Optimizing Nitrogen Form Ratios for Enhanced Growth, Yield, and Fruit Quality in Processing Tomato (Solanum lycopersicumL.)

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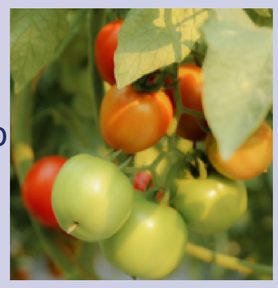
Introduction

In Thailand, tomatoes are usually cultivated in open fields using flood irrigation, a practice that often leads to inefficient fertilizer use especially nitrogen.

This inefficiency not only limits crop productivity but also contributes to environmental concerns such as nitrogen leaching and greenhouse gas emissions.

Improving nitrogen use efficiency is therefore critical for enhancing tomato production and promoting sustainable agricultural practices.



Materials and Methods

This study, conducted during the 2022-2023 dry season, aimed to evaluate the effects of **different nitrogen form ratios nitrate (NO3-) to ammonium (NH4+), NH4+ to urea, and NO3- to urea** on the growth, yield, fruit quality, and carotenoid content of processing tomato.

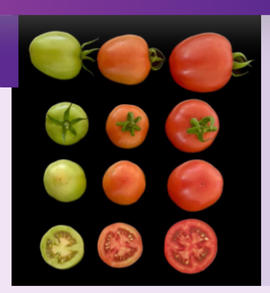
Three nitrogen sources were applied: **NO3- (15-0-0), NH4+ (21-0-0), and urea (46-0-0)**, under a randomized complete block design (RCBD) with thirteen treatments and three replications.

The experiment was conducted in a plastic-net house to minimize environmental variability.

Yield and yield components data collection

Measuring carotenoid and ascorbic acid accumulation

Conclusion



These findings highlight that selecting appropriate nitrogen form ratios tailored to specific production goals can enhance both the productivity and nutritional quality of tomatoes, supporting more efficient and environmentally responsible farming systems.

Acknowledgments

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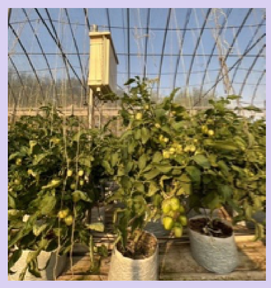
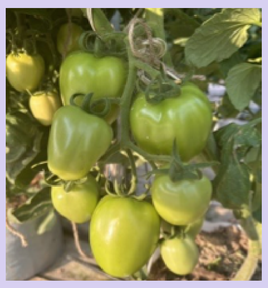
Results and discussion

The NO3-:urea ratio of 70:30 led to the highest fruit number (52 fruit/plant) and total yield per plant (3,111 gram).





- Nitrate is an easily available nitrogen source that promotes rapid vegetative growth and flower initiation.
- Plants absorb nitrate with little energy, and it directly aids photosynthesis by forming amino acids.
- Added urea slowly releases nitrogen, supporting plant nutrition during the long fruiting period of indeterminate tomatoes.

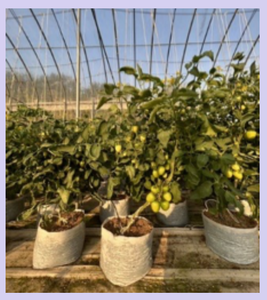
Table 1 Fruit number and yield of tomato with different ratio of nitrogen forms grown under plastic-net house in the dry season during December 2021 to March 2022

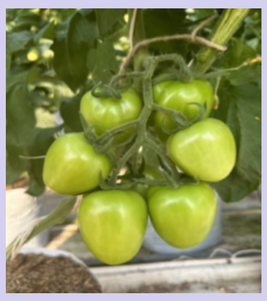
Treatment		Fruit number (no./plant)				Fruit yield (g/plant)			
		Marketable		Unmarketable		Marketable		Unmarketable	
No_3^- (100)	(N1)	48.56	a-c	17.56	bc	3086.11	ab	594.78	ab
NH_4^+ (100)	(N2)	36.91	e	15.32	cd	2171.78	d	508.89	bc
Urea (100)	(N3)	49.11	ab	13.67	cd	2432.91	cd	392.01	b-d
No_3^- : NH_4^+ (70:30)	(M1)	47.18	a-d	23.23	ab	2673.26	a-d	787.88	a
No_3^- : NH_4^+ (50:50)	(M2)	44.12	a-e	9.67	de	2870.08	a-c	357.16	c-e
No_3^- : NH_4^+ (30:70)	(M3)	41.00	b-e	10.39	c-e	2579.38	a-d	328.32	c-e
NH_4^+: Urea (70:30)	(M4)	39.59	de	10.37	c-e	2435.38	cd	318.94	c-e
NH_4^+: Urea (50:50)	(M5)	42.44	b-e	13.01	cd	2519.34	b-d	393.00	b-d
NH_4^+: Urea (30:70)	(M6)	40.17	c-e	26.89	a	2230.89	d	806.86	a
No_3^- : Urea (70:30)	(M7)	52.29	a	10.77	c-e	3111.10	a	307.59	c-e
No_3^- : Urea (50:50)	(M8)	47.92	a-d	5.44	ef	2861.36	a-c	142.61	ef
No_3^- : Urea (30:70)	(M9)	48.44	a-c	8.44	d-f	2939.61	a-c	270.61	de
Water		12.19	f	1.39	f	778.36	e	37.67	f
Mean		42.30		12.78		2514.58		403.56	
F-test		**		**		**		**	
CV (%)		12.17		34.98		13.63		32.66	

Means in the same column followed by the same letter are not significantly different at P ⩽ 0.05 by LSD
**; Significant at P ⩽ 0.01 levels

Conversely, the NH4+:urea ratio of 30:70 produced the highest average fruit weight, as well as the greatest fruit width, length, and flesh thickness.

- Ammonium's metabolic processing may redirect plant resources toward individual fruit development rather than fruit set frequency.





Treatment		Fruit weight (mm)		Fruit width (mm)		Fruit length (mm)		Flesh thickness (mm)	
No_3^- (100)	(N1)	95.70	de	52.70	de	60.98	d	7.35	b-d
NH_4^+ (100)	(N2)	96.22	de	53.53	c-e	60.64	d	7.36	b-d
Urea (100)	(N3)	123.28	ab	56.58	ab	65.01	b	8.17	ab
No_3^- : NH_4^+ (70:30)	(M1)	95.54	de	54.44	b-e	62.76	b-d	6.71	cd
No_3^- : NH_4^+ (50:50)	(M2)	111.78	bc	55.95	bc	65.46	b	7.36	b-d
No_3^- : NH_4^+ (30:70)	(M3)	105.75	cd	55.51	b-d	64.83	bc	7.36	b-d
NH_4^+: Urea (70:30)	(M4)	99.28	de	53.06	c-e	62.91	b-d	7.31	b-d
NH_4^+: Urea (50:50)	(M5)	87.94	e	51.55	e	57.13	e	6.31	d
NH_4^+: Urea (30:70)	(M6)	134.22	a	59.48	a	71.64	a	9.09	a
No_3^- : Urea (70:30)	(M7)	119.86	b	56.50	b	65.91	b	8.48	ab
No_3^- : Urea (50:50)	(M8)	98.66	de	52.13	e	63.99	b-d	7.41	b-d
No_3^- : Urea (30:70)	(M9)	93.45	de	52.87	de	61.51	cd	8.07	ab
Water		65.26	f	46.59	f	56.35	e	7.96	a-c
Mean		102.07		53.91		63.01		7.61	
F-test		**		**		**		*	
CV (%)		7.25		3.20		3.16		9.99	

The No3- : Urea (70:30) ratio significantly enhanced fruit redness and maximized beta-carotene content. The highest ascorbic acid levels were found in treatments with NH4+:urea ratios of 50:50 and 70:30.

Table 3. Lycopene, beta-carotene and ascorbic acid of tomato with different ratio of nitrogen forms grown under plastic-net house in the dry season during December 2021 to March2022

Treatment		Beta-carotene (mg/100gFW)		Ascorbic acid (mg/100gFW)	
No_3^- (100)	(N1)	7.56	c	6.68	d
NH_4^+ (100)	(N2)	10.19	ab	7.04	d
Urea (100)	(N3)	9.97	ab	4.79	ef
No_3^- : NH_4^+ (70:30)	(M1)	8.76	bc	6.21	de
No_3^- : NH_4^+ (50:50)	(M2)	9.62	ab	10.60	bc
No_3^- : NH_4^+ (30:70)	(M3)	7.83	c	9.77	c
NH_4^+: Urea (70:30)	(M4)	7.55	c	16.58	a
NH_4^+: Urea (50:50)	(M5)	7.72	c	16.64	a
NH_4^+: Urea (30:70)	(M6)	4.78	d	10.44	bc
No_3^- : Urea (70:30)	(M7)	10.44	a	10.01	bc
No_3^- : Urea (50:50)	(M8)	4.80	d	11.39	b
No_3^- : Urea (30:70)	(M9)	7.50	c	6.75	d
Water		4.57	d	4.15	f
Mean		8.06		9.31	
F-test		**		**	
CV (%)		12.64		9.40	

**; Significant at P ⩽ 0.01 levels
Means in the same column followed by the same letter are not significantly different at P ⩽ 0.05 by LSD