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# Investigation and Monitoring Systems for Powdery Mildew Disease in Sirugamani Variety of Betel Vine Plants Using Digital Image Processing Techniques

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**Abstract—** Betel vine leaves are popularly known as Vetrilai in Tamil and also commonly known as Pan in Hindi. The biological name of betel vine is known as Piper betel. In this research paper, the powdery mildew disease is identified for sirugamani variety of betel vine leaves using digital image processing techniques by investigating the microscopic change in the color and appearance of the betel vine leaves. For statistical analysis, the digital images of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease from its first day to fifth day of infection are individually collected by a high-resolution digital camera. The red, green and blue color components of collected images are separated, and the mean, median and standard deviation values are calculated for all the three color components. Finally, the calculated values are stored in a database for healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification. The statistical values of all the infected betel vine leaves for all the three color components are decreasing as the day of infection increases for all the betel vine leaves. These analyses help to identify the infection of the powdery mildew disease in the early stage of betel vine leaves.

***Keywords***- *Betel Vine, Powdery Mildew Disease, Oidium Piperis*

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## I. INTRODUCTION

Betel vine leaves are popularly known as Vetrilai in Tamil and also commonly known as Pan in Hindi. The biological name of betel vine is known as Piper betel. The betel vine leaves have the richest source of vitamins and minerals, essential for human health. The six betel vine leaves with a little bit of slaked lime are equal to 300 ml of cow milk particularly for the vitamin and mineral nutrition. The fresh juice of betel vine leaf is used in many ayurvedic preparations. A group of research work is going on in the field of betel vine disease analysis at various centers within the country under the name of "All India Coordinated Research Project on Betel vine". The betel vine leaves are classified into many varieties based on their color, size and taste [38]. Around 100 varieties of betel vine leaves are cultivated throughout the world. Among these varieties, around 40 varieties of betel vine leaves are cultivated in India [36]. The betel vine plants are widely cultivated in the states of Tamil Nadu, Uttar Pradesh, Bihar, Maharashtra, Karnataka, West Bengal, Andhra Pradesh and Kerala. In Tamil Nadu, the most popular cultivation varieties are karpoori, vellai kodi, pachai kodi and sirugamani. Among these varieties sirugamani variety of betel vine leaves are considered for this research paper. In betel vine cultivation, diseases are one of the most important problems that reduce the harvest quantity of the betel vine leaves. The important diseases that infect the betel vine leaves are powdery mildew disease, powdery mildew disease, bacterial leaf spot disease and leaf rot disease. Among these diseases, powdery mildew disease is considered for this research paper. The fungus oidium piperis cause powdery mildew disease. Figure 1 shows the images of front and back view of betel vine leaves affected by the powdery mildew disease. This disease only affects the betel vine leaves which will disappear during the hot season [36]. Initially, the disease appears on the under surface of the leaves as white to brown powdery patches.

Figure 1. Betel vine leaves affected by the powdery mildew disease

These patches gradually increase in size and often combine with each other. They vary in size from minute spot to 40 mm in diameter and are covered by dusty growth which is fairly thick in cases of a severe attack [38]. Young leaves when infected fail to grow and become deformed, the surface being cracked and the margin of the infected leaf turned inwards [37].

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## II. MATERIALS AND METHODS

The application of digital image processing techniques are divided into two phases, that is, analysis of healthy or uninfected betel vine leaves and analysis of infected betel vine leaves. The term healthy betel vine leaves denote the betel vine leaves without infection of any disease. The term infected betel vine leave denotes the betel vine leaves infected by the powdery mildew disease for first five days after identification of infection. The front and back view images of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease from its first day to fifth day of infection are individually collected by a high-resolution digital camera for sirugamani variety of betel vine leaves. The digital images are collected from various plantations located in Erode, Karur and Trichy districts of Tamil Nadu, India. Initially, healthy betel vine plants are identified and betel vine leaves selected from the above plants and serially numbered. The selected leaves are kept under observation for next five days from the day of image collection, to identify the sign of disease infection which is not identifiable at the time of image collection. During the observation, if any sign of infection is noticed in any particular leaf, then the image of such leaf will be rejected. For this observation, the digital images of selected healthy betel vine leaves for sirugamani variety are collected daily during the period of observation. The RGB color components of collected images are separated and their mean, median and standard deviation values are calculated. If the above statistical values on any particular day are deviating from the statistical values of the previous day for particular leaf, then it is considered as a infected betel vine leaf and this infected betel vine leaf is rejected from the samples. Finally, the statistical values of selected healthy betel vine leaves are stored in a database.

The healthy betel vine plants, which lie nearest to the betel vine plants infected by the powdery mildew disease are identified for sirugamani variety. The sample betel vine leaves are selected from the above plants and they are serially numbered. The digital images of selected betel vine leaves are collected and their RGB color components are separated. The mean, median and standard deviation values are calculated and compared with the stored database values of healthy betel vine leaves. If the calculated values and stored statistical values are in the same range for all color components, then the selected healthy betel vine leaves are accepted and included in the selection list otherwise, samples of betel vine leaves are rejected.

These selected healthy betel vine leaves are kept under observation for next three days to identify any sign of disease infection. For this purpose, the digital images of betel vine leaves are collected serially. The RGB color components are separated and the mean, median and standard deviation values are calculated for all the selected betel vine leaves on a daily basis. These calculated values are compared with the stored database values of healthy betel vine leaves. If any differences are identified between calculated values and stored database values on any one particular day for the particular betel vine leaf, that particular day is counted as the first day of infection for the particular betel vine leaf and they are selected for analysis. The images of betel vine leaves infected with the powdery mildew disease are collected serially for first five days after identification of infection. Their RGB color components are separated, and its mean, median and standard deviation values are calculated for all color components and calculated values are stored in a database for sirugamani variety of betel vine leaves.

## III. RESULT AND DISCUSSION

### 3.1 Calculation of Mean Value

The red component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in figure 2. For the healthy betel vine leaves, the mean values of the red component in front view ranges are between 156.99 and 191.17. The mean values of the red component in back view ranges are between 192.68 and 216.98.

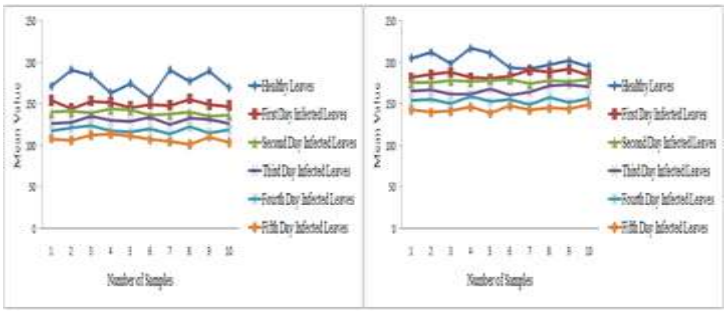
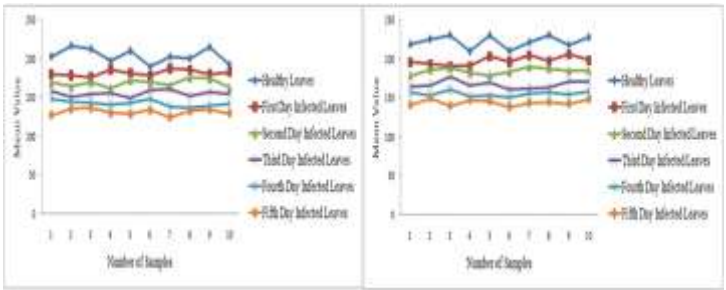



Figure 2. The red component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days




Th Figure 3 green component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

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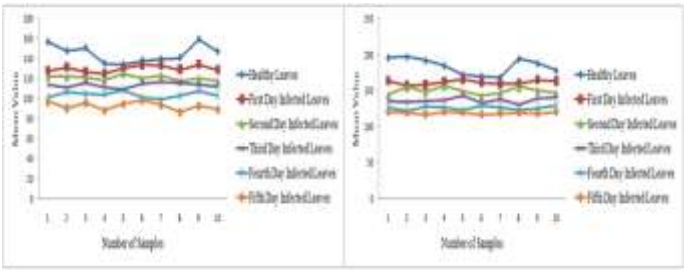

Figure 4. The blue component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

For betel vine leaves infected by the powdery mildew disease on the first day, the mean values of the red component in front view ranges are between 144.80 and 155.95. The mean values of the red component in back view ranges are between 180.85 and 191.94. For betel vine leaves infected by the powdery mildew disease on the second day, the mean values of the red component in front view ranges are between 135.34 and 143.83. The mean values of the red component in back view ranges are between 174.01 and 179.97. For betel vine leaves infected by the powdery mildew disease on the third day, the mean values of the red component in front view ranges are between 125.90 and 134.96. The mean values of the red component in back view ranges are between 160.44 and 173.06. For betel vine leaves infected by the powdery mildew disease on the fourth day, the mean values of the red component in front view ranges are between 114.10 and 124.68. The mean values of the red component in back view ranges are between 149.04 and 159.98. For betel vine leaves infected by the powdery mildew disease on the fifth day, the mean values of the red component in front view ranges are between 101.34 and 113.98. The mean values of the red component in back view ranges are between 139.05 and 148.99.

The green component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in figure 3. For the healthy betel vine leaves, the mean values of the green component in front view ranges are between 189.70 and 216.76. The mean values of the green component in back view ranges are between 209.78 and 230.20. For betel vine leaves infected by the powdery mildew disease on the first day, the mean values of the green component in front view ranges are between 176.02 and 187.53. The mean values of the green component in back view ranges are between 190.56 and 205.93. For betel vine leaves infected by the powdery mildew disease on the second day, the mean values of the green component in front view ranges are between 161.87 and 175.88. The mean values of the green component in back view ranges are between 178.67 and 189.96. For betel vine leaves infected by the powdery mildew disease on the third day, the mean values of the green component in front view ranges are between 149.02 and 160.88. The mean values of the green component in back view ranges are between 161.15 and 177.58. For betel vine leaves infected by the powdery mildew disease on the fourth day, the mean values of the green component in front view ranges are between 137.02 and 148.29. The mean values of the green component in back view ranges are between 150.43 and 160.89. For betel vine leaves infected by the powdery mildew disease on the fifth day, the mean values of the green component in front view ranges are between 124.37 and 136.44. The mean values of the green component in back view ranges are between 138.34 and 149.88.

The blue component mean values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in figure 4. For the healthy betel vine leaves, the mean values of the blue component in front view ranges are between 134.20 and 159.49. The mean values of the blue component in back view ranges are between 167.94 and 196.92. For betel vine leaves infected by the powdery mildew disease on the first day, the mean values of the blue component in front view ranges are between 125.02 and 133.97. The mean values of the blue component in back view ranges are between 157.06 and 166.08. For betel vine leaves infected by the powdery mildew disease on the second day, the mean values of the blue component in front view ranges are between 117.10 and 124.95. The mean values of the blue component in back view ranges are between 143.04 and 156.59. For betel vine leaves infected by the powdery mildew disease on the third day, the mean values of the blue component in front view ranges are between 109.01 and 116.87. The mean values of the blue component in back view ranges are between 130.02 and 142.19. For betel vine leaves infected by the powdery mildew disease on the fourth day, the mean values of the blue component in front view ranges are between 99.06 and 108.61. The mean values of the blue component in back view ranges are between 121.11 and 129.19. For betel vine leaves infected by the powdery mildew disease on the fifth day, the mean values of the blue component in front view ranges are between 86.61 and 98.22. The mean values of the blue component in back view ranges are between 117.14 and 120.91.

### 3.2. Calculation of Median Value

The red component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after identification are shown in figure 5.For the healthy betel vine leaves, the median values of the red component in front view ranges are between 125 and 174. The median values of the red component in back view ranges are between 193 and 214. For betel vine leaves infected by the powdery mildew disease on the first day, the median values of the red

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component in front view ranges are between 114 and 124. The median values of the red component in back view ranges are between 184 and 192. For betel vine leaves infected by the powdery mildew disease on the second day, the median values of the red component in front view ranges are between 104 and 113. The median values of the red component in back view ranges are between 174 and 183. For betel vine leaves infected by the powdery mildew disease on the third day, the median values of the red component in front view ranges are between 96 and 103. The median values of the red component in back view ranges are between 159 and 173. For betel vine leaves infected by the powdery mildew disease on the fourth day, the median values of the red component in front view ranges are between 81 and 95. The median values of the red component in back view ranges are between 141 and 158. For betel vine leaves infected by the powdery mildew disease on the fifth day, the median values of the red component in front view ranges are between 45 and 80. The median values of the red component in back view ranges are between 129 and 140. The green component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by powdery mildew disease for first five days after its identification are shown in figure 6. For the healthy betel vine leaves, the median values of the green component in front view ranges are between 171 and 203.

The median values of the green component in back view ranges are between 194 and 223. For betel vine leaves infected by the powdery mildew disease on the first day, the median values of the green component in front view ranges are between 158 and 170. The median values of the green component in back view ranges are between 181 and 193. For betel vine leaves infected by the powdery mildew disease on the second day, the median values of the green component in front view ranges are between 141 and 153. The median values of the green component in back view ranges are between 161 and 180. For betel vine leaves infected by the powdery mildew disease on the third day, the median values of the green component in front view ranges are between 127 and 140. The median values of the green component in back view ranges are between 149 and 160. For betel vine leaves infected by the powdery mildew disease on the fourth day, the median values of the green component in front view ranges are between 118 and 126. The median values of the green component in back view ranges are between 137 and 148. For betel vine leaves infected by the powdery mildew disease on the fifth day, the median values of the green component in front view ranges are between 110 and 117. The median values of the green component in back view ranges are between 126 and 136.

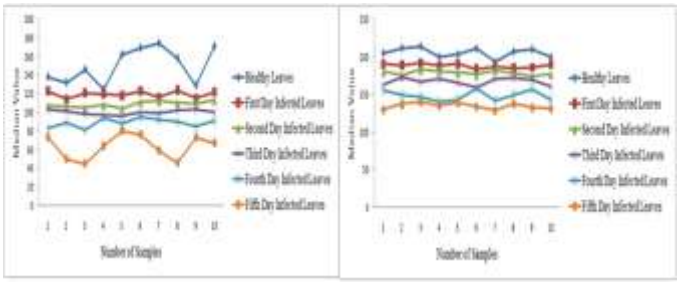

Figure 5. The red component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

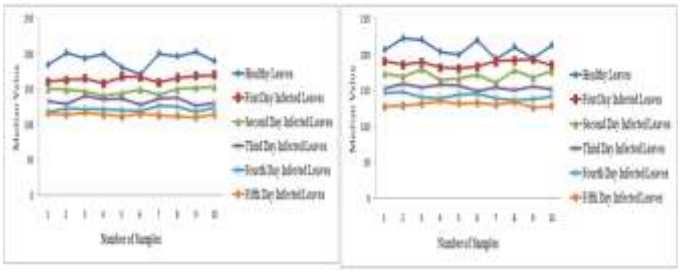

Figure 6. The green component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

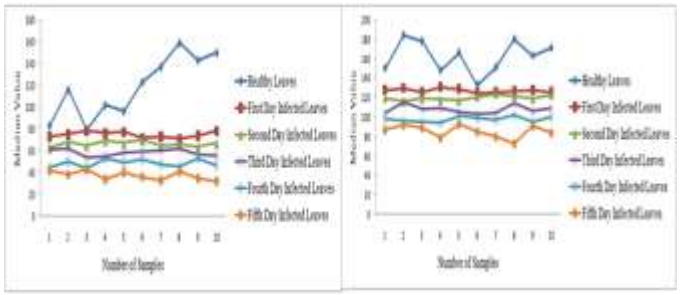

Figure 7. The blue component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

The blue component median values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in figure 7. For the healthy betel vine leaves, the median values of the blue component in front view ranges are between 79 and 159. The median values of the blue component in back view ranges are between 133 and 184. For betel vine leaves infected by the powdery mildew disease on the first day, the median values of the blue component in front view ranges are between 71 and 78. The median values of the blue component in back view ranges are between 125 and 131. For betel vine leaves infected by the powdery mildew disease on the second day, the median values of the blue component in front view ranges are between 63 and 70. The median values of the blue component in back view ranges are between 116 and 124. For betel vine leaves infected by powdery mildew disease on the third day, the median values of the blue component in front view ranges are between

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54 and 62. The median values of the blue component in back view ranges are between 103 and 115. For betel vine leaves infected by the powdery mildew disease on the fourth day, the median values of the blue component in front view ranges are between 44 and 53. The median values of the blue component in back view ranges are between 94 and 102. For betel vine leaves infected by the powdery mildew disease on the fifth day, the median values of the blue component in front view ranges are between 32 and 43. The median values of the blue component in back view ranges are between 73 and 93.

### 3.3. Calculation of Standard Deviation Value

The red component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by powdery mildew disease for first five days after its identification are shown in figure 8. For the healthy betel vine leaves, the standard deviation values of the red component in front view ranges are between 75.42 and 86.96. The standard deviation values of the red component in back view ranges are between 65.01 and 76.94. For betel vine leaves infected by powdery mildew disease on the first day, the standard deviation values of the red component in front view ranges are between 66.01 and 74.91. The standard deviation values of the red component in back view ranges are between 53.26 and 64.66. For betel vine leaves infected by the powdery mildew disease on the second day, the standard deviation values of the red component in front view ranges are between 54.36 and 65.86. The standard deviation values of the red component in back view ranges are between 40.04 and 54.61. For betel vine leaves infected by the powdery mildew disease on the third day, the standard deviation values of the red component in front view ranges are between 45.10 and 53.93. The standard deviation values of the red component in back view ranges are between 29.06 and 39.80. For betel vine leaves infected by the powdery mildew disease on the fourth day, the standard deviation values of the red component in front view ranges are between 36.01 and 44.91. The standard deviation values of the red component in back view ranges are between 20.08 and 28.91. For betel vine leaves infected by the powdery mildew disease on the fifth day, the standard deviation values of the red component in front view ranges are between 20.08 and 35.78. The standard deviation values of the red component in back view ranges are between 10.15 and 19.24.

The green component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in figure 9. For the healthy betel vine leaves, the standard deviation values of the green component in front view ranges are between 67.06 and 78.62. The standard deviation values of the green component in back view ranges are between 66.01 and 75.88. For betel vine leaves infected by the powdery mildew disease on the first day, the standard deviation values of the green component in front view ranges are between 50.58 and 65.06. The standard deviation values of the green component in back view ranges are between 61.07 and 65.97. For betel vine leaves infected by the powdery mildew disease on the second day, the standard deviation values of the green component in front view ranges are between 42.01 and 49.93. The standard deviation values of the green component in back view ranges are between 55.09 and 59.99. For betel vine leaves infected by the powdery mildew disease on the third day, the standard deviation values of the green component in front view ranges are between 34.07 and 41.89. The standard deviation values of the green component in back view ranges are between 40.08 and 54.61. For betel vine leaves infected by the powdery mildew disease on the fourth day, the standard deviation values of the green component in front view ranges are between 22.55 and 33.91. The standard deviation values of the green component in back view ranges are between 32.51 and 39.97. For betel vine leaves infected by the powdery mildew disease on the fifth day, the standard deviation values of the green component in front view ranges are between 08.11 and 21.94. The standard deviation values of the green component in back view ranges are between 18.69 and 31.99.

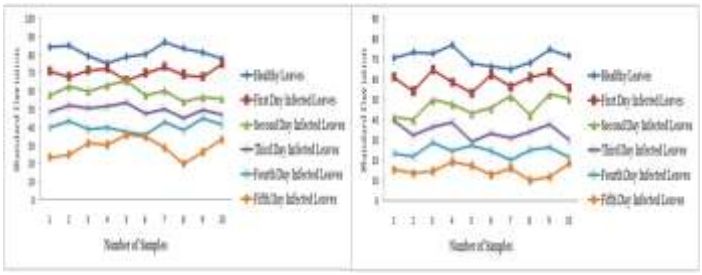

Figure 8. The red component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

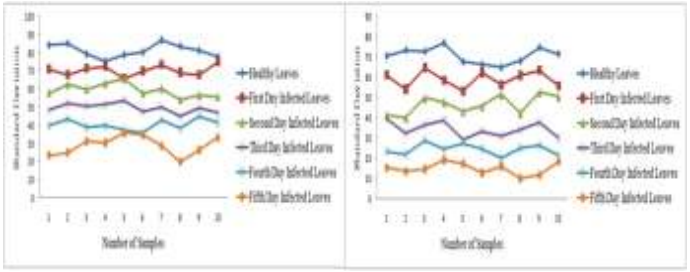

Figure 9. The green component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

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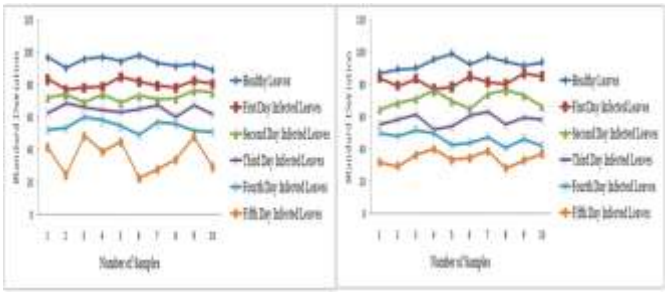

Figure 10. The blue component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days

The blue component standard deviation values for front and back view of healthy betel vine leaves and betel vine leaves infected by the powdery mildew disease for first five days after its identification are shown in 10. For the healthy betel vine leaves, the standard deviation values of the blue component in front view ranges are between 89.21 and 98.21. The standard deviation values of the blue component in back view ranges are between 87.08 and 98.89. For betel vine leaves infected by the powdery mildew disease on the first day, the standard deviation values of the blue component in front view ranges are between 77.12 and 84.89. The standard deviation values of the blue component in back view ranges are between 77.13 and 86.83. For betel vine leaves infected by the powdery mildew disease on the second day, the standard deviation values of the blue component in front view ranges are between 69.05 and 76.30. The standard deviation values of the blue component in back view ranges are between 64.55 and 76.28. For betel vine leaves infected by the powdery mildew disease on the third day, the standard deviation values of the blue component in front view ranges are between 60.16 and 68.70. The standard deviation values of the blue component in back view ranges are between 52.09 and 62.92. For betel vine leaves infected by the powdery mildew disease on the fourth day, the standard deviation values of the blue component in front view ranges are between 49.11 and 59.87. The standard deviation values of the blue component in back view ranges are between 40.93 and 51.98. For betel vine leaves infected by the powdery mildew disease on the fifth day, the standard deviation values of the blue component in front view ranges are between 22.30 and 48.36. The standard deviation values of the blue component in back view ranges are between 28.16 and 39.88.

## IV. CONCLUSION

The statistical analysis on RGB color components of healthy and infected betel vine leaves shows that the statistical values for infected leaves varies on the basis of the duration of infection. The mean, median and standard deviation values of all color components have decreased as the day of infection increases for the infected betel vine leaves. This analysis helps to identify the infection of powdery mildew disease in the early stage for sirugamani variety of betel vine leaves.

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