INTRODUCTION

In India, okra is generally harvested without any safety to prevent bruising and after harvesting it is dumped at one place, which results mechanical injuries to the ridges of pods. To reduce the post harvest losses in okra, it should be least handled (Dhall et al., 2014). Labourers are usually unwilling to take up okra harvesting work and demand exorbitant wages because the bristles on the okra pods cause injury to the skin during the harvesting operation i.e. in hand plucking method. In order to avoid that, it was suggested to wash hands thoroughly after okra plucking operation or wear gloves throughout operation. Okra growing farmers and labourers do not prefer to wear gloves as the same obstructs the movement of fingers necessary to carry out the harvesting operation efficiently.

The tools available in the market (horticulture secateurs, circular snip, okra plucker) were inefficient for harvesting okra, as reported by earlier workers. Secateurs and circular snip could not reach the stalk of the pod easily, because of wider in size and shape. Scissors were having effective reach but much care and time is required in opening the scissors and operating them. Moreover their continuous use resulted in a fatigue in the fingers and thumb. Washing of hand thoroughly after picking is also not effective. The pods harvested with minimum handling and field packaging can retain their green colour, crisp texture. The average postharvest loss of okra at production level was 11.5 per cent (Prasad, 2015). Straight blade okra plucker, was not effective because okra pods have been harvested by holding the pod in one hand and cutting the pod from the plant with the other hand using a cutting tool.

Okra pod harvester and cutter were developed in USA which could harvest and hold the pods (Welborn, 1998). Longer pods could not be cut because of straight cutting and short length of arm. Okra pods grow at the bottom of the forks i.e. from where the branches/leaves come out from these stem
of the plant. Stalk of the pod is tender and requires very little force to break it or to cut it with the help of a sharp tool. There are very small triangular spaces left on the either side of the stalk of the okra pod. The close harvesting of okra therefore needs to be carried out carefully, otherwise the stem of the plant or the petiole of the leaf may get cut or damaged.

Mechanical harvesting of okra depends on physical properties of the okra like uniformity of plant size and other plant characteristics greatly affect the productivity of machine harvested okra (Aminu et al, 2016; Salau and Makinde, 2016 and Pawar et al, 2017). So there was necessity to design okra cutter-holder which will provide an okra harvesting tool that not only cut the okra pod from the plant but also holds the okra pod. That avoids injuries of hand which are made by bristles on the pod at reduced cost of harvesting of okra to get maximum profit. To overcome these hindrances the okra cutter-holder was developed.

MATERIALS AND METHODS

Following plant and tool parameters were considered for developing the okra cutter-holder.

Plant parameters

Location of the okra pod on the plant and space available around the pod stalk for inserting the cutting tool, diameter of the pod, stalk diameter and length also the shearing strength were determined and presented in Table 1.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Dimensional Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Height of plant</td>
<td>0.5 – 1.6 m</td>
</tr>
<tr>
<td>2</td>
<td>Length of okra pod</td>
<td>8 – 11 cm</td>
</tr>
<tr>
<td>3</td>
<td>Diameter of okra pod (crown)</td>
<td>1 – 2 cm</td>
</tr>
<tr>
<td>4</td>
<td>Diameter of the stem of okra pod</td>
<td>6 – 8 mm</td>
</tr>
<tr>
<td>5</td>
<td>Length of the stem of okra pod</td>
<td>1.5 – 2 cm</td>
</tr>
<tr>
<td>6</td>
<td>Angle between stalk of pod and stem of plant</td>
<td>15° – 20°</td>
</tr>
<tr>
<td>7</td>
<td>Angle between stalk of pod and petiole of the leaf</td>
<td>20° – 25°</td>
</tr>
<tr>
<td>8</td>
<td>Safe angular spacing available for cutting the pod</td>
<td>35°</td>
</tr>
</tbody>
</table>

Table 1. Average specifications of okra plant.

Tool parameters

Size, shape, weight and operational force of tool as well as the size and shape of the blade were major concern while designing the tool.

Safety and comfort parameters

The injuries inflicted on the skin of the palm in general and fingers and thumb in particular along with adaptability, portability and ease of operation of new designed tool were given prime importance while designing.

Constructional details of okra cutter-holder

The harvesting tool was designed based on the physical data of the okra plant at the time of harvesting as described in the Table 1. The tool is having least number of parts for easy operation and low maintenance. It consists fork, blade, pad (with slot) and holder as shown in the Fig. 1. The length of holder was 110 mm to accommodate longest okra length. The width of blade and the holder was 20 mm to cut and hold widest okra pod i.e. 2 cm. the fork length was kept 150 mm to reduce the effort required for cutting. The cutting blade was supported by the nylon pad with slot to help the shearing action of the blade.

The holder with blade and the fork were attached at an angle of 30° on the basis of angle between pod and the leaf. Two screws of 4 mm in diameter were used for connection of each holder plate.
Development of Okra-Cutter-Holder

Operation of tool

The tool is held with the help of thumb and other fingers. The stalk of okra pod is then admitted in the throat between blade and pad. The fork ends are then pressed sufficiently so that the blade would come closer to pad (slot), this process cut the pedicel by shearing and separate the pod. At the end of cutting stroke fork ends come closer and the okra pod is caught by the holders. Then cut okra pod could be placed in the basket or bag without touching it. The operation of the tool is illustrated in Fig. 2.

RESULTS AND DISCUSSION

Adaptability

Before conducting the field trials, labourers were handed over the prototype and were asked to practice okra harvesting by using them for some time. After giving sufficient practice they were asked to express their views regarding the adaptability of the new tool. All of them given a feedback that the tool is quite handy and convenient for okra harvesting. They confirmed their opinion at the end of field trials. These opinions are given below.

Portability and Ease of Operation

Portability of a tool mainly depends upon its weight. The weight of tool is 102 g so handling and transporting is not a problem. The labourers employed for the field trials also expressed the same opinion. The tool was given to different workers and the feedback was taken to assess the ease of operation. Tool was found handy and easy to operate by the workers.

Harvesting Capacity of the Okra Cutter-Holder

Harvesting capacity of the okra cutter-holder is 297-318 okra per hour (i.e. 10.0 – 10.9 kg/hr). Comparative tests results of okra cutter-holder, straight blade okra plucker, hand picking and okra-cutter-holder shown that Okra cutter-holder could harvest more okra per hour than other methods of harvesting okra (Table 2).

CONCLUSION

The angle between stalk of pod and stem of plant varies from 15° to 20°. The angle between stalk of pod and petiole of the leaf varies from 20° to 25°. The Design of the okra cutter holder was based on these two basic parameters. Quantity of okra collected is 297-318 okra per hour (10.0 – 10.9 kg/hr) which is greater than quantity of okra collected by straight blade plucker method and hand picking method (5.2 – 6.1 kg/hr). The okra could be cut properly without damage. The okra cutter-holder can cut and hold okra pod properly and reduce the injuries due to bristles of the pod to

Fig. 1 Details of okra cutter-holder

Fig. 2 operation of okra cutter-holder
the hand. Tool was found handy and easy to operate by the workers.

**REFERENCES**


Received on 04/05/2017 Accepted on 10/06/2017