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HORTICULTURE

Factors Affecting Cutting of Peduncle of Tomato (*Solanum lycopersicum)*

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ABSTRACT

A study of peduncle parameters were conducted inorder to find the factors affecting cutting of peduncles in the harvesting operation. The study was conducted as an initial step for designing a cutting unit for harvesting tomato. Cross section of peduncle was studied in the lab. Cutting force required to cut the peduncle was measured for tomatoes harvested on different stages, i.e. mature unripe, immature unripe and mature ripe. Also, force for cutting the peduncle with different diameters were measured. It was seen that, peduncle length is an unavoidable factor to determine the cutting portion. It decides where to make the cut, for detaching the fruit from the plant. The parameters like blade parameters, cell structure of cutting material and force for cutting directly affects the cutting operation.

Highlights

- The force required for cutting the peduncle of tomato is not depending on the diameter of the peduncle.

Keywords: Peduncle, tomato, cutting force

Tomato (*Solanum lycopersicum)* is a widely grown crop all over the world. Its been produced both in open field and green houses, which make it available throughout the year. The plants generally grow to one–two metres in height and often stretch and vines over nearby plants. Harvesting is an operation of separating the fruit from the parent plant through the detachment of peduncle. A peduncle can be treated as a pipe or path for the translocation minerals for the fruits (Ogawa *et al.,* 2007). In this study evaluation of peduncle parameters that affects cutting is carried out. This is done as an initial step which may help in development of a cutting unit in the harvesting operation of the tomato in the future.

MATERIALS AND METHODS

Study site and set up

The study location is situated between 10° 52′ 30″ North Latitude and 76° East longitude. Tomato (*Solanum lycopersicum*) variety Anagha, a hybrid variety from Maharashtra Hybrid Seeds Co. Pvt. Ltd. was used for the study. Ten fruits were selected for the peduncle study. The parameters like length and diameter of the peduncle of the selected fruits were measured. The length was measured using a measuring tape and the diameter was measured using digital vernier caliper. The study was conducted during the period of Feb-May, 2015.

Cross section of peduncle

The cross section of the peduncle was taken in the laboratory set up. Thin hand section of the peduncle was taken using a blade. Saffron coloring pigment was used to get the coloured section of the peduncle. The slide was prepared by selecting the most appropriate section. The more thin the section is, the more accurate the result will be. The magnified image was obtained through Leica microscope using 4 × lens. Image was obtained using a software-image analyser and the image was captured using Olympus camera.

Cutting force

The cutting force (firmness and toughness) required to cut the peduncle of tomato was determined using TPA (Texture Profile Analysis). It was determined using a Texture Analyzer (TA.XT texture analyser, Stable micro systems Ltd.). It is a microprocessor controlled system which can be interfaced to a wide range of peripherals, including PC type computers. It is versatile and easy to use and is similar to a universal testing machine. The Texture Analyzer consists of two separate modules. The test bed and the control console (Key board). By connecting the texture analyzer to a personal computer installed with texture Exponent 32 software program (version 3.0). The texture analyzer can be controlled and the result can be obtained in a graphical format, find multiple peaks, measure gradients, areas, averages and then save the data on disc.

The texture analyzer measures force, distance and time, thus providing three dimensional product analyses. Force may be measured against set distance and distance may be measured to achieve set of forces. The probe carrier contains a sensitive cell. The load cell has mechanical overload and under load protection and an electronic monitoring system that stops the motor drive when an overload condition is detected.

Distance and speed control is achieved using a step motor attached to a fine lead screw that winds the probe carrier up and down.

The tomato with peduncles was marked for the different distance from apex to find out cutting force. Samples were placed on the heavy-duty platform of the texture analyser, positioned under the blade set probe and the test was carried out. The blade with 2.95 mm thickness and 30^0 angles was used for this test.

TPA (Texture Profile Analysis) operational procedure:

Mode	:	TPA
Option	:	return to start
Pre-test speed	:	1.0 mm/s
Test speed	:	1.0 mm/s
Post test speed	:	1.0 mm/s
Distance	:	3 mm
Force	:	20 g
Time	:	150 s
Data acquisition rate	:	200 pps
Load cell	:	50 kg

Fig. 1: Texture Analyser

RESULTS AND DISCUSSION

Peduncle parameters

The peduncle length and circumference have direct role in determining the cutting operation. Weight of the fruit, peduncle length and peduncle diameter are seen varying independently. Tomato has shorter peduncles. This makes some inconvenience in the harvesting operation. The shortest value recorded for the peduncle length for the selected samples was 18 mm and the longest was 25 mm. Peduncle length is an unavoidable factor to determine the cutting portion. It decides where to make the cut, for detaching the fruit from the plant.

Table 1: Peduncle dimensions of tomato

Sample No.	Tomato weight (gm)	Peduncle length (mm)	Average peduncle circumference (mm)
1	31.80	18	2.07
2	43.54	23	1.88
3	48.37	21	2
4	35.50	19	1.94
5	33.32	25	1.47
6	46.50	20	1.47
7	39.73	18	0.97
8	43.58	19	1.95
9	46.44	22	1.89
10	38.25	23	1.9

Burks *et al.* (2005) mentioned the importance of proper harvesting with and without the presence of peduncle after harvesting. If the peduncle length is too short, mechanical harvest will be a failure. Also, fruits harvested along with the peduncle have got more market value because of its appearance.

Factors affecting cutting

Cutting has been identified as one of the important production methods. Depending upon the mechanical and physical properties of the material to be cut, geometry of the cutter blade and the nature of cutting process were determined.

Blade Parameters

Most of the operational part of a cutting element has one sided wedge shape. Blade parameters like blade thickness, wedge angle, blade shape, edge thickness, edge smoothness etc, will affect the cutting ability of the cutting tool. Burks *et al.* (2005) pointed out a method to detach the fruit using a sharp blade and justifies that the fruit damages will be less if we use this method.

Wedge Angle

Wedge angle is the angle of the cutting portion of a cutting tool. It is measured between the center of the blade and the bevel or flat cut by the sharpening surface. Smaller the angle of wedge, lesser will be the force required for cutting and resistive force offered by soft materials like peduncle.

Edge Thickness

Edge thickness determines the sharpness of the cutting blade. An edge is considered to be sharp if the thickness comes under a few thousands of an inch. Ideal edge thickness is considered as zero when the edges come together. Cutting will be smooth if the edge is sharp and it effects the slicing action of the cutting tool.

Blade Thickness

Blade thickness affects the cutting and slicing action significantly. Irrespective of the sharpness of the cutting edge, blade thickness also has a major role in cutting process.

Blade Shape

Shape of the blade is determined by the type of the function that the blade has to do. Generally, straight edge blades are confined for slicing action and curve type blades for cutting action.

Cell Structure of Cutting Material

Cutting is done using a knife or cutter blade which has either flat or wedge shape. The force applied to the cutting blade results in a pressure at the cutting portion against the material; here the material refers to the fruit peduncle. This pressure leads to the breakage of the bond between the plant materials. Hence separation takes place and hence two cutting planes are formed.

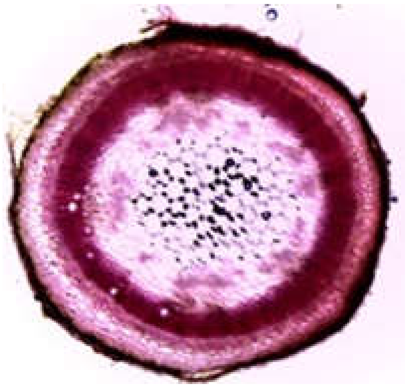

Fig. 2: Cross sectional view of tomato peduncle

The peduncle of the crop consists of cells which are well arranged in a distinct manner to form a tissue. Presence of fibro vascular bundle of tissue makes the peduncle structure strong and reinforced. Hence, cutting the peduncle causes the destruction of fibro vascular fascicles. In monocot plants, the fibro vascular structures are spread evenly over the entire cross sectional area. In this type, the cutting tool has to pass through the entire cross sectional area to get the cutting done. While in dicot plants like tomato and cucumber, the fibro vascular bundles are seen only at the periphery of the peduncle and hence cutting has to take place only at this peripheral side.

Transverse sections of mature fruit peduncles of tomato revealed a central pith parenchyma with slightly thickened and partly lignified cell walls. Vascular bundles were arranged circularly around the pith. A thin vascular cambium is seen between the xylem and phloem. Generally, the phloem's transverse area fraction considerably exceeded that of the xylem (Horbens *et al.*, 2014). Remnants of erstwhile primary xylem can be seen and some secondary tissues have been produced secondary xylem vessels which are composed of tracheids, vessels, xylem fibers and xylem parenchyma. This shows a woody type structure in fruit peduncle.

Cutting Force

The cutting force required for cutting the peduncle of tomato was obtained in terms of firmness from the texture analyser data. The force required for cutting the peduncle was determined using a texture analyser.

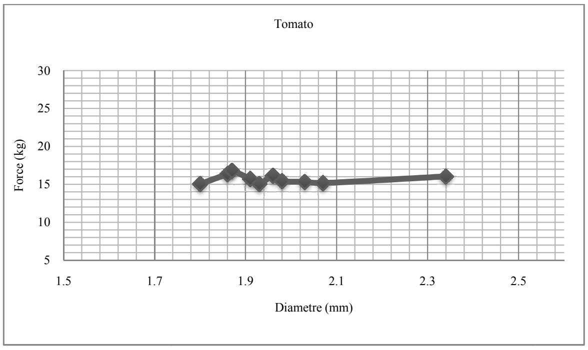

Fig. 3: Cutting force of tomato peduncle

It is clear from the given data that, the force required for cutting the peduncle of tomato is not depending on the diameter of the peduncle. Force is varying irrelevant to the diameter of the tomato peduncle.

In case of mature tomato peduncle, the force required for cutting the tomato peduncle was more compared to immature tomato. The reason behind this change is understandable from the cross section view of tomato peduncle. The cross sectional view of mature peduncle shows an onset of secondary growth.

Table 2: Force required for cutting tomato peduncle at different stages of harvesting

Harvesting stage of tomato	Force (Kg)
Mature unripe	15.04
Immature unripe	16.64
Mature ripe	16.79

Remnants of erstwhile primary xylem can be seen and some secondary tissues have been produced secondary xylem vessels which are composed of tracheids, vessels, xylem fibers and xylem parenchyma. This represents the wood structure of dicot stem that is responsible for giving mechanical support for holding the fruit and upward conduction of tomato stem. The presence of this wood matter inside a mature tomato peduncle is the main cause for increase in cutting force required.

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