Evidence of micronutrient fertilizer effect on agronomic fortified tef under different landscape positions in Amhara region

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SOILS: WHERE FOOD BEGINS

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Agronomic biofortification

- Addition of micronutrient-supplying organic and inorganic fertilizers to improve micronutrient concentration in staple crops.
- Most evidence reported on wheat and maize grown under uniform landscape positions.
- Little evidence on tef grown under variable field landscape positions.

Tef (*Eragrostis tef* Zucc.)

- Drought tolerant.
- Grows in different environments and altitudes.
- Provides 2/3 of daily protein intake.

Hand-threshing *tef*
Photo credit: GeoNutrition

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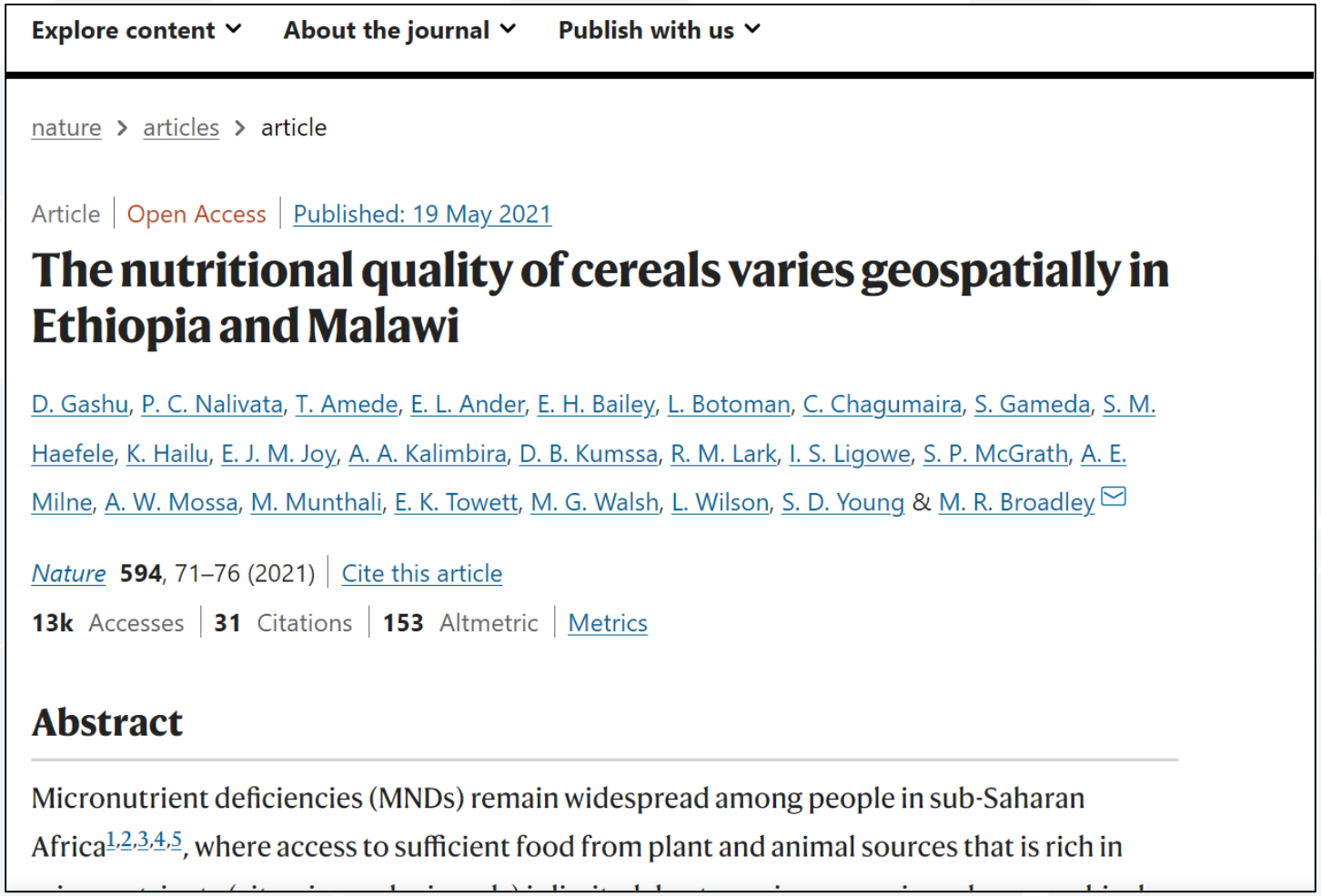
Micronutrient surveillance in Africa



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Article | Open Access | Published: 19 May 2021

The nutritional quality of cereals varies geospatially in Ethiopia and Malawi

D. Gashu, P. C. Nalivata, T. Amede, E. L. Ander, E. H. Bailey, L. Botoman, C. Chagumaira, S. Gameda, S. M. Haefele, K. Hailu, E. J. M. Joy, A. A. Kalimbira, D. B. Kumssa, R. M. Lark, I. S. Ligowe, S. P. McGrath, A. E. Milne, A. W. Mossa, M. Munthali, E. K. Towett, M. G. Walsh, L. Wilson, S. D. Young & M. R. Broadley

Nature **594**, 71–76 (2021) | Cite this article

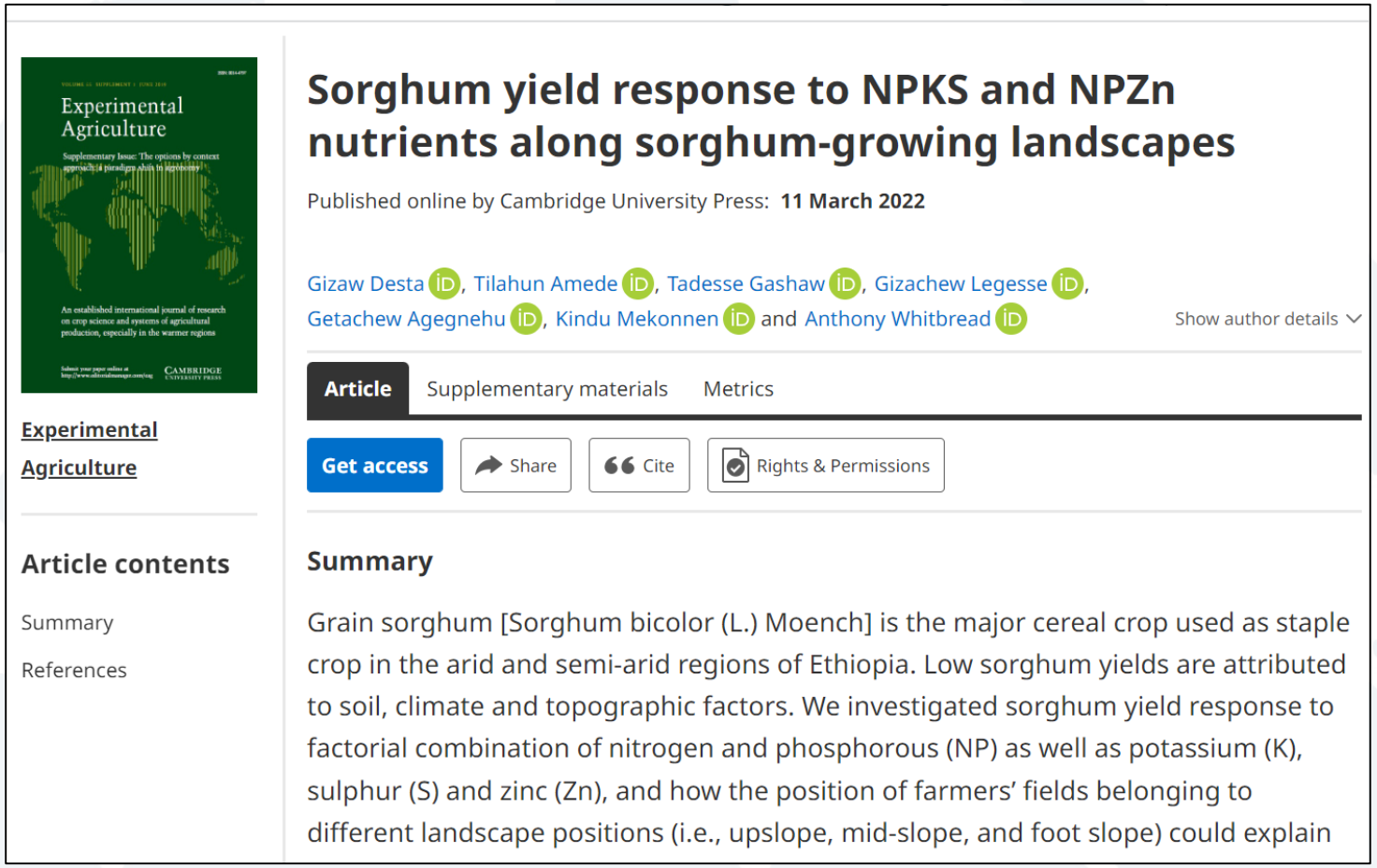
13k Accesses | **31** Citations | **153** Altmetric | Metrics

Abstract

Micronutrient deficiencies (MNDs) remain widespread among people in sub-Saharan Africa[1,2,3,4,5], where access to sufficient food from plant and animal sources that is rich in

- Geospatial variation in micronutrients at sub-national scale.
- Micronutrients availability in crops influenced differently by soil pH, soil organic matter, temperature, rainfall and topography.

Landscape effect in sorghum



- Fertilizer * Landscape position effect on sorghum yields.
- Homogeneous response to fertilization on foot slopes compared to mid- and up-slopes.

Study objectives and Methods

1. To test effects of zinc and selenium containing fertilizer on grain zinc concentration of tef grown under different field landscape positions in Western Amhara region of Ethiopia.

2. To test effect of different micronutrient fertilizer application methods on grain zinc concentration of tef.

- Field experiments were established under three landscape positions:
    1. Hillslope,
    2. Midslope, and
    3. Footslope; over two cropping seasons (2018, 2019).

Treatments

- *Standard recommendation (kg ha^{-1}) = 80 N, 46 P_2O_5, 40 K_2O + S.
- S and Urea applied at varied rates.

Treatment	Fertilizer applied
1	*Standard recommendation + Urea (Control)
2	Standard recommendation + Urea + Basal Zn (25 kg $ZnSO_4.7H_2O$ ha^{-1})
3	Standard recommendation + Urea + Basal Zn + Foliar Zn (12.5 kg $ZnSO_4.7H_2O$ ha^{-1}) + Foliar Se (20 g sodium selenate ha^{-1})
4	Standard recommendation + Urea + Basal Zn + Side dressing Zn
5	⅓ Standard recommendation

Data analyses

- Treatments were compared using the following four orthogonal contrasts (C) in R:

Contrast	Treatment comparison
C1	No Zn input vs Zn applied
C2	Soil vs Soil + Foliar application
C3	Basal vs Basal + Side dressed
C4	Control vs ⅓ Standard recommendation

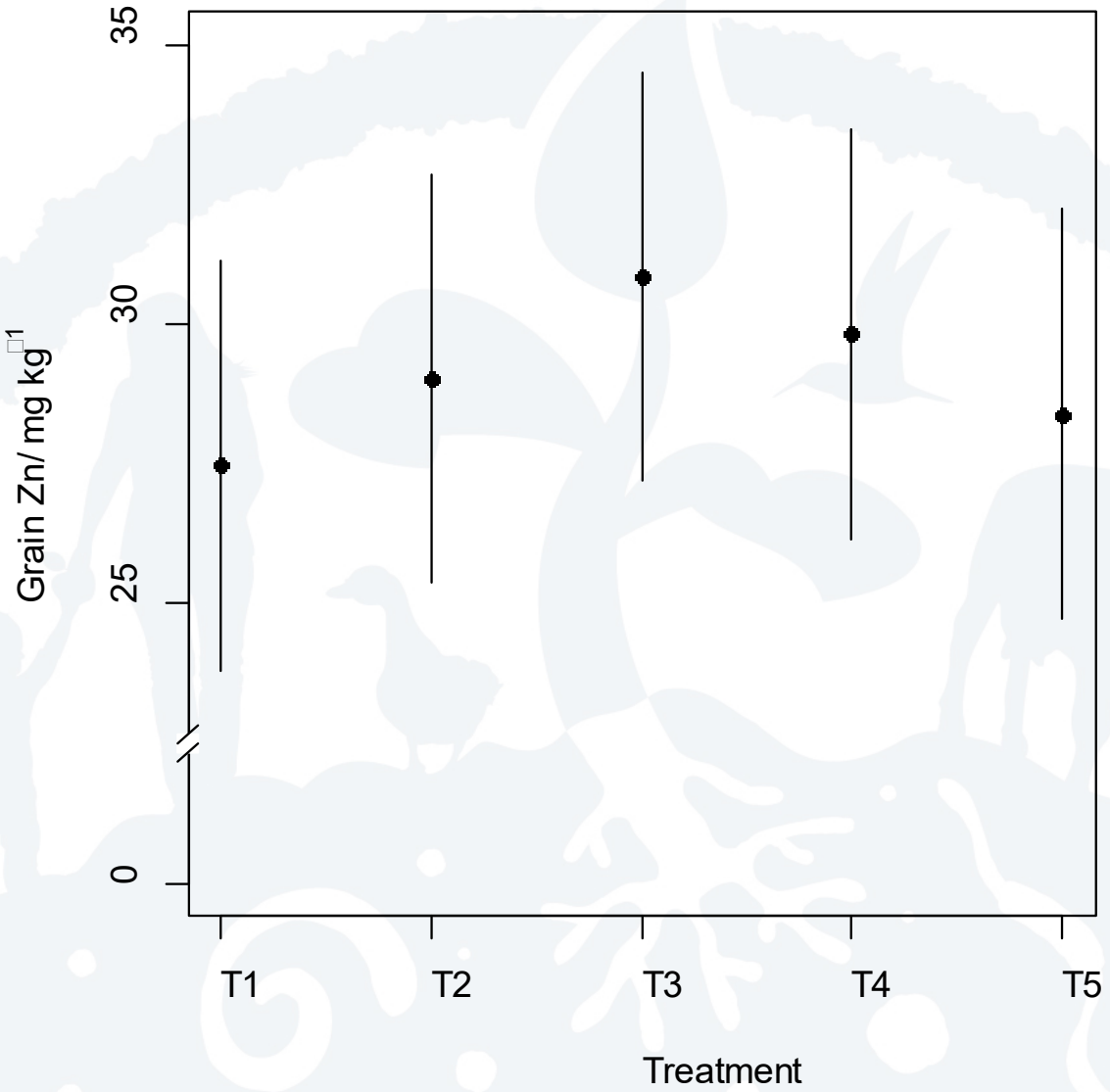
Treatment and Landscape effect on grain zinc

Type III Analysis of Variance Table with Satterthwaite's method

	Sum Sq	Mean Sq	NumDF	DenDF	F value	Pr(>F)
Landscape.unit	3.006	1.503	2	129.63	0.5428	0.582430
C1	266.317	266.317	1	220.05	96.1893	< 2.2e-16 ***
C2	78.092	78.092	1	220.09	28.2054	2.664e-07 ***
C3	18.158	18.158	1	219.96	6.5585	0.011108 *
C4	25.198	25.198	1	220.06	9.1010	0.002855 **
Landscape.unit:C1	4.081	2.041	2	220.05	0.7370	0.479717
Landscape.unit:C2	1.844	0.922	2	220.09	0.3331	0.717079
Landscape.unit:C3	0.430	0.215	2	219.96	0.0777	0.925278
Landscape.unit:C4	3.880	1.940	2	220.06	0.7007	0.497346

- Strong difference among treatments observed.
- No evidence for a difference among landscape units.
- No evidence for an interaction: i.e. differences between the treatment responses on the different landscape units.

C1: No Zn input vs Zn
C2: Soil vs Soil + Foliar
C3: Basal vs Basal + Side
C4: Control vs 0.33 control



- Adding Zn in fertilizer increases grain Zn concentration (C1).
- Foliar in addition to soil application increases grain Zn concentration (C2).
- Side dressing increases grain Zn concentration (C3).
- When no Zn is applied, there is a larger Zn concentration in grain at the smaller NP rate.

T1= NPSK+ Urea
T2= NPSK+ Urea + Basal Zn
T3= NPSK+ Urea + Basal Zn + Foliar Zn + Foliar Se
T4 = NPSK+ Urea + Basal Zn + Side Zn
T5= 0.33NPSK + Urea

Conclusions

- Targeting of micronutrient fertilizer application in ongoing agronomic biofortification interventions is unlikely to be influenced by field landscape position but more so by micronutrient and N fertilizer application, and method of micronutrient fertilizer application.

Acknowledgements

Co-authors:

1. Sam Gameda,
2. Martin Broadley,
3. Murray Lark,
4. Stephan Haefele,
5. Elizabeth Bailey,
6. Lolita Wilson,
7. Abdul Mossa,
8. Getachew Agegnehu,
9. Tesfaye Shiferaw
10. Mesfin Kebede Desta,
11. Dereje Tirfessa,
12. Tadesse Gashaw Asrat,
13. Gizaw Desta,
14. Tilahun Amede

BILL & MELINDA GATES foundation

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GeoNutrition

The University of Nottingham

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