**Table SX**. Summary of studies and sites included in the meta-analysis

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Citation** | **Site name** | **Latitude** | **Longitude** | **MAT (°C)** | **MAP (mm yr-1)** | **Ecosystem type** | **Experiment type** | **N addition rate (g m-2)** | **P addition rate (g m-2)** |
| (Aerts *et al.*, 2003) | bovenpolder | 51.85 | 5.62 | 9.5 | 821 | grassland | field | 10 | 5 |
| bethunepolder | 52.07 | 5.58 | 9.5 | 821 | grassland | field | 10 | 5 |
| (Arens *et al.*, 2008) | pituffik | 76.55 | -68.57 | -11.4 | 126 | tundra | field | 5 | 2.5 |
| (Augustine *et al.*, 2003) | mpala\_ranch | 0.28 | 37.88 | 16.2 | 703 | grassland | field | 40 | 10 |
| (Aydin & Uzun, 2005) | ondokuz | 41.35 | 36.25 | 14.1 | 665 | grassland | field | 18 | 5.2 |
| (Bennett & Adams, 2001) | hamersley | -22.28 | 117.67 | 25.2 | 350 | grassland | field | 5 | 2.5 |
| (Blanke *et al.*, 2012) | alpflix | 46.53 | 9.65 | 1.1 | 1300 | grassland | field | 5 | 6 |
| (Boeye *et al.*, 1997) | buitengoor | 51.20 | 5.17 | 9.7 | 803 | wetland | field | 20 | 5 |
| goorken | 51.32 | 5.12 | 9.7 | 803 | wetland | field | 20 | 5 |
| zwarte\_beek | 51.08 | 5.30 | 9.7 | 803 | wetland | field | 20 | 5 |
| (Borer *et al.*, 2014) | sedgwick | 34.7 | -119.88 | NA | NA | grassland | field | 10 | 10 |
| (Bowman *et al.*, 1993) | niwot\_ridge | 40.06 | -105.58 | -3 | 900 | tundra | field | 25 | 25 |
| (Bown *et al.*, 2007) | purokohukohu | NA | NA | NA | NA | NA | pot | 7.14 (mM) | 0.42 (mM) |
| (Cárate-Tandalla *et al.*, 2018) | bombuscaro | -4.12 | -78.97 | 19.4 | 2230 | forest | field | 5 | 1 |
| cajanuma | -4.12 | -79.18 | 9.4 | 4500 | forest | field | 5 | 1 |
| sanfrancisco | -3.97 | -79.18 | 15.7 | 1950 | forest | field | 5 | 1 |
| (Carswell *et al.*, 2005) | okarito | -43.20 | 170.30 | NA | NA | NA | pot | 5 (mM) | 1.33 (mM) |
| (Cleland *et al.*, 2019) | bldr.us | 39.97 | -105.23 | 9.7 | 425 | grassland | field | 10 | 10 |
| bnch.us | 44.28 | -121.97 | 5.5 | 1647 | grassland | field | 10 | 10 |
| bogong.au | -36.87 | 147.24 | 5.7 | 1592 | grassland | field | 10 | 10 |
| burrawan.au | -27.73 | 151.14 | 18.4 | 683 | grassland | field | 10 | 10 |
| cbgb.us | 41.79 | -93.39 | 9.0 | 855 | grassland | field | 10 | 10 |
| cdcr.us | 45.40 | -93.2 | 6.4 | 750 | grassland | field | 10 | 10 |
| cdpt.us | 41.2 | -101.63 | NA | 445 | grassland | field | 10 | 10 |
| cowi.ca | 48.46 | -123.38 | 9.8 | 764 | grassland | field | 10 | 10 |
| elliot.us | 32.88 | -117.05 | 17.2 | 331 | grassland | field | 10 | 10 |
| frue.ch | 47.11 | 8.54 | 6.5 | 1355 | grassland | field | 10 | 10 |
| gilb.za | -29.28 | 30.29 | 13.1 | 926 | grassland | field | 10 | 10 |
| hall.us | 36.87 | -86.7 | NA | 1282 | grassland | field | 10 | 10 |
| hart.us | 42.72 | -119.5 | NA | 272 | grassland | field | 10 | 10 |
| konz.us | 39.07 | -96.58 | 11.9 | 877 | grassland | field | 10 | 10 |
| lancaster.uk | 53.99 | -2.63 | 8.0 | 1322 | grassland | field | 10 | 10 |
| look.us | 44.21 | -122.13 | 4.8 | 1898 | grassland | field | 10 | 10 |
| mtca.au | -31.78 | 117.61 | 17.3 | 330 | grassland | field | 10 | 10 |
| sage.us | 39.43 | -120.24 | 5.7 | 882 | grassland | field | 10 | 10 |
| saline.us | 39.05 | -99.1 | 11.8 | 607 | grassland | field | 10 | 10 |
| sgs.us | 40.82 | -104.77 | 8.4 | 365 | grassland | field | 10 | 10 |
| shps.us | 44.24 | -112.2 | 5.5 | 262 | grassland | field | 10 | 10 |
| sier.us | 39.24 | -121.28 | 15.6 | 935 | grassland | field | 10 | 10 |
| smith.us | 48.21 | -122.62 | 9.8 | 597 | grassland | field | 10 | 10 |
| spin.us | 38.14 | -84.5 | 12.5 | 1140 | grassland | field | 10 | 10 |
| summ.za | -29.81 | 30.72 | 18.2 | 939 | grassland | field | 10 | 10 |
| trel.us | 40.08 | -88.83 | NA | 982 | grassland | field | 10 | 10 |
| ukul.za | -29.67 | 30.4 | NA | 880 | grassland | field | 10 | 10 |
| unc.us | 36.01 | -79.02 | 14.6 | 1163 | grassland | field | 10 | 10 |
| valm.ch | 46.63 | 10.37 | 0.3 | 1098 | grassland | field | 10 | 10 |
| (Craft *et al.*, 1995) | everglades | 26.38 | -80.46 | NA | NA | grassland | field | 22.4 | 4.8 |
| (Craine *et al.*, 2008) | pretoriuskop | -25.13 | 31.23 | NA | 737 | grassland | field | 10 | 5 |
| letaba | -23.76 | 31.43 | NA | 457 | grassland | field | 10 | 5 |
| makhohlola | -25.30 | 31.91 | NA | 620 | grassland | field | 10 | 5 |
| satara | -24.40 | 31.75 | NA | 544 | grassland | field | 10 | 5 |
| nwashitsumbe | -22.78 | 31.25 | NA | 516 | grassland | field | 10 | 5 |
| (Crous *et al.*, 2017) | ANUglass | NA | NA | NA | NA | NA | pot | 3.3 (g yr-1) | 0.153 (g yr-1) |
| (Cunha *et al.*, 2024) | londrina | -23.32 | -51.18 | NA | NA | NA | pot | 8.4 | 4.5 |
| (D’Antonio & Mack, 2006) | volcanoNP | 19.1 | -155.55 | 20.5 | 1500 | forest | field | 10 | 10 |
| (Davidson *et al.*, 2004) | fazendaVitoria | -2.98 | -47.52 | 26.6 | 1800 | forest | field | 10 | 5 |
| (Dong *et al.*, 2016) | baingoin | 31.43 | 90.03 | -1.2 | 301.2 | grassland | field | 15 | 12.9 |
| (Eller *et al.*, 2017) | flottbek | 53.56 | 9.86 | NA | NA | NA | pot | 1.3 (g pot-1) | 1.3 (g pot-1) |
| (Falk *et al.*, 2010) | luneberg | 53.25 | 9.97 | 8.4 | 811 | grassland | field | 5 | 2 |
| (Fisher *et al.*, 2013) | tambopata | -12.84 | -69.30 | 26.4 | 2730 | forest | field | 2.5 | 0.5 |
| tono | -12.95 | -71.53 | 20.7 | 3087 | forest | field | 2.5 | 0.5 |
| san\_pedro | -13.05 | -71.54 | 18.8 | 5302 | forest | field | 2.5 | 0.5 |
| wayqecha | -13.19 | -71.59 | 12.5 | 1706 | forest | field | 2.5 | 0.5 |
| (Firn *et al.*, 2019) | bogong.au | -36.87 | 147.24 | 5.7 | 1592 | grassland | field | 10 | 10 |
| burrawan.au | -27.73 | 151.14 | 18.4 | 683 | grassland | field | 10 | 10 |
| cbgb.us | 41.79 | -93.39 | 9.0 | 855 | grassland | field | 10 | 10 |
| cowi.ca | 48.46 | -123.38 | 9.8 | 764 | grassland | field | 10 | 10 |
| elliot.us | 32.88 | -117.05 | 17.2 | 331 | grassland | field | 10 | 10 |
| frue.ch | 47.11 | 8.54 | 6.5 | 1355 | grassland | field | 10 | 10 |
| gilb.za | -29.28 | 30.29 | 13.1 | 926 | grassland | field | 10 | 10 |
| kiny.au | -36.20 | 143.75 | 15.5 | 426 | grassland | field | 10 | 10 |
| konz.us | 39.07 | -96.58 | 11.9 | 877 | grassland | field | 10 | 10 |
| lancaster.uk | 53.99 | -2.63 | 8.0 | 1322 | grassland | field | 10 | 10 |
| look.us | 44.21 | -122.13 | 4.8 | 1898 | grassland | field | 10 | 10 |
| mcla.us | 38.86 | -122.41 | 13.5 | 867 | grassland | field | 10 | 10 |
| mtca.au | -31.78 | 117.61 | 17.3 | 330 | grassland | field | 10 | 10 |
| saline.us | 39.05 | -99.10 | 11.8 | 607 | grassland | field | 10 | 10 |
| sgs.us | 40.82 | -104.77 | 8.4 | 365 | grassland | field | 10 | 10 |
| shps.us | 44.24 | -112.2 | 5.5 | 262 | grassland | field | 10 | 10 |
| smith.us | 48.21 | -122.62 | 9.8 | 597 | grassland | field | 10 | 10 |
| summ.za | -29.81 | 30.72 | 18.2 | 939 | grassland | field | 10 | 10 |
| valm.ch | 46.63 | 10.37 | 0.3 | 1098 | grassland | field | 10 | 10 |
| (Fornara *et al.*, 2013) | nash | 51.41 | -0.64 | NA | NA | grassland | field | 10 | 3.5 |
| (Friedrich *et al.*, 2012) | luneberggh2 | 53.25 | 9.97 | NA | NA | NA | pot | 4.8 | 0.4 |
| (Frost *et al.*, 2009) | hammersmith | 31.30 | -81.28 | 19.7 | 1290 | wetland | field | 50 | 10 |
| (Gough & Hobbie, 2003) | toolik\_nonacidic | 68.63 | -149.72 | -10 | 320 | tundra | field | 10 | 5 |
| (Güsewell *et al.*, 2002) | vechtplassen | 52.50 | 5.70 | 9.3 | 804 | wetland | field | 20 | 5 |
| (Güsewell *et al.*, 2003) | gusewellS1 | 51.70 | 3.90 | 9.3 | 804 | wetland | field | 20 | 5 |
| gusewellS2 | 51.70 | 3.90 | 9.3 | 804 | wetland | field | 20 | 5 |
| (Haag, 1974) | tuktoyaktuk | 69.43 | -133.02 | -10.1 | 161 | tundra | field | 10 | 10 |
| (Han *et al.*, 2011) | seefs\_sunny | 38.79 | 110.35 | 8.4 | 437 | grassland | field | 10 | 3 |
| (Harrington *et al.*, 2001) | volcanoNP | 19.10 | -155.55 | 23.4 | 2500 | forest | field | 10 | 10 |
| ≈ | 22.13 | -159.63 | 23.4 | 2500 | forest | field | 10 | 10 |
| (Haubensak & D’Antonio, 2011) | ggnra | 37.87 | -122.52 | NA | NA | grassland | field | 10 | 10 |
| (He *et al.*, 2016) | haibei | 37.62 | 101.2 | -1.7 | 560 | grassland | field | 10 | 5 |
| (Herbert & Fownes, 1995) | naPaliKona | 22.13 | -159.63 | 23.4 | 2500 | forest | field | 10 | 10 |
| (Hersch-Green *et al.*, 2024) | kbs.us | 42.41 | -85.39 | 8.8 | 903 | grassland | field | 10 | 10 |
| konz.us | 39.07 | -96.58 | 11.9 | 877 | grassland | field | 10 | 10 |
| spin.us | 38.14 | -84.50 | 12.5 | 1140 | grassland | field | 10 | 10 |
| (Huff *et al.*, 2015) | tifft | 42.87 | -78.87 | 9.0 | 924 | grassland | field | 10 | 8.6 |
| (Iversen *et al.*, 2010) | undercBog | 46 | -89 | NA | NA | wetland | field | 6 | 2 |
| undercRichFen | 46 | -89 | NA | NA | wetland | field | 6 | 2 |
| (Jing *et al.*, 2016) | haibeiAGERS | 37.6 | 101.32 | 0.3 | 280 | grassland | field | 10 | 5 |
| (Ket *et al.*, 2011) | altamaha | 31.33 | -81.47 | 19.7 | 1290 | wetland | field | 50 | 10 |
| (Lawrence, 2001) | kembera | 0.12 | 110.5 | 24.4 | 3016 | forest | field | 54 | 60 |
| (Li *et al.*, 2011) | daqinggou | 42.97 | 122.35 | 6.4 | 450 | grassland | field | 20 | 10 |
| (Li *et al.*, 2014) | amwelu | 34.92 | 102.88 | 2.4 | 550 | grassland | field | 10 | 10 |
| (Ludwig *et al.*, 2001) | tarangire | -3.5 | 36 | 22 | 798 | grassland | field | 20 | 8 |
| (Lund *et al.*, 2009) | fajemyr | 56.25 | 13.55 | 6.2 | 700 | wetland | field | 4 | 0.4 |
| (Mayor *et al.*, 2014) | gigante | 9.11 | -79.84 | 26 | 2600 | forest | field | 12.5 | 5 |
| (McMaster *et al.*, 1982) | echoValley | 32.9 | 70 | 17.2 | 476 | shrubland | field | 4 | 2 |
| (Mo *et al.*, 2019) | xiaolongRS | 21.45 | 110.9 | 23 | 1700 | forest | field | 10 | 10 |
| (Mo *et al.*, 2021) | xiaoliangRS | 21.45 | 110.9 | 23 | 1550 | forest | field | 10 | 10 |
| (Ngai & Jefferies, 2004) | laPerouse | NA | NA | NA | NA | wetland | field | 17 | 12 |
| (Ngatia *et al.*, 2015) | mpala | 0 | 37 | NA | 550 | grassland | field | 10 | 5 |
| (Nielsen *et al.*, 2009) | brandbjerg | 55.88 | 11.97 | 8.0 | 613 | grassland | field | 7.5 | 1 |
| (O’Halloran *et al.*, 2010) | tshane | -24.17 | 21.89 | NA | 365 | grassland | field | 6.7 | 3.3 |
| (Øien, 2004) | solendet | 62.67 | 11.83 | 0.6 | 600 | wetland | field | 12 | 3 |
| (Prystupa *et al.*, 2004) | uniBueAi | -34.58 | -58.48 | 16.8 | 1040 | cropland | field | 10 | 5.7 |
| (Rejmánková *et al.*, 2008) | belize | 18.83 | -89.12 | 26.5 | 1400 | wetland | field | 20 | 10 |
| (Ren *et al.*, 2010) | lanzhou | 33.97 | 101.88 | 1.2 | 620 | grassland | field | 10 | 20 |
| (Ries & Shugart, 2008) | pandamatenga | -18.66 | 25.5 | NA | 698 | grassland | field | 20 | 10 |
| (Scott *et al.*, 2015) | ruakura | -37.78 | 175.32 | NA | NA | grassland | field | 10 | 3.15 |
| (Shaver *et al.*, 1998) | toolik\_inlet | 68.63 | -149.57 | NA | NA | tundra | field | 10 | 10 |
| toolik\_sag | 68.77 | -148.87 | NA | NA | tundra | field | 10 | 10 |
| (Soudzilovskaia *et al.*, 2005) | teberda | 48.45 | 41.7 | NA | NA | tundra | field | 9 | 2.5 |
| (Tischer *et al.*, 2015) | cordillera | -3.97 | -70.07 | 15.3 | 2176 | grassland | field | 5 | 1 |
| (van Cleve & Oliver, 1982) | fairbanks | 64.83 | -147.72 | 1.2 | 226 | forest | field | 11.1 | 5.5 |
| (van der Hoek *et al.*, 2004) | bennekomse | 52.02 | 5.6 | NA | NA | grassland | field | 20 | 4 |
| (van der Waal *et al.*, 2011) | klaserie | -24.22 | 31.27 | 21.1 | 460 | grassland | field | 30 | 25 |
| (van Duren *et al.*, 1997a) | hasselt | 57 | 7 | NA | NA | grassland | field | 20 | 8 |
| (van Duren *et al.*, 1997b) | drentsche | 53.08 | 6.67 | NA | NA | grassland | field | 20 | 8 |
| (van Wijnen & Bakker, 1999) | schiermonnikoog | 53.5 | 6.17 | NA | NA | wetland | field | 25 | 10 |
| (Verlinden *et al.*, 2018) | katelijne | 51.08 | 4.53 | NA | NA | NA | mesocosm | 9.5 | 2 |
| (Verryckt *et al.*, 2022) | nouragues | 4.00 | -52.60 | 26 | 3000 | forest | field | 12.5 | 5 |
| (Wang *et al.*, 2017) | huitong | 26.67 | 109.43 | 16.5 | 1200 | forest | field | 20 | 5 |
| (Wang *et al.*, 2018) | haibeiAMERS | 37.617 | 101.2 | -1.7 | 560 | tundra | field | 10 | 5 |
| (Wang *et al.*, 2019) | qianyanzhou | 26.70 | 105.10 | 17.9 | 1600 | forest | field | 10 | 5 |
| (Warren & Adams, 2002) | bullsbrook | -31.67 | 116.02 | 19.1 | 692 | forest | field | 2 (mM) | 0.34 (mM) |
| (Wigand *et al.*, 2004) | nags\_creek | 41.63 | -71.32 | NA | NA | wetland | field | 32 | 3.2 |
| (Wright *et al.*, 2011) | barro | 9.12 | -79.85 | NA | NA | forest | field | 12.5 | 5 |
| (Yang *et al.*, 2014) | haibei | 37.6 | 101.3 | -1.7 | 561 | grassland | field | 10 | 5 |
| (Ye *et al.*, 2022) | jiulianshan\_RS | 24.49 | 114.38 | 16.8 | 1927 | forest | field | 10 | 5 |
| (Ye *et al.*, 2023) | jiulianshan | 24.49 | 114.38 | 16.8 | 1927 | forest | field | 10 | 5 |
| (Yu *et al.*, 2009) | daqinguo | 42.97 | 122.35 | 6 | 450 | grassland | field | 20 | 10 |
| (Yu *et al.*, 2015) |  |  |  |  |  |  |  |  |  |
| (Yu *et al.*, 2022) | primary | 18.73 | 108.90 | 19.7 | 2198 | forest | field | 10 | 10 |
| secondary | 18.74 | 108.86 | 19.7 | 2198 | forest | field | 10 | 10 |
| (Zeng & Wang, 2015) | saihanba | 42.42 | 117.35 | -1.4 | 450.1 | forest | field | 5 | 5 |

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