**Assessment of the Fertilizing Properties of Rabbit Urine Combined with Cattle Manure on the Growth and Yield of Maize**

ABSTRACT

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| The objective of this study is to evaluate the fertilizing properties of rabbit urine combined with cattle manure on the growth and yield of maize. The study was conducted between January and June 2024, in a real-world setting located in the natural region of Buyogoma, within the central plateaus agro-ecological zone, at the Provincial Office of Environment, Agriculture, and Livestock of Cankuzo in Burundi.The study was carried out using a randomized complete block experimental design. Five randomized treatments were used: a control without fertilizer (T0), cattle manure alone (T1), cattle manure combined with rabbit urine diluted 5 times (T2), cattle manure with rabbit urine diluted 2 times (T3), and cattle manure with undiluted rabbit urine (T4).The collected and analyzed data included maize plant growth parameters (number of leaves, plant height, and number of ears) and dry grain yield. The results showed that treatment T3, using urine diluted twice, recorded the highest number of leaves with 10.42±0.64, and significantly greater plant heights of 38.36±0.949 cm, 126.39±24.606 cm, and 191.250±8.290 cm at 4, 8, and 13 weeks after sowing, respectively. Similarly, the highest average number of ears, 1.67±0.476, was also produced under treatment T3, which included urine diluted twice in addition to cattle manure.The highest average dry grain yield was also observed under treatment T3, closely followed by treatment T4, with yields of 4.066±0.055 t/ha and 4.032±0.074 t/ha respectively, both significantly higher than the other treatments. In contrast, the control treatment (T0), which received no fertilizer, recorded the lowest yield at 0.128±0.003 t/ha.This study therefore highlights the positive effect of using rabbit urine as a liquid fertilizer combined with cattle manure, contributing to improved growth and yield of maize.Haut du formulaireBas du formulaire |

**Key words:** *Rabbit Urine, fertilizer, Growth, yield, maize.*

**1. INTRODUCTION**

Maize is cultivated widely throughout the world and has the highest production among all the cereals. Maize is preferred staple food for 900 million poor, 120 ‐140 million poor farm families, and about one‐third of all malnourished children globally (Murdia et al., 2016). Maize is already the leading cereal in terms of production volume and is set to become the most widely grown and traded crop in the coming decade (Erenstein et al., 2022). In Burundi, maize is the main cereal crop cultivated year-round across the entire country, including low, mid, and high altitudes (Bizoza et al., 2022). To develop and reach its optimal yield, maize generally requires complete fertilization that includes major nutrients (Nitrogen, Phosphorus, Potassium), a secondary element (such as calcium), and two trace elements (copper and zinc) (Akanza & N’Da, 2018).

However, the loss of soil fertility is a well-known issue in Burundi, resulting in a drastic reduction in agricultural yields (ISABU & IFDC, 2022). In cereal-based cropping systems, which are predominant in Africa, mineral fertilization alone is not sufficient to maintain soil fertility (Akanza et al., 2016). In Burundi, soil fertility restoration is largely achieved through manure application (from small livestock) among small-scale farmers (IFAD, 2018). In-depth tests conducted on both animal manure and chemical fertilizers have shown that the former is more effective and environmentally friendly (Leite et al., 2010).

Rabbit urine is non-toxic and environmentally friendly. It may serve as a suitable alternative to chemical fertilizers due to its minimal ecological risks and the fact that it requires no additional treatment before use (Arowogbola et al., 2022). Said et al. (2018) demonstrated that rabbit urine contains essential nutrients such as nitrogen, potassium, and phosphates necessary for plant growth. The average daily urinary excretion from a healthy adult rabbit includes approximately 0.9 g of total nitrogen, 10 mg of total phosphorus, and 370 mg of potassium. The main compound excreted in urine is urea, the end product of nitrogen metabolism (Lamothe et al., 2015).

Chandra et al. (2019) consider liquid fertilizer to be a natural organic product with a relatively slow action that provides nitrogen over a longer period. Ekwere et al. (2023) found the following nutrient composition in rabbit urine: 2.36% nitrogen, 2.11% phosphorus, 3.56% potassium, 1.26% sulfur, 3.55% calcium, and a pH of 8.50. It can be used alone or in combination with other inorganic fertilizers. The nutrient content of cattle manure is 0.40% nitrogen (N), 0.20% phosphorus (P), and 0.10% potassium (K) (Wijayanto et al., 2022). Cow dung contains 22.8 g/kg of nitrogen (N), 13.6 g/kg of phosphorus (P), and 68.6 g/kg of potassium (K) (Aboubakar et al., 2020).

The present study was conducted to evaluate the effect of applying rabbit urine combined with cattle manure on maize fertilization. With the current rise in rabbit farming in Burundi, the use of rabbit urine as fertilizer represents an opportunity for farmers. This practice can significantly reduce the costs associated with purchasing chemical fertilizers, offering an affordable and accessible alternative. It not only contributes to more efficient resource management but also leads to a noticeable improvement in farm profitability. At the same time, cattle manure remains a major resource, being the most commonly used organic fertilizer in the country in terms of quantity. The increase in maize production, especially on large farms, requires substantial amounts of organic manure, highlighting the importance of these natural resources for Burundian agriculture.

**2. MATERIALS AND METHODS**

**2.1. Study site and period**

The study was carried out from January to June 2024 in real-world conditions in the Buyogoma natural region, located within the central plateaus agro-ecological zone at the Provincial Office of Environment, Agriculture, and Livestock (POEAL) of Cankuzo, Burundi. This region lies at an altitude ranging from 1200 m to 1800 m, with annual rainfall between 1100 mm and 1400 mm (FEWS NET, 2021). It is an agro-ecological zone where hybrid maize cultivation is among the main agricultural activities (Ndayizeye, 2022).The experimental site is geographically located at -3°12'46.4" South latitude and 30°33'33.6" East longitude.

**2.2. Plant material**

The BAZOOKA variety was used. Its growth cycle ranges from 113 to 152 days, with a potential yield of 7.4 t/ha. It is suitable for cultivation zones between 800 and 1800 meters in altitude (ONCCS, 2020).

**2.3. Fertilizer procurement**

The cattle manure was purchased from a farmer living near the experimental site. The rabbit urine was obtained from a rabbit farming unit at a secondary school located near the Provincial Office of Environment, Agriculture, and Livestock (POEAL) in Cankuzo. Urine collection began in December 2023 and was done daily. From the rabbit hutch, the urine was channeled through troughs into a collection container. The collected amount was then transferred each morning into 20 liter jerry cans, which were hermetically sealed until use, for at least 30 days after storage.

**2.4. Experimental design and trial management**

**2.4.1. Experimental design**

The experimental design, as shown in figure 1, was a randomized complete block design including five treatments (three different doses of rabbit urine combined with cattle manure, one treatment with only cattle manure, and one absolute control without any fertilizer). Each treatment was replicated three times and randomized.

The experimental field covered an area of 16 m x 10.75 m (i.e., 172 m²), while each elementary plot measured 2.25 m x 2 m (i.e.,4.5m²). Elementary plots were separated by 1-meter alleys, and a 1-meter buffer zone was maintained around the edges of the experimental field.

The experimental design included a single factor (fertilization dose) analyzed across the following five treatments:

* T0: Absolute control (no rabbit urine or cattle manure)
* T1: Cattle manure only
* T2: Cattle manure + rabbit urine diluted 5 times
* T3: Cattle manure + rabbit urine diluted 2 times
* T4: Cattle manure + undiluted rabbit urine



**Figure 1**: Experimental Design

### ****2.4.2. Tillage, sowing period, and planting density****

Tillage was carried out from **January 18 to 19, 2024,** to an average depth of **20 cm**, completely breaking up soil clods. Weed removal was done immediately after tilling. **Sowing took place on February 1st,** during the 2024B cropping season, using **spacing of 75 cm between rows and 50 cm between planting holes,** with **2 seeds per hole**.

Each **elementary plot** had **4 rows**, and each row had **5 planting holes**, giving a total of **20 holes per plot**. Each block therefore had **100 holes**, for a total of **300 holes across the 3 blocks**, resulting in **600 seeds sown**.

### ****2.4.3. Application of cattle manure and rabbit urine****

A quantity of **400 grams of cattle manure per hole** was applied at sowing for treatments **T1, T2, T3, and T4.** Additionally**, 1 liter of rabbit urine** was used per treatment, diluted with tap water in a **1:2 ratio (urine diluted twice)** and **1:5 ratio (urine diluted five times).** This means: **T3** received 1 liter of urine mixed with **2 liters of water**, **T2** received 1 liter of urine mixed with **5 liters of water**, and **T4** received **pure (undiluted) urine.**

In each planting hole, a volume of **25 cl (250 mL)** of rabbit urine (diluted or not) was applied according to the designated proportions. The rabbit urine was applied **three times** as follows: The first application of rabbit urine took place at sowing, by adding it into the planting hole along with cattle manure.
The second application of rabbit urine was done at the 5–6 leaf stage, during the 4th week after sowing (WAS), during weeding and hoeing, and the third application of rabbit urine was carried out in the 8th week after sowing, during ridging, shortly before flowering.
For the second and third applications, the urine was poured into furrows dug around the plants, which were then covered back up.

### ****2.4.4. Sample size and data collection****

The sample size was calculated using the **Krejcie & Morgan (1970)** formula:

$$n=\frac{z^{2}p\left(1-p\right)N}{d^{2}\left(N-1\right)+z^{2}p(1-p)}$$

Where:

* **n** is the sample size,
* **N** is the total number of maize plants (600),
* **p** is the proportion of plants with a yield above the median (0.50),
* **z** is the Student’s t-value for α = 5% (1.96),
* **d** is the margin of error (0.05).

$n=\frac{(1,96^{2}\*0,50\left(1-0,50\right)600}{0,05^{2}\*\left(600-1\right)+1,96^{2}\*0,50\left(1-0,50\right)}$=234

The total calculated sample size was **234**. Dividing this by the **15 experimental units** gave **15.6 plants per elementary plot**, which was **rounded to 16 plants per plot,** giving a **total sample of 240 plants.**

The **16 plants** in each plot were selected using the **“X” method** described by **FAO (2018).** This involves two diagonal lines crossing the plot, each passing through **8 planting holes**. As each hole contained **2 plants**, the sample included **16 plants per unit** (see Figure 2).

**Data collection** focused on maize growth parameters (number of leaves per plant, plant height, number of ears per plant) and dry grain yield in tons per hectare (t/ha)

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**Figure 2**: Diagram illustrating the selection of the sample

### ****2.5. Data Analysis****

The collected data were subjected to analysis of variance using IBM SPSS software version 21. Multiple comparisons of means were performed using Tukey’s test at a 5% probability level.

### ****3. RESULTS AND DISCUSSION****

This study examined the effect of rabbit urine used as a fertilizer, in addition to cattle manure, on corn growth and dry grain yield. Growth parameters analyzed included leaf number, plant height, and number of ears per plant. For all parameters studied, rabbit urine application resulted in a positive effect, with differences between treatments (p < 0.05). This is explained by the richness of essential nutrients in rabbit urine, which is particularly beneficial for corn growth. Cattle manure also contains nutrients essential for corn growth.

In fact, rabbit urine has higher average nutrient concentrations than other animal urines (cow, goat, sheep, horse, pig). Its average composition is 2.72% nitrogen (N), 1.1% phosphorus (P) and 0.5% potassium (K) (Wijayanto et al., 2022).

#### ****3.1. Effect of different treatments on maize growth parameters and yield****

To assess the influence of the type of treatment used as fertilizer, a one-way analysis of variance (ANOVA 1) was used, as shown in Table 1.

**Table 1: ANOVA 1**

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#### ****3.2. Average number of leaves per maize plant****

The number of leaves presented in Table 2 shows a significant difference (p < 0.05) between treatments. At the fourth week after sowing, maize plants treated with T0 (no fertilizers) had the lowest number of leaves with 4.79±0.41. In contrast, plants treated with T1, T2, T3, and T4 had the same number of leaves, which was 5. Pairwise mean comparison showed that these treatments belonged to the same homogeneous group (a).

At the 8th week after sowing, the results indicate that treatment T3 (rabbit urine diluted twice + cattle manure) had the highest number of leaves at 10.42±0.64, followed by T4 (undiluted rabbit urine + cattle manure) with 10.40±0.49, and T2 (rabbit urine diluted five times + cattle manure) with 10.25±0.72. The difference in the average number of leaves among treatments T2, T3, and T4 (all involving rabbit urine) was statistically significant (p = 0.000).

Conversely, T0 (no fertilizer) still showed the lowest number of leaves at 7.67±0.47, which was statistically different from the other treatments (p = 0.000). This may be due to the positive effect of rabbit urine on plant growth. These results are consistent with those found by Kurnianta et al., 2021, which indicate that applying liquid organic fertilizer made from rabbit urine increases leaf number and plant height.

**Table 2: Average number of leaves per maize plant after application of rabbit urine**

|  |  |
| --- | --- |
| **Treatment** | **Number of leaves per plant** |
| 4 WAS | 8 WAS |
| T0 | 4,79±0,41b | 7,67±0,47c |
| T1 | 5,00a | 9,56±0,50b |
| T2 | 5,00a | 10,25±0,72a |
| T3 | 5,00a | 10,42±0,64a |
| T4 | 5,00a | 10,40±0,49a |

T0 = no rabbit urine or cattle manure; T1 = cattle manure only; T2 = cattle manure + rabbit urine diluted 5 times;

 T3 = cattle manure + rabbit urine diluted 2 times; T4 = cattle manure + undiluted rabbit urine.

#### ****3.3. Variation in plant height (in cm)****

For all treatments, the average height of maize plants varied significantly between treatments (p < 0.05). Treatment T3 (rabbit urine diluted twice + cattle manure) recorded the highest plant height with 38.36±0.949 cm, 126.39±24.606 cm, and 191.25±8.290 cm at 4, 8, and 13 weeks after sowing, respectively (Table 3). T3 was followed by T4 (undiluted rabbit urine + cattle manure) with respective heights of 37.50±1.106 cm, 121.74±19.928 cm, and 180.063±8.253 cm at 4, 8, and 13 weeks after sowing, respectively.

The lowest plant height at 4, 8, and 13 weeks was observed in the control treatment T0 (no fertilizer), with 19.43±1.902 cm, 47.43±6.177 cm, and 77.167±3.075 cm, respectively. T3 and T4 stood out with the highest plant heights, indicating that high concentrations of rabbit urine significantly impact maize growth. These findings are consistent with Indabo & Abubakar (2020), who reported that rabbit urine influenced the morphological traits (plant height and leaf number) of tomato plants when applied alongside the recommended doses of NPK fertilizer.

**Table 3: Average plant height (in cm) after application of rabbit urine**

|  |  |
| --- | --- |
|  | **Plant height (in cm)** |
| **Treatment** | **4 WAS** | **8 WAS** | **13 WAS** |
| T0 | 19,43±1,902d | 47,43±6,177c | 77,167±3,075c |
| T1 | 36,18±1,108c | 97,76±22,008b | 177,440±4,685b |
| T2 | 36,54±1,304c | 99,81±19,520b | 178,760±3,945b |
| T3 | 38,36±0,949a | 126,39±24,606a | 191,250±8,290a |
| T4 | 37,50±1,106b | 121,74±19,928a | 180,063±8,253b |

T0 = no rabbit urine or cattle manure; T1 = cattle manure only; T2 = cattle manure + rabbit urine diluted 5 times;

T3 = cattle manure + rabbit urine diluted 2 times; T4 = cattle manure + undiluted rabbit urine.

#### ****3.4. Average number of ears per plant and grain yield (t/ha) per treatment****

The analysis of the number of ears per maize plant and dry grain yield (Table 4) shows a significant difference (p < 0.05). Treatment T3 (rabbit urine diluted twice + cattle manure) yielded the highest average number of ears per plant at 1.67±0.476. In contrast, T0 (control) and T1 (cattle manure only) had lower values of 1 and 1.35±0.483 ears per plant, respectively. This suggests that the absence of rabbit urine, which provides additional nutrients, limits ear production.

However, the use of cattle manure alone (T1) still showed improvement over the control. Treatments T2 and T4 (rabbit urine + cattle manure) showed even better performance with 1.40±0.494 and 1.58±0.498 ears per plant, respectively. These results are consistent with those of Ekwere et al. (2023), who found that the highest number of pods per cowpea plant

was achieved with the application of 750 ml rabbit urine combined with 200 kg/ha NPK fertilizer.

Variance analysis of dry grain yield revealed significant differences depending on the fertilizer treatments (p < 0.05). Table 4 shows the highest yield (4.066±0.055 t/ha) was obtained with T3. In contrast, T0 gave the lowest yield at 0.128±0.003 t/ha, highlighting the crucial importance of biofertilizers in maize production.

Treatments T3 and T4 showed the best results with 4.066±0.055 t/ha and 4.032±0.074 t/ha, respectively, and belonged to the same homogeneous group, indicating that they had similar effects on yield. The significant differences between T0 and the other treatments underscore the impact of fertilizers on crop growth and yield, supporting findings from Patil et al. (2012), who reported that various urine sources improved soil nutrient status and agronomic yield parameters when applied.

**Table 4: Effect of rabbit urine on number of ears per plant and grain yield (t/ha)**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Ears per plant** | **Grain yield (t/ha)** |
| T0 | 1,00c | 0,128±0,003d |
| T1 | 1,35±0,483b | 3,522±0,015c |
| T2 | 1,40±0,494b | 3,651±0,002b |
| T3 | 1,67±0,476a | 4,066±0,055a |
| T4 | 1,58±0,498ab | 4,032±0,074a |

T0 = no rabbit urine or cattle manure; T1 = cattle manure only; T2 = cattle manure + rabbit urine diluted 5 times; T3 = cattle manure + rabbit urine diluted 2 times; T4 = cattle manure + undiluted rabbit urine.

### ****4. CONCLUSION****

The objective of this study was to evaluate the effect of rabbit urine combined with cattle manure on maize cultivation. The results indicate that the application of rabbit urine diluted twice, in addition to cattle manure, significantly improved the growth parameters considered in this study—namely, the number of leaves, plant height, and number of ears per plant. The application of rabbit urine diluted twice also enhanced the dry grain yield. According to this study, the optimal dilution ratio for rabbit urine in maize fertilization is 1 liter of urine mixed with 2 liters of tap water (i.e., urine diluted twice). This solution should be applied in three stages: at sowing, 4 weeks after sowing, and 8 weeks after sowing.

**DISCLAIMER FOR ARTIFICIAL INTELLIGENCE**

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

**REFERENCES**

Aboubakar, A., Zing Zing, B., Nzeket, A. B., Moussima Yaka, D. A., Tchudjo Tchuente, A. N., Mfopou Mewouo, Y. C., & Birang A Madong, C. R. (2020). Effects of amendments on growth, yield and chemical composition of black nightshade in suburban areas of Yaoundé, Cameroon. *International Journal of Biological and Chemical Sciences*, *14*(6), 2134–2146. https://doi.org/10.4314/ijbcs.v14i6.16

Akanza, P. K., & N’Da, H. A. (2018). Effects of fertilizer on soil fertility, nutrition, and maize yield: implications for diagnosing soil deficiencies. Journal of the West African Society of Chemistry, 045, 54–66.

Akanza, P. K., Sanogo, S., & N’Da, H. A. (2016). Combined influence of organic and mineral fertilizers on maize nutrition and yield: impact on diagnosing soil deficiencies. Tropicultura, 34(2), 208–220.

Arowogbola, A. Y., Adeyeye, A. M., Jonathan, A. A., Olumakinde, A., Koledoye, A. S., & Francis, D. B. (2022). Effects of Rabbit Urine and Urea Fertilizer on the Growth and Yield Performance of Amaranthus (Amaranthus hybridus L.). Journal of Drug Design and Medicinal Chemistry, 8(2), 16–19. <https://doi.org/10.11648/j.jddmc.20220802.11>

Bizoza, S., Mutuo, P. K., & Leo, Y. L. (2022). Study results on the maize value chain in Burundi (pp. 1–33). IITA-BURUNDI.

Chandra, S. M., Lavanya, N., Chandana, P., Naveen Kumar, B., Kumar, R., Author, C., Naresh, R., Varsha, N., Wasim Chand, S., & Indar Navsare, R. (2019). Production and potential of ancient liquid organics panchagavya and kunapajala to improve soil health and crop productivity: A review. Journal of Pharmacognosy and Phytochemistry, 8(6), 702–713. <http://www.phytojournal.com>

Ekwere, O. J., Udounang, P. I., Efretuei, A. O., & Umoh, F. O. (2023). Evaluation of Rabbit Urine as Bio-fertilizer for the Growth and Yield of Cowpea (Vigna unguiculata (L.) Walp). AKSU Journal of Agriculture and Food Sciences, 7(3), 37–48.

Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. M. (2022). Global maize production, consumption and trade: trends and R&D implications. *Food Security*, *14*(5), 1295–1319. https://doi.org/10.1007/s12571-022-01288-7

FAO. (2018). Integrated Management of Fall Armyworm on Maize: A guide for farmer field schools in Africa. Rome (Italy), 147 p.

FEWS NET. (2021). Livelihood Zoning Activity of BURUNDI. Report of the Famine Early Warning Systems Network (FEWS NET).

IFAD. (2018). Agricultural Production Intensification and Vulnerability Reduction Project in Burundi (PIPARV-B). Final design report.

Indabo, S. S., & Abubakar, A. A. (2020). Effect of Rabbit Urine Application Rate as a Bio-Fertilizer on Agro-Morphological Traits of UC82B Tomato (Lycopersicon esculentum Mill) Variety in Zaria, Nigeria. Dutse Journal of Pure and Applied Sciences, 6(2), 344–352.

ISABU, & IFDC. (2022). Soil Fertility Mapping of Burundi: 2022 Edition.

Krejcie, & Morgan. (1970). Determining sample size for research activities: The case of organizational research. Educational and Psychological Measurement, 2(1), 20–34.

Kurnianta, L. D., Sedijani, P., & Raksun, A. (2021). The Effect of Liquid Organic Fertilizer (LOF) Made from Rabbit Urine and NPK Fertilizer on the Growth of Bok Choy (Brassica rapa L. Subsp. chinensis). Jurnal Biologi Tropis, 21(1), 157–170. <https://doi.org/10.29303/jbt.v21i1.2426>

Lamothe, L., Theau-Clement, M., Combes, S., Allain, D., Lebas, F., Normand, B. Le, & Gidenne, T. (2015). General Physiology. The Rabbit: From Biology to Farming, 1st Ed., Quae Editions, 270 p.

Leite, L. F. C., Oliveira, F. C., Araújo, A. S. F., Galvao, S. R. S., Lemos, J. O., & Silva, E. F. L. (2010). Soil Organic Carbon and Biological Indicators in an Acrisol under tillage systems and organic management in north-eastern Brazil. Australian Journal of Soil Research, 48, 258–265.

Murdia, L. K., Wadhwani, R., Wadhawan, N., Bajpai, P., & Shekhawat, S. (2016). Maize utilization in India: an overview. *American Journal of Food and Nutrition*, *4*(6), 169–176. https://doi.org/10.12691/ajfn-4-6-5

Ndayizeye, Y. (2022). Dynamics of the Hybrid Maize Seed Market in Burundi. Master's Thesis. Faculty of Agronomy and Bioengineering, Department of Rural Socioeconomics, University of Burundi.

ONCCS. (2020). National Catalogue of Plant Species and Varieties Admitted for Certification in Burundi – 2020 Edition.

Patil, S. V., Halikatti, S. I., Hiremath, S. M., Babalad, H. B., Sreenivasa, M. N., Hebsur, N. S., & Somanagouda, G. (2012). Effect of Organics on Growth and Yield of Chickpea (Cicer arietinum L.) in Vertisols. Karnataka Journal of Agricultural Sciences, 25(3), 326–331.

Said, M. I., Asriany, A., Sirajuddin, S. N., Abustam, E., & Rasyid, R. (2018). Evaluation of the quality of liquid organic fertilizer from rabbit’s urine waste fermented using local microorganisms as decomposers. Iraqi Journal of Agricultural Sciences, 49(6), 990–1003.

Wijayanto, B., Sucahyo, A., & Rimartin, G. A. (2022). The Effect of Rabbit Urine Fertilizer Application on the Growth ofWater Spinach (Ipomoea Aquatica). *In International Symposium Southeast Asia Vegetable 2021 (SEAVEG 2021)*, 591-600. Atlantis Press. https://doi.org/10.2991/978-94-6463-028-2