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Fertilizer management strategy to reduce global warming potential and improve soil fertility in a Nitisol in Southwestern Ethiopia

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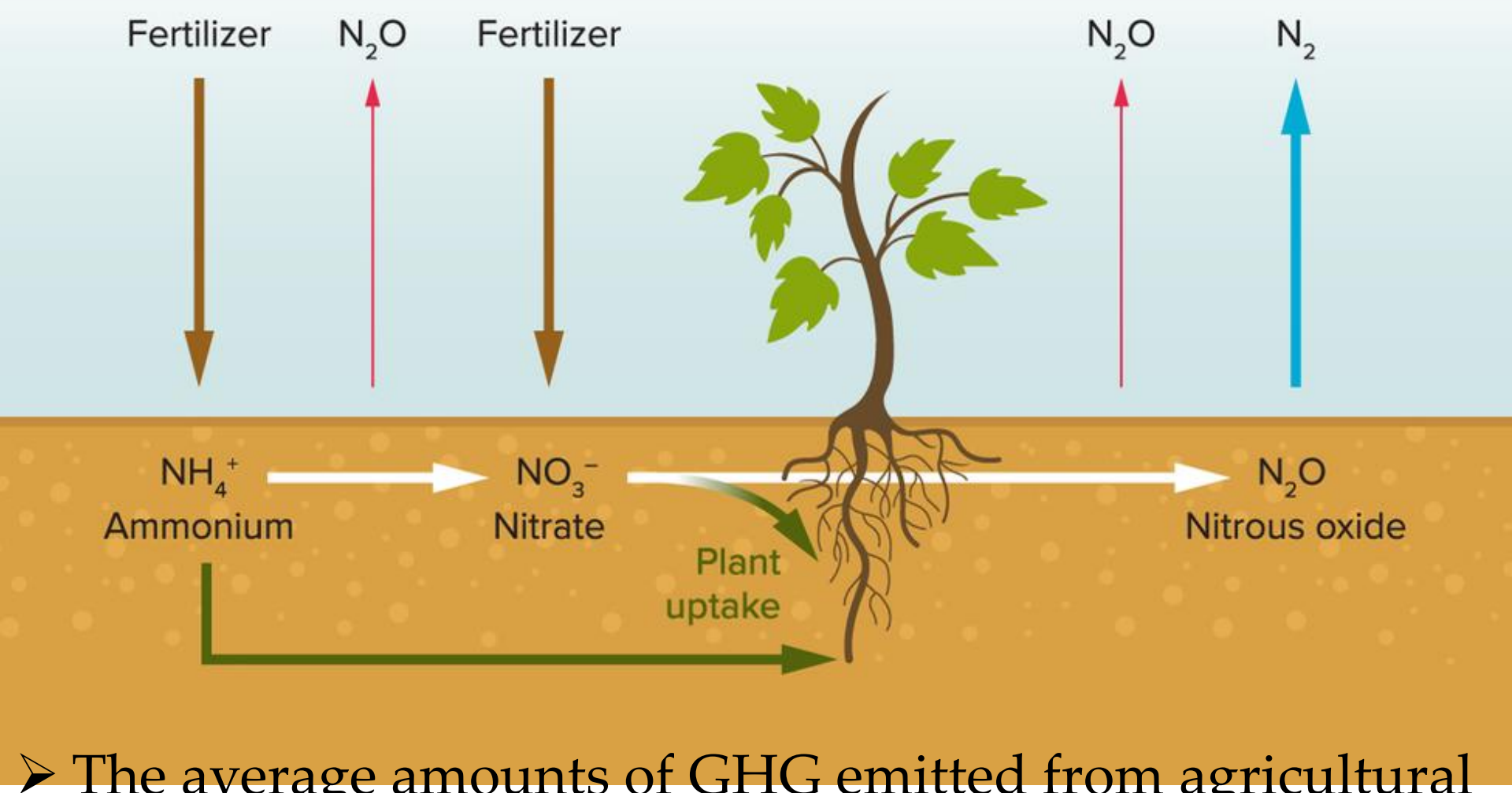
Introduction



- The average amounts of GHG emitted from agricultural soils are estimated to be **14%** of the total global GHG emissions and thereby accelerate GWP.

- The current fertilizer management practice in Ethiopia is characterized by;
  - ✓Low amount with limited nutrient types
  - ✓Low productivity, and low GHG emissions
- Based on the global average value Ethiopia is contributing insignificant amount of GHGs **(0.03%)** emissions as a global warming potential, from all agricultural activities (Raji and Dörsch, 2020; Worku, M. A., 2020).

- However, Ethiopia aimed to increase the use of mineral fertilizer per hectare from **65 kg ha^{-1}** in 2010 to **247 kg ha^{-1} in 2030** (Worku, M. A., 2020).
- In addition, N_2O emissions from mineral fertilizer expected bout 58% in 2030 from total soil based emissions, and
- Will increase from **4.3 Mt CO_2e** in 2010 to **35 Mt CO_2e** in 2030 of GWP.
- As a result the increasing trend in N fertilizer application rate is expected to increase N_2O emission in double increase GWP.

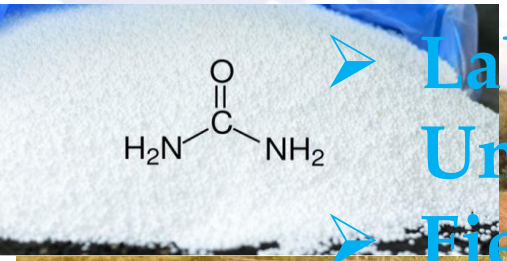
- Combined uses of organic and mineral amendments have been widely used as a means for soil fertility improvement (Ejigu et al., 2021; Mamuye et al., 2021).

- However, the effect of soil fertilizer management practices on GWP and soil quality is less understood in agricultural soils of Ethiopia.

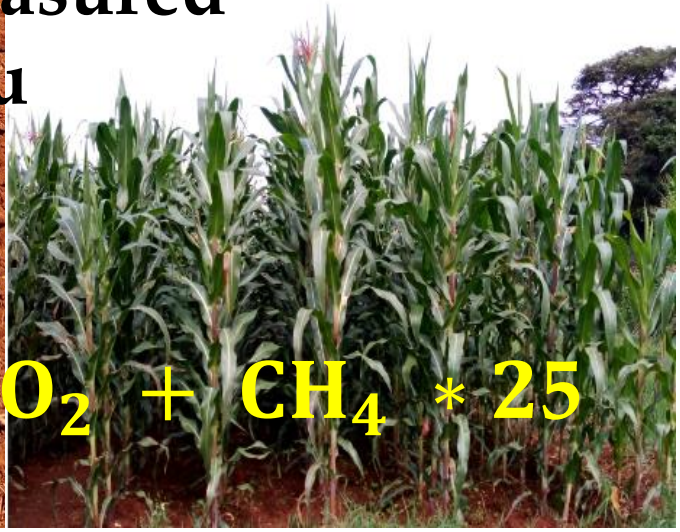
- The study evaluated the effects of combined application of biowaste compost and mineral fertilizers on GWP, and soil fertility in a Nitisol.

Materials and Methods

- 7 treatments with 4 replication
- Lab incubation was conducted at the University of Rostock, Germany
- Field experiment was conducted at Jimma University Research Center



N_2O, CO_2 and CH_4 measured by GC-2014, Shimadzu



$$GWP = N_2O * 298 + CO_2 + CH_4 * 25$$

Results and Discussions

- The treatment with 100min was significantly (P<0.05) increased by 27.1% , 30.4% and 34% of the average GWP values compared to 80min, 50min and 30min treatments respectively in wet soil.

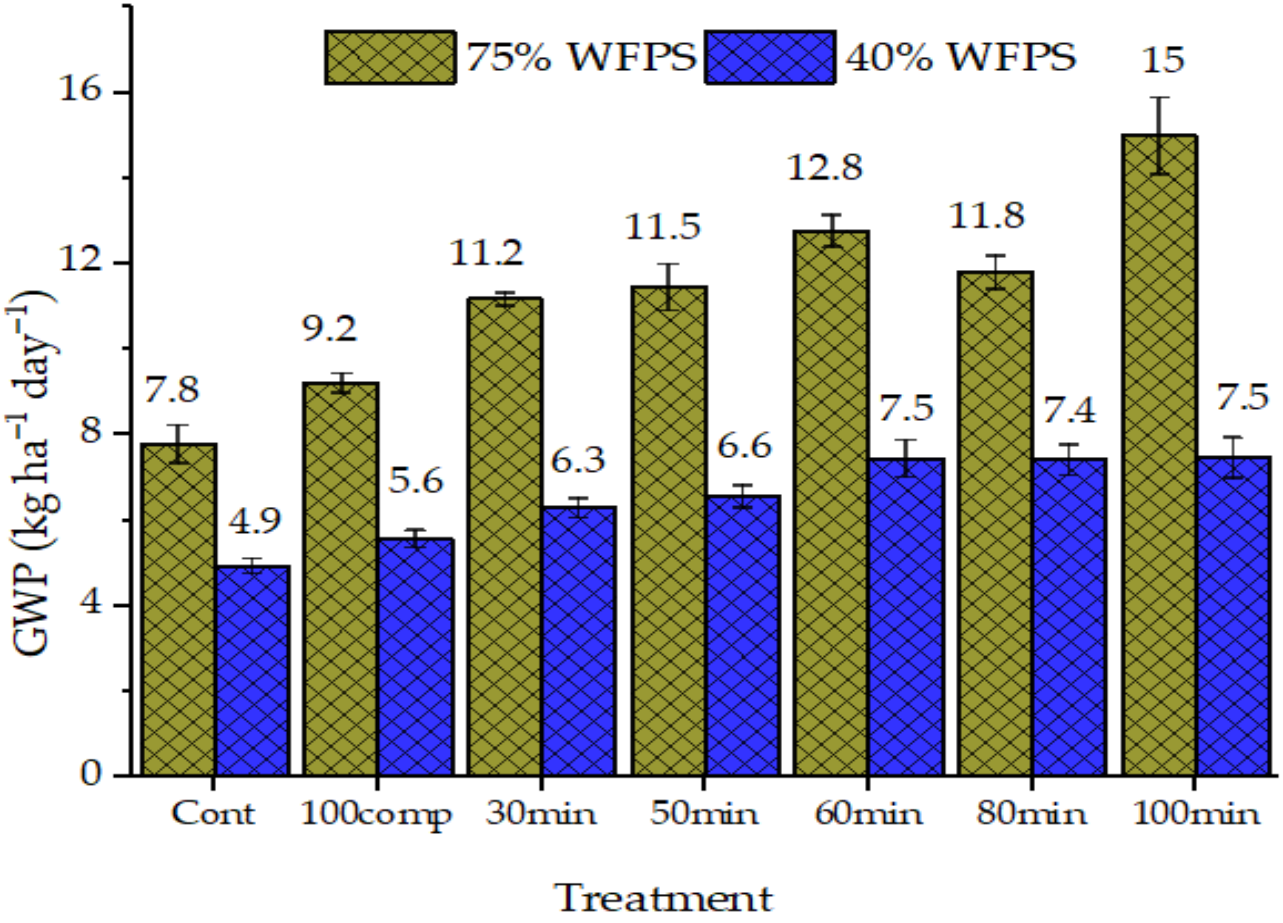


Figure 1. Global warming potential (GWP) in different fertilizer types and water filled pore-space (WFPS) (40% and 75%).

- This may be attributed to;
  - ✓slow release of mineral nitrogen by microbial activity and
  - ✓low contribution to GHGs emissions in combined fertilizer applied jars compared to 100min treatment
- Due to the low GHG contribution, combined fertilizer application could reduce GWP.

Table 1. Soil minerals (mg kg^{-1} soil) and chemical properties

Soil parameters	Treatment						
	Cont	100min	80min	60min	50min	30min	100comp
Fe	46.5± 2.8^{ab}	52 ± 2^{ab}	65 ± 3.1^{ab}	58.9 ± 3.5^{ab}	48.2 ± 2.8^{ab}	13.5 ± 2.1^{b}	3.7 ± 0.6^{a}
Ca	266.1 ± 21^{a}	162.64 ± 30^{b}	350.3± 11.6^{d}	356.2 ± 21.2^{d}	281.69 ± 34.07^{a}	437.1 ± 38.9^{c}	121.7 ± 7.3^{b}
Mg	30.4 ± 2.3^{abd}	16.3 ± 2.9^{a}	47.7 ± 6.5^{cd}	42.9 ± 9.7^{d}	57.3 ± 10.5^{c}	40.2 ± 3.3^{bd}	20.5 ± 1.4^{a}
K	27.9 ± 3.6^{a}	61.7 ± 12.2^{e}	90.5 ± 6.3^{bc}	122.8 ± 11.2^{d}	108.6 ± 1.6^{d}	101.48 ± 7.89^{c}	75 ± 5.2^{be}
N	227.5± 17.1^{a}	332.5 ± 26.3^{bd}	315 ± 23.8^{ad}	371 ± 21.6^{b}	335.3 ± 12.8^{bd}	350 ± 18.3^{bd}	285 ± 17.3^{a}
P	0.3± 1^{a}	0.2 ± 0.05^{a}	-0.14 ± 0.1^{a}	0.4±0.1^{a}	0.07 ± 0.01^{a}	-0.02 ±0.01^{a}	0.6 ± 0.1^{a}
S	45 ± 12^{a}	-2.2 ± 1.02^{a}	20 ± 8.02^{a}	10 ± 2.1^{a}	235 ± 55.1^{b}	30 ± 4.1^{a}	15±2.8^{a}
C	2375± 95.7^{a}	2575 ± 359.4^{a}	2975 ± 596.5^{ac}	3250 ± 70.2^{bc}	3600 ± 81.7^{b}	3475 ± 221.7^{bc}	3875 ± 170.8^{b}
Zn	8.4 ±1.2^{ab}	7.9±2.1^{ab}	18.2 ± 1.5^{c}	10.1±91^{abc}	7.5±1.3^{ab}	12 ± 0.4^{bc}	2.8±0.4^{a}
Mn	158 ± 16.8^{a}	182.5 ± 17.3^{a}	407.6 ± 64.3^{b}	238.3 ±2 0.3^{c}	181.4 ± 12.7^{ac}	38.5 ± 14.6^{b}	179 ± 2^{a}
pH	0.04 ± 0.01^{a}	0.14 ± 0.01^{bc}	0.16 ± 0.04^{bc}	0.17 ± 0.03^{bc}	0.15±0.06^{bc}	0.20±0 005^{b}	0.09 ± 0.01^{ac}
Ec	0.2	0.2	0.17 ± 0.02^{a}	0.20±0.008^{a}	0.17 ± 0.008^{a}	0.16±0.01^{a}	0.18 ±

- Carbon 26.21–39.81%
- Calcium, 73.2–168.8%
- Magnesium 146.6–251.5%
- Potassium 47–99%

Were increased in combined fertilizer in comparison to 100min treatment

Conclusion

- Combined application of compost and mineral fertilizer can be an option to;
  - ✓ reduce GWP and
  - ✓ improving soil quality and in Nitisols in Southwestern Ethiopia

Recommendation

- We recommend that 30 kg N or 50 kg N in combination with compost of 4.9 or 3.5 t ha^{-1} be applied in Nitisol to;
  - ✓ reduce GWP and
  - ✓ improve soil fertility in smallholder farming system

- Future investigations would be recommended to evaluate GHG emission at the farm conditions

Acknowledgment

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