Asian Journal of Research in Crop Science

Volume 9, Issue 3, Page 68-75, 2024; Article no.AJRCS.122849
ISSN: 2581-7167

Evaluation of the Impact of a Fertilizer Mixture from Plant Extracts and Urea on Corn Yield in Vietnam

Nguyen Tuan Khoi [a*]

[a] *Faculty of Agronomy, BacGiang Agriculture and Forestry University, Vietnam.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: https://doi.org/10.9734/ajrcs/2024/v9i3290

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/122849

Original Research Article

Received: 01/07/2024
Accepted: 03/09/2024
Published: 07/09/2024

ABSTRACT

This study evaluates the impact of a fertilizer mixture combining plant extracts and urea on the growth and yield of NK54 maize in Vietnam. The experimental design included five treatments with different combinations of urea and plant extracts, compared against a control treatment. Growth parameters such as plant height, leaf number, leaf area, and leaf area index (LAI) were monitored throughout the growing season. The results indicated that the application of urea-coated plant extracts significantly improved growth duration, plant height, and leaf development compared to conventional urea fertilization. Specifically, treatments using the urea-plant extract mixture achieved higher plant heights and leaf area, with Treatment T3 (9 ml concentrated extract + 1 kg Urea) showing the highest theoretical and actual yields. The theoretical yield ranged from 63.62 to 68 q/ha, and the actual yield ranged from 43.7 to 48.4 q/ha, with Treatment T3 consistently outperforming others. The findings suggest that integrating plant extracts with urea can enhance maize growth and yield, highlighting the importance of optimizing fertilization strategies for improving crop productivity.

**Corresponding author: E-mail: khoint@bafu.edu.vn;*

Cite as: *Khoi, Nguyen Tuan. 2024. "Evaluation of the Impact of a Fertilizer Mixture from Plant Extracts and Urea on Corn Yield in Vietnam". Asian Journal of Research in Crop Science 9 (3):68-75. https://doi.org/10.9734/ajrcs/2024/v9i3290.*

Keywords: Fertilizer mixture; plant extracts; urea; corn yield; Vietnam.

1. INTRODUCTION

Maize (*Zea mays* L.) is a crucial crop for food security and agricultural sustainability, with its yield significantly influenced by fertilization practices [1]. Traditional urea fertilization, while effective in providing essential nitrogen, often leads to inefficient nutrient use and environmental concerns. Recent research has explored alternative fertilization methods to enhance nutrient efficiency and crop performance [2]. One such approach involves combining urea with plant extracts, which may offer a more controlled release of nutrients and additional growth benefits.

In this study, we investigate the effects of a fertilizer mixture that integrates urea with plant extracts on the growth and yield of NK54 maize, a widely cultivated variety in Vietnam. The aim is to assess how this combination impacts various growth parameters, including plant height, leaf development, and overall yield. By comparing different treatments of urea and plant extracts against a control, we seek to identify the most effective fertilization strategy for optimizing maize production [3]. The results will provide insights into the potential benefits of this innovative approach and contribute to improving agricultural practices for enhanced maize yield and sustainability.

2. METHODOLOGY

2.1 Method for Extracting Plant Extracts

Pineapple peel and core were collected, thoroughly washed, and finely chopped to increase the surface area for solvent contact. The material was then ground using a grinder to optimize the extraction process.

The ground material was soaked in distilled water at a ratio of 1:5. The soaking process lasted for 12 hours at a temperature of 15°C, with gentle stirring every 3 hours to enhance extraction efficiency.

After soaking, the extract was separated from the residue by filtering through a cloth and then lightly pressing the residue to recover the maximum amount of extract.

2.2 Method for Preparing Fertilizer Mixtures from Plant Extracts and Urea

The extract was concentrated using a distillation machine to a ratio of 50:1 (1 liter of soaked extract yielding 20 ml of concentrated extract).

The concentrated extract was mixed with Urea fertilizer at the following ratios and the mixture was stored at 5°C:

Treatment 1: No extract used

Treatment 2: 6 ml concentrated extract + 1 kg Urea

Treatment 3: 9 ml concentrated extract + 1 kg Urea

Treatment 4: 12 ml concentrated extract + 1 kg Urea

Treatment 5: 15 ml concentrated extract + 1 kg Urea

The treatments were applied on a base fertilizer of 90 kg P_2O_5 + 90 kg K_2O, with methods and application regulations strictly following TCVN 13381-2:2021 for maize. The maize variety used in the experiment is NK54, which was developed and distributed by Syngenta Vietnam.

The experiment consisted of 5 treatments, arranged in a randomized complete block design (RCBD) with 3 replications. Each treatment covered an area of 4 m², with a total experimental area of 3 x 4 x 5 = 60 m².

The duration from sowing to the end of the experiment was from February 15, 2022, to June 5, 2022.

List 1. Experimental scheme

				Security strip			
Security strip	Repeat 1	T4	T3	Control	T2	T1	Security strip
	Repeat 2	Control	T2	T1	T4	T3	
	Repeat 3	T1	T4	T2	T3	Control	
Security strip							

The method for monitoring leaf area, leaf area index, and other growth and development indicators strictly adhered to the regulations outlined in TCVN 13381-2:2021, issued by the Ministry of Agriculture and Rural Development of Vietnam.

Data were collected and recorded, and then analyzed using Analysis of Variance (ANOVA) with the IRRISTAT 4.0 program and Excel.

3. RESULTS AND DISCUSSION

Growth and development are physiological functions of plants that respond to the environmental conditions in which they are nurtured [4]. Growth is not merely a collection of simple, isolated physiological functions but rather the result of the integrated activity of many distinct physiological functions of the plant [5].

The growth duration of different varieties through various stages reflects the plant's response to external conditions and its biological characteristics [6]. Understanding the growth duration at different stages of plant development helps in devising technical measures and planning planting schedules for crop rotation systems to achieve the highest land use efficiency [7]. The results of monitoring the duration of the growth stages are presented in Table 1.

The growth duration of the NK54 maize variety across the treatments ranged from 103 to 106 days, with the longest durations observed in Treatments T3 and T4 (106 days), and the shortest in the control treatment (103 days). The shorter growth duration in the control treatment highlights the significant role of using urea-coated plant extracts, which provides a gradual supply of nitrogen, allowing the plant to grow and develop robustly. This results in well-developed roots, stems, and leaves, larger tassels, and more branches, ultimately enhancing the potential yield of maize

Maize plant height increases continuously from the start of growth until the kernels reach the milk stage [8]. Plant height is a characteristic feature of the variety and is an important parameter as it is closely related to growth, development, and lodging resistance [9]. While greater plant height can indicate higher yield potential, excessively tall plants are more prone to lodging. Monitoring the dynamics of plant height growth helps assess the uniformity of growth under different fertilizer levels and enables the implementation of appropriate technical measures [10]. Plant height is influenced by various factors such as variety, climatic conditions, and planting techniques. It is measured from the ground up to the tip of the highest leaf [11]. Throughout the growth period, plant height increases gradually, with the most significant growth occurring from the 9-leaf stage to tasseling, and it stabilizes after pollination is complete.

The results of monitoring the morphological characteristics of the NK54 maize variety are as follows Table 2.

The height growth process shows clear differences after each stage. The growth rate of plant height is highest during the elongation period, corresponding to 5-8 weeks after planting, that is, from when the maize plants have 7-9 leaves until the tassels become visible [12].

The average height growth rate during different stages is as follows: approximately 19.27 - 21.18 cm/week at 3-4 weeks after planting, 22.59 - 23.95 cm/week at 4-5 weeks after

Table 1. Effects of the fertilizer mixture from extracts and Urea on the growth parameters of NK54 maize variety

Treatment	The time from sowing to germination (day)	The time from sowing to tasseling (day)	The time from sowing to pollen shedding (day)	The time from sowing to silking (day)	The time from sowing to physiological maturity (day)
Control	3	56	59	61	103
T1	3	56	58	60	104
T2	3	57	59	61	104
T3	3	56	58	60	106
T4	3	57	59	61	106

Table 2. Effects of the fertilizer mixture from extracts and Urea on the height of NK54 maize variety

Treatment	Three weeks after planting (cm)	Four weeks after planting (cm)	Five weeks after planting (cm)	Six weeks after planting (cm)	Seven weeks after planting (cm)	Eight weeks after planting (cm)
Control	34.45a	54.67a	77.67a	116.53a	154.57a	181.95a
T1	37.52c	57.80bc	80.39b	118.43ab	155.85a	189.22b
T2	36.07b	57.25b	80.92b	119.48bc	156.88ab	190.18b
T3	38.15c	58.43c	81.11b	121.67c	158.63c	192.17b
T4	38.00c	57.37bc	81.32b	121.75c	159.65c	190.70b
$LSD_{0.05}$	1.22	1.17	1.49	2.47	2.69	4.30
CV%	2.3	1.4	1.3	1.4	1.2	1.6

Values with the same letter within the same column indicate no significant difference, while different letters within the same column indicate a significant difference at a 95% confidence level.

planting, 38.04 - 40.56 cm/week at 5-6 weeks after planting, 36.96 - 38.04 cm/week at 6-7 weeks after planting, and 27.38 - 33.54 cm/week at 7-8 weeks after planting. After 7 weeks, the growth rate slows down and stops when the kernels begin to reach the milk stage.

Thus, maize plants fertilized with nitrogen combined with plant extracts exhibit greater height and higher growth rates compared to those fertilized with conventional nitrogen. The difference in plant height between the control treatment and the experimental formulations during the period from 3 to 8 weeks after sowing was quite pronounced. This difference was significant at a 95% confidence level.

Table 3 shows that leaf emergence was relatively slow in the initial weeks, with minimal differences between the treatments. The rate of leaf production was highest after 7-8 weeks of planting, corresponding to the tasseling period, with Treatment T4 having the highest leaf emergence rate at 2.93 leaves per week, and the control treatment having the lowest rate at 2.57 leaves per week. Observations revealed that the number of leaves and the leaf emergence rate were lower and slower when only urea was used compared to when urea was combined with plant extracts. This difference was statistically significant at a 95% confidence level. Urea-coated plant extracts had a significant effect on increasing both the number of leaves and the rate of leaf growth at a 95% confidence level. Thus, while the number of leaves tended to increase over the monitored weeks, the increase was not substantial.

Table 3. Effects of the fertilizer mixture from extracts and Urea on the leaf emergence rate of NK54 maize variety

Treatment	Three weeks after planting (leaves)	Four weeks after planting (leaves)	Five weeks after planting (leaves)	Six weeks after planting (leaves)	Seven weeks after planting (leaves)	Eight weeks after planting (leaves)
Control	4.00a	5.37a	7.50a	8.70a	11.37a	13.93a
T1	4.00a	5.47ab	7.63ab	8.67a	11.4ab	14.17ab
T2	4.07b	5.47ab	7.70b	8.77ab	11.57bc	14.33b
T3	4.00a	5.63bc	7.70b	8.8ab	11.63cd	14.4b
T4	4.03ab	5.67c	7.67ab	8.87b	11.8d	14.37b
$LSD_{0.05}$	0.05	0.18	0.18	0.13	0.19	0.34
CV%	0.8	2.2	1.6	1.0	1.1	1.6

Values with the same letter within the same column indicate no significant difference, while different letters within the same column indicate a significant difference at a 95% confidence level

Table 4. Effects of the fertilizer mixture from extracts and Urea on leaf area and leaf area index of NK54 maize variety

Treatment	The 7-9 leaf stage		Tasseling stage		Milk stage	
	Leaf area (m²)	Leaf area index (m² leaf area/m² land)	Leaf area (m²)	Leaf area index (m² leaf area/m² land)	Leaf area (m²)	Leaf area index (m² leaf area/m² land)
Control	0.056	0.320a	0.371	2.119a	0.375	2.144a
T1	0.062	0.353ab	0.408	2.334b	0.412	2.355a
T2	0.058	0.334ab	0.398	2.275ab	0.403	2.300a
T3	0.067	0.381b	0.412	2.352b	0.416	2.380a
T4	0.061	0.349ab	0.404	2.311b	0.411	2.348a
LSD		0.05		0.19		1.07
CV%		7.8		4.5		2.5

Values with the same letter within the same column indicate no significant difference, while different letters within the same column indicate a significant difference at a 95% confidence level.

Table 4 shows that leaf area and leaf area index (LAI) for the treatments increased gradually during growth and reached their maximum at the milk stage. The leaf area index can be used to estimate the yield of maize varieties and assess the effectiveness of agronomic practices.

Overall, the control treatment had the lowest leaf area across all monitoring stages. During the 7-9 leaf stage, leaf area ranged from 0.04 to 0.07 m², with the highest value in Treatment T4 at 0.067 m². In the tasseling stage, leaf area increased rapidly, as this is the period when the plant accumulates biomass in preparation for its development. The maize plant needs to develop a robust leaf structure for better photosynthesis, producing more nutrients for tasseling, silking, and grain filling. During this stage, leaf area ranged from 0.371 to 0.412 m², with Treatment T3 having the highest leaf area at 0.412 m² and the control having the lowest at 0.371 m².

In the milk stage, leaf area of the treatments increased slightly, ranging from 0.065 to 0.082 m². The highest leaf area was in Treatment T3 at 0.416 m², and the lowest was in the control at 0.375 m², with a 95% confidence level.

The leaf area index (LAI) represents the extent of leaf cover per unit area of land occupied by the plant (m² leaves/m² land). LAI is a crucial physiological parameter that characterizes the plant's photosynthetic capacity and is an important factor influencing maize yield at harvest [4,5]

During the 7-9 leaf stage, LAI ranged from 0.320 to 0.381 m² leaves/m² land, as the plant had not yet reached its maximum leaf number, resulting in lower LAI values. Treatment T3 had the highest LAI at 0.381 m² leaves/m² land, while the control had the lowest at 0.320 m² leaves/m² land, with no significant difference. In the tasseling stage, LAI increased rapidly, ranging from 2.119 to 2.352 m² leaves/m² land, with Treatment T3 achieving the highest value at 2.352 m² leaves/m² land, and the control having the lowest at 2.119 m² leaves/m² land. By the milk stage, the plant had stabilized, resulting in the highest LAI during its growth and development cycle. During this period, although some leaves aged and wilted, LAI increased only slightly, with values ranging from 2.144 to 2.380 m² leaves/m² land across the treatments.

Overall, the treatments were statistically similar. The differences in leaf area (LA) and leaf area index (LAI) during the 7-9 leaf stage and tendril twisting stage between the use of plant extracts and no plant extracts were significant at a 95% confidence level. However, by the milk stage, these differences were no longer observed.

According to Table 5, the final number of leaves for the NK54 maize variety ranges from 17.93 to 18.3 leaves per plant, with the highest count in Treatment 4 at 18.3 leaves per plant and the lowest in the control treatment at 17.93 leaves per plant. Compared to the control, Treatments 1, 2, 3, and 4 exhibited an increase of approximately 0.27 to 0.37 leaves per plant, though these differences are not statistically significant. However, when providing a sufficient amount of fertilizer to meet the plant's growth needs, the final number of leaves across the treatments did not increase substantially. Overall,

the number of leaves among the treatments did not differ greatly, suggesting that nitrogen has a minor impact on leaf number, with the number of leaves being more influenced by the characteristics of each variety.

The height of the NK54 maize variety ranges from 182 to 192.12 cm, with the tallest plants in Treatment T3 reaching 192.12 cm and the shortest in the control treatment at 182 cm.

Ear height is measured from the ground to the highest effective ear node [13]. It directly affects ear development, which in turn influences the plant's yield and its ability to resist pests and diseases. Typically, ear height is related to the final plant height, with an optimal ratio being approximately half of the final plant height. The NK54 variety has an ear height ranging from 83.08 to 87.59 cm, with the highest in Treatment T3 at 87.59 cm and the lowest in the control at 83.08 cm. The ratio of ear height to final plant height is consistently around 45%.

The theoretical yield represents the potential yield of each variety and is directly dependent on yield components such as the number of effective ears, rows per ear, kernels per row, 1000-kernel weight, and indirectly influenced by environmental conditions and agronomic practices [1-14].

Table 6 shows that the application of nitrogen fertilizer combined with plant extracts affects the theoretical yield of the NK54 maize variety, ranging from 63.62 to 68 quintals per hectare, with the highest yield in Treatment T3 at 68 quintals per hectare and the lowest in the control treatment at 63.62 quintals per hectare. The differences between the other treatments are not significant at the 95% confidence level.

Actual yield is a critical parameter in both variety development and maize production [15]. It is a composite measure that accurately reflects the genetic characteristics and growth conditions of the variety under specific cultivation and ecological conditions [16]. A variety with high yield potential can only realize its potential when grown under suitable conditions. Therefore, under the same climate, soil, and management practices, only varieties that are well-adapted will demonstrate good growth, development, and high yield [17].

Table 5. Effects of the fertilizer mixture from extracts and Urea on the morphological characteristics of NK54 maize variety

Treatment	Final leaf number (leaves)	Final height (cm)	Cob height (cm)	Cob height ratio (%)
Control	17.93a	182a	83.08a	45.65b
T1	18.2a	188.77b	86.31c	45.72b
T2	18.23a	189.88c	86.87c	45.75b
T3	18.26a	192.12d	87.59c	45.59b
T4	18.3a	190.23d	85.70b	45.01a
$LSD_{0.05}$	*4.5*	*0.2*	*1.8*	*0.5*
CV%	*1.6*	*0.6*	*1.4*	*0.7*

Values with the same letter within the same column indicate no significant difference, while different letters within the same column indicate a significant difference at a 95% confidence level.

Table 6. Effects of the fertilizer mixture from extracts and Urea on the yield of NK54 maize variety

Treatment	Theoretical yield (quintals/ha)	Actual yield (quintals/ha)
Control	63.62a	44.1ab
T1	66.08ab	42.65a
T2	67.63b	43.7ab
T3	68b	48.4b
T4	67.43b	44.59ab
$LSD_{0.05}$	*3.8*	*5.6*
CV%	*3.0*	*6.6*

Values with the same letter within the same column indicate no significant difference, while different letters within the same column indicate a significant difference at a 95% confidence level.

According to Table 6, the average maize yield ranges from 43.7 to 48.4 quintals per hectare, with Treatment T3 achieving the highest yield of 48.4 quintals per hectare. The differences between the other treatments are not significant at the 95% confidence level.

4. CONCLUSION

The application of urea-coated plant extracts positively influenced the growth duration, plant height, leaf number, leaf area, and leaf area index (LAI) of the NK54 maize variety compared to conventional urea fertilization. Specifically, the growth duration ranged from 103 to 106 days, with treatments T3 (9 ml concentrated extract + 1 kg Urea) and T4 (12 ml concentrated extract + 1 kg Urea) showing longer growth durations, indicating that gradual nutrient supply benefits plant development.

Plant height ranged from 182 to 192.12 cm, with taller plants observed in treatments using the urea-plant extract combination. Additionally, the rate of leaf emergence and the final leaf number were higher in the 7-8week period, with Treatment T4 showing the highest leaf emergence rate.

Leaf area and LAI increased progressively throughout the growth stages, reaching their peak at the milk stage, with Treatment T3 demonstrating the highest values.

The theoretical yield ranged from 63.62 to 68 quintals per hectare, with Treatment T3 achieving the highest theoretical yield, while the average actual yield ranged from 43.7 to 48.4 quintals per hectare, with Treatment T3 also showing the highest actual yield.

Although the differences in actual yield among treatments were not statistically significant, the combination of urea with plant extracts generally improved various growth parameters and theoretical yield for NK54 maize. This underscores the importance of considering environmental conditions and agronomic practices to maximize maize NK54 potential.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. McRoberts, Keenan C. Impact of forage fertilization with urea and composted cattle manure on soil fertility in sandy soils of south-central Vietnam. International Journal of Agronomy. 2016;1 (2016):4709024.
2. Cong, Phan Thi. Inoculant plant growth-promoting microorganisms enhance utilisation of urea-N and grain yield of paddy rice in southern Vietnam. European Journal of Soil Biology. 2009;45(1): 52-61.
3. Tran, Tien Minh. Application rate and composting method affect the immediate and residual manure fertilizer value in a maize–rice–rice–maize cropping sequence on a degraded soil in northern Vietnam. Soil Science and Plant Nutrition. 2012;58(2):206-223.
4. Doan, Thuy Thu. Impact of compost, vermicompost and biochar on soil fertility, maize yield and soil erosion in Northern Vietnam: A three year mesocosm experiment. Science of the Total Environment. 2015;514:147-154.
5. Doan, Thuy Thu. Site-specific effects of organic amendments on parameters of tropical agricultural soil and yield: A field experiment in three countries in Southeast Asia. Agronomy. 2021;11(2):348.
6. Gagnon Bernard, Noura Ziadi, Cynthia Grant. Urea fertilizer forms affect grain corn yield and nitrogen use efficiency. Canadian Journal of Soil Science. 2012;92(2):341-351.
7. Gil-Ortiz, Ricardo. New eco-friendly polymeric-coated urea fertilizers enhanced crop yield in wheat. Agronomy. 2020;10(3):438.
8. Bernardi, Alberto C. de Campos. Yield, quality components, and nitrogen levels of silage corn fertilized with urea and zeolite. Communications in soil science and plant analysis. 2011;42(11):1266-1275.
9. Zheng, Wenkui. Improving crop yields, nitrogen use efficiencies, and profits by using mixtures of coated controlled-released and uncoated urea in a wheat-maize system. Field Crops Research. 2017;205:106-115.

10. Gao, Yongxiang. Mixture of controlled-release and conventional urea fertilizer application changed soil aggregate stability, humic acid molecular composition, and maize nitrogen uptake. Science of The Total Environment. 2021;789:147778.
11. Irshad M. Urea and manure effect on growth and mineral contents of maize under saline conditions. Journal of Plant Nutrition. 2002;25(1):189-200.
12. Yang, Yang. Performance of matrix-based slow-release urea in reducing nitrogen loss and improving maize yields and profits. Field Crops Research. 2017;212 :73-81.
13. Guo, Jinjin. Blending urea and slow-release nitrogen fertilizer increases dryland maize yield and nitrogen use efficiency while mitigating ammonia volatilization. *Science* of the Total Environment. 2021;790:148058.
14. Vanlauwe, Bernard. Maize yield as affected by organic inputs and urea in the West African moist savanna. Agronomy Journal. 2001;93(6): 1191-1199.
15. Gao Canhong. The integration of bio and organic fertilizers improve plant growth, grain yield, quality and metabolism of hybrid maize (*Zea mays* L.). Agronomy. 2020;10(3):319.
16. Zhang, Wushuai. The effects of controlled release urea on maize productivity and reactive nitrogen losses: A meta-analysis. Environmental Pollution. 2019;246: 559-565.
17. Zhang, Shui-Qin. Effects of urea enhanced with different weathered coal-derived humic acid components on maize yield and fate of fertilizer nitrogen. Journal of Integrative Agriculture. 2019;18(3):656-666.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/122849