**Supporting Material**

# Integrated Learning Framework for Enhanced Prediction of Biochar Adsorption Properties

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# Table S.1 Summary of sample data (including input and output of biochar Yield \* SSA).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C**(%) | **H**(%) | **N**(%) | **O**(%) | **S**(%) | **ash**(%) | **VM**(%) | **FC**(%) | **Time**(min) | **T(℃)** | **V(℃/min)** | **PH** | **Yield\*SSA** |
| 26.89 | 1.35 | 2.55 | 68.96 | 0.23 | 54.71 | 36.72 | 13.92 | 240.00 | 500.00 | 15.00 | 7.58 | 346.35204 |
| 37.36 | 1.94 | 2.46 | 57.93 | 0.31 | 45.12 | 45.24 | 13.92 | 240.00 | 500.00 | 15.00 | 7.58 | 392.55597 |
| 42.56 | 2.20 | 2.36 | 52.61 | 0.27 | 41.41 | 50.02 | 13.92 | 240.00 | 500.00 | 15.00 | 7.58 | 275.94734 |
| 45.34 | 2.37 | 1.90 | 49.96 | 0.44 | 32.01 | 57.87 | 13.92 | 240.00 | 500.00 | 15.00 | 7.58 | 435.52126 |
| 54.40 | 2.84 | 0.86 | 41.54 | 0.37 | 28.14 | 72.10 | 13.92 | 240.00 | 500.00 | 15.00 | 7.58 | 370.42116 |
| 28.28 | 3.78 | 4.24 | 20.87 | 0.76 | 42.84 | 47.91 | 3.94 | 120.00 | 650.00 | 12.48 | 7.58 | 1402.756 |
| 32.53 | 3.63 | 3.58 | 25.08 | 0.76 | 35.19 | 54.40 | 3.41 | 120.00 | 650.00 | 12.48 | 7.58 | 1316.0235 |
| 36.79 | 3.48 | 2.92 | 29.28 | 0.76 | 27.55 | 60.89 | 2.88 | 120.00 | 650.00 | 12.48 | 7.58 | 1413.1584 |
| 41.05 | 3.32 | 2.26 | 33.48 | 0.76 | 19.90 | 67.37 | 2.35 | 120.00 | 650.00 | 12.48 | 7.58 | 1271.4526 |
| 45.30 | 3.17 | 1.60 | 37.69 | 0.76 | 12.25 | 73.86 | 1.82 | 120.00 | 650.00 | 12.48 | 7.58 | 1088.3278 |
| 26.00 | 3.90 | 4.50 | 27.12 | 0.76 | 49.10 | 47.10 | 3.80 | 60.00 | 500.00 | 12.48 | 5.70 | 464.411 |
| 36.75 | 2.15 | 5.15 | 27.12 | 0.76 | 24.60 | 73.15 | 2.25 | 60.00 | 500.00 | 12.48 | 5.70 | 211.185 |
| 31.65 | 2.55 | 4.95 | 27.12 | 0.76 | 31.80 | 65.65 | 2.55 | 60.00 | 500.00 | 12.48 | 5.70 | 349.602 |
| 18.43 | 2.25 | 1.62 | 18.64 | 0.76 | 59.07 | 37.46 | 3.48 | 83.56 | 600.00 | 20.00 | 7.58 | 1792.9684 |
| 21.31 | 2.68 | 1.50 | 20.94 | 0.76 | 53.57 | 41.65 | 4.78 | 83.56 | 600.00 | 20.00 | 7.58 | 3062.04 |
| 24.18 | 3.12 | 1.39 | 23.25 | 0.76 | 48.07 | 45.84 | 6.09 | 83.56 | 600.00 | 20.00 | 7.58 | 3969.8424 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60.00 | 400.00 | 10.00 | 8.22 | 979.6675 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60.00 | 400.00 | 10.00 | 8.48 | 1261.288 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60.00 | 400.00 | 10.00 | 9.00 | 1294.407 |
| 23.92 | 3.19 | 2.54 | 18.93 | 1.60 | 44.57 | 46.73 | 3.46 | 90.00 | 400.00 | 30.00 | 7.58 | 316.55 |
| 23.92 | 3.19 | 2.54 | 18.93 | 1.60 | 44.57 | 46.73 | 3.46 | 90.00 | 800.00 | 30.00 | 7.58 | 1645.91 |
| 36.22 | 1.91 | 1.92 | 13.58 | 0.10 | 46.27 | 34.34 | 19.39 | 60.00 | 700.00 | 35.00 | 7.58 | 2830.1985 |
| 37.92 | 2.03 | 2.15 | 12.74 | 0.15 | 45.01 | 34.22 | 20.77 | 60.00 | 700.00 | 35.00 | 7.58 | 2394.2408 |
| 12.18 | 5.82 | 1.26 | 23.06 | 0.68 | 56.23 | 27.12 | 16.65 | 60.00 | 700.00 | 35.00 | 9.37 | 451.719 |
| 10.44 | 2.16 | 0.99 | 9.55 | 0.32 | 76.54 | 10.79 | 12.67 | 60.00 | 700.00 | 35.00 | 9.40 | 1890.925 |
| 26.52 | 6.24 | 4.08 | 20.24 | 0.90 | 42.02 | 46.88 | 6.76 | 60.00 | 400.00 | 10.00 | 7.19 | 332.5293 |
| 26.52 | 6.24 | 4.08 | 20.24 | 0.90 | 42.02 | 46.88 | 6.76 | 60.00 | 400.00 | 10.00 | 7.19 | 236.3576 |
| 26.52 | 6.24 | 4.08 | 20.24 | 0.90 | 42.02 | 46.88 | 6.76 | 60.00 | 700.00 | 10.00 | 7.19 | 374.3696 |
| 26.52 | 6.24 | 4.08 | 20.24 | 0.90 | 42.02 | 46.88 | 6.76 | 60.00 | 700.00 | 10.00 | 7.19 | 284.1778 |
| 26.52 | 6.24 | 4.08 | 20.24 | 0.90 | 42.02 | 46.88 | 6.76 | 60.00 | 700.00 | 10.00 | 7.19 | 432.1485 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 831.954 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 750.00 | 10.00 | 6.85 | 885.6432 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 717.0792 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 505.5827 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 538.5057 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 765.628 |
| 26.24 | 6.02 | 3.04 | 13.37 | 2.32 | 49.01 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 365.4798 |
| 26.24 | 6.02 | 3.04 | 7.33 | 2.32 | 55.05 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.85 | 1962.823 |
| 24.47 | 5.06 | 2.77 | 11.49 | 1.94 | 54.27 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 6.97 | 1244.8255 |
| 22.69 | 4.11 | 2.50 | 15.66 | 1.56 | 53.49 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 7.10 | 1301.6804 |
| 20.92 | 3.15 | 2.23 | 19.82 | 1.18 | 52.70 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 7.22 | 1608.3486 |
| 19.14 | 2.19 | 1.96 | 23.98 | 0.80 | 51.92 | 47.46 | 13.92 | 60.00 | 550.00 | 10.00 | 7.34 | 1756.2156 |
| 6.87 | 1.17 | 1.75 | 7.54 | 0.41 | 82.26 | 7.23 | 10.51 | 30.00 | 600.00 | 12.48 | 7.58 | 978.432 |
| 17.78 | 1.39 | 1.85 | 6.39 | 0.26 | 72.33 | 8.11 | 19.56 | 30.00 | 600.00 | 12.48 | 7.58 | 1466.438 |
| 25.60 | 1.50 | 1.70 | 6.27 | 0.17 | 64.76 | 8.79 | 26.45 | 30.00 | 600.00 | 12.48 | 7.58 | 2723.1855 |
| 37.15 | 1.74 | 1.53 | 6.13 | 0.10 | 53.35 | 8.37 | 38.28 | 30.00 | 600.00 | 12.48 | 7.58 | 2624.355 |
| 57.98 | 2.18 | 1.10 | 8.41 | 0.12 | 30.21 | 9.50 | 60.29 | 30.00 | 600.00 | 12.48 | 7.58 | 3361.4176 |
| 36.71 | 4.24 | 5.42 | 23.70 | 0.92 | 28.43 | 55.70 | 15.81 | 83.56 | 500.00 | 12.48 | 6.80 | 1452.33 |
| 12.18 | 5.82 | 1.26 | 23.06 | 0.68 | 56.23 | 27.12 | 16.65 | 83.56 | 500.00 | 12.48 | 7.32 | 1158.156 |
| 24.45 | 5.03 | 3.34 | 23.38 | 0.80 | 42.33 | 41.41 | 16.23 | 83.56 | 500.00 | 12.48 | 7.06 | 1155.42 |
| 30.58 | 4.64 | 4.38 | 23.54 | 0.86 | 35.38 | 48.56 | 16.02 | 83.56 | 500.00 | 12.48 | 6.93 | 1066.47 |
| 36.71 | 4.24 | 5.42 | 23.70 | 0.92 | 28.43 | 55.70 | 15.81 | 83.56 | 700.00 | 12.48 | 6.80 | 3787.168 |
| 12.18 | 5.82 | 1.26 | 23.06 | 0.68 | 56.23 | 27.12 | 16.65 | 83.56 | 700.00 | 12.48 | 7.32 | 1998.224 |
| 24.45 | 5.03 | 3.34 | 23.38 | 0.80 | 42.33 | 41.41 | 16.23 | 83.56 | 700.00 | 12.48 | 7.06 | 1975.47 |
| 30.58 | 4.64 | 4.38 | 23.54 | 0.86 | 35.38 | 48.56 | 16.02 | 83.56 | 700.00 | 12.48 | 6.93 | 1304.464 |
| 36.71 | 4.24 | 5.42 | 23.70 | 0.92 | 28.43 | 55.70 | 15.81 | 83.56 | 900.00 | 12.48 | 6.80 | 1347.23 |
| 12.18 | 5.82 | 1.26 | 23.06 | 0.68 | 56.23 | 27.12 | 16.65 | 83.56 | 900.00 | 12.48 | 7.32 | 880.968 |
| 24.45 | 5.03 | 3.34 | 23.38 | 0.80 | 42.33 | 41.41 | 16.23 | 83.56 | 900.00 | 12.48 | 7.06 | 805.086 |
| 30.58 | 4.64 | 4.38 | 23.54 | 0.86 | 35.38 | 48.56 | 16.02 | 83.56 | 900.00 | 12.48 | 6.93 | 721 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45.00 | 450.00 | 10.00 | 7.58 | 821.3376 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45.00 | 500.00 | 10.00 | 7.58 | 833.1162 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45.00 | 550.00 | 10.00 | 7.58 | 873.0228 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45.00 | 450.00 | 10.00 | 7.58 | 181.56 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45.00 | 500.00 | 10.00 | 7.58 | 171.6456 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45.00 | 550.00 | 10.00 | 7.58 | 177.9288 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45.00 | 450.00 | 10.00 | 7.58 | 269.0184 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45.00 | 500.00 | 10.00 | 7.58 | 245.214 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45.00 | 550.00 | 10.00 | 7.58 | 236.61 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45.00 | 450.00 | 10.00 | 7.58 | 405.3888 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45.00 | 500.00 | 10.00 | 7.58 | 389.1888 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45.00 | 550.00 | 10.00 | 7.58 | 402.2784 |
| 53.09 | 7.02 | 2.38 | 37.40 | 0.11 | 1.31 | 75.03 | 19.20 | 60.00 | 400.00 | 10.00 | 2.00 | 832.2936 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60.00 | 400.00 | 10.00 | 5.40 | 979.6675 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60.00 | 400.00 | 10.00 | 6.30 | 1261.288 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60.00 | 400.00 | 10.00 | 8.20 | 1294.407 |
| 51.33 | 6.68 | 4.46 | 37.19 | 0.34 | 9.63 | 64.05 | 19.60 | 60.00 | 400.00 | 10.00 | 9.20 | 1483.7438 |
| 24.27 | 0.87 | 2.97 | 5.13 | 0.44 | 65.61 | 14.40 | 15.04 | 45.00 | 550.00 | 10.00 | 8.41 | 447.0534 |
| 55.14 | 2.10 | 1.73 | 6.11 | 0.25 | 35.71 | 12.95 | 46.63 | 45.00 | 550.00 | 10.00 | 8.69 | 461.6094 |
| 38.51 | 1.27 | 0.63 | 18.09 | 0.23 | 41.27 | 30.58 | 28.15 | 60.00 | 700.00 | 35.00 | 7.58 | 4042.7232 |
| 40.91 | 1.46 | 0.82 | 17.21 | 0.19 | 39.41 | 30.22 | 30.37 | 60.00 | 700.00 | 35.00 | 7.58 | 3257.6166 |
| 36.22 | 1.91 | 1.92 | 13.58 | 0.10 | 46.27 | 34.34 | 19.39 | 60.00 | 700.00 | 35.00 | 4.25 | 2824.3458 |
| 37.92 | 2.03 | 2.15 | 12.74 | 0.15 | 45.01 | 34.22 | 20.77 | 60.00 | 700.00 | 35.00 | 3.90 | 2368.1028 |
| 12.18 | 5.82 | 1.26 | 23.06 | 0.68 | 56.23 | 27.12 | 16.65 | 60.00 | 700.00 | 35.00 | 9.37 | 451.719 |
| 10.44 | 2.16 | 0.99 | 9.55 | 0.32 | 76.54 | 10.79 | 12.67 | 60.00 | 700.00 | 35.00 | 7.58 | 1880.7228 |
| 12.51 | 0.19 | 1.13 | 9.12 | 0.42 | 76.63 | 10.28 | 13.09 | 60.00 | 700.00 | 35.00 | 9.40 | 1317.95 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90.00 | 500.00 | 10.00 | 7.58 | 411.5103 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90.00 | 600.00 | 10.00 | 7.58 | 461.8452 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90.00 | 700.00 | 10.00 | 7.58 | 645.3171 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90.00 | 800.00 | 10.00 | 7.58 | 1044.7883 |
| 48.19 | 6.96 | 4.29 | 40.11 | 0.57 | 44.10 | 24.50 | 3.53 | 90.00 | 500.00 | 10.00 | 7.58 | 824.776 |
| 48.19 | 6.96 | 4.29 | 40.11 | 0.57 | 44.10 | 24.50 | 3.53 | 90.00 | 600.00 | 10.00 | 7.58 | 691.9284 |
| 48.19 | 6.96 | 4.29 | 40.11 | 0.57 | 44.10 | 24.50 | 3.53 | 90.00 | 700.00 | 10.00 | 7.58 | 1343.988 |
| 48.19 | 6.96 | 4.29 | 40.11 | 0.57 | 44.10 | 24.50 | 3.53 | 90.00 | 800.00 | 10.00 | 7.58 | 1685.2248 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90.00 | 500.00 | 10.00 | 7.58 | 1784.4072 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90.00 | 600.00 | 10.00 | 7.58 | 1302.7644 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90.00 | 700.00 | 10.00 | 7.58 | 1907.0376 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90.00 | 800.00 | 10.00 | 7.58 | 2478.384 |
| 47.67 | 7.97 | 7.77 | 35.73 | 0.86 | 58.80 | 32.66 | 4.70 | 90.00 | 500.00 | 10.00 | 7.58 | 1836.786 |
| 47.67 | 7.97 | 7.77 | 35.73 | 0.86 | 58.80 | 32.66 | 4.70 | 90.00 | 600.00 | 10.00 | 7.58 | 1495.406 |
| 47.67 | 7.97 | 7.77 | 35.73 | 0.86 | 58.80 | 32.66 | 4.70 | 90.00 | 700.00 | 10.00 | 7.58 | 1874.5248 |
| 47.67 | 7.97 | 7.77 | 35.73 | 0.86 | 58.80 | 32.66 | 4.70 | 90.00 | 800.00 | 10.00 | 7.58 | 2679.0551 |
| 22.01 | 1.57 | 2.02 | 27.12 | 0.76 | 68.56 | 22.61 | 8.83 | 120.00 | 650.00 | 12.48 | 9.82 | 1359.925 |
| 29.57 | 1.70 | 1.83 | 27.12 | 0.76 | 60.11 | 32.38 | 7.51 | 120.00 | 650.00 | 12.48 | 9.67 | 1297.429 |
| 37.69 | 1.90 | 1.59 | 27.12 | 0.76 | 50.47 | 37.84 | 11.69 | 120.00 | 650.00 | 12.48 | 9.27 | 1397.012 |
| 47.37 | 2.16 | 1.34 | 27.12 | 0.76 | 39.07 | 43.35 | 17.58 | 120.00 | 650.00 | 12.48 | 9.15 | 1251.648 |
| 54.88 | 2.20 | 1.12 | 27.12 | 0.76 | 30.99 | 53.07 | 15.94 | 120.00 | 650.00 | 12.48 | 9.03 | 1069.8552 |
| 35.90 | 1.47 | 3.92 | 23.37 | 0.62 | 34.72 | 47.46 | 13.92 | 360.00 | 400.00 | 10.00 | 9.79 | 243.44 |
| 46.10 | 0.94 | 2.15 | 7.03 | 0.42 | 43.36 | 47.46 | 13.92 | 360.00 | 500.00 | 10.00 | 10.93 | 399.31 |
| 48.90 | 0.14 | 1.54 | 0.43 | 0.35 | 48.64 | 47.46 | 13.92 | 360.00 | 600.00 | 10.00 | 11.37 | 912.73 |
| 57.57 | 3.27 | 1.07 | 25.17 | 1.57 | 11.35 | 47.46 | 13.92 | 360.00 | 400.00 | 10.00 | 7.59 | 1383.46 |
| 68.77 | 2.75 | 1.42 | 13.57 | 0.20 | 13.29 | 47.46 | 13.92 | 360.00 | 500.00 | 10.00 | 8.62 | 903.89 |
| 76.23 | 1.81 | 0.38 | 6.32 | 0.11 | 15.15 | 47.46 | 13.92 | 360.00 | 600.00 | 10.00 | 10.84 | 738.14 |
| 12.42 | 1.32 | 1.37 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 15.00 | 300.00 | 5.00 | 7.21 | 1650.31711 |
| 12.36 | 1.30 | 1.32 | 23.70 | 0.70 | 89.11 | 47.46 | 13.92 | 15.00 | 300.00 | 5.00 | 7.73 | 1595.4489 |
| 12.41 | 1.29 | 1.31 | 23.70 | 0.70 | 89.41 | 47.46 | 13.92 | 15.00 | 300.00 | 5.00 | 8.31 | 2050.59652 |
| 12.46 | 2.45 | 1.45 | 23.70 | 0.70 | 87.23 | 47.46 | 13.92 | 15.00 | 300.00 | 5.00 | 8.51 | 1609.128405 |
| 12.26 | 2.04 | 1.39 | 23.70 | 0.70 | 87.27 | 47.46 | 13.92 | 15.00 | 500.00 | 5.00 | 8.43 | 2403.13216 |
| 12.02 | 1.31 | 1.32 | 23.70 | 0.70 | 87.38 | 47.46 | 13.92 | 15.00 | 700.00 | 5.00 | 8.36 | 1596.821265 |
| 12.35 | 1.40 | 1.12 | 23.70 | 0.70 | 77.59 | 47.46 | 13.92 | 15.00 | 700.00 | 5.00 | 8.27 | 2674.0875 |
| 12.34 | 1.44 | 1.18 | 23.70 | 0.70 | 84.55 | 47.46 | 13.92 | 60.00 | 700.00 | 5.00 | 8.07 | 2413.50525 |
| 12.36 | 1.42 | 1.14 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 120.00 | 700.00 | 5.00 | 7.73 | 2335.7116 |

# Table S.2 Summary of sample data (including input and output of biochar Yield \* Dp).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C**(%) | **H**(%) | **N**(%) | **O**(%) | **S**(%) | **ash**(%) | **VM**(%) | **FC**(%) | **Time**(min) | **T(℃)** | **V(℃/min)** | **PH** | **Yield\*Dp** |
| 26.89 | 1.35 | 2.55 | 68.96 | 0.23 | 54.71 | 36.72 | 13.92 | 240 | 500 | 15.00 | 7.58 | 1110.32964 |
| 37.36 | 1.94 | 2.46 | 57.93 | 0.31 | 45.12 | 45.24 | 13.92 | 240 | 500 | 15.00 | 7.58 | 1331.62461 |
| 42.56 | 2.20 | 2.36 | 52.61 | 0.27 | 41.41 | 50.02 | 13.92 | 240 | 500 | 15.00 | 7.58 | 827.3974 |
| 45.34 | 2.37 | 1.90 | 49.96 | 0.44 | 32.01 | 57.87 | 13.92 | 240 | 500 | 15.00 | 7.58 | 991.29196 |
| 54.40 | 2.84 | 0.86 | 41.54 | 0.37 | 28.14 | 72.10 | 13.92 | 240 | 500 | 15.00 | 7.58 | 807.56324 |
| 26.00 | 3.90 | 4.50 | 27.12 | 0.76 | 49.10 | 47.10 | 3.80 | 60 | 500 | 12.48 | 5.70 | 1308.2 |
| 36.75 | 2.15 | 5.15 | 27.12 | 0.76 | 24.60 | 73.15 | 2.25 | 60 | 500 | 12.48 | 5.70 | 763.515 |
| 31.65 | 2.55 | 4.95 | 27.12 | 0.76 | 31.80 | 65.65 | 2.55 | 60 | 500 | 12.48 | 5.70 | 942.866 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60 | 400 | 10.00 | 8.22 | 309.9712 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60 | 400 | 10.00 | 8.48 | 224.784 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60 | 400 | 10.00 | 9.00 | 244.8756 |
| 26.24 | 6.02 | 3.04 | 7.33 | 2.32 | 55.05 | 47.46 | 13.92 | 60 | 550 | 10.00 | 6.85 | 407.11332 |
| 24.47 | 5.06 | 2.77 | 11.49 | 1.94 | 54.27 | 47.46 | 13.92 | 60 | 550 | 10.00 | 6.97 | 636.47041 |
| 22.69 | 4.11 | 2.50 | 15.66 | 1.56 | 53.49 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.10 | 657.23052 |
| 20.92 | 3.15 | 2.23 | 19.82 | 1.18 | 52.70 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.22 | 678.08094 |
| 19.14 | 2.19 | 1.96 | 23.98 | 0.80 | 51.92 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.34 | 704.28288 |
| 6.87 | 1.17 | 1.75 | 7.54 | 0.41 | 82.26 | 7.23 | 10.51 | 30 | 600 | 12.48 | 7.58 | 1789.008 |
| 17.78 | 1.39 | 1.85 | 6.39 | 0.26 | 72.33 | 8.11 | 19.56 | 30 | 600 | 12.48 | 7.58 | 688.7494 |
| 25.60 | 1.50 | 1.70 | 6.27 | 0.17 | 64.76 | 8.79 | 26.45 | 30 | 600 | 12.48 | 7.58 | 240.4044 |
| 12.42 | 1.32 | 1.37 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 15 | 300 | 5.00 | 7.21 | 1214.7707 |
| 12.36 | 1.30 | 1.32 | 23.70 | 0.70 | 89.11 | 47.46 | 13.92 | 15 | 300 | 5.00 | 7.73 | 1206.9216 |
| 12.41 | 1.29 | 1.31 | 23.70 | 0.70 | 89.41 | 47.46 | 13.92 | 15 | 300 | 5.00 | 8.31 | 1065.22766 |
| 12.46 | 2.45 | 1.45 | 23.70 | 0.70 | 87.23 | 47.46 | 13.92 | 15 | 300 | 5.00 | 8.51 | 1238.80779 |
| 12.26 | 2.04 | 1.39 | 23.70 | 0.70 | 87.27 | 47.46 | 13.92 | 15 | 500 | 5.00 | 8.43 | 1232.39776 |
| 12.02 | 1.31 | 1.32 | 23.70 | 0.70 | 87.38 | 47.46 | 13.92 | 15 | 700 | 5.00 | 8.36 | 1220.79486 |
| 12.35 | 1.40 | 1.12 | 23.70 | 0.70 | 77.59 | 47.46 | 13.92 | 15 | 700 | 5.00 | 8.27 | 1109.66625 |
| 12.34 | 1.44 | 1.18 | 23.70 | 0.70 | 84.55 | 47.46 | 13.92 | 60 | 700 | 5.00 | 8.07 | 1003.75929 |
| 12.36 | 1.42 | 1.14 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 120 | 700 | 5.00 | 7.73 | 979.3853 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 450 | 10.00 | 7.58 | 3315.0864 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 500 | 10.00 | 7.58 | 3114.409 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 550 | 10.00 | 7.58 | 2792.5433 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 450 | 10.00 | 7.58 | 4406.1008 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 500 | 10.00 | 7.58 | 4230.0258 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 550 | 10.00 | 7.58 | 4372.2944 |
| 44.20 | 4.20 | 1.90 | 49.30 | 0.30 | 8.60 | 68.50 | 14.50 | 120 | 500 | 20.00 | 7.58 | 242.0592 |
| 41.55 | 3.83 | 1.93 | 52.05 | 0.58 | 14.28 | 63.60 | 12.70 | 120 | 500 | 20.00 | 7.58 | 279.9225 |
| 38.90 | 3.45 | 1.95 | 54.80 | 0.85 | 19.95 | 58.70 | 10.90 | 120 | 500 | 20.00 | 7.58 | 310.4595 |
| 36.25 | 3.08 | 1.98 | 57.55 | 1.13 | 25.63 | 53.80 | 9.10 | 120 | 500 | 20.00 | 7.58 | 351.5995 |
| 33.60 | 2.70 | 2.00 | 60.30 | 1.40 | 31.30 | 48.90 | 7.30 | 120 | 500 | 20.00 | 7.58 | 445.0812 |
| 53.09 | 7.02 | 2.38 | 37.40 | 0.11 | 1.31 | 75.03 | 19.20 | 60 | 400 | 10.00 | 2.00 | 358.6872 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60 | 400 | 10.00 | 5.40 | 309.9712 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60 | 400 | 10.00 | 6.30 | 224.784 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60 | 400 | 10.00 | 8.20 | 244.8756 |
| 51.33 | 6.68 | 4.46 | 37.19 | 0.34 | 9.63 | 64.05 | 19.60 | 60 | 400 | 10.00 | 9.20 | 197.1662 |
| 45.79 | 6.15 | 1.47 | 46.33 | 1.47 | 6.38 | 71.14 | 15.42 | 180 | 550 | 5.00 | 2.96 | 3596.482098 |
| 44.95 | 5.89 | 0.40 | 48.71 | 0.06 | 5.24 | 71.31 | 16.68 | 180 | 550 | 5.00 | 2.59 | 3802.363002 |
| 47.55 | 6.22 | 0.32 | 45.91 | 0.03 | 1.68 | 75.98 | 15.21 | 180 | 550 | 5.00 | 2.18 | 4211.154492 |
| 86.70 | 3.32 | 0.49 | 7.89 | 0.04 | 5.79 | 11.51 | 78.26 | 45 | 550 | 10.00 | 10.02 | 2888.228 |
| 24.27 | 0.87 | 2.97 | 5.13 | 0.44 | 65.61 | 14.40 | 15.04 | 45 | 550 | 10.00 | 8.41 | 3941.2053 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 500 | 10.00 | 7.58 | 692.563595 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 600 | 10.00 | 7.58 | 589.659468 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 700 | 10.00 | 7.58 | 435.130059 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 800 | 10.00 | 7.58 | 343.762575 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 500 | 10.00 | 7.58 | 564.20071 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 600 | 10.00 | 7.58 | 635.094604 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 700 | 10.00 | 7.58 | 490.654632 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 800 | 10.00 | 7.58 | 414.010605 |
| 12.42 | 1.32 | 1.37 | 23.70 | 0.70 | 88.98 | 47.46 | 17.62 | 15 | 300 | 5.00 | 7.21 | 1214.7707 |
| 12.36 | 1.30 | 1.32 | 23.70 | 0.70 | 89.11 | 47.46 | 17.62 | 15 | 300 | 5.00 | 7.73 | 1206.9216 |
| 12.41 | 1.29 | 1.31 | 23.70 | 0.70 | 89.41 | 47.46 | 17.62 | 15 | 300 | 5.00 | 8.31 | 1065.22766 |
| 12.46 | 2.45 | 1.45 | 23.70 | 0.70 | 87.23 | 47.46 | 17.62 | 15 | 300 | 5.00 | 8.51 | 1238.80779 |
| 12.26 | 2.04 | 1.39 | 23.70 | 0.70 | 87.27 | 47.46 | 17.62 | 15 | 500 | 5.00 | 8.43 | 1232.39776 |
| 12.02 | 1.31 | 1.32 | 23.70 | 0.70 | 87.38 | 47.46 | 17.62 | 15 | 700 | 5.00 | 8.36 | 1220.79486 |
| 12.35 | 1.40 | 1.12 | 23.70 | 0.70 | 77.59 | 47.46 | 17.62 | 15 | 700 | 5.00 | 8.27 | 1109.66625 |
| 12.34 | 1.44 | 1.18 | 23.70 | 0.70 | 84.55 | 47.46 | 17.62 | 60 | 700 | 5.00 | 8.07 | 1003.75929 |
| 12.36 | 1.42 | 1.14 | 23.70 | 0.70 | 88.98 | 47.46 | 17.62 | 120 | 700 | 5.00 | 7.73 | 979.3853 |

# Table S.3 Summary of sample data (including input and output of biochar Yield \* Vt).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **C**(%) | **H**(%) | **N**(%) | **O**(%) | **S**(%) | **ash**(%) | **VM**(%) | **FC**(%) | **Time**(min) | **T(℃)** | **V(℃/min)** | **PH** | **Yield\*Vt** |
| 26.89 | 1.35 | 2.55 | 68.96 | 0.23 | 54.71 | 36.72 | 13.92 | 240 | 500 | 15.00 | 7.58 | 1.20342 |
| 37.36 | 1.94 | 2.46 | 57.93 | 0.31 | 45.12 | 45.24 | 13.92 | 240 | 500 | 15.00 | 7.58 | 2.117745 |
| 42.56 | 2.20 | 2.36 | 52.61 | 0.27 | 41.41 | 50.02 | 13.92 | 240 | 500 | 15.00 | 7.58 | 1.390448 |
| 45.34 | 2.37 | 1.90 | 49.96 | 0.44 | 32.01 | 57.87 | 13.92 | 240 | 500 | 15.00 | 7.58 | 2.245103 |
| 54.40 | 2.84 | 0.86 | 41.54 | 0.37 | 28.14 | 72.10 | 13.92 | 240 | 500 | 15.00 | 7.58 | 1.498856 |
| 28.28 | 3.78 | 4.24 | 20.87 | 0.76 | 42.84 | 47.91 | 3.94 | 120 | 650 | 12.48 | 7.58 | 1.89717 |
| 32.53 | 3.63 | 3.58 | 25.08 | 0.76 | 35.19 | 54.40 | 3.41 | 120 | 650 | 12.48 | 7.58 | 2.64732 |
| 36.79 | 3.48 | 2.92 | 29.28 | 0.76 | 27.55 | 60.89 | 2.88 | 120 | 650 | 12.48 | 7.58 | 2.61696 |
| 41.05 | 3.32 | 2.26 | 33.48 | 0.76 | 19.90 | 67.37 | 2.35 | 120 | 650 | 12.48 | 7.58 | 2.5883 |
| 45.30 | 3.17 | 1.60 | 37.69 | 0.76 | 12.25 | 73.86 | 1.82 | 120 | 650 | 12.48 | 7.58 | 2.30111 |
| 26.00 | 3.90 | 4.50 | 27.12 | 0.76 | 49.10 | 47.10 | 3.80 | 60 | 500 | 12.48 | 5.70 | 4.18624 |
| 36.75 | 2.15 | 5.15 | 27.12 | 0.76 | 24.60 | 73.15 | 2.25 | 60 | 500 | 12.48 | 5.70 | 1.78695 |
| 31.65 | 2.55 | 4.95 | 27.12 | 0.76 | 31.80 | 65.65 | 2.55 | 60 | 500 | 12.48 | 5.70 | 3.01929 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60 | 400 | 10.00 | 8.22 | 1.58508 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60 | 400 | 10.00 | 8.48 | 1.7394 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60 | 400 | 10.00 | 9.00 | 1.76202 |
| 26.24 | 6.02 | 3.04 | 7.33 | 2.32 | 55.05 | 47.46 | 13.92 | 60 | 550 | 10.00 | 6.85 | 3.19821 |
| 24.47 | 5.06 | 2.77 | 11.49 | 1.94 | 54.27 | 47.46 | 13.92 | 60 | 550 | 10.00 | 6.97 | 3.02174 |
| 22.69 | 4.11 | 2.50 | 15.66 | 1.56 | 53.49 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.10 | 3.05624 |
| 20.92 | 3.15 | 2.23 | 19.82 | 1.18 | 52.70 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.22 | 3.73014 |
| 19.14 | 2.19 | 1.96 | 23.98 | 0.80 | 51.92 | 47.46 | 13.92 | 60 | 550 | 10.00 | 7.34 | 4.1173 |
| 6.87 | 1.17 | 1.75 | 7.54 | 0.41 | 82.26 | 7.23 | 10.51 | 30 | 600 | 12.48 | 7.58 | 7.01376 |
| 17.78 | 1.39 | 1.85 | 6.39 | 0.26 | 72.33 | 8.11 | 19.56 | 30 | 600 | 12.48 | 7.58 | 4.769894 |
| 25.60 | 1.50 | 1.70 | 6.27 | 0.17 | 64.76 | 8.79 | 26.45 | 30 | 600 | 12.48 | 7.58 | 3.512886 |
| 37.15 | 1.74 | 1.53 | 6.13 | 0.10 | 53.35 | 8.37 | 38.28 | 30 | 600 | 12.48 | 7.58 | 2.992368 |
| 57.98 | 2.18 | 1.10 | 8.41 | 0.12 | 30.21 | 9.50 | 60.29 | 30 | 600 | 12.48 | 7.58 | 2.107674 |
| 53.09 | 7.02 | 2.38 | 37.40 | 0.11 | 1.31 | 75.03 | 19.20 | 60 | 400 | 10.00 | 2.00 | 1.56708 |
| 52.50 | 6.91 | 3.07 | 37.33 | 0.19 | 4.08 | 71.37 | 19.33 | 60 | 400 | 10.00 | 5.40 | 1.58508 |
| 52.21 | 6.85 | 3.42 | 37.30 | 0.23 | 5.47 | 69.54 | 19.40 | 60 | 400 | 10.00 | 6.30 | 1.7394 |
| 51.92 | 6.79 | 3.77 | 37.26 | 0.26 | 6.86 | 67.71 | 19.47 | 60 | 400 | 10.00 | 8.20 | 1.76202 |
| 51.33 | 6.68 | 4.46 | 37.19 | 0.34 | 9.63 | 64.05 | 19.60 | 60 | 400 | 10.00 | 9.20 | 1.8172 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 500 | 10.00 | 7.58 | 1.022717 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 600 | 10.00 | 7.58 | 1.210257 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 700 | 10.00 | 7.58 | 1.475141 |
| 47.93 | 7.46 | 6.03 | 37.92 | 0.72 | 4.69 | 16.40 | 2.77 | 90 | 800 | 10.00 | 7.58 | 1.794126 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 500 | 10.00 | 7.58 | 3.835582 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 600 | 10.00 | 7.58 | 3.46674 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 700 | 10.00 | 7.58 | 3.710928 |
| 48.44 | 6.45 | 2.54 | 42.30 | 0.43 | 18.76 | 65.59 | 11.09 | 90 | 800 | 10.00 | 7.58 | 4.24538 |
| 22.01 | 1.57 | 2.02 | 27.12 | 0.76 | 68.56 | 22.61 | 8.83 | 120 | 650 | 12.48 | 9.82 | 1.88958 |
| 29.57 | 1.70 | 1.83 | 27.12 | 0.76 | 60.11 | 32.38 | 7.51 | 120 | 650 | 12.48 | 9.67 | 2.64056 |
| 37.69 | 1.90 | 1.59 | 27.12 | 0.76 | 50.47 | 37.84 | 11.69 | 120 | 650 | 12.48 | 9.27 | 2.60536 |
| 47.37 | 2.16 | 1.34 | 27.12 | 0.76 | 39.07 | 43.35 | 17.58 | 120 | 650 | 12.48 | 9.15 | 2.5584 |
| 54.88 | 2.20 | 1.12 | 27.12 | 0.76 | 30.99 | 53.07 | 15.94 | 120 | 650 | 12.48 | 9.03 | 2.27697 |
| 35.90 | 1.47 | 3.92 | 23.37 | 0.62 | 34.72 | 47.46 | 13.92 | 360 | 400 | 10.00 | 9.79 | 8.7352 |
| 46.10 | 0.94 | 2.15 | 7.03 | 0.42 | 43.36 | 47.46 | 13.92 | 360 | 500 | 10.00 | 10.93 | 5.5247 |
| 48.90 | 0.14 | 1.54 | 0.43 | 0.35 | 48.64 | 47.46 | 13.92 | 360 | 600 | 10.00 | 11.37 | 2.7258 |
| 57.57 | 3.27 | 1.07 | 25.17 | 1.57 | 11.35 | 47.46 | 13.92 | 360 | 400 | 10.00 | 7.59 | 4.1316 |
| 68.77 | 2.75 | 1.42 | 13.57 | 0.20 | 13.29 | 47.46 | 13.92 | 360 | 500 | 10.00 | 8.62 | 2.6994 |
| 76.23 | 1.81 | 0.38 | 6.32 | 0.11 | 15.15 | 47.46 | 13.92 | 360 | 600 | 10.00 | 10.84 | 2.2044 |
| 12.42 | 1.32 | 1.37 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 15 | 300 | 5.00 | 7.21 | 3.665168 |
| 12.36 | 1.30 | 1.32 | 23.70 | 0.70 | 89.11 | 47.46 | 13.92 | 15 | 300 | 5.00 | 7.73 | 3.653046 |
| 12.41 | 1.29 | 1.31 | 23.70 | 0.70 | 89.41 | 47.46 | 13.92 | 15 | 300 | 5.00 | 8.31 | 4.3082555 |
| 12.46 | 2.45 | 1.45 | 23.70 | 0.70 | 87.23 | 47.46 | 13.92 | 15 | 300 | 5.00 | 8.51 | 3.65687775 |
| 12.26 | 2.04 | 1.39 | 23.70 | 0.70 | 87.27 | 47.46 | 13.92 | 15 | 500 | 5.00 | 8.43 | 4.333824 |
| 12.02 | 1.31 | 1.32 | 23.70 | 0.70 | 87.38 | 47.46 | 13.92 | 15 | 700 | 5.00 | 8.36 | 4.1943585 |
| 12.35 | 1.40 | 1.12 | 23.70 | 0.70 | 77.59 | 47.46 | 13.92 | 15 | 700 | 5.00 | 8.27 | 5.0325 |
| 12.34 | 1.44 | 1.18 | 23.70 | 0.70 | 84.55 | 47.46 | 13.92 | 60 | 700 | 5.00 | 8.07 | 4.5136125 |
| 12.36 | 1.42 | 1.14 | 23.70 | 0.70 | 88.98 | 47.46 | 13.92 | 120 | 700 | 5.00 | 7.73 | 4.5133725 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 450 | 10.00 | 7.90 | 3.3150864 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 500 | 10.00 | 7.90 | 3.114409 |
| 47.57 | 6.15 | 0.18 | 43.99 | 0.04 | 1.95 | 76.15 | 16.50 | 45 | 550 | 10.00 | 7.90 | 2.7925433 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45 | 450 | 10.00 | 7.90 | 6.6982464 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45 | 500 | 10.00 | 7.90 | 6.7943043 |
| 33.29 | 5.06 | 5.14 | 16.91 | 1.62 | 35.74 | 52.08 | 6.26 | 45 | 550 | 10.00 | 7.90 | 7.1197542 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45 | 450 | 10.00 | 7.90 | 5.94431 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45 | 500 | 10.00 | 7.90 | 5.6197106 |
| 36.86 | 5.33 | 3.85 | 23.51 | 1.23 | 27.29 | 58.10 | 8.81 | 45 | 550 | 10.00 | 7.90 | 5.8254238 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45 | 450 | 10.00 | 7.90 | 5.1342368 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45 | 500 | 10.00 | 7.90 | 4.679928 |
| 40.43 | 5.60 | 2.66 | 30.45 | 0.83 | 18.86 | 64.11 | 11.38 | 45 | 550 | 10.00 | 7.90 | 4.51572 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 450 | 10.00 | 7.90 | 4.4061008 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 500 | 10.00 | 7.90 | 4.2300258 |
| 44.00 | 5.88 | 1.42 | 37.22 | 0.44 | 10.39 | 70.14 | 13.94 | 45 | 550 | 10.00 | 7.90 | 4.3722944 |

# Table S.4 Summarize the feature weight ranking of SHAP and the Yield\*SSA, Yield\*Dp, and Yield\*Vt of the data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Yield\*SSA | | Yield\*Dp | | Yield\*Vt | |
| Feature | Mean Absolute SHAP Value | Feature | Mean Absolute SHAP Value | Feature | Mean Absolute SHAP Value |
| Temperature | 2.249954 | Temperature | 3.721972 | Time | 4.437967 |
| Ash | 1.349004 | VM | 2.138143 | Temperature | 2.246251 |
| FC | 1.222683 | Time | 1.717293 | O | 2.044015 |
| H | 1.122668 | H | 1.324079 | S | 1.980269 |
| C | 0.814893 | Ash | 0.550871 | C | 1.740328 |
| N | 0.637874 | C | 0.537917 | H | 1.469153 |
| Time | 0.607908 | S | 0.508481 | PH | 0.955268 |
| S | 0.381162 | FC | 0.35554 | Reaction rate | 0.890767 |
| Reaction rate | 0.380224 | PH | 0.196007 | Ash | 0.752036 |
| VM | 0.273245 | O | 0.18617 | FC | 0.669724 |
| O | 0.233901 | N | 0.143421 | N | 0.498139 |

# Table S.5 Summarize the optimal weight ratio of integrated learning for each indicator under Bayesian optimization in biochar.

|  |  |  |
| --- | --- | --- |
| Performance index\ Weight ratio | RF | CatBoost |
| Yield \* SSA | 0.591836734693877 | 0.408163265306122 |
| Yield \* Dp | 0.816326530612244 | 0.183673469387755 |
| Yield \* Vt | 0.673469387755102 | 0.326530612244898 |
| Average proportion of integrated learning | 0.598639456 | 0.401360544 |

# Table S.6 Summarize the true values, predicted values, and error rates of Yield\*SSA in the training, validation, and testing sets of biochar under Bayesian optimization and integrated learning.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Train set** | | | **Validation set** | | | **Testing set** | | |
| **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** |
| 399.31 | 397.8228 | 0.37% | 1383.46 | 1274.687 | 7.86% | 691.9284 | 605.6572 | 12.47% |
| 316.55 | 315.8904 | 0.21% | 1595.449 | 1545.926 | 3.10% | 1466.438 | 1548.373 | 5.59% |
| 1294.407 | 1298.934 | 0.35% | 717.0792 | 641.9646 | 10.48% | 1608.349 | 2311.779 | 43.74% |
| 1158.156 | 1158.47 | 0.03% | 1645.91 | 1619.262 | 1.62% | 1069.855 | 1034.9 | 3.27% |
| 1880.723 | 1888.541 | 0.42% | 805.086 | 690.1105 | 14.28% | 1251.648 | 1190.281 | 4.90% |
| 402.2784 | 399.0909 | 0.79% | 2335.712 | 2284.886 | 2.18% | 1316.024 | 1380.622 | 4.91% |
| 4042.723 | 4048.252 | 0.14% | 2050.597 | 2106.366 | 2.72% | 1304.464 | 1346.694 | 3.24% |
| 284.1778 | 280.7501 | 1.21% | 833.1162 | 834.6796 | 0.19% | 832.2936 | 701.0541 | 15.77% |
| 171.6456 | 173.7229 | 1.21% | 831.954 | 756.7529 | 9.04% | 1302.764 | 1328.966 | 2.01% |
| 1756.216 | 1764.26 | 0.46% | 2830.199 | 2821.921 | 0.29% | 978.432 | 986.2367 | 0.80% |
| 691.9284 | 524.21 | 24.24% | 1874.525 | 1717.208 | 8.39% | 912.73 | 964.6459 | 5.69% |
| 1890.925 | 1890.409 | 0.03% | 1685.225 | 1626.54 | 3.48% | 1347.23 | 1452.635 | 7.82% |
| 3969.842 | 3975.775 | 0.15% | 1998.224 | 1849.215 | 7.46% | 1483.744 | 1855.272 | 25.04% |
| 1495.406 | 1513.78 | 1.23% | 824.776 | 756.5018 | 8.28% | 979.6675 | 988.3963 | 0.89% |
| 1975.47 | 1988.059 | 0.64% | 1962.823 | 1820.173 | 7.27% | 1359.925 | 1486.757 | 9.33% |
| 1784.407 | 1792.181 | 0.44% | 402.2784 | 286.088 | 28.88% | 1301.68 | 1246.965 | 4.20% |
| 2478.384 | 2462.594 | 0.64% | 1397.012 | 1529.25 | 9.47% | 1452.33 | 1517.613 | 4.50% |
| 365.4798 | 351.6691 | 3.78% | 464.411 | 540.614 | 16.41% | 885.6432 | 838.3746 | 5.34% |
| 411.5103 | 435.2925 | 5.78% | 880.968 | 897.5755 | 1.89% | 1261.288 | 1230.679 | 2.43% |
| 1609.128 | 1608.618 | 0.03% | 1294.407 | 934.5654 | 27.80% | 1596.821 | 1932.978 | 21.05% |
| 236.3576 | 223.7788 | 5.32% | 645.3171 | 562.4339 | 12.84% | 1343.988 | 1418.048 | 5.51% |
| 236.61 | 237.4965 | 0.37% | 275.9473 | 272.8684 | 1.12% | 903.89 | 934.6842 | 3.41% |
| 1402.756 | 1386.549 | 1.16% | 2674.088 | 2660.759 | 0.50% | 2723.186 | 3499.3 | 28.50% |
| 3361.418 | 3367.729 | 0.19% | 432.1485 | 394.6053 | 8.69% | 1044.788 | 995.8796 | 4.68% |
| 392.556 | 396.5485 | 1.02% |  |  |  | 1271.453 | 1244.303 | 2.14% |
| 245.214 | 246.0152 | 0.33% |  |  |  |  |  |  |
| 3787.168 | 3782.667 | 0.12% |  |  |  |  |  |  |
| 538.5057 | 520.99 | 3.25% |  |  |  |  |  |  |
| 435.5213 | 440.9627 | 1.25% |  |  |  |  |  |  |
| 177.9288 | 182.9447 | 2.82% |  |  |  |  |  |  |
| 405.3888 | 409.168 | 0.93% |  |  |  |  |  |  |
| 451.719 | 457.2761 | 1.23% |  |  |  |  |  |  |
| 2368.103 | 2375.026 | 0.29% |  |  |  |  |  |  |
| 2824.346 | 2813.851 | 0.37% |  |  |  |  |  |  |
| 332.5293 | 318.4954 | 4.22% |  |  |  |  |  |  |
| 370.4212 | 362.1483 | 2.23% |  |  |  |  |  |  |
| 461.8452 | 520.99 | 12.81% |  |  |  |  |  |  |
| 1066.47 | 1049.963 | 1.55% |  |  |  |  |  |  |
| 2403.132 | 2391.918 | 0.47% |  |  |  |  |  |  |
| 1650.317 | 1651.815 | 0.09% |  |  |  |  |  |  |
| 211.185 | 204.0907 | 3.36% |  |  |  |  |  |  |
| 451.719 | 445.5518 | 1.37% |  |  |  |  |  |  |
| 2679.055 | 2673.842 | 0.19% |  |  |  |  |  |  |
| 1155.42 | 1149.201 | 0.54% |  |  |  |  |  |  |
| 738.14 | 730.207 | 1.07% |  |  |  |  |  |  |
| 1088.328 | 1089.701 | 0.13% |  |  |  |  |  |  |
| 979.6675 | 981.3035 | 0.17% |  |  |  |  |  |  |
| 243.44 | 241.6016 | 0.76% |  |  |  |  |  |  |
| 389.1888 | 395.38 | 1.59% |  |  |  |  |  |  |
| 721 | 684.0411 | 5.13% |  |  |  |  |  |  |
| 181.56 | 184.0987 | 1.40% |  |  |  |  |  |  |
| 349.602 | 344.9207 | 1.34% |  |  |  |  |  |  |
| 1792.968 | 1793.47 | 0.03% |  |  |  |  |  |  |
| 275.9473 | 272.8684 | 1.12% |  |  |  |  |  |  |
| 3257.617 | 3261.628 | 0.12% |  |  |  |  |  |  |
| 1317.95 | 1328.995 | 0.84% |  |  |  |  |  |  |
| 346.352 | 335.5803 | 3.11% |  |  |  |  |  |  |
| 1261.288 | 1257.306 | 0.32% |  |  |  |  |  |  |
| 1836.786 | 1832.048 | 0.26% |  |  |  |  |  |  |
| 447.0534 | 445.5518 | 0.34% |  |  |  |  |  |  |
| 374.3696 | 387.3443 | 3.47% |  |  |  |  |  |  |
| 1297.429 | 1307.581 | 0.78% |  |  |  |  |  |  |
| 873.0228 | 876.6889 | 0.42% |  |  |  |  |  |  |
| 2413.505 | 2424.2 | 0.44% |  |  |  |  |  |  |
| 1413.158 | 1410.79 | 0.17% |  |  |  |  |  |  |
| 1244.826 | 1234.461 | 0.83% |  |  |  |  |  |  |
| 821.3376 | 833.3383 | 1.46% |  |  |  |  |  |  |
| 765.628 | 734.8978 | 4.01% |  |  |  |  |  |  |
| 979.6675 | 989.5127 | 1.00% |  |  |  |  |  |  |
| 2394.241 | 2378.444 | 0.66% |  |  |  |  |  |  |
| 3062.04 | 3074.278 | 0.40% |  |  |  |  |  |  |
| 1907.038 | 1918.089 | 0.58% |  |  |  |  |  |  |

Table S.7 Summarize the true values, predicted values, and error rates of Yield\*Dp in the training, validation, and testing sets of biochar under Bayesian optimization and integrated learning.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Train set** | | | **Validation set** | | | **Testing set** | | |
| **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** |
| 1065.228 | 1063.332 | 0.18% | 3114.409 | 3316.023 | 6.47% | 636.4704 | 628.4406 | 1.26% |
| 4230.026 | 4246.069 | 0.38% | 635.0946 | 413.7073 | 34.86% | 763.515 | 736.2132 | 3.58% |
| 942.866 | 942.3352 | 0.06% | 979.3853 | 1021.203 | 4.27% | 979.3853 | 829.2637 | 15.33% |
| 309.9712 | 309.6897 | 0.09% | 435.1301 | 371.9058 | 14.53% | 2792.543 | 3387.269 | 21.30% |
| 1214.771 | 1214.11 | 0.05% | 1238.808 | 1225.95 | 1.04% | 3802.363 | 3589.042 | 5.61% |
| 351.5995 | 352.9234 | 0.38% | 490.6546 | 410.3264 | 16.37% | 1110.33 | 1011.42 | 8.91% |
| 2888.228 | 2888.215 | 0.00% | 1232.398 | 1221.193 | 0.91% | 657.2305 | 654.6987 | 0.39% |
| 343.7626 | 351.4188 | 2.23% | 1206.922 | 1206.089 | 0.07% | 1789.008 | 1339.354 | 25.13% |
| 414.0106 | 413.7073 | 0.07% | 1238.808 | 1234.277 | 0.37% | 4372.294 | 4201.255 | 3.91% |
| 1003.759 | 1004.651 | 0.09% | 244.8756 | 224.7121 | 8.23% | 445.0812 | 448.0333 | 0.66% |
| 827.3974 | 827.0987 | 0.04% | 1214.771 | 1212.847 | 0.16% | 589.6595 | 524.1338 | 11.11% |
| 807.5632 | 807.526 | 0.00% | 224.784 | 207.5969 | 7.65% | 704.2829 | 656.0958 | 6.84% |
| 657.2305 | 645.6365 | 1.76% | 244.8756 | 254.9257 | 4.10% | 1308.2 | 1217.786 | 6.91% |
| 4211.154 | 4211.19 | 0.00% |  |  |  | 1220.795 | 1199.157 | 1.77% |
| 3596.482 | 3596.742 | 0.01% |  |  |  |  |  |  |
| 1331.625 | 1331.592 | 0.00% |  |  |  |  |  |  |
| 224.784 | 224.5748 | 0.09% |  |  |  |  |  |  |
| 3315.086 | 3316.023 | 0.03% |  |  |  |  |  |  |
| 242.0592 | 241.8558 | 0.08% |  |  |  |  |  |  |
| 1109.666 | 1109.591 | 0.01% |  |  |  |  |  |  |
| 1206.922 | 1207.603 | 0.06% |  |  |  |  |  |  |
| 3941.205 | 3941.479 | 0.01% |  |  |  |  |  |  |
| 1232.398 | 1232.339 | 0.00% |  |  |  |  |  |  |
| 240.4044 | 240.2344 | 0.07% |  |  |  |  |  |  |
| 991.292 | 990.9943 | 0.03% |  |  |  |  |  |  |
| 197.1662 | 197.4524 | 0.15% |  |  |  |  |  |  |
| 678.0809 | 656.0958 | 3.24% |  |  |  |  |  |  |
| 692.5636 | 689.0026 | 0.51% |  |  |  |  |  |  |
| 407.1133 | 407.1978 | 0.02% |  |  |  |  |  |  |
| 4406.101 | 4389.804 | 0.37% |  |  |  |  |  |  |
| 309.9712 | 310.0325 | 0.02% |  |  |  |  |  |  |
| 310.4595 | 310.3155 | 0.05% |  |  |  |  |  |  |
| 1065.228 | 1065.36 | 0.01% |  |  |  |  |  |  |
| 1220.795 | 1221.514 | 0.06% |  |  |  |  |  |  |
| 1109.666 | 1109.784 | 0.01% |  |  |  |  |  |  |
| 1003.759 | 1003.553 | 0.02% |  |  |  |  |  |  |
| 279.9225 | 279.8045 | 0.04% |  |  |  |  |  |  |
| 688.7494 | 679.3718 | 1.36% |  |  |  |  |  |  |
| 358.6872 | 358.891 | 0.06% |  |  |  |  |  |  |

# Table S.8 Summarize the true values, predicted values, and error rates of Yield\*Dp in the training, validation, and testing sets of biochar under Bayesian optimization and integrated learning.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Train set** | | | **Validation set** | | | **Testing set** | | |
| **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** | **True value** | **Predict value** | **MRE** |
| 2.60536 | 2.604112 | 0.05% | 4.1173 | 3.878259 | 5.81% | 1.20342 | 1.318945 | 9.60% |
| 4.230026 | 4.230338 | 0.01% | 1.56708 | 1.670464 | 6.60% | 1.475141 | 1.376479 | 6.69% |
| 3.46674 | 3.492888 | 0.75% | 1.76202 | 2.195197 | 24.58% | 6.794304 | 6.521781 | 4.01% |
| 2.2044 | 2.204491 | 0.00% | 4.406101 | 4.210247 | 4.45% | 4.18624 | 4.19466 | 0.20% |
| 3.315086 | 3.279287 | 1.08% | 1.7394 | 1.758573 | 1.10% | 4.194359 | 4.42436 | 5.48% |
| 1.78695 | 1.787049 | 0.01% | 3.114409 | 3.061878 | 1.69% | 3.01929 | 2.516018 | 16.67% |
| 2.7258 | 2.725768 | 0.00% | 3.653046 | 3.618755 | 0.94% | 5.94431 | 5.730127 | 3.60% |
| 4.333824 | 4.333624 | 0.00% | 5.134237 | 4.486302 | 12.62% | 1.7394 | 1.846266 | 6.14% |
| 1.8172 | 1.817838 | 0.04% | 2.245103 | 2.634531 | 17.35% | 3.512886 | 3.891772 | 10.79% |
| 3.835582 | 3.785746 | 1.30% | 3.710928 | 3.78543 | 2.01% | 2.64732 | 2.457316 | 7.18% |
| 3.05624 | 3.056144 | 0.00% | 4.679928 | 4.428549 | 5.37% | 1.498856 | 1.64894 | 10.01% |
| 4.513373 | 4.513506 | 0.00% | 2.27697 | 2.930973 | 28.72% | 4.372294 | 4.683024 | 7.11% |
| 2.792543 | 2.793141 | 0.02% | 7.119754 | 6.550731 | 7.99% | 2.5883 | 2.317064 | 10.48% |
| 1.76202 | 1.762169 | 0.01% | 3.19821 | 3.157507 | 1.27% | 5.5247 | 4.743429 | 14.14% |
| 2.992368 | 2.992477 | 0.00% | 4.308256 | 4.002371 | 7.10% | 1.794126 | 2.088014 | 16.38% |
| 1.390448 | 1.390496 | 0.00% |  |  |  |  |  |  |
| 1.89717 | 1.896688 | 0.03% |  |  |  |  |  |  |
| 2.6994 | 2.698959 | 0.02% |  |  |  |  |  |  |
| 2.117745 | 2.117255 | 0.02% |  |  |  |  |  |  |
| 5.0325 | 5.031808 | 0.01% |  |  |  |  |  |  |
| 2.5584 | 2.559241 | 0.03% |  |  |  |  |  |  |
| 5.825424 | 5.824154 | 0.02% |  |  |  |  |  |  |
| 5.619711 | 5.620369 | 0.01% |  |  |  |  |  |  |
| 3.656878 | 3.657469 | 0.02% |  |  |  |  |  |  |
| 1.022717 | 1.023247 | 0.05% |  |  |  |  |  |  |
| 2.61696 | 2.617456 | 0.02% |  |  |  |  |  |  |
| 3.73014 | 3.729732 | 0.01% |  |  |  |  |  |  |
| 4.51572 | 4.515811 | 0.00% |  |  |  |  |  |  |
| 2.64056 | 2.641157 | 0.02% |  |  |  |  |  |  |
| 7.01376 | 7.013939 | 0.00% |  |  |  |  |  |  |
| 3.665168 | 3.664629 | 0.01% |  |  |  |  |  |  |
| 8.7352 | 8.735787 | 0.01% |  |  |  |  |  |  |
| 4.513613 | 4.513995 | 0.01% |  |  |  |  |  |  |
| 4.1316 | 4.131498 | 0.00% |  |  |  |  |  |  |
| 3.02174 | 3.021961 | 0.01% |  |  |  |  |  |  |
| 4.24538 | 4.244784 | 0.01% |  |  |  |  |  |  |
| 4.769894 | 4.77005 | 0.00% |  |  |  |  |  |  |
| 1.58508 | 1.58477 | 0.02% |  |  |  |  |  |  |
| 1.210257 | 1.209647 | 0.05% |  |  |  |  |  |  |
| 2.30111 | 2.300726 | 0.02% |  |  |  |  |  |  |
| 6.698246 | 6.698701 | 0.01% |  |  |  |  |  |  |
| 2.107674 | 2.107834 | 0.01% |  |  |  |  |  |  |
| 1.88958 | 1.889224 | 0.02% |  |  |  |  |  |  |
| 1.58508 | 1.58454 | 0.03% |  |  |  |  |  |  |

# Table S.9 summarizes the RMSE under Bayesian optimization and integrated learning in Yield\*SSA, Yield\*Dp, Yield\*Vt.

|  |  |  |  |
| --- | --- | --- | --- |
| Times | Yield\*SSA | Yield\*Dp | Yield\*Vt |
| 1 | 9.90906 | 14.10369 | 1.8733 |
| 2 | 9.88034 | 14.10369 | 1.8733 |
| 3 | 9.88034 | 13.97979 | 1.8733 |
| 4 | 4.27829 | 2.32044 | 0.52256 |
| 5 | 4.27829 | 2.32044 | 0.52256 |
| 6 | 4.27829 | 2.32044 | 0.52256 |
| 7 | 4.27829 | 2.28816 | 0.51183 |
| 8 | 4.27829 | 2.27542 | 0.51183 |
| 9 | 4.17399 | 2.27542 | 0.51183 |
| 10 | 4.17399 | 2.27542 | 0.51183 |
| 11 | 4.15565 | 1.77636 | 0.51183 |
| 12 | 3.33781 | 1.468 | 0.51183 |
| 13 | 3.29714 | 1.32471 | 0.31031 |
| 14 | 3.29714 | 1.23792 | 0.31031 |
| 15 | 3.29714 | 1.22454 | 0.30528 |
| 16 | 3.25108 | 0.97411 | 0.30528 |
| 17 | 3.25108 | 0.97411 | 0.30528 |
| 18 | 3.25108 | 0.97411 | 0.30528 |
| 19 | 3.25108 | 0.97411 | 0.30528 |
| 20 | 3.25108 | 0.97297 | 0.30528 |
| 21 | 3.23784 | 0.97297 | 0.29242 |
| 22 | 3.23784 | 0.97297 | 0.29242 |
| 23 | 3.23784 | 0.97136 | 0.29242 |
| 24 | 3.23784 | 0.97136 | 0.29242 |
| 25 | 3.20739 | 0.97136 | 0.29242 |
| 26 | 3.20739 | 0.97136 | 0.29242 |
| 27 | 3.20739 | 0.97136 | 0.29242 |
| 28 | 3.20543 | 0.97136 | 0.29242 |
| 29 | 3.18938 | 0.97136 | 0.29242 |
| 30 | 3.18938 | 0.97136 | 0.29242 |
| 31 | 3.18938 | 0.97136 | 0.29242 |
| 32 | 3.18938 | 0.97136 | 0.29242 |
| 33 | 3.18938 | 0.97136 | 0.29242 |
| 34 | 3.18938 | 0.97136 | 0.29242 |
| 35 | 3.18938 | 0.97136 | 0.29242 |
| 36 | 3.18938 | 0.97136 | 0.29242 |
| 37 | 3.18938 | 0.97136 | 0.29242 |
| 38 | 3.18938 | 0.97136 | 0.29242 |
| 39 | 3.18938 | 0.97136 | 0.29242 |
| 40 | 3.18938 | 0.97136 | 0.29242 |
| 41 | 3.18938 | 0.97136 | 0.29242 |
| 42 | 3.18938 | 0.97136 | 0.29242 |
| 43 | 3.18938 | 0.97136 | 0.29242 |
| 44 | 3.18938 | 0.97136 | 0.29242 |
| 45 | 3.18938 | 0.97136 | 0.29242 |
| 46 | 3.18938 | 0.9548 | 0.29242 |
| 47 | 3.18938 | 0.9548 | 0.29242 |
| 48 | 3.18938 | 0.9548 | 0.29242 |
| 49 | 3.18938 | 0.9548 | 0.29242 |
| 50 | 3.18938 | 0.94573 | 0.29242 |