The Pharma Innovation Journal 2022; 11(12): 3034-3038

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 3034-3038

www.thepharmajournal.com
Received: 09-09-2022
Accepted: 12-10-2022

B Nageswar
Ph.D. Scholar, Department of Farm Machinery and Power Engineering, Dr. N.T.R. College of Agricultural Engineering, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

B Hari Babu
Associate Professor, Department of Farm Machinery and Power Engineering, Dr. NTR. College of Agricultural Engineering, Bapatla. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

C Ramana
Associate Director of Research and University Head, Department of Farm Machinery and Power Engineering, Regional Agricultural Research Station, Tirupati. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

K Madhusudhana Reddy
Senior Scientist (Agril. Engg) Regional Agricultural Research Station, Tirupati. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

B Sreenivasula Reddy
Associate Professor, Department of Processing and Food Engineering, Dr. NTR. College of Agricultural Engineering, Bapatla. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

Corresponding Author:
B Nageswar
Ph.D. Scholar, Department of Farm Machinery and Power Engineering, Dr. N.T.R. College of Agricultural Engineering, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

Studies on soil and groundnut plant parameters for design and development of a groundnut digger-cum-stripper

B Nageswar, B Hari Babu, C Ramana, K Madhusudhana Reddy and B Sreenivasula Reddy

Abstract
The physical properties of soil and groundnut plants are plays important role in the design of harvesting, conveying, and stripping equipment, to decide the digging depth, blade angle, forward speed, plant catch height, conveyor speed, stripper speed, and stripper spacing. The present study aimed to determine soil properties and plant properties of groundnut varieties viz., *Kadiri-6, Dharani*. The average soil strength, bulk density, and moisture content of the soil are 1531 Kpa, 1.54 g cc, and 11.26 % respectively. The average length, breadth, root length, number of branches, number of filled and unfilled pods per plant, and pod locating depth of the groundnut plants are varied from 37.2, 27.8, 15.5, 5.2, and 4.6 cm respectively for *Kadiri-6*. Similarly, the average length, breadth, root length, number of branches, number of filled and unfilled pods per plant, and pod locating depth of the groundnut plants are varied from 42, 24.8, 15.4, 7.2, and 4.2cm respectively for *Dharani* variety.

Keywords: Moisture content, bulk density, soil strength, plant width, length, root depth, pod locating depth

1. Introduction
Groundnut is one of the most important and economical oilseed crops which is mostly grown in tropical to the sub-tropical area. It's mostly grown for oil, protein, and carbohydrates (Abdzad Gohari *et al*., 2010) [1]. Groundnut is the fifth most important oilseed crop in the world (Burns, 2010) [7]. The multiple uses of the groundnut make it an excellent cash crop for domestic markets as well as foreign trade. Groundnut is grown on nearly 29.70 million hectares in the world with an annual production of 50.89 metric tons and the average productivity is 1713 kg ha^{-1} in 2018-19 (MOA, 2021). China is the large producer of groundnut with 17.33 MT followed by India at 9.25 MT, Nigeria at 4.60 MT, Sudan at 2.88 MT, and the USA at 2.49 MT during 2018-19. India is the second largest producer of the Groundnut after china, where it is cultivated in an area of 4.8 M ha (which is 5.8% higher than china) with 9.2 M tons of production and the average pod yield was 1893kg/ha in 2018-19. Most of it is cultivated by small and medium farmers in the semi-arid zones of India (Govindaraj and Mishra, 2011) [3].
Harvesting and threshing of the groundnut are the most important and labor-intensive operations in groundnut cultivation. The removal of groundnut pods is a time consuming process and cost expensive. In general, the period during which ground nut is harvested is warmer weather with high temperatures, therefore, laborers experience bad weather to work. So the availability of labor is very difficult at the harvesting stage. During peak seasons, due to the non-availability of labor, harvest delays occur and lead to high threshing losses. In addition, the migration of the agricultural labor force from the rural areas aggravated the problems for the farmers.
Nowadays, Farmers prefer machines that can carry both harvesting and threshing operations at a time with a minimum number of labors. Hence, a low-cost tractor-mounted Groundnut digger-cum- stripper is required to carry out all operations like digging, conveying, and stripping of groundnut crops simultaneously on a single pass. The proposed machine not only reduces the drudgery of humans and animals, but it is also possible to enhance the cropping intensity, precision of application, and timeliness. All these operations finally improve the efficiency in the utilization of different crop inputs and also minimize the losses at various stages of crop production. Mechanical machines for harvesting and threshing groundnut is the

way to reduce labor requirements and carry out the timely harvest. Engineering properties are useful and necessary in the design and operation of various farm equipment employed for agricultural operations (Sahay and Singh, 1994) [4]. The important engineering properties namely physical, mechanical, aerodynamic, and frictional properties, which are directly related to machine development, were determined in the present study. Basic information on these properties is of great importance and helps engineers and scientists with equipment development and its efficient operation. The knowledge of engineering properties is important for the design, development, and efficient operation of a harvester cum thresher.

2. Materials and Methods

The chapter describes the methodology used for the design and development of a tractor-mounted groundnut digger-cum-stripper. The details of materials used for the fabrication of the equipment, experimental methodology for field evaluation of the developed equipment, and measurement techniques adopted during the investigation were described in the following sections.

2.1 Experimental Site

Performance evaluation of the developed groundnut digger-cum-stripper was conducted at Regional Agricultural Research Station, Tirupati. It is located in the Chittoor district of Andhra Pradesh. The geographical location of the experimental plot is14.65º N and 79.42º E with an elevation of 182.9 m above the mean sea level. The average annual temperature is 26.7 ºC and the mean temperature ranges from 22.24 to 39.6 ºC reaching a peak of 45 ºC in May. The average rainfall, relative humidity, and wind speed of the test location are 896 mm, 53%, and 10.3 km h^{-1} per year respectively. The soil of the experimental plot is sandy loam. The field area of 500 m^2 was sown with locally popular groundnut varieties of *Kadiri-6, and Dharani* in the Rabi season for study.

2.2 Physical and Mechanical Properties of Soil Affecting the Design of Groundnut Digger-Cum-Stripper

2.2.1 Type of Soil

The type of soil affects the draft requirement, as well as the maximum penetration depth of the tool. Particle size analysis was conducted on five different soil samples taken from different locations of the experimental plot. The percentage of sand, silt, and clay in the soil sample were recorded. An international pipette method (Gee and Bauder, 1986) [2] was employed for the particle size analysis.

The digging blades of the groundnut digger-cum-stripper interact with soil to uproot the groundnut plants. Therefore, soil properties directly affect the digging performance of groundnut diggers. Hence the following properties of the soil were evaluated before designing the groundnut digger-cum-stripper.

- Soil moisture content
- Soil bulk density
- Soil strength

2.2.2 Soil Moisture Content

The soil moisture content was determined by the oven drying method. Five samples were collected randomly from the test plot and kept in an oven at 105 ºC for 24 hours. The moisture content was calculated as per the given formula (Shukla *et al.*, 2014).

$$M_S\,(\%) = \frac{W - W_d}{W_d} \times 100 \quad \text{..... (1)}$$

Where,
M_S = moisture content in dry basis, %
W = wet weight of sample, g
W_d = weight of dry sample, g

2.2.3 Bulk Density of the Soil

Metallic core sampler was used to take soil samples in the test field. The bulk density of soil is the ratio of dry weight of soil to its corresponding volume of the core sampler. The bulk density was determined by the fallowing formula

$$\gamma = \frac{W}{V} \quad \text{..... (2)}$$

Where,
W = dry weight of sample, g
V = volume of the core sample, cm^3

2.2.4 Soil Strength

The strength of the soil was relevant in the determination of the power requirement of the machine. Soil strength was measured with the help of a cone penetrometer in the field.

2.2.5 Physical Parameters of Groundnut Crop Affecting The Design Of Groundnut Digger-Cum-Stripper

Plant height, width, root length, number of pods per plant, and number of plants per unit area are the important variables that affect the performance of the digging and stripping unit during operation. The crop parameters were collected before the harvesting of the crop.

Plate 1: Groundnut crop at harvesting stage

2.2.6 Plant Height

The plant height of the groundnut crop may vary with variety, soil texture, growing season, spacing between the plants, and climatic conditions. The plant height of *K6* and *Dharani* varieties was measured by selecting plants randomly in the field with the help of the steel rule at the time of harvesting as shown in Plate 2.

Plate 2: Measuring plant height at the harvesting stage

2.2.7 Width of plant canopy

The width of plant canopy of the groundnut crop depends on the density of the plants, and varieties. The plant canopy width of *K6* and *Dharani* varieties was measured by selecting plants randomly in the field with the help of the steel rule at the time of harvesting as shown in Plate 3.

Plate 3: Measuring the width of the plant canopy at the harvesting stage

2.2.8 Root Length

The root length of the groundnut plant was measured at the time of harvesting by digging the soil manually beside the plant root up to the bottommost edge of the root. The plant root lengths were measured with the help of the steel rule in the test plot as shown in Plate 4.

Plate 4: Measurement of root length of groundnut plant at harvesting stage

2.2.9 Number of plants per unit area

The plants present per unit area were counted manually at different locations in the test plot.

2.2.10 Number of pods per plant

The number of pods per plant was measured by the manual excavation of the soil and uprooting of the plant for complete recovery of the pods with the roots. The uprooted plant with the pods was counted to evaluate the number of pods present i` 1n each plant. These plants were selected randomly in the test field as show in Plate 5.

Plate 5: Number of pods per plant at harvesting stage

2.2.11 Number of Filled and Unfilled pods

Number of grain filled and unfilled pods per plant were counted manually. The plants are randomly selected, uprooted and counted for the number of grain filled and unfilled pods.

3. Results and Discussion

This chapter presented the results obtained for the design and development of tractor mounted groundnut digger-cum stripper, it is also furnished with the observations and results of the soil, plant and machine parameters, laboratory and field trials conducted during the development and performance evaluation of the developed machine.

3.1 Physical and Mechanical Properties of Soil Effecting the Design of Groundnut Digger-Cum-Stripper

The soil of the experimental field was determined as sandy loam soil. Soil physical and mechanical properties are in relation with machine parameters were found to be important from design point of any digging system. The independent soil moisture content and the dependent parameters bulk density, soil resistance. The interactions between these parameters were found to affect the performance of digging system in terms of digging efficiency and power requirement operating the machine under field conditions.

3.1.1 Soil Moisture Content at Harvesting stage

Before conducting the each experiment, the soil moisture content was determined randomly at five different locations and at different intervals to see the effect of soil moisture content on other parameters. The observed values were varies from 10.19-12.33% with an average of 11.26±1.07% at the time of crop harvesting. The recorded results were close to the results obtained by (Zhichao *et al.*, 2010) [6]

3.1.2 Bulk density at Harvesting stage

Bulk density is an indicator of soil compaction and soil health. It affects infiltration, rooting depth, available water capacity, soil porosity, plant nutrient availability, and soil microorganism activity. Which of these parameters further influences the key soil processes and productivity. Soil bulk

density measured at five different locations of the experimental plot with replications for studying the effect of soil bulk density on other parameters. The observed values were obtained in the range of 1.57 to 1.72 g cc^{-1} with mean value of 1.54 g cc^{-1} as shown in Table 1.

3.1.3 Soil Resistance at Harvesting stage

Soil resistance is an indication of soil hardness measured by penetrating the cone penetrometer in to the soil. Before conducting the each experiment, soil resistance was measured for each experimental plot randomly at five locations for studying the effect of soil resistance on the other parameters. The observed values were in the range of 1419 kPa to 1643 kPa with an average value of 1531 kPa.

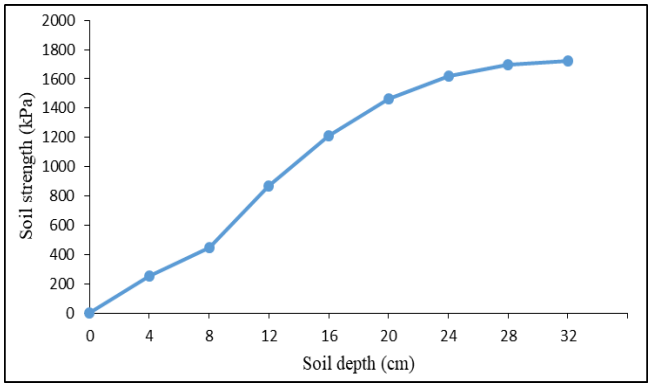

Fig 1: Effect of soil depth on soil strength

Table 1: Soil properties

Sl. No.	Parameters	Mean ± SD
1	Moisture content (%)	11.26±1.07
2	Bulk density (%)	1.54±0.15
3	Soil strength (kPa)	1531±112

3.2 Physical and Mechanical Properties of Groundnut Crop

Plant physical properties are expected to influence on the design of machine. These properties ascertain the range of machine parameters to be used while operating the machine. Hence plant physical properties are used in design of groundnut digger-cum-stripper. The parameters such as plant height, plant canopy width, root length, number of pods per plant, pod location depth and number of branches of each plant were determined for the locally available popular varieties of *Kadiri-6* and *Dharani*. The interactions between these parameters affected the performance of digging, conveying and stripping system in terms of digging, picking, conveying, stripping efficiencies and power requirement to operate the machine at given physical and mechanical properties of the crop.

3.2.1 Plant Height

The height of the selected groundnut plant variety of *Kadiri-6* varied from 32 - 41cm with an average height of 37.2±3.27 cm and for *Dharani* variety it was varied from 35-47 cm with an average height of 42±2.12 cm.

3.2.2 Plant Canopy Width

The canopy width of the *Kadiri-6* groundnut plant varied from 25-31 cm with an average canopy width of 27.8±2.59 cm and for *Dharani* variety it was varied from 23-26 cm with an average plant width of 24.8±1.30 cm.

3.2.3 Root Length

The root length of the selected groundnut plant varieties of *Kadiri-6* varied from 13-18 cm with an average root length of 15.4±1.95 cm and for *Dharani* variety it was varied from 14-17cm with an average root length of 15.4±1.14 cm.

3.2.4 Number of Filled Pods

The number of grain filled pods for the selected groundnut plant varieties of *Kadiri-6* was varied from 12-21 with an average pod number of 17±3.39 and for *Dharani* variety it was varied from 15-19 with an average pod number of 17.6±1.57.

3.2.5 Number of Unfilled Pods

The number of unfilled pods for the selected groundnut plant varieties of *Kadiri-6* varied from 3-6 with an average unfilled pod number of 4.4±0.84 and for *Dharani* variety it was varied from 3-5 with an average unfilled pod number of 4.2±0.45.

3.2.6 Number of Branches

The total number of branches for the selected groundnut plant varieties of *Kadiri-6* varied from 4-6 with an average number of 5.2±0.84 and for *Dharani* variety it was varied from 6-8 with an average number of 7.2±1.10.

3.2.7 Pod Locating Depth

The pod locating depth of the selected groundnut plant varieties of *Kadiri-6* varied from 4-5 cm with an average depth of 4.6±0.55 cm and for *Dharani* variety it varied from 4-5 cm with an average pod depth of 4.2±0.45 cm.

Table 2: Crop parameters of selected groundnut crop varieties

Sl. No.	Dimensions	*Kadiri-6*	*Dharani*
		Mean ± SD	
1	Length (cm)	37.2±3.27	42±2.12
2	Canopy width (cm)	27.8±2.59	24.8±1.30
3	Root length (cm)	15.4±1.95	15.4±1.14
5	Un filled pods (Nos.)	4.4±0.84	4.2±0.45
6	Number of filled pods (Nos.)	17±3.39	17.6±1.57
7	Pod depth (cm)	4.6±0.55	4.2±0.45
8	Number of branches (Nos.)	5.2±0.84	7.2±1.10

4. Conclusion

- The average soil strength, bulk density and moisture content of the soil were 1531 Kpa, 1.54 g cc and 11.26 % respectively.
- The average length, breadth, root length, number of branches, number of filled and unfilled pods per plant and pod locating depth of the groundnut plants are varied from 37.2, 27.8, 15.5, 5.2 and 4.6 cm respectively for *Kadiri-6*.
- The average length, breadth, root length, number of branches, number of filled and unfilled pods per plant and pod locating depth of the groundnut plants are varied from 42, 24.8, 15.4, 7.2 and 4.2cm respectively for *Dharani* variety.

5. References

1. Abdzad Gohari A, Noorhosseini Niyaki SA. Effects of Iron and Nitrogen fertilizers on yield and yield

Components of Peanut in Astaneh Ashrafiyeh, Iran. American-Eurasian Journal of Agriculture & Environment Science. 2010;9(3):256-262.
2. Gee GW, Bauder JW. Particle-size Analysis, in Methods of Soil Analysis, Part 1. Soil Science Society of America. Book Series 5, 2nd edition. Madison. 1986. p. 383-411
3. Govindaraj G, Mishra AP. Labour demand and labour-saving options: A case of groundnut crop in India. Agricultural Economics Research Review, 24(347-2016-16986); c2011. p .423-428.
4. Sahay KM, Singh KK. Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd. Noida, Uttar Pradesh-201 301, India; c1994.
5. Shukla A, Panchal H, Mishra M, Patel PR, Srivastava HS, Patel P, Shukla AK. Soil moisture estimation using gravimetric technique and FDR probe technique: a comparative analysis. American International Journal of Research in Formal, Applied and Natural Sciences. 2014;8:89-92.
6. Zhichao Hu, Wang Haiou, Wang Jiannam, Hu Lianglonng, Tian Lijjia, Zong Ting. Experiment on half feed peanut combine harvester, transactions of the Chinese society for Agricultural machinery. 2010;4:79-84.
7. Burns K. Into the archive. In Into the Archive Duke University Press, 2010 Sep 27.