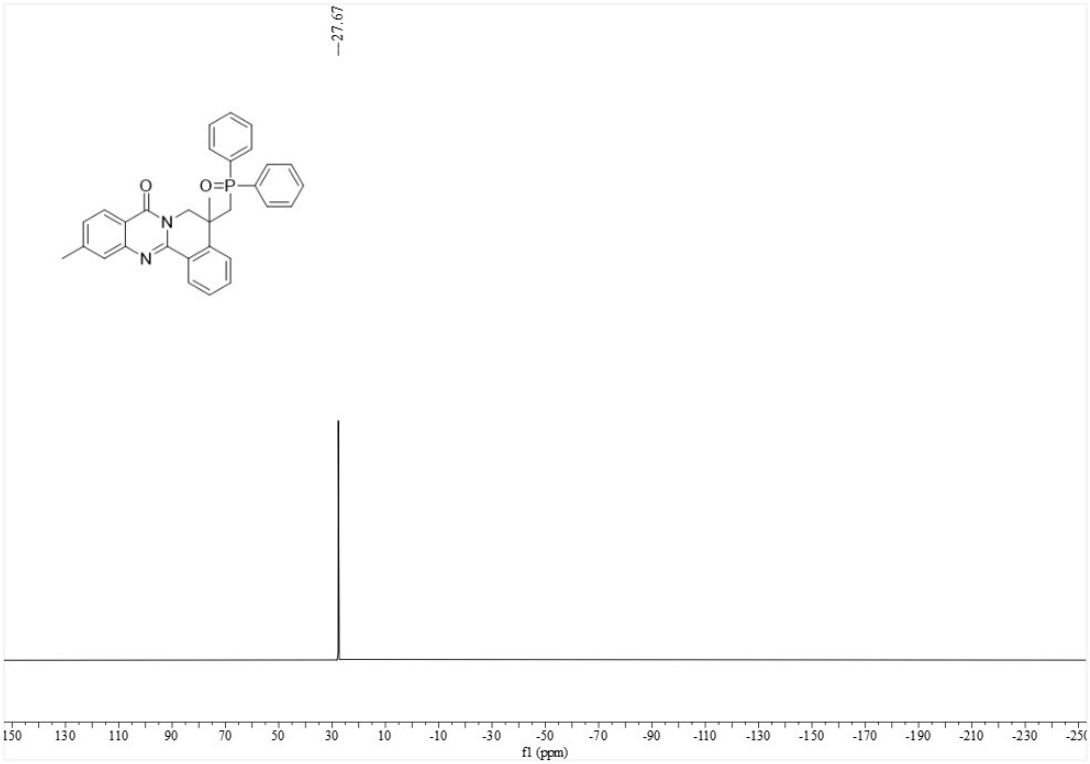
^{1}H NMR of **3u** (400 MHz, $CDCl_3$):



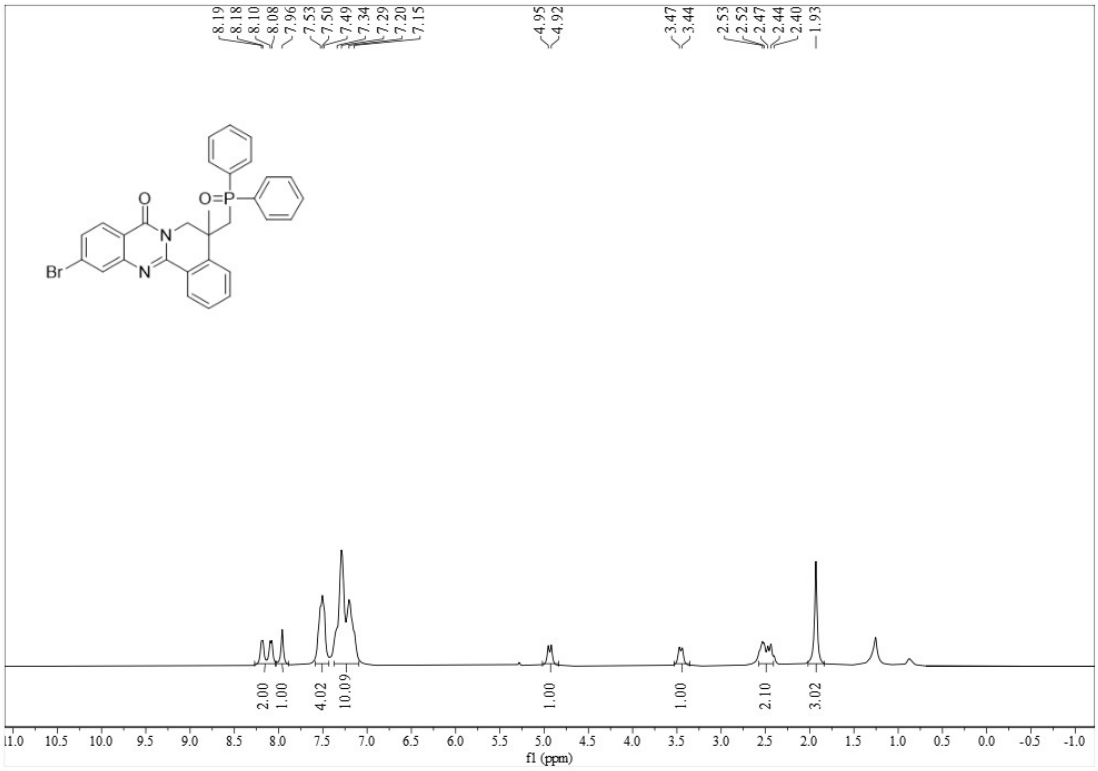
^{13}C NMR of **3u** (100 MHz, $CDCl_3$):



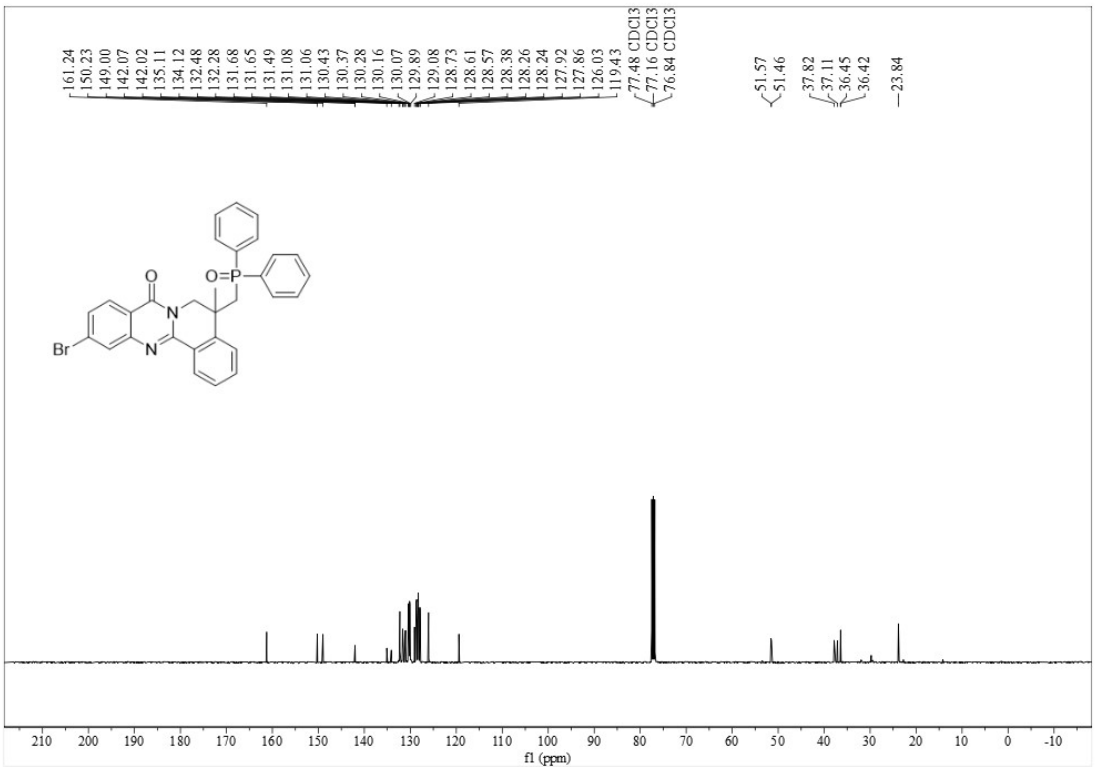
^{31}P NMR of **3u** (162 MHz, $CDCl_3$):



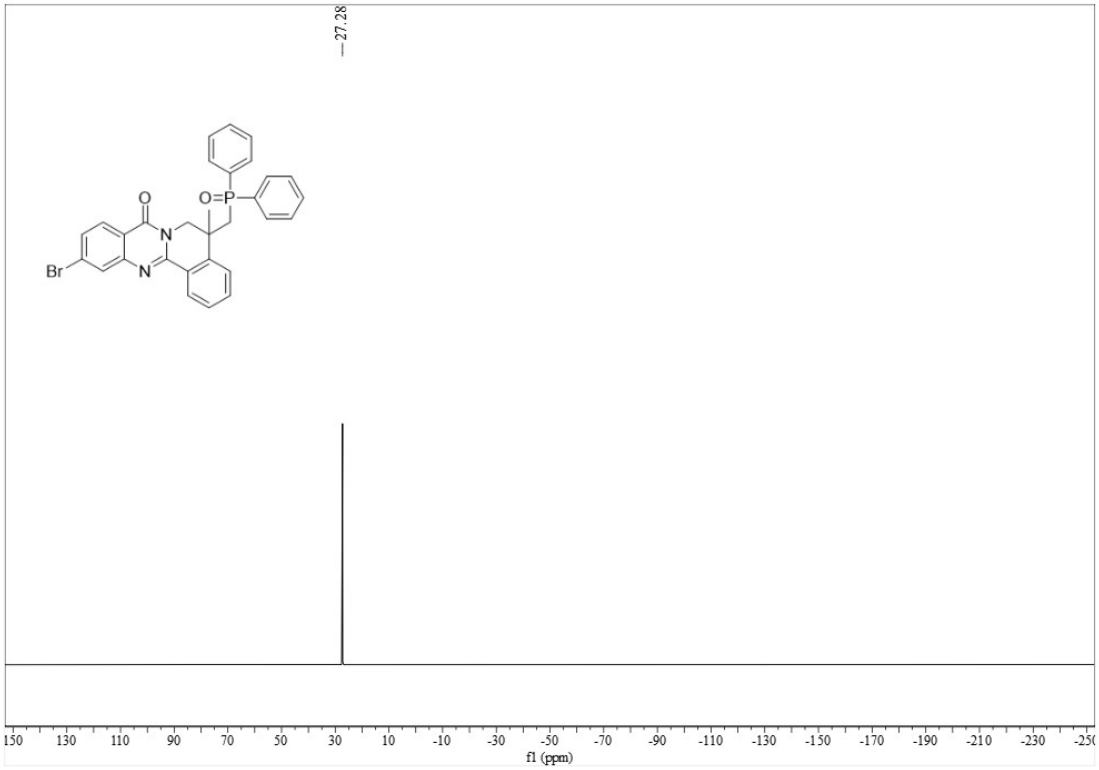
^{1}H NMR of **3v** (400 MHz, $CDCl_3$):



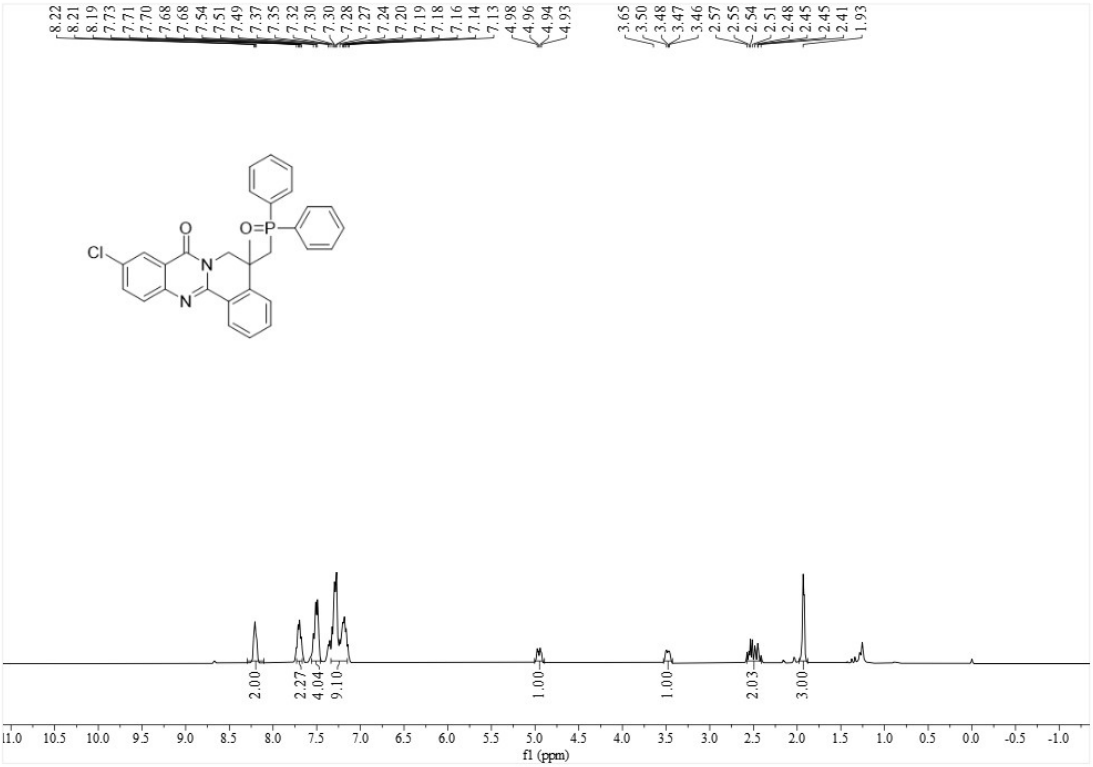
^{13}C NMR of **3v** (100 MHz, $CDCl_3$):



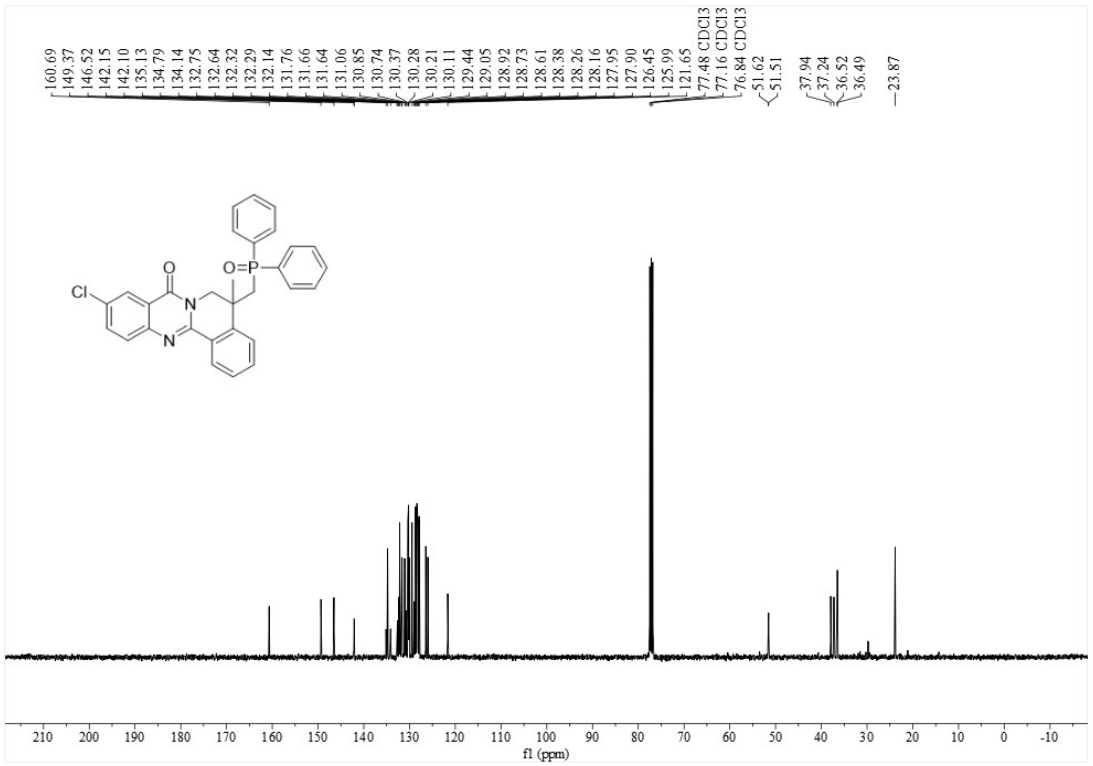
^{31}P NMR of **3v** (162 MHz, $CDCl_3$):



^{1}H NMR of **3w** (400 MHz, $CDCl_3$):



^{13}C NMR of **3w** (100 MHz, $CDCl_3$):



^{31}P NMR of **3w** (162 MHz, $CDCl_3$):