THE APPLICATION OF VARIOUS DOSES OF NPK FERTILIZER ON GROWTH AND PRODUCTION OF WATER SPINACH AND SPINACH PLANTS ON FLOATING AGRICULTURE SYSTEM

by Susilawati Susilawati

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Ammar Muhammad, **Susilawati***, **Irmawati**, **Sulaiman Firdaus**, **Gustiar Fitra**
Department of Agronomy, Faculty of Agriculture, University of Sriwijaya, Indonesia

Ikhtiara Alfina, **Ligra Mellita**
Department of Agroecotechnology, Faculty of Agriculture, Universitas Sriwijaya, Indonesia

*E-mail: susilawati@fp.unsri.ac.id

ABSTRACT
The research was conducted to determine the effect of applying various doses of NPK fertilizer on growth and production of water spinach (*Ipomoea reptans* Poir) and spinach (*Amaranthus* sp.) plants on a floating cultivation system. The research was carried out in a pond located within the Universitas Sriwijaya Indralaya campus, while analysis activities were carried out at the Plant Physiology Laboratory, Universitas Sriwijaya. The study was conducted from June to August 2021 using a factorial randomized block design consisting of 8 treatments and 3 replicates with 3 plants per unit. The details of the treatment on water spinach were as follows: P_0 = Control (without NPK), P_1 = 0.5 NPK / polybag, P_2 = 1 NPK / polybag, and P_3 = 1.5 NPK / polybag. While for spinach, the treatments consisted of: P_0 = Control (without NPK fertilizer), P_1 = 3.75 g NPK fertilizer, P_2 = 7.50 g NPK fertilizer and P_3 = 15.0 g NPK fertilizer. Analysis of variance and 5 % level of Least Significance Difference test were used for data analysis. Parameters observed were plant height, number of leaves, fresh weight of roots and shoots, root length, leaf area, and leaf greenness. The results showed that the application of NPK increased the growth of water spinach on the parameters of plant height, number of leaves, leaf greenness, shoot fresh weight and root length compared to spinach plants.

KEY WORDS
Spinach, water spinach, NPK, floating agriculture.

Land availability has been a main problem hindering agricultural activities of horticultural crops, including vegetable crops. Water spinach (*Ipomea reptans* Poir) is one of popular vegetable plant in Indonesia due to its delicious taste. This plant belongs to the group of annual and short-lived plants and does not require a large area to cultivate, so that it is possible to cultivate it in places where land is generally limited. Besides water spinach, spinach (*Amaranthus* sp.) is also a favorable vegetable crop because it contains high nutrients, such as vitamin C ($C_6H_8O_6$). The process of vitamin C biosynthesis is strongly influenced by photosynthesis and the reactions that accompany it, so that several nutrients such as N, P and K are needed since they are related to the process of photosynthesis, enzymatic reactions and distribution of energy which have an influence on the process of vitamin C synthesis (Ghifari *et al.* 2019).

South Sumatra province has a very wide potential for peatland, especially lowland swamps. The flat surface of the peatland causes almost the entire peatland area inundated with water during the rainy season. The inundation period ranges from 3 to 6 months causing the land cannot be used for cultivation activities. Towards low tide, the initial activity farmers carried out was a floating rice seedlings nursery (Meihana *et al*., 2019; Simatupang dan Rina, 2019; Karla *et al.*, 2019; Lakitan, 2021). Besides for rice cultivation, the development of floating farming systems for vegetable cultivation is also prospectively developed based on the statements of farmers who are interested in the use of the introduced floating agriculture (Bernas et al., 2012; Hasbi et al., 2017). The results of Syafrullah's research (2014)

concluded that the type of plastic glass waste raft had the best effect on the growth and production of spinach compared to other types of rafts, the type of compost daffodil grass had the best effect on the growth and production of spinach compared to other types of compost and the application of floating organic spinach cultivation technology on flooded peatland yielded the same results when compared to conventional cultivation systems on dry land.

The availability of nutrients for plants growth is the main requirement in increasing crop production. The use of compound fertilizer (in form of NPK fertilizer) is more efficient in terms of application because of its availability in the market and the ingredients are easily absorbed by plants. NPK compound fertilizer is a type of fertilizer that contains the main nutrients needed by plants. The application of NPK compound fertilizer has a good effect on plants due to the availability of N, P and K elements in compound NPK which is more balanced and more efficient in its application to plants. One of the compound fertilizers commonly used by farmers is NPK 16:16:16 compound fertilizer (containing 16% N, 16% P_2O_5, and 16% K_2O). This means that NPK fertilizer contains balanced macro nutrients which are good for plant growth (Missdiani et al., 2020). The aim of this study was to determine the growth of water spinach (*Ipomoea reptans* Poir) and spinach (*Amaranthus sp.)* using various doses of NPK fertilizer in floating agriculture.

MATERIALS AND METHODS OF RESEARCH

The research was carried out in the water reservoir inside Universitas Sriwijaya main campus in Indralaya, and the analysis was carried out at the Plant Physiology Laboratory, Department of Agronomy, Universitas Sriwijaya. The research was carried out from June to August 2021. The research used water spinach and spinach seeds, NPK fertilizer, top soil, and tools for processing the planting media, floating rafts, oven, SPAD, and digital scale. The study used a factorial randomized block design with 2 factors, consisting of 8 treatments and 3 replications, so there were 24 units. Each treatment unit consisted of 3 plants. The details of the water spinach plant treatment are as follows: P_0 = without NPK fertilizer, P_1 = 0.5 NPK/polybag, P_2 = 1 NPK/polybag, and P_3 = 1.5 NPK/polybag. And for spinach, consisted of: P_0 = Control (without NPK fertilizer), P_1 = 3.75 gr NPK fertilizer, P_2 = 7.50 gr NPK fertilizer, and P_3 = 15.0 gr NPK fertilizer. Parameters observed were plant height, number of leaves, root and crown fresh weight, root length, leaf area, and leaf greenness level. The data obtained was analyzed statistically using Analysis of Variance (ANOVA) based on Randomized Block Design (RBD) which further tested using Least Significant Difference (LSD) when the treatments showed any significance effect.

RESULTS OF STUDY

The use of NPK fertilizers affected the growth and yield of water spincah and spinach cultivated using floating system. The dose applied was in accordance with the needs of each commodity. Floating system produced a higher plant height for water spinach than the spinach. Water spinach plant height ranged from 11.50-12 cm and spinach plants ranged from 6.43-9.11 cm in the first week after planting. The second week of plant height for water spinach ranged from 18.33-22.50 cm and that of spinach ranged from 11.47-15.57 cm and the third week of water spinach ranged from 37.10-45.33 cm and that of spinach ranged from 21.50-28.00 cm, the data is presented in Figure 1.

Apart from plant height, growth is indicated by the addition of the number of leaves. With increasing age of the plants, the increase in the number of leaves on water spinach plants from the first week to the third week for each treatment was as follows P_0 from 3.00 to 25.67 leaves; P_1 from 4.00 to 37.10 leaves; P_2 from 3.67 to 19.33 and P_3 from 3.67 to 18.67 leaves. The increase in the number of leaves of spinach plant was relatively lower than that of water spinach plant. The number of leaves for treatment P_0 and P_1 from 3.00 to 9.67; P_2 from 3.67 to 13.33 and P_3 from 3.33 to 11.33 leaves (Figure 2).

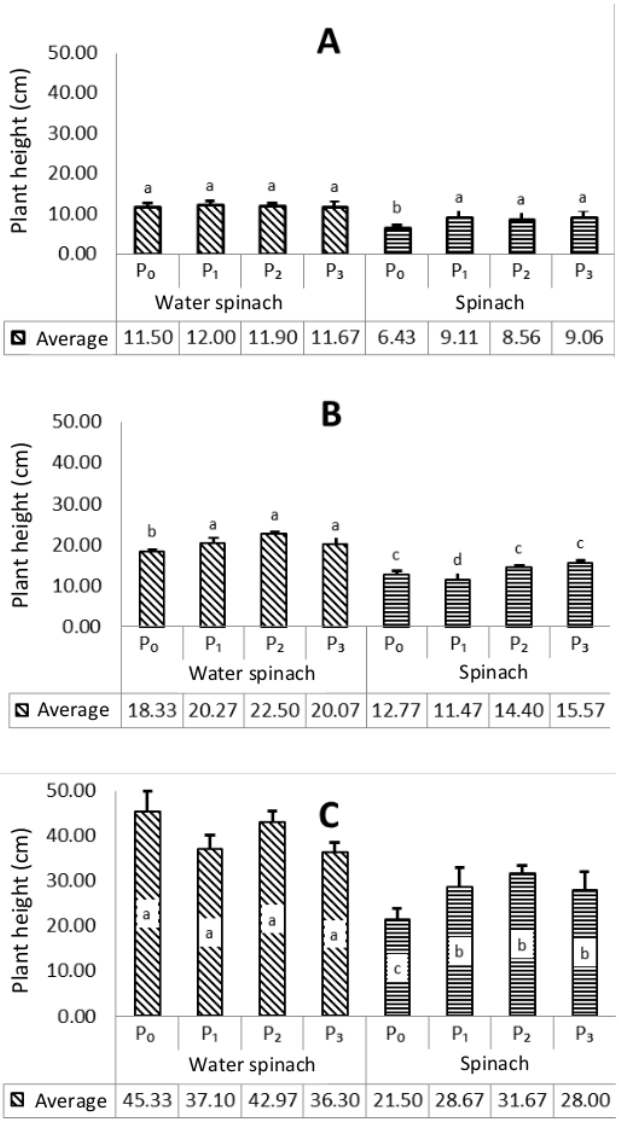


Figure 1 – Plant height for 3 weeks after treatment of NPK fertilizer (P)
(A=first week; B=second week; C=third week)

The results of measuring the total leaf area in the third week, obtained that in general the total area of water spinach plants is smaller than that of spinach plants. Increasing the dose of NPK fertilizer on water spinach and spinach plants increased the total leaf area, for spinach plants there was a decrease at the highest dose or the P_3 treatment. The total leaf area data is shown in Figure 3.

The leaf greenness level of water spinach ranged from 19.33 to 37.10 grams, which was higher than that of the spinach ranged from 18.27 to 20.73. The application of fertilizers showed an increase in the leaf greenness level for water spinach and spinach until treatment P_2 then decreased in treatment P_3 (Figure 4).

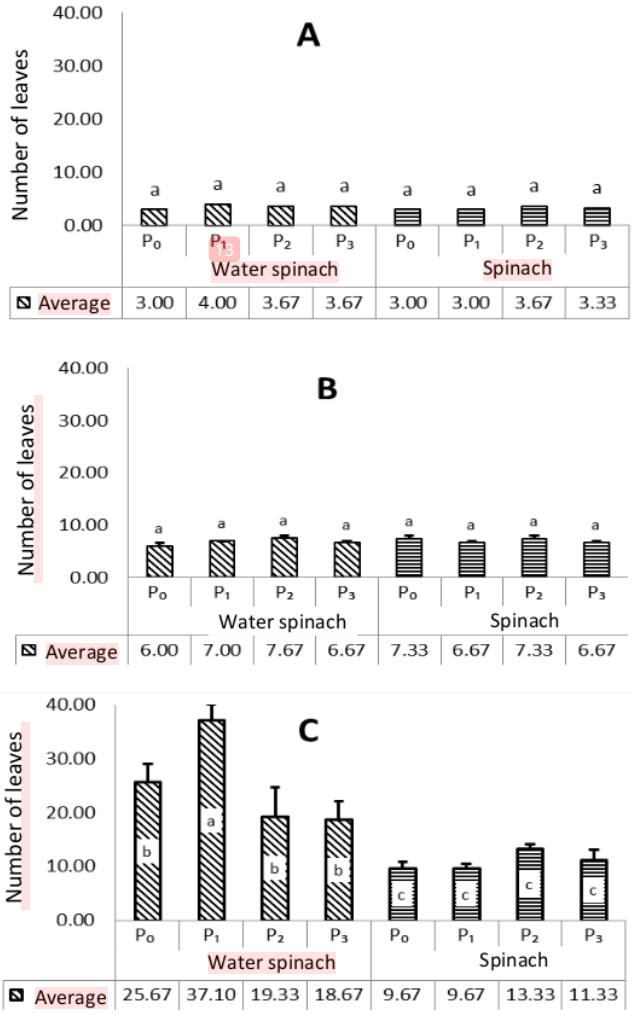


Figure 2 – Numbers of leaves for three weeks after treatment of NPK fertilizer (P) (A=first week; B=second week; C=third week)

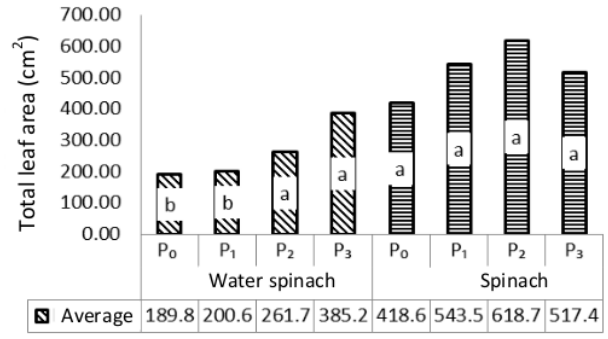
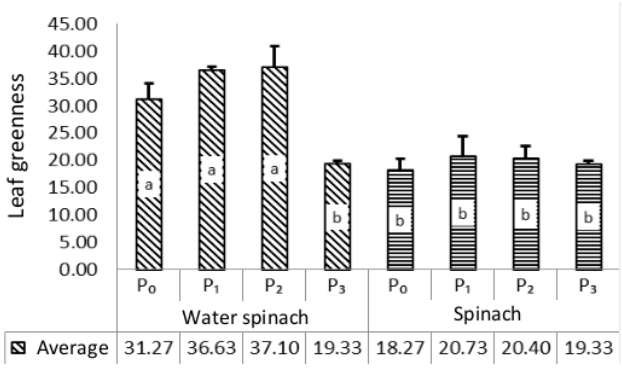
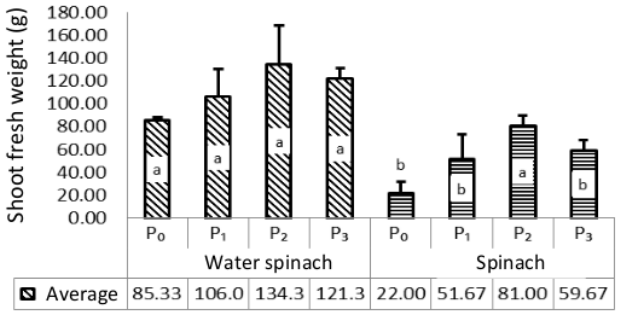


Figure 3 – Total leaf area at week 3 after treatment



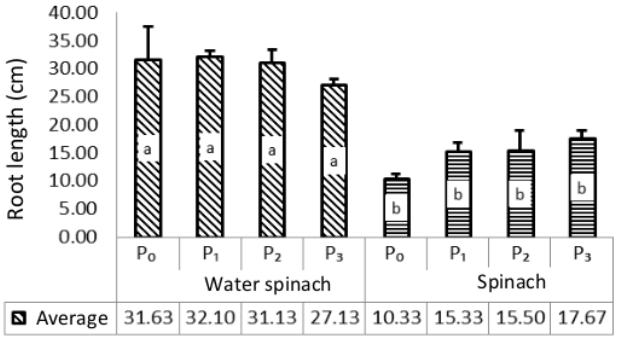
	P_0	P_1	P_2	P_3	P_0	P_1	P_2	P_3
Average	31.27	36.63	37.10	19.33	18.27	20.73	20.40	19.33

Figure 4 – The leaf greenness level at harvest



	P_0	P_1	P_2	P_3	P_0	P_1	P_2	P_3
Average	85.33	106.0	134.3	121.3	22.00	51.67	81.00	59.67

Figure 5 – Shoot fresh weight at harvest



	P_0	P_1	P_2	P_3	P_0	P_1	P_2	P_3
Average	31.63	32.10	31.13	27.13	10.33	15.33	15.50	17.67

Figure 6 – Root length at harvest

The results of the research on the application of NPK fertilizer to the shoot fresh weight of water spinach and spinach plants increased with increasing doses of fertilizer. The shoot fresh weight of water spinach ranged from 85.33 to 134.30 grams and that of spinach ranged from 22.0 to 81.00 grams (Figure 5).

The root length of water spinach plants ranged from 27.13 to 32.10 cm and that of spinach plants ranged from 10.33 to 17.67. The longest root in water spinach was obtained in treatment P_1, which was 32.10 cm and the shortest in treatment P_3, which was 27.13 cm, whereas in spinach the longest roots were in the P_3 treatment, which was 17.67 cm and the shortest in the P_0 treatment, which was 10.33 cm (Figure 6).

DISCUSSION OF RESULTS

Peatlands with dry conditions in the dry season or inundated throughout the year greatly limit plant cultivation activities. Dry conditions make the land unusable because the water table is far below the surface, which can be overcome by lowering the height of the mounds commonly used by farmers. Lakitan (2014) revealed that a technological solution is needed to deal with floods and droughts in peatland area. The results of study from Susilawati and Lakitan (2019) on bush beans plants found that the treatment of a water level 15 cm below the surface resulted in bean production which was no different from the treatment of a water table 20 cm below the soil surface. The application of floating agriculture is an alternative to developing plant cultivation in flooded peatlands (Susilawati et al., 2021; Siaga and Lakitan, 2021; Siaga et al., 2018). The results of the study showed that the cultivation of water spinach and spinach vegetables showed differences. Water spinach plant height is higher than spinach plants. However, increasing the dose of fertilizer until the P_2 treatment on both commodities increased plant height. The research results of Raksun et al. (2020) found that NPK fertilizer had an effect on the height of water spinach plants.

The number of leaves on the two plants, both water spinach and spinach in the first and second week, was relatively the same. However, in the third week the number of leaves on the water spinach plants greatly increased compared to the spinach plants. The increase in the number of leaves was due to the better growth of water spinach plants compared to spinach plants. This is because increasing plant age increased plant weight so that the planting media base was slightly submerged in floating system. Conditions like this do not suppress the growth of water spinach compared to spinach plants. Even though they are land straddles, their stems are still hollow. The anatomy of water spinach stems strongly supported the growth in floating conditions so that plants continued to grow and develop compared to spinach plants which do not have cavities.

The obtained total leaf area parameter contradicts with the number of leaves, where the total area is high in spinach plants which have fewer leaves than water spinach plants. Likewise, based on the size of water spinach leaves it ranges from 4-7 cm x 2-4 cm (Suratman et al., 2000), while spinach leaves are 1.5-6.0 cm x 0.5-3.2 cm. The research results of Setiawati et al. (2019) using organic vermicompost fertilizer and bamboo leaf litter mulch on spinach plants obtained the highest number of leaves 40.33 with a leaf area of 1000.2 cm2 at 5 g vermicompost/kg soil and 5 cm mulch thickness. The results of this study are not in line with the results of research on floating spinach, where spinach leaves are wider with a total of 13.33 leaves with a total leaf area of 618.70 cm^2. Another parameter as indicator of plant response to fertilization is the leaves greenness level. The leaves greenness level of water spinach plants is higher than that of spinach plants. Physically, the color of water spinach leaves is greener than spinach leaves. Spinach leaves are relatively lighter green and thinner than water spinach leaves which are darker green and thicker. Leaf organs are plant parts that are very responsive to fertilizers, so changes in leaf color and thickness greatly affect consumption fresh weight. Idha and Herlian (2018) stated that soil treatment with manure plus NPK gave the best growth and the best consumption fresh weight in lettuce plants.

The results showed that the shoot fresh weight of water spinach plant was higher than that of the spinach plant. However, the highest shoot fresh weight of the two plants was obtained in the same treatment, which was P_2. The shoot fresh weight of water spinach was 134.30 grams and that of spinach was 85.00 grams per plant. The high fresh weight of water spinach which is the result for consumption indicates that the water spinach plant is able to grow well in a floating system. This is because the stems of water spinach have cavities that allows oxygen circulation to the roots so that the roots are still able to respirate. Roots can thus support the growth of the above parts or the canopy. This is different from spinach plants, even though spinach stems are herbaceous, but their ability to distribute oxygen is not as fast as water spinach, where the stems have cavities. However, spinach plants have the potential to be developed in a floating system besides water spinach which is easier because it is supported by the anatomy of the stem. The advantages of water spinach plants

can also be indicated from the root length parameter. Water spinach plant roots are longer than spinach plants. In addition to plants that have hollow stems and herbaceous stems, plants with woody stems can also grow at shallow water levels, even at high water levels above the ground. The results of research on red chili plants those are able to be flooded in the vegetative and generative phases (Susilawati et al. 2012a; Susilawati et al. 2021b).

The results of this research are the first steps that can be taken to develop floating agriculture in swamps, especially in reservoirs within Sriwijaya University Campus. Several related fields can be involved, including the fields of plant ecophysiology, plant breeding, agroclimatology and soil fertility.

CONCLUSION

Based on the results of the study it can be concluded that the floating agriculture of water spinach plants is better than that of spinach plants. The use of NPK fertilizer in vegetable floating agriculture can increase the growth of water spinach plants compared to spinach plants.

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