PRELIMINARY STUDY ON DIFFERENTIATION BETWEEN NON INFECTED AND INFECTED GANODERMA BONINENSE IN OIL PALM TREES BASED ON ALOS PALSAR 2

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KEY WORDS: Basal Stem Rot (BSR), backscatter, temperature

ABSTRACT: In 2015, Malaysia's monthly export of oil palm product was 25.370294 tonnes valued at RM60, 169.49 million, which puts Malaysia as one of the biggest producers and exporters of palm oil and its products in the world. To preserve Malaysia's role in fulfilling the global demand for various oil palm products, it is necessary to control the quality and quantity of oil palm harvested. However, oil palm plantations in Malaysia are now facing the threat of Ganoderma boninense, a Basal Stem Rot (BSR) disease caused by fungus. This disease reduces oil palm production as infected mature oil palm dies after 2-3 years of being infected, and is therefore making the plant health crucial in attaining maximum production. The objective of this study is to differentiate between non infected and infected Ganoderma boninense of oil palm tree using backscatter values of ALOS PALSAR 2 dataset acquired at Felda Tembangau, Kemayan Pahang Malaysia. The methodology involves; collecting of ALOS PALSAR 2 and tabular data in the study area, processing of ALOS PALSAR 2 including converting digital numbers to backscatters value, speckle filtering, and analysis of the relationship between extracted backscatter values of HH, HV, and 16 ground control points (GCP) with tree temperature for which GPS coordinates were collected.

1. INTRODUCTION

Oil Palm trees in Malaysia and other countries in South East Asia are vulnerable to various fungus attacks, the most common being the Ganoderma boninense, which will result in Basal Stem Rot (BSR) disease. This disease has been one of the major culprits in oil palm yield reduction throughout most production area in the country. There had listed 15 species of Ganoderma from all over the world whereby 7 of it were from peninsular Malaysia (Turner, 1981) and the most dangerous Ganoderma in peninsular Malaysia is Ganoderma boninense (Khairudin, 1990)

This disease progresses by halting the growth of an oil palm tree, with unopened spear leaves and dry rotting of the internal tissue at the stem base. However, the disease is usually only detected when it is already at the critical stage whereby some of the symptoms include wilting of the leaves, production of fruiting bodies, holes in the trunk and in severe cases, fallen trees; which poses an adverse effect on the plantation. Due to this, various techniques have been developed for an early detection of the disease such as Ganoderma Selective Medium (GSM) (Ariffin et al., 1993), polymerase chain reaction-DNA (PCR-DNA) technique (Idris et al., 2003), enzyme-linked immunosorbent assay-polyclonal antibody (ELISA-PAb) (Idris and Rafidah, 2008), GanoSken Tomography (Idris et al., 2010), Mid-infrared spectroscopy (Shohreh et al., 2014) and Field Spectroscopy (Izzuddin et al., 2013). It is reported that plants with less than 20 % infection can still be saved with proper treatment (Meor et al., 2009)., therefore, early detection of the disease is important as to address the issue of Ganoderma boninense disease in oil palm plantation.

Prior to the digitization of information regarding land use, data acquisition was obtained through conventional methods of land surveying. In 1960, remote sensing was first introduced and since then, it has been extensively used in various areas, especially to store layers of data regarding land usage and its elements. In remote sensing, the usage of optical remote sensing remains the most utilized due to its to its advantage resolution, both radiometric and spatial. However, the usage of optical remote sensing would result in degradation of the imagery due to haze which is a very common phenomenon in Malaysia and other countries in South East Asia (Van Gelder, 2004). On the other hand, radar data originating from an active sensor may provide better images, capable of operating 24/7 and weather independent. The use of radar remote sensing would enable image acquisition regardless of the weather conditions and sunlight emission due to the different physical concept of active sensors and the wavelengths used in radar remote sensing. This in turn, will allow for frequent observation of an area, even if the said area is surrounded by thick clouds or haze. Radar remote sensing may be carried out through various types of satellite radar such as ALOS, Sentinel, RadarSat, Kompsat and others. On 24th May 2014, Japan Aerospace Exploration Agency (JAXA) launched a satellite ALOS-2 comprising of three main sensors which are; 1) Panochromatic Remote-Sensing Equipment For Stereo Mapping (PRISM) for digital height mapping; 2) Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), a near-infrared radiometer sensor, capable of monitoring land and sea and provide better spatial resolution; and 3) Phased Array type L-band Synthetic Aperture Radar (PALSAR), an active microwave sensor to enable observation regardless of the sunlight condition. This satellite is specifically developed for Synthetic Aperture Radar (SAR) to produce 2 dimension or 3 dimension object image, such as landscapes and vegetation area.

Therefore, the usage of ALOS PALSAR radar satellite would produce better imagery and frequent observation, particularly when coupled with the utilization of L-band wavelength. Higher L-band such as 15-20 cm range in ALOS PALSAR is more useful in acquiring images as it can penetrate through the foliage and interact with the trunk of an oil palm and even the ground beneath. In addition, radar has been proven to be more sensitive to the canopy structure whereby the received backscatter intensity represented in the image is a composition of interactions with the crown, the trunk and the ground surface. As a result, the usage of fully polarimetric SAR may be analyzed to produce a relationship between backscatter values, texture and crop status.

This paper serves as a preliminary study to differentiate between non infected and infected Ganoderma boninense of oil palm tree using backscatter values of ALOS PALSAR 2 with the study areas comprise of oil palm plantations in Felda Tembangau, Kemayan Pahang Malaysia.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. ALOS PALSAR 2. ALOS PALSAR 2 PALSAR L-band with 1.2 GHz center frequency and dual polarization HH (Horizontal - transmit and Horizontal - receive) and HV (Horizontal - transmit and Vertical - receive) and imagery level 1.5 with high sensitive polarimetric mode developed by Japan Aerospace Exploration Agency (JAXA). Data acquisition is shown in Table 1.

Table 1. Acquired satellite remote sensing data.

Satellite sensor	Date of acquisition	Level of process	Pixel Spacing	Polarizations
ALOS PALSAR 2	25/5/2016	1.5	6.25 m	L band (HH, HV)

Sources from JAXA

2.1.2. Preliminary field survey data. The field data was collected on 22 March 2016. The foundation for these field trips was the collection of non infected and infected Ganoderma boninense of oil palm tree using thermal sensor camera whereby a total of 16 ground control points with corresponding GPS coordinates were collected.

2.2. Methods

2.2.1. Study site. This study was conducted in FELDA Tembangau which is located between 3° 0'49.82" N to 3° 0'51.70" N latitude and 102°28'37.31" E to 102°28'38.25" E longitude. The oil palm plantation is located at Kemayan, Pahang; 193km from the Kuantan city center.

Figure 1. Google Earth images of study site.

2.2.2. Imagery processing ALOS PALSAR 2. Image processing was performed using the Sentinel-1 Toolbox (S1TBX), an open source software for exploiting ESA SAR missions, including SENTINEL-1, ERS-1 & 2 and ENVISAT, as well as third party SAR data from ALOS PALSAR, TerraSAR-X, COSMO-SkyMed and RADARSAT-2. The methods of ALOS PALSAR 2 data processing in this study were employed as follows, Sigma nought calibration, geometric correction and automatic coregistration, speckle filtering, linear is converted to dB and masking.

3. RESULT AND DISCUSSION

The samples were categorized according to their healthiness levels, which were Stage A, Stage B and Stage C as described in Table 2. The number of oil palm trees for each healthiness levels was non infected (11), Stage A (1), Stage B (4) and no sample in Stage C. Detail information of each tree is tabulated in Table 3. The healthiness level of BSR infection of trees is identified based on the visual symptoms by the expert from Felda Global Ventures Holdings Bhd.

Table 2. Category and description of healthiness level of the oil palm trees

Category	Description
Non infected	Healthy palm, no foliage symptom (0%), no fruiting body
Stage A	Mild infection, no foliage symptom (0-25%), produce fruiting bodies
Stage B	Moderate infection, produce foliage symptom (25-50%), fruiting bodies
Stage C	Severe infection, produce foliage symptom (50-75%) and fruiting bodies

Table 3. Number of trees based on different healthiness level

Tree ID	Healthiness level	Tree temperature (Celsius)
P21	STAGE B	34.1
P22	NON INFECTED	31.2
P23	NON INFECTED	31
P24	NON INFECTED	31.4
P25	NON INFECTED	32.1
P26	NON INFECTED	32.2
P27	STAGE B	35
P28	STAGE A	33.4
P29	NON INFECTED	32.2
P210	STAGE B	35.8
P211	NON INFECTED	31.7
P212	NON INFECTED	32.2
P213	NON INFECTED	33.5
P214	NON INFECTED	34.2
P215	STAGE B	34.8
P216	NON INFECTED	32.7

From the data Table 3, we calculated the average of trees temperature to see there are different temperature between non infected tree and infected tree. The limitation of this study is the number of samples of non infected and infected tree is not the same quantities. Based on figure 3, there is a trend showing the temperature of non-infected tree was lower than infected tree. According to (Siti Khairunniza, 2015) it can be concluded that medium maturity of leaves which was taken from frond number 9 gave significant correlation with healthiness level of oil palm tree.

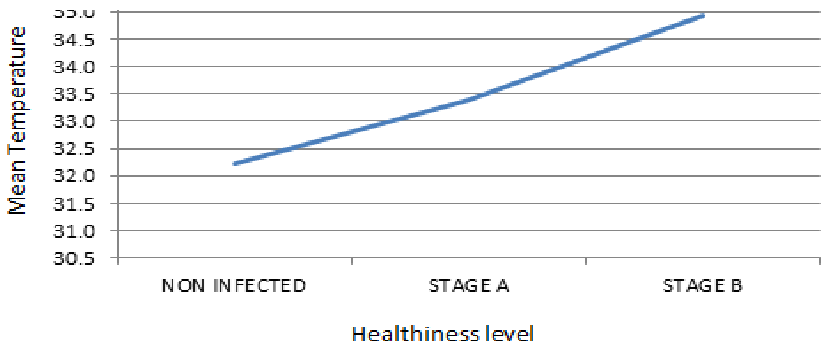

Figure 2. Mean Temperature of Healtiness Level

Figure 3 shows the distribution of HH and HV values. Most of the HH values are on the low end of the scale, so the distribution is skewed to the right. The indicated interquartile range is 1.003 and the median is about 10.769. There one outlier value in the upper whisker. While for HV values are mostly in the high end of the scale so the distribution is skewed to the left. The indicated interquartile range is 2.807 and the median is about 17.632.

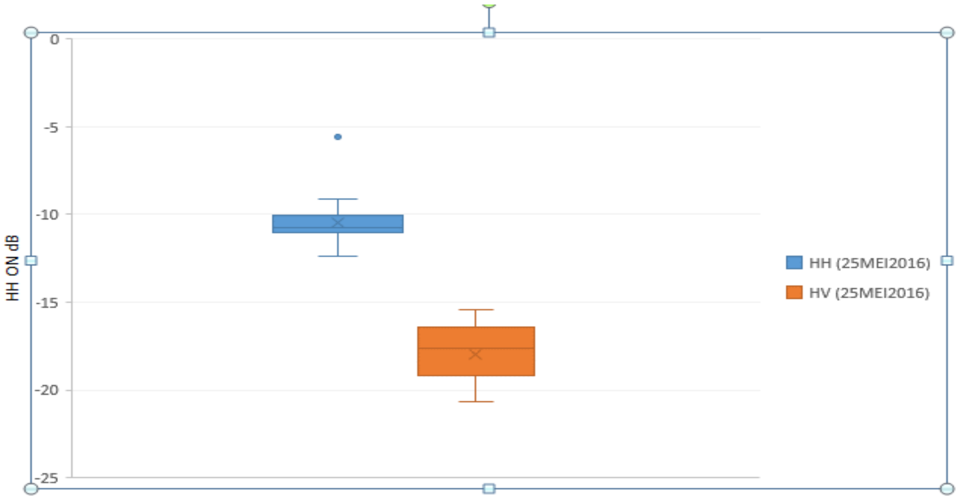

Figure 3. The Distribution of HH and HV Values

Figure 4 (a) shows the relationship between non infected & infected temperature and HH values. Range temperature for non infected oil palm trees is from $31^{o} – 34.2^{o}$ and mean HH value is -10.175. While the infected oil palm trees are from $33.4^{o} – 35.8^{o}$ and mean HH value is -11.003.

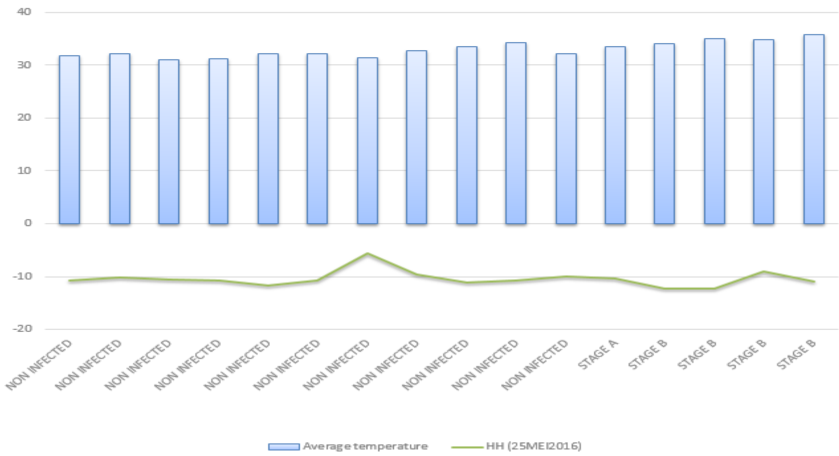

Figure 4 (a). The Relationship Between Non Infected & Infected Temperature And HH Values

Figure 4 (b) shows the relationship between non infected & infected temperature and HV values. Range temperature for non infected oil palm trees is from $31^{o} – 34.2^{o}$ and mean HV value is -18.246. While the infected oil palm trees are from $33.4^{o} – 35.8^{o}$ and mean HV value is -17.265.

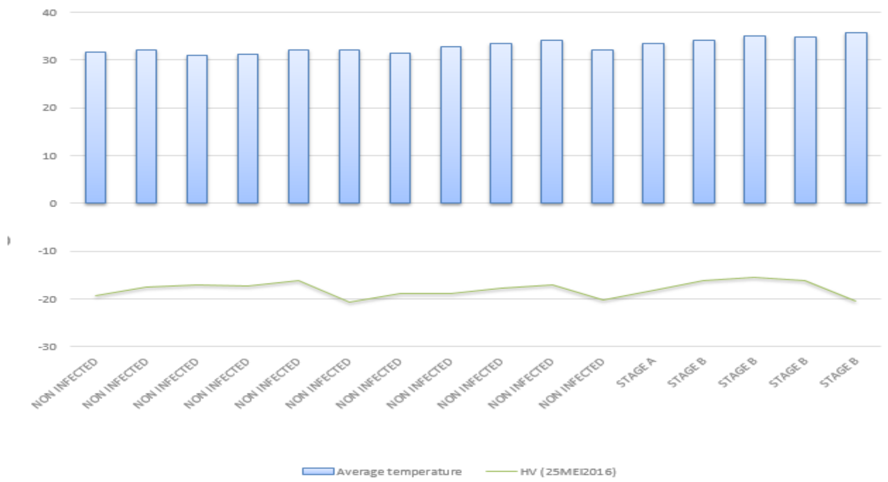

Figure 4 (b). The Relationship Between Non Infected & Infected Temperature And HV Values

4. CONCLUSION

The study has shown a the temperature of non-infected tree was lower than infected tree based on ground data taken using a thermal camera sensor. We found a mean HH value of non infected tree is -10.175 and mean HH value of infected tree is 11.003 and on the mean HV value of non infected tree is -18.246 and mean HV value of infected tree is -17.265. Concluded the result, there are no relationship between non-infected tree and infected tree based on HH and HV values. For future works we will consider to collect more ALOS PALSAR 2 images and parameter samples of oil palm for mapping and create a model of detecting Ganoderma boninense disease.

Acknowledgement

The authors would like to thank JAXA-SAFE and Felda Global Ventures Holdings Bhd is allowing us to conduct our research work and providing data.

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