RESEARCH ARTICLE

DEVELOPMENT OF MANUAL EXPERIMENTAL PLOT SEEDER

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Abstract: The basic purpose of mechanization is to raise agricultural productivity, increase profitability and thus improve quality of life of farming community. The improvement of machine for sowing of experimental plots is a continuing problem facing by plants breeders, agronomists, plant pathologists and other agricultural scientists. Most part of the country, old traditional method is used for sowing. Traditional sowing method adversely affects result in improper placement of the seed into the soil at the correct soil depth, failure to properly keep the seeds firmly in the soil, uneven placement of the seeds at the correct interval in a row. Seed sowing is the most labour intensive operation. The labour requirement in manual sowing of gram seed is as high as 30 labour-ha^{-1} and time requirement for sowing is also high. Keeping this in mind, manual experimental plot seeder was developedfor gram. The field capacity of experimental plot seeder was observed to be 0.0547 ha h^{-1}(Digvijay variety of gram) and 0.0864 ha h^{-1} (Kripa variety of gram) &the field efficiency was observed to be 75.95 %(Digvijay variety of gram) and 80 %(Kripa variety of gram).

Keywords: Plot seeder, Field experiment, Crop, Productivity

INTRODUCTION

The plot sowing operation is an important part of field experiments. Whether the sowing accuracy is good or not will directly affect the results of field experiments. Plot seeders are specially used for breeding new and good crop varieties in field experiments and they are not different from the traditional seeders. During the plot sowing operation, the seed quantity is strictly controlled in one plot, that is, plot seeders must be able to sow quantitatively. It is well recognized that accuracy and uniformity of a plot seeder are essential for achieving satisfactory experimental results.

Pulses are the most important crop grown throughout the country. India occupies first rank in the production of pulses in the world (Indian Economy, 2012-13). It is widely grown in different part of country mainly by small and marginal farmers.Chickpea (*Cicer arientinum* L.) is a cool-season annual pulse crop that belongs to the Leguminosae family. It is the third most important pulse crop after dry beans and dry pea. Chickpea is grown in wide range of environments comprising about 44 countries in tropical, subtropical, and temperate regions of the world. Chickpea is used in a variety of food preparations that are rich in protein. Seeds have about 20 % protein, 5 % fat, and 55 % carbohydrate. It is consumed as a dry pulse crop or as a green vegetable .

Physical properties

Some of the physical properties of Digvijay and Kripa Varity of chickpea seeds were determined (Table 1). The three principle dimensions of 100 randomly selected seeds of each Digvijay and KripaVarity were measured with Vernier caliper having least count of 0.01 mm. Sphericity of chickpea was calculated as the ratio of equivalent diameter to length (Mohsenin, 1970). This physical parameter is used for deciding the cell size of seed rotor.Bulk density of the chickpea was determined by using 100cc Corning glass graduated cylinder used for measuring volume of the sample (Mohsenin, 1970). Bulk density was used for deciding the seed capacity of seed box.

Development of manual experimental plot seeder

Experimental plot seeder was designed and developed (fig. 1), on the basis of above mentioned physical properties. It consists of eight functional components: 1. Main frame, 2. Furrow opener, 3. Power transmission unit, 4. Seed metering mechanism, 5. Seed collecting unit, 6. Supporting wheel, 7. Markers, 8. Handle

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Table 1.

	Properties	**Variety of chickpea**	
		Digvijay	**Kripa**
1	Length, mm	8.610	12.504
2	Width/diameter, mm	6.382	9.206
3	Breadth, mm	5.983	8.956
4	Size($\sqrt[3]{(l \times b \times t)}$), mm	6.834	10.082
5	Sphericity ($\frac{\sqrt[3]{(l \times b \times t}}{l}$)	0.815	0.810
6	Angle of Repose, degree	29.47	28.52
7	Bulk density (kg m^{-3})	767.1	691.9

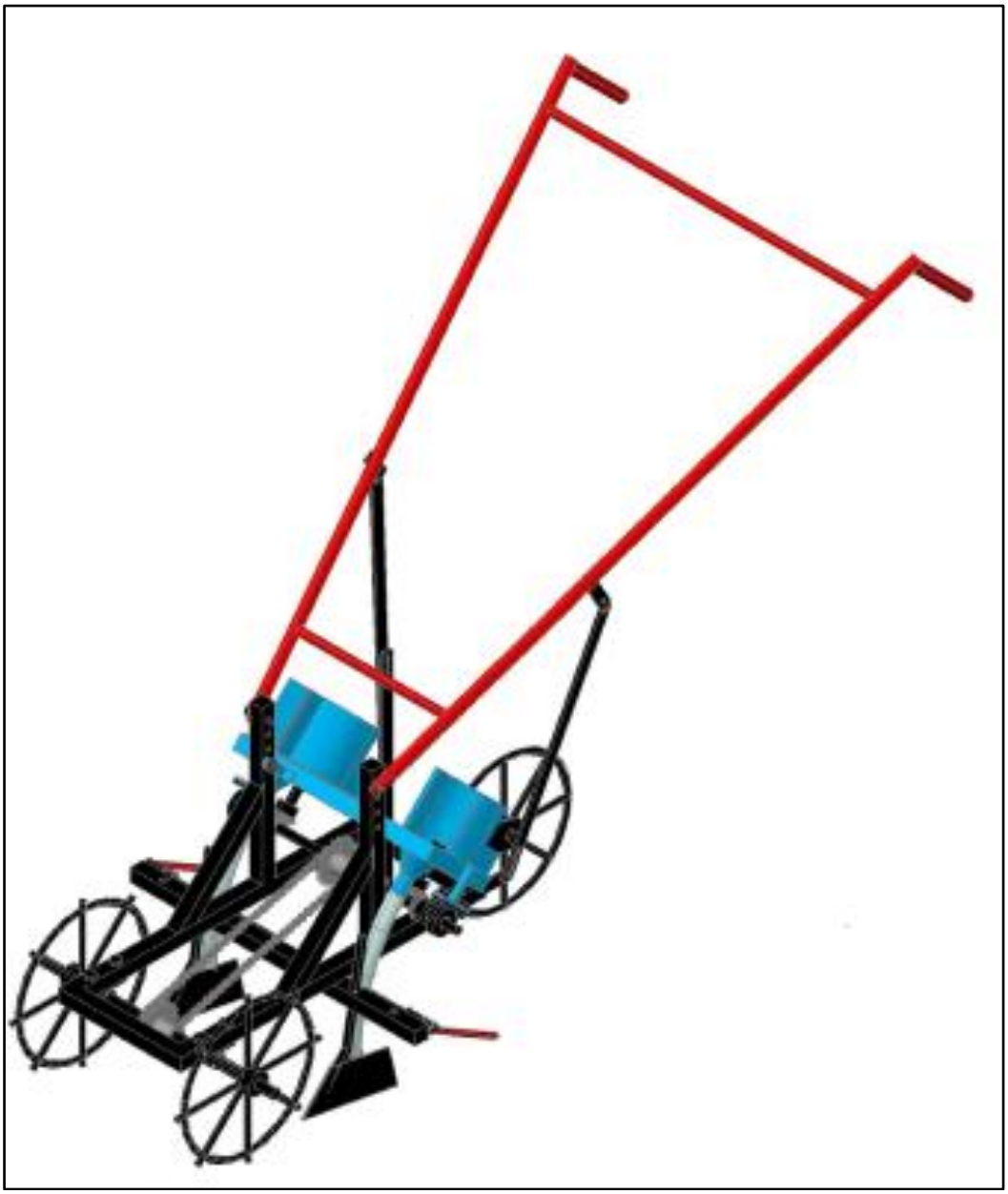

Fig. 1. Three Dimensional View of Manual Experimental Plot Seeder

Main Frame

The main frame assembly was made from MS and guage square pipe of size 25 mm. The size of the main frame assembly was 600 x 240 mm. On this main frame different systems of the machine were fixed viz. ground wheels and power transmission system, seed box and seed metering mechanism, furrow openers, handle, supporting wheel etc.

Furrow Opener

Two shovel type furrow openers for each seed metering unit was developed for this machine.The standard of furrow openers was made up of MS square rod of size 10 mm and the lower end of the standard was having a bend, on which the shovel of the furrow openers was welded and forming an obtuse angle with the soil. The shovel of the furrow openers was made up from MS sheet. The shovel was provided at the bottom of standard with overall dimensions of 147 x 90 x 60 mm. A boot was provided at the center of the shovel welded to the standard for accommodating the seed tube for dropping of seeds. The diameter of the boot was 25 mm having 2 mm thickness.

Power Transmission Unit

A chain and sprocket drive system was used to transmit the drive power from the ground wheels of the seeder to the driven shafts and from driven shaft to the rotor shaft of the seed metering mechanism.The power transmission unit consists of the following components:

1. Ground wheel: Two ground wheels were provided on the front side of the main frame. Ground wheel was made up of MS square rod of diameter 10 mm. The effective diameter of the ground wheel was 250 mm. There were 8 lugs welded on the periphery of ground wheel. Lugs have 10 mm diameter and having 100 mm length. Lugs were provided on ground wheel to avoid the slippage of the ground wheel.

2. Power transmission shafts: three types of power transmission shafts were provided i.e. Ground wheel shaft (Drive shaft), Driven shaft, and Seed rotor shaft.

a. Ground wheel shaft: The shaft was made up of MS bright bar of 18 mm diameter and having 465 mm length. A drive sprocket having 18 numbers of teeth was mounted on this ground wheel shaft at the center. This drive sprocket transmits power from ground wheel shaft to the driven sprocket with the help of chain.

b. Driven shaft: The driven shaft was made up of MS bright bar. The driven shaft was of diameter 16 mm and having 440 mm length. The step at the both ends of the shaft was made by reducing the diameter of shaft by 1 mm. This step was of 35 mm length and diameter of 15 mm at the two sides of the shaft.

c. Seed rotor shaft: Two rotor shafts were developed for two metering mechanism of manual experimental plot seeder. The rotor shaft was made up of MS bar. The diameter of the rotor shaft was 16 mm and having 90 mm length. At the bottom end of the rotor shaft an 18 teeth bevel gear was fitted with key nut for receiving the power from driven shaft.

3. Chain and sprocket arrangement: The driving sprocket was mounted at center of the ground wheel shaft having 18 numbers of teeth. Drive sprocket transmit power to the driven shaft through standard cycle chain. Driven sprocket was mounted at center of the driven shaft having 18 numbers of teeth with 12.7 mm pitch. Both the sprockets have 18 teeth. There was no power reduction between the drive and the driven shaft. Cycle chain was used to connect the two sprockets.

4. Bevel gear mechanism: The two pairs of bevel gear were used to transmit rotational power of driven shaft to seed rotor shaft at right angle. The bevel gears had 18 numbers of teeth on its periphery. The internal diameter of the bevel gear was 16 mm.

Seed metering mechanism

The inclined plate type metering mechanism was selected for manual experimental plot seeder. The inclined plate metering mechanism gives the better performance of seed placement than others. The seed metering mechanism consists of following components.

a. Seed box: The seed box was cylindrical in shape and flat at the bottom. The seed box was made up of MS sheet. The diameter of the seed box was 115 mm, which was fitted on the rectangular MS sheet having dimensions of 150 x 125 mm. Seed box assembly make an angle of 450 with the main frame. The round slot was made at the center of the bottom of the seed box having 16 mm diameter. This slot was provided for inserting the rotor shaft into the seed rotor. The rectangular slot was provided at the bottom of seed box for dropping the seeds from the rotor into seed tube. The size of this rectangular slot was 38 x 28 mm. There was one slot with flap arrangement was provided on the seed box for emptying the seed box after sowing one plot.

b. Seed rotor: The seed rotor used for this mechanism was of acrylic plastic type with cells on its periphery.The number of cells on seed rotor was calculated by the formula as given by Sharma and Mukesh. A rotor of 113 mm diameter and 6 mm thickness was developing for metering the seed. The cells were provided on the periphery of the seed rotor, as per the spacing requirement of the crop to be sown. This rotor rotated in the seed rotor box with the help of rotor shaft. The rotor had the “square” shape hole of size 16 mm for mounting on rotor shaft, so that there was no need to have a key and key way arrangement for the rotor and rotor shaft. While changing the rotor for other varieties, there was no

need to remove the rotor shaft, only nut fitted on rotor shaft remove from the top of the rotor shaft and then the rotor was remove out and another rotor will be placed in the seed box. Separate rotors were to be used for planting different varieties different crops

c. Brush: The experimental plot seeder was developed with one stationary brush in each seed box. Brush was provided for more positive unloading of seeds into the seed collecting funnel.

d. Seed drain arrangement: Separate seed drain arrangement was provided on each seed box. This flap was made from MS sheet and size of flap was 600 x 600 mm.

Seed collecting unit

There was an arrangement for collecting seeds from the seed rotors. Seed collecting funnel welded at the bottom of seed box assembly. The seed collecting funnel made up of MS sheet. The seed tubes were attached at the bottom of the funnels, which carry the seeds from the funnel to the bottom of the furrow openers through boot**.**

Supporting wheel

This wheel support and balance the weight of the seeder. The supporting wheel was made up from MS round rod of 10 mm diameter. The effective diameter of supporting wheel was 250 mm. Supporting wheel was attached at rare end of the main frame with the help of MS flat. The size of MS flat was 40 mm and having length of 180 mm.

Markers

Seeder was provided with markers. Markers were attached to the main frame with the help of nut and bolts. Markers were developed for maintaining row to row distance (PAU, Ludhiana). These were adjustable. It was fitted on square pipe of size 25 mm and having length of 600 mm with the help of nut and bolt arrangement. The provision was provided for adjusting the distance between markers according to the row to row spacing.

Handle

The handle of the seeder was designed to be adjustable for the different height of individuals thereby reducing drudgery. The handles help the operator to push the planter while in operation (Ibukun et al, 2014). It was made up from MS round pipe having 20 mm diameter. The length of handle was 1060 mm.

Operation of the manual experimental plot seeder

The developed experimental plot seeder was based on the pushing and pulling power of the operator. Two persons operates this machine, one person push the machine and another person pull the machine with help of rope. A hook was welded at the center of the front side of the main frame for tying the rope. Ground wheel rotated with the ground wheel shaft. The driving sprocket was mounted at center of the ground wheel shaft. Due to the rotation of ground wheel shaft driving sprocket will rotate. The driving sprocket transmitted power with rotary motion to the driven sprocket with the help of chain. Driven sprocket was mounted at center of the driven shaft. Both the sprockets having of same diameter and having same number of teeth and rotated at the same speed. Thus, the seed rotor was making same number of revolutions per minute as those of the ground wheel. In one rotation of the ground wheel, the seeder covers a distance of 785 mm. During this time, the seed rotor also made one rotation. There were eight cells on the seed rotor and it dropped eight seeds per rotation. Driven sprocket was mounted at the middle of the driven shaft. Motion of the driven sprocket caused the motion of driven shaft. Bevel gears were fixed on the middle of driven shaft. Two separate bevel gears fitted on driven shaft for two seed box. Due to motion of the driven shaft, bevel gear was rotated, bevel gear was provided for transmitting the rotational power of the ground wheel at right angle to the seed rotor. Bevel gear rotated the rotor shaft. The seed rotor picked up seeds from the seed box in the cells and dropped them into the collecting funnel. Brush was provided for more positive unloading of seeds into the seed collecting funnel. From collecting hopper seeds were transferred to the furrow openers through the seed tubes at recommended spacing.

Performance of the manual experimental plot seeder

The performance of developed experimental plot seeder was conductedto obtain field capacity of machine &Field efficiency. Seed rate was obtained to be 90.7kg-ha^{-1}& 137.4kg-ha^{-1}for Digvijay & Kripa Varity respectively by calibration. The effective capacity in field test was 0.047 ha-h^{-1} with average speed of 1.2 km-h^{-1}. The field efficiency of the manual experimental plot seeder in the field test was 75.95 %.

CONCLUSION

1. The developed experimental plot seeder was based on the pushing and pulling power of the operator.
2. Seed rate was obtained to be 90.7kg-ha^{-1}& 137.4kg-ha^{-1}for Digvijay & Kripa Varity respectively by calibration
3. The effective capacity in field test was 0.047 ha-h^{-1} with average speed of 1.2 km-h^{-1}
4. The field efficiency of the manual experimental plot seeder in the field test was 75.95 %.

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