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RESEARCH ARTICLE

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Development of shaking and pod exposing attachments for tractor drawn groundnut digger

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ABSTRACT

Harvesting of groundnut is a labour consuming, expensive and tedious operation. The farmers required to repeat the operation of harrowing several times to expose detached and left out pods. Therefore, this operation requires more time, labour and energy, which ultimately increase in the cost of crop production. Hence, the shaking and pod exposing attachments were developed and attachments were tested for its performance in the medium black soil for semi spreading variety of groundnut. The test results for digging and exposing indicated that the average draft requirement was 782 kg and 691 kg with an average speed of 3.79 km/h and 4.28 km/h, respectively. The average effective field capacity and field efficiency in case of digger shaker were 0.35 ha/h and 80.10 per cent while for the pod exposure it was 0.41 ha/h and 81.33 per cent, respectively. The average digging efficiency of digger shaker was 90 per cent and the pod exposing efficiency of pod exposure was 93.28 per cent. The fuel consumption was found to be in the range of 3.7 to 4.14 l/h.

Key words : Development, Pod shaking, Pod exposing, Tractor drawn groundnut digger

INTRODUCTION

Harvesting of groundnut (*Archis hypogaea* L.) or peanut crop consists of removal of the groundnut plants along with the pods from soil. Generally farmers, in India, are using bullock drawn blade harrow, improved blade harrow and tractor drawn blade harrow for harvesting of spreading variety of groundnut (Gadir and Ahmad, 2001; Garg and Verma, 1900; Gupta *et al.*,2002). Improper penetration of blade due to clogging with vines and working under hard soil is common problems faced in above said implements during the operation, resulting in more per cent of pods left out in the field. The farmer is required to repeat the operation of harrowing several times to expose detached and left out pods. Therefore, this operation requires more time, more labour and power, which ultimately increase the cost of crop production. Hence, the investigation on development of shaking and pod exposing attachments for tractor drawn groundnut digger was carried out at Department of Farm Machinery and Power, College of Agricultural Engineering and Technology, Junagadh in 2005.

MATERIALS AND METHODS

Developed attachments consisted of shaking attachment, gearbox assembly, crank arrangement and pod exposing attachment.

Shaking attachment:

Shaking attachment consisted of square bars, round bars and lifting rods. Two MS square bars of size 25 × 25 mm having length of 600 mm were rounded on both the side with the help of lathe machine in such a way that they can be fitted in between three tynes with the help of bushes and oscillate. On either side of blade three pieces of 20 mm MS round bar each having 300 mm length and 20 mm diameter were taken and at one end of each round bars outer threading was provided so that it can be tightened with holes in square bar. On the each square bar seven lifting rods were fitted above the round bars with help of nuts, which were made from 20 mm diameter of conduit pipe. The lengths of lifting rods were ranged in between 600 to 400 mm. These lifting rods were bolted on square bars at 70 mm spacing with help of nuts so that during exposing it can be removed and pod exposing attachment can be fitted with the help of same nut bolts. The lifting rods were bended downward at rear end with the help of suitable fixture so that a groundnut plant after digging passes backward easily. The 20 mm diameter of MS round bar was laterally attached to lifting rods in such a way

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that all lifting rods remain separated at same spacing. The developed groundnut digger shaker attachment can be seen in Fig. 1.

Fig. 1 : Groundnut digger shaker

Gearbox assembly:

Gearbox is used for transmitting power from tractor PTO to the shaking and pod exposing attachments. It consisted of four bevel gears, which were mounted in housing on steel shafts. This housing was attached to the ring gear. The bevel gears mesh with two side gears. The side gears were attached to the two counter shafts of mild steel having diameter 25 mm. The outer shafts transmit power to connecting rod. The gear ratio was 2:1 which was decided by trial and error method in such a way that there would no damage to machine parts during the harvesting operation.

Two circular flanges, called cranks, were provided on the outer side of both shafts having 200 mm diameter and made from 20 x 10 mm MS plate. On each flange two holes were provided so that displacement of connecting rod can be adjusted as per requirement of the operation.

Crank and connecting rod arrangement:

Crank arrangement consisted of a crank and connecting rod fitted at each end of the frame. Connecting rod is made of two links having length of 350 mm and 250 mm, respectively and made from 20 mm MS flat. One end of 350 mm link was attached to the circular crank with the help of ball bearing while another end connected to 250 mm link and other end of 250 mm link connected to square bar with the help of nuts and bolted on square bar. Connecting rod used in the system converts the rotary motion of the shaft into vertical up and down motion.

Pod exposing attachment:

Pod exposing attachment consisted of two rectangular frames having 600 mm length and 410 mm width made of MS flats. In each rectangular frame series of MS flats having size 25 X 5 mm are welded in such a way that they were 25mm apart and at an angle of 20° with frame. The both rectangular frames were bolted on the square bars with the help of 10 mm nuts. This attachment was attached after removal of pod shaking attachment. The pod exposing attachment is shown in Fig. 2.

Fig. 2 : Pod exposing attachment

Power transmission system:

The power to operate various units of groundnut digger shaker and pod exposure was obtained from PTO shaft located at the back of the tractor. The power from PTO was transferred to the digger shaker or pod exposure through gearbox, telescopic shaft with universal joint.

The power transmission unit consisted of gearbox with bevel gear and telescopic shaft. The gearbox was mounted on frame having one input shaft and two output shaft. The input shaft was attached to the tractor PTO through telescopic shaft. The power was transmitted from PTO to gearbox through universal joint. Then the power was transmitted to the connecting rod through output shaft and crank from the gearbox. Finally from connecting rod, the power was transmitted to pod shaking or pod exposing unit.

The working performances of the developed shaking and pod exposing attachments to groundnut digger were tested in terms of field parameters, operating parameters and performance parameters as per standard procedure given by ISI test code, at the instructional farm of Junagadh Agricultural University, Junagadh.

RESULTS AND ANALYSIS

The results are summarized below according to objective of the study.

Pre-test observations:

The plot size for testing purpose was selected, as per ISI test code No. IS: 11235-1985 and it was as 0.25 ha of crop area.

Moisture content was found to be 14.26 % (db) at the time of digging and 12.97 % at the time of pod exposing. The bulk density of soil was 1.42 g/cc. The semi-spreading variety (GG-20) of groundnut was grown 60 cm row spacing. The plant density was found as 9 plants per meter of length.

The lateral pod distribution pattern in the soil was found to be 20 cm on either side of tap root. The maximum depth of pod setting was found to be 10 cm. About 96.8 % of pods were set inside the periphery of 35 cm. The remaining percentage of pods was situated in between 35 to 40 cm of periphery.

Field observations for evaluation of developed attachments:

During field trials of attachments, following field observations were taken for its performance evaluation.

Depth of cut:

In case of groundnut digger shaker depth obtained was in the range of 11 to 13 cm with an average depth of 12 cm as shown in Table 1. This was adequate for digging the groundnut plants without any damage because the pod zone depth of groundnut was up to 10 cm. In case of pod exposure the depth of cut was12 to 14 cm with an average depth of 13 cm.

Speed of operation:

The average speed of operation of digger shaker was 3.79 km /h, while in case of pod exposing attachment, the average speed was 4.28 km/h. Groundnut digger shaker was found to be operating at lower speed as compared to exposure, it may be due to higher draft requirement and higher moisture content during digging.

Draft of machines:

The results presented in Table 1, indicates that average draft in case of groundnut digger shaker was 782 kg at the working depth of 12 cm, while the average draft requirement for pod exposure was 691.3 at working depth of 13 cm. The draft required for operating machines were well within the capacity of power developed by 35 hp tractors.

Power requirement:

Table 1 shows that the average power required for

Table 1 : Field test observations of groundnut digger shaker and pod exposing attachment

Sr. No.	Observations	Groundnut digger shaker attachment	Groundnut pod exposing attachment
		Avg. of three replications	Avg. of three replications
1.	Depth of cut (cm)	12	13
2.	Width of cut (cm)	120	120
3.	Time required for 50 m run (s)	47.33	42
4.	Starting time (am)	--	---
5.	Finishing time (am)	--	---
6.	Net Total Time (min)	31.33	30
7.	Total time loss (min)	10	7
8.	Total working time (min)	41.33	36
9.	Pull with tractor (kg)	426.66	426.7
10.	Pull with Tractor and Implement	1208.66	1118
11.	Net Pull (kg)	782	691.3
12.	Angle of Inclination (degree)	0	0
13.	Draft (kg)	782	691.3
14.	Speed of operation (km/h)	3.79	4.28
15.	Power requirement (hp)	10.96	10.93
16.	Theoretical field capacity (ha/h)	0.45	0.51
17.	Effective field capacity (ha/h)	0.35	0.41
18.	Field efficiency (%)	80.10	81.33
19.	Fuel consumption (l/h)	4.14	3.7
20.	Per cent slip (%)	8.97	11.41

Table 2 : Observations of field losses during operation of groundnut digger shaker Sample Area: - 2m x 1.2 m

Sr. No.	Observations	I	II	III
1.	Quantity of damaged pods collected from the plant in a sample area. (g)	8.3	9.6	7.2
2.	Quantity of left-out but exposed pod in the soil. (g)	18.7	20.8	15.8
3.	Quantity of left-out but buried pod in the soil. (g)	8.3	11.6	9.4
4.	Quantity of left out but pods with un-dug plants. (g)	----	----	-----
5.	Quantity of undamaged pods collected from sample area. (g)	330.3	325.2	338
6.	Total quantity of pods collected from the plants. (g)	365.6	367.2	363.6
7.	Percentage of Damaged pods	2.27	2.61	1.98
8.	Percentage of Exposed pods	5.11	5.66	4.35
9.	Percentage of Buried pods	2.27	3.16	2.59
10.	Percentage Un-dug pods	---	---	---
11.	Total Percentage of pod losses.	9.65	11.43	8.92
12.	Digging Efficiency, (%)	90.35	88.57	91.08

Table 3 : Observations of field losses during operation of groundnut pod exposure (Sample Area: - 4m x 1.2 m)

Sr. No.	Observations	I	II	III
1.	Total quantity of pods exposed (g)	30.3	34	36.7
2.	Quantity of damaged pods during exposing (g)	---	---	---
3.	Quantity of left-out pods below soil after exposing (g)	2.7	2.5	2.0
4.	Total quantity of pods from sample area after digging (g)	33.0	36.5	38.7
5.	Percentage of damaged pods	---	---	---
6.	Percentage of left-out pods	7.18	6.84	5.16
7.	Total pod losses (%)	7.18	6.84	5.16
8.	Exposing efficiency (%)	92.81	93.15	94.83

digger shaker pod exposure was 10.96 hp and 10.93 hp, respectively. Since the average available drawbar horsepower of 35 hp tractors was approximately 21 hp, so the implement can perform effectively at higher drafts.

Effective field capacity:

The calculated values of field capacities for digger shaker and pod exposure are given in Table 1. An average effective field capacity digger shaker was 0.35 ha/h while in case of pod exposure it was 0.41 ha/h. The effective field capacity was low in case of digger shaker because the time consumed for cleaning the blade due to clogging of vines (Table 1).

Field efficiency:

An average field efficiency of digger shaker was 80 per cent while in case of pod exposure it was of 81.33 per cent (Table 1).

Fuel consumption:

Average fuel consumption in case of digger shaker was 4.14 l/h while in case of pod exposure it was 3.70 l/h. The fuel consumption in case of digger shaker was more due to more draft requirement (Table 1).

Wheel slip:

The average wheel slip in case of groundnut digger shaker was 8.97 per cent while in case of pod exposure it was 11.41 per cent. The slip increased with increase in forward speed of operation. The slip observed in case of pod exposure was more due to soft soil and also the forward speed of pod exposure was higher so more slip was observed (Table 1).

Pod losses and digging efficiency by the groundnut digger shaker attachment:

As presented in Table 2, the average exposed pod losses, buried pod losses and damaged pod losses were observed to be 5.04 per cent, 2.67 per cent and 2.29 per cent, respectively. Thus, the average total pod losses were obtained 10 per cent with an average digging efficiency of 90 per cent. Those pods remained during digging operation by the groundnut digger shaker attachment were recovered *i.e.* removed by the pod exposing attachment

Pod losses and exposing efficiency at pod exposing attachment:

As presented in Table 3, the average lefts out pod losses were observed as 6.72 per cent while damaged pod loss were nil. Thus total pod losses were obtained 6.72 per cent with exposing efficiency of 93.28 per cent.

Cost of harvesting:

Considering the costing of material required and labour charges (Rs.100 and Rs.50 for skilled and unskilled persons) the cost of developed attachments (Shaking and Pod Exposing) was calculated Rs. 25,000/-. The developed machines required only two labour, while for manually harvesting required 14 labour per hectare. The total cost required for operation *i.e.* for harvesting with attachments was Rs. 673.17 /ha which saves Rs135/- as against manual harvesting (Rs. 807.804 /ha).

Conclusion:

- The digging and exposing efficiency of developed machines was 90 and 93 per cent, respectively with minimum pod losses.
- The average draft requirement of machines was ranged between 691 to 782 kg, which is well within 35 hp tractor.
- The average field capacity of machines was 0.40 ha/h with average field efficiency of 81 per cent.

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