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Technical Paper

Ultrasonic Wave Characteristics of Arumanis Mangoes And Damage Arumanis Mangoes By Fruit Fly

Karakteristik Gelombang Ultrasonik Mangga Arumanis dan Mangga Arumanis yang Dirusak oleh Lalat Buah

Warji[1] dan Rokhani Hasbullah[2]

Abstract

The objective of this research was to study the ultrasonic wave characteristic at arumanis mangoes damage caused by fruit fly. The ultrasonic characteristics that was used to sort the damaged mangoes from the normal mangoes were attenuation, velocity and moment zero power (Mo) number. Results showed that mean attenuation coefficient of normal arumanis mangoes was 36.45 Np/m, mean velocity of ultrasonic wave was 518.19 m/s and Mo number was 4.58. The mean attenuation coefficient arumanis mangoes which damaged by fruit fly was 30.67 Np/m, mean velocity of ultrasonic wave was 731.72 m/s and Mo number was 6.40. Relation between the ultrasonic wave characteristic with arumanis mangoes damage caused by fruit fly showed that attenuation coefficient of arumanis mangoes was increase but damage arumanis mangoes level was decrease, while Mo number was increase in parallel with increase of damage arumanis mangoes level. The ultrasonic wave velocities of arumanis mangoes didn't show clear correlation with damage arumanis mangoes level, as shown by from value of r^2=0.01. Larva weight of inversely to value of attenuation coefficient, correlation of logarithm value r^2=0.94. Correlation value of larva weight Mo with number was r^2=0.38.

Keyword : *ultrasonic wave, arumanis mangoes, fruit fly, attenuation coefficient, Mo number*

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Introduction

Potency and opportunity of commodity market of horticulture, the specially fruits progressively with the increasing of request fruits demand. Arumanis mangoes represent one of commodity of horticulture having good market potency and prospective as preeminent commodity because produce mango increasing. But the problems are the availability, technique of handling post harvest, distribution system and quality control fruit. Some effort conducted to develop technology of fruits post harvest so that the acceptable fruit as commodity export, one of them is the technological development of sorting or grading.

Generally fruit sorting or grading still be conducted traditionally and based on size or visible physical, although grading or sorting nondestructively method and inner quality sorting of fruit have be developed. Nondestructive testing have been developed for the fruit are image processing method, near infra red method, X-ray method, method of NMR (Nuclear Magnetic Resonance) and ultrasonic wave method.

The ultrasonic wave method on agriculture commodity, among other things hardness of avocado (Mizrach, 1999), physical of mango and avocado (Mizrach, 2000), robotic of strawberry harvester (Yonjie, 2005), mangosteen quality (Juansah, 2005 and Nasution, 2006), damage of potato vegetable (Efriyanti, 2006), maturity of banana (Soeseno, 2007) shell of rice quality (Maschuri, 2007), rice quality (Sujana, 2007), dehydration peel of orange(Camarena, 2007) and condition early banana draining (Fabiano, 2007).

Ultrasonic wave method applicable to know quality of inner fruit without destroying, this method hasn't negative effects and penetrative fruit interior. Quality grading of arumanis mangoes still conducted based on weight and size measure so that can't know quality of fruit interior. The fruits after be harvested has potency infected by larva coming from fruit fly egg. Inner damage of arumanis mangoes by attacked fruit fly can anticipated using ultrasonic wave so that require to be conducted research about characteristic of ultrasonic wave at arumanis mangoes.

The objectives of this research is to study the ultrasonic wave characteristic at arumanis mangoes damage caused by fruit fly, to study relation between the ultrasonic wave characteristic with arumanis mangoes damage caused by fruit fly.

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Materials and Methods

Materials were used are arumanis mangoes and fruit fly. Arumanis mangoes was used the is best quality from Probolinggo, while fruit fly used is Bactrocera dorsalis, species of fruit fly which is becoming mango major pest. Equipments that are needed peripheral of fruit fly development and investment of fruit fly, peripheral ultrasonic wave measurement include transducer transmitter and receiver of ultrasonic wave, space transducer equipped thick measurement sample, digital oscilloscope, ultrasonic transmitter and personal computer. Other equipments used were meter shove, digital weighing and knife.

The first step was to propagate the fruit flies. Next, the mango fruit was entered into fly cage in order to investment of fly egg, each cage filled as much 10 fruit so that in each this step there was 30 mangoes which condition of fruit fly investment, others also condition 20 arumanis mangoes which don't invest fruit fly. Mango let in cage of fly for 4 day. Third step was measurement of ultrasonic wave, ultrasonic tester and oscilloscope flamed, than the mangoes placed above space and noted distance among both transducers. Finally, mango measured weight, its diameter and mango opened its interior to be perceived the damage, volume of damage measured and deliberated weight of its larva.

Analyses data consist of ultrasonic wave velocity, coefficient of attenuation and Mo value. Ultrasonic wave velocity was analyses by using data of output from digital oscilloscope seen in screen of monitor which have been kept in the form of data excel. Kept data then turned into graph of wave and noted first dot wave penetrate substance and dot of wave of moment go out from substance. Data result of thick measurement fruit and data of time used to count ultrasonic wave velocity.

Coefficient of Attenuation counted with converting tension of signal sent and accepted after pass through over certain become wave graph. Result of the measurement of ultrasonic wave in the form of relation among amplitude and time of transformed by using FFT (Fast Fourier Transform) becoming relation among power spectral density with frequency. This Transform used program of Matlab and yield Mo value. After got the data characteristic of ultrasonic wave which is in the form of ultrasonic wave velocity, coefficient of attenuation and Mo, the conducted by study to characteristic of ultrasonic wave at arumanis mangoes attacked by fruit fly, continued with study of relation among damage of arumanis mangoes effect of fruit fly attack with ultrasonic wave characteristic.

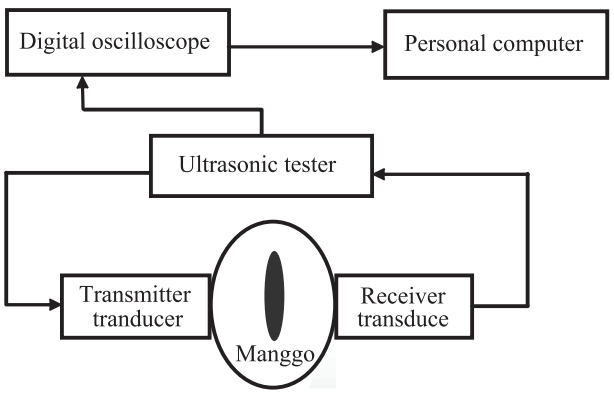

Figure 1. Ultrasonic measurement

Results and Discussion

Mangoes attacked its inner fruit fly larva was hollow and soft texture, this matter different with mango which is not attacked by a fruit fly. The ultrasonic wave characteristic (ultrasonic wave velocity, zero moment power and attenuation coefficient) what have through destroyed mangoes medium have value which is unlike mango which don't destroy. This characteristic difference used to predict mango which not attacked mango fruit fly and mangoes which damage by fruit fly, considering that mangoes investment by fruit fly are exterior oftentimes still looked to be nicely.

Level of ultrasonic wave energy absorb by medium (attenuation coefficient) at soft medium is smaller than hard or solid medium. So that arumanis mangoes attacked by a fruit fly with soften texture or hollow absorb little ultrasonic wave energy, whereas at mango which not attacked by fruit fly with hard texture absorb bigger ultrasonic wave energy.

Correlation between larva weight and attenuation coefficient of arumanis mangoes indicate that ever greater of larva weight progressively lower attenuation coefficient. This matter related with level of damage at mango, more larva exist in fruit hence mount ever greater damage. The damage of arumanis mangoes resulted by activity of fruit fly larva, the effect of this activity is flesh of arumanis mango become to soften and hollow. Besides influenced by texture destroy mangoes, coefficient attenuation of ultrasonic wave at mango attacked by fruit fly also influenced by existence of itself larva, because larva measure up to different physical with mangoes kernel. The coefficient attenuation of ultrasonic wave which pass at larva of fruit is lower than pass at mangoes kernel medium.

Level of energy ultrasonic wave absorb by medium (attenuation coefficient) at soft medium smaller than hard or solid medium. So arumanis mangoes attacked by fruit fly with soften or hollow texture absorbs little ultrasonic wave energy, whereas at mangoes not attacked by a fruit fly with hard texture absorbs more ultrasonic wave energy. This matter as according to attenuation coefficient value result of measurement, where at mangoes attacked by fruit fly that is mean 30.67 Np/m and which not attacked by fruit fly mean is 36.45 Np/m.

The attenuation coefficient at air according to result measurement by Juansah (2005) is equal to 5.15 Np/m. This Matter show at mango which not attacked by fruit fly more high than attenuation coefficient of mangoes attacked by fruit fly or attenuation on air.

The larva weight inversely proportional to value of attenuation coefficient, with correlation of logarithm value r^2=0.94 (Figure 2). This value show existence closest correlation between weight of larva with attenuation coefficient so this characteristic applicable to predict level of damage by existing larva in arumanis mangoes.

While weight of larva of fruit fly don't own correlation which is close to ultrasonic wave velocity of arumanis mangoes, this matter shown from value r^2=0.01 (Figure 3). This is according with Juansah (2005) that there no clear correlation between ultrasonic wave velocity in mango with the physical of mango. The velocity mean of ultrasonic wave on normal mango was 518.19 m/s, velocity mean arumanis mangoes which damaged by fruit fly was 731.72 m/s. If value of this speed is evaluated in each mango component (husk, flesh and seed) and various storey level of maturity, there is possibility of will be got clear correlation. The bad correlation predicts caused by variation of hardness of kernel and size of seed in mango, whereas at this research isn't conducted by study to each mango, but conducted by measurement of ultrasonic wave to whole mango. Others, ultrasonic wave velocity only determine from one dot of quickest trigger reach transducer receiver, if wave of this trigger don't thought to part of mango attacked by fruit fly hence can't detect fruit damage.

Level of moment zero power got from data processing of ultrasonic amplitude of wave to time by using program of Matlab at submenu Matlab FFT. Process this processing yield value spectral, range from this spectral is recognized by moment zero power (Mo). Larva weight compare diametrical with Mo value, ever greater weight of ever greater larva Mo value. But the level of correlation between both parameter is small, that is r^2=0.38 (Figure 4). This value shows inexistence close correlation between larva weight with value of Mo so that this characteristic can't be used to predict storey level of damage from side of existing larva in arumanis mangoes. Mo mean of ultrasonic wave on normal mango was 4.58, Mo mean arumanis mangoes which damaged by fruit fly was 6.40.

Damage volume haven't clear correlation with attenuation coefficient, this matter shown by

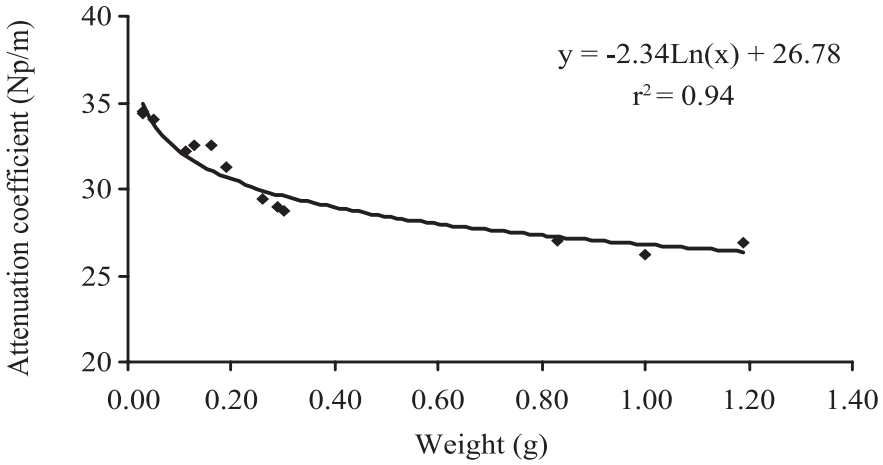

Figure 2. Correlation between larva weight and attenuation coefficient

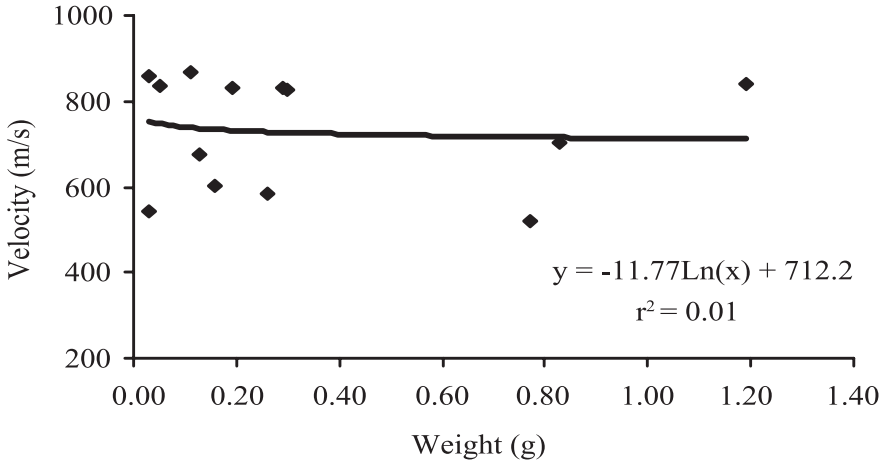

Figure 3. Correlation between larva weight and ultrasonic wave velocity

value of small correlation that is r^2= 0.21(Figure 5). The correlation is small because process of measurement only evaluate from direction of diameter b (b position), do not evaluate at direction of diameter c (c position) and instruct diameter a (a position).

The result shown that damage of physical in mango form of cylinder, this matters enable ruined fruit with small diameter but length and volume bigger perhaps compared to ruined mango with same diameter with first condition but is not long. While the measurement only to detected instruct diameter of just b (b position) so that if wishing better correlation between volume of damage with coefficient of attenuation can conduct measurement from third the mango side.

While correlation volume of damage with ultrasonic wave velocity is r^2=0.39 (Figure 6). Volume of damage and ultrasonic wave velocity are increasing, but low close. So that the correlation both parameter can't be used as based prediction. Low close this besides because volume factor, also inexistence of correlation between ultrasonic wave velocity with fruit physical

Correlation damage volume with Mo value is r^2=0.51 (Figure 7), this matter indicates that no clear relation between both. The bad correlation between volume of damage with characteristic of ultrasonic wave, covering attenuation coefficient, ultrasonic wave velocity and Mo, indicating that characteristic of this ultrasonic wave can't be used to predict damage volume of arumanis mangoes effect by fruit fly attack.

Damage diameter of arumanis mango able predict by ultrasonic wave characteristic, this matter seen from relation between ultrasonic wave characteristic and damage diameter. Level of diameter correlation to attenuation coefficient is r^2=0.70 (Figure 8). The diameter level of damage inversely proportional with attenuation coefficient value, ever greater damage diameter smaller attenuation value, its meaning progressively little energy ultrasonic wave absorb by arumanis mangoes. Its because damage mangoes have soft texture and hollow. Damage which is the in form of cavity generally contain air, where soft texture or contain smaller air absorb compared to energy ultrasonic wave of solid or hard texture.

Correlation ultrasonic wave velocity and damage diameter is r^2=0.19 (Figure 9), this correlation not become choice in evaluating damage based on ultrasonic wave characteristic. While correlation between damage diameter and Mo value is r^2=0.48 (Figure10).

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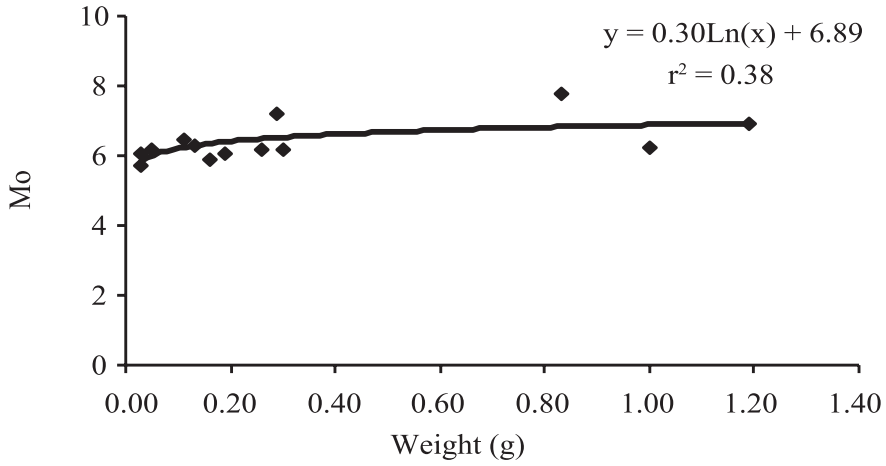

Figure 4. Correlation between larva weight and *moment zero power*

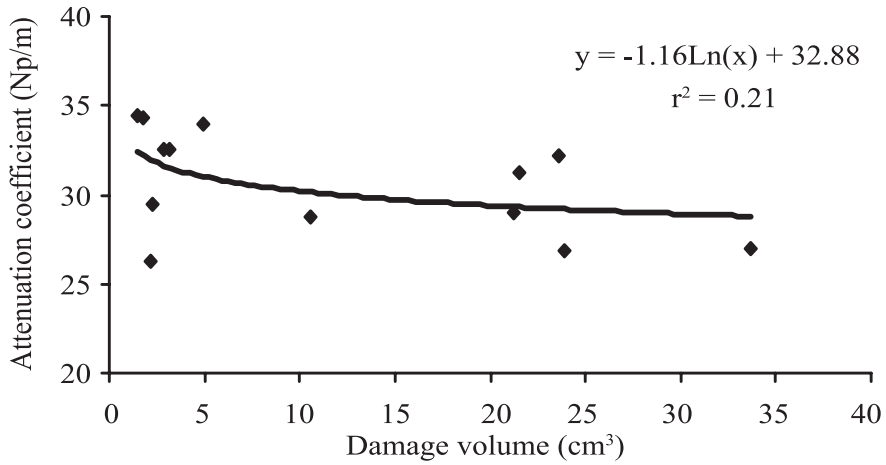

Figure 5. Correlation between damage volume and ultrasonic coefficient

Conclusions

The attenuation coefficient mean normal arumanis mangoes was 36.45 Np/m, velocity mean of ultrasonic wave was 518.19 m/s and Mo number was 4.58. The attenuation coefficient mean arumanis mangoes which damaged by fruit fly was 30.67 Np/m, velocity mean of ultrasonic wave was 731.72 m/s and Mo number was 6.40. The correlation between arumanis mangoes damage parameter (weight of larva, damage diameter and damage volume) and the ultrasonic wave characteristic (attenuation coefficient, ultrasonic wave velocity and Mo value) indicating that attenuation coefficient and larva weight have best correlation, with value r^2=0.94. Others the correlation having good correlation is larva weight and Mo value, with value r^2=0.70.

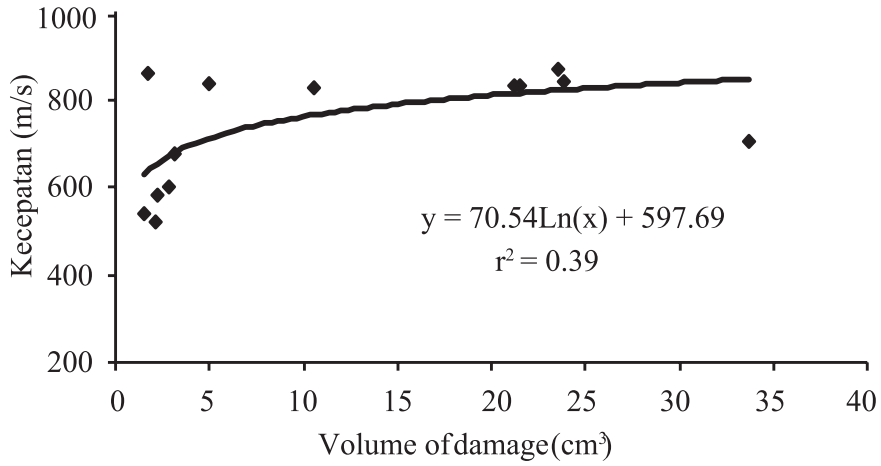

Figure 6. Correlation between damage volume and velocity

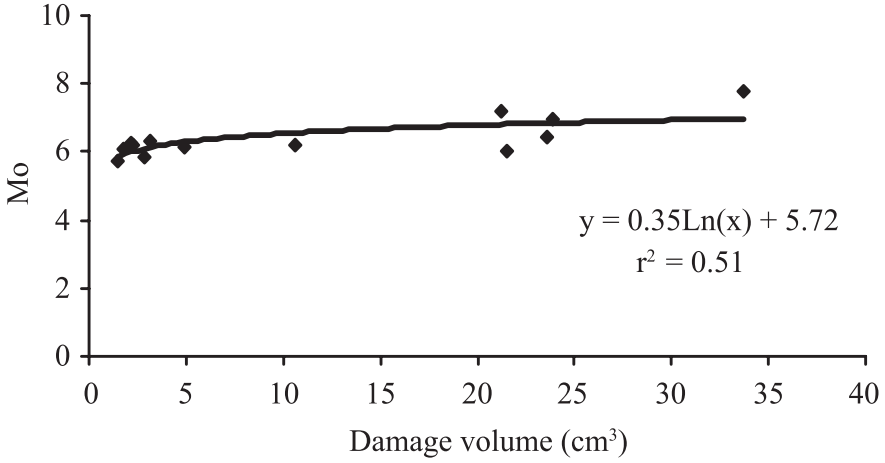

Figure 7. Correlation between damage volume and *moment zero power*

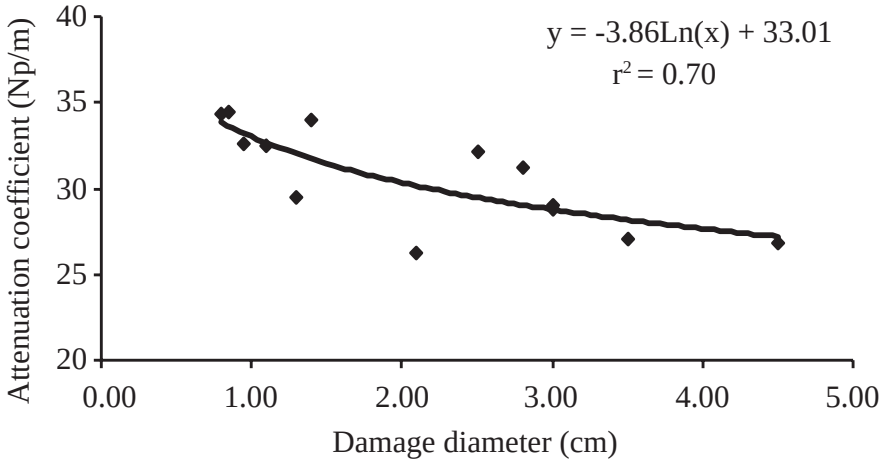

Figure 8. Correlation between attenuation coefficient and damage diameter

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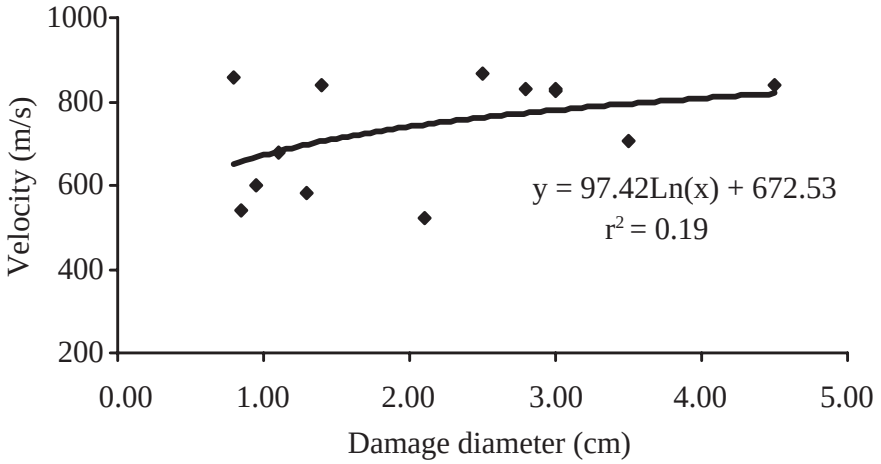

Figure 9. Correlation between ultrasonic wave velocity and damage diameter

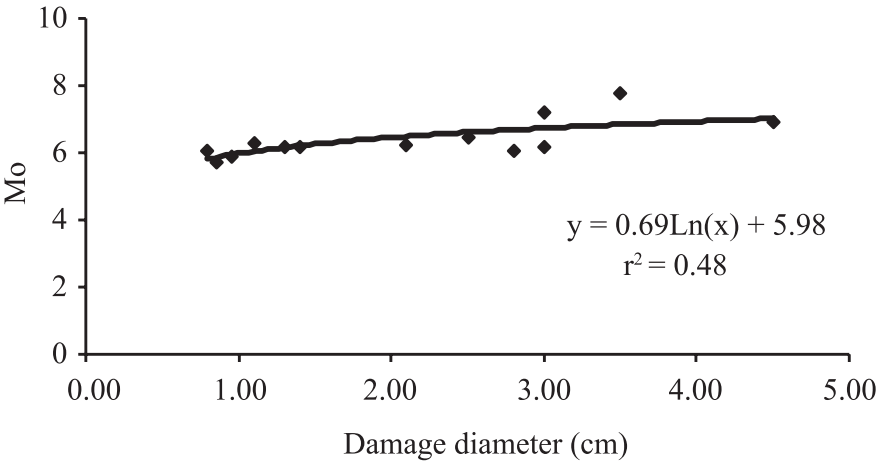

Figure 10. Correlation between zero moment power and damage diameter