

Original Research Article

Morphological Characteristics of Potato (*Solanum tuberosum* L.) Variety Hartapel Origin South Buru-Moluccas

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Abstract	Keywords
The purpose of this study was to obtain information on morphological characteristics of potato (<i>Solanum tuberosum</i> L.) variety Hartapel, origin South Buru. The research was conducted in the Fakal village of South Buru of Moluccas located 1124 m above sea level. The results showed that potato variety Hartapel was found to be a local variety which has long been adapted to local growing environment. Morphological characters of this variety are influenced by environmental factors. The morphological characterization of Hartapel potato variety from South Buru can provide a source of information that can be useful for preserving germplasm diversity of potato varieties. In addition, morphological characterization results can be used as baseline for further development of Hartapel variety of potatoes and can serve as source of information on biodiversity of potato plants.	Characterization Hartapel potato variety Moluccas Morphology South Buru

Introduction

The potato is one of the world's most important food crops and the world's most important vegetable crop. Potato produces more carbohydrate per acre per year than any other crop except sugarcane. It has a higher quality protein than any other vegetable, and only soybean yields more protein per acre (Rhoades, 1982; Ortiz, 1998). As a staple food, potato is the fourth most important crop after rice, wheat, and maize, and has historically contributed to food and nutrition security in the world (Yuan, 2003; FAOSTAT, 2015; FAO, 2015). The plant has a production capacity of energy and

protein per unit of land which is high when compared with other crops. Potato tubers are not only rich in carbohydrates, but is a mineral resource for consumption, as well as the food needs of half a billion people in the world (FAOSTAT, 2015; FAO, 2015). Potatoes are known to have the highest genetic diversity of all cultivated plants (FAO, 2015; Roca et al., 2003). However, the improved commercial varieties consumed around the world have mainly been generated from only one of the eight existing species, i.e., *Solanum tuberosum* subsp. *tuberosum*.

Global interest in potato increased recently as world food prices soared, threatening the global food security and stability. Potato is increasingly regarded as a vital food-security crop. Potato belongs to the botanical family Solanaceae and within it to the genus *Solanum*, which consists of more than 2,000 species (Hawkes, 1978). Apart from the cultivated potato *S. tuberosum* L. ssp. *tuberosum*, seven other cultivated and 228 wild potato species have been identified.

Spooner and Salas (2006) have recently revised the taxonomy of potato species by combining the seven cultivated species into one single potato species (*S. tuberosum*) with eight cultivar groups. The cultivated potato originated from wild *Solanum* species in the Andes of South America and the coastal strip of central to southern Chile (Hawkes, 1978). After the first potatoes were brought to Europe in the late sixteenth century, this crop plant was rapidly distributed and is now utilised all over the world, mostly in temperate regions (Hawkes, 1990). Today, there are more than 4,500 varieties of *S. tuberosum* ssp. *tuberosum* (Hils and Pieterse, 2009). Potato is known to have the richest genetic diversity of any cultivated plant because of its high number of varieties and related species (FAO, 2015; Messer, 2000).

Based on the important role of this plant in the world, it is necessary to obtain improved varieties with high production rate and the corresponding growing environment. One effort that can be achieved is through the characterization of the specific varieties or local varieties which can be used as a source of diversity in the process of improvement of the potato plant, both to increase production and the needs of consumption. In South Buru, District Leksula found four local varieties cultivated at 700-1300 m above sea level altitude.

Local varieties encountered is Hartapel, Baklawan, Kenine and Lanbow. Its origin is unknown, but has been cultivated for hundreds of years by the locals. Until now there has been no research reports about its characteristics, agronomic and genetic superiority of the varieties. Morphological characters of a variety of potatoes can be known through the identification of traits such as stems, leaves, flowers and tubers. The purpose of this study to obtain information morphological characters varieties Hartapel origin South Buru.

Materials and methods

Observation of morphological characters do in Fakal Village, South Buru at an altitude of 1124 m above sea level. Identified varieties are varieties Hartapel, planted with a population of 20 plants/plot with a spacing of 60 x 30 cm. The size of tubers seed are used ranged from 30-50 g. Observed morphological characters include stems, leaves, flowers and tubers. Observations on the environment grow crops include altitude, temperature, texture classes and soil pH. Information origin of the potato crop is done through interview farmers, field staff of local agriculture and information from various sources of relevant literature. Leaf morphological characters were observed on leaves located in the upper third of the main stem. Observation of morphological characters is done with reference to the guidelines UPOV TG/23/5 1986, combined with the Individual Test Guidelines BUSS Potatoes (Center for Plant Variety Protection, 2006).

Results and discussion

History and origins

Introduction of the potato crop in Indonesia by the Dutch in 1794 to Cisarua (Cimahi) spread it to various areas including Pangalengan, Wonosobo, Tawangmangu, Berastagi, Curup, Tomohon, and other areas (Permadi, 1989). The potatoes developed in Indonesia are cultivars imported from European that have been adapted. The origin of the potato crop in the Moluccas is not known, but encountered in mountainous areas Seram Island, among others in the village Lohiasapalewa and Riring and Buru in the village Fakal and Mangeswaen. Hartapel potato variety is one of the local varieties that have adapted to the environment and cultivated by farmers in the village Fakal and Mangeswaen - South Buru. In the village Fakal and Mangeswaen, potatoes are consumed as a food source in addition to rice and other crops. This variety grows at altitudes ranging from 700-1300 m above sea level and has not been identified morphologically.

Environmental conditions for crop growing

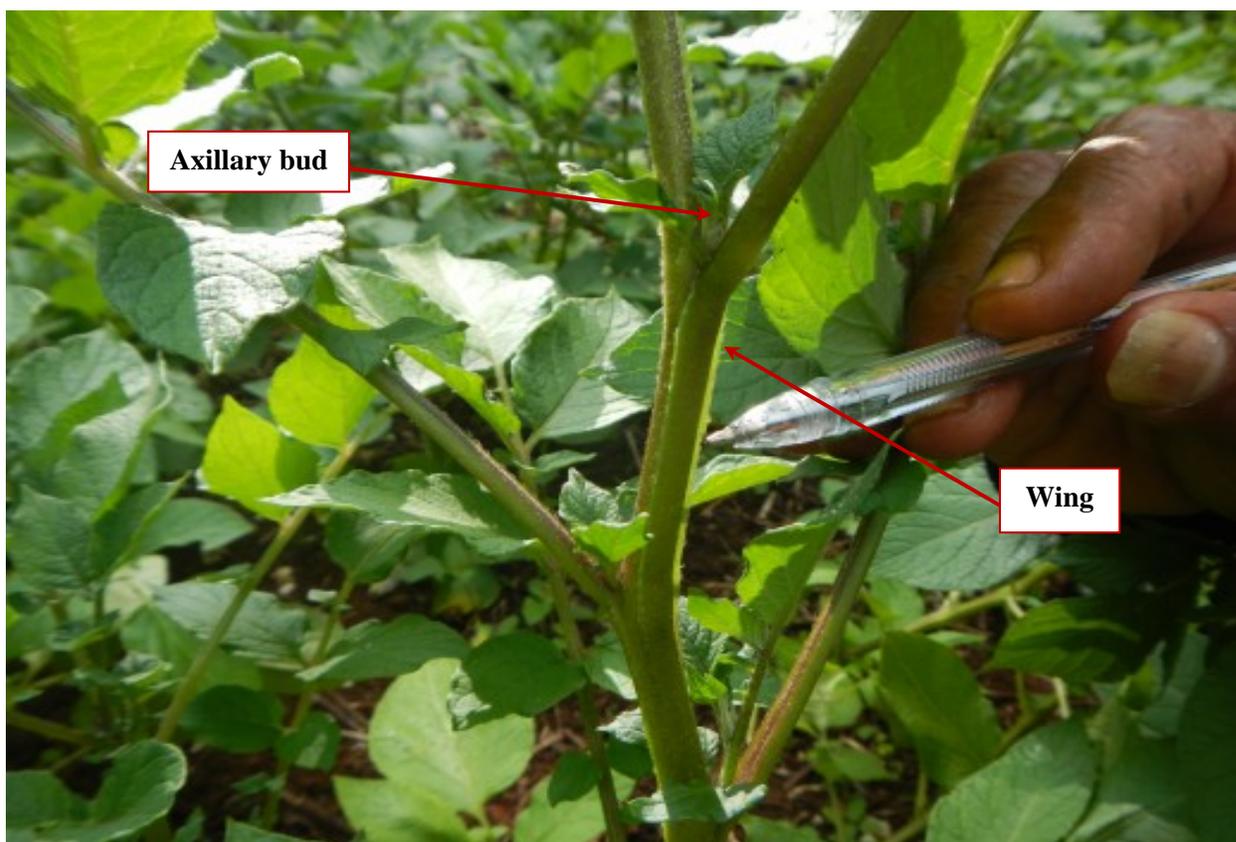
Hartapel potato variety forms tubers on daytime temperature: 29-32°C and night: 16-24°C, as

well as soil temperature during the day: 20-21°C. Potato plants require low temperatures for growth and tuber formation process requires optimum temperature of 18°C (Acquaah, 2007; Asandhi, 1987; Harwati, 2008; Lafta and Lorenzen, 1995; Menzel, 1985). At high temperatures, gibberellin concentration will increase, leading to inhibition of tuber formation (Levy and Veilleux, 2007; Menzel, 1985; Fernie and Willmitzer, 2001). Besides climatic factors, soil factors play an important role. Hartapel potato variety grows in soil with clay texture class at pH 6.2. The growth of Hartapel potato variety on the environment itself serves as its own identifier, and in contrast to other highland varieties in Indonesia.

Morphology of stem

Potato stem above the ground surface is green and more striking green color in plants which is older. The erect stems grow at an angle greater than 45 degrees with the ground. The number of stems and branches that appear above the soil surface depends on the number of buds on the tubers sprout or influenced by the storage and generation levels. The average number of buds on the tuber which appear on the surface of soil that forms the stem as much as eight. Hollow stem is not woody. The old plants and ready to be harvested plants have hard and woody stems. The shape of upper stem is not round, slightly angled or winged (ridges of tissue growing outward from the stem) (Fig. 1).

Fig. 1: The shape of upper stem of Hartapel potato variety.



Morphology of leaves

Compound leaves arise in spiral pattern on aerial stems and not encountered with interjected leaflets. In the angle between stems and leaves (leaf axil), branches or inflorescences are produced. At the base

of the leaves, pseudostipular leaflets are also found and sometimes these fall off or are not produced at all. Leaves that emerge from the tuber as a single leaf, later develop into compound leaf consisting of terminal leaflet and lateral leaflets without interjected leaflets (Fig. 2).

Fig. 2: The morphological appearance of leaves of Hartapel potato variety.

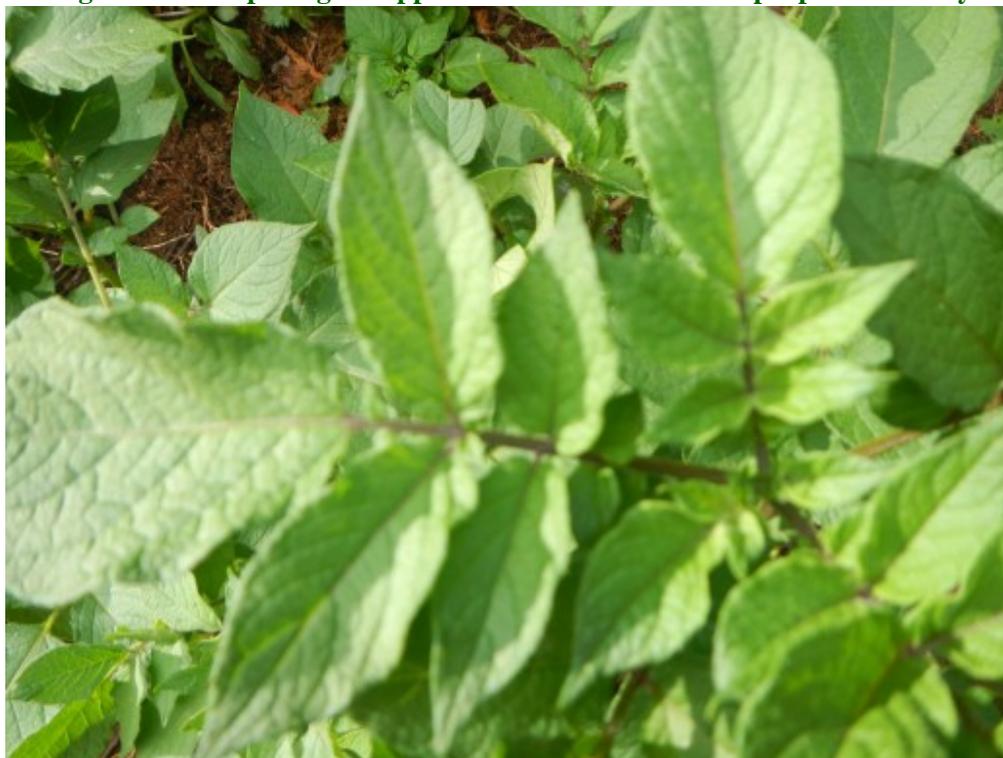


Fig. 3: The flowers of Hartapel potato variety.



The color of the rachis is purple and is positioned against the main stem in tapered angle (acute) which forms an angle of less than 45 degrees. At the rachis, lies lateral leaflets with six strands. Lateral leaflets are oblong oval in shape. The size is expressed in terms of the ratio between the width and length of 3/5 (Burton, 1966). Compound leaves on the stalk essentially also is found axillary bud that can be developed to form a secondary branch with simpodial system (Cutter, 1978). Leaf size is influenced by temperature, when the temperature is higher than the optimal level, leaf size will be smaller with decreased leaf area (Fleisher et al., 2006; Wheeler et al., 1986).

Morphology of flowers

Flowers are arranged as an inflorescence formed at the tip of the stem and the number of flowers is 3-5. The main stalk of the inflorescence is normally divided into two branches. Inflorescence composed of two monochasial cymosa, and the main stalk (penduncle) forms as a simple umbrella (umbel). Early flowers are located near the branching of flower stalk and the flowers bloom within two to three days. The flowers are trumpet-shaped, purple colored and complete with a diameter of ≥ 3 cm (Fig. 3). The calyx consists of five sepals and the corolla consists of five petals that are partly joined at their base; stamens are five in number with yellow anthers and a pistil is with one ovary.

Morphology of tubers

In potato, the stems arise at the beginning of each growing season from a tuber of the previous year, referred to as the mother tuber. A potato tuber is a modified underground stem, not a swollen root. The "eyes" of potato tubers are stem buds, similar to buds on the nodes of a stem. Each potato tuber has several eyes, and each eye is capable of producing a separate stem.

The potato is a herbaceous annual plant grows up to 100 cm tall. As the potato plant grows, its compound leaves manufacture starch that is transferred to the ends of its underground stems or stolons. The stems thicken to form a few or as many as 20-24 tubers close to the soil surface. The number of tubers that actually reach maturity depends on available moisture and soil nutrients.

Tubers may vary in shape and size, and normally weigh up to 200 g. At the end of the growing season, the plant's leaves and stems die down to the soil level and its new tubers detach from their stolons. The tubers then serve as a nutrient store that allows the plant to survive the cold and later regrow and reproduce. Each tuber has 8 to 10 buds, arranged in a spiral pattern around its surface. The buds generate shoots that grow into new plants when conditions are again favorable.

On the bottom stem segments of stolon growing horizontally and laterally into the soil forms tubers. The length of stolon may reach 10 to 20 cm. The shape of the potato tuber is tapered at the base of the bulb, the width at the end or it can be said as a form of kidney. The potato varieties can be characterized by tuber shape, but the shape of the tubers is influenced by cultivation techniques and environmental factors. The buds are arranged in a spiral, and more to the end of the tuber eye shoots which is more solid. Buds are shallow in depth, the skin color of the tuber is pink (Fig. 4) and the tuber pith color is yellow (Fig. 5). Tuber skin color is not directly related to the tuber pith color or characteristic tuber pith color. Skin and pith color of tuber can be used as an identification feature of Hartapel potato variety. According to the time of harvesting and growing shoots, the dormancy period can reach 90 days. The number of tubers per plant is about 14 to 20 tubers of various sizes. The shoots are purple in tuber seed that can also be used as identification characteristic of varieties of this kind (Fig. 6).

Fig. 4: Tubers of potato variety Hartapel.

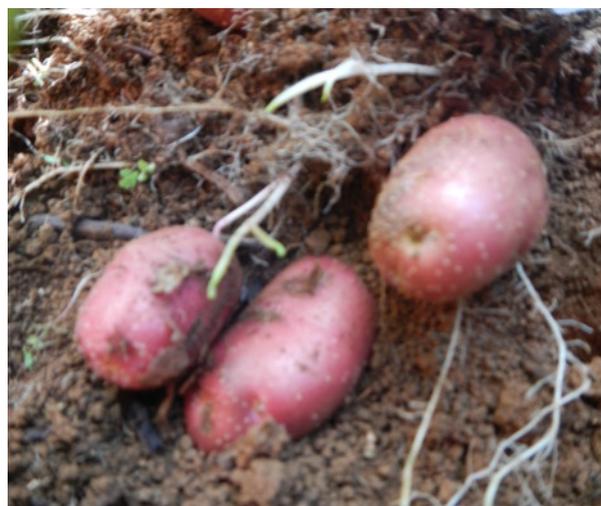
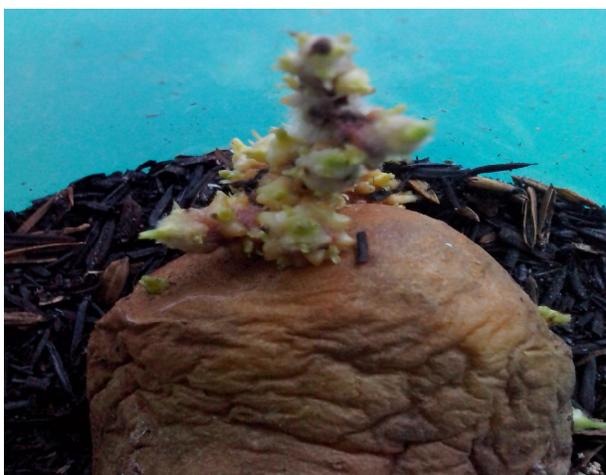


Fig. 5: Tuber pith color (yellow) of potato variety Hartapel.



Fig. 6: Shoots from a tuber of potato variety Hartapel.



Conclusion

The origin of Hartapel potato variety is unknown, but it has been believed as an adapted variety, grows and produces well in the Fakal village of South Buru-Moluccas. This variety can grow and form tubers well at an altitudinal range of 700 to 1300 m above sea level. Growth and morphological characters of Hartapel potato variety is influenced by many factors, among others, environmental factors such as temperature, soil and soil pH plays major role. Morphology of stems, leaves, flowers and tubers are specific, including the shape and color which are all forming identification keys of Hartapel potato variety. Morphological characterization of Hartapel potato variety can provide a source of information that can be used for conserving germplasm diversity of potato varieties.

In addition, morphological characterization results can be used as a baseline information for further development of Hartapel potato varieties.

Acknowledgments

Authors are thankful to the Head of the Regional Technical Implementation Unit (UPTD) and Field Officers. Subdistrict Leksula South Buru, District Agricultural Office is gratefully acknowledged for the encouragement and for research activity and facilities.

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