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MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERS OF CASSAVA (MANIHOT ESCULENTA CRANTZ) WHICH WET TOLERANT

Rahmawati Rahmawati
Jember University, Agronomy Department, Agriculture Faculty, Jember

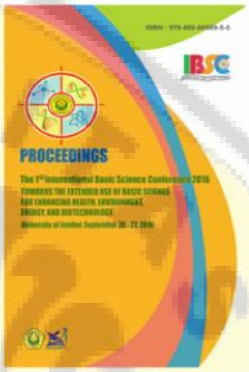
Tri Agus Siswoyo
Jember University, Agronomy Department, Agriculture Faculty, Jember & Jember University, Center for Development Advance Sciences and Technology (CDAST), Jember

Didik Puji Restanto
Jember University, Agronomy Department, Agriculture Faculty, Jember & Jember University, Center for Development Advance Sciences and Technology (CDAST), Jember

Sri Hartatik
Jember University, Agronomy Department, Agriculture Faculty, Jember

Sigit Soeparjono
Jember University, Agronomy Department, Agriculture Faculty, Jember

Sholeh Avivi
Jember University, Agronomy Department, Agriculture Faculty, Jember & Jember University, Center for Development Advance Sciences and Technology (CDAST), Jember



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ABSTRACT Weather conditions often unstable changed and increase the floods of agricultural land. Land which was originally drought will experience wetness and need variety of a plant that wetness tolerant. This study were aimed to get cassava that wet tolerant and to study the morphological, physiological characters of cassava grown on wetness land. The experiment was conducted based on factorial random plot design that consisting two factors with five replications. The first factor were four varieties namely: V1 = Daun Ganja; V2 = Sawi Ketan; V3 = Kasesat Beracun; V4 = Gajah. The second factor was wet treatment consisting of 2 the condition that were K0 = as control, media with 100% field capacity; K1 = as wet treatment by watering of media maintain on -10 cm from media surface. The difference between treatments tested with Duncan Multiple Range Test (DMRT) with the probability 5%. Wet treatment started when plant aged was 2 months after planting, during eight weeks. The observations on variables based on morphological and physiological characters. Result showed that every varieties give the different response on wet treatment. Best response on wet tolerant variety shown by variety code of V2 (Sawi Ketan) were indicated by plant height, total leaf number produced, stem diameter, fresh weight of root, dry weight of root, fresh weight of shoot, dry weight of shoot, photosynthesis index, stomata conductivity and root volume.

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Morphological and Physiological Characters of Cassava (Manihot esculenta *Crantz*) Which Wet Tolerant

Rahmawati[1], Tri Agus Siswoyo[1,2], Didik Puji Restanto[1,2], Sri Hartatik[1], Sigit Soeparjono[1], Sholeh Avivi[1,2]*
[1]Jember University, Agronomy Department, Post Graduate Program, Agriculture Faculty, Jember, 68121, East-Java, Indonesia
[2]Jember University, Center for Development Advance Sciences and Technology (CDAST), Jember, 68121, East-Java, Indonesia,
e-mail: savivi.faperta@unej.ac.id

Abstract—Weather conditions often unstable changed and increase the floods of agricultural land. Land which was originally drought will experience wetness and need variety of a plant that wetness tolerant. This study were aimed to get cassava that wet tolerant and to study the morphological, physiological characters of cassava grown on wetness land. The experiment was conducted based on factorial random plot design that consisting two factors with five replications. The first factor were four varieties namely: V1 = Daun Ganja; V2 = Sawi Ketan; V3 = Kasesat Beracun; V4 = Gajah. The second factor was wet treatment consisting of 2 the condition that were K0 = as control, media with 100% field capacity; K1 = as wet treatment by watering of media maintain on -10 cm from media surface. The difference between treatments tested with Duncan Multiple Range Test (DMRT) with the probability 5%. Wet treatment started when plant aged was 2 months after planting, during eight weeks. The observations on variables based on morphological and physiological characters. Result showed that every varieties give the different response on wet treatment. Best response on wet tolerant variety shown by variety code of V2 (Sawi Ketan) were indicated by plant height, total leaf number produced, stem diameter, fresh weight of root, dry weight of root, fresh weight of shoot, dry weight of shoot, photosynthesis index, stomata conductivity and root volume.

Keywords—cassava, variety, tolerant, shoot, weight

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is an ingredient food alternative replacement of rice have developed [1], this is supported by Indonesia is agrarian country with most of the people are employed in the agricultural sector. The number of people who increase have seized the area agricultural, as a result the ability land to satisfy the needs of food for the people have decreased, the state indonesian companies imports in some commodities that is to satisfy the needs of domestic, one of them is cassava. According to Department of Statistic (2014) said that the cassava national 2014 which 20 million tons while production level national only of 24 million tons, and import cassava in April 2016 was recorded at 6.051 ton. The effort can be done to solve the lack of production cassava namely by intensification and extension program.

Intensification focused on providing seeds cassava which have resistance to biotic and abiotik stress especially water stress, while extension done on marginal land or less fertile including wetlands (marsh, tidal, land often exposed to flood). Data from Pusdatarawa (data center information of

marshes and the seaboerd) said that marsh land in indonesia is 33,3 million hectares , total land swamp developed the government only about 1,8 million hectares and by residents only 2,4 million hectares

Based on the nature of physical and chemical, cassava is tuber or tree roots with stem diameter average 2-3 cm and long 50-80 cm, depending on the type of cassava grown or varieties [2]. Cassava is food crops and trade, as trade plants, cassava can produce to be gaplek, tapioca, ethanol, liquid sugar, sorbitol, monosodium glutamate and aromatic flour. These plants can be used as raw materials to the industry to downstream [3]. Based on the area of food commodities, harvest cassava to level three after rice and corn, the main source of carbohydrates as the third society [4]. Cassava does not require a special condition to growth and relatively easy to cultivation. Morphology and physiology a plant is the result from interaction between genetic and environment, when a population of plants planted on condition the same neighborhood, then diversity emerging caused distinction genetic make-up if other factors are constant [5].

Indonesian cassava variety featured which wet tolerant has not been found . Efforts assembly of the cassava with wet tolerant begins with know characters cassava which wet tolerant. This research were aimed to study morphology and physiology character of the cassava has planted by wet treatment, as well as to receive varieties casava which wet tolerant.

MATERIAL AND METHOD

The experiments was done at Agrokusuma greenhouse of agriculture Faculty and at laboratory CDAST *(Center For Development of Advanced Science and Technology)* Jember University begin in December 2015 until june 2016. Materials that used in this experiment is 4 varieties cassava , polybag , pail, pipe , planting media, a measuring glass, fertilizer NPK. Tools used in this observation is ruler meter, the digital scalpel, calipers, leaf porometer, MINI-PAM, camera, tally counter and tools that deals with maintenance plants and the harvest.

The experiment was conducted based on factorial random plot design that consisting two factors with five replications. The first factor were four varieties namely: V1 = Daun Ganja; V2 = Sawi Ketan; V3 = Kasesat Beracun; V4 = Gajah. The second factor was wet treatment consisting of 2 the condition that were K0 = as control, media with 100% field capacity; K1 = as wet treatment by watering of media maintain on -10 cm from media surface. Thus treatment in this experiment is V1K0 (Daun Ganja with control), V1K1 (Daun Ganja with wet treatment), V2K0 (Sawi Ketan with control), V2K1 (Sawi Ketan with wet treatment), V3K0 (Kasesat Beracun with control), V3K1 (Kasesat Beracun with wet treatment), V4K0 (Gajah with control) dan V4K1 (Gajah with wet treatment).

Wet treatment started when plant aged was 2 months after planting, during eight weeks. Analysis data using Analysis of variance (ANOVA) and the difference between treatments tested with Duncan Multiple Range Test (DMRT) with probability of 5%. Tolerant characteristic of cassava based on characters has observed which consisting of plant height, total leaf number produced, stem diameter, distance between internode, fresh weight of shoot, root volume, fresh weight of root, dry weight of shoot, dry weight of root, photosynthesis index, and stomata conductivity.

RESULTS AND DISCUSSION

The generally of cassava excluding species of plant which tolerant of the excess water and over the next relatively a long time, at the forming tuber when the experience excess water and tuber will be decaying. In growth phase, the excess water in relative long durations or excess water repeatedly can affect the growth of cassava plant and has resulted in change morphology and physiology plant. Mechanism of tolerance plant from excess water condition is an adaptation metabolic allow cells to maintain intregity so that it can survive in conditions hypoxia to minimize damage.

The condition O_2 which limited influenced the growth , the development, and survival of plant. The best response plant to excess water is switching from metabolism respiration aerobic to anaerobic fermentation respiration. Domination protein formed during the hypoxia is enzymes involved in fermentation pathway[6]. The cells of plant need to keep supply ATP is being constantly, so the use of acceptors is the key elements for survival in the condition of excess water. Response of plants can also decrease of stomata conductivity and photosynthesis index, and hydraulic conductivity of roots [7]. Physiological changes in turn affect reserve and translocation of carbohydrates. Efficient use of carbohydrates can be criterion of species tolerant and intolerant.

Table 1. Effect Of Wet Treatment On Several Parameters

Variable	Variance all of Variable					
	Wet (K)		Variety (V)		Interaction (VxK)	
Plant height	18705.63	**	1905.825	**	32.31875	ns
Total leaf number produced	81.22	ns	414.29	**	102.82	ns
Stem diameter	0.20	ns	0.14	Ns	0.13	ns
Photosyntesis index	102.4	**	230.7	**	141.05	**
Stomata conductivity	144.27	**	75.03	**	13.83	**
Fresh weight of shoot	517107.6	**	296289.63	**	182692.2	**
Fresh weight of root	87329.03	**	35218.83	**	21121.22	**
Dry weight of shoot	47610.00	**	94586.27	**	17955.50	**
Dry weight of root	11414.26	**	6131.53	**	3695.04	**
Root volume	21114.03	**	37409.49	**	8855.62	**

Note : ns = no significant * = significant ** = highly significant

Result of the experiment has shown on summary analysis of variance, refer to table. 1 where its influence wet stress or wet treatment at several varieties of cassava on morphology and physiology shows that to varieties treatment and wet treatment show that interaction highly significant is shown by photosynthesis index, stomata conductivity, fresh weight of shoot, fresh weight of root, dry weight of shoot, dry weight of root, root volume, and then non-significant it is shown by plant height, total leaf number produced and stem diameter.

In treatment the use of different varieties show highly significant on variable of plant height, total leaf number produced, photosynthesis index, stomata conductivity, fresh weight of shoot, fresh weight of root, dry weight of shoot, dry weight of root and root volume, and then on stem diameter observation show that non-significant. Wet treatment influence highly significant shown by plant height, photosynthesis index, stomata conductivity, fresh weight of shoot, fresh weight of root, dry weight of shoot, dry weight of root and root volume and then on total leaf number produced, stem diameter observation show that non-significant, refer to table 1.

Tabel 2. Morphological And Physiological Caracters From 4 Varieties Of Cassava With Wet Treatment

Treatment	Height Plant (cm)	Total leaf number Produced	stem diameter (cm)	Photosynthesis index	Stomata conductivity	fresh weight of shoot (g)	Fresh weight of root (g)	Root volume (ml)	Dry weight of shoot (g)	Dry weight of root (g)
V1K0	127 d	39 a	1.31 cd	430.0 bc	23.79 c	586 d	30.8 g	179 d	146 d	5.74 ef
V1K1	171 b	32.6 b	1.144 e	413.8 d	20.46 f	462.2 e	49.4 c	153 e	90.4 f	6.76 e
V2K0	150 c	29.6 bc	1.24 de	433.0 a	24.62 b	226.2 h	41.8 e	149 f	136.6 e	10.7 c
V2K1	199 a	40.8 a	1.66 a	433.8 a	23.57 c	851.6 b	280.2 a	189 c	320.2 b	106 a
V3K0	130 d	20.4 d	1.14 e	427.8 c	29.64 a	281.4 g	46.6 d	143.6 g	75.2 g	8.76 d
V3K1	171 b	25.8 c	1.42 bc	428.8 bc	22.08 d	416.6 f	153.6 b	25 h	146 d	47.2 b
V4K0	153 c	25.4 c	1.44 bc	429.0 bc	21.10 e	632.2 c	29.6 g	273.2 a	275.8 c	5.1 f
V4K1	193 a	26.6 c	1.47 b	430.6 b	17.85 g	905 a	39.4 f	194 b	353 a	5.92 e

Note: Same letter indicated no significant according to test DMRT 5%

Some genotypes plant capable of adapting to the water stress environment through physiological adaptation or genetic mechanism. Every variety shows phenotype and genotip that is different. The character is consistent with each variety character[5]. Result from observation where morphology and physiology character to 4 varieties of cassava is different. The characters that can determine tolerance plants about wet treatment indicated by several variables observation are showing influential very significant at varieties tested (table 1).

In table 2. Seen in the variable plant heigh, total leaf number produced, stem diameter, photosynthesis index, fresh weight of roots, and dry weight of root the highest value indicated code V2K1 treatment, this could be referred to where the plant more tolerant about wet condition than the other varieties, as a form of metabolic adaptation to maintain integrity the cells of plants, so that the able to minimize the damage. While on the variables of observation fresh weight of shoot and dry weight of shoot the highest value shown by code V4K1, this point that the changes in the root of a plant from exposure wet can affect growth header plants, the adventive of roots and modification of roots to be fiber roots which spreads horizontally (Fig. 2), While in the condition without wet treatment roots have started to modified tubers at the age of 114 HST. Fibers the establishment of the roots in cassava with wet condition is one form of adaptation plants in responding about wet condition to help plants to keep and can receive nutrient and oxygen. The development of the root which is good, would be followed by the more improved header growth plants and stems, where stems have a role in support being plants. More large diameter of the stem means the plants will be more strong because in size the body caused by addition tissue cell resulting by addition cell size (Fig. 3).

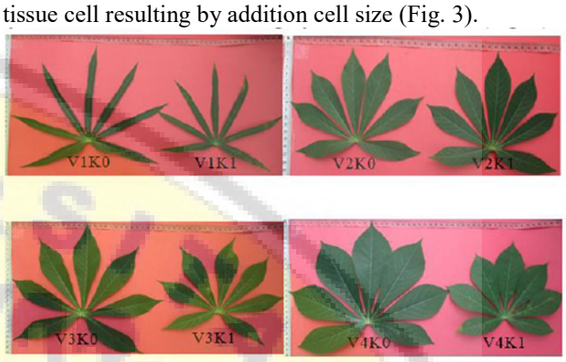

Fig. 1. Leaves 4 varieties of cassava with wet treatment

For soil that experienced excess water will changed physicochemical at the soil. The higher stress, can decrease redox potential (Eh) of the soil and increase pH of soil [8]. Reduction of redox potential (Eh) at soil cause decrease availability of N, P, and K in the soil [9]. On the other hand, micro elements as Fe, Mn, and Cu will increase [10]. Decline in the nitrogen available on soil can be against the decline in the chlorophyll leaves of cassava (Fig. 1), where is wet treatment it can be seen that chlorophyll content lower being indicated by the colored leaves paler and a size leaves less than cassava without wet treatment (control). In tolerant variety a reduction in chlorophyll lower than sensitive variety [11].

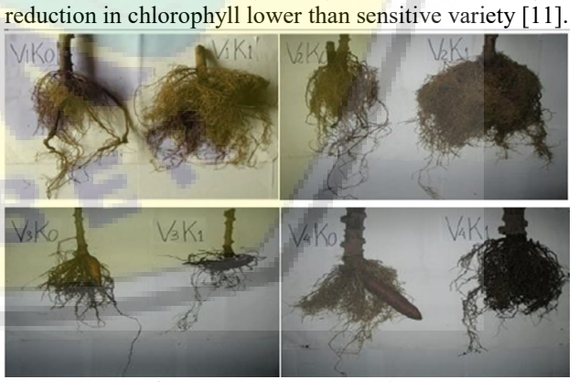

Fig. 2. Roots of 4 varieties cassava with wet treatment

In Fig. 2 it can be seen cassava plant does adaptation system too by increasing the proportion of fiber roots on the ground above wet (approaches the surface the ground). This is in line with adaptation system in plants of the sugar cane by increasing the proportion of root at surface of soil when waterlogging, and the establishment of roots adventive is generally response of tolerant plants of waterlogging [12] where adventive roots, having its high porosity, help plants to proceed with absorption water and nutrient in a waterlogging condition, replace the older root system. With the increase the proportion of roots, so plant remains involve nutrient element more optimal so photosynthesis also keeps run in optimal so plant height, volume roots and fresh weight of roots would up and also followed with increasing dry weight of roots as well as dry weight of shoot (table 2).

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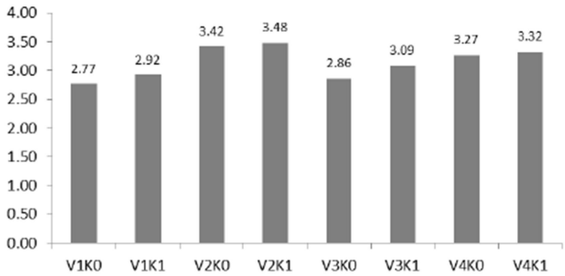

Fig. 3 Internode on a graph (centimeter) at 4 varieties of cassava with wet treatment

In Fig. 3 it can be seen that distance between internodes on wet condition and without wet condition experienced that the difference where the wet condition, the distance between internodes greater if compared without wet conditions to all of cassava varieties which tested. Treatment by code V2K1 has distance between the highest internode with the other varieties and control. This is because one of the reasons the role of gibberellin who be able to attract lengthening internode of stems, lengthening shoots of stems to the events of the cell division. Gibberellin also increase cell division in the meristematic (for example on internode of stem)

Fig. 4. Performance of 4 varieties cassava with wet treatment

The influence of giberelin to cells elongation cause of the hydrolase starch produced by gibberellin that supports the establishment of the *alpha amylase*. Gibberellin work on genes by causing activation at specific genes, the genes that activated form new enzymes that causes the occurrence of a change morphogenetic [13]. Gibberellin with high concentration (up to 1000 ppm) could hinder off root formation. While gibberellin in low concentration as support the growth of adventive roots as *Pisum sativum* and speed of division and cell growth, so that to be quickly becoming high of plant [10]. In Tomatoes Gibberellin (GA)-like substances are shown to be present in the bleeding sap of tomatoes. It is demonstrated that these substances can promote stem elongation in intact tomato plants. Waterlogging of the root system inhibits growth of stem and severely reduces the export of GAs from the root to the shoot in the xylem sap [16]. The performance of four varieties cassava with wet treatment in this research shown on Fig. 4.

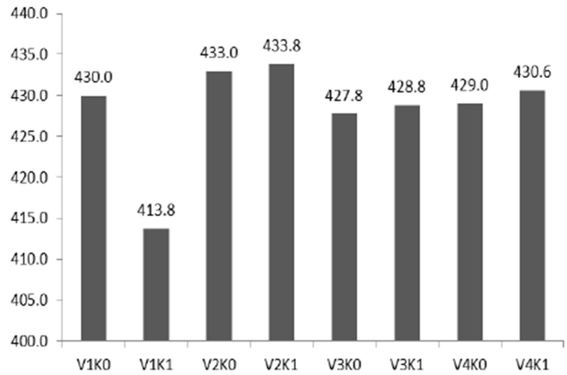

Fig. 5. Photosynthesis index during wet treatment

In Fig. 5, wet treatment gives highly significant impact in the photosynthesis index where wet treatment in cassava reduced the photosynthesis index at the beginning, but for next to harvest, tolerant plant going to show high level in photosynthesis index [14], indicated by plant V2K1, V3K1 and V4K1 while for V1K1 decreasing large enough in photosynthesis index so that the intolerant plant about wet condition. This is because plant which capable of adapting with wetness do translocation fotosintat by increasing the proportion of fiber root. Cassava treated by wet treatment can experience respiration that tends to anaerobic, where plants of stagnant in a short time will experience hypoxia (loss of oxygen). But if plants are far away (over flooding) all in a long period of time, so plants experienced the state of anoksia (the state of environmnet without oxygen) [14].

Wet treatment on cassava makes plant still can carry out photosynthesis with optimal that is to raise the proportion of fiber root that spreads horizontally in surface of soil, it is means that root still can be oxygen so aerobic respiration also can going well so that higher fotosintat produced. This situation positively correlate with fresh weight of shoot, indicated in Fig. 6. Diversity is also reflects a different from cassava genotypes on the growing environment, due to the genetic factors or environment. This means there is a difference individuals genotype value which tested. Variation contained in an individual that caused by 2 that is genetic factor and environmental factor. Genetic factor or genetic variation is at an individual plants causing differences in variety of [13].

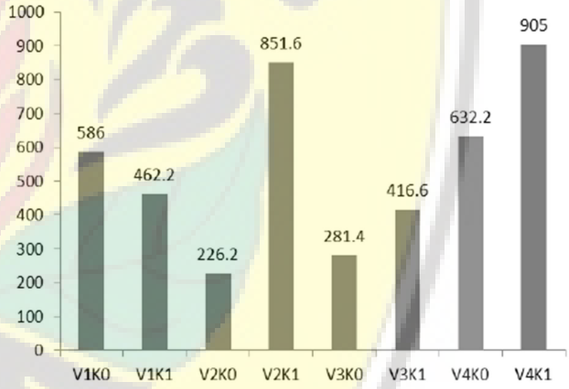

Fig. 6. Fresh weight of shoot (gram) after wet treatment

The low performance of Daun Ganja (V1) variety the possibility is also caused by the variety not fit with local growing environment or with the condition of the excess water given because even this as superior variety, but not assembled for specific location. Genetic factor or internal factor influenced by genetic trait or of the nature of derivative as it plant ages, the morphology of plant, power results, capacity storing a reserve food, resistance to disease and others. External factor is environment factor, such as climate, land and biotic factor. The difference of growth and the results supposedly caused by one or more of factors.

Anaerobic respiration produces CO2, NADH and NAD that is not the main ingredient used as energy to the photosynthesis process, while in aerobic respiration (the happening in treatment without flooding) can produce ATP, FADH2, NADH, and CO2, which will used as a load energy supply for the process of photosynthesis[10]. So that can be concluded that with the flooding, so of the cassava plant experienced anaerobic respiration that tends to decrease index the rate of photosynthesis. There is something more though that can happen to plant experienced anaerobic repiration, namely denitrification N. The flooded condition of certain fluctuant anaerobic microorganisms use nitrate as a source of oxygen in respiration, so as to cause denitrification by releasing

nitrogen oxide (N_2O). Denitrification decreases nitrat-N, and it is common symptom on waterlogging condition [15] .

CONCLUSION

Based on the research done and discussion can be concluded that there are cassava varieties show better results on wet condition than the condition without wet based on variable observation height plant, total leaf number produced, stem diameter, the distance between internode, fresh weight of shoot, fresh weight of roots, root volume, dry weight of shoots, dry weigth of roots and photosynthesis index, but shows more low result on observation in stomata conductivity .

The best response on cassava variety which wet tolerant indicated by Sawi Ketan variety (V2) and Gajah variety (V4). While variety that not tolerant of wetness indicated by Daun Ganja variety (V1) .

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