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Fennel Seeds Planting by Investigated Novel Pneumatic Technology

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ABSTRACT

The chief purpose of this work is to design and develop a new technology of pneumatic medicinal seeds planting "PMSP". An investigated prototype was identified which activates by the air vacuum system. It is made from two drums one inside others. The clearance between them considers a suction chamber. Regulated this space affects the suction volume to get high/low vacuum pressure. Through the indoor experiments, the best vacuum space is identified by two holes on the circumference inner tube with 8.0 mm diameter. The performance of the prototype was evaluated by studying some variables; forward speeds "1.7, 2.0 and 2.4 kmh^{-1}, vacuum drum speeds "20, 22, 24 and 26 rpm", and vacuum pressures "9.0 and 11.0kPa" per constant vacuum holes on the outer drum of 0.75mm diameters. The results indicated that; using vacuum pressure of 9.0 kPa, the highest percentage of latitude seeds distribution relative to seeding centerline was recorded 94.12 and 90.49% respectively, for right and lift exit seeds tubes under the forward speed of 1.7 kmh^{-1} and vacuum drum speed of 24 rpm. While the corresponding percentages at using vacuum pressures of 11.0 kPa were recorded 90.01 and 94.31% respectively under the above conditions but per the forward speed of 2.0 kmh^{-1} and vacuum drum speeds of 24 rpm. Also, to realize the lowest miss index "0.0%", multiple indexes "5.0%" and highest quality of feed index "95%" was found at a forward speed of 2.4 kmh^{-1} and vacuum pressure of 9.0 kPa under vacuum drum speed of 22rpm.

Keywords: Medicinal seeds, Suction chamber, Vacuum pressures, Planting, Vacuum drum speed, Fennel seeds

INTRODUCTION

The typical element for precision farming as defined by each of Abo El-Ees (1985) and Liu *et al.* (2004) is the manage crop production as a set specific three bases; optimize profit, reduce waste and maintain environmental quality. But Michal (2008) defined precision agriculture relative to three combinations of interaction among soils, machine operation, and application rate of fertilizer. Furthermore, in agricultural planting machines, the precision planter is provided for accurate placement of single seeds at equal intervals within rows (Ismail *et al*., 2010 & Singh *et al*., 2011). Planting medicinal and aromatic "PMSP" seeds required careful treatments because the seeds need special treatments during planting. It may be due to the irregular seeds in shape or seeds having a finny on their surface or very light mass seeds…. etc. Medicinal and aromatic plants are considered among the untraditional crops that represent a large portion of the national income. The fennel (*Foeniculumvulgare* Mill.) is persistent as the aromatic plant. In Egypt, the production of fennel is about 5846Mg (Economic affairs sector, 2020). There were several technics for precision planting, but the most appropriate method is a vacuum air system (Ismail *et al*., 2014). Previous studies have demonstrated that three factors mainly contribute to the performance of a vacuum-type metering unit. One of the factors is the peripheral speed of the vacuum disk as it is associated with the forward speed of the planter, while the other two factors are the vacuum applied on the vacuum disk and the hole diameter (Yazgi and Degirmencioglu, 2007). On the other hand, Hajahmed *et al.* (2012) developed a photo electronic system to calculate fine seed flow from the metering system of the row crop planter and to determine seeds spacing. They specified that the established system can be accurately used to detect seed flow from the metering device with a strong linear relationship between the system measured and actual measurement (R= 0.993).

Xue *et al*. (2019) try to reach a high quality of planting "Ip" at height field operating speeds by adding double-setting seed pickers to the mechanical seed-metering device and studying the influence of parameters of seed cell diameter for setting plates" L1 & L2" and seed holder angles "α and β" on the metering performance. The best performance, represented by the highest "Ip" "99.59%", occurred at "L2 = 5.18 mm" and "β = 61.9°". Also, Ismail *et al*. (2009); Ismail (2011), and Bagherpour (2019) studied the impact of seed hole diameter on the quality index (I_q), miss index (I_{miss}), and multiple indexes (I_{mult}) and reached to the highest performance at seed hole diameter of 4.0 mm. Değirmencioğlu *et al.* (2018) studied the influence of using twin vacuum disks to improve seed spacing uniformity at higher forward speeds while forward speeds used were (2.0; 3.0 & 4.0 m/s). The results explained that the best quality of feeding index was 7.0m/s. During the mechanization of medicinal fennel seeds, many problems were verified. So, this work aimed to:

1- Develop a pneumatic precision planter from local material to suit for seeding fennel seeds.
2- Studying several variables that affect investigated pneumatic precision planter unit performance.

MATERIALS AND METHODS

The role of this research is to investigate a new pneumatic precision device "PPd" suitable for planting

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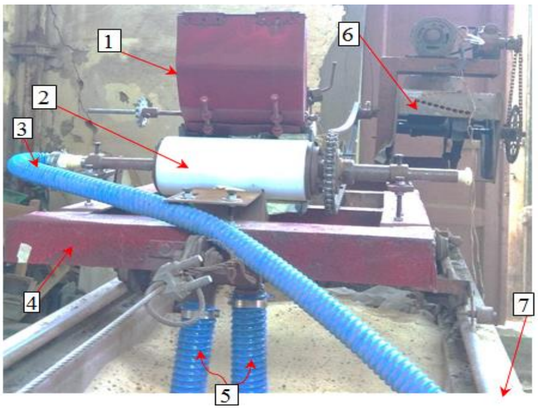
fennel seeds. The simulated device with "PPd" system was manufactured in a local workshop at Meet-Fadala-Dakahlia governorate in 2020.

To evaluate the effect of some engineering variables on the performance of developed "PPd" seeder, which includes the pneumatic precision device, the medicinal seeds, and operation parameters. The following topics clear each in detail:

Planting device: the proposed device, as shown in figure (1), included a seed-box, feeding device, air delivery system, seed tubes, transmission system, and frame.

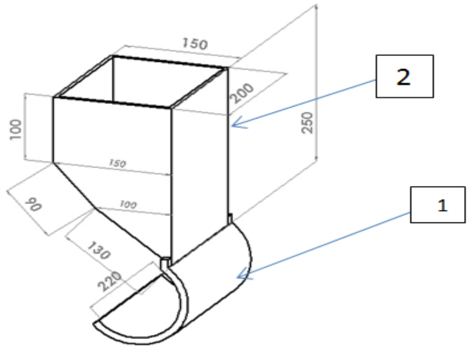
The seed box is involved two parts (figure 2): the upper part is trapezoidal with the upper open of 150 × 200mm, and a lower open has dimensions of 30 × 200mm for width and length, respectively. The second part has a semi-circle of 55mm diameter and 220mm width which is divided into four sectors by 50 mm in between each one.

The feeding device as shown in figure (3), is the feeding device of "PMSP" made from two drums one inside others. The clearance between them considers a vacuum space named the suction chamber. Regulated this space affects the suction volume to get high/low vacuum pressure. The volume of 01076 cm^3 gets by outside drum prepared from 30 × 31.9 × 0.79 cm. Teflon with 250; 101 and 81.0 mm length, outer and inner drum diameters respectively, while the internal drum is connected relative to the longitudinal axis of the outside drum which fastened from two sides. It constricted from the iron sheet of 220; 69.1 and 2.0mm diameter, length, and thickness respectively. At the two side ends of the outside drum, an iron suction tube was connected using the special mechanism that allows rotating the outside drum and keeping the suction tube and internal drum fixed. The suction tube is assembled from the iron tube with an outer and inner diameter of 27.4 and 25.4 mm respectively. The inner part of the suction tube was located on both sides of the outside drum which on its parts distributed two holes on the circumference suction tube with 8.0 mm diameter that was an arrangement to appropriate smallest seeds.



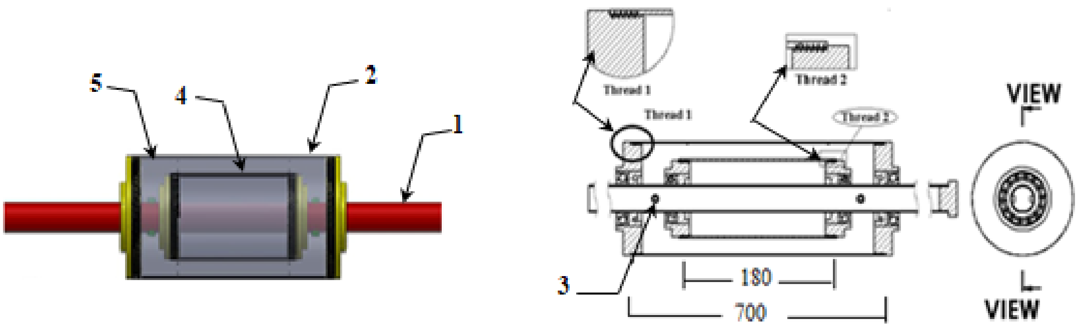
1- Seed box 2- Feeding device 3- Air delivery system
4- Frame 5- Seed tubes 6- Transmission system 7- Soil bin

Figure 1. The planting unit at indoor experiments.



1-Semi-circle 2- Seed box

Figure 2. The seed box



1-Suction tube 2- Circumference holes 3-Seed catching holes 4- Inner drum 5- Outer drum

Figure 3. Investigated feeding device.

The air delivery tube: is made of flexible plastic with 40 mm in diameter and 300mm in length. One end of the tube is connected to the vacuum drum of the feeding device and the other end is connected to the blower.

The frame: is shown in figure (1) made of beam steel U-shaped of 75 × 80mm with 650mm of length, 600mm width, and 80mm of high. The frame was supported by two hitch points to move the planter on the soil bin with the wire.

Seed tubes: consist of two iron tubes with a diameter of 50.8 mm and 120 mm length installed in the iron plate with 170 mm in length and 110 mm in width which moves to forward and backward through screws fixed to the trolley. The iron tubes ended with plastic tubes with 52mm in diameter and 350mm in length.

Air suction unit: It composed of a blower of 1600 watt -50 Hz, with two suction levels.

To obtain the motion for both the feeding drum and the trolley the following power systems can use:-

Power system: the transmission system of the planting device consists of the gearbox, gears/chain, and electrical motor. The transmission system function is to transmit the motion from the gearbox to the planting device and also to the trolley. The source of power is an electric motor of 0.24 kW (0.33 hp) with 1450 rpm.

Movement the trolley: It takes the movement from an electric motor of 3.75 kW (5.0hp). It is used to provide different forward speeds to the investigated feeding device in the lab.

Soil bin specifications: it has 0.75 m wide, 6.0 m long, and 0.4 m of center depth. The soil bin fills with the soil texture of 0.1; 0.15 and 99.75% of clay, silt, and sand respectively. Soil moisture content and bulk densities were 4.8% and 1.15g/cm^3 respectively.

Experimental procedures were carried out at Farm Machinery Laboratory Research constructed by Ismail (2004) as part of outcomes from a project financed by Researching Unit of Mansoura University.

Fennel seed variety: is a local variety of seeds (*Foeniculumvulgare var. vulgar).* The recommendations of seeds planting were about 20-25 cm in row space and 70 cm within rows.

Pre experimental preparation

Laboratory tests were done to estimate some of the physical properties for fennel seeds to estimate some specifications of planting units as well as to optimize the factors affecting the feeding rate and application rate. These factors included the numbers and diameters of holes and the rotational speed of the metering device.

Indoor experiments

The indoor experiments were carried out in the soil bin using the trolley and the investigated unit with a pneumatic drum at studied variables including; four vacuum drum speeds "VDS of 20; 22; 24 and 26 rpm", two suction pressure "VP" of 9.0and 11.0 kPa" and three forward speeds "FS of 1.7;2.0 and2.4kmh^{-1}". To determine the properties of seeds and air the digital venire used to measure the main dimensions, airflow velocity meter used for measuring air velocity inside the tube to determine the air velocity, electrical digital balance used to determine the mass of seed samples to calculate bulk density, the tape was used for measuring the distance between the seeds along the planting line, stopwatch, electrical oven, used to determine seeds moisture content and manometer.

The seeds' properties can calculate as follows:

The geometric mean diameter (Dg) of the seed was calculated using the following relationships of Mohsenin (1986) and Singh and Sarawat (2005):

$$Dg = (lWT)^{1/3}$$

Where; Dg = geometric mean diameter, mm,
l = length of the seed, mm,
W= width of seed, mm, and
T = thickness of seed, mm,

The arithmetic mean diameters (Da) of the seed were calculated from the following relationships (Mohsenin, 1986 and Ismail, 1988):

$$Da = \left(\frac{l + W + T}{3}\right)$$

The degree of sphericity "∅" is defined as the ratio of the surface area of a sphere with the same volume as the seed to the surface area of the seed. This measurement was determined using the following equation (Mohsenin, 1986 and Ismail, 1988):

$$\emptyset = ((lWT)^{1/3}/l) * 100$$

Latitude of seed distribution is the most important factor in the dispersion of the seeds around the center of the rows. The tested row length was 3 m. The counted numbers of seeds per unit length of soil bin that lies between 0 to ±3cm from the seeding centerline were determined. The latitude distributions were calculated using the following equation:

$$D = \frac{SD}{d_{th}} \times 100 \quad \text{(Hunt et al., 1983)}$$

Where: D = seeds dispersion, %
SD = standard deviation, cm and
d_{th} = theoretical distance, cm.

Longitude of the seed distributions: The theoretical seed spacing was determined using the following equation.

$$X_s = \frac{60 \times v}{\lambda c \times n} \quad \text{(Ismail and Ismail, 2007)}$$

Where :X_s= theoretical seed spacing along the row (m),
***v* = forward speed (m/s),**
***n* = rotational speed of the metering device (rpm)**
λc = number of seed delivered per one revolution of the feeding device.

Seed spacing in the row was measured along distance of 3.0 m, and the uniformity of the seeds was determined by Kachman & Smith (1995) and Ismail & Ismail (2007).

Miss index (%) is the percentage of spacing greater than 1.5 times from the theoretical spacing and it indicates the percentage of missed seed locations or skips. It was calculated from the following equation:

$$\text{Miss index} = \frac{n_1}{N} \times 100 \quad \text{(Ismail, 1988 and Ismail et al., 1989)}$$

Where: n_1 = number of measured spacing greater than 1.5,
***N*=total number of measured spacing.**

Multiple index (%) is the percentage of spacing that is less than or equal to half of the theoretical spacing and it indicates the percentage of multiple seed drops. It was determined using the following equation:

$$\text{Multiple index} = \frac{n_2}{N} \times 100 \quad \text{(Ismail, 1988 \& Ismail et al., 1989)}$$

Where: n_2 = number of measured spacing less than or equal to half a recommend seeds distance.

Quality of feed index (%) is the percentage of spacing that is more than half but not more than 1.5 times of theoretical spacing. The quality of the feed index is an alternate way of presenting the performance of misses and multiples. It was determined from the following equation:

Quality of feed index (%) =100 - (Miss Index+ Multiple Index)
(Ismail, 1988 and Ismail *et al.*, 2009)

RESULTS AND DISCUSSION

Fennel seeds physical and mechanical properties

The physical properties of fennel seeds were illustrated in table (1) under moisture content of $4.93^{\pm 0.85}$.

Table 1. Some of fennel seeds physical properties

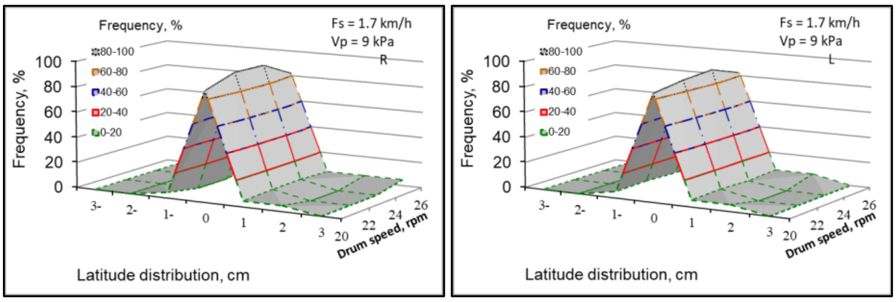
	l, mm	T, mm	W, g	Da, mm	Dg, mm	∅, %
Average	6.58	1.97	1.46	3.33	2.63	0.40
SD	±1.26	±0.62	±0.38	±0.75	±0.67	±0.53
CV	19.13	31.43	25.98	25.51	24.21	1.27

Latitude seed distribution

The latitude of fennel seed distribution in percentage is as shown in Fig.(4) demonstrating that the highest numbers of latitude seed distribution were laid around the center line (zero deviation) of "x" axis under different (VDS, rpm) and (VP = 9.0 kPa) for right and left exit out tube and at constant (FS) of 1.7 kmh^{-1}. By increasing the "VDS" from 20 rpm until 24 rpm with increment of 2.0 rpm, the percentage of fennel seeds that out from right exit out tube "R" relative direction of motion rests around zero deviation were recorded about 86.4, 94.4 and 94.12% respectively. But, the amount of seeds around zero deviation rapidly decreases "81.87%"at increase "VDS" more than that 26 rpm. However, for the left exit out tube "L" there were 84.25, 88.25, 90.49, and 82.35, respectively (Fig.4-A).

Moreover, at the same variables "FS = 1.7km h^{-1}" but vacuum pressure of 11.0 kPa, the percentage of fennel seeds that out from "R tube" relative to direction of motion rests around zero deviation were 83.80, 80.57, 89.03 and 77.52% at increasing "VDS, rpm" from 20rpm to 26rpm with increment of 2.0 rpm respectively. On the other hand, the percentage of fennel seeds, that out from "L" tube relative to direction of motion rests around zero deviation were 84.43, 85.75, 86.88 and 75.77% respectively (Fig. 4-B). The above results did not take a directional trend. This may be due to more vibration acting upon feeding system during test.

The latitude of fennel seed distribution for "R" tube under different "VDS" of 20, 22, 24 and 26 rpm, vacuum pressure of VP = 9.0 kPa, and "FS" of 2.0 km/h as illustrated in Fig. (5-A) indicated that the percentage of seeds at the centerline were 85.40, 87.00, 88.64 and 77.43% respectively. On the other hand, the fennel seed distributions for "L" tube under the above variables were recorded at 82.91, 84.71, 86.21 and 77.28%, respectively. Moreover, at the same above variables but with vacuum pressure of 11.0 k Pa the percentage of seeds distributions at the centerline for "R" were 84.65, 89.47, 90.01, and 83.34%, respectively. However, there were recorded 84.35, 87.58, 94.31, and 81.60% respectively at "L" tube as shown in Fig. (5-B).



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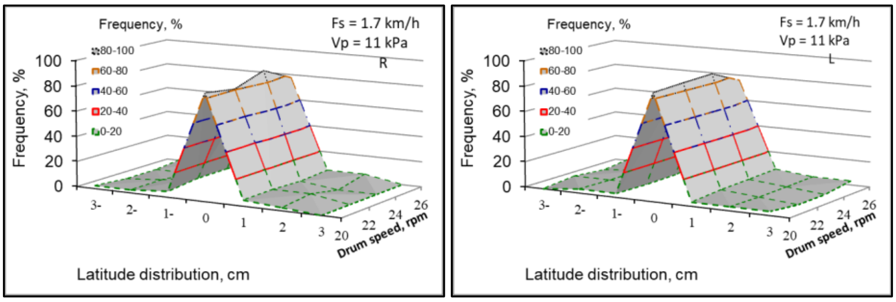
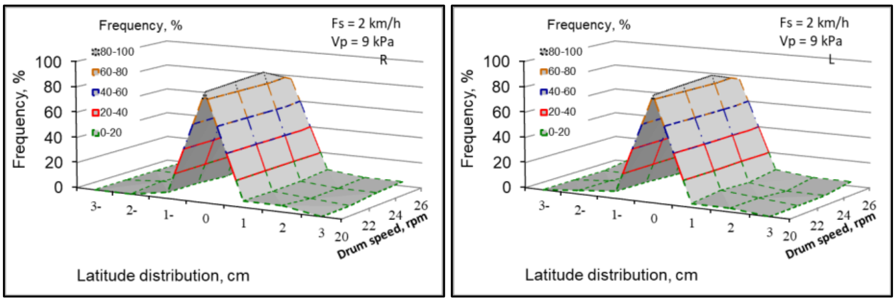


B

Figure 4. The lateral of fennel distribution at 1.7 kmh^{-1}forward speed



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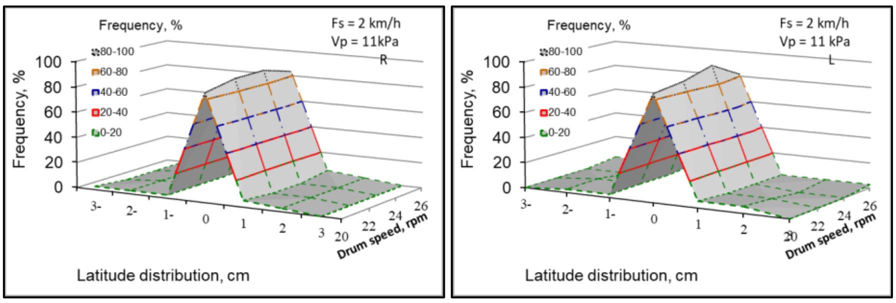


B

Figure 5. The lateral of fennel distribution at 2.0 kmh^{-1}forward speed

At "VDS" of 20, 22, 24 and 26 rpm, "VP" 9.0 kPa and "FS" of 2.4 $kmh^{-1}$for "R" the percentage of seed at the centerline were 80.40, 80.00, 82.40, and 81.42% respectively as shown in Fig. (6-A). However, the "L" recorded 70.91, 76.19, 77.78, and 76.92% respectively. Moreover, at the same above variables but "VP" was 11.0

kPa the percentage of seed at the centerline for "R" were 60.53, 71.84, 73.84, and 71.82% respectively as shown in Fig. (6-B). While, there were 66.70, 75.01, 76.48, and 76.92% respectively for "L".

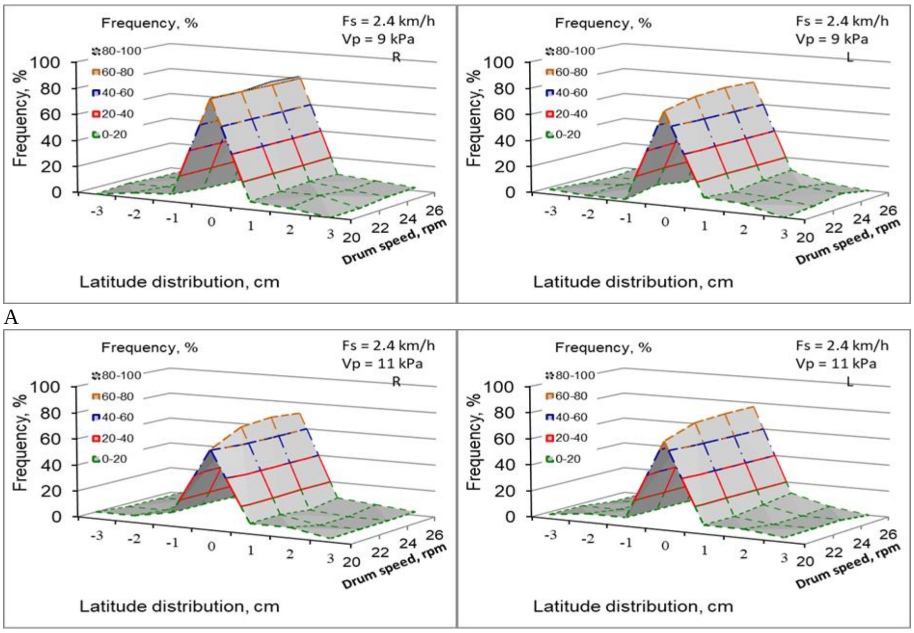


Figure 6. The lateral of fennel distribution at 2.4 kmh^{-1} forward speed

Longitudinal seeds distribution

The frequency curves of longitudinal seeds distribution in travel planting motion were calculated and illustrated in Figs from 7 to 10 under four of "VDS, rpm". The relationship as shown in Fig. (7) indicated that pre different planting forward speed "FS, kmh^{-1}" of 1.7; 2.0 to 2.4kmh^{-1}, the frequency of longitudinal seeds distribution that established at recommended distance "20-25cm" recorded 32.56, 62.50 and 62.50% and 43.75, 43.75 and 68.42% for "R" and "L" tubes respectively, under "VP" of 11.0kPa and "VDS" of 20 rpm. Meanwhile, at "VDS" of 22rpm and "VP" of 11.0kPa the frequency of longitudinal seeds distribution that establish at "20-25cm" recorded 36.59; 62.50 and 43.59% and 45.24, 70.00 and 50.03% for "R" and "L" respectively for different "FS" of 1.7; 2.0 to 2.4kmh^{-1} "Fig. 8".

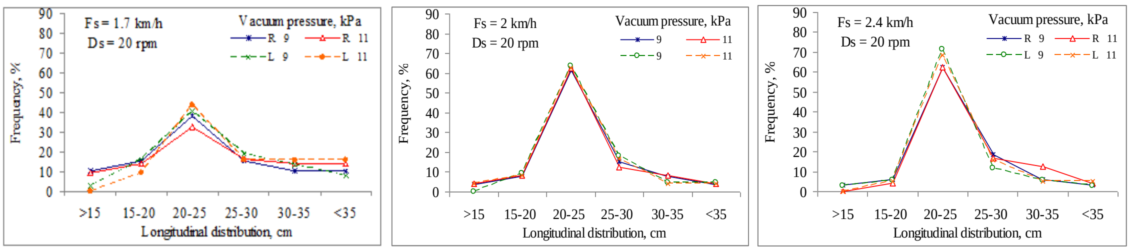


Fig. 7. The frequency of fennel seeds longitudinal distribution "VDS = 20rpm"

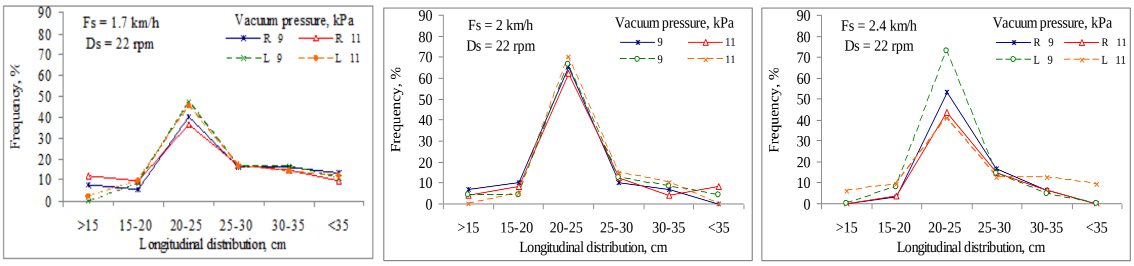


Fig. 8. The frequency of fennel seeds longitudinal distribution "FS" at "VDS = 22rpm"

The verified as shown in Fig. (9) that the frequency curves of longitudinal seeds distribution during the travel planting motion for "FS, kmh^{-1}" of 1.7; 2.0 to 2.4kmh^{-1} and "VDS" of 24 rpm were 55.56, 64.00 and 45.24% and 52.63, 59.09 and 52.94% for "R" and "L" respectively under recommended inter seeds distance of 20-25cm. While the frequency of longitudinal seeds distribution were recorded 50.00, 56.52 and 46.15% and 54.55, 58.33 and 57.69% for "R" and "L" at "FS" of 1.7; 2.0 to 2.4kmh^{-1} respectively under "VDS" of 26 rpm as shown in Fig. (10).

Generally, may be suggested to identify the highest frequency of longitudinal seeds distribution (73.02%) around the recommended inter row space of "20 to 25cm" may be found at "VDS" of 22rpm, "FS" of 2.4km h^{-1} and "VP" of 9.0kPa. Also, the longitudinal seeds distribution of (70.00%), may be found at "VDS" of 22rpm, "FS" of 2.0km h^{-1}and "VP" of 11.0kPa.

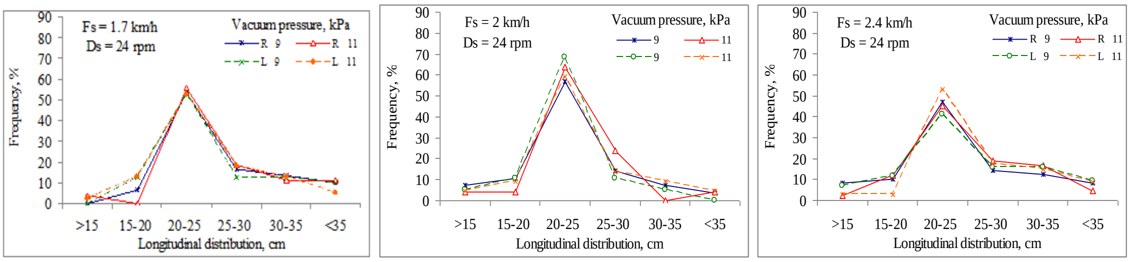


Fig. 9. The frequency of fennel seeds longitudinal distribution "FS" at "VDS = 24rpm"

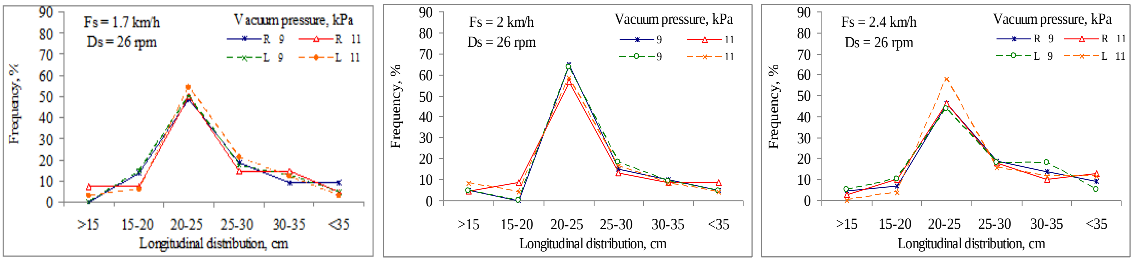
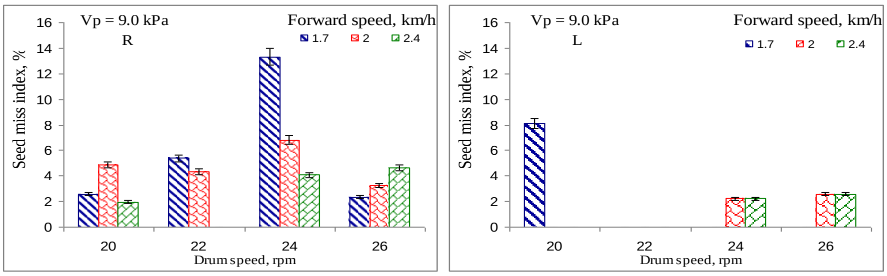


Fig. 10. The frequency of fennel seeds longitudinal distribution "FS" at "VDS = 26rpm"

Miss index

The results at Fig (11-A) show that the percentages of miss index were 13.33 and 14.81% respectively at VP of 9.0 and 11.0kPa for right exit out "R" tube and FS of 1.7 km h^{-1} . Then the corresponding percentages at left exit out "L" tube were 8.11 and 12.12%. On the other sides, the lowest percentages were 0.00, 0.00, 0.00 and 2.94 at the previous conditions of "VP" and "FS" of 2.4 km h^{-1}. These results clear that the optimum miss indexes are the lowest, which are found at "VDS" of 22 and 24 rpm respectively at VP of 9.0 and 11.0kPa.



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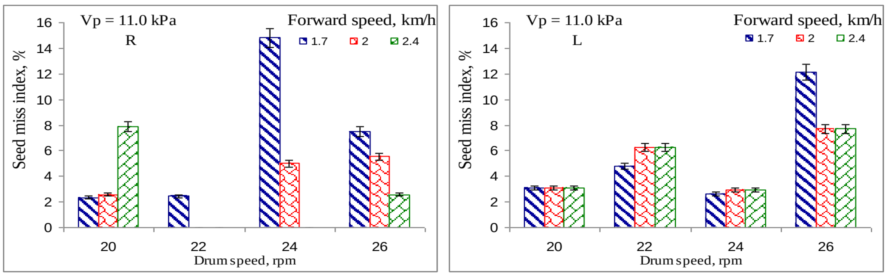

B

Figure 11. Factors affecting miss index for fennel seeds at two seeds tubes

Regarding to Fig.(11-B), miss index with zero levels was illustrated during operating the planter at "VDS" of 20 rpm & "FS" of 2.0 or 2.4 km h^{-1} and "VP" of 9.0 kPa or operating planter at "VDS" of 22rpm & "FS" of 1.7 or 2.0 or 2.4 km h^{-1}and "VP" of 9.0 kPa. Also, the optimum planter operating may be operated at VDS" of 22 rpm, &"FS" of 2.0 or 2.4 km h^{-1} and "VP" of 11.0 kPa or at VDS" of 24 rpm & "FS" of 1.7 km h^{-1}and "VP" of 9.0 kPa or at VDS" of 24 rpm &"FS" of 2.4 km h^{-1} and "VP" of 11.0kPa or VDS" of 26rpm,"FS" of 1.7 km h^{-1}and "VP" of 9.0kPa. Finally, If needed to operate planter at higher travel speed (FS = 2.4km h^{-1}) with zero void index may be identify at 22rpm and 9.0kPa or under 24rpm and 11.0kPa.

Multiple indexes

The results as shown in Fig(12-A) show that pre different vacuum drum speed "VDS" of 20; 22; 24and 26 rpm under vacuum pressure of 9.0kPa at right exit out tube "R", the percentages of multiple indexes for seeds at "FS = 1.7 km h^{-1}" recorded 25.6, 13.5, 6.7, and 23.3%, but at "FS = 2.0 km h^{-1}" verified from 26.8, 30.4, 43.2, and 9.7% while at "FS = 2.4 km h^{-1}" conformed 19.6, 5.0, 18.4 and 13.9 % respectively. While at left exit out tube "L", the percentages of multiple indexes for seeds at "FS = 1.7 km h^{-1}" recorded 18.9, 16.7, 17.5 and 22.5%, but at "FS = 2.0 km h^{-1}" verified from 17.1, 30.8, 24.1 and 8.6% while at "FS = 2.4 km h^{-1}" conformed 14.6, 9.5, 22.2 and 15.4% respectively.

Meanwhile, under above parameters but at "VP = 11.0kPa as shown in Fig. (12-B), the data of percentages of multiple indexes for seeds at "FS = 1.7 km h^{-1}" recorded 25.6; 31.7; 3.7 and 25.0% but at "FS = 2.0 km h^{-1}" verified 30.8; 18.4; 20.0 and 28.1 while at "FS = 2.4 km h^{-1}" conformed 36.8; 25.6; 16.7 and 20.5% respectively. Also, at left exit out tube "L", the percentages of multiple indexes for seeds at "FS = 1.7

km h-1" recorded 18.8, 23.8, 15.8 and 15.2%, but at "FS = 2.0 km h^{-1}" verified from 17.1, 36.8, 9.4, 14.3 and 18.4% while at "FS = 2.4 km h^{-1}" conformed 18.8, 21.9, 11.8 and 3.9% respectively. The trend was found for the left-out tube "L" but the lowest percentages of multiple indexes of seeds (9.5%) found at "FS" of 2.4km h^{-1}; "VDS" of 22.0rpm and "VP" of 9.0kPa or at 2.4km h-1 ; 28rpm and 11.0kPa.

Generally, to conformed the agricultural requirement as recommend by (Ismail, 1989; 1991; and Ismail & Ismail, 2007) for the best multiple indexes for seeds most more that 4.0%, then can be operate the planter under 24 rpm vacuum drum speed & travel or planting speed of 1.7 using vacuum pressure of 11.0 kPa or operating the planter under26 rpm & 2.4 km h^{-1} at the same previous vacuum.

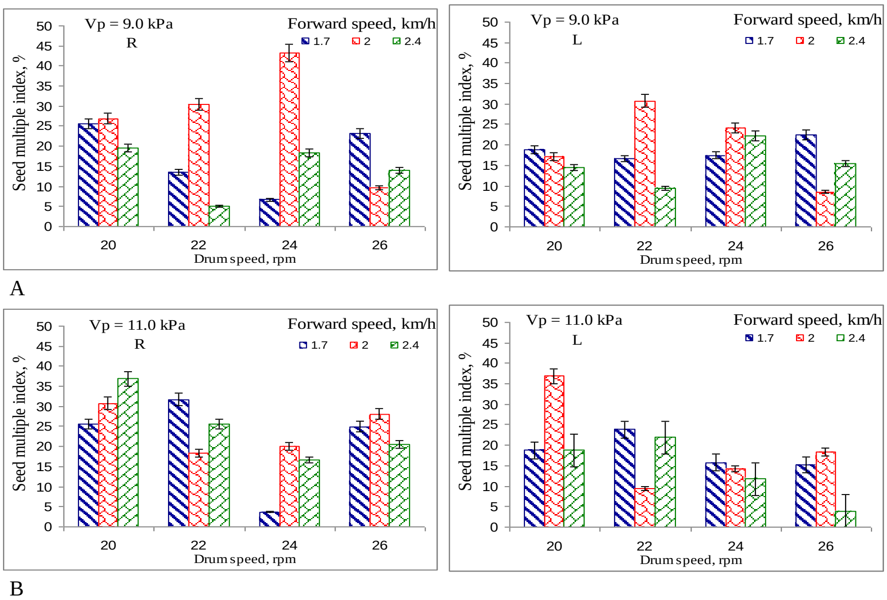

Figure 12. Factors affecting multiple indexes

Quality of feed index (QF, %)

The Figure (13) shows that at "FS" 1.7, 2.0, and 2.4 kmh-1 & "VDS" (20, 22, 24, 26 rpm) and "VP" 9.0, kPa, for "R" tube, the percentages of seeds were (72.0, 81.0, 80.0, and 74.4%), (68.3, 65.2, 70.5, and 87.1%), and (78.4, 95.0, 77.6, and 81.4%), respectively. The data at 11.0kPa were (72.1, 65.9, 81.5 and 67.5%), (66.7, 82.0, 75.0, and 66.3%), and (72.1, 74.4, 83.0, and 77.0), respectively. However, for "L" the results at Fig. (13) shows that at "FS" 1.7,2.0, and 2.4 kmh-1 & "VDS " (20, 22, 24 and 26) rpm, and "VP" 9.0 kPa, the percentages of seeds were (73.0, 83.0, 82.5, and 77.5%), (77.0, 66.7, 65.5 and 88.6%), and (85.4, 90.5, 76.0, and 82.1%), respectively. The data at 11.0kPa were (78.1, 71.4, 81.6, and 72.7 %), (63.2, 87.5, 82.9 and 76.3%), and (78.1, 72.0, 85.3 and 88.5%), respectively.

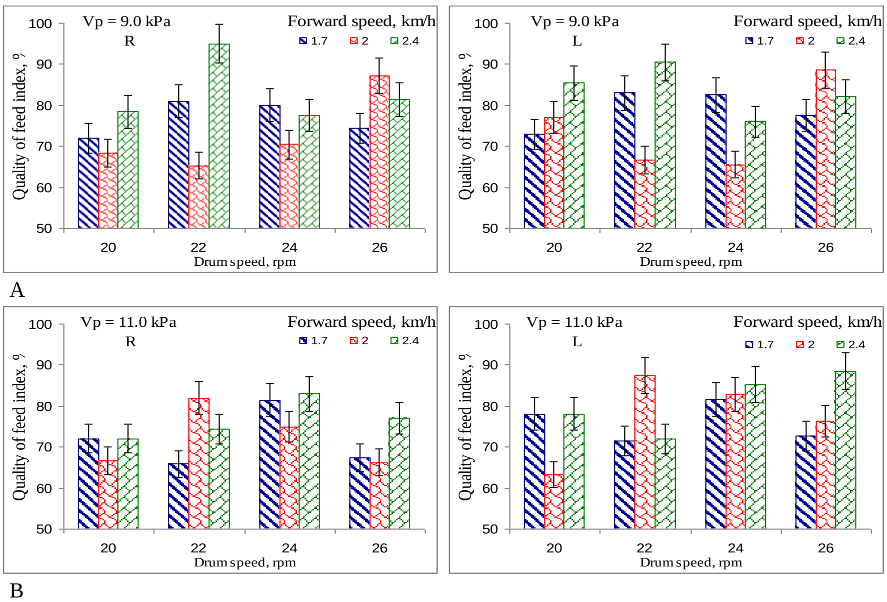

Fig 13. Factors affecting quality of feed index (QF, %)

RECOMMENDATION

Regarding to the recommended from the previous studies at lowest each of seeds void index "less that 2%" & double indexes "less than 4%" and the uniformity of seeds distribution less than 94%. So, the above recommendation may be recognize at:

- Using vacuum pressure of 9.0 kPa which is the highest percentage of latitude seeds distribution at the center line were recorded 94.12 and 90.49 % respectively at right and lift exit out tubes and at a forward speed of 1.7 $kmh^{-1}$and vacuum drum speed of 24 rpm.

- Or at using vacuum pressures of 11.0 kPa which were recorded 90.01 and 94.31 % respectively at right and lift exit out tubes and at forward speed of 2.0 $kmh^{-1}$and vacuum drum speed of 24 rpm.
- Also, to realize the lowest miss index “0.0%”, multiple indexes “5.0%” and highest quality of feed index “95%” was found at a forward speed of 2.4 km h^{-1} and vacuum pressure of 9.0 kPa under vacuum drum speed of 22rpm.

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زراعة بذور الشمر بإستخدام تقنية حديثة تعمل بشفط الهواء

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الغرض الرئيسي من هذا العمل هو تصميم وتطوير تقنية جديدة لزراعة بذور النباتات الطبية بشفط الهواء "PMSP". تم تطوير نموذج أولي يعمل بنظام التفريغ الهوائي. وهي مصنوعة من إسطوانتين واحدة داخل الأخرى. الخلوص بينهما هو غرفة الشفط. تؤثر هذه المساحة المنظمة على حجم الشفط للحصول على ضغط فراغ مرتفع/منخفض. من خلال التجارب الأولية، تم تحديد أفضل حجم لحيز تفريغ من خلال ثقبين على محيط الأنبوب الداخلي بقطر ٨,٠ مم. تم تقييم أداء النموذج الأولي بدراسة بعض المتغيرات؛ السرعات الأمامية "١,٧، ٢,٠، ٢,٤ كم في الساعة-١"، وسرعات اسطوانة مسك البذور "٢٠، ٢٢، ٢٤، ٢٦ لفة الدقيقة-١" وضغط شفط الهواء"٩,٠ و ١١,٠ كيلو باسكال". تم تحديد ثقوب قطر مسك البذور على الأسطوانة الخارجية عند ٠,٧٥ مم. أشارت النتائج إلى أنه باستخدام وضغط شفط الهواء ٩,٠ كيلو باسكال، سجلت أعلى نسبة مئوية لتوزيع البذور على منتصف خط الزراعة بحوالى ٩٤,١٢ و ٩٠,٤٩٪ على التوالي، لأنابيب الخروج اليمنى واليسرى عند سرعة أمامية ١,٧ كيلومتر الساعة-١، وسرعة اسطوانة مسك البذور تبلغ ٢٤ لفة الدقيقة-١. بينما تم تسجيل النسب المئوية المقابلة عند استخدام وضغط شفط الهواء ١١,٠ كيلوباسكال فكانت ٩٠,٠١ و ٩٤,٣١٪ على التوالي عند نفس ظروف التشغيل السابق ذكرها عند سرعة أمامية ٢,٠ كيلومتر الساعة-١، وسرعة اسطوانة مسك البذور تبلغ ٢٤ لفة الدقيقة-١. تم الحصول على نسبة غياب للبذور "٠,٠٪"، نسبة إزدواجية البذور "٥,٠٪" وأعلى جودة للمعدل البذر "٩٥٪" عند سرعة أمامية ٢,٤ كيلومتر الساعة-١، وضغط شفط الهواء ٩,٠ كيلو باسكال وسرعة اسطوانة مسك البذور تبلغ ٢٢ لفة الدقيقة-١.