**Supplementary tables**

Table S1. Rainfall, minimum temperature, and maximum temperature in Axum and Mekelle during 2015 and 2016

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location | Year | Rainfall (mm) | Min. Temperature (°C) | Max. Temperature (°C) |
| Axum | 2015 | 725 | 11 | 27 |
|  | 2016 | 675 | 11 | 27 |
| Mekelle | 2015 | 580 | 11 | 28 |
|  | 2016 | 560 | 11 | 28 |

*Source: (NMA 2017b)*

Table S2. Description of crop and weed management and assessment operations in the two experimental sites

|  |  |  |
| --- | --- | --- |
| Operations | 2015 | 2016 |
| **Axum Research Site** |  |  |
| First ard ploughing | 13 May | 16 May |
| Second ard ploughing | 6 Jun | 3 Jun |
| Third ard ploughing | 3 Jul | 30 Jun |
| Fourth ard ploughing | 21 Jul | 19 Jul |
| Seed bed preparation and field designing | 21 Jul | 19 Jul |
| Field fertilizing\* and sowing\*\* | 21 Jul | 19 Jul |
| Crop assessment | 27 July–21 Nov | 25 July–29 Nov |
| Weed assessment |  |  |
| First weeding | 19 Aug | 22 Aug |
| Second weeding | 01 Oct | 03 Oct |
| Third weeding | 19 Nov | 26 Nov |
| Crop harvesting | 22 Nov | 30 Nov |
| Crop and weed biomass measurement | 06 Dec | 13 Dec |
| Crop threshing and grain weighing | 06–10 Dec | 14–17 Dec |
| **Mekelle Research Site** |  |  |
| First ard ploughing | 24 May | 26 May |
| Second ard ploughing | 23 Jun | 27 Jun |
| Third ard ploughing | 28 Jul | 30 Jul |
| Seed bed preparation and field designing | 27 Jul | 01 Aug |
| Field fertilizing\* and sowing\*\* | 27 Jul | 01 Aug |
| Crop assessment | 03 Aug–07 Dec | 08 Aug–09 Dec |
| Weed assessment |  |  |
| First weeding | 03 Sep | 05 Sep |
| Second weeding | 29 Sep | 05 Oct |
| Third weeding | 27 Nov | 26 Nov |
| Crop harvesting | 01 Dec | 28 Nov |
| Crop and weed biomass measurement | 14 Dec | 5 Dec |
| Crop threshing and grain weighing | 14–19 Dec | 05–11 Dec |

*\*Fertilising of the field was done by applying DAP and urea at a rate of 60 kg N and 60 kg P2O5 per ha for Vertisol soils and 40 kg N and 40 kg P2O5 per ha for light sandy loam soils. Axum has Vertisol and Mekelle has Cambisol; \*\*Sowing was done at the nationally recommended seed rate of 25 kg/ha.*

Table S3. ANOVA table with P-values for the main and interaction effects of factors on the agronomic traits of teff

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Factor effects | Days to 50% emergence | Days to 50% heading | Days to 50% maturity | Plant height (cm) | Total tiller no./plant | Biomass yield (kg/ha) | Grain yield (kg/ha) |
| Tillage frequency (TF) | 0.195 | 0.0773 | 0.7023 | **0.0018** | 0.8369 | **<.0001** | **<.0001** |
| Seed rate (kg/ha) (SR) | **<.0001** | **<.0001** | **<.0001** | **0.0201** | **<.0001** | **<.0001** | **<.0001** |
| TF\*SR | 0.5173 | 0.8457 | 0.566 | 0.3139 | 0.6703 | 0.5386 | 0.2325 |
| Glyphosate (Gp) | 0.5533 | 0.4508 | 0.9609 | **<.0001** | 0.8252 | **0.0184** | **0.0236** |
| TF\*Gp | 0.7505 | 0.9947 | 0.4107 | **0.0297** | 0.1643 | 0.4175 | 0.2276 |
| SR\*Gp | 0.1155 | 0.2407 | 0.7693 | 0.8214 | 0.7873 | 0.909 | 0.6331 |
| TF\*SR\*Gp | 0.1398 | 0.0064 | 0.2317 | 0.2964 | 0.4311 | 0.5276 | 0.7851 |
| Year (Yr) | 0.0811 | **<.0001** | **<.0001** | **<.0001** | **<.0001** | **<.0001** | **<.0001** |
| TF\*Yr | 0.1306 | 0.1994 | 0.9614 | **0.0074** | 0.3506 | 0.4204 | 0.8782 |
| SR\*Yr | **0.001** | 0.1472 | **0.0179** | 0.741 | **<.0001** | 0.2989 | 0.2766 |
| TF\*SR\*Yr | 0.4468 | 0.4976 | 0.381 | 0.4006 | 0.4628 | 0.8954 | 0.8143 |
| Gp\*Yr | 0.4342 | 0.7828 | 0.8205 | **0.0012** | 0.5103 | 0.5238 | 0.6528 |
| TF\*Gp\*Yr | 0.6293 | 0.7608 | 0.4429 | 0.1845 | 0.3674 | 0.9034 | 0.9638 |
| SR\*Gp\*Yr | 0.0693 | 0.2217 | 0.8182 | 0.6898 | 0.355 | 0.7771 | 0.4471 |
| TF\*SR\*Gp\*Yr | 0.071 | 0.1556 | **0.0007** | 0.4106 | 0.8833 | 0.172 | 0.0845 |
| Location (Loc) | **<.0001** | **<.0001** | **<.0001** | **<.0001** | **0.012** | 0.4403 | **0.0269** |
| TF\*Loc | 0.195 | 0.0773 | 0.5153 | 0.1601 | 0.8588 | 0.6846 | 0.4151 |
| SR\*Loc | **<.0001** | **<.000**1 | 0.4868 | 0.2127 | **0.0004** | **0.0021** | **0.0116** |
| TF\*SR\*Loc | 0.5173 | 0.8457 | 0.2116 | 0.7495 | 0.9678 | 0.6314 | 0.6615 |
| Gp\*Loc | 0.5533 | 0.4508 | 0.8066 | 0.2567 | 0.0829 | **0.0253** | 0.075 |
| TF\*Gp\*Loc | 0.7505 | 0.9947 | 0.9279 | 0.4831 | 0.2445 | 0.8228 | 0.4786 |
| SR\*Gp\*Loc | 0.1155 | 0.2407 | 0.6293 | 0.1192 | 0.2275 | 0.9037 | 0.9322 |
| TF\*SR\*Gp\*Loc | 0.1398 | 0.0065 | **0.0165** | 0.6695 | 0.4048 | 0.874 | 0.6514 |
| Yr\*Loc | **<.0001** | **<.0001** | **<.0001** | **0.0094** | 0.1478 | **<.0001** | **<.0001** |
| TF\*Yr\*Loc | 0.1306 | 0.1994 | 0.8597 | 0.1068 | 0.4872 | 0.1356 | 0.5848 |
| SR\*Yr\*Loc | **0.001** | 0.1472 | **<.0001** | 0.2445 | **0.0002** | 0.1086 | **0.0182** |
| TF\*SR\*Yr\*Loc | 0.4468 | 0.4976 | 0.6313 | **0.0438** | **0.033** | **0.0432** | **0.0129** |
| Gp\*Yr\*Loc | 0.4342 | 0.7828 | 0.9638 | 0.6121 | 0.0764 | 0.4713 | 0.782 |
| TF\*Gp\*Yr\*Loc | 0.6293 | 0.7608 | 0.9614 | 0.438 | 0.8644 | 0.3192 | 0.1394 |
| SR\*Gp\*Yr\*Loc | 0.0693 | 0.2217 | 0.8813 | 0.9773 | 0.3595 | 0.9552 | 0.7452 |
| TF\*SR\*Gp\*Yr\*Loc | 0.071 | 0.1556 | 0.2408 | 0.0836 | 0.6015 | 0.9056 | 0.6302 |
| Transformation | - | - | - | - | - | - | - |
| Typea | Ar(1) | Ar(1) | Ar(1) | un | un | Ar(1) | Ar(1) |

*a Among the commonly used serial structures used for correlations, First order autoregressive AR(1) and “unstructured” (un, in SAS) were used. This was used during the analysis because it resulted in models with lower values of Akaike information criterion (AIC) and Schwarz Bayesian information criterion (BIC)*

Table S4. ANOVA table with P-values for the effect of seed rate on teff analysed separately for locations and years

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Teff agronomic traits | Axum | | Mekelle | |
| 2015 | 2016 | 2015 | 2016 |
| Days to 50% emergence | **<.0001** | **0.0049** | **<.0001** | **<.0001** |
| Days to 50% heading | **<.0001** | **0.0037** | **0.0002** | **<.0001** |
| Days to 50% maturity | **<.0001** | **0.004** | **0.0005** | **<.0001** |
| Plant height (cm) | 0.2238 | 0.5322 | **0.0043** | **0.0474** |
| Total tiller no./plant | **<.0001** | **0.0206** | **0.0117** | **0.0023** |
| Crop biomass (kg/ha) | **<.0001** | **<.0001** | 0.4397 | **0.0185** |
| Grain Yield (kg/ha) | **0.0015** | **<.0001** | 0.2597 | **0.0187** |

Table S5. ANOVA table with P-values for the main and interaction effects on weeds

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Factor Effect | Monocot density (no./ m2) | Dicot density (no./m2) | Total density (no./m2) | Monocot dry weight (g/m2) | Dicot dry weight (g/m2) | Total dry weight (g/m2) | Weed cover (%) |
| Tillage frequency (TF) | **0.0244** | **0.0474** | **0.0156** | **0.0416** | 0.1382 | **0.0437** | **<.0001** |
| Seed rate (kg/ha) (SR) | **0.0005** | 0.0787 | **0.0002** | **0.0495** | **0.0006** | **0.0306** | **0.0018** |
| TF\*SR | 0.1526 | 0.8219 | 0.3463 | 0.6657 | 0.929 | 0.815 | 0.6117 |
| Glyphosate (Gp) | 0.4051 | 0.2421 | 0.9783 | **0.0113** | 0.7496 | **0.0195** | **<.0001** |
| TF\*Gp | 0.8774 | 0.6984 | 0.7746 | 0.1523 | 0.756 | 0.1394 | **0.0008** |
| SR\*Gp | 0.9862 | 0.8023 | 0.918 | 0.1209 | 0.4954 | 0.135 | 0.9237 |
| TF\*SR\*Gp | 0.1232 | 0.3588 | 0.1877 | 0.2116 | 0.4317 | 0.2404 | 0.6636 |
| Year (Yr) | **<.0001** | **0.0002** | **<.0001** | **<.0001** | **<.0001** | **<.0001** | **<.0001** |
| TF\*Yr | 0.0753 | 0.1275 | 0.1519 | 0.1529 | **0.0499** | 0.0563 | 0.7812 |
| SR\*Yr | 0.0769 | 0.4865 | 0.0568 | 0.3198 | 0.0626 | 0.1079 | 0.8795 |
| TF\*SR\*Yr | 0.1834 | 0.2129 | 0.6696 | 0.5409 | 0.9368 | 0.5646 | 0.7234 |
| Gp\*Yr | 0.9939 | 0.8569 | 0.9221 | 0.38 | 0.4673 | 0.2909 | 0.4267 |
| TF\*Gp\*Yr | 0.9275 | 0.9581 | 0.9674 | 0.4469 | 0.3607 | 0.693 | 0.346 |
| SR\*Gp\*Yr | 0.054 | 0.7309 | 0.2407 | 0.3874 | 0.7203 | 0.3185 | 0.2511 |
| TF\*SR\*Gp\*Yr | 0.4945 | 0.4388 | 0.4044 | **0.0155** | 0.4647 | **0.0445** | 0.9951 |
| Location (Loc) | **0.0007** | **<.0001** | **<.0001** | **0.0012** | **<.0001** | **0.0475** | **0.0013** |
| TF\*Loc | 0.3517 | 0.8527 | 0.3318 | 0.1942 | 0.4748 | 0.2839 | **0.0002** |
| SR\*Loc | 0.9108 | 0.9955 | 0.9182 | 0.0623 | **0.0017** | **0.0095** | 0.1522 |
| TF\*SR\*Loc | 0.2071 | 0.6812 | 0.3211 | **0.0294** | 0.8568 | **0.0286** | 0.5448 |
| Gp\*Loc | 0.5041 | 0.0863 | 0.1123 | 0.1512 | 0.5213 | 0.1306 | **<.0001** |
| TF\*Gp\*Loc | 0.7657 | 0.7835 | 0.6619 | **0.0447** | 0.1869 | **0.0372** | 0.1762 |
| SR\*Gp\*Loc | 0.8965 | 0.181 | 0.339 | 0.5362 | 0.8222 | 0.5651 | 0.5272 |
| TF\*SR\*Gp\*Loc | 0.1146 | 0.5308 | 0.1838 | 0.6684 | 0.6769 | 0.5265 | 0.7083 |
| Yr\*Loc | **<.0001** | **<.0001** | **<.0001** | 0.1768 | **<.0001** | 0.3996 | **0.0158** |
| TF\*Yr\*Loc | 0.209 | 0.2475 | 0.1557 | 0.5756 | 0.7027 | 0.6008 | 0.3584 |
| SR\*Yr\*Loc | 0.5201 | 0.1755 | 0.1993 | 0.2982 | **0.0312** | 0.0832 | 0.8676 |
| TF\*SR\*Yr\*Loc | **0.0429** | 0.3019 | 0.1389 | 0.1211 | 0.7599 | 0.2074 | 0.1474 |
| Gp\*Yr\*Loc | 0.6524 | 0.494 | 0.4794 | 0.7145 | 0.9606 | 0.7101 | 0.4564 |
| TF\*Gp\*Yr\*Loc | 0.5607 | 0.9804 | 0.6609 | 0.9926 | 0.2634 | 0.9224 | 0.2638 |
| SR\*Gp\*Yr\*Loc | 0.2247 | 0.5608 | 0.1592 | 0.6896 | 0.6923 | 0.7943 | 0.9094 |
| TF\*SR\*Gp\*Yr\*Loc | 0.5371 | 0.8948 | 0.7608 | 0.4176 | 0.6843 | 0.3114 | 0.8757 |
| Transformation | - | - | - | - | - | - | - |
| Typesa | un | Ar(1) | un | un | un | Ar(1) | un |

*a Among the commonly used serial structures used for correlations, First order autoregressive AR(1) and “unstructured” (un, in SAS) were used. This was used during the analysis because it resulted in models with lower values of Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (BIC)*