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Design and Development of Low Cost Nursery Seeder for Cinnamon-*Cinnamomum zelanicum*

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Abstract— Proper spacing reduces the competition between plants to acquire nutrients, water, space, light, etc. Plant spacing uniformity begins with the uniformity of seed spacing. However, when practicing conventional manual seeding, maintaining of uniformity distribution of cinnamon seeds in nursery poly bags causes serious difficulties. Therefore, this study developed a cinnamon nursery poly bag seeder to avoid uneven distribution of seeding in conventional seeding practices with acceptable efficiency and low cost. Accordingly, the final prototype was developed by adopting pneumatic type seed metering system.The results revealed that the average time taken for seeding a single nursery poly bag by the conventional manual seeding and the developed seeder was 11.9s and 2.9s where the saving of time with 74.9 % higher. Moreover, the developed seeder was found to be accurate in maintaining even seed distribution within the polybag. Thus, the developed pneumatic type cinnamon poly bag seeder can be proposed as an appropriate tool to replace the existing tedious process of manual seeding in cinnamon cultivations.

Index Terms— Cinnamon – *Cinnamomum zelanicum*, Seeder, Pneumatic metering, Uniformity of seed spacing, Conventional maunal seeding, Nursery Polybag, Low Cost Seeder

1 INTRODUCTION

The nursery plants imbedded in ground should embrace a good vigor from the beginning in Cinnamon cultivation for the accomplishment of finest harvest. The main intention of maintaining good nursery of Cinnamon is to place plants with qualitative condition in the field. The qualitative condition of the plants, beginning from nursery to field is an important factor that facilitates the maintenance of vigor of Cinnamon plant in the field to obtain a better harvest [1]. The propagation of cinnamon is done by seeds, rooted cuttings and air layering. Nevertheless, the adoption of rooted cutting and air layering methods rarely subsist in Sri Lanka. The possibility of using plant tissue culture has been established, but there is no information about the adoption of tissue culture technology for commercial propagation of cinnamon hitherto [1].

There are three different methods adopted in seed propagation namely direct sowing of seeds in field, transplanting of nursery raised plants or root ball method, and transplanting seedlings upsurge in polythene bags[2].

Cinnamon seedlings are raised in 125cmx 20cm polythene bags filled with a 1:1:1:1 of potting mixture made of top soil, cow dung, sand and choir. Cinnamon seeds in between 7-10 are seeded in polythene bags and covered with coir or thin layer of potting mixture. In one polybag, minimum of 5 Cinnamon saplings should be placed while positioning in the ground after 4 to 6 months next to planting. [3].

Seed spacing uniformity can affect cinnamon plant spacing within the polybag being subjected to both vegetative and reproductive growth, yield and establishing uniform crop stands fields is the main goal of the growers [4].

Generally, seeding of cinnamon is a tedious task to carry on by hands. The difficulty subsists to maintain the seed spacing distribution within the polybag when sowing process conducted manually. Since one worker is deemed to maintain one polybag and spend more time in one posture, often prone to ache in the hands. Cinnamon nursery owners' encounter with spending high cost due to lack of skilled labourers. Moreover, since the seeds are positioned in non-uniform distribution during seeding process, the plants often form several proximity clusters in the polybags leading competition for water nutrient and the sunlight. Thus, low growth and development of plant inside the polythene bag could transpire. In order to avoid this problem, a necessity for developing a Seeder had been risen.

Basically, the conventional seeder consisted with the seed hopper, seed metering device, seed delivering tubes etc[5].

In the way of mechanization of seeding process the seed metering method is considerable event in order to make precision metering of appropriate amount of seed [6]. Basically there are two popularized metering systems called mechanical metering system and pneumatic metering system [7]. In accordance with the traces of Literature, the difficulty was raised during the metering of irregular shaped seeds. Hence, pneumatic metering devices can be stated as an ideal advantage of metering irregular shaped seeds and spherical seeds as well. Fundamentally, Pneumatic planter consists of the components such as frame, seed hopper, aspirator blower, metering unit and delivering unit [8].

Seed damageability, seed doubling are the major problems encountered with mechanical metering system when compere to the pneumatic metering system.

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As a remedial measure for this problem, a pneumatic type seeder was developed. The pneumatic precision seed metering device is designed especially to meet the requirements of sowing cinnamon seeds with the recommended seed rate while ensuring the even seed distribution to obtain good quality cinnoman seedlings at low cost of production fig.1.

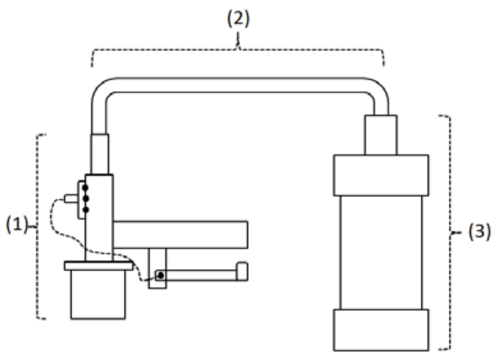

Fig.1. Design of pneumatic metering type seeder

2 Materials and Methods

2.1 Designing Phase

Designing phase was mainly aimd at the seeder headder component which could accomplish with precise seed metering, placing and topping of thin layer of soil after the placing of seeds. Light weight design and low cost of production were also among the objectives. The design comprised with generating low pressure vacuum air flow by the pump(3), air delivering tube(2), soil and seed piking holding and releasing header (1) fig.1. Air flow control valves were constructed to operate direction control of the vacuume pressure inside the tubes to operate the device.

The header was designed to facilitate fixing both seed and soil metering caps alternatively according to the purpose fig.2. Seed and soil metering header system is consisted of seed metering cap and soil metering cap which can be altered with the header during the process of seeding or placing the top soil after the seeding fig.5. The device consists of air delivery tube (a), low pressure air flow control valves (b) operating cable for the valve (c) main header body socket to fix soil or covering materials metering (d) operating lever of valve (e) holding handle (f) The control switches were constructed and fixed to the header body to control the low air pressure air (a) towards the header in order to pick the and release the seeds and soil. The control switch were operated by the lever which was connected through the cable(c). Seed metering cap fig.3 was designed to gather seeds from the hopper under the low pressured air flow. When control valve is closed the low pressure-air flow is connected with the seed metering headder and picks the seeds from the hopper. The device is then could securely picked upward while the seeds were holding to the header by the low pressure air flow. The next step is to place the seeds on the polybag by pressing the air flow control valve to direct the low pressuresuction air flow to the ambient atmosphere. The soil metering cap fig.4 also follows the same operation principle mentioned above. Negative air pressure developing system is responsible to develop the low air pressure air flow from the header and attached hoses are facilited to the air movements.

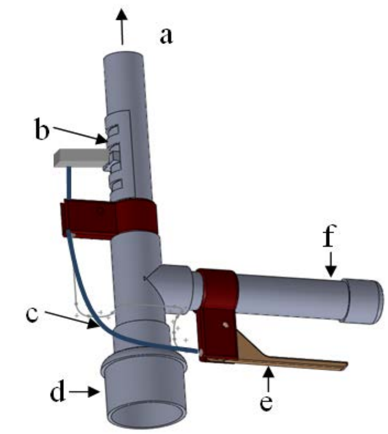

Fig.2. Assembly of Seed and soil metering Header.

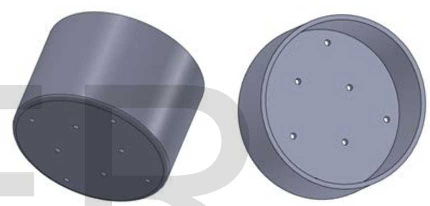

Fig.3. Design of seed metering cap

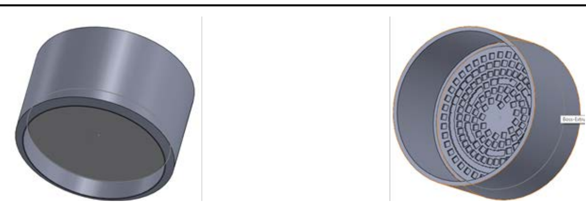

Fig.4. Design of soil metering cap

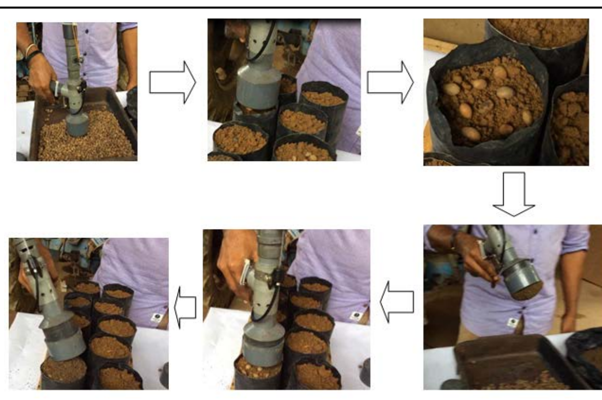

Fig.5. Design of soil metering cap

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2.2 Construction Phase

The seeder was constructed to facilitate the operation function explained in designing phase. PVC tubes and fittings were found to be the best material among the rest in order to cater the low cost and light weight design of the seeder. The control switch was prepared by movable semicircular shaped PVC strip (10mm X25 mm) in which the radius was similar to the outer diameter of the air delivery tube. Several holes were drilled on the perimeter of air delivery tube in a manner that they can be closed or opened by moving the PVC strip over the surface of the holes. The PVC strip was fixed over the series of holes with "u" shaped guided passage prepared by another sets of PVC strips. The guided passage was fixed by with PVC solvent. The moveable strip was spring loaded and a cable was fixed between the strip and the control lever. The seed metering cap was fabricated by creating different diameter sizes holes in the flat surface of the metering cap. Nine holes of following diameters were created in 12 metering caps to select the best diameter for the device. The tested diameters were 2.25, 2.5, 2.75, 3.0, 3.25, 3.5, 3.75, 4.0, 4.25, 4.5, 4.75, 5.0 (mm). The holes were created as they were evenly distributed within the equal spacing on the PVC end cap size 64mm in the diameter. The testing was carried out to find the appropriate diameter class to gather precise number of seeds and place the seeds in equal spacing inside the poly bag.

Soil metering cap was constructed by removing the flat surface of PVC end cap (diameter size 64 mm) by placing a wire mesh and fabric cloth layer inside the cap. The amount of soil needed to hold and release is a matter of the placement of the mesh number of wire mesh and the thickness of the fabric cloth. Proper specification of the two materials prevents soil entering in to the delivery tubes at low air pressure suction flow. The low pressure air flow was obtained by constructing axial flow type vacuum pump. The vacuum pump was operated with axial flow electric fan (230V, 650W) fixed to a knapsack system. The vacuum pump was made by placing an axial flow fan in the middle of 50cm length 20cm diameter PVC pipe and one end of it was connected to the air delivery tube.

2.3 Preliminary Testing

A laboratory test was conducted to find the appropriate diameter class to be used in the seed metering cap at the lowest power consumption. The test was conducted by fixing metering PVC caps in different diameter classes one by one starting from 2.25, up to 5.0 (mm). The power consumption was accounted by detecting the V versus I configurations at each test attempts. High current capacity rheostat voltmeter and ammeter configuration as shown in the Fig.6 was used. Obtained data were interpreted in double Y axis graph that demonstrated the power consumption versus diameter class of the seed gathering cap. Same testing configuration was used to assess the power consumption for picking up and releasing the soil metering header cap Fig.6.

The power required to hold the amount of soil was a function of the moisture content of the soil. Therefore, in order to find required negative air pressure to gather required amount of

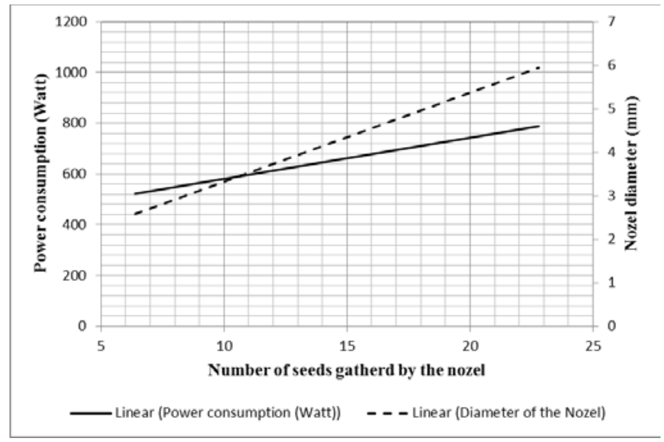

Fig.7. Number of seeds gathered by the header cap with respect to the power consumption and nozzle diameter.

soil i.e. the covering material under different moisture percentage ranging from 10%, 20%, 30%, 40% was tested. Data were interpreted in double Y axis graph. The power consumption and moisture percentage of the covering material against weight of dry soil is shown in the Fig8. The test results were used to modify the prototyped seeder with respect to high precision and low power consumption. The modified seeder

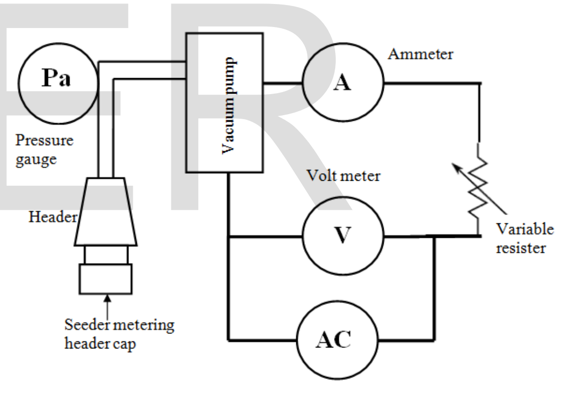

Fig.6. Schematic diagramme for preliminary testing

was tested in the real field condition to test the performance.

2.4 Filed Performance Testing

Time required to complete one polybag and seed pattern and even seed distribution were the two parameters considered for the field performance evaluation of the seeder. In addition, economy of the new approach to the conventional practice was assessed. The field test was conducted with the participation of local nursery farmers at cinnamon nursery. Thirty five nursery poly bags were seeded five times by using seeder and conventional manual procedures. Uniformity of the seed spacing in polybag was taken in to account as visual observation. The average seeding time taken for seeding 35 bags by with the conventional and machine seeding were 416.8 seconds, 104.4 seconds respectively.

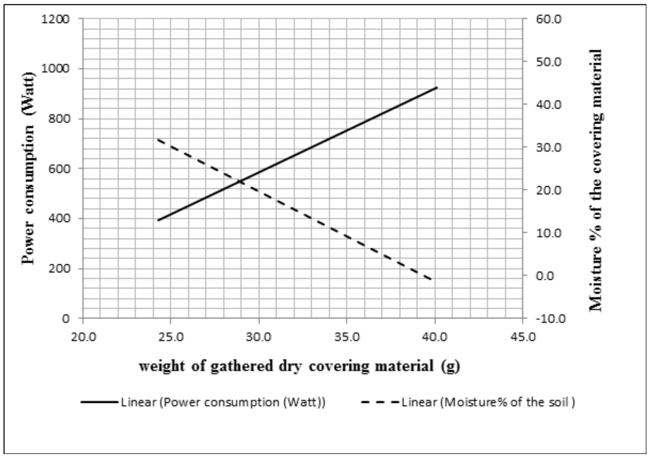

Fig.8. Variation in the weight of captured dry covering materials with power consumption and moisture percentage of covering material

3 Results and Discussion

The test conducted for the selection of suitable diameter size for the nozzles diameter of the seed metering cap reveald that the number of seeds gathering was increased with the increase of nozzle diameter and power consumption fig.7. Accordingly, Optimum number of seeds (9 seeds) gathering was obtained at 3.1 mm of nozzle diameter when the the power and negative pressures of, 560 W and 13.33 kPa were employed in the system respectively.

The weight of dry covering material was increased with the advance of power consumption which was inversely related with the moisture percentage fig.8. An adequate amount of covering material (30g – dry basis) gathering was obtained with moisture content of 20% at the power of 560W which is optimum compatible configuration to the process of cinnamon seed metering.

Even seed distribution represented 80% of designed seeder when compared to 8.58% of conventional manual seeding. This reflects an explicit indication on the applicability of designed and developed nursery poly bag seeder for cinnamon seeding process that helps to reduce uneven distribution by 78.12% compared to conventional method.

4 Conclusion

The optimum seed gathering by the header was obtained at nozzle diameter of 3.1 mm and at the rated power of 560 W. The optimum system configurations for soil topping were 30g of soil at the power of 560W when the moisture content of soil at 20%. Both operations were executed best when the vacuum pressures recorded as 13.33 kPa. The results revealed that the average time taken for seeding a single nursery polybag by the conventional manual seeding to the developed seeder was 11.9s and 2.9s where the saving of time recorder 74.9 % increment.

Moreover, the developed seeder displayed excellent in maintaining accurate seed spacing i.e. ensures even seed distribution within the polybag at 78.12% rate of increment when it is compared to the conventional method.

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