# **Supplementary online material**

## **Table S1**

**Table S1.** Response of wheat grain yield (kg ha-1) to N, P, K and S fertilizer on different soil types in Ethiopia

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nutrient | Rate (kg ha-1) | Cambisols | Luvisols | Nitisols | Vertisols |
| N | 0 | 2212  (1410-3013) | 2930  (1680-4181) | 2634  (1624-3645) | 2702  (1954 - 3450) |
|  | 46 | 2888  (2086-3689) | 3319  (2068-4570) | 3008  (1998-4019) | 3189  (2441-3937) |
|  | 92 | 2997  (2196-3799) | 3483  (2232-4733) | 3226  (2215 - 4236) | 4098  (3350-4846) |
|  | 138 | 3170  (2368-3971) | 3582  (2331-4833) | 3044  (2034 - 4055) | 3538  (2790-4287) |
|  | 176 | 2981  (2180-3783) | 3557  (2307-4808) | 3316  (2305 - 4326) | 3820  (3072-4568) |
|  | 222 | 2806  (2005-3608) | 2603  (1352-3854) | 3179  (2168 - 4189) | 3948  (3200-4696) |
| P | 0 | 2860  (2202-3517) | 3176  (2015-4338) | 2822  (1879 - 3765) | 2774  (2116 - 3431) |
|  | 10 | 3357  (2699-4014) | 3346  (2184-4507) | 2991  (2049 - 3934) | 2777  (2120 - 3435) |
|  | 20 | 3636  (2979-4294) | 3306  (2145-4467) | 3251  (2308 - 4194) | 2933  (2275 - 3590) |
|  | 30 | 3325  (2668-3983) | 3267  (2106-4428) | 2990  (2047 - 3933) | 2931  (2274 - 3589) |
|  | 40 | 3601  (2943-4258) | 3296  (2134-4457) | 3212  (2269 - 4155) | 2970  (2313 - 3628) |
|  | 50 | 3720  (3063-4378) | 2738  (1577-3899) | 3369  (2426 - 4312) | 3043  (2385 - 3700) |
| K | 0 | 3828  (3028-4629) | 3516  (2097-4935) | 2951  (1949 - 3952) | 3111  (2254 - 3967) |
|  | 18 | 4065  (3264-4865) | 3338  (1919 -4757) | 3266  (2264 - 4267) | 3616  (2759 - 4472) |
|  | 36 | 3866  (3097-4635) | 3616  (2197-5035) | 3200  (2199 - 4202) | 3377  (2549 - 4206) |
|  | 54 | 3775  (2975-4576) | 3527  (2108-4946) | 3057  (2055 - 4059) | 3268  (2411 - 4124) |
|  | 72 | 3890  (3089-4691) | 3345  (1926-4763) | 2974  (1973 - 3976) | 3709  (2853 - 4566) |
|  | 90 | 3804  (2722-4886) | 3519  (2101-4938) | 3206  (2205 - 4208) | 3521  (2608 - 4433) |
|  | 108 | 4107  (3025-5189) | 3290  (1871-4709) | 3171  (2154 - 4188) | 3639  (2726 - 4551) |
|  | 126 | 3557  (2475-4639) | 2579  (1160-3998) | 3256  (2239 - 4273) | 3493  (2580 - 4405) |
| S | 0 | 3327  (2674-3981) | 3462  (2160-4763) | 2988  (2068 - 3908) | 3330  (2704 - 3956) |
|  | 10 | 3419  (2765-4072) | 3376  (2074-4678) | 2901  (1981 - 3820) | 3344  (2718 - 3970) |
|  | 20 | 3336  (2682-3989) | 3540  (2238-4841) | 3095  (2175 - 4014) | 3294  (2668 - 3920) |
|  | 30 | 3369  (2715-4022) | 3499  (2197-4801) | 3067  (2148 - 3987) | 3225  (2599 - 3851) |
|  | 40 | 3284  (2627-3941) | 3547  (2246-4849) | 3141  (2221 - 4061) | 3172  (2544 - 3800) |
|  | 50 | 3421  (2770-4072) | 2825  (1523-4126) | 2967  (2047 - 3886) | 3252  (2628 - 3876) |

*Numbers in parenthesis represent 95% confidence limits; Na represent data not available; Na = Data not available*

## **Table S2**

**Table S2.** Response of wheat grain yield (kg ha-1) to N, P, K and S fertilizer in different agro-ecological zones (AEZ) in Ethiopia

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Nutrient | Rate (kg ha-1) | H3 | M3 | SH3 | SM3 | SM4 |
| N | 0 | 2865  (1836- 3895) | 1425  (278- 2572) | 2977  (2225- 3729) | 1789  (938- 2639) | 2574  (1674- 3474) |
|  | 46 | 3220  (2191- 4249) | 2703  (1556- 3849) | 3400  (2649- 4152) | 2141  (1291- 2991) | 3338  (2438- 4237) |
|  | 92 | 3458  (2429- 4487) | 3145  (1999- 4292) | 3987  (3235- 4739) | 2549  (1699- 3400) | 3757  (2857- 4657) |
|  | 138 | 3252  (2223- 4281) | 3014  (1867- 4161) | 3638  (2886- 4389) | 2475  (1625- 3325) | 3733  (2833- 4633) |
|  | 176 | 3562  (2532- 4591) | 2923  (1777- 4070) | 3496  (2744- 4248) | 2712  (1862- 3562) | 4046  (3146- 4946) |
|  | 222 | 3420  (2391- 4449) | 2978  (1832- 4125) | 2890  (2138- 3641) | 2998  (2148- 3848) | 3978  (3078- 4878) |
| P | 0 | 3285  (2577- 3993) | 2817  (1952- 3682) | 2867  (2243- 3491) | 2123  (1387- 2858) | 3261  (2486-4037) |
|  | 10 | 3477  (2769- 4184) | 2822  (1957- 3687) | 3131  (2507- 3755) | 2561  (1826- 3296) | 3406  (2631- 4182) |
|  | 20 | 3795  (3087- 4503) | 3373  (2508- 4238) | 3210  (2586- 3834) | 2724  (1988- 3459) | 3415  (2639- 4190) |
|  | 30 | 3466  (2765- 4166) | 2432  (1567- 3296) | 3099  (2471- 3726) | 2659  (1924- 3394) | 3467  (2692- 4242) |
|  | 40 | 3731  (3024- 4439) | 3320  (2456- 4185) | 3165  (2541- 3788) | 2738  (2003- 3473) | 3526  (275 - 4301) |
|  | 50 | 3869  (3162- 4577) | 3626  (2761- 4491) | 2906  (2282- 3530) | 2862  (2127- 3598) | 3639  (2864- 4415) |
| K | 0 | 3260  (2332- 4187) | 1929  (858- 2999) | 3524  (2589- 4330) | 2984  (1850- 4118) | 4518  (2846- 6189) |
|  | 18 | 3571  (2644- 4498) | 2906  (1836- 3976) | 3561  (2747- 4341) | 3263  (2129- 4397) | 4881  (3209- 6552) |
|  | 36 | 3541  (2618- 4463) | 2350  (1410- 3289) | 3544  (2803- 4433) | 3165  (2031- 4299) | 4616  (3025- 6207) |
|  | 54 | 3340  (2413- 4268) | 1891  (821 - 2961) | 3618  (2729- 4359) | 2864  (1730- 3998) | 4906  (3234- 6577) |
|  | 72 | 3196  (2269- 4123) | 2252  (1182- 3322) | 3544  (2749- 4490) | 3343  (2209- 4477) | 5282  (3610- 6953) |
|  | 90 | 3483  (2549- 4418) | Na | 3620  (2108- 3738) | 3169  (2035- 4303) | Na |
|  | 108 | 3421  (2467- 4375) | Na | 3459  (2007- 3749) | 3340  (2206- 4474) | Na |
|  | 126 | 3509  (2555- 4463) | Na | 2878  (2746- 4376) | 3079  (1945- 4213) | Na |
| S | 0 | 3371  (2457- 4284) | 2554  (1589- 3519) | 3457  (2659- 4255) | 2810  (2032- 3589) | 3371  (2541- 4202) |
|  | 10 | 3232  (2318- 4145) | 3074  (2109- 4039) | 3426  (2628- 4224) | 2838  (2060- 3617) | 3429  (2599- 4260) |
|  | 20 | 3442  (2528- 4355) | 2898  (1933- 3862) | 3476  (2677- 4274) | 2757  (1978- 3535) | 3404  (2573- 4234) |
|  | 30 | 3420  (2507- 4334) | 2806  (1842- 3771) | 3401  (2603- 4199) | 2703  (1925- 3481) | 3379  (2549- 4210) |
|  | 40 | 3418  (2505- 4332) | 2564  (1600- 3529) | 3569  (2771- 4367) | 2650  (1864- 3436) | 3311  (2480- 4141) |
|  | 50 | 3335  (2421- 4248) | 2853  (1888- 3817) | 3190  (2392- 3988) | 2701  (1928- 3473) | 3450  (2620- 4281) |

*Numbers in parenthesis represent 95% confidence limits; Na represent data not available; Na = Data not available*

## **Table S3**

**Table S3.** Changes in yield (%) relative to the control due to N, P, K and S fertilizer on different soil types and agro-ecological zones (AEZ) in Ethiopia

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Soil type |  |  |  |  | AEZ |  |  |  |  |
| Nutrient | Rate | Cambisols | Luvisols | Nitisols | Vertisols |  | H3 | M3 | SH3 | SM3 | SM4 |
| N | 46 | 30.6 | 13.3 | 14.2 | 18.0 |  | 12.4 | 89.7 | 14.2 | 19.7 | 29.7 |
|  | 92 | 35.5 | 18.9 | 22.5 | 51.7 |  | 20.7 | 120.7 | 33.9 | 42.5 | 46.0 |
|  | 138 | 43.3 | 22.3 | 15.6 | 30.9 |  | 13.5 | 111.5 | 22.2 | 38.3 | 45.0 |
|  | 176 | 34.8 | 21.4 | 25.9 | 41.4 |  | 24.3 | 105.1 | 17.4 | 51.6 | 57.2 |
|  | 222 | 26.9 | -11.2 | 20.7 | 46.1 |  | 19.4 | 109.0 | -2.9 | 67.6 | 54.5 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| P | 10 | 17.4 | 5.4 | 6.0 | 0.1 |  | 5.8 | 0.2 | 9.2 | 20.6 | 4.4 |
|  | 20 | 27.1 | 4.1 | 15.2 | 5.7 |  | 15.5 | 19.7 | 12.0 | 28.3 | 4.7 |
|  | 30 | 16.3 | 2.9 | 6.0 | 5.7 |  | 5.5 | -13.7 | 8.1 | 25.2 | 6.3 |
|  | 40 | 25.9 | 3.8 | 13.8 | 7.1 |  | 13.6 | 17.9 | 10.4 | 29.0 | 8.1 |
|  | 50 | 30.1 | -13.8 | 19.4 | 9.7 |  | 17.8 | 28.7 | 1.4 | 34.8 | 11.6 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| K | 15 | 6.2 | -5.1 | 10.7 | 16.2 |  | 9.5 | 50.6 | 1.0 | 9.3 | 8.0 |
|  | 30 | 1.0 | 2.8 | 8.4 | 8.6 |  | 8.6 | 21.8 | 0.6 | 6.1 | 2.2 |
|  | 45 | -1.4 | 0.3 | 3.6 | 5.0 |  | 2.5 | -2.0 | 2.7 | -4.0 | 8.6 |
|  | 60 | 1.6 | -4.9 | 0.8 | 19.2 |  | -2.0 | 16.7 | 0.6 | 12.0 | 16.9 |
|  | 75 | -0.6 | 0.1 | 8.6 | 13.2 |  | 6.8 |  | 2.7 | 6.2 |  |
|  | 90 | 7.3 | -6.4 | 7.5 | 17.0 |  | 4.9 |  | -1.8 | 11.9 |  |
|  | 105 | -7.1 | -26.6 | 10.3 | 12.3 |  | 7.6 |  | -18.3 | 3.2 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| S | 10 | 2.8 | -2.5 | -2.9 | 0.4 |  | -4.1 | 20.4 | -0.9 | 1.0 | 1.7 |
|  | 20 | 0.3 | 2.3 | 3.6 | -1.1 |  | 2.1 | 13.5 | 0.5 | -1.9 | 1.0 |
|  | 30 | 1.3 | 1.1 | 2.6 | -3.2 |  | 1.5 | 9.9 | -1.6 | -3.8 | 0.2 |
|  | 40 | -1.3 | 2.5 | 5.1 | -4.7 |  | 1.4 | 0.4 | 3.2 | -5.7 | -1.8 |
|  | 50 | 2.8 | -18.4 | -0.7 | -2.3 |  | -1.1 | 11.7 | -7.7 | -3.9 | 2.3 |

## **Figure S1**

|  |  |
| --- | --- |
|  |  |
|  |  |

**Figure S1**. Variation in yield response of wheat to K and S rates on different soils