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Research Paper

The Effect of Flooding On Content Nutritional Elements N, P, K in Ultisols

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ABSTRACT
The purpose of the study was to determine changes in the nutrient content of N, P, K in Ultisols soil due to flooding.
This research was conducted in June-August 2018 at the Soil Laboratory of the Faculty of Agriculture, Mulawarman University.
The treatments in this study were flooding given at levels of 50% and 100% of the field capacity on the planting medium, the soil was flooded for 4 hours and 8 hours, and flooding was given 5 times in 14 days with a 2-day interval. Soil sampling was carried out in the last 2 weeks of each plant growth phase. The data collected is the nutrient content of N, P and K at each phase of plant growth.
The results showed that: (1) the effect of inundationon the total N content was high in the vegetative phase, then decreased in the generative and pre-harvest phases, and lowest in the harvest phase; (2) The effect of inundation on the available P content was highest in the vegetative phase, then decreased in the generative phase, and increased again in the pre-harvest and harvest phases; and (3) the effect of inundation on the available K content, which is high in the vegetative phase, then decreases in the generative and pre-harvest phases, and the lowest in the harvest phase.
KEYWORDS: Flooding, Total N, Available P, Available K, Ultisols

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I. INTRODUCTION

Land in East Kalimantan is generally dominated by ultisols soil, which generally has a relatively low fertility level including less fertile soil, easily erodes, low soil pH, undulating to hilly topography, poor in nitrogen (N) and phosphorus (P) content, and Potassium (K) as well as low cation exchange capacity (CEC) so that it is not able to support plant growth to provide maximum yields.

Flooding is a condition where the soil is no longer able to hold water, causing inundation. In addition to affecting root performance, flooding also affects the chemical conditions of the soil. Changes in oxidative to reductive conditions affect the level of availability and solubility of nutrients needed by plants. This alternating reductive condition with oxidative conditions also triggers elements that are toxic to plants, such as the availability of excess iron, which coats the root surface of plants. This condition will inhibit the uptake of other nutrients for plants.

According to Lindsay (1979) in inundated soil conditions, there will be a change in the life of aerobic microorganisms, turning into anaerobic life. Changes in these microorganisms will cause biochemical changes in the soil. The role of soil microorganisms is in the process of dissolution, fixation, mineralization, immobilization, and oxidation-reduction.

Flooding will affect the behavior of essential nutrients in the soil solution, as well as the growth and yield of rice. The most important change due to inundation is the change in redox potential. A decrease in oxygen supply to near zero in less than a day and an increase in pH to near neutral, have an impact on chemical transformation and nutrient dynamics in the soil, especially the behavior of the elements Al, Fe, Mn, N, P, K, S, Zn, Cu, and Si. Changes in the form of Fe cations as a result of flooding will have an impact on the uptake of P anions, thus affecting their availability to plants (Prasetyo et al 2004).

The purpose of the study was to determine changes in the nutrient content of N, P, K in Ultisols soil due to flooding at various stages of plant growth.

II. MATERIALS AND METHODS

A. Time and Place

This research was carried out for ± 1 month in June 2021. The research was carried out at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda City, East Kalimantan.

B. Tools and Materials

The materials used were: Ultisols soil taken on JalanBatuCermin, Sempaja Utara Village, Samarinda District, East Kalimantan Province, 5 N HCL, P-Bray solution, P dye, standard series, sulfuric acid (9597%), a mixture of selen, boric acid, 40% sodium hydroxide, methyl red, sulfuric acid standard solution, H2SO4N, 0.050N sulfuric acid standard solution.

The tools used are: 25 ml dispenser, 10 ml dispenser, test tube, 2 ml pipette, filter paper, 50 ml shake bottle, shaker machine, flame photometer, spectrophotometer, digestion tube, 250 ml boiling flask, 100 ml erlenmayer, 10 ml burette , magnetic stirrer, test tube, tube shaker, distillation apparatus.

C. Flood treatment

The flooding treatment consisted of 4 types, namely: 4 hours of inundation, with a water saturation level of 50% of field capacity (f1), 4 hours of inundation, with a 100% water saturation level of field capacity (f2), long inundation 8 hours with a water saturation level of 50% of field capacity (f3), and a long inundation of 8 hours, with a water saturation level of 100% of field capacity (f4).

D. Work Procedure

1. Inundation process

The inundation process was given at levels of 50% and 100% of the field capacity on the planting medium, the soil was flooded for 4 hours and 8 hours. The flooding treatment was carried out 5 times in 14 days with an interval of 2 days.

2. Soil sampling

Sampling was carried out from each phase of plant growth, namely the vegetative phase (at the age of 41 days after planting), the generative phase (at the age of 55 days after planting), the pre-harvest phase (at the age of 69 days after planting), and finally the harvest phase (at the age of 83 days after planting).

3. Preparation of soil samples

Soil that has been sampled is prepared for analysis in the laboratory, the soil is placed in a tray and then air-dried for 3 days, after the dry soil is crushed using a soil blender, sieved with a 2 mm sieve, prepared for analysis.

4. Soil sample analysis

After the sample was prepared, a chemical analysis of the soil was carried out in the Soil Science laboratory, Faculty of Agriculture, Mulawarman University.

E. Data Retrieval

The data collected in the study were obtained from the following observational variables: After 28 days of growing tomato plants, the plants were then given flooding conditions in a day at a level of 50% and 100% of field capacity with 4 hours and 8 hours of flooding. The provision of flooding and observations were continued during the growth of the vegetative phase of the plant until the growth of the generative phase or entering the flowering phase of the tomato plant, continued from the flowering phase to the fertilization phase and then continued until the final harvest phase of the tomato plant. Parameters observed were as follows: (1) total N content by Khedjal method, (2) available P content by Bray method, and (3) K content available by Morgan method.

III. RESULTS AND DISCUSSION

A. Total N Elementary Content of Soil

The total N element content given various flooding treatments is presented in Table 1.

Table 1.Total N Elemental Content in Various Flooding Treatments

Flood Treatment (F)	N Total at Vegetative Phase (%)	N Total atGenerative Phase (%)	N Total atPre Harvest Phase (%)	N Total atHarvest Phase (%)
The floodingtime is 4 hours, with a water saturation level of 50% of the field capacity (f1)	0.43 (S)	0.41 (S)	0.37 (S)	0,36 (S)
The floodingtime is 4 hours, with a water saturation level of 100% of the field capacity (f2)	0.51 (T)	046 (S)	0,39 (S)	0.39 (S)
The floodingtime is 8 hours, with a water saturation level of 50% of the field capacity (f3)	0,51 (T)	0.42 (S)	0.35 (S)	0,35 (S)
The floodingtime is 8 hours, with a water saturation level of 100% of the field capacity (f4)	0,44 (S)	0.42 (S)	0.40 (S)	0,41 (S)

Source: Soil Laboratory of FapertaUnmul(2021)

Note: Determination of nutrient status based on the criteria for BPT Bogor in 2005; S = moderate; T = height

The results presented in Table 1 show that: (1) in the f1 treatment, the N content of the soil in the vegetative phase was 0.43%, in the generative phase was 0.41%, in the pre-harvest phase was 0.37%, and in the pre-harvest phase 0.37%. harvest phase is 0.36%. The highest soil N content occurred in the vegetative phase, while the lowest was in the harvest phase; (2) in the f2 treatment, the N content of the soil in the vegetative phase was 0.51%, in the generative phase was 0.46%, in the pre-harvest phase was 0.39%, and in the harvest phase was 0.39%. The soil N content was highest in the vegetative phase, while the lowest was in the pre-harvest and harvest phases; (3) in the f3 treatment, the N soil content in the vegetative phase was 0.51%, in the generative phase was 0.42%, in the pre-harvest phase was 0.35%, and in the harvest phase was 0.35%. The soil N content was highest in the vegetative phase, while the lowest was in the pre-harvest and harvest phases; and (4) in the f4 treatment, the N content in the vegetative phase was 0.44%, in the generative phase was 0.42%, in the pre-harvest phase was 0.40%, and in the harvest phase was 0.41%.

There was a decrease in the N content in the vegetative phase to the generative phase caused by several factors, such as leaching of N elements due to flooding and the influence of N uptake by plants. As stated by Hanafiah in Sitanggang (2013), that the N element in soil and plants is very mobile, so the presence of N quickly changes or even disappears. Loss of N can be through denitrification, volatilization, transport of crop yields or leaching and erosion of the soil surface.

B. Elemental P Content Available in Soil

The content of available P elements given various flooding treatments is presented in Table 2.

Table 2.Elemental P Content Available in Various FloodingTreatments

Flood Treatment (F)	P Available at Vegetative Phase (ppm)	P Available at Generative Phase (ppm)	P Available at Pre Harvest Phase (ppm)	P Available at Harvest Phase (ppm)
The floodingtime is 4 hours, with a water saturation level of 50% of the field capacity (f1)	85,37 (ST)	45,85 (ST)	63,98 (ST)	92,69 (ST)
The floodingtime is 4 hours, with a water saturation level of 100% of the field capacity (f2)	93,33 (ST)	34,44 (T)	73,06 (ST)	73,71 (ST)
The flooding time is 8 hours, with a water saturation level of 50% of the field capacity (f3)	93,70 (ST)	54,91 (ST)	69,45 (ST)	99.17 (ST)
The floodingtime is 8 hours, with a water saturation level of 100% of the field capacity (f4)	103,89 (ST)	64,91 (ST)	56,48 (ST)	80,09 (ST)

Source: Soil Laboratory of FapertaUnmul(2021)

Note: Determination of nutrient status based on the criteria for BPT Bogor in 2005; ST = very high.

The research results presented in Table 2 show that; (1) in the f1 treatment, the P content of the soil in the vegetative phase was 85.37 ppm, in the generative phase was 45.85 ppm, in the pre-harvest phase was 63.98 ppm, and in the harvest phase was 92.69 ppm. The highest soil P content was in the harvest phase, while the lowest was in the generative phase, (2) in the f2 treatment, the soil P content in the vegetative phase was 93.33 ppm, in the generative phase was 34.44 ppm, in the pre-harvest phase. that is 73.06 ppm, and in phase that is 73.71 ppm. The highest soil P content was in the vegetative phase, while the lowest was in the generative phase, (3) in the f3 treatment, the soil P content in the vegetative phase was 93.70 ppm, in the generative phase was 54.91 ppm, in the pre-harvest phase. which is 69.46 ppm, and in the harvest phase is 99.17 ppm. Soil P content was highest in the harvest phase, while the lowest was in the generative phase. and (4) in the f4 treatment, the P content of the soil in the vegetative phase was 103.89 ppm, in the generative phase was 64.91 ppm, in the pre-harvest phase was 56.48 ppm, and in the harvest phase was 80.09 ppm. Soil P content was highest in the vegetative phase, while the lowest was in the pre-harvest phase.

Based on the results of the study, it was shown that in various flooding treatments the available P content was high in the vegetative phase, then decreased in the generative phase, and increased again in the pre-harvest and harvest phases. As stated by Setyorini and abdulrahman (1991) that the availability of P nutrients after flooding is mainly due to the reduction of Fe3+ to Fe2+. Furthermore, there was a decrease in available P again due to uptake by plants during the growth and development of the generative phase of the plant. However, before the harvest phase, the available P content increases again due to the release of P by the soil and P uptake by plants has also decreased.

C. Content of K Elements Available in Soil

The content of available K elements given various flooding treatments is presented in Table 3.

Table 3.Elemental K Content Available in Various FloodingTreatments

Flood Treatment (F)	K Available at Vegetative Phase (ppm)	KAvailable at Generative Phase (ppm)	KAvailable at Pre Harvest Phase (ppm)	KAvailable at Harvest Phase (ppm)
The flooding time is 4 hours, with a water saturation level of 50% of the field capacity (f1)	185,58 (ST)	177,48 (ST)	192,83 (ST)	142,07 (ST)

The floodingtime is 4 hours, with a water saturation level of 100% of the field capacity (f2)	177,05 (ST)	174,49 (ST)	163,18 (ST)	141,64 (ST)
The flooding time is 8 hours, with a water saturation level of 50% of the field capacity (f3)	186,65 (ST)	164,68 (ST)	180,46 (ST)	126,28 (ST)
The flooding time is 8 hours, with a water saturation level of 100% of the field capacity (f4)	174,70 (ST)	179,18 (ST)	169,80 (ST)	125,00 (ST)

Source: Soil Laboratory of FapertaUnmul(2021)
Note: Determination of nutrient status based on the criteria for BPT Bogor in 2005; ST = very high.

The results presented in Table 3 show that: (1) In the f1 treatment, the K content of the soil in the vegetative phase was 185.58 ppm, in the generative phase was 177.48 ppm, in the pre-harvest phase was 192.83 ppm, and in the pre-harvest phase 192.83 ppm. harvest phase is 142.07 ppm. The highest soil K content is in the pre-harvest phase, while the lowest is in the harvest phase; (2) In the f2 treatment, the K content of the soil in the vegetative phase was 177.05 ppm, in the generative phase was 174.49 ppm, in the pre-harvest phase was 163.18 ppm, and in the harvest phase was 141.64 ppm. Soil K content was highest in the vegetative phase, while the lowest was in the harvest phase; (3) P The results of the research presented in Table 2 show that in the f3 treatment, the K content of the soil in the vegetative phase was 186.85 ppm, in the generative phase was 164.68 ppm, in the pre-harvest phase was 180.46 ppm, and in the harvest phase. namely 126.28 ppm. The highest soil K content was in the vegetative phase, while the lowest was in the harvest phase; and (4) in the f4 treatment, the K content in the vegetative phase was 174.70 ppm, in the generative phase was 179.18 ppm, in the pre-harvest phase was 169.8 ppm, and in the harvest phase was 125.00 ppm. The soil K content was highest in the generative phase, while the lowest was in the harvest phase.

The results showed that the available K content in Ultisols soil was highest in the vegetative phase, while the lowest available K content in the harvest phase. It was stated by Setyorini and abdulrahman (1991) that inundation reduces the redox potential (Eh) of the soil thereby increasing the solubility of Fe^{2+} and Mn^{2+}. These cations can replace K^+ which is adsorbed by clay, so that K is released into the soil solution, therefore inundation can increase the availability of K in the soil. However, in the harvest phase, the available K content in the soil decreases again, this is because most of the available K is absorbed by plants.

IV. CONCLUSION

Based on the results of research and discussion, it can be concluded, as follows:

1. The effect of flooding on total N is high in the vegetative phase, then decreases in the generative and pre-harvest phases, and is lowest in the harvest phase.
2. The effect of flooding on available P was highest in the vegetative phase, then decreased in the generative phase, and increased again in the pre-harvest and harvest phases.
3. The effect of flooding on available K is high in the vegetative phase, then decreases in the generative and pre-harvest phases, and the lowest in the harvest phase..

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