Supplementary Table 1. Planting and harvesting dates for experimental sites in Malawi, Mozambique, Zambia and Zimbabwe between 2008 and 2014 seasons

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Activity | DTC | UZ | Makoholi | MFTC | MRS | CRS | SRS | NURS |
| 2008 | Planting | 10/12/2007 | 06/12/2007 | - | - | - | - | - | - |
|  | Harvesting | 12/05/2008 | 26/04/2008 | - | - | - | - | - | - |
| 2009 | Planting | 26/11/2008 | 20/11/2008 | 23/12/2008 | - | - | - | - | - |
|  | Harvesting | 07/05/2009 | 15/04/2009 | 15/04/2009 | - | - | - | - | - |
| 2010 | Planting | 23/12/2009 | 01/12/2009 | 01/12/2009 | 20/11/2009 | - | - | 26/11/2009 | - |
|  | Harvesting | 21/04/2010 | 16/04/2010 | 13/05/2010 | 22/04/2010 | - | - | 13/04/2010 | - |
| 2011 | Planting | 09/11/2010 | 23/11/2010 | 23/12/2010 | 09/12/2010 | - | 15/12/2010 | 25/11/2010 | - |
|  | Harvesting | 12/04/2011 | 19/04/2011 | 31/05/2011 | 28/04/2011 | - | 01/06/2011 | 14/04/2011 | - |
| 2012 | Planting | 29/11/2011 | 23/11/2011 | 15/12/2011 | 15/11/2011 | 27/12/2011 | 01/01/2012 | 27/11/2011 | - |
|  | Harvesting | 24/04/2012 | 19/04/2012 | 01/06/2012 | 01/06/2012 | 09/05/2012 | 02/06/2012 | 27/03/2012 | - |
| 2013 | Planting | 06/12/2012 | 23/11/2012 | 07/12/2012 | 30/11/2012 | 14/12/2012 | 13/12/2012 | 28/11/2012 | 13/12/2012 |
|  | Harvesting | 26/04/2013 | 19/04/2013 | 10/05/2013 | 14/04/2013 | 07/05/2013 | 29/05/2013 | 10/04/2013 | 18/05/2013 |
| 2014 | Planting | 12/11/2013 | 19/11/2013 | 27/11/2013 | 17/12/2013 | 29/12/2013 | 17/12/2013 | 16/12/2013 | 23/12/2013 |
|  | Harvesting | 04/04/2014 | 04/04/2014 | 30/04/2014 | 04/04/2014 | 29/05/2014 | 03/06/2014 | 06/04/2014 | 21/05/2014 |

Supplementary Table 2. Land history before trials were established at the experimental sites

|  |  |
| --- | --- |
| Site | History of the land before experimentation |
| UZ | Conventional maize-soybean rotation  |
| DTC | Conventional maize production, green manure cover crop fallow followed by trials |
| Makoholi | Conventional maize production |
| MFTC | Conventional maize production |
| MRS | Conventional maize production |
| CRS | Fallow after clearing of virgin land, then unfertilized maize plots followed by trials |
| NUR | Conventional Maize-legume rotation |
| SRS | Fallow |

Supplementary Table 3. Effect of mulch and nitrogen levels on the chlorophyll content of maize at flowering stage in DTC and UZ, Zimbabwe

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site | Year | Fixed effects | Coefficients/Estimates | se | df | F-values | P-values | Transformation |
| DTC | 2013 | Intercept | 3.10 | 0.06 | 71.00 | 50.44 | 0.00 | Log |
|  |  | Mulch | -0.01 | 0.01 | 71.00 | -0.421 | 0.68 |  |
|  |  | Nitrogen | 0.01 | 0.00 | 71.00 | 5.386 | 0.00 |  |
|  |  | Mulch\*Nitrogen | 0.00 | 0.00 | 71.00 | -0.404 | 0.69 |  |
|  | 2014 | Intercept | 3.43 | 0.04 | 146.00 | 94.606 | 0.00 | Log |
|  |  | Mulch | 0.00 | 0.01 | 146.00 | -0.103 | 0.92 |  |
|  |  | Nitrogen | 0.00 | 0.00 | 146.00 | 6.392 | 0.00 |  |
|   |   | Mulch\*Nitrogen | 0.00 | 0.00 | 146.00 | 0.416 | 0.68 |   |
| UZ | 2013 | Intercept | 30.2 | 1.2 | 71 | 24.3 | 0.00 | None |
|  |  | Mulch | 0.1 | 0.3 | 71 | 0.6 | 0.58 |  |
|  |  | Nitrogen | 0.0 | 0.0 | 71 | 1.5 | 0.14 |  |
|  |  | Mulch\*Nitrogen | 0.0 | 0.0 | 71 | -1.4 | 0.18 |  |
|  | 2014 | Intercept | 37.6 | 1.3 | 32.26 | 28.0 | 0.00 | None |
|  |  | Mulch | -1.1 | 0.2 | 142 | -4.6 | 0.00 |  |
|  |  | Nitrogen | 0.1 | 0.0 | 142 | 3.6 | 0.00 |  |
|   |   | Mulch\*Nitrogen | 0.0 | 0.0 | 142 | 2.0 | 0.04 |   |

Supplementary Table 4. Summary of GLMM showing the variation in maize grain yield (kg ha-1) across years as a result of different levels of maize residue mulch, seasonal rainfall and the duration since mulch application started in Zambia and Zimbabwe

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Country | Site | Fixed effects | Coefficients/Estimates | se | df | F-values | P-values | Transformation |
| Zimbabwe | DTC | Intercept | 321.866955 | 41.32456 | 152.7 | 7.789 | 0.000 | Square root |
|  |  | Mulch | 5.714711 | 2.658444 | 152 | 2.15 | 0.033 |  |
|  |  | Duration | 251.1 | 41.2 | 152 | 6.1 | 0.000 |  |
|  |  | Mulch\*Rainfall | -0.01 | 0.01 | 152 | -1.7 | 0.086 |  |
|  |  | Duration\*Rainfall | -0.004834 | 0.002798 | 152 | -1.728 | 0.086 |  |
|  | Makoholi | Intercept | 25.921557 | 2.965811 | 14 | 8.74 | 0.000 | Square root |
|  |  | Mulch | 4.362574 | 2.154832 | 213.93 | 2.025 | 0.044 |  |
|  |  | Duration | -2.6 | 0.65 | 214.5 | -4.0 | 0.000 |  |
|  |  | Mulch\*Rainfall | -0.007785 | 0.003549 | 213.93 | -2.193 | 0.029 |  |
|  | UZ | Intercept | 5083.5024 | 262.4911 | 89.89 | 19.366 | 0.000 | None |
|  |  | Mulch | 784.5827 | 347.7317 | 139.96 | 2.256 | 0.026 |  |
|  |  | Duration | -1234.2 | 506.8 | 140.0 | -2.4 | 0.016 |  |
|  |  | Mulch\*Rainfall | -1.4262 | 0.6169 | 139.96 | -2.312 | 0.022 |  |
| Zambia | MFTC | Intercept | 6432.2223 | 323.0498 | 79.44 | 19.911 | 0.000 | None |
|  |  | Mulch | 918.7957 | 431.0374 | 79.44 | 2.132 | 0.036 |  |
|  |  | Duration | -815.3 | 100.3 | 79.4 | -8.1 | 0.000 |  |
|  |  | Mulch\*Rainfall | -1.1771 | 0.5514 | 79.44 | -2.135 | 0.036 |  |
|  | MRS | Intercept | 79.847968 | 2.356758 | 50.67 | 33.88 | 0.000 | Square root |
|  |  | Mulch | 37.227737 | 6.491349 | 62.17 | 5.735 | 0.000 |  |
|  |  | Duration | -10.9 | 0.93 | 65.0 | -11.7 | 0.000 |  |
|   |   | Mulch\*Rainfall | -0.043341 | 0.007488 | 62.17 | -5.788 | 0.000 |   |

Supplementary Table 5. Summary of GLMM showing the variation in maize grain yield (kg ha-1) across years as a result of different levels of maize residue mulch, seasonal rainfall and the duration since mulch application started in Malawi and Mozambique

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Country** | **Site** | **Fixed effects** | **Coefficients/Estimates** | **se** | **df** | **F-values** | **P-values** | **Transformation** |
| Malawi | CRS | Intercept | 5950.03 | 282.07 | 9.26 | 21.09 | 0.000 | None |
|  |  | Mulch | -17.84 | 46.82 | 50.84 | -0.38 | 0.705 |  |
| Mozambique | SRS | Intercept | 7.85 | 0.14 | 31.98 | 55.32 | 0.000 | Log |
|  |  | Mulch | 0.01 | 0.01 | 93.00 | 0.34 | 0.731 |  |
|  |  | Rainfall | 0.01 | 0.01 | 93.00 | 0.57 | 0.573 |  |
|  |  | Duration | -0.06 | 0.04 | 93.0 | -1.55 | 0.125 |  |
|  | NUR | Intercept | 7762.0547 | 682.5257 | 44.16 | 11.373 | 0.000 | None |
|  |  | Mulch | 925.5444 | 207.8826 | 40.24 | 4.452 | 0.000 |  |
|  |  | Duration | -2171.5 | 405.1 | 42.4 | -5.36 | 0.000 |  |
|   |   | Mulch\*Rainfall | -0.7693 | 0.2043 | 40.24 | -3.765 | 0.001 |   |

Supplementary Table 6. The effect of mulch and nitrogen combinations on maize grain yield across years in three locations in Malawi and Zimbabwe

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Country | Site | Fixed effects | Coefficients/Estimates | se | df | F-values | P-values | Transformation |
| Zimbabwe | DTC | Intercept | 29.07 | 3.9 | 39.2 | 7.4 | 0.0000 | Square root |
|  |  | Mulch | 27.98 | 3.7 | 215.0 | 7.5 | 0.0000 |  |
|  |  | Nitrogen | 0.14 | 0.0 | 215.0 | 3.7 | 0.0003 |  |
|  |  | Duration | -1.54 | 1.3 | 215.0 | -1.2 | 0.2407 |  |
|  |  | Mulch\*Nitrogen | 0.00 | 0.0 | 215.0 | -0.3 | 0.7537 |  |
|  |  | Mulch\*Rainfall | -0.04 | 0.0 | 215.0 | -7.3 | 0.0000 |  |
|  | Makoholi | Intercept | 6.59 | 0.3 | 89.1 | 22.5 | 0.0000 | Log |
|  |  | Mulch | -0.02 | 0.1 | 140.0 | -0.2 | 0.8050 |  |
|  |  | Nitrogen | 0.01 | 0.0 | 140.0 | 5.3 | 0.0000 |  |
|  |  | Duration | -0.20 | 0.2 | 140.0 | -1.0 | 0.3080 |  |
|  |  | Mulch\*Nitrogen | 0.00 | 0.0 | 140.0 | -1.3 | 0.1990 |  |
|  |  | Mulch\*Rainfall | 0.00 | 0.0 | 140.0 | 1.2 | 0.2150 |  |
|  | UZ | Intercept | 4651.86 | 316.5 | 32.6 | 14.7 | 0.000 | None |
|  |  | Mulch | -523.73 | 210.4 | 181.4 | -2.5 | 0.014 |  |
|  |  | Nitrogen | 15.41 | 3.4 | 181.5 | 4.5 | 0.000 |  |
|  |  | Duration | -844.2 | 95.5 | 181.4 | -8.8 | 0.000 |  |
|  |  | Mulch\*Nitrogen | 2.37 | 0.7 | 181.5 | 3.4 | 0.001 |  |
|   |   | Mulch\*Rainfall | 0.63 | 0.3 | 181.4 | 2.3 | 0.022 |   |
| Malawi | Chitedze | Intercept | 4574.8 | 395.4 | 249.8 | 11.6 | 0.0000 | None |
|  |  | Mulch | -1367.4 | 565.1 | 249.8 | -2.4 | 0.0162 |  |
|  |  | Nitrogen | 10.5 | 4.4 | 249.8 | 2.4 | 0.0170 |  |
|  |  | Duration | -98.2 | 157.5 | 249.8 | -0.6 | 0.5338 |  |
|  |  | Mulch\*Nitrogen | 0.7 | 0.9 | 249.8 | 0.8 | 0.4322 |  |
|  |  | Mulch\*Rainfall | 1.6 | 0.7 | 249.8 | 2.3 | 0.0217 |  |

  

Plate 1. Animal traction ripper tine attached to a beam of a conventional mouldboard plough (*left picture*), and furrows created by the ripper for planting maize at selected inter-row spacing (*right picture*).