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CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

6. Conclusions

Based on the results of this study, the following conclusions could be summarized:

6.1 The Theoretical Analysis Conclusions

1- 1-The theoretical derived equations for calculating the variables affecting the vacuum pressure in the hole showed that:

- The values of the predicted vacuum discharge through the hole ranged from 1.8×10^{-5} m^3/s to 2.88×10^{-5} m^3/s for the seed plate of 1.0 mm hole diameter under different blower speeds.
- There was no change in the predicted vacuum velocity in the hole by changing the hole diameter. However, as expected, it was increased from 24.3 m/s to 38.4 m/s as the blower speed increased from 4000-rpm to 5500-rpm for the seed plate of 1.0 mm hole diameter.
- The predicted static pressure to hold seed against the force of gravity and the dynamic pressure corresponding to seed terminal velocity were 16.51 Pa. and 37.35 Pa, respectively. These values are in agreement with previous finding by Fallak el al., (1984).
- The predicted pressure difference across the hole does not increase by more than 963.2 Pa. under experimental conditions.
- The average value of the predicted pressure for picking-up the onion seed (3.1 kPa.) was resulted

at 4500-rpm blower speed using the seed plate of 1.0 mm hole diameter.

- The values of the static lift force due to the vacuum pressure difference and the contact force per unit length of contact values were close to zero, which means no reversed pressure difference might be deformed and there is no need to eject the seed mechanically (Fallak el al., 1984).
- The predicted vacuum pressure for holding the seed against the hole were 113.6, 71.6 and 49.7 Pa. for 0.8, 1.0 and 1.2 mm hole diameters, respectively.
- The average value of the predicted pressure in the hole (3.6 kPa.) was resulted at 4500-rpm blower speed using the seed plate of 1.0 mm hole diameter.

2- The relation between predicted and measured vacuum pressure in the hole at various levels of blower speeds using different hole diameters showed that, the final model could satisfactorily predict the vacuum pressure in the hole of a precision vacuum seeder for onion seeds with an efficiency of 0.98.

3- The model developed in the current study could be also used to predict the vacuum pressure in the hole for other vegetables seeds that have properties like onion seeds.

6.2 Actual Seed Spacing under Soil bin and Field Conditions

- The highest values of the actual seed spacing in the soil bin were obtained with the seed plate of 1.0 mm hole diameter, 4000-rpm blower speed, 0.08 m/s disc speed and 5.3 km/h forward speed for the two row.
- The closest values of the actual seed spacing in relation to the nominal seed spacing were resulted with the seed plate of 1.0 mm hole diameter, 4500-rpm blower speed,

0.21 m/s disc speed and 3.6 km/h forward speed for the two rows of developed prototype.

- Results of statistical analysis under soil bin condition showed that there was no appreciable difference between the two rows of the developed prototype under different operational conditions.
- The relationship between the actual seed spacing with the forward speed, disc speeds and blower speed using different hole diameters are given as the following:

$$ASS = a_0 + a_1 FS - a_2 BS - a_3 DS - a_4 FS*DS - a_5 FS^2 + a_6 DS^2 + a_7 BS^2$$

Where:

ASS = actual seed spacing, (cm)

FS = forward speed (km/h),

BS = blower speed (rpm),

DS = disc speeds (rpm), and

a_0 to a_7 = constants depending on hole diameters.

- Results of field tests in the actual seed spacing showed that the highest values were obtained at 5.3 km/h forward speed. However, the lowest values were obtained at 2.7 km/h forward speed for tow seeders.
- The closing value of the actual seed spacing under field conditions in relation to the nominal seed spacing were obtained for the developed prototype compared with Keverneland precision vacuum seeder at 3.6 km/h forward speed.
- The relation between the actual seed spacing resulted from soil bin tests with that from field tests for the developed prototype showed an agreement with R^2 = 0.74.

6.3 Seed Miss Index under Soil bin and Field Conditions

- The lowest values of the seed miss indices in the soil bin were obtained with the second row at 0.8 mm hole diameter, 5500-rpm blower speed, 7.3-rpm (0.08 m/s) disc speed and 3.6 km/h forward speed.

- Results of statistical analysis in the soil bin showed that there was no appreciable difference between the two rows of the developed prototype under different operational conditions.
- The relationship between the seed miss index with the forward speed, disc speeds and blower speed using different hole diameters under soil bin condition are given as the following:

$$MISS = a_0 + a_1 FS - a_2 DS - a_3 FS*DS - a_4 BS*DS - a_5 FS^2 + a_6 DS^2 + a_7 BS^2$$

  Where:

  MISS = seed miss index, (%),
  FS = forward speed (km/h),
  BS = blower speed (rpm),
  DS = disc speed (rpm), and
  a_0 to a_7 = constants depending on hole diameters.
- Results of field tests in the seed miss index showed that the lowest values were obtained at 3.6 km/h forward speed
- There is no difference between the two seeders in the seed miss index under different levels of forward speeds in the field.
- The relation between the seed miss index resulted from soil bin tests with that from field tests for the developed prototype showed an agreement with R^2 = 0.99.

6.4 Seed Multiple Index under Soil bin and Field Conditions

- The lowest values of the seed multiple indices in the soil bin were obtained at 1.0 mm hole diameter, 4000-rpm blower speed, 18.7-rpm (0.28 m/s) disc speed and 3.6 km/h forward speed.
- Results of statistical analysis showed that there was no appreciable difference between the two rows of the developed prototype in the soil bin under different operational conditions.

- The relationship between the seed multiple index in the soil bin with the forward speed, disc speeds and blower speed using different hole diameters are given as the following:

$$MULI = a_0 + a_1 FS - a_2 BS - a_3 DS - a_4\, FS*DS - a_5\, FS^2 + a_6\, DS^2 + a_7\, BS^2 + a_8\, FS*BS*DS$$

  Where:

  MULI = seed multiple index, (%),
  FS = forward speed (km/h),
  BS = blower speed (rpm), and
  DS = disc speed (rpm).
  a_0 to a_8 = constants depending on hole diameters.

- Results of field tests in the seed multiple index showed that the lowest values were obtained at 3.6 km/h forward speed.
- There is none potential difference in the seed multiple index between the tow seeders at 3.6 and 5.3 km/h forward speeds. However, the Keverneland precision vacuum seeder resulted in the highest value of the seed multiple index compared with the developed prototype at 2.7 km/h forward speed.
- The relation between the seed multiple index resulted from soil bin tests with that from field tests for the developed prototype showed an agreement with R^2 = 0.93.

6.5 Quality of Feed Index under Soil Bin and Field Conditions

- The highest values of the quality of feed indices in the soil bin were obtained at 1.0 mm hole diameter, 4500-rpm blower speed, and 3.6 km/h forward speed.
- Results of statistical analysis showed that there was no appreciable difference between the two rows of the developed prototype in the soil bin under different operational conditions.

- The relationship between the quality of feed index with the forward speed, disc speed and blower speed using different hole diameters are given as the following:

$$QUA = a_0 + a_1 FS - a_2 BS - a_3 DS - a_4 FS*BS - a_5 FS*DS - a_6 FS^2 + a_7 DS^2 + a_8 BS^2$$

Where:

QUA = quality of feed index (%),

FS = forward speed (km/h),

BS = blower speed (rpm),

DS = disk speeds (rpm),and

a_0 to a_8 = constants depending on hole diameters.

- Results of field tests in the quality of feed index showed that the highest values were obtained at 3.6 km/h forward speed for tow seeders.
- There was none potential difference in the quality of feed index between the tow seeders at 3.6 and 5.3 km/h forward speeds. However, the developed prototype resulted in the highest value of the quality of feed index in the soil bin as a compared with the Keverneland precision vacuum seeder at 2.7 km/h forward speed.
- The relation between the quality of feed index resulted from soil bin tests with that from field tests for the developed prototype showed an agreement with R^2 = 0.65.

6.6 Precision in Spacing under Soil bin and Field Conditions

- The lowest values of the precision in spacing in the soil bin were obtained at 1.0 mm hole diameter, 4500-rpm blower speed, 7.3-rpm (0.08 m/s) disc speed and 3.6 km/h forward speed.
- Results of statistical analysis showed that there was no appreciable difference between the two rows of the developed prototype under different operational conditions.

- Results of field tests in the precision in spacing showed that the lowest values were obtained at 3.6 km/h forward speed for tow seeders.
- There was none potential difference in the precision in spacing between tow seeders at 2.7 and 5.3 km/h forward speeds. However, at 3.6 km/h, the Keverneland precision vacuum seeder resulted in the highest value of precision in spacing in the field tests as a compared with the developed prototype.
- The relation between the precision in spacing resulted from soil bin tests with that from field tests for the developed prototype showed an agreement with R^2 = 0.71.

6.7 Seed Catching Efficiency under Soil bin Condition

- The highest values of the seed catching efficiency were resulted at 1.2 mm hole diameter, 5500-rpm blower speed, and 7.3-rpm (0.08 m/s) disc speed.
- Results of statistical analysis showed that there was no appreciable difference between the two rows of the developed prototype under different operational conditions.
- The relationship between the seed catching efficiency with the blower speed and disc speed using different hole diameters are given as the following:

  $SCE = a_0 + a_1 BS - a_2 BS^2 + a_3 DS - a_4 DS^2 + a_5 BS^2 DS - a_6 DS^2 BS$

  Where:

  SCE = seed catching efficiency (%),
  BS = blower speed (rpm), and
  DS = disc speed (rpm).
  a_0 to a_6 = constants depending on hole diameters.

6.8 The Vacuum Pressure under Soil bin Condition.

- The highest values in the vacuum pressure were obtained at 0.8 mm hole diameter and 5500-rpm blower speed.

- The relationship between the vacuum pressure in the hole with respect to blower speed and hole diameters are given as the following:

$$V = - 257 + 209 H + 0.0777 BS - 56.2 (H)^2 - 0.000003 (BS)^2 - 0.0297 (H*BS)$$

Where:

V = vacuum pressure (mbar),
BS = blower speed (rpm),
H = hole diameter (mm).

6.9 Longitudinal and Lateral Seed Distribution

- There is none potential difference in the uniformity of plants distribution around the centre line of the row for the two seeders.
- There is none potential change in the uniformity of plants distribution around the centre line as the forward speed increased from 2.7 to 5.3 km/h for the two seeders.
- The highest values in the elevation differences around the centre line of the row were obtained at 5.3 km/h forward speed for the two seeders.

6.10 Actual Field Capacity for the Two Seeders

- There is none potential difference in the actual field capacity between the two seeders under experimental conditions.
- The highest values in the actual field efficiency were obtained at 2.7 km/h forward speed.

6.11 Total Costs of Planting for the Two Precision Seeders

- Total price for the developed prototype decreased as a compared with the Keverneland precision vacuum seeder by about 48 %.
- The lowest values of the total costs resulted at 5.3 km/h forward speeds for the tow seeders.
- The Keverneland precision vacuum seeder gave the highest values of the total costs as a compared with the developed prototype at different levels of forward speeds.

7. Recommendations

The following are recommendations arising from the work presented in this study.

- Results of theoretical analysis to determine the vacuum pressure in the hole under this study showed that the average value of the predicted pressure in the hole for onion seeds equal 3.6 kPa. was resulted at 4500-rpm blower speed using the seed plate of 1.0 mm hole diameter.
- The model developed in the current study could be used to predict the vacuum pressure in the hole for other vegetables seeds that have properties like onion seeds (Giza 20).
- The soil bin results showed an agreement with the field results for all measurements under this study. This indicated that the data from soil bin tests could be considered as a good indicator for estimation of parameters under field conditions. This approach would avoid the need for field tests in develop and fabricate a precision vacuum seeders.
- Soil bin and field tests showed that the most favorable conditions in terms of operating developed precision vacuum seeder will be 0.21 m/s disc speed and at 4500-rpm blower speed with the seed plate of 1.0 mm hole diameter at 3.6 km/h forward speed for planting onion seeds under Egyptian conditions.
- Soil bin and field tests showed that there was no appreciable difference between the two rows of the developed prototype under different operational conditions.

8. Suggestions for Future Research

The following are suggestions for future research based on the results presented in this thesis:

- The developed model under this study could be used for other vegetables seeds like onion seeds.

However, there is still a need to develop other models for other vegetables, seeds which have different properties with onion seed.

- There is a strongly need of dsign and manufacure the whole componants of this machine for planting onion seeds on the commerecial scale using local materials.
- Investigate the capability of determine the performance of this kind of machine under different soil types is highly needed.
- The power requirements for this kind of machine should be investigated .