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Developed Equipment for Seed Coating of some Crops

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ABSTRACT

This study was carried out to design simple equipment for seed coating using mixture from organic and inorganic filler. The experiments were conducted at El-Serw agricultural research station – Damietta governorate – Egypt at season 2019. The coating equipment consists of main frame, spinning as coating unit, power source and power transmutation unit. Experiments were run with a small batch processing capability. Locally available mixture of soft compost and calcium peroxide were tried and tested for possible application as coating material at coating unit tilt angles (20, 40 and 60°); rotating speeds (40, 60, 80 and 100 rpm) and coating times (3, 6, 9 and 12 minutes). The evaluation included two types of seeds (radish and sugar beet). Results indicated that germination, duplicity, productivity, weight of 1000 coated seed, static coefficient of friction and repose angle were (82 and 85 %); (6.1 and 4.8 %); (6.9 and 9.5 kg/h.); (36 and 43 gram); (0.50, and 0.42); and (31 and 23°) at tilt angle of 40°, rotating speed of 80 rpm and 3 min. for radish and sugar beet, respectively. At field experiment with planting sugar beet it was needed about 2.0 – 2.5 kg/fed substitutional about 4 – 4.5 kg/fed in traditional method. That save about 50% amount of seeds.

Keywords: seed coating, soft compost, germination, duplicity.

INTRODUCTION

Seed coating or encapsulating is the process of applying materials that may obscure the original shape and size of the seed, resulting in a substantial weight increase and improved plant ability, deter insects, enhance seed handling characteristics, and improve germination and seedling establishment. This practice is used to modify the physical properties of seed (Avelar *et al*., 2012). The physical modification of seed aims to improve seed handling through standardization of seed weight and size (Halmer, 2008), reduce friction and improve flowability. Seed-coating technologies could be key to improving seedling establishment (Liu, 2010), plant growth (Madsen, 2012). Seed coating has long been used, especially for the seeds of vegetables, to increase seed size, improve seed shape and texture, facilitate direct sowing, and improves the contact between seeds and soil (Baudet and Peres, 2004; Levien *et al*., 2008).

In an alternating manner, powder is dusted and water sprayed onto seeds during the coating operation. Water was sprayed onto the seeds to activate the binder to adhere the pelleting materials to the seeds. Seed are sprayed many times in an enclosed chamber to build up an even film layer, or apply a coat of several layer (Black and Bewley 2000). In many cases, seed size is small or irregular, making singularization and precision placement difficult. In addition, seeds should be protected from a range of pests that attack germination seeds. The basic coating treatment is film coating, where a thin layer of external material (usually < 10% of seed weight) is applied. Where seed weight is increased up to 100–500% (depending on seed morphology), the procedure is described as 'encrusting', and is defined as such as long as the original shape of the seed is still evident (Halmer, 2000; and Gregg and Billups2010). Where the amount of external material makes it impossible to discriminate the initial seed shape (the result usually being a spherical shape), the process is named 'pelleting' (Taylor *et al*., 1998). While film coated and encrusted seed are discerned by weight, pellets are sorted by diameter. Film-coated seeds have better flow characteristics in the planter (Hill, 1997) due to reduced friction between seeds. Commercial coating formulations usually are blends of binders and fillers, formulated as dry powders (Halmer, 2000). Sugar beet is coming as one of the most important crops in Egypt whose cultivated area is about 257667 fed/year to produce about 19٫919 Mg /fed equal total yield 5132589 Mg / year (Agric. Statistical Year Book, 2018).

The coating may thus retard the germination rate and reduce the percentage of germination in comparison with the raw or noncoated seeds. Several previous studies have reported satisfactory effects of seed coating on seed germination, seedling growth, root and shoot growth, leaf area, dry biomass and increase in yield (Gevrek *et al*., 2012; Tavares *et al*., 2012; and Tavares *et al*., 2013). Pellet build-up is the ratio of filler material to seed, expressed on a weight basis. The inert material creates natural water holding media and provides small amount of nutrients to young seedlings (Scott 1989). The success of seed coating largely depends on an accurate selection of the coating material, which may influence seed germination (Pedrini 2017 and Yang *et al*., 2014). The friction of seeds tumbling on each other is responsible for the spherical shapes produced and acts to smooth the external pellet surface. The process is followed by size sorting with sieves, and then drying (Halmer, 2000). Film coating is routinely performed in vented or perforated pans on a large-scale

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basis either on a batch or continuous system. Capacities vary from 100 to 10 000 kg/h depending on seed type, and target weight gain. (Halmer, 1998 and Robani, 1994).

Franzin *et al*. (2004) found that germination of lettuce seed was inhibited after coating. Also, rice seeds coated with calcium peroxide have been reported to increase germination (Jeyanny*et al*., 2007). Studies have shown that the utilization of calcium peroxide were able to improve oxygen supply to seeds (Yamauchiand Chuong 1995). The formed film may act as a physical barrier, which has been reported to reduce leaching of inhibitors from seed coverings and may restrict oxygen diffusion to the embryo (Duan and Burris, 1997).In addition, seed coating improves plantability, reduces the percentage of skips and doubles, reduces the formation of dust from seed and minimizes the leaching of insecticide from treated seed (Avelar *et al*., 2012). Yehia (2008), design and study the factors affecting of the design coating machine for crop seeds. The maximum wheat-grain germination of 98.1 % was obtained with coating time of 30 min. Meanwhile, the minimum wheat-grain germination of 38.3 % was obtained with coating time of 60 min. The coated wheat-grain productivity increased 166 % by increasing coating-unit speed from 13 to 36 rpm. Meanwhile, the coated wheat-grain productivity increased 400 % by increasing grain-batch mass from 1 to 5 kg. There are several reviews on the materials and equipment for film coating and pelleting (Halmer, 2000; Hill, 1999; Robani, 1994; Taylor *et al*., 1998).

This study aims to design simple equipment for seed coating that can be done by the farmers themselves. Specifically, it aims to: (a) evaluate the feasibility of using mixture include soft compost for coating various types of seeds that improves the mechanical sowing, mechanical proprieties, increase germination, emergence, and growth responses of coated seeds.(b) evaluate the potential of seed coating as a strategy of maximizing (germination and coated-grain production);and minimizing (duplicity and operating costs).

MATERIALS AND METHODS

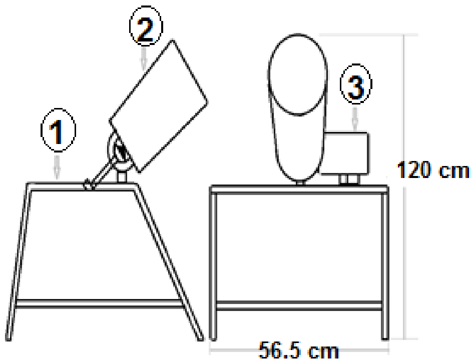
This study was performed at the Laboratory of Agricultural engineering, El-Serw Agricultural Research Station at season (2019) for coating seeds in a reasonable amount of time by constructing a seed coating equipment that effectively coats seed innutrient-rich organic matter such as mixture include dry powdered of soft compost to increase size and better uniformity.

Coating equipment characteristics:

The schematic diagram of the coating equipment is shown in Fig. 1. The main dimensions are [height 120 cm, width 56.5 cm and length 104 cm]. The designed coating equipment consists of main frame, rotating basin works as coating unit, power (electric motor) and power transmission system.

- The main frame is made of steel angle with dimensions of 4 x 4 x 0.4 cm, height of 76.5 cm, width of 56.5 cm and length of 70 cm, which welded and manufactured locally. It is used for supporting the operating parts of the equipment by means of braces or legs, which designed to support the ends of the equipment, at the upper portion of the main frame a rotating basin is fixed at the proper elevation as shown in Fig. 2.
- The rotating basin or coating unit, that causes an even distribution of coating material on the seeds has the rotary pan with cylindrical form and is journaled to revolve on the vertically disposed center. The dimensions of the cylindrical basin are as follow: the diameter of 25 cm and depth of 36 cm.
- An electric motor of 0.042 kW (1/16 hp) was used to rotate the coating machine by mains of a beveled gear which meshes with a beveled pinion rig idly secured to the bottom of coating unit for turning it in the direction of the arrow marked on Fig. 2.

Fig. 1. Photo of coating.



(1) frame, (2) coating unit, and (3) motor.

Fig. 2. Sketch of coating.

The basin adjusted for rotation upon a vertically disposed center at different inclination angles, which was adjusted as to inclination by means of adjustable spring attached to the T-lever and anchored at their outer ends on a portion of the main frame afford a resilient cushion for the oscillating movement of the lever and by their action tend to bring the lever to its normal position. The bottom of the rotating basin is perforated with a series of very small holes for discharge the excess sprayed water. The coated material is discharged by inclination of the coating unit. The motor spins a basin containing the seeds and coating materials while the operators periodically mist the contents with water in 30-second intervals. Use water sparingly to avoid over saturating the mix. If the mix gets too wet, large soggy clumps will form. The coating equipment was designed to be easily taken apart for storage or transport.

Seeds used: Radish (*Raphanussativus* L.) of a weight equal 250 gram and multi-germ sugar beet (*Beta vulgaris* L.) of a weight equal 250 gram represent small, and medium seeds, respectively were tested. The samples were manually cleaned to remove foreign matters such as; dust, dirt, broken and immature seeds. The weight of coated seeds were 6438 and 6124 gram for radish and sugar beet, respectively. Some physical properties of the tested seeds are shown in Table1.

Table 1. Some physical properties of radish and sugar beet seeds according to Gautam *et al.* 2016; Fawal *et al.* 2008; Kasap and Altuntas 2006.

Physical parameter	Radish	Sugar beet
Moisture content (%)	10.43	9.80
W of 1000 kernel, g	11.74	16.2
Bulk density, kg/m^3	600	148.70
Particle density, kg/m^3	1050	852
Porosity, %	47.78	57.3
Repose angle, degree	29°	21°
S.C.F., Galv. Steel	0.49	0.38
Germination, %	98	98

Coating materials: A filler mixture powder of soft compost and calcium peroxide were sieved and manually mixed. Filler powder was used as an inert material to regular seed shape and increase size of seeds.

Table 2. Chemical and physical properties of Coating materials.

Chemical properties: -	
pH	7.30
EC (dS m^{-1})	4.10
Total organic carbon (%)	16.60
Total organic matter (%)	28.60
Total nitrogen (%)	0.95
Total phosphorus (%)	0.31
Total potassium (%)	0.27
C/N ratio	17.47
Physical properties: -	
Bulk density (kg m^{-3})	655.00
Moisture content (%)	25.60
Water holding capacity (g water/g dry sample)	3.50
Porosity (%)	60.69

Experimental procedure:

During preliminary trials, it was clear that rotating speeds must range from 40 to 100 rpm, which suitable for the seeds under tested. That because the lowest levels of speeds are causes uncompleted rotation and seeds still at the bottom of spin basin without coating. On the other sides the highest levels of speeds cause a high centrifuge force, the seeds and coating component to the basin wall without any coating action.

The mixture of filler was spread inside the rotated basin (coating unit). The seeds batch was spread inside the rotating coating basin. Water mist was sprayed onto the seeds using a hand-held mist sprayer and the mixed coating materials in powder form was added alternately, while rotating the basin to ensure uniform coating. The seeds are exit from coating basin and spread in the air to dry. The coating seeds were dried at room temperature 15-30 ^{0}C (Yamauchi and Chuong 1995) for 48 h to allow the hardening of the coating material to the seed in case of storing or can be sown directly.

When coated seeds are sown and irrigated, the oxygen derived from calcium peroxide is believed to supply sufficient oxygen for germination and seedling emergence as follows:

$$2CaO + 2H_2O \rightarrow 2C_a(OH)_2 + O_2$$

$$C_a(OH)_2 + CO_{2\rightarrow} C_aCO_3 + H_2O$$

Treatments variables: Three kinds of seeds (radish and sugar beet); three degrees of tilt angles (20, 40 and 60^0); four rotating speeds (40, 60, 80 and 100 rpm) and four operating times (3, 6, 9 and 12 minutes) were evaluated.

Measurements: Seed germination, duplicity, machine productivity, weight of 1000 coated seed, static coefficient of friction, repose angle and machine cost

Laboratory tests:

Seed germination after with and without coating were examined under laboratory conditions. A hundred seed were randomly selected and sown in sand trays. The trays were moistened with water and kept saturated throughout the germination period. The number of normal seedlings was recorded and germination percentage was calculated. A batch of uncoated seeds was included as control. Four replicates were planted with a hundred seed each according to (ISTA, 2007).

Percentage of duplicity was determined by counting the number of coated seeds comparing to added seeds.

The productivity of the coating equipment was obtained using seed-batch mass of 1.0 kg of each type of seed. It was determined with the help of a digital stopwatch of 0.1-sec accuracy and an electrical balance of (0.01g) accuracy. Equipment productivity was calculated as follows:

$$P = \frac{W_{out}}{t}, kg/h$$

Where: W_{out} = mass of output coated seeds, kg. and t = time of test duration (h).

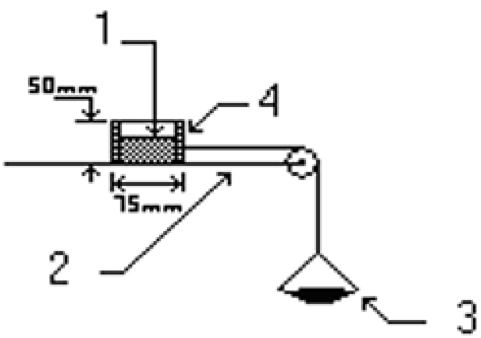
The mass (M) of the individual seeds was determined in gram by using an electric digital balance with an accuracy of 0.0001g. The measurement was replicated for 100 seeds, which, were taken randomly. Thousand seeds were measured by counting 100 seed and weighting them and then multiplied by 10 to give mass of 1000 seeds.

The static coefficient of friction (angle of external friction): A cylinder of 75 mm diameter and 50 mm height filled with samples. Friction coefficient was measured by method shown in Fig. (3) on galvanized steel. Fine sand was added gradually to the mass, which makes cylinder start to move on horizontal plain with a regular movement. The friction coefficient (*f*) was determined from the following equation: -

$$f = Q/P$$

Where: Q= mass of sand, g and P= mass of block, g
***f* seeds= *f* cylinder with seeds– *f* cylinder**

The friction coefficient of seeds was the average of four replicates.



1- Seeds. 2-Friction surface 3-Added sand 4-Cylinder

Fig. 3. Friction coefficient of seeds

Repose angle (angle of internal friction): - It is the angle (θ) between the inclined side of the feeding cone and its horizontal base due to the free fall of seeds through it (Fig. 4). The seeds were poured under gravity from a suitable height to form a cone at same spot. More seeds were let to be fallen on the top of the formed cone. The angle was recorded to represent repose angle of seeds. Assuming that the horizontal base length of the cone (x) and the cone height (L), then the repose angle can be calculated using the following simple relations: -

$$\theta = \tan^{-1} \frac{L}{0.5X}$$

The recorded angle was the average of five replicates.

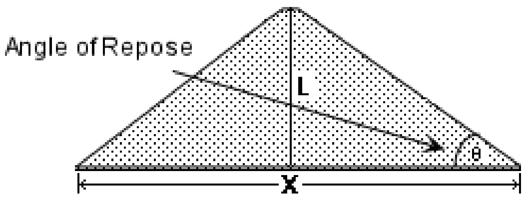


Fig. 4. Repose angle of seeds

Field experiment: Through manual sowing**,** a field trial with coated sugar beet seeds was carried out to determine coated seeds amount needed for the unit area (one feddan) comparing to un-coated seeds.

Statistical analysis: Treatment effects were analyzed using analysis of variance and means.

RESULTS AND DISCUSSION

Effect of studied variables on germination, %:

Figure 5 shows the effect of seed type, tilt angle, rotating speed, and operating time on germination, %. The highest mean germination was 92.31±0.11 % for sugar beet and the lowest was 90.93±0.15 % for radish seeds. There is an increment in germination, % when decreasing time, due to the less coating layer formed by time around seeds. The mean germination, % increases from 90.12±1.15 % after 12 minutes to 93.2±1.21 % after 3 minutes. The mean germination, % increases from 87.09±1.45 % at a tilt angle of 40° to 95.46±0.95 % at a tilt angle of 20°, because, at a tilt angle of 20°, there isn't sufficient coating, while the optimum coating was at a tilt angle of 40° and after that the formation process started to decrease and consequently the germination increase. Because of the higher centrifugal force at the higher speeds and consequently un-completed coated or formation process at lower and higher levels of speeds, the mean germination, % decreases from 93.95±1.06 % at rotating speed of 40 rpm to 87.75±1.50 % at rotating speed of 80 rpm and started to increase by increasing speed up to 93.79±1.86 % at rotating speed of 100 rpm. The seed type, tilt angle, rotating speed, and operating time had highly significant effect on germination, % (P< 0.01). It was noticed that germination, % increased with seed type, tilt angle, rotating speed, and operating time, according to the descending order (radish<sugar beet); (40º < 60º < 20º); (80 < 60 < 100 < 40 rpm); and (12 < 9< 6 < 3 minutes), respectively.

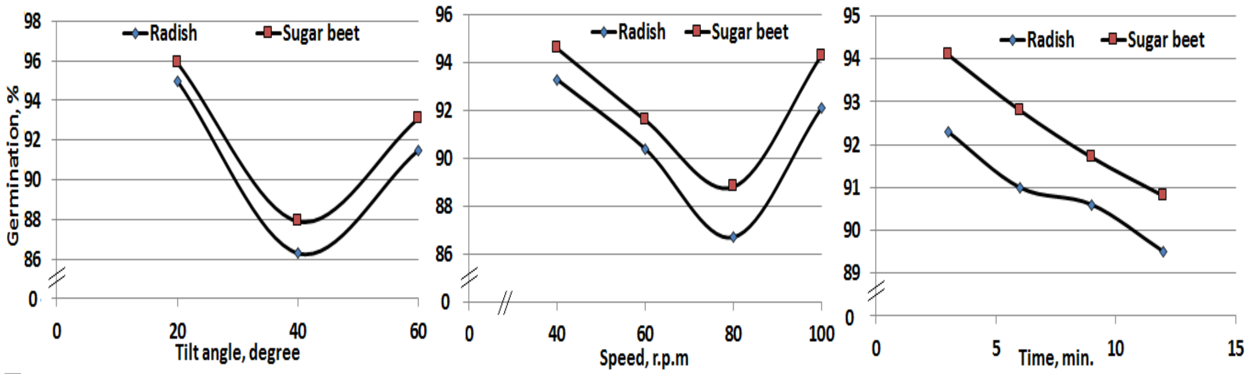


Fig. 5. Effect of seed type, tilt angle, rotating speed, and operating time on germination, %

Effect of studied variables on duplicity, %:

Figure 6 shows the effect of seed type, tilt angle, rotating speed, and operating time on duplicity, %. The lowest mean duplicity was 7.45±0.26 % for sugar beet seeds and the highest was 9.06±1.40 % for radish seeds, because the sugar beet seeds is larger than radish and consequently the chance of duplicity increase with fine seeds. There is decrement in duplicity, % when decreasing time, due to the less period and consequently the less chance for seeds to cohesion with each other. The mean duplicity, % decreases from about 6.9±1.46 % after 12 minutes to about 2.2±0.70 % after 3 minutes. The mean duplicity, % decreases from 6.2±0.45 % at a tilt angle of 40° to 2.8±0.95 % at a tilt angle of 20°, because, at a tilt angle of 20 and 60°, there was uncompleted rotation, so seeds and coating material still at the base of coating basin. The mean duplicity, % increases from 0.4±0.02% at rotating speed of 40 rpm to 11.1±1.25 % at rotating speed of 80 rpm and started to decrease by increasing speed up to 1.8±1.96 % at rotating speed of 100 rpm, because of the higher centrifugal force at the higher speeds and consequently un-completed coated or formation process at lower and higher levels of speeds. All variables had highly significant effect on duplicity, % (P< 0.01). It was noticed that duplicity, % decreased with seed type, tilt angle, rotating speed, and operating time, according to the descending order (radish < sugar beet); (40º < 60º < 20º); (80 < 60 < 100 < 40r.p.m); and (12 < 9 < 6 < 3 minutes), respectively.

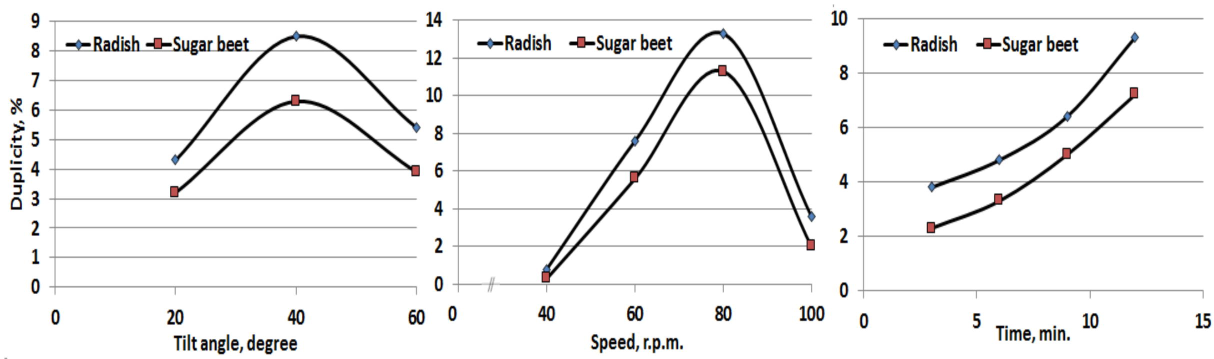


Fig. 6. Effect of seed type, operating time, tilt angle and rotating speed on duplicity, %

Effect of seed type, tilt angle and rotating speed on productivity, kg/h:

Figure 7 shows the effect of seed type, tilt angle, and rotating speed on productivity, kg/h. The highest mean productivity was 7.98±2.02kg/h. for sugar beet seeds and the lowest was 5.8±0.47 kg/h. for radish seeds, because the weight of sugar beet seeds is higher than radish seeds. The mean productivity increases from 6.55±1.48kg/h. at a tilt angle of 20° to 7.5±1.67kg/h. at a tilt angle of 40°, while it was 6.65±1.48kg/h. at a tilt angle of 60°. The mean productivity, % increases from 4.35±0.92kg/h. at rotating speed of 40 rpm to 8.6±1.98kg/h. at rotating speed of 100 rpm. The seed type, tilt angle and rotating speed had highly significant effect on productivity (P< 0.01). It was noticed that productivity, kg/h. increased with seed type, tilt angles and rotating speeds, according to the descending order (radish < sugar beet); (20º < 60º <40º); and (40 < 60 <80 <100r.p.m), respectively.

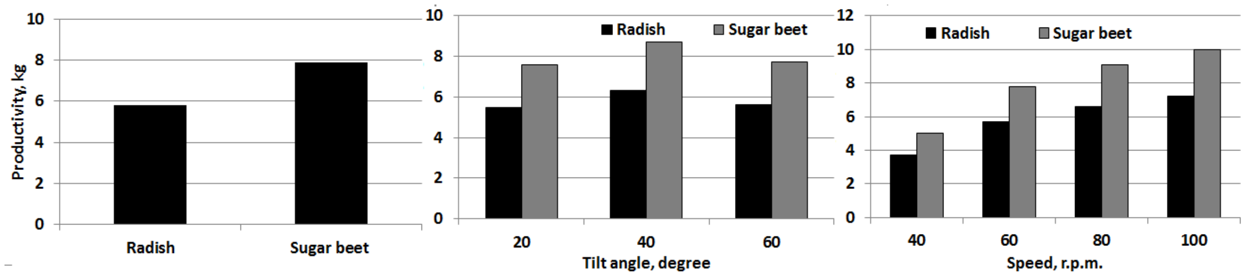


Fig. 7. Effect of seed type, tilt angle and rotating speed on productivity, kg/h.

Effect of studied variables on weight of 1000 coated seed, g.

Figure 8 shows the effect of seed type, tilt angle, rotating speed, and operating time on weight of 1000 coated seed, g. The mean weight of 1000 coated seed, g. increased from 22±1.5, 30±1.2 and 471±15 gram to 56±1.5, 85±1.9 and 633±12 gram by increasing time from 3 to 12 min. for radish, sugar beet, respectively. The maximum mean weight of 1000 coated seed, g. was 45±1.7, 62±2.2 and 592±9.8 g. at a tilt angle of 40° for radish, sugar beet, respectively. The minimum mean weight of 1000 coated seed, g. was 33±1.4, 46±2.1 and 518±9.1 g. at a tilt angle of 20°, while it were 38±1.5, 54±2.3 and 555±9.1 g. at a tilt angle of 60° for radish, sugar beet, respectively, due to the un-completed coating process at atilt angle of 20 and 60°. The mean weight of 1000 coated seed, g. were increased from (28±0.4, 44±1.2 and 457±8.8 g) to (47±1.4, 63±2.2 and 634±11.8 g.) by increasing rotating speed from 40 to 80 rpm and started to decrease to (44±1.1, 56±1.2 and 578±10.8 g) at a rotating speed of 100 rpm for radish, sugar beet, respectively, because of the higher centrifugal force at the higher speeds and consequently un-completed coating or formation process. Also, at lower levels of speeds, there was un-completed coating or formation process. All variables had highly significant effect on weight of 1000 coated seed, g (P< 0.01). It was noticed that the mean weight of 1000 coated seed, g. increased with operating times, tilt angles and rotating speeds, according to the descending order (3 < 6 < 9 < 12 minutes); (20º < 60º < 40º); and (40 < 60 < 100 < 80 rpm), respectively.

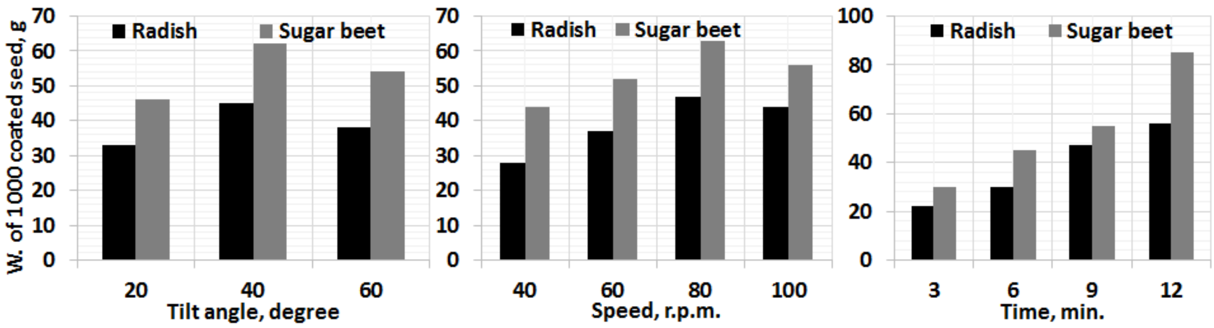


Fig. 8. Effect of seed type, operating time, tilt angle and rotating speed on weight of 1000 coated seed, g.

Effect of studied variables on static coefficient of friction and repose angle.

Tables from 3 to 5 illustrated the effect of seed type, operating time, tilt angle and rotating speed on static coefficient of friction and repose angle. The mean static coefficient of friction and repose angle were increased from (0.51and 32°) and (0.44 and 23°) to (0.53 and 34°) and (0.47 and 25°) by increasing operating time from 3 to 12 min. for radish and sugar beet, respectively. The maximum mean values of static coefficient of friction and repose angle was (0.53 and 0.49); and (34 and 25°) at a tilt angle of 60°, while the minimum mean values were (0.51, and 0.42); and (32 and 22°) at a tilt angle of 40° for radish and sugar beet, respectively. The maximum mean values of static coefficient of friction and repose angle was (0.55 and 0.49); and (37, and 27°) at a rotating speed of 40 rpm, while the minimum mean values were (0.51 and 0.42); and (31 and 22°) at a rotating speed of 80 rpm for radish, sugar beet, respectively. The seed type, tilt angle and rotating speed had highly significant effect on static coefficient of friction and repose angle ($P < 0.01$).

Table 3. The static coefficient of friction and repose angle at different levels of operating times.

Time, min.	Repose angle, degree			
	Radish	Sugar beet	Radish	Sugar beet
3	0.53	0.47	34	25
6	0.53	0.46	34	25
9	0.51	0.45	33	23
12	0.51	0.44	32	23

Table 4. The static coefficient of friction and repose angle at different levels of tilt angle.

Tilt angle, degree	Repose angle, degree			
	Radish	Sugar beet	Radish	Sugar beet
20	0.53	0.45	34	25
40	0.51	0.42	32	22
60	0.53	0.49	34	25

Table 5. The static coefficient of friction and repose angle at different levels of speeds.

Speed, rpm	Repose angle, degree			
	Radish	Sugar beet	Radish	Sugar beet
40	0.55	0.49	37	27
60	0.52	0.46	33	24
80	0.51	0.42	31	22
100	0.53	0.45	34	24

CONCLUSION

The optimum conditions of coating equipment were: exposure time of 3 minutes, rotating speed of 80 rpm and tilt angle of 40°. The results obtained at optimum conditions were: germination, duplicity, productivity, weight of 1000 coated seed, static coefficient of friction, repose angle and machine cost were (82 and 85 %); (6.1 and 4.8 %); (6.9 and 9.5 kg/h.); (36 and 43 g); (0.50 and 0.42); and (31 and 23°) for radish, sugar beet, respectively. There is a need to conduct follow up experiments in a wider scale to further validate the results of the study. Moreover, the conduct of follow up trials in the field is recommended to evaluate the performance of the technology, in comparison with the existing farmers' practice, under actual field conditions.

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تطوير معدة لتغليف بذور بعض المحاصيل

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تم إجراء هذه الدراسة بهدف تغليف بذور بعض المحاصيل بمواد عضوية ومواد غير عضوية وذلك لتحسين خصائص الاستدارة وزيادة الحجم والوزن للبذور الصغيرة والخفيفة، مما يسهل الزراعة آلياً ويخفض تأثرها بالماء والرياح بعد عملية الزراعة. كذلك يعمل على توفير كمية التقاوي خاصة للبذور التي يتم استيرادها من الخارج بالعملة الصعبة مثل بذور بنجر السكر. وقد تم إجراء التجارب في محطة البحوث الزراعية بالسرو – دمياط سنة (٢٠١٩) على معدة تغليف مكونه من هيكل رئيسي وحوض دوار يعمل كوحدة للتغليف ومصدر للقدرة ونقل الحركة. تم اجراء التجربة علي دفعات صغيرة استخدم فيها خليط من بيروكسيد الكالسيوم والكومبوست الناعم. تم اختبار إمكانية استخدام الخليط كمادة مغلفة عند زوايا إمالة لوحدة التغليف ٢٠، ٤٠، ٦٠° وسرعات ٤٠، ٦٠، ٨٠، ١٠٠ لفة/دقيقة و أزمنة تغليف وهي ٣، ٦، ٩، ١٢ دقيقة، لتغليف بذور الفجل والبنجر.وكانت النتائج كالتالي: نسبة الإنبات (٨٢، ٨٥ %)، والازدواجية للبذور (٦,١، ٤,٨ %)، الإنتاجية (٦,٩، ٩,٥ كجم/ساعة)، وزن ١٠٠٠ بذرة مغلفة (٣٦، ٤٣ جرام)، ومعامل الاحتكاك الداخلي للبذور (٠,٥٠، ٠,٤٢)، ومعامل الاحتكاك الخارجي (٣١، ٢٣°) عند زاوية ميل ٤٠° وسرعة ٨٠ لفة/دقيقة وزمن تغليف ٣ دقائق لكل من بذور الفجل وبنجر السكر علي الترتيب. ولتقدير كفاءة التغليف تم إجراء تجربة حقلية على بذور بنجر السكر حيث وجد أن الفدان الواحد يحتاج من ٢,٠ – ٢,٥ كيلوجرام تشمل عملية الترقيع فى حين يحتاج الفدان عند زراعة البذور بدون تغليف إلى حوالى ٤ كجم بما يوفر تقريباً نصف كمية التقاوي. وتوصي الدراسة بتطبيق نتائج البحث علي تغليف بذور بنجر السكر أحادي الأجنة حيث توصي الدراسات الحديثة بإستخدام هذا النوع من البذور.