10.1071/RJ23026
The Rangeland Journal

Supplementary Material

The effects of clipping frequency and nitrogen fertilisation on greenhouse gas emissions and net ecosystem exchange in an Australian temperate grassland

Zahra Padashbarmchi[A,*], *Budiman Minasny*[A], *Milad Bagheri Shirvan*[A], *Luciano A. González*[A] and *Feike A. Dijkstra*[A]

[A]Sydney Institute of Agriculture, School of Life and Environmental Sciences, Faculty of Science, The University of Sydney, NSW 2006, Australia

*Correspondence to: Email: zahra.padashbarmchi@sydney.edu.au

Supplementary Materials - Tables

Table S1. Effect of clipping frequency (Cl) and N fertiliser addition (N) on the ecosystem respiration during day ($R_{eco, day}$) and night ($R_{eco, night}$), net ecosystem exchange (NEE), photosynthesis, CH_4, N_2O, global warming potential in a 100-year time horizon (GWP-100) and soil temperature and moisture at two periods (P) (mean ± standard error). Different letters in each column represent significant differences among Period (post hoc Tukey's HSD test results are only shown for significant main or interactive effects of Period). *p*-values are shown bold when significant ($p < 0.05$).

Period	Clipping frequency	N levels (kg ha^{-1})	($R_{eco, night}$) (mg m^{-2} h^{-1})	($R_{eco, day}$) (mg m^{-2} h^{-1})	NEE (mg m^{-2} h^{-1})	Photosynthesis (mg m^{-2} h^{-1})	CH_4 (µg m^{-2} h^{-1})	N_2O (µg m^{-2} h^{-1})	GWP-100 (g CO_2 eq. m^{-2} d^{-1})	Temperature (˚C)	Moisture (%)
Period 1	Low	40	272.11±15.37	321.61±7.41	-29.00±23.54	-423.39±25.12a	-16.89±1.24b	9.01±1.40b	-0.65±0.56	23.97±0.51a	18.42±1.29b
		0	257.18±13.30	330.70±4.64	-46.63±23.61	-464.48±21.42a	-12.41±1.14b	16.49±2.15a	-1.02±0.57	24.38±0.33a	18.23±1.30b
	High	40	185.63±6.82	337.88±7.43	52.30±20.05	-345.03±32.11a	-15.61±1.22b	8.12±1.02b	1.30±0.48	23.64±0.36a	18.76±1.19b
		0	216.23±9.26	359.43±8.91	33.47±29.37	-421.98±39.51a	-17.77±1.28b	14.24±2.29a	0.89±0.70	24.58±0.44a	17.68±1.23b
Period 2	Low	40	224.39±11.00	318.41±6.97	-30.85±19.78	-563.36±32.85b	-4.45±0.60a	13.62±1.49a	-0.65±0.47	20.63±0.65b	28.19±0.62a
		0	222.69±11.03	316.33±12.67	-8.92±28.37	-598.94±41.38b	-6.83±0.66a	10.68±1.29a	-0.15±0.68	18.86±0.77b	27.60±0.69a
	High	40	182.82±9.74	316.58±13.06	-39.23±23.53	-509.43±36.79b	-6.01±0.71a	14.99±1.87a	-0.85±0.56	20.33±0.79b	27.43±0.55a
		0	187.59±9.22	339.72±8.19	-51.15±18.94	-591.34±24.93b	-5.65±0.60a	16.73±1.75a	-1.12±0.45	20.55±0.71b	26.93±0.47a
	ANOVA *P*-value										
	N		0.76	0.09	0.82	0.24	0.54	0.05	0.84	0.48	0.46
	Cl		**0.04**	**<0.0001**	0.20	0.22	0.77	0.66	0.20	0.72	0.78
	P		0.75	0.11	0.19	**0.0002**	**<0.0001**	0.36	0.20	**0.03**	**0.0002**
	N*Cl		0.34	0.25	0.10	0.83	0.12	0.91	0.10	0.71	0.66
	Cl*P		0.06	0.51	0.31	0.27	0.45	0.09	0.32	0.75	0.46
	N*P		0.67	0.19	0.95	0.82	0.55	**0.01**	0.96	0.58	0.62
	N*Cl*P		0.22	0.62	0.86	0.91	0.08	039	0.87	0.94	0.57

Table S2. Grassland shoot biomass (g DM m^{-2}) at different treatments

Clipping frequency	N levels (kg ha^{-1})	Shoot biomass (g DM m^{-2})
Low	40	246
	0	258
Low Clipping Frequency		**252**
High	40	127
	0	105.5
High Clipping Frequency		**116.25**

Table S3. Clipping and N fertilisation dates (2018-2021) for experimental treatment groups. N0 and N40 represent N fertiliser application rates in kg ha^{-1}.

	Low frequency		High frequency	
	N0	**N40**	**N0**	**N40**
Clipping (cutting) dates	8/11/2018 14/01/2019 15/04/2019 23/08/2019 5/02/2020 19/03/2020 4/08/2020 4/11/2020 20/01/2021 18/04/2021	8/11/2018 14/01/2019 15/04/2019 23/08/2019 5/02/2020 19/03/2020 4/08/2020 4/11/2020 20/01/2021 18/04/2021	8/11/2018 14/01/2019 13/02/2019 15/04/2019 15/06/2019 23/08/2019 18/10/2019 5/02/2020 18/02/2020 19/03/2020 19/05/2020 4/08/2020 12/10/2020 4/11/2020 21/11/2020 20/01/2021 15/02/2021 18/04/2021 30/07/2021	8/11/2018 14/01/2019 13/02/2019 15/04/2019 15/06/2019 23/08/2019 18/10/2019 5/02/2020 18/02/2020 19/03/2020 19/05/2020 4/08/2020 12/10/2020 4/11/2020 21/11/2020 20/01/2021 15/02/2021 18/04/2021 30/07/2021
N Fertiliser application dates	----	8/11/2018 12/09/2019 10/09/2020	-----	8/11/2018 12/09/2019 10/09/2020

Supplementary Materials - Figures

Fig. S1. Chamber system installed on-site for GHG measurements.

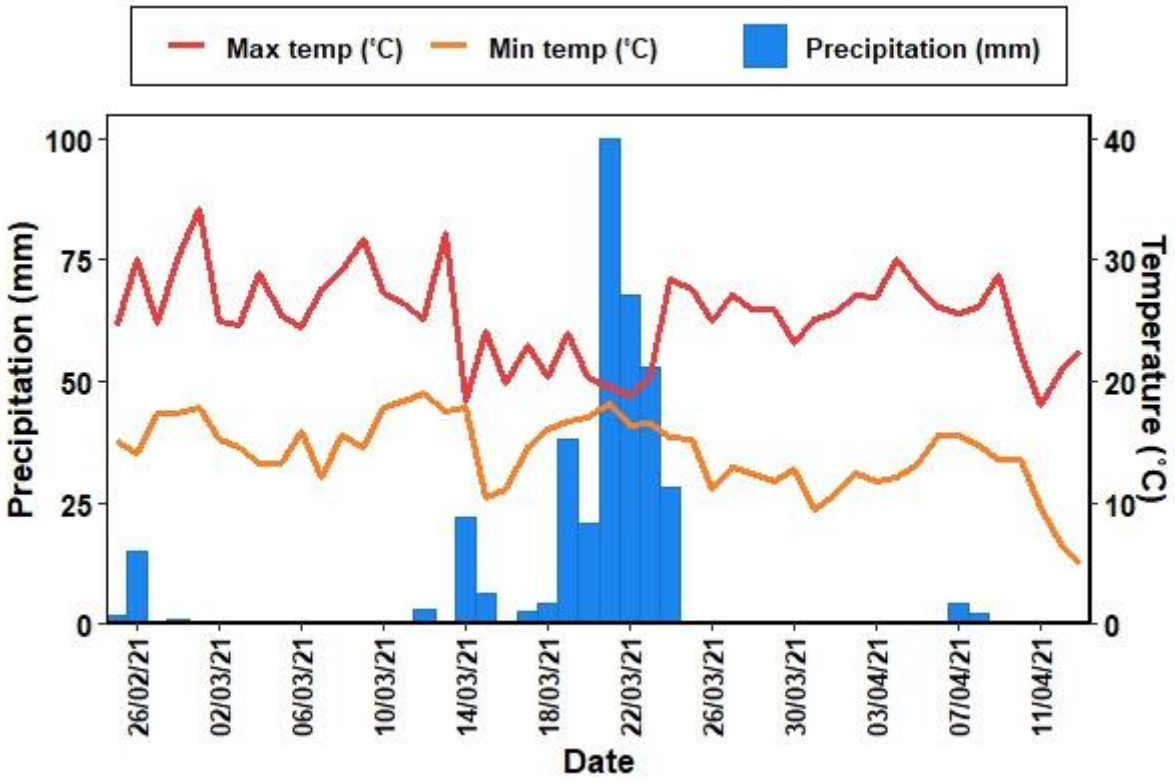

Fig. S2. Mean daily precipitation, maximum (Max temp (°C)) and minimum temperature (Min temp (°C)) at the experimental site during the experimental period.

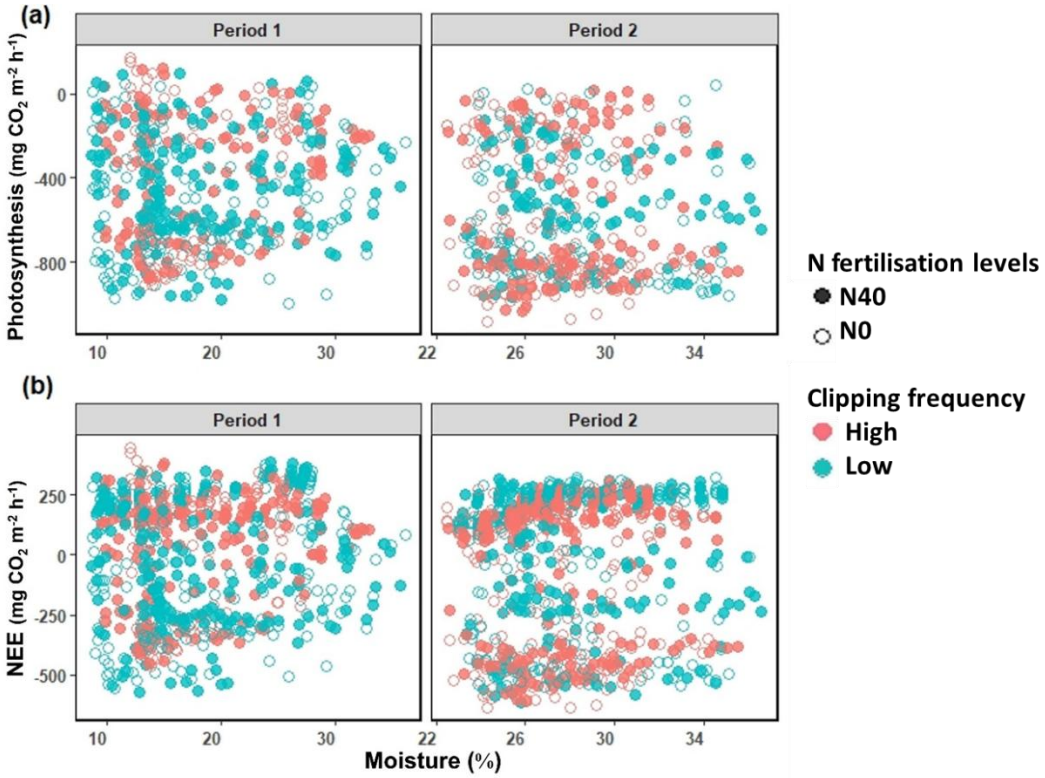

Fig. S3. Relationship between photosynthesis (a) and NEE (b) with soil moisture level. The open and closed circles represent 0 and 40 kg ha^{-1} N fertilisation levels, respectively. N0 and N40 represent N fertiliser application rates in kg ha^{-1}. Green and red circles denote low and high clipping frequency groups, respectively.

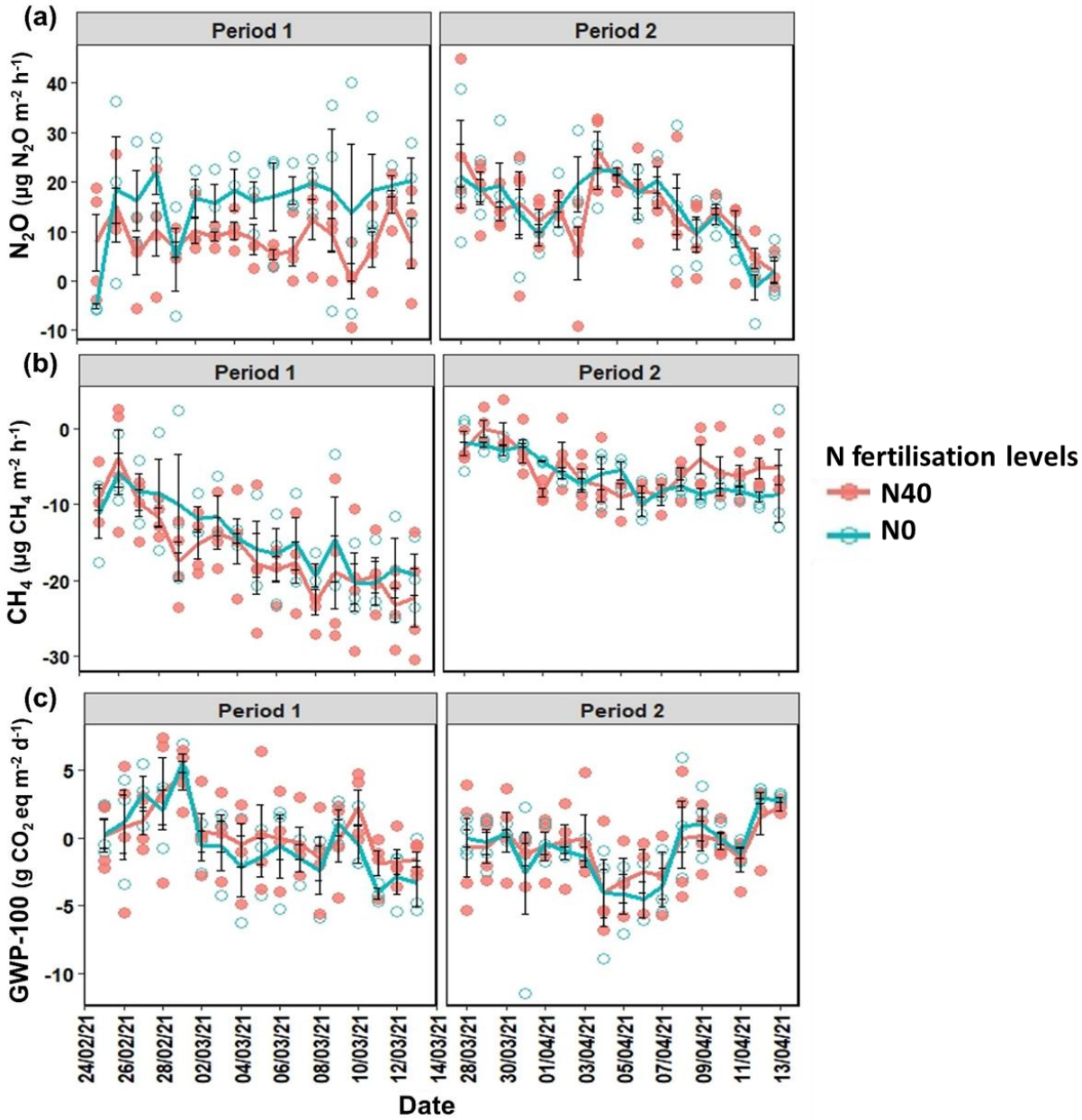

Fig. S4. Temporal variation of the N_2O (a), CH_4 (b) and GWP-100 (c) level with N fertilisation during the course of measurements. The circles represent the daily average fluxes of each chamber and solid lines denote the daily average fluxes of all chambers for the 0 (green) and 40 (red) kg ha^{-1} N fertilisation levels. N0 and N40 represent N fertiliser application rates in kg ha^{-1}. Error bars represent standard errors.

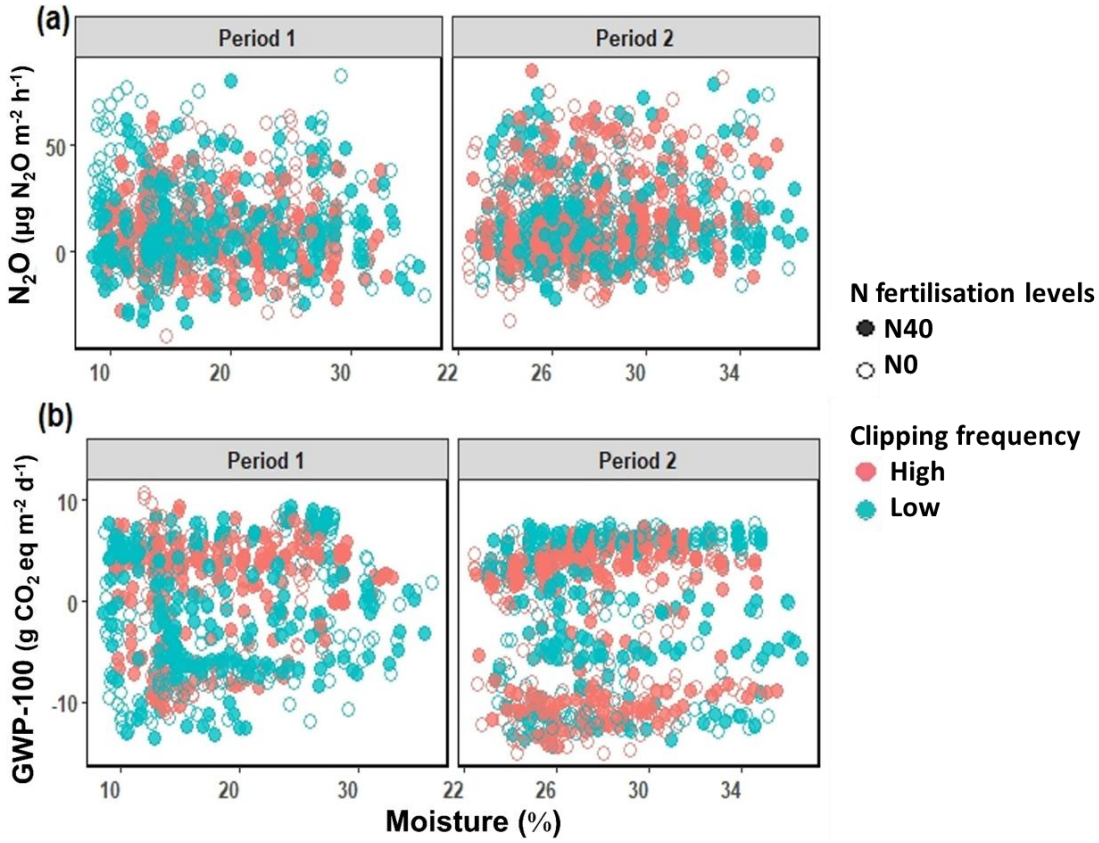

Fig. S5. Relationship between N_2O (a) and GWP-100 (b) with soil moisture level. The open and closed circles represent 0 and 40 kg ha^{-1} N fertilisation levels, respectively. N0 and N40 represent N fertiliser application rates in kg ha^{-1}. Green and red circles denote low and high clipping frequency groups, respectively.

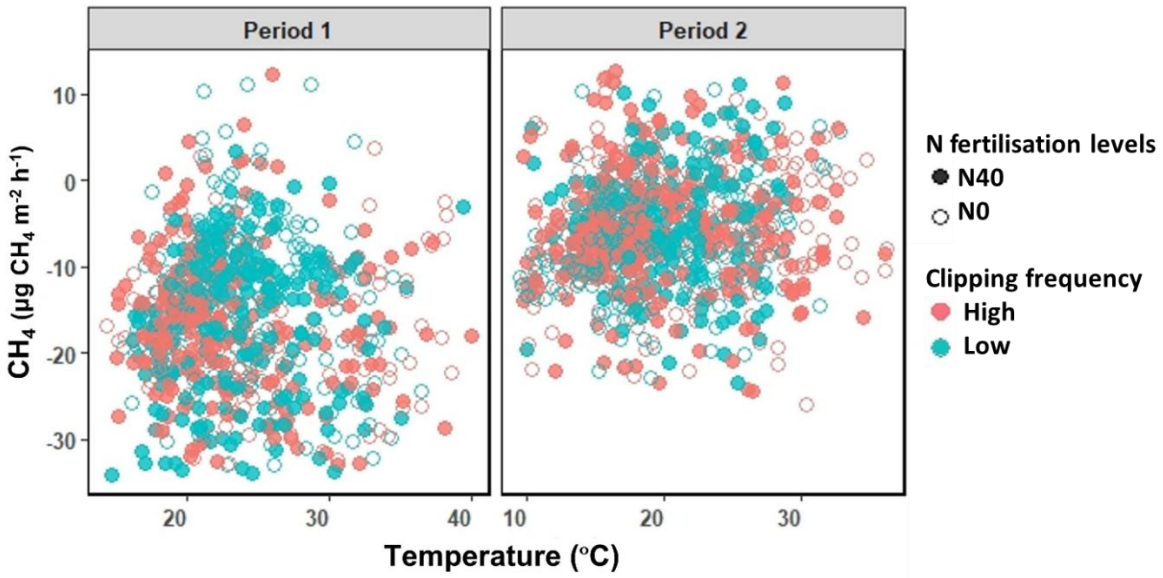

Fig. S6. Relationship between CH_4 with soil temperature level. The open and closed circles represent 0 and 40 kg ha^{-1} N fertilisation levels, respectively. N0 and N40 represent N fertiliser application rates in kg ha^{-1}. Green and red circles denote low and high clipping frequency groups, respectively.