DEVELOPMENT OF A PORTABLE PNEUMATIC GRAIN BROADCASTING UNIT

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ABSTRACT

The present research was carried out in El-Sharkia Governorate, El-Sowa Village in 2014 season to develop and evaluate a portable pneumatic grain broadcasting unit under Egyptian conditions in clay soil. The study included three fan peripheral speeds of 1.7, 1.97 and 2.18 m/s with three grain path lengths of 50, 100 and 200 mm from air outlet under two types of dry and germinated grains. These parameters were evaluated with horizontal and vertical fan comparing to manual broadcasting on rice grains (Giza 178). Broadcasting width, coefficient of variance (CV), coefficient of distribution uniformity, consumed energy according to power requirements and total costs were determined under split-split plot design with three replicates for all treatments. The obtained results showed that fan peripheral speed of 2.18 m/s and outlet path length of 100 mm with horizontal fan gave the best results for all tests. The highest broadcasting widths of 10.2 and 8.8 m were obtained under horizontal fan with dry and germinated grains, respectively. The least values for CV were under fan peripheral speed of 2.18 m/s and 100 mm outlet path length. CV values were 20.22, 18.25, 17.33 and 22.21, 21.15, 19.10 under fan peripheral speed of 1.7, 1.97 and 2.18 m/s with 100 mm outlet path length for dry grains with horizontal and vertical fan positions, comparing to 47.50 for manual broadcasting. While the highest values of C.U. were 79.78, 81.75, 82.67 and 77.79, 78.85, 80.90 obtained at the same previous conditions. For germinated grains, CV values were 25.23, 21.12, 19.11 and 27.23, 25.15, 21.45 for horizontal and vertical fan, respectively comparing to 49.71 for manual broadcasting under the same fan peripheral speeds and outlet path length. The highest values of C.U. are 74.77, 78.88, 80.89 and 72.77, 74.85, 78.55 obtained at the same previous conditions. Consumed energy values were 0.56 and 0.87 kWh/fed, for dry and germinated grains, respectively. The broadcasting costs were 10.60 and 13.85 LE/fed for dry and germinated grains, respectively comparing to 20 LE/fed with the traditional method.

Key words: *broadcasting, distribution, peripheral speed, air velocity*

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INTRODUCTION

The cultivated area of rice is about 1.363 million feddans that produced about 4.79 million tons' paddy rice. Because of fragmented areas, most farmers use the manual method to broadcast grains in their fields, which give bad distribution uniformity. Mechanical rice planting is very important in saving hand labor, improving production, allowing further mechanization and decreasing production costs. **Helmy et al. (2000)** concluded that the grain yield of rice crop variety Giza 181, by using the mechanical drilling in dry condition, gave the lowest cost (87.5 L.E./Mg) and highest net profit (412.5 L.E./Mg). **Kamel et al. (2002)** indicated that there are significant differences in the amount skewing, coefficient of variation and minimum and maximum points in the overlapped pattern of resulting from choice of methods. Using blades with curved C- shaped, the coefficient of variation was varied from about 51.05 to 38.04 % for spinner speed of 540 rpm and -10 blade angle degrees without wind protection. Using spiral curved shaped blades; the coefficient of variation was varied from 42.70 to 32.93 % at the same conditions. **Kishta and Eliwa (2005)** developed and evaluated a portable grain and fertilizers spreader. They found that the highest uniformity coefficient of distribution of 95.80 % is noticed at beater speed of 500 rpm when using the electrical device in the wheat field. Increasing total required time 1.2 h/fed by manual device (fertilizer) caused to continuous decreasing in effective field capacity. The highest field efficiency of 61.60 % and the lowest operational cost of 1.57 LE/fed are achieved at a better speed of 500 rpm using electrical spreader in the wheat field. **Morad *et al.* (2005)** reported that the optimum distribution pattern and high degree of fertilizer uniformity can be achieved under the following conditions: Linear speed of about 10.5 m/s, (500 rpm), blade angle of +15 deg forward, (0.26 rad), dip angle of 0 deg (0 rad), gate opening of 16.63 cm^2 and machine forward speed of about 6 km/h. **Abo El-Naga (2006)** found that the best uniformity of grain distribution obtained by using developed distributor unit at diameter of pipe 5.08 cm and air stream velocities of 12.5 and 17.75 m/s. Best uniformity of grain distribution obtained by using developed distributor at pipe diameter of 3.81 cm and air stream velocities of 12.5 and 17.75 m/s. Increasing of air stream velocity increased grain discharge for all varieties of small grains at steady gate out area 4.28 cm^2. **Khoshtaghaza and Mehdizadeh (2006)** showed that by increasing mass of the kernel from 0.02 to 0.05 g and moisture content from 7 to 20 % (w.b.), its terminal velocity increased linearly from 7.04 to 7.74 m/s and 6.81 to 8.63 m/s, respectively. **Alireza and Sheikhdavoodi (2012)** stated that the uniformity and accuracy of seed broadcasting on field surface is significant parameter of broadcaster performance and improper and inaccurate broadcasting causes abnormal and nonhomogeneous soil fertility which is against to the purposes of sustainable agriculture. Also, broadcasters are used for planting seeds like wheat, barley etc., so it's appropriate performance effect on crop production.

Aerodynamic properties such as the terminal velocities of agricultural products are important and required for the design of air conveying systems and the separation equipment. Physical properties such as density, shape and size, etc. need to be known for calculating the terminal velocity and drag coefficient for separating the desirable products from unwanted materials. As a result, aerodynamic properties such as terminal velocity and drag coefficient are needed for air conveying and pneumatic separation of materials **(Gupta et al., 2007). Gharekhani et al. (2013)** mentioned that the terminal velocity of paddy and white rice increased linearly with an increase in moisture content from 5 to 37% (w.b.). The drag coefficient of white rice decreased linearly while for paddies the two varieties showed a quadratic trend with moisture content increase. Generally, the use of tractor with ordinary attached broadcasting machines could be compact the soil layers due to its heavy weight. Therefore, the object of this research is to manufacture and evaluate a broadcasting unit to give the best uniformity of grains distribution, the high field capacity and efficiency, save total cost requirements and also reduce soil compaction to the minimum values.

MATERIALS AND METHODS

Field experiments were carried out at private farm at El-Sowa Village, El-Sharkia Governorate, to develop and evaluate a portable pneumatic grain-broadcasting unit during 2014 season. The experimental tests done in

Soil Dept., Faculty of Agric., Zagazig University at clay soil texture. Soil specifications are presented in table 1.

Table 1: Soil physical analysis: -

Soil composition%				Soil texture
Clay, %	Silt, %	Sand, %		
		Coarse	Fine	
48	20	5.2	26.8	Clay

Test factors:

The used grains: The paddy grains, which were selected for this research, was a commercial variety of paddy grains, Giza 178 and were obtained from Al-Serw Agric. Res. Station, Agric. Res. Center, Egypt. The grains were cleaned manually to remove all foreign matters, broken and immature grains. The initial grain moisture content was determined using a pre-calibrated moisture meter (Wile 35). All the physical properties were assessed at the moisture content of 12.2% (wet basis).

To determine the angle of repose of the paddy grains, a plastic tube with 110 mm diameter and 120 mm height was kept vertically on a horizontal floor and filled with the sample from a height of 150 mm. The tube was slowly raised over the glass floor so that whole material could slide and form a heap. The angle of repose was calculated using the following equation (Jha ,1999):

$$\theta = tan^{-1}\left(\frac{2H}{D}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (1)$$

Where, θ is the angle of repose in degrees, H and D are the height and diameter of the heap in mm, respectively.

The modified paddy grain portable unit was evaluated for broadcasting 60 kg/fed of dry and germinated paddy grains in clay soil after puddling process (leveling in water). The physical properties of the paddy grains are tabulated in Table (2).

Table (2): Physical properties of paddy grains

Grains (paddy) Form	Bulk density, (g/cm^3)	Moisture content, (%)	Angle of repose, (deg.)	Coefficient of friction with plastic	Diameter range, (mm
Dry	0.545	12.2	44±0.28	0.54±0.41	2-4±0.34
Germinated	0.684	19.5	52±0.28	0.61±0.41	2-4±0.34

The developed portable unit construction

Specifications of The developed portable unit Fig. 1 are shown in Table 3.

Fig. 1. The developed portable unit

Table 3: Specifications of The developed portable unit

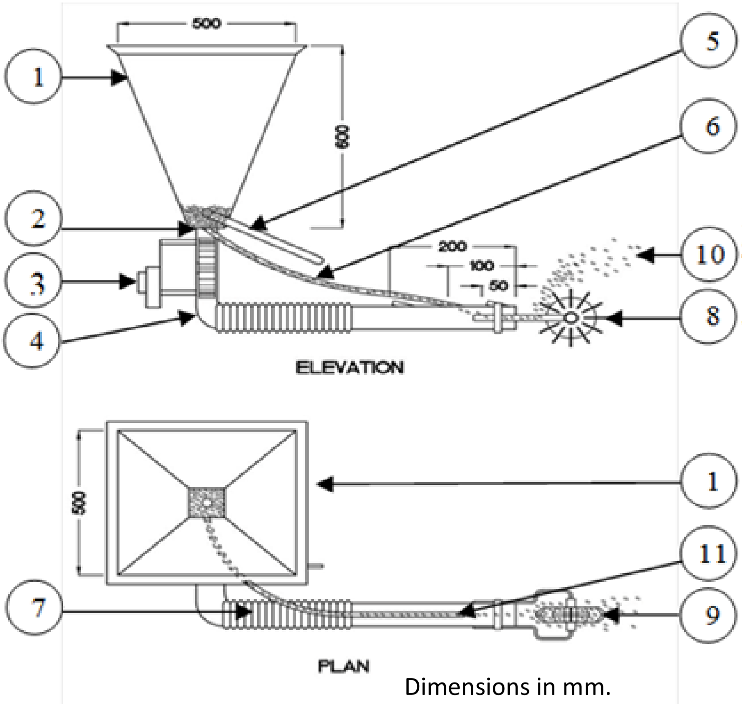
Item	Specifications	Item	Specifications
Engine	2 strokes, air cooling, single cylinder, gasoline	Air flow (m³/h)	640
Cylinder Volume (cc)	70	Air velocity (m/sec.)	100
Rotation (rpm)	6000	Fuel cons.(L/h)	4.25
Power (kW)	3.68	Fuel tank (L.)	1.8
Mass net (kg)	15.5	Tank capacity (L.)	20

The developed portable unit consists mainly of the grain hopper, broadcasting device and power system. The specifications of each part could be discussed as follows:

Grain hopper

The developed portable unit (Fig. 2) has a quadrilateral steel hopper (1), 0.5 mm thickness with dimensions of 600 mm height and 500 mm upper width with 100 mm bottom width at approximately volume of 0.062 m^3. A 30 mm outlet diameter was adjusted for rice grain flow. At the bottom outlet of the hopper there is an outlet grain gate with area of 5.069 cm^2 (2); controlled by the outlet grain controller (5), and a plastic grain hose (6) of about 30 mm diameter and 500 mm length.

The grain hose is connected to the end of the air duct tube (4) at individually three different holes of 50, 100 and 200 mm to be tested under treatments as the outlet path length [the point where air duct and grains are facing before leaving the tube end and hit the spreader fan (8)].



1- Hopper; 2- Grain gate; 3- Engine and pump; 4- Air duct tube; 5- Gate control; 6- Grain tube; 7- Flexible hose; 8- Spreader fan (horizontal position) 9- Spreader fan;10- Broadcasting grains; 11- Grain inlet hole

Fig. 2: A schematic diagram of The developed portable unit

Broadcasting device

The developed unit has a plastic spreader fan (Fig. 3) with maximum diameter of 130 mm and maximum height of 40 mm with 12 vertical hexagonal vanes. Each vane is 40 mm height; 40 mm width with 1.0 mm thickness. The vanes angle was adjusted at zero deg. according to (**Morad**

***et al.* 2005**). The broadcasting device is rotating depending on the air ducted from the engine pump through the air duct tube.

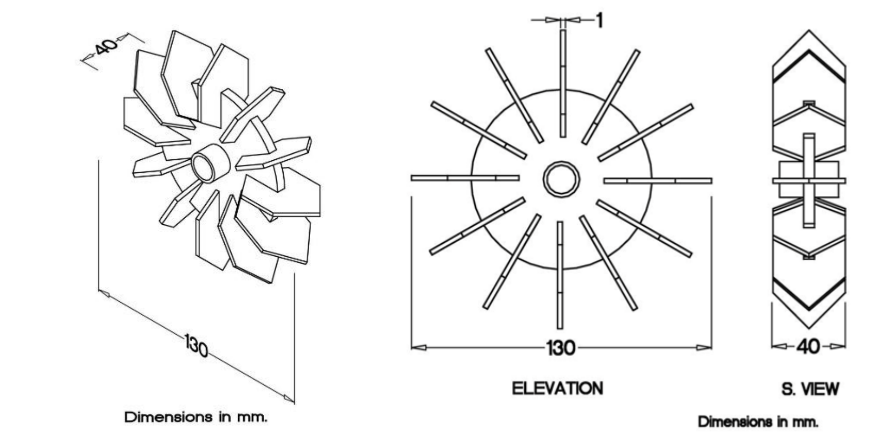


Fig. 3: Plastic spreader fan

Power system

As in Fig. 3, The engine (3) of about 3. 68 kW transmits the power to an inertial aluminum pump which blasts air that broadcasting grains through blowing air.

Test factors: The study included;

- three spreader fan rotational speeds of 250, 290 and 320 rpm represents fan peripheral speeds of 1.7 m/s, 1.97 and 2.18 m/s, respectively according to three air velocities of 50, 75 and 90 m/s, respectively.
- three grain path lengths of 50, 100 and 200 mm from air outlet were pinpointed by making three circular holes on the air duct tube before the end of the grain outlet path. Two of the three holes must be closed while using the third one in each treatment to prevent air leakage.
- two grain states (dry and germinated) in dry and muddy soil, respectively.
- two spreader fan positions of horizontal and vertical comparing to the manual broadcasting.
- Field trials were carried out to estimate the operator speed (ground speed) and was supposed to be steady at 2.4 km/h (0.67 m/s) according to operator motion in mud.

Note: It is advisable to pay attention that, this measurement was carried out depending on steady-hand operator (without moving from left to right and without twisting) to pinpoint the broadcasting centerline and measure the broadcasting width accurately depending only on spreader fan distribution. Also, field capacity was estimated according to time consumed and also timed consumed as re-filling the hopper with grains three times/fed with dry grains and four times with germinated grains.

INSTRUMENTATION

- **Speedometer:** Speedometer laser technique was used for measuring the broadcasting fan.
- **Graduated flask:** One liter graduated flask with accuracy of 0.01 cm^3 was used to measure grains bulk density.
- **Moisture content caliper:** A Wile 35 Moisture meter was used for measuring grains moisture content (wet basis) before broadcasting grains.
- **Electronic balance:** An electronic balance was used for weighing grains while filling grain hopper before broadcasting grains with accuracy of 0.5 g.
- **Wooden frame:** A square wooden frame of 1.0 m^2 with 50 mm height was constructed. The frame bottom was covered by a plastic sheet for gathering the broadcasted grains during laboratory tests.

During all experiments, the average wind speed was about 2.1 km/h (0.69 m/s) and the air temperature varied from 22 to 28 ^oC. After each treatment, the materials from each sheet was put in small sacs and weighted to calculate the coefficient of variation and coefficient of uniformity. Accordingly, grain germination and damage were tested in vitro and were found to be neglected as there was no effect while using the modified grains portable unit.

Experimental Procedures

In split-split plot design, an experimental area of about 2.0 feddans were divided into two main plots represent the grain status (dry and germinated grains) and each of them was divided into three sup plots according to the used broadcasting system (horizontal or vertical spreader fan position and manual broadcasting). Two of sup plots were divided into three sup-sup plots according to spreader fan peripheral speeds. The experimental treatments were carried out after the soil tillage and irrigation then puddling (leveling in water) and were replicated three times. The outlet grain gate was adjusted for the two broadcasting systems at 60 kg/fed.

MEASUREMENTS

A - Broadcasting width

The distribution uniformity pattern (includes the coefficient of variation and coefficient of uniformity) indicates the degree of grains uniformity distribution in terms of coefficient of variation and symmetry.

To evaluate of the distribution pattern and unit performance was carried out using collection sheets having dimensions of 1.0×1.0 m.

- Coefficient of Variation (CV)

According to **Coates (1992),** the standard deviation (δ) and coefficient of variation (CV) are determined as follows:

$$\delta = \sqrt{\frac{\sum (x_i - x_a)^2}{n-1}} \quad \text{..............................(2)}$$

Where:

x_i = The individual reading.

x_a = Mean reading = $\sum \frac{x_i}{n}$

n = Number of readings.

$$C.V. = \frac{\delta}{x_a} x100 \quad \text{.....................................(3)}$$

- Coefficient of uniformity (CU)

The coefficient of distribution uniformity is calculated by the following equation, (**Dragos, 1975**):

$$C.U. = 1 - CV \quad \text{..(4)}$$

B- Energy requirements

The following formula was used to estimate power consumption **(Hunt, 1983)**:

$$P = \frac{FC \ x \ \rho.f \ x \ LCV \ x \ 427 \ x \ \eta_{th} \ x \ \eta_{mec}}{3600 \ x \ 75 \ x \ 1.36} kW \quad \text{....................(5)}$$

Where:

FC= fuel consumption, L/h,

$\rho.f$= density of fuel, kg / L (for diesel = 0.85),
L.C.V= calorific value of fuel (10000 kcal / kg),
427= thermo-mechanical equivalent, J / kcal,
η_{th}= thermal efficiency of engine (≈ 35% for diesel engines) and
η_{mec}= mechanical efficiency of engine (≈80%).

The specific energy calculated by using the following equation

$$Specific\ energy\ (kW.h/\ fed) = \frac{Power\ requirement\ (kW)}{Effective\ \ field\ \ capacity\ (fed\ /\ h)} \quad ..(6)$$

D- Broadcasting cost.

The economic machinery costs (fixed and variable) as well as repair and maintenance is derived from theories described by **Nilsson (1972), Have (1991) and Hunt (1995),** and expresses the total yearly fixed and variable costs as a function of machine capacity:

$$C = \left[\psi\ x\ \rho\ \mathrm{x}\ \theta + \frac{A\ x\ U}{\theta\ x\ FE}\ x(r\ x\ \rho\ x\theta + L + \delta\ x\ \theta)\right] / \mathrm{Pr} ....(7)$$

Where; C: is the total yearly costs (LE),
Ψ: is a factor expressing depreciation and interest as a fraction of the purchase price, (1/year)
ρ: is the purchase price per unit capacity (LE.h/ton),
θ: is the machine capacity (ton/h),
A: is the treated seasonal area (fed/year),
U: is the expected crop yield (ton/fed),
FE: is the field efficiency expressing the ratio between gross and theoretical capacity,
r: is a factor expressing repair and maintenance costs as a fraction of purchase price,
δ: is the fuel costs proportional to the capacity (LE/L), and
Pr: is process productivity (ton).

- Statistical analysis: The obtained data were tabulated and analyzed statistically by using a computer program for estimating the regression analysis and the probability at level 5% while the graphs were drawn using the Microsoft excel window 2007.

RESULTS AND DISCUSSION

A- Effect of spreader fan peripheral speed on broadcasting width

From Fig 4, it is indicated that increasing fan peripheral speed resulted in increasing broadcasting width. For dry grains, results in Fig. 4 (A) show that the most amount of grains is distributed in small width at lower fan peripheral speed of 1.7 m/s compared with the high speed of 1.97 and 2.18 m/s which increases the broadcasting width around the centerline of the portable unit carrier especially under 200 mm outlet path length.

The broadcasting width readings were 10.2, 6.4 and 4.4 m under fan peripheral speed of 2.18 m/s and outlet path length of 200 mm for horizontal and vertical fan comparing to manual broadcasting, respectively. It is clear that fan peripheral speed of 2.18 m/s and outlet path length of 200 mm showed the best broadcasting width. Fan peripheral speed of 1.7 m/s with outlet path length of 50 mm showed the least values of broadcasting width while fan peripheral speed of 1.97 m/s and outlet path length of 100 mm showed medium values and the two factors gave similar trends.

For germinated grains, similar trends were shown in Fig. 4 (B). Under the same previous conditions of fan peripheral speed and outlet path length values of broadcasting widths were 8.8, 5.5 and 3.7 m for horizontal and vertical fan comparing to manual broadcasting, respectively. These results were under fan peripheral speed of 2.18 m/s and 200 mm outlet path length. In the same way fan peripheral speed of 1.7 m/s and outlet path length 50 mm showed the least values of broadcasting width and medium values were obtained under fan peripheral speed of 1.97 m/s with two other outlet path length of 50 and 100 mm. This result may be attributed to the increase in centrifugal force occurred by high fan peripheral speed which caused increasing fan speed. So, the effective width could be increased by increasing fan peripheral speed. Comparing the two states of grains there were significant differences between dry and germinated grains (R^2=0.9494).

Effect of fan peripheral speed and outlet path length on CV and CU.

Fig 5 shows the effect of fan peripheral speed and outlet path length on CV for both dry and germinated grains at different positions of fan comparing to manual broadcasting.

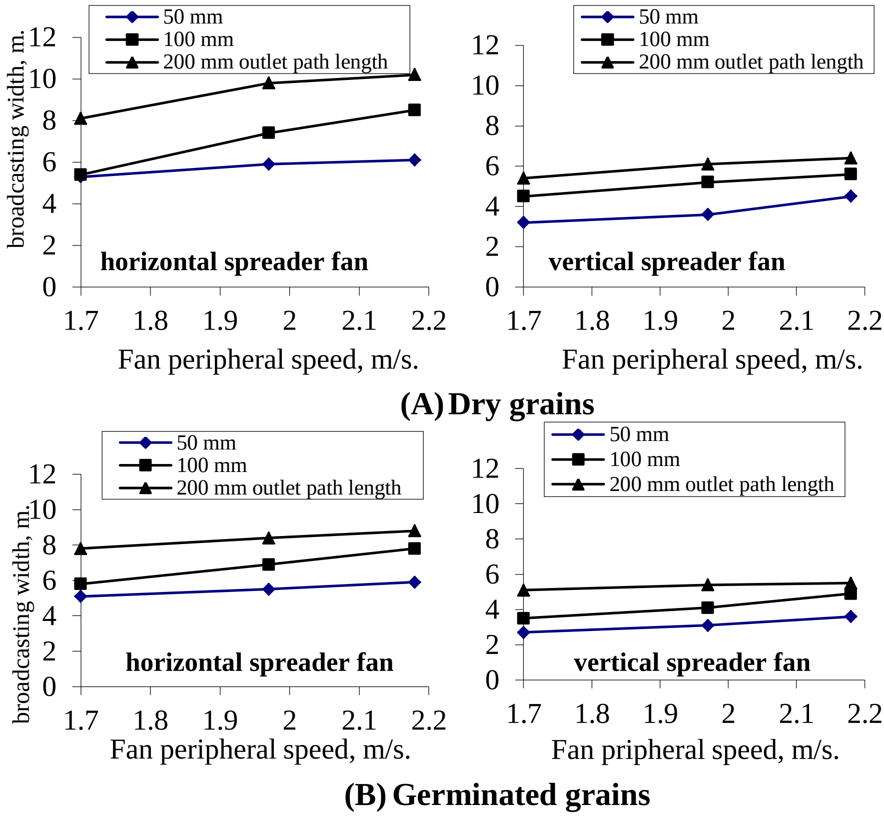


Fig.4: Effect of fan peripheral speed and outlet path on broadcasting width for (A): dry grains and (B) germinated grains

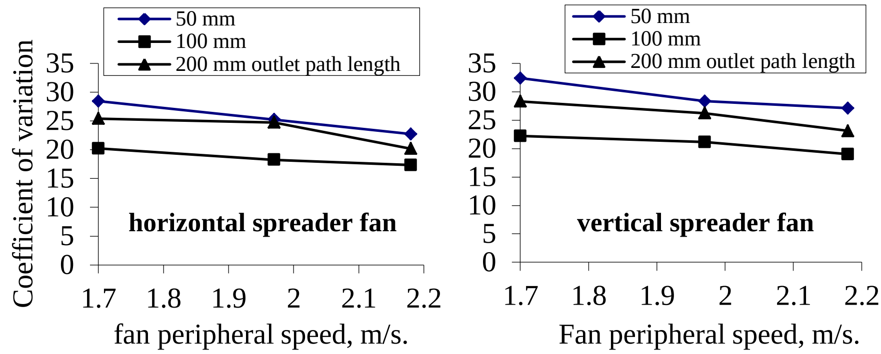
For dry grains from Fig 5 (A), it is clear that increasing fan peripheral speed resulted in decreasing CV values under all treatments and consequently increasing the CU. Also, it is obvious that using fan showed a decrement in CV values comparing with the control treatment. Using horizontal fan gave the least values for CV in all treatments. CV values were 20.22, 18.25, 17.33 and 22.21, 21.15, 19.10 for horizontal and vertical fan, respectively comparing to 47.50 for control treatment (manual broadcasting). These results were under fan peripheral speed of 1.7, 1.97 and 2.18 m/s with 100 mm outlet path length. The highest values of C.U. are 79.78, 81.75, 82.67 and 77.79, 78.85, 80.90 obtained at the same previous conditions. These results may be attributed to the increase in centrifugal force occurred at high peripheral speed. So, the coefficient of variation could be decreased by increase fan peripheral speed. The best distribution pattern is coincided the lowest values of C.V. The fan peripheral speed of 2.18 gave the lowest value of C.V. of 22.71, 17.33, 20.19 and 27.11, 19.01, 23.11 under different outlet path length of 50, 100 and 200 mm for horizontal and vertical position, respectively. Results show that, the suitable peripheral speed for dry grains is 2.18 m/s. The two other outlet path length showed similar results and trends.

With germinated grains Fig 5 (B), the same trend for CV values were shown for all treatments comparing to the control treatments under the same conditions with dry grains. CV values were 25.23, 21.12, 19.11 and 27.23, 25.15, 21.45 for horizontal and vertical fan, respectively comparing to 49.71 for control treatment (manual broadcasting). These results were under fan peripheral speed of 1.7, 1.97 and 2.18 m/s with 100 mm outlet path length. The highest values of C.U. are 74.77, 78.88, 80.89 and 72.77, 74.85, 78.55 obtained at the same previous conditions. These results may be attributed to the increase in centrifugal force occurred at high peripheral speed.

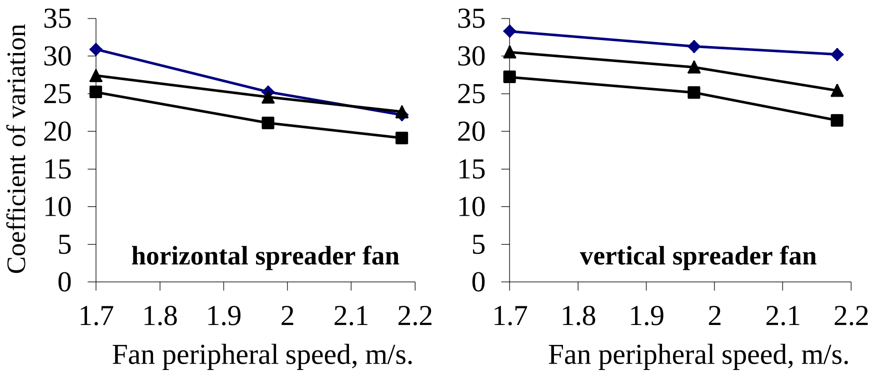
Although the outlet path length of 50 mm showed the best broadcasting cone, but the number of grains per m^2 was less than the recommended values. Therefore, outlet path length of 100 mm showed the best values of number of grains per m^2. The regression analysis showed that outlet path length is an important factor which affects the coefficient of variations of broadcasting (R^2 = 0.957). It was found that, with the probability of 5% which meant outlet path length value affects coefficient of variations of broadcasting. The maximum coefficient of variations was gained for manual broadcasting and the minimum value was obtained in broadcasting grains by horizontal and vertical fan broadcasting. These results may be because more fan peripheral speed results in more grains distribution and in the same way the outlet path length of 50 and 200 m led to sudden impact for grains with scattering fan with 50 mm and more friction with 200 mm which showed the obtained results.

Effect of fan peripheral speed on specific energy:

Specific energy is highly affected by fan peripheral speed. Fig.6 shows that increasing fan peripheral speed from 1.7 to 2.18 m/s decreased specific energy from 1.12 to 0.45 kWh/fed, for dry and germinated grains, respectively.



(A) Dry grains



(B) Germinated grains

Fig.5: Effect of fan peripheral speed and outlet path on coefficient of variation for: (A) dry grains and (B) germinated grains

The decrease of specific energy consumed as the fan peripheral speed increased was attributed to change portable unit fuel consuming to the high velocity and also the increase in portable unit field capacity. The specific energy values at the suitable portable unit fan peripheral speed of 2.18 m/s were 0.56 and 0.87 kWh/fed, for dry and germinated grains, respectively. These values of energy consumed are considered economically so cheap comparing with the manual broadcasting specially in mud as there is no other equipment could broadcast grains in mud and therefore, in Egypt, grain broadcasting is widely manually operated.

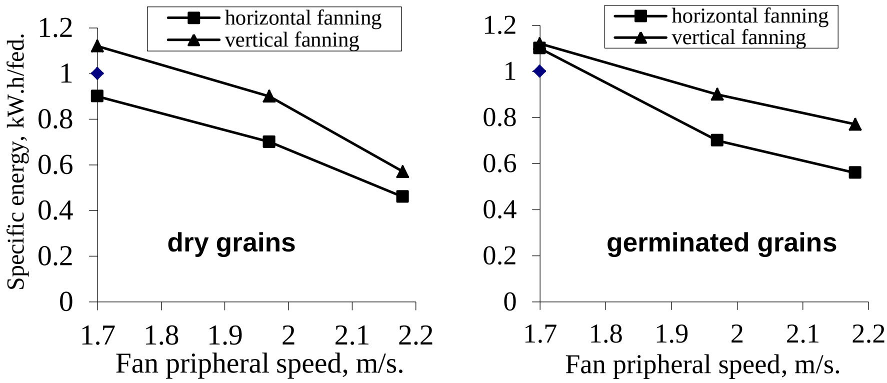


Fig.6: Effect of fan peripheral speed and outlet path length on specific energy under 100 mm outlet path length with dry and germinated grains

Effect of different parameters on broadcasting cost:

Although the outlet path length of 200 mm (Fig 7) showed the highest broadcasting width, the outlet path length of 100 mm showed the least values of CV concerning the effect of ground speed on broadcasting cost (LE/fed). Data indicated that at the mentioned ground speeds of 0.67 m/s with fan peripheral speed of 2.18 m/s and outlet path length of 200 mm the average broadcasting costs were 10.60 and 13.85 LE/fed for dry and germinated grains, respectively comparing to 20 LE/fed for manual broadcasting according to the operator rental costs per hour.

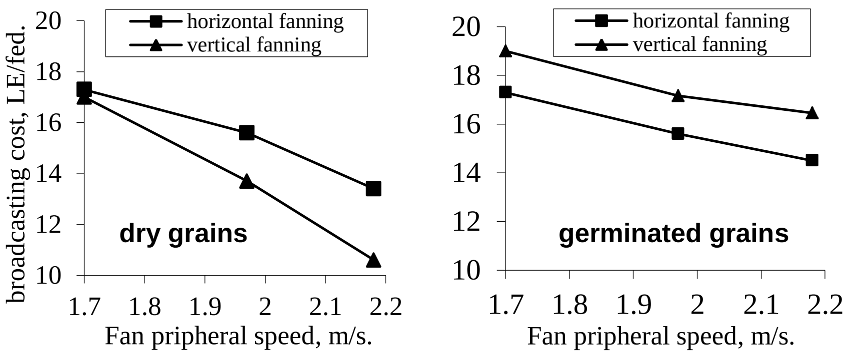


Fig.7: Effect of fan peripheral speed and outlet path length on broadcasting cost under 200 mm outlet path length with dry and germinated grains

These mentioned results were estimated according to time consumed and also timed consumed while re-filling the hopper with grains three times/fed with dry grains and four times with germinated grains assuming broadcasting width of approximately 10 m. It is noticed that increasing fan peripheral speed resulted in decreasing broadcasting cost. This was attributed to the increase in portable unit field capacity and they were considered to be acceptable compared with manual broadcasting.

CONCLUSION

It was found that the developed portable unit is suitable for paddy grains broadcasting effectively with dry or germinated grains and it is so easy to be manufactured and adjusted to be used for different agricultural operations. The desirable results could be summarized as follows:

- The highest broadcasting width of 10.2 and 8.8 m was obtained under fan peripheral speed of 2.18 m/s and outlet path length of 200 mm for horizontal fan of dry and germinated grains, respectively.
- For dry grains Under fan peripheral speed of 1.7, 1.97 and 2.18 m/s and 100 mm outlet path length gave the least CV values of 20.22, 18.25, 17.33 and 22.21, 21.15, 19.10 for horizontal and vertical fan, respectively comparing to 47.50 for control treatment (manual broadcasting) , the highest values of C.U. are 79.78, 81.75, 82.67 and 77.79, 78.85, 80.90 obtained at the same previous conditions.
- For germinated grains CV values were 25.23, 21.12, 19.11 and 27.23, 25.15, 21.45 for horizontal and vertical fan, respectively comparing to 49.71 for control treatment (manual broadcasting). These results were under fan peripheral speed of 1.7, 1.97 and 2.18 m/s with 100 mm outlet path length. The highest values of C.U. are 74.77, 78.88, 80.89 and 72.77, 74.85, 78.55 obtained at the same previous conditions.
- The specific energy at the suitable portable unit fan peripheral speed of 2.18 m/s were 0.56 and 0.87 kWh/fed, and accordingly the broadcasting costs were 10.60 and 13.85 LE/fed for dry and germinated grains, respectively comparing to 20 LE/fed for manual broadcasting.

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الملخص العربي

تطوير آلة محمولة لنثر الحبوب بضغط الهواء

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تعتبر عملية بذار الحبوب من العمليات الزراعية المهمة بعد تهيئة مرقد مناسب للبذرة بعمليتي الحراثة والتنعيم وتتم بطريقتين الأولى يدويا وهي طريقة قديمة والثانية تتم بواسطة معدات البذار الميكانيكي وهي طريقة متطورة. وتقوم آلة نثر الحبوب بزراعة المحاصيل الكثيفة مثل الأرز والقمح والشعير والبرسيم حيث تقوم بنثر الحبوب عشوائياً على سطح التربة ويتراوح العرض الشغال لها من ٦ – ١٢.٥ م حسب حجم الآلة ، وقد تعددت أشكال وأنواع آلات النثر حسب الغرض منها فمنها ما هو محمول على ظهر العامل وتدار يدوياً ومنها ما هو معلق خلف الجرار أو محمول على إطار خلف الجرار أو النثر بالطائرات.

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وتعتمد على وجود قرص تلقيم وريش عرضية تقوم بنثر الحبوب بالطرد المركزي مما يكسبها طاقة حركة فى المستوى الأفقي ولكن تكثر عيوب هذه الطرق حيث يكون توزيع الحبوب غير منتظم نسبياً مقارنة ببعض الآلات الأخرى حيث أن قرص التلقيم غير موجب الإزاحة فلا يرتبط فيها معدل التلقيم بسرعة تقدم الآلة مما يتطلب مهارات خاصة لتنسيق سرعة العمل مع سرعة تقدم الآلة ، كذلك تتأثر كفاءة التوزيع بالرياح مع صعوبة ضبط عرض النثر.

وللتغلب على هذه المشاكل أجريت هذه الدراسة حيث تم تطوير وحدة نثر محمولة على ظهر العامل تعمل على نثر الحبوب بضغط الهواء - فى تربة طينية بعد إجراء عمليات الحرث والتسوية والتلويط فى وجود الماء - اعتماداً على وجود مروحة بلاستيك مزودة بعوارض رأسية مثبتة فى نهاية ماسورة خروج هواء مدفوع حيث يعمل الهواء المدفوع على إدارة المروحة ذات العوارض بسرعات مختلفة ، وقد تم تصنيع وتركيب خزان حبوب على شكل رباعى الاوجه (اعتماداً على الخصائص الطبيعية لحبوب الأرز) مزود ببوابة خروج الحبوب يمكن التحكم فيها وتتصل نهايته من أسفل بنهاية ماسورة خروج الهواء المدفوع فتخرج الحبوب المدفوعة بالهواء مصطدمة بالقرص ذو العوارض فتتناثر الحبوب بشكل منتظم ، حيث يمكن التحكم فى عرض النثر وكمية الحبوب عن طريق التحكم فى سرعة الهواء المدفوع بواسطة ذراع توصيل فى يد العامل.

تمت التجربة فى مزرعة خاصة ذات تربة طينية فى محافظة الشرقية فى موسم ٢٠١٤م على زراعة حبوب الأرز صنف جيزة ١٧٨ حيث شملت متغيرات الدراسة زراعة ٦٠ كجم/فدان حبوب الأرز فى حالتين مختلفتين (بذرة جافة فى أرض جافة – بذرة مستنبتة فى أرض رطبة) وكذلك تم دراسة تأثير وضع مروحة النثر (أفقى – رأسي) وبعد مخرج الحبوب (٥٠ – ١٠٠ – ٢٠٠ مم) عن نهاية ماسورة خروج الهواء المدفوع بسرعات ١.٧ ، ١.٩٧ ، ٢.١٨ م/ث والتى تدير مروحة النثر ذات العوارض وتأثير ذلك على نمط التوزيع (عرض النثر) ومقاييس التشتت مثل معامل الانتظامية ، معامل الاختلاف ، وكذلك التأثير على الطاقة المستهلكة والتكاليف الكلية.

وأظهرت النتائج أن سرعة الهواء ٢.١٨ م/ث وطول مسار مخرج الحبوب ١٠٠ مم مع وضع مروحة النثر فى الوضع الأفقي أعطت أفضل النتائج لجميع القياسات. وبالرغم من الحصول على أعلى عرض نثر ١٠.٢ و ٨.٨ متر للحبوب الجافة والمستنبتة على التوالى إلا أن أقل قيم لمعامل الاختلاف كانت ١٧.٣٣ و١٩.١١ مع (مروحة النثر أفقياً – مروحة النثر رأسياً) على التوالي مقارنة بـ ٤٧.٥٠ و٤٩.٧١ مع النظام التقليدي (اليدوي) مع الحبوب الجافة والمستنبتة على التوالي. وأيضا كانت أفضل قيم معامل الانتظامية ٨٢.٦٧ ، ٨٠.٩٠ للحبوب الجافة مع الوضع الأفقى والرأسي على التوالي و ٨٠.٨٩ و٧٨.٥٥ للحبوب المستنبتة مع الوضع الأفقي والرأسي على التوالي. وكانت الطاقة المستهلكة ٠.٥٦ و ٠.٨٧ كيلو وات ساعة/فدان، على

الحبوب الجافة والمستنبتة للنثر الأفقي على التوالي. وكانت تكاليف النثر الكلية ١٠.٦٠ و١٣.٨٥ جنيه/فدان للحبوب الجافة والمستنبتة على التوالي مقارنة بـ ٢٠ جنيه/فدان للنظام التقليدي.

وتوصى الدراسة بتصنيع آلة النثر المطورة للتغلب على المشكلات التى تواجهنا من تفتت الحيازات وصغرها مما يستوجب توفير آلات ومعدات صغيرة الحجم تناسب المساحات الصغيرة مع إمكانية تجربتها لتناسب زراعة عديد من الحبوب الأخرى وتوصى الدراسة أيضاً بدراسة عدد وزوايا ميل العوارض على مروحة النثر وبعدها عن مخرج الحبوب وكذلك دراسة أقطار مختلفة لمروحة النثر و دراسة نوع المادة المصنوع منها مروحة النثر.