The physical properties and root spread of cassava bunch for design of the inter-row weeding machine

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Abstract. This research aimed to study the physical properties and pattern of cassava bunches in soil as data for inter-row weeding machine design. The study consisted of the bunch weight, bunch size, and spreading pattern of bunch. The 3 – 12 months old Huay-Bong variety was investigated monthly. The results showed that at 3 months old the cassava had a bunch weight, cassava root diameter, and bunch spreading perpendicular to row of 0.4 – 1.0 kg, 1.1 – 3.1 centimetres, and 34.0 – 98.0 centimetres respectively. At the harvesting period the bunch weight was 1.8 – 6.1 kg with cassava root diameter of 3.0 – 8.0 centimetres, while the spreading of bunch perpendicular to row on each side was 10.0 – 50.0 centimetres, and row distance was 19.0 – 110.0 centimetres. Finally the average of depth of bunch was 24.5 – 33.1 centimetres respectively.

1. Introduction
Cassava or tapioca is a tropical root crop which has played an important role in the Thai economy [1]. Thailand was ranked as the world’s largest cassava products exporter with an annual production of 33 million tons in 2016 [2], and had planted an area of 8.8 million rai (1.4 million ha) with a yield of 32.9 million tons [3, 4].

The cassava production processes consist of planting, cultivating, harvesting, post-harvesting, and processing. To increase production efficiency, farm machineries are needed. Nowdays, cassava cultivation in Thailand is mainly done by hand, hence it takes time and more expense due to the lack of labour. Thus, high performance and efficient cassava cultivating machinery needs to be designed and developed.

Then, this research aimed to study the physical properties of cassava as a data for the calculated and designed the cultivating machine.

2. Materials and method

2.1. The weight of cassava bunch and maximum diameter of cassava root
The weight of cassava bunch as figure 1 and maximum diameter of cassava root as figure 2 were investigated starting from 3 months old to 12 months old for the growth comparison. Cassava bunch was weight by spring balance with 0.1 kg graduate, and the diameter of cassava root was measured by Vernier Caliper.
2.1.1. The root spread of cassava bunch to perpendicular with row crop. The root spread in perpendicular with row crop; by measuring the width from one end to the other end point of the bunch on the horizontal plane perpendicular to the row as figure 3 by measuring tape with 1 millimetre graduate.

2.1.2. The root spread of cassava bunch to align with row crop. The root spread in aligned with row crop; by measuring the width from one end to the other end point of the bunch on the horizontal plane align to the row as figure 4.

2.1.3. The depth of cassava bunch. The penetration of bunches; by measuring the depth of bunch from the ridge surface to the deepest of the bunch on the vertical plane as figure 5.
3. Results and discussion

3.1. Results of the weight of cassava bunch and maximum diameter of cassava root

Figure 6 – 7 show the growth rate of cassava root of 3 – 12 months old. They reveal that the older the cassava the larger the cassava root size, but after 8 months old the size of cassava root is slightly unchanged. Thus, if a farmer wants to cultivate their cassava such as inter-row weeder, they should be concerned about the cassava size to avoid damage.

Figure 5. The depth of cassava bunch measurement.

Figure 6. The weight of cassava bunch within 3 – 12 months old.
3.2. Result of the root spread of cassava bunch

3.2.1. Result of the root spread of cassava bunch perpendicular to row crop. Table 1 shows the summary of the cassava bunch spreading out perpendicular to row. The result shows that the spreading out of cassava bunch within 3 – 12 months old was 20.0 – 100.0 centimeters. Then, to avoid cassava damage, the cassava inter-row weeder should work at least 35.0 centimeters apart from cassava stem that covering 95th percentile.

3.2.2. Result of the root spread of cassava bunch to align with row. The spreading range of cassava bunch along to row within 3 – 12 months old was 19.0 – 110.0 centimeters (table 1).

| Root spread (cm) | Cumulative of the root spread of cassava bunch (%) |  |  
|------------------|----------------------------------------------------|----|---
|                  | perpendicular to row | align with row |  |
| 0 – 100          | 1.12% | 5.58% |   |
| 101 – 200        | 19.70% | 29.37% |   |
| 201 – 300        | 49.07% | 57.99% |   |
| 301 – 400        | 71.38% | 75.09% |   |
| 401 – 500        | 81.78% | 88.85% |   |
| 501 – 600        | 91.82% | 93.68% |   |
| 601 – 700        | 96.28% | 98.14% |   |
| 701 – 800        | 98.51% | 99.26% |   |
| 801 – 900        | 99.26% | 99.26% |   |
| More 901         | 100.00% | 100.00% |   |
| **Average**      | 35.2 cm | 31.5 cm |   |
| **SD**           | 17.1 cm | 16.6 cm |   |
| **Range**        | 20.0 – 100.0 cm | 19.0 – 110.0 cm |   |
3.2.3. Result of the depth of cassava bunch. The results revealed that at 3 – 12 months old the depth of cassava bunch was in the range of 11.0 – 63.0 centimeters. The average of depth overall harvesting period was 24.5 – 33.1 centimeters as figure 8. This data proved that the average of bunches depth was not different. This is because during the first period cassava bunches were performed while the ridge was still complete, but during last period cassava bunches penetrated deeper simultaneously with the ridge melt down. Thus the inter-row weeder implement designed should work at least 45.0 centimeters underneath of ridge surfaced.

Figure 8. Depth of cassava bunch within 3 – 12 months old.

4. Conclusion
To design the inter-row weeder that covers the 95th percentile, the machine should work 35 centimeters apart from cassava stem, and 45 centimeters deeper than the ridge surface. Under these conditions, the inter-row weeder machine can work without damaging the cassava root.

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