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Research Article

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Tolerance Test of Shallots (*Allium cepa* L.) at Tidal Swamplands (a Case study of Central Kalimantan, Indonesia)

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Abstract The cultivation of shallot (*Allium cepa* L.) can be implemented at sub-optimal lands especially at tidal swamplands because of its capability of adaptation. The experiment was conducted on April 2018 to December 2018 at tidal swamplands in Mambulau Barat, Anjir Serapat Timur sub-district, Kapuas district. The objective of this study was to obtain adaptive varieties in tidal swamplands. The design statistic for study used randomized complete block design with 3 replications. Several shallot varieties used in this study include Pikatan, Tajuk, Bima Brebes, Super Philip, Bauji, Kramat 1, Maja, Katumi, Mentes, Pancasona, Biru Lancur, Keta Monca, Manjung, Rubaru, dan GH2. The result showed thath they have good productivity at tidal swampland with yield range 8.96 tons/ha to 17.94 tons/ha. The highest productivity was achieved by genotype of Ketamonca 17.94 tons/ha, while the lowest is GH2 with production of 48.96 tons/ha and the optimum tuber weight per is Tajuk with total weigh of 9.13 grams.

Keywords *Allium cepa* L., tidal swamplands, Central Kalimantan

1. Introduction

Shallot has a wide adaptation, so that this plant is able to adapt from lowlands to highlands [1]. It can then be implemented at various land typologies. Shallot which has high economic valueis consumed by the wider community both in the form of fresh and processed form, and it is considered as the main rating of public consumption in addition to garlic and red chili. The average consumption of shallot per capita within a week is 0.49 ounces and comparing to garlic and red chilli, it is higher 0.31 ounces and 0.03 ounce respectively [2]. The high demand for shallots causes price fluctuation within a certain period of time.

Tidal swampland development is an alternative to agricultural landuse that should be managed appropriately. In Indonesia, the potential of tidal swamplandsreach20.1 million hectares in which 9.53 million hectares are potential for agricultural land development located in several islands such as Sumatra, (3.9 million hectares); Papua (2.8 million hectares) and Kalimantan (2.7 million hectares) [3].

Total areas of tidal swampland that has been cultivated both by local communities or by government through transmigration program is approximately 4.1 million hectares. Central Kalimantan with total areas of tidal swampland 5.5 million Ha, consist of 4,131,360 Ha allocated for agricultural and fisheries land, and 1,195,771 ha for consecravtion located in ex mega project of PLG. The results of study has been showed that in peatland areas, they can produce shallot 5.8 ton/ha, while in dry lands developed from quartz sand materials, they can produce 12.4 ton/ha [4].

The farming of shallots at tidal swamplandsshould be managed specifically include water management, fertilization and dolomite application in order to increase soil pH. Land management using flat bed system that is higher than land surface can be implemented in order to prevent leaching so that the application fertilizer can be used optimally. Green management is expected to be able to produce shallot well adapted to at tidal swamplands.The aim of this study was to determine the tolerance and adaptation of 15 shallot varieties culticated in tidal swamplands.

Materials and Methods

The study was conducted on April 2017- February 2018 at tidal swamplands with land type B/C located in Mambulau Barat, Anjir Serapat Timur sub-district, Kapuas District, Central Kalimantan Province.

There are 15 genotypes of shallots used in this this study such as Pikatan, Tajuk, Bima Brebes, Super Philip, Bauji, Kramat 1, Maja, Katumi, Mentes, Pancasona, Biru Lancur, Keta Monca, Manjung, Rubaru, and GH2. These genotypes are came form Central Kalimantan, Madura, Nganjuk, and West Java. The materials used involves manure, urea, TSP, KCl, herbicides, and pesticides. Several tools used include hoes, machetes, tripe, scissors, plastic bags, digital scales, meters, cameras and stationery.

All of 15 genotypes of shallots were observed in order to know the response of shallots to various environmental conditions with experiment areas 10 m x 2 m and spacing of planting 20cm x 15cm. The shallot cultivation technique used invlove:

(1) Planting a tuber as shallot seeds per hole; (2) each land was simply managed by using manure 5 tons/ha and left for 14 days; (3) NPK fertilizer is applied 15 days after planting (DAP); (3) weeding; (4) pest and diseases control; (5). Measurements with interval 15; 30 and 45 days after planting; (6) Harvest in 60 days after planting and observation to several parameter include number of plants growing 15 DAP, plant height (cm); number of leaves (strands); harvest time at diferrent land typology, tidal swamplands and dry lands; 7) Root length (cm); 8) Number of tubers per clump; 9) Weight of wet bulbs per clump 10) Hardness of bulb, 11) Diameter of shallot (mm). The 15 genotypes were tested in experiment using a Complete Randomized Block Design with 3 replications. Data from observations in the field were further analyzed using SAS software and Duncan's test. Observation of tolerance selection was conducted using several tolerance index methods, namely:

1. Stress susceptibility index (SSI) = $1-(YsYns/)\ 1-(\bar{Y}s/\bar{Y}ns)$ [5];
2. Tolerance (TOL) = $Yns - Ys$ [6];
3. Stress Tolerance Index (STI) = $YsxYp\bar{Y}ns\ 2$ [7];
4. Mean productivity (MP) = $Ys + Yns\ 2$ [6];
5. Harmonic Mean (HM) = $2\ YsxYnsYs + Yns$ [8];
6. Stress Susceptibility percentage Index (SSPI) = $[(Yns - Ys)\ (2\ x\bar{Y}ns/)]\ x\ 100$ [9]; and
7. Yield Stability Index (YSI) = YS/YNS [10].

Where Ys, Yns is the average output of the recorded condition and normal conditions for each number of hypotheses and $\bar{Y}s$,$\bar{Y}ns$, showing the results of the results in the recorded condition and the normal conditions of the range of the tested prototypes.

Results and Discussion

The result of variety analysis for agronomic character diversity of 15 shallot varieties planted at tidal swampland is presented at Table 1. Data variety for productivity, tuber weight, for the character of root length and tuber hardness did not vary significantly at test level of 5%.

The result of observation showed that shallots are quite adaptable to tidal swampland environmental conditions, although they have limiting factors such as the presence of Al and Fe stress. However, they still have good production.The productivity of shallot was ranged from 8.96 to 17.94 tons per hectare. The lowest productivity was produced by e GH2 variety, while the highest is Keta Monca. The weight of tuber, root length, and tuber hardness are ranged respectively 3.71 (GH2) -9.13 grams (Tajuk), root length, 1.57 (GH2) to 2.46 cm (KetaMonca) and 2.98 (Pikatan) to 4.76 (Tajukr) for tuber hardness. Based on agronomic characters, they showed that KetaMonca variety is very adaptive at swamplands. Other research show that the result of adaptation for 9 shallot varieties has character 2.7-9.7 for number of tubers, 0.61-3.02 cm for tuber diameter, and 19.4-46.29 grams per clump for tuber weight. This information can then be used as basic consideration that the prospect of shallot development can be implemented at tidal swamplands in Central Kalimantan.

The results of experiments showed that the productivity of shallots at tidal swampland show good results with land management of minimum tillage in order to maintain the condition of land under anaerobic conditions and pyrite content cannot be oxidized. The highest productivity of shallots was produced by Ketamonca genotype (17.94 tons/ha) (Figure 1) and the lowest was GH2 genotype (8.96 tons/ha). The harvest period time in tidal swampland was relatively short and it takes only 57 days after planting (DAP)(3 days faster), compared to dry land that require up to 60 DAP.

The productivity of shallots is strongly influenced by the weight per tuber and reflected by tuber weight. The highest weight per tuber in this study is Tajuk genotype with value of 9.15 tons/ha. However, because of small number of tubers, the productivity become low.

The highest tuber weight per plant is Tajukwith total weight of 9.13 grams. The potential of this genotype is 6-10 grams, so that the yield of tuber weight is almost the same. The productivity of Tajuk genotype is 15.54 tons/ha for wet bulbs, and this is also almost the same with national genotype potential i.e. 14 tons/ha for dried bulbs. It can then indicate that the results of this study is not quite different with plant tat cultivated at dry lands.

Table 1: The character of agronomic for 15 shallot genotipes at tidal swampland in Central Kalimantan

Varieties	Productivity (ton hectare^{-1})	Tuber weight(gr)	Root length (cm)	Tuber hardness
Pikatan	11.70ab	5.95bc	2.96	2.98
Tajuk	15.54ab	9.13a	4.14	4.76
Bima Brebes	13.95ab	6.22bc	3.67	4.15
Super Philips	15.35ab	5.17bc	3.92	3.40
Bauji	12.85ab	5.67bc	2.87	3.31
Kramat 1	13.22ab	5.42bc	3.04	3.37
Maja	15.07ab	5.42bc	3.15	3.34
Katumi	10.26ab	5.07bc	2.70	3.29
Mentes Pancasona	10.54ab	5.11bc	3.92	3.37
Biru Lancur	17.11ab	6.65bc	3.31	3.56
Keta Monca	12.02ab	5.94bc	3.39	3.79
Manjung	17.94a	5.48bc	4.56	4.46
Rubaru	10.81ab	6.27bc	2.98	3.34
GH2	10.54ab	4.47bc	3.37	3.42
	8.96b	3.71c	2.31	3.9

Note: The value followed by the same letter in the same column was not significantly different at the 5% test level based on Duncan's multiple test.

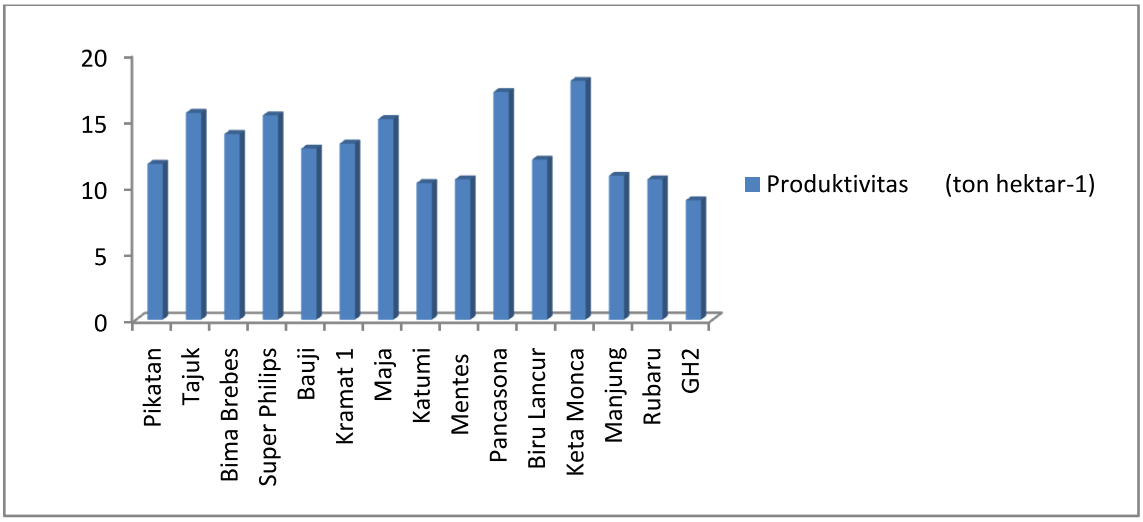


Figure 1: Productivity of 15 genotypes of shallot at tidal swamplands (ton hektar^{-1})

The lowest tuber weight per plant was produced by the GH2 strain (3.71 grams). This genotype still need further test phase at various seasons and environment in order to dtermine its adaptability to various land typologies, seasons and its interactions with the environment. The tuber weight or number of different tubers for the 15 genotypes that have been tested showed that the performances of shallot is influenced not only by by genetics but also by environmental factors [11], and large shallots produce a small number of tillers [12].

The level of tuber hardness was not significantly different for each genotypes and this is in line with the reported research which stated that there is no significant difference for shallot tuber hardness in Paluvalley although it was treated with different fertilizers. The level of hardness on shallot shows that photosynthate accumulation ability is in good conditionsincluding the level of pectin in the tuber.The tuber hardness test result in value between 2. 98 (kg/m^2) and 4.76 (kg/m^2), especially for Pikatan and Tajuk genotypes. Anshari et al [13] added that shallot with high level of hardness has a greater ability to performe photosynthesis, so that photosynthate accumulation in the tuber becomes higher and then tuber hardness becomes increase. The level of hardness in tuber is more influenced by genetic factors compared to the environment and this condition is due to changes in water-soluble pectin (protopectin) into water-soluble pectin [14]. In addition, it is also influenced by the evaporation of water in the intercellular space so that cells become wrinkled and fused and substances the pectin are binded each other so that the shallots will be harder.

The results of analysis for root length character were not significantly different for the 15 genotypes of shallots. The root lengths from the lowest to the highest is 2.31 cm-4.36 cm. The longest is Tajuk while the lowest is GH2 genotype. Roots are part of plants that are directly affected by Al and Fe stress. Short roots are likely to experience stress. Cheng et al. [15] stated that roots can affect growth in tomato plants because they affect cell division and fitohormon balance, so that if the roots are disturbed or root stress is not well developed. Furthermore, it is very influential on O_2 diffusion and nutrient absorption which results in deficiencies in plants involving nutrients and macro and micro nutrients which eventually produce low production.

Assessment of 15 Genotypes Using 7 Tolerance Test Methods

The phenotypic appearance of shallots in the field was tested using 7 methods to see the stability and tolerance at tidal swamplands (Table 2). Some tolerance index methods used produce different tolerant genotypes for each method (Table 2).

Based on Stress Susceptibility Index (SSI) method, those with low value are stable genotypes in two different conditions. Genotypes G2, G3, G6, G7, G8, G11, G14 and G15 have stability values below 1 so that these 7 genotypes are stable and tolerant genotypes compared to the other seven genotypes. The results of analysis using Tolerance Method (TOL) showed that G2 and G12 genotypes were tolerant genotypes compared to other genotypes because these two genotypes had the lowest stability value compared to other genotypes.

Table 2: The results of analisys using various tolerance methods to the 15 genotypes of shallot at tidal swamplands

Genotype	Yns	Ys	SSI	TOL	STI	MP	HM	SSPI	YSI
G1	17.4	11.70	1.1	5.68	0.67	14.56	14	24.91	0.67
G2	14.84	15.54	0.97	-0.72	1.05	15.2	15.2	-2.43	1.05
G3	20.56	13.95	0.84	6.59	0.68	17.27	16.64	16.03	0.68
G4	17.87	15.35	1.07	2.5	0.86	16.62	16.53	6.99	0.86
G5	24.44	12.85	1.09	11.57	0.53	18.66	16.86	23.67	0.53
G6	20.74	13.22	0.76	7.5	0.64	16.99	16.16	10.08	0.64
G7	16.76	15.07	0.93	1.67	0.9	15.93	15.88	4.98	0.90
G8	21.11	10.26	0.79	10.83	0.49	15.7	13.83	25.65	0.49
G9	22.5	10.54	1.04	11.94	0.47	16.53	14.37	47.76	0.47
G10	22.04	17.11	1.09	4.91	0.78	19.59	19.28	11.14	0.78
G11	19.72	12.02	0.82	7.68	0.61	15.88	14.95	19.47	0.61
G12	17.87	17.94	1.01	-0.09	1.01	17.92	17.91	-0.25	1.01
G13	17.69	10.81	1.03	6.86	0.61	14.26	13.43	19.39	0.61
G14	18.98	10.54	0.79	8.43	0.56	14.77	13.57	22.18	0.56
G15	11.39	8.96	0.96	2.41	0.79	10.19	10.04	10.58	0.79

Notes : Yns = Yield at normal conditions; Ys= yield at stress conditions; TOL =*Tolerance of Stress;* SSI = *Stress susceptibility index;* STI = *Stress Tolerance Index*; MP = *Mean productivity; HM = Harmonic Mean;* SSPI = *Stress Susceptibility percentage Index;* YSI =*Yield Stability Index;* G1=Pikatan, G2=Tajuk, G3=BimaBrebes, G4=Super Philip, G5=Bauji, G6=Kramat 1, G7=Maja, G8=Katumi, G9=Mentes, G10=Pancasona, G11=BiruLancur, G12=Ketamonca, G13=Manjung, G14=Rubaru, G15=GH2.

The STI (Stress Tolerance Index) method showed that tolerant genotypes include G2 and G12, whereas for MP (Mean productivity), the tolerant genotypes are G3, G5, G10 and G12. The HM (Harmonic Mean) showed that there are two genotypes namely G10 and G12 that have tolerance better than other genotypes. The SSPI (Stress Susceptibility Percentage Index) method showed that G1, G8 and G9 are more tolerant while the YSI (Yield Stability Index) method showed that tolerant genotypes are G2 and G12.

The results of tolerance analysis using the TOL, SSI, STI, MP, HM, SSPI and YSI methods indicate that the G12 genotype is a genotype that is tolerant to the TOL, STI, MP, HM and YSI methods, whereas for G2, it is tolerant genotype for the SSI, TOL , STI and YSI method. The G3 genotype is only tolerant to the SSI and MP methods while for the G8, it is tolerant genotype according to the SSI and SSPI methods.

The methods of Stress susceptibility index (SSI) was used to measure the decrease in production or yield in stress condition compared to the optimum conditions. The low SSI values indicates that this genotype is tolerant of stress in tidal swampland. Several genotypes that have lower index values indicate that they have more stable production ability in both stress conditions and normal conditions. The genotypes that have lowest values include G6 (0.76), G8 and G14 (0.79). Whilefor the highest are G1 (1.1) and G5 and G11 genotypes have the same value (1.09). Kumar et al., (2014) has classified that there 4 group of SSI values: highly drought tolerant (SSI <0.50, drought tolerant (SSI = 0.51-0.75), moderately drought tolerant (SSI = 0, 76-1) and drought susceptible (SSI> 1.00). Based on these divisions, moderately drought tolerant genotypes (SSI = 0.76-1) involve G2, G3, G6, G7, G8, G11, G14 and G15 genotypes. The drought susceptible (SSI> 1.00) genotypes include G1, G4, G5, G9, G10, G12 and G13.

The lowest TOL values are -0.09 and -0.72 for G12 and G2 genotypes, while the highest values are G9 (11.94) and G5 (11.57). The low value of tolerance of stress (TOL) indicates that the genotype has a high tolerance to stress condition and it is quite stable under stressed conditions and without stress.

Stress tolerance index (STI) can be used to identify genotypes that have high productivity under stress and normal conditions. A high value of STI indicates that the genotype is tolerant to stress conditions. STI values areclassified into 2 groups, namely STI> 1 = tolerant genotype and STI <1 = sensitive genotype. Based on the results of the STI analysis, there are only two tolerant genotypes, namely G2 and G12. While the other 13 genotypes are sensitive groups.

Measurements using Mean Productivity (MP), tolerant genotypes are seen from high production on optimal land and they are relatively low in stress conditions. A high MP value indicates that this genotype is tolerant [16]. Based on this measurement there are 7 genotypes that have high MP values, namely genotypes of G3, G4, G5, G6, G9, G10 and G12. However, the other genotypes also have high productivity in tidal swamplands.

The high Mean Harmonic (HM) indicated that the plant is tolerant at tidal swamplands, while for those with low values indicate that the plant is sensitive. Based on this method which has high HM values, they include G3, G4, G5, G6, G10 and G12genotypes. Based on the MP and HM method, several genotypes that have high values except G9 genotype, they are not included in the HM method.

The Stress Susceptibility Percentage Index (SSPI), emphasized on productivity stability at stress and optimal conditions rather than high productivity at both stress and optimal conditions [17]. The existence of environmental changes will cause changes in productivity of shallots. The SSPI value is the percentage of yieldchanges at stress and normal conditions so that the smaller the SSPI value, it means that thee plant is tolerant. This explained that genotypes that have low values are G8, G9, G5 and G14, while for those with the highest values are G2 and G12 genotypes which are categorized as sensitive.

Yield Stability Index (YSI) is a method that can be used for tolerant genotypes and sensitive genotypes. The high YSI value indicates that the genotype has high productivity even though it is at stress condition. The YSI value can be goruped into 4 categories, i.e. highly stability in drought tolerant (YSI> 0.60), stable drought tolerant (YSI = 0.41-0.60), moderately stability in drought tolerant (YSI = 0.20-0,40) and drought susceptible (YSI <0.20). Based on these categories, the 15 genotypes tested are included to highly stability in drought tolerant (YSI> 0.60) for 11 genotypes namely G1, G2, G3, G4, G6, G7, G10, G11, G12, G13 and G15 and stabildrought tolerant (YSI = 0.41-0.60) for 4 genotypes namely G5, G8, G9 and G14. Based on the Yield Stability Index model, it shows that all genotypes that have been tested are tolerant at tidal swamplands because they have high productivity even though they are planted in tidal swamplands with limiting factors for Al and Fe stress which in a certain amount can disrupt shallot plant growth.

Correlation Analysis between Tolerance Index

Estimation of tolerant genotypes to Al and Fe stress at tidal swamplands using various methods will give different results for several methods used [18]. The use of various selection methods will provide complete information in making selection. Correlation analysis between stress conditions (Ys) and productivity under normal conditions (Yns) and correlations with all methods provide important information about tolerant genotypes and best index to be used for selection.

Based on correlation value, productivity in stress conditions (Ys) does not have correlation with productivity at optimum conditions (Yns) where r = 0.088 (Table 3). This condition provides information that the potential of yield at optimum conditions do not affect the results atstress conditions. The correlation value indicates that selection of genotypes with high productivity under optimum conditions is not efficient or cannot be used for high yielding plants at stress condition.

Table 3: Correlation coefficient between yield tolerance index at normal conditions (Yns) and stress conditions (Ys)

	Yns	Ys	SSI	TOL	STI	MP	HM	SSPI	YSI
Yns	1								
Ys	0.088	1							
SSI	-0.016	0.285	1						
TOL	0.747**	-0.597*	-0.203	1					
STI	-0.611*	0.723**	0.248	-0.975**	1				
MP	0.793**	0.677**	0.163	0.187	0.009	1			
HM	0.564*	0.866**	0.219	-0.124	0.284	0.947**	1		
SSPI	0.531*	-0.663**	0.034	0.870**	-0.879**	-0.014	-0.298	1	
YSI	-0.611*	0.723**	0.248	-0.975**	1.000**	-0.009	0.284	-0.879**	1

The coefficient of tolerance index correlation with Ys and Yns showed a positive significant correlation with Ys and Yns namely MP and HM. TOL, SSPI has a negative correlation with Ys and STI, YSi has negative correlation with Yns while HM has positive correlation with MP and SSP and it also positively correlatiton with TOL.

The MP and HM index are used to determine tolerant genotype based on the potential yields in both stress and optimum conditions. Positive correlation values for Ys and Yns show greater tolerance to stress in tidal swampland, so that the index is ideal for selection in both environmental conditions.

The TOL and SSI index separate tolerant genotypes and genotypes based on high yields in stress conditions. The smaller index value indicates that genotype is more tolerant and conversely, the higher index value indicates that the genotype is a susceptible genotype. The TOL index value has negative correlation with Ys, so that the index is very effective to use because it still has high productivity even though it is in a stress condition.

The selection method used showed that the index using TOL and SSPI is very suitable to be used for high yield genotypes in stress environments while STI and YSI are very suitable for optimum environments. The MP and HM indexare very suitable to be used for selection in both stress and optimum environments.

Principal Component Analysis (PCA)

The relationship of genotypes and stress tolerant index for Al and Fe in tidal swampland can be seen using Principal Component Analysis (PCA) (Figure 2). The total variation obtained from the two main components is 87.5%, where the main component (PC1) describes 53.7% with the highest value found in the STI and YSI index. Genotypes that have positive and highest will have highest potential yield in stress and optimal conditions.

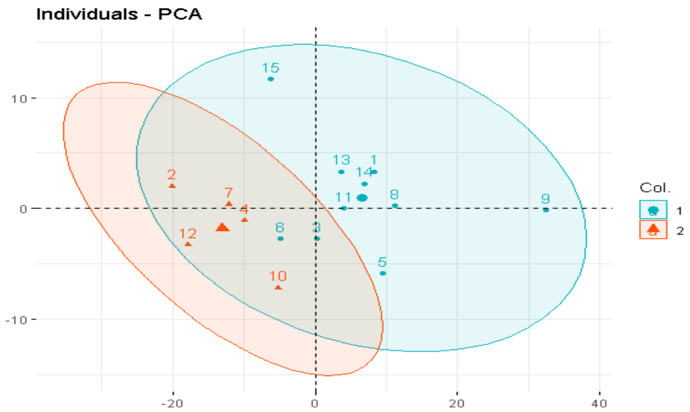
Table 4: Main component of analysis results for productivity at optimum conditions (Yns) and stress conditions (Ys) using seven index of tolerance to the 15 genotypes of shallots

Variable	PC1	PC2	PC3	PC4	PC5	PC6
Yns	-0.244	-0.481	-0.058	-0.072	-0.392	0.053
Ys	0.359	-0.35	-0.042	0.179	0.19	0.481
SSI	0.117	-0.119	0.946	-0.277	-0.014	0.017
TOL	-0.436	-0.154	-0.019	-0.177	-0.442	-0.275
STI	0.45	0.055	0.023	0.252	-0.427	-0.22
MP	0.039	-0.569	-0.068	0.056	-0.175	0.332
HM	0.174	-0.526	-0.075	-0.021	0.456	-0.692
SSPI	-0.414	-0.046	0.297	0.851	0.106	-0.058
YSI	0.45	0.055	0.023	0.252	-0.427	-0.22
Eigenvalues	48.34	30.45	9.86	1.09	0.25	0.01
Variation (%)	53.7	33.8	11.0	1.2	0.3	0.000
Cum. Percentage (%)	53.7	87.5	98.5	99.7	1.000	1.000

The second main component (PC2) explain that 33.8% of total variability with positive values between STI and YSI. The second component is stress tolerant dimension and separates tolerant genotypes from intolerant ones. Genotypes that have high PC1 and low PC2 are very good at both stress and optimal conditions (Aliakbar et al., 2014). Based on that value of index, the highest values are G3 (Bima Brebes), G4 (Super Philip), G5 (Bauji), G6 (Kramat 1), G9 (Mentes, G10 (Pancasona) and G12 (Ketamonca)genotypes.

The biplot analysis in Figure 2 showed that the 15 genotypes tested is grouped into 2 large groups, namely group 1 (G1, G3, G5, G6, G9, G11, G13, G14 and G15) and group 2 (G2, G4, G7, G10 and G12). Based on the grouping, it shows that group 1 is genotypes that have high yield at optimum conditions, while for group 2, they are genotypes that have high productivity in stress and optimal condition. Biplot analysis using 7 tolerance indix which have not been effective in separating group 1 and group 2 for tolerant and sensitive plants.

PC2 (10%)



PC1 (87,9%)

Figure 2: The main component (AKU) analysis results were based on tolerance from 15 genotypes of red rice planted in the fields according to Central Kalimantan

Analysis Based on UPGMA dendograms

Cluster analysis based on Yns and Ys results and seven tolerance index showed that there are two large groups. The first group include 5 genotypes (G2, G4, G7, G10 and G12), while for other group, there are 10 genotypes (G1, G3, G5, G6, G8, G9, G11, G13, G14 and G15).

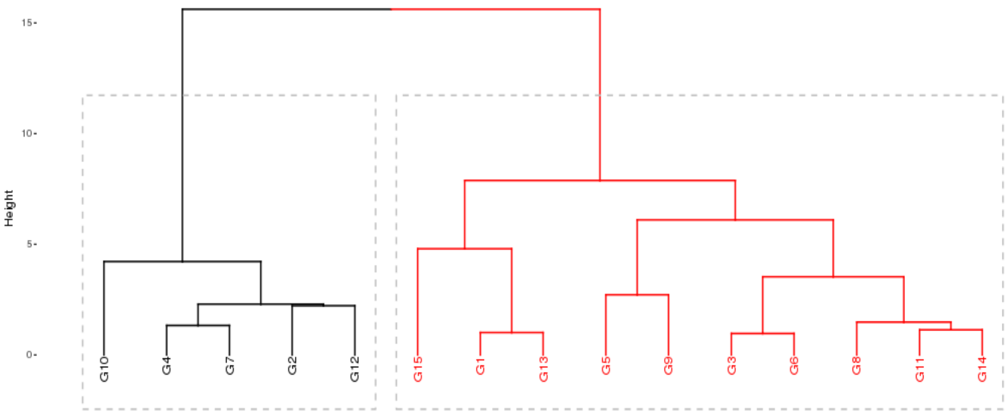


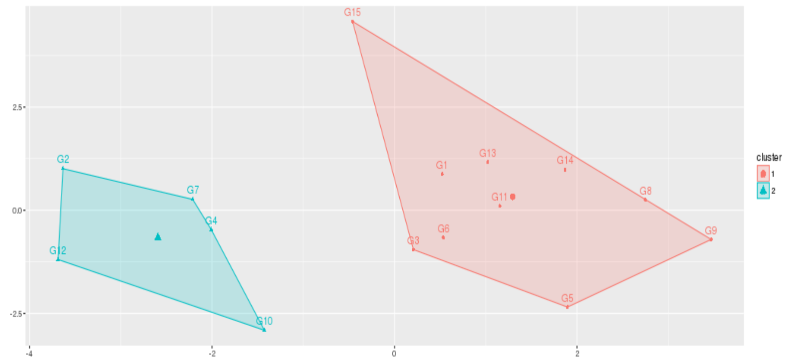
Figure 3: Dendogram Based on Tolerance Index In 15 genotypes of shallots

The results of grouping showed that genotypes of G2, G4, G7, G10 and G12 are the best and more tolerant genotypes for two environmental conditions both at tidal swampland and dry land. These results are supported by high index value for tolerance index using TOL, YSI, MP and HM. The second group showed that the genotype was more sensitive so that it was only suitable for use at optimum conditions.

Based on Cluster plot (Figure 3), it shows that for G2, G7, G10 and G12, they have high productivity both in two environments (tides and dry land) and these genotype are also more tolerant. The second group shows that there are 4 genotypes (G3, G5, G9 and G15) that have high productivity only on optimum land (dry land).

PC1 (53,7%)

PC2 (33,8%)



PC1 (53,7%)

Figure 4: Biplot Based on Intolerance in 15 genotypes of shallots

Conclusion

The tested genotype has positive response at tidal swamplands, with fairly good productivity and extensive adaptability in both lowlands and highlands. The productivity of shallots is quite optimum in the range of 8.96 tons/ha to 17.94 tons/ha. The highest productivity was achieved by Ketamonca genotype with production of 17.94 tons/ha. While the lowest is GH2 that produce 8.96 tons/ha and the best weight per tuber is Tajuk with weight of 9.13 gr.

The seven methods of tolerance index indicated that Tajuk, BimaBrebes and Ketamonca are genotypes that have tolerance to tidalswampland and dry land. Based on 5 tolerance index, TOL, STI, MP, HM and YSI, they show that G12 genotype is tolerant genotype.

The results of analysis using correlation coefficient indicated that the tolerance index of TOL and SSPI method is an appropriate selection method for stress conditionat tidal swamplands, while for optimum land,the appropriate method was STI and YSI. Tolerance index method that is suitable for the protected environment and optimal land that is most effective using MP and HM.

Based on PCA and dendogram, the best tolerance index for used is STI and YSI index. Selected genotypes as tolerant genotypes consist of Tajuk and Ketamonca.

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References

[1]. Swasono, FDH, 2012, 'Karakteristik fisiologi toleransi tanaman bawang merah terhadap cekaman kekeringan di tanah pasir pantai'. *Jurnal AgriSains*, vol. 3, no. 4, hlm. 88-103.

[2]. Badan Pusat Statistik. 2015. Berita Resmi Statistik 3 Agustus 2015.

[3]. Alihamsyah T. 2004. Potensidanpendayagunaanlahanrawauntukpeningkatanproduksipadi. Ekonomi Padidan Beras Indonesia. *Dalam* F. Kasrino, E. Pasandaran, dan A.M. Fagi (Penyunting). Badan Litbang Pertanian. Jakarta.

[4]. Firmansyah, MA, Musaddad, D, Liana, T. Mokhtar, MS dan Yufdi, MP. Uji adaptasi bawang merah di lahan gambut pada saat musim hujan di Kalimantan Tengah. 2014. Jurnal Hortikultura. Vol. 24 (2): 114-123.

[5]. Fischer RA and Maurer R. 1978. Drought resistance in spring wheat cultivars. I. Grain yield responses. *Crop and Pasture Science* 29, 897–912.

[6]. Rosielle AA and Hamblin J. 1981. Theoretical aspects of selection for yield in stress and nonstress environment. *Crop Science* 21, 943–946.

[7]. Fernandez GCJ. 1992. *Effective selection criteria for assessing stress tolerance*. In:Kuo,

[8]. Schneider KA, Rosales-Serna R, Ibarra-Perez F, Cazares-Enriquez B, Acosta-Gallegos JA, Ramirez-Vallejo P, Wassimi N, Kelly JD. 1997. Improving common bean performance under drought stress. *Crop Science* 37: 43–50.

[9]. Moosavi SS, Samadi BY, Naghavi MR, Zali AA, Dashti H, Pourshahbazi A. 2008. Introduction of new indices to identify relative drought tolerance and resitance in wheat genotypes. *DESERT*, 12: 165-178.

[10]. Bouslama M and Schapaugh WT. 1984. Stress tolerance in soybeans 1. Evaluation of three screening techniques for heat and drought tolerance. *Crop Science* 24(5), 933–937.

[11]. Budianto, Aris, Ngawit & Sudika, 2009, 'Keragaman genetik beberapa sifat dan seleksi klon berulang sederhana pada tanaman bawang merah kultivar Ampenan", Crop Agro., vol. 2, no.1, hlm. 28-38.

[12]. Kusmana, RS and H. Basuki Kurniawan. (2009). Adaptation Test Five Varieties Shallots Origin Highlands and Medium Lowlands Ecosystem at Brebes. Journal of Horticulture, 19 (3), 281-286.

[13]. Anshari, M, Tohari, BH, Sunarminto&Sulistyaningsih, E, 2011. 'Pertumbuhan, hasildankualitasumbibawangmerahpadakadar air tanahdanketinggiantempatberbeda', *J. Agrivigor*., vol.10, no.2, hlm.128-13, diunduh 24 Maret 2017, <Download.portalgaruda.org/article.php?article=29699&val= 2165>.

[14]. Mutia, AK, Purwanto, YA & Pujantoro, L, 2014, 'Perubahan kualitas bawang merah (*Allium ascalonicum* L.) selama penyimpanan pada tingkat kadar air dan suhu yang berbeda', *J. Pascapanen*, vol. 11, no. 2, hlm. 108-155, diunduh 24 Maret 2017, <Ejurnal.litbang.pertanian.go.id/index.php/jpasca/article/.../216>.

[15]. Cheng F, Cheng Z, Meng H, Tang X. 2016. The garlic allelochemical diallyl disulfide affects tomato root growth by influencing cell division, phytohormone balance and expansin gene expression. *Frontiers in Plant Science* 7:1199.

[16]. Fernández, G.C.J. (1992) Effective selection criteria for assessing plant stress tolerance. Proceedings of the International Symposium on "Adaptation of Vegetables and other Food Crops in Temperature and Water Stress", Taiwan, 13-16 August 1992.

[17]. Moosavi, H., Zeynali, M., & Pour, Z. H. (2012). Fracture resistance of premolars restored by various types and placement techniques of resin composites. International journal of dentistry, 2012.

[18]. Farshadfar E, Poursiahbidi MM and Pour ALP. 2012. Repeatability of Drought tolerance indices in bread wheat genotypes. *International journal of Agriculture and crop Science*. 4 (13): 891-903.