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Genetic parameters resistance of several genotypes and f1 crossing results of papaya plant (*Carica papaya* L.) on mealybug pest (*Paracoccus marginatus*) with no choice test method

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Abstract

The efforts to obtain genetic information and resilience of several papaya genotypes, so the resistant genotypes are selected.This study aims to obtain information on the genetic parameters and best resistance level of papaya plants against the mealybug (*Paracoccus marginatus*) using no choice test method. The research was conducted in Cot Cut Village, Aceh Besar District, Pest Laboratory and Weed Science Laboratory, Faculty of Agriculture, University of Syiah Kuala from September 2017 to January 2018 and used Completely Randomized Design (CRD) non-factorial pattern with plant genotype as treatment. Each genotype was repeated 3 times with 5 samples per repetition. Papaya seedlings used were 11 genotypes, 7 genotypes of which were from previous crosses from 4 elders: Dapina (USK7), Carisya (USK1), Calina (USK4) and Carmida (USK6). The results showed the lowest intensity of attack was in USK1 genotype of 37.65% and the lowest number of ovisac was found at USK7 with value 7.18. High heritability values are found in plant height, length of petiole and dry weight. There is a significant correlation on all plant growth characters with the intensity of the attack with the highest value on the leaf area index character with the intensity of the attack with a very real value of -0.73. There were no genotypes with the resistant category, but genotypes were found with rather resistant categories that could be considered for selection.

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Introduction

Papaya (*Carica papaya* L.) is a plant originated from Central America. Papaya is one of the most important fruits commodity in Indonesia, papaya fruit is favored by all levels of society because it has a sweet taste and contains many nutrients and vitamins, especially vitamins A and C, papaya is also used as raw materials for food industry, medicine, cosmetics and pesticides (Sujiprihati, 2009).

Aceh Province is one of regions that hasthe most high production of papaya in Indonesia. Based on the Central Bureau of Statistics (2016), there are three highest papaya producing districts in Aceh, that areBireuen Regency with production of 28.778 quintals, Aceh Besar Regency with production of 21.507 quintals and Regency of Aceh Utara with production of 11.235 quintals. The many obstacles encountered on cultivation of papaya plants causing domestic market is inappropriate with highly production.

One of the obstacleon cultivation of papaya plants is pest attack. Such as *Paracoccus marginatus*, this pest is very influential on the production of papaya plants. *P. marginatus* first exposed in may 2008 on papaya plants at Bogor Botanical Gardens, West Java (Rauf, 2008).

According to Ivak (2010), the yield of papaya crops decreased by 58% and production costs increased by 84% caused by the attack ofpapayamealy bug.There is no effective alternative to suppress the population of mealybug in Indonesia until now.

P. marginatus is one of the most difficult to control,thiscontrol strategy is very limited because mealybug have a thick waxy coating on the surface of its body that capable of avoiding synthetic contact (Krishnan *et al.,* 2016). Plant breeding activities can be solved the problem by conduct a series. First of all by forming the population so that genetic diversity is available. One of the efforts in plant breeding is to obtain papaya crops resistant to mealybug by doing genetic analysis of papaya plant that resistance to *P. marginatus*.

Based on Wahyuni (2016), characterization and estimation of genetic endurance parameters in several papaya genotypes have shown no genotypes found to be resistant to mealybug after four weeks of mealybuginfestation owever, in the second and third weeks after pest infestations, genotypes of USK1 and USK7 have the lowest intensity of mealybug attack. So the genotypes USK1 and USK7 are used as elders for the crossing line that has been done in this study before.

It is hoped that there is a genotype that has resistance to the mealybug from the crosses. One way to obtain resistant genotypes is to perform a selection based on analysis of genetic pest resistance of mealybug on papaya plants. Resistant genotypes are the solution resolve the environmentally friendly and sustainable. Budiyanti and Sunyoto (2014), also mentioned that knowledge of the genetic parameters in papaya plant breeding is the key in choosing procedures that will provide maximum selection progress.

Materials and methods

This research was conducted in Cot Cut Village, Regency of Aceh Besar, from September 2017 to January 2018. The seeds of papaya used amounted to 165 from 11 genotypes, 7 genotypes were the result of previous crosses with 4 elders namely Dapina (USK4), Carisya (USK7), Calina (USK1) and Carmida (USK6), F1 crosses from 4 elders are USK7 X USK4, USK1 X USK7, USK7 X USK6, USK6 X USK6, USK4 X USK7, USK4 X USK6, USK6 X USK4.

Seeds was prepared directly planted into the nursery polybags with planting hole size 0.5 - 1 cm, at age 2 weeks after seedling, the seedlings are transferred to a large polybags media planting with 10 kg volume of prepared soil. Fertilization is done by papaya seedling 30 day after planting,fertilizer used is NPK 1 gram/plant. Mealybug source used is derived from papaya plants around Aceh Besar had taken mealybug ovisac, and then breeded in some seeds that have been prepared.

Mealybug infestation uses no choicetest method, papaya genotype 30 days after planting directly infected mealybug by taking one egg sack (ovisac) *P. marginatus* from papaya plants stricken, mealybug ovisac put on the surface of the fourth leaf of papaya buds. Furthermore, the plant covering using mica plastic with a top cover using gauze.

This research uses experimental method with Completely Randomized Design (CRD) non factorial pattern with plant genotype as treatment. Each genotype was repeated 3 times with 5 samples per repetition, then continued with Least Significant Difference test (BNT) 5%.Observations include plant growth variables (plant height, number of leaves, length of petiole, stem diameter, leaf area index and dry weight), as well as endurance variables (attack intensity and number of ovisac).

The intensity of the attack is calculated by the formula Natawigena (1989), as follows :

$$P = \frac{\sum(n \times v)}{z \times n} \times 100\%$$

Information :

P =Intensity of attack

n =Number of leaves from each attack category

v =Scale value of each attack category

z =Scale value of the highest attack category

n = Number of leaves observed

Analysis of genetic parameters on each character of papaya was observed using the formula:

The value of heritability in the broad sense can be calculated by the formula:

$$h^2_{bs} = \frac{\sigma^2 g}{\sigma^2 p} \times 100\%$$

Genetic Advance expectations was obtained by using Falconer's (1989) formula: h^2bs(Sp).(i)

Genetic correlations between properties were obtained using excel data processing techniques. Correlation was done to see the relationship between growth morphology character of papaya plants against the resistance of pest attack of *P.marginatus*.

Results and discussion

Based on the observations of the fourth week after the infestation mealybug, the intensity of the attack had a very significant effect on the genotype tested. The highest intensity of attack is shown by the genotype of USK4. Genotypes categorized rather resistant are USK7, USK1, USK6, USK1XUSK7 and USK7XUSK6 with value 38.01%, 37.65%, 48.00%, 50.59%, 48.20% and 44.51%. The number of *P. marginatus*o visac also very significant effect on the genotype tested. Ovisac *P. marginatus* most commonly found in USK4 genotype with 16.10 ovisac value (Table 1).

Table 1. Average Quantitative Number of Ovisac, Intensity of Attack (%) and Category of Papaya Resilience 4 weeks After Infestation (WAI).

Genotype	Number of ovisac	4 WAI (%)	Category
USK7	7.18 a	38.01 a	rather resistant
USK1	7.28 a	37.65 a	rather resistant
USK4	16.10 e	78.39 d	susceptible
USK6	8.10 ab	48.00 ab	rather resistant
USK7XUSK4	7.92 a	51.43 abc	rather susceptible
USK1XUSK7	9.45 abc	50.59 ab	rather resistant
USK7XUSK6	12.42 bcde	48.20 ab	rather resistant
USK6XUSK7	12.66 cde	44.51 a	rather resistant
USK4XUSK7	13.07 cde	73.24 cd	rather susceptible
USK4XUSK6	10.89 abcd	59.23 abcd	rather susceptible
USK6XUSK4	14.23 de	67.00 bcd	rather susceptible
$BNT_{0.05}$	4.36	21.94	

Description: The number followed by the same letter in the same column is not significant in the $BNT_{0,05}$ test.

Alternative in pest control with plant breeding method is using resistant varieties on the most practical, economical, and safe for environment. The use of resistant varieties is intended to reduce pest populations in the early phases during plant growth and the level of attack from pests (Baliadi, 2008).

According Nasir (2013), resistant plants are that exhibit little or less damage to infectious diseased bodies compared to other plants in the same environmental conditions in the field. Genotypes with resistant categories are thought to have genetic sources of resistance of the mealybug pest so that they can be selected for further testing. Based on the results of research have not found papaya genotype resistant to pest attack *P. marginatus* using no choice test method.

Table 2. Heritability Value, Genetic Advance and GeneticAdvanceExpectations Some Characters in Papaya Plants 60 days after planting.

No	Character	GA	GAE(%)	H^2bs (%)	Category H^2bs
1	Plant High	3.46	5.77	58.67	high
2	Number of leaves	0.47	6.16	48.80	medium
3	Stem diameter	0.05	1.70	21.76	medium
4	length of petiol	0.94	5.35	55.11	high
5	Dry weigh	7.49	8.33	60.55	high
6	Leaf area index	10.92	27.24	35.81	medium

Description: GA = genetic advance, GAE = genetic advance expectations, H^2bs = heritability in the broadest sense.

Based on research that has been done by Pramayudi and Hartati (2012), observation of stage development of *P. marginatus* eggs on papaya plants, obtained the average length of stage of the egg is 7 days. Mealybug are very active since the first instar nymph up to the adult phase.

The papaya plants that are infested by mealybug pests and enclosed with mica plastic cause *P. marginatus* pest attacks on plants to grow very quickly.

Lolong *et al.* (2014), mentioned that the *P. marginatus* population is more in monoculture than in the polyculture cultivation pattern. The high intensity of *P. marginatus* infestation in monoculture planting due to lack of genotype diversity.

The study of A'yun (2015), mentioning the no choice test method on soybean plants against pod sucking pests showed higher pod damage rates compared with choice test, this is because on the test without the choice pests cannot choose the preferred soybean crop but must attack only one plant.

The highest Genetic Advance(GA) and genetic advance expectations (GAE) was found in leaf area index with high category and dry weight with high enough criteria (Table 2). According to Standfield (1991), Criteria of genetic advance expectations are: 0 <GAE <3.3% = low, 3.3% <GAE<6.6% = slightly low, 6.6% <GAE<10% = high enough, and GAE> 10% = high.

High category heritability is found in plant height, length of petiole and dry weight with values of 58.67, 55.11 and 60.55, respectively. This suggests the application of selection to the growth character will have an effect on the improvement of a plant genotype (Table 2). Kumar *et al.,* (2018) mentioned high heritability indicating that a selection program based on that character would be more effectively done to improve the genotype quality of papaya. High heritability followed high genetic expectations suggest that these traits are largely governed by the action of additive genes and phenotypic selection, these properties can be more effective for the desired genetic improvement.

Table 3. Correlation between growth and resistance characteristics of papaya plants on 60 days after planting.

Character	NL	SD	LP	LAI	DW	IA	NO
PH	0.83**	0.84**	0.84**	0.80**	0.88**	-0.32tn	-0.27tn
NL		0.61**	0.76**	0.72**	0.77**	-0.40*	-0.54*
SD			0.90**	0.88**	0.88**	-0.52**	-0.54**
LP				0.93**	0.86**	-0.60**	-0.42*
LAI					0.93**	-0.73**	-0.54**
DW						-0.59**	-0.48*
IA							0.80**

Description: PH = plant height, NL = number of leaves, SD = stem diameter, LP = length of petiol, LAI = leaf area index, DW = dry weight, IA = intensity of attack,NO = number of ovisac.

Jameela *et al.,* (2014) mentioned that the high heritability prediction value identified that the diversity of the characters was more influenced by genetic factors than environmental factors. Consistent with Martono's (2009) opinion, that the high heritability value for a character indicates that the character is more determined by the genetic appearance so that selection in this population will be efficient and effective.

There is a significant correlation on all plant growth characters against the intensity of the attack with the highest value found on leaf area index character with intensity of attack with a very real value of -0.73 (Table 3). Negative correlations give an indication that an increase in a property will decrease other properties, whereas a positive correlation occurs when an increase in a property will improve other correlated traits.

This indicates that the growth of plant growth characteristic such as plant height, leaf number, stem diameter, length of petiole, leaf area index and dry weight of plant will suppress the intensity of *P. marginatus* pest attack.

Hapsariand Adie (2010), states that the genetic correlation between traits is an assessment of the closeness of the relationship between the two correlated traits. The positive correlation prediction value reflects the relationship between the correlated characters. The results showed a positive correlation of attack intensity with the number of ovisac of *P. marginatus* (Table 3). This is in line with the results of research Tairas *et al.,* (2014) which mentions the number of *P.marginatus* populations positively correlated with the attack intensity of papaya fruit and leaf.

Conclusion

There is no genotype with resistant category on no choice test, genotype with lowest attack intensity is found in genotype USK1(elder) with value 37.65% and the category was rather resistant. High heritability values were encountered in plant height, length of petiol and dry weight and there was a negative correlation in growth character parameters of papaya plants with intensity of pest attack of *P. marginatus*.

The negative correlation showed that the plant growth parameters value like plant high, leaf number, stem diameter, length of cauliflower, leaf area index and dry weight, will decrease intensity of *P. marginatus* attack. The character of leaf area index has the highest correlation value with intensity of attack with value -0.73.

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