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Possibility of Using Air-Blast Duster for Broadcasting Soaked Paddy

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ABSTRACT

This study aims to investigate the possibility of using the air-blast duster as a broadcaster for the direct-seeding of soaked paddy rice in flooded fields. In order to achieve that four blower air stream velocities of 55, 68, 77 and 86 m/s, four different metering chamber volume of 17, 24, 31 and 38cm^3 and three tilt angles of the seed blowing duct of 0, 5 and 10º were studied. These variables were tested and analyzed statistically. The main obtained results were as follows; the best results of coefficient of variation for uniformity of seed distribution and seeds density were 18.5% and 643 seeds/m^2, respectively, which obtained at the metering chamber volume of 24 cm^3, an air stream velocity of 68 m/s and a tilt angle of 5º. The effective field capacity of the distributor was 1.88 fed/h at the same previous operating factors. The economic evaluation also showed the feasibility of using a knapsack power duster as an alternative method to the traditional sowing methods with a decrease of about 35% in the total operating costs.

***Keywords**: direct-seeded rice, air-blast duster, seed distribution uniformity.*

INTRODUCTION

In Egypt, rice (*Oryza sativa* L.) plays a vital role as one of the country's key cereal grains (Awad *et al.*, 2022). Rice seedlings are transplanted by hiring skilled labour. Nowadays, there is a reduction in skilled labour leading to a delay in the planting date and eventually low rice production. To tackle this issue, direct seeding of rice is the sole feasible option for assisting farmers. Using conventional methods in manual seeding leads to decreased grain yield for different crops because of non-uniformity and higher plant population. Two systems are for the direct rice planted in flooded fields. The first is sowing manually by skilled labour at a seed rate of 80 kg/fed and a cost of 250 Egyptian pounds per fed. The second is the seedling dropping using a group of fourteen workers with a price of about 1120 Egyptian pounds with a planting rate of 100 kg/fed. However, the disadvantages of the two previous seeding methods are a waste of selected seeds, high cost, and irregular seed distribution.Thakur *et al.* (2004) assessed various planting techniques in irrigated rice cultivation. They found that the wet seeding spot method of rice planting is an advanced technique that yields higher crop output, consumes less water, reduces labor requirements, and simplifies weed control. Gupta and Herwanto (1992) designed and developed a direct paddy seeder to match a two-wheel tractor. The machine had a field capacity of 0.5ha/h at a forward speed of 0.81m/s. The main aim of using improved sowing equipment for seed planting is to ensure the precise distribution of seeds. Various technical factors of the machine significantly influence the successful attainment of the predetermined seed spacing. These include the type of seed pickup mechanism, machine operating speed, the overall gear ratio between drive wheels and seed rotor, and, to some extent, the quality of the seeds. Methods of seed sowing include: A. wet direct seeding and B. dry direct Seeding. Direct seeding involves sowing rice seeds directly in the well-prepared primary field, whether dry or wet. Both methods have their own merits and demerits. Wet direct seeding is more commonly used in irrigated areas. Before being planted in wet rice, the seeds undergo a soaking process in water and are subsequently kept in darkness to promote sprouting. The seedling root will emerge at 2-3 mm length at this stage. The sprouted seeds are sown in well-puddled and leveled fields using drum seeders. Ali *et al.* (2013) evaluated the planting methods used for the growth and yield of paddy. The study findings showed that the grain yield and cost-benefit ratio of the various planting techniques followed the order of line transplantation > conventional transplantation > direct seed dibbling > direct seed drill > pre-germinated seed broadcast. It can be inferred from the results that line transplanting is the preferred method of planting rice in regions with abundant and cost-effective labor, as it yields higher production and economic returns compared to alternative methods. Direct sowing of rice is an ancient practice of rice cultivation. The dry seed is manually scattered onto the surface of the soil and subsequently integrated through either plowing or harrowing, while ensuring the soil remains dry. The process of dry seeding rice involves drilling the seed into a finely prepared seedbed at a depth of 2-3 centimeters. The direct sowing of paddy can save approximately 25% of irrigation water by eliminating puddling and extending irrigation intervals (Singh, 2014). Liu *et al.* (2015) showed that dry direct-seeded rice was found to be a viable option for transplanted-flooded rice in Central China. Dry direct-seeded rice represents a viable cropping approach predicted to decrease water and labor demands compared to the traditional method of transplanted flooded rice. Abo El-Naga (2006) developed a simple distribution unit for sowing small seeds by the air stream and studied the effect of different air stream velocities on uniformity of seed distribution and seed discharge for

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gate out of seed box. He found that the best uniformity of seed distribution was obtained by using a developed distributor unit at a diameter of pipe 5.08 cm and air stream velocities of 12.5 and 17.75 m/s. Also, increasing air stream velocity increased seed discharge for all varieties of slight seeds at steady gate out area (4.28 cm^2). Sudhir *et al.* (2007) found that the grain yield was 30% higher in direct seeding than in other methods under their study. So far, in Egypt, the direct seeding of soaked and incubated rice grains is still an ideal and alternative method to overcome labour-scarce problems. Kumar and Ladha (2011) several studies were conducted in many countries on the direct seeding of rice as an alternative to rice transplanting. Most field experiments have established that direct-seeded rice can yield as high as transplanted rice if adequately managed. Some studies found that direct rice seeding is the best alternate cropping technique, which requires less water and labour than the transplanted rice. Wang *et al.* (2020) mentioned that a suitable direct seeding method was of great significance to improve the germination rate and grain yield of direct seeded rice. Zhong *et al.* (2021) mentioned that regarding to the condition of lack number of agriculture labour in village where mostly rice field is existed could be concluded that farm machineries become main factor in agriculture sector. Farm machinery not only solves the problem of lack of labour but also increases labor productivity, increases crop cultivation and production time, reduces harvest losses and increases quality of agriculture product. Ahmed (2016) developed a compact pneumatic grain spreading device and assessed its effectiveness across various parameters. The evaluation included three different fan peripheral speeds: 1.7, 1.97, and 2.18 m/s; three-grain path lengths: 50, 100, and 200 mm; two-grain conditions (dry and germinated); and two fan positions (horizontal and vertical). The findings showed that the optimal outcomes for all measurements were achieved with a fan peripheral speed of 2.18 m/s, an outlet path length of 100 mm, and a horizontal fan position. The consumption of energy and broadcasting costs were measured at 0.56 and 0.87 kWh/fed, and 10.60 and 13.85 LE/fed for dry and germinated grains, respectively. Conversely, the cost associated with manual broadcasting totaled 20 LE/fed. Dhruw and Verma (2018) assert that the power-operated paddy seeder is essential for seeding pre-germinated rice and dry seeds. This method is being increasingly favored over manual transplanting because of reduced labor, increased profits, and comparable yields.

This research was conducted to investigate the possibility of using an air-blast duster for sowing soaked paddy rice in flooded fields. The specific objective was to achieve the best uniformity of paddy seed distribution affected by an air stream velocity flow from the blower, different metering chamber volume, and the tilt angle of blowing duct. Also, decrease the total operating costs of sowing paddy in flooded fields.

MATERIALS AND METHODS

Field experiments were carried out at Tag Elez Agricultural Research Station Dakahlia Governorate, Egypt. The possibility of using an air-blast duster in sowing-soaked paddy in flooded fields is the aim and a new technique. No researchers used an air duster device for a mechanically broadcasting soaked paddy. Table 1 indicates the technical specifications of the air-blast duster (ABD) used in this study to carry and scattering the soaked rice seeds.

Table 1. The technical specifications of the air-blast duster (ABD)

Item	Specifications	Item	Specifications
Engine stroke type	Single cylinder, two-stroke, air-cooling, with gasoline	Max air flow (m^3/h)	1300
Cylinder displacement (cc)	77	Air velocity (m/sec.)	120
Max engine speed (rpm)	6000	Sprayer capacity	Liquid + powder
Power output (kW/HP/rpm)	3.6/4.8/6000	Fuel tank capacity (l)	1.9
Spraying horizontal range (m)	15	Tank capacity (l)	16
Gross weight (kg)	13	Dimensions (W×L×H) cm	40×55×80

Soaked paddy for 48 hours in water was used for direct seeding in flooded fields to avoid the seeds floating. If dry seeds are used, floating seeds move from one place to another place by air current, which leads to irregular distribution of seeds. So, it's very important to use the soaked seeds in direct seeding in flooded fields. Variety of paddy Giza 178 seeds was used in all treatments. Giza 178 variety is an Egyptian rice cultivar; it is a short and thin-grain with a height of 95 cm. The average productivity per feddan ranges between 4.5 - 5.5 tons. It requires 130 - 140 days from planting to harvest, depending on the method of planting. It is cultivated well in saline soils of the northern Delta and tolerates drought conditions, the recommended seed rate is 70 - 80 kg/feddan, according to soil sality, (Technical recommendations for rice crop, 2020). Some properties of the soaked paddy in seeding time were; the seed's moisture content of about 28.2 %w.b, the average bulk density of 1.13g/cm^3, the average mass of 1000 seeds of 26.6 g, the average coefficient of friction (seed/plastic) of 0.56, the average repose angle of 35.5º and the average of terminal velocity of 14.7m/s. All previous labouratory measurements were doing 48 hours after soaking the seeds.

The curved shape of the tank is generally used in the air-blast duster for gently and smoothness in the free flow (gravity flow) of powder and granules shown in Fig. 1. The tank capacity of the soaked rice seeds was about of 18 kg. Many initial experiments and measurements carried out to determine the possibility of using air-blast duster in broadcasting-soaked rice seeds, as follows:

Fig.1. The spherical cone shape tank used for gently and smoothness free flow

To find out the rated move speed of the operator in a muddy field, a simulation was carried out perfectly. The seeds tank was filled with 18 kg of soaked seeds, operated the duster engine, and then the worker carried an air-blast duster and moved a distance of 100 meters in a muddy field. The time of the trip was calculated and the experiment repeated ten times. The average worker's field speed in flooded fields was about 0.52 m/s.

Seed air stream length (SASL) is the length of the air stream loaded with seeds. It was measured at four air stream velocities of 55, 68, 77 and 86 m/s, flow from the blower under three setting angle of air duct of 0, 5 and 10º, up to the horizontal level which parallel to the soil's surface (Fig. 3).

Seed discharge rate (SDR) was measured at different volumes of metering orifice gate of 6, 10, 17, 24, 31, and 38cm^3 (Fig. 2). The engine has been operated during the experiments, as the engine vibrations have a positive effect on the gravity flow and good regular flow of seeds from the metering gate to the blowing duct. The optimum seed flow rate which corresponds to the worker's field speed to achieve the recommended seed rate of 75 kg per fed was 3.16 kg/min which was calculated as:-

$$SDR = \frac{F \times W \times R \times 60}{4200}$$

Where:-

SDR: seeds discharge rate, kg/min

F: worker's field speed, 0.52 m/s;W: the length of the air stream loaded with seeds or broadcasting width (W), ≈ 5 m

R: seed rate ≈ 85 kg/fed

4200: constant, fed is an area unit equals 4200 m2

N.B: After soaking rice seeds in water for 48 hours the quantity of seeds increased from 75 kg to about 85 kg due to absorbing seeds with water.

Many trials carried out to find the suitable volumes of metering orifice gate achieved the discharge rate (D) of 3.16 kg/min which gave a seed rate of ≈ 85 kg/fed, and it was 24 cm^3.

Treatment and Experimental measurements

In experimental field operation, the operator directs the seed-blowing duct to the left at an angle of 45º with the direction of travel, does not move the tube to the right or left, and moves as much as possible with a regular walking step. Also, broadcasting operations should always be upwind of the target area shown in Fig. 2. The studied variables were the following:

- Four air velocities of 55, 68, 77 and 86 m/s were measured by an anemometer;
- Four metering chamber volume (MCV) of 17, 24, 31 and 38 cm^3 Fig. 3;
- Three tilt angles of seed blowing duct of 0, 5 and 10º.

There were three replicates for all treatments under study which were arranged in a split-split plot design.

Fig. 2. Working method in the field

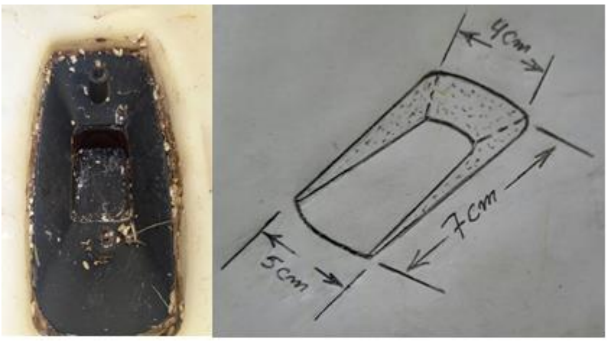

Fig. 3. Metering gate adjustment

Three tilt angles of seed blowing duct of 0, 5 and 10º Fig. 4.

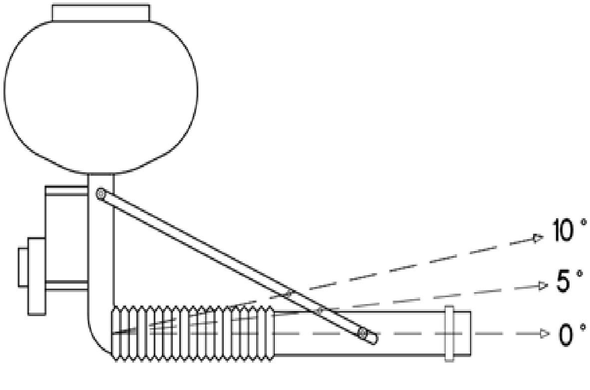

Fig. 4. Three tilt angles of the seed blowing duct

Measurements:-

Seed discharge rate (SDR**,** kg/min) of soaked rice on the laboratory tests was measured three times by opening the metering chamber volume (MCV, cm^3) at different volumes of (17, 24, 31, and 38cm^3). The amount of mass (M) of seeds out from the ABD per one minute, (T) was massed (kg). Then, the seed discharge rate, (SMR) is defined as:

$$SDR = \frac{M}{T} \text{.......kg/min}$$

Seed air stream length (SASL, m) was measured at four air velocities of (55, 68, 77, and 86m/s) flow from the blower under three setting angles of the air duct of (0, 5, and 10°) up to the horizontal level which parallels to the soil's surface. The optimum SASL was measured. It was 5.3 m at air stream velocity of 68m/s and air duct angle of 5º which achieved the best uniformity of seed distribution.

The uniformity of seed distribution (USD), as depicted in Fig. 5, was assessed using a tray arrangement designed to collect seeds delivered from the broadcaster following the standard method system outlined by the ASAE (1997).

The tray dimensions were 32×15×13cm, arranged in three rows spaced 100 cm apart and perpendicular to the direction of travel. Seeds collected by each tray were then placed in small polyethylene bags and counted. Subsequently, the coefficient of variation (CV, %) for seed distribution uniformity was calculated as follows:

$$CV = \frac{\sigma}{\chi^{-}} \times 100$$

$$\sigma = \sqrt{\frac{\Sigma(\chi - \chi^{-})}{n-1}}$$

Where :

χ : the individual reading,

$\bar{\chi}$: mean reading $= \frac{\Sigma(\chi_1 + \chi_2 + \chi_3 + ...+ \chi_n)}{n}$,

n : total number of reading, and

σ : stanard deviation.

Coates (1992) reported that the coefficient of variation under 10% is excellent; however, values lower than 20% are acceptable for most field applications.

Number of seeds per square meter (N), a wooden frame (1×1m) from each plot after 2 hours from sowing is a randomizing setting for each treatment. After counting the seeds from the wooden frame, it's easy to calculate the number of seeds per square meter, (N).

Fig. 5. The uniformity of seed distribution in flooded field

Actual seeding density (ASD), logically, the seeding density per m^2 is a retarget according to the feed rate. Therefore, the actual seeding density per fed is determined by the following equation:

$$ASD = N \times 4200$$

Where:

ASD : actual seeding density, seeds/fed,
N : actual number of seeds per square meter in muddy field.

Theoretical seeding density (TSD), can be calculated from the following equation:

$$TSD = \frac{SR \times 10^6}{m}$$

Where:

SR : the seed rate, kg/fed
m : the mass of 1000 seeds of paddy Giza 178 variety, (21.2 gm).

The sowing efficiency (SE; %) considered an important factor in evaluating the sowing performance. It was calculated from the following equation:

$$SE = \frac{ASD}{TSD} \times 100$$

Effective field capacity (EC), (fed/h) was calculated according to Ismail (2022) as follows:

$$EC = \frac{60}{A_t} \qquad fed.h^{-1}$$

Where;

At = Nt + Tt + Pt (h.fed-1)
At: total actual operation time per fed, min. fed-1;
Nt: maintenance and lubrication time, min. fed-1;
Tt: turning time, min. fed-1 and
Pt: parasitic time, min. fed-1

The specific energy, (kW.h/fed) was found by estimating the fuel consumption (fu) l/h relative to the operating power of the air-blast duster and then applied according to the following equation of Hunt (1983):

$$SE = \left(\frac{f_u \times \rho_f \times LCV}{3600}\right) \times \left(\frac{427 \times \eta_{th} \times \eta_{mec}}{75 \times 1.36 \times EC}\right)$$

Where:

SE : the specific energy, fu: fuel consumption rate, l/h
ρf: fuel density 0.72 kg/l for gasoline,
LCV: fuel calorific value (10000 kcal/kg),
427: thermo-mechanical equivalent, J/kcal,
ηt: thermal efficiency of engine, 25% for Otto engine,
Hmec0: engine mechanical efficiency (≈ 80%),
EC: effective field capacity, fed/h

To caculating the human labour specific energy, (HE, kW.h/fed), the conversion of physical unit of human labour into energy unit, the energy equivalent of an adult man is 1.97 MJ/h and for an adult woman it is 1.57 MJ/h. The following equation was used according to Asmat Ullah (2009).

$$HE = \left(\frac{Wh \times Hl \times En.eq}{3.6 \times EC}\right)$$

Where:

HE: human labour specific energy (kW.h/fed),
Wh: total working hours of human labour,
Hl: number of human labour,
En.eq: energy equivalent of human labour, (1.97 MJ/h for adult man).
3.6: constant for conversion from MJ to kW.h

Total costs for sowing operation, to determine the cost of the air-blast duster, the following equations were used (Awady, 1978):

$$C = \frac{p}{h}\left[\frac{1}{l_i} + \frac{I}{2} + t + r\right] + (1.2 \times W \times S \times F) + \frac{m}{144}$$

where:

C: hourly cost, LE/h;
P: machine price, LE;
h: yearly working hours, h/year; li: machine life expectancy, year;
I: interest rate per year; t: tax overheads ratio;
r: repair and maintenance ratio; 1.2: a factor accounting for lubrication;
W: the power consumption during carrying operation, kW;
S: specific fuel consumption, liter/kW; F: fuel price, LE/liter ;
m: operator monthly salary, LE/month;
144: is a monthly working hour.

The total cost (LE/fed) was determined using the following formula:

Total cost (LE/fed)

$$= \frac{\text{Machine cost (LE/h)}}{\text{Effective field capacity (fed/h)}}$$

Experimental analyses, the split split plot design was used in this study, the data was collected and analyzed by the statistical analyses program (Excel). The regression analysis for the measurements of seeds discharge rate (SDR), seeds air stream length (SASL) and the coefficient of variation of uniformity of seeds distribution (USD), were determined.

RESULTS AND DISCUSSION

The laboratory tests and field experiments were carried out to evaluate the performance of the ABD and its ability to distribute different application rates of soaked paddy rice in flooded fields. The collected data was analyzed to obtain the best combination set of operating parameters under study. the results of this investigation could discussed under the following headings:

Seeds discharge rate, (SDR; kg/min)

Focus on the effect of the different metering chamber volumes on the discharge rate of paddy seeds, which soaked for 48 hours in water (Fig. 6) indicated this effect. It was easy to observe that by increasing both the metering chamber volume and the air stream velocities, the SMR increased.

This result may be logical, so more extension for the metering chamber leads to more drill ability of seeds and easy flow ability of soaked paddy. Also, increasing the air stream velocity by increasing the rotational speed of the engine leads to more vibration, which improves and increases the seed gravity flow quality. The seeds discharge rate increased from 1.9 to 2.4 kg/min (1.3 times) by increasing the metering chamber volume from 10 to 17cm^3 (87.5%) by increasing the volume of the metering chamber from 17 to 38cm^3 at an air stream velocity of 68m/s.

Also, it was increased by 77.2% for increasing air stream velocity from 55 to 86m/s at a metering chamber volume of 24cm^3. Finally, many trials were carried out to find the suitable metering chamber volume to achieve the seeds discharge rate (SDR) of 3.16 kg/min which gives a seed rate of 75 kg/fed which recommended by specialists in rice farming and was 24cm^3 at an air velocity of 68m/s.

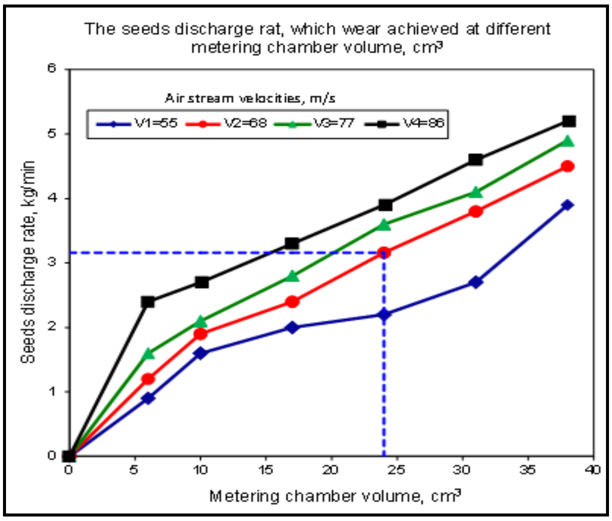

Fig. 6. The metering chamber volume via the seed discharge rate at different air stream velocities

The multiple regression analysis shows the effect of air stream velocities flow from the blower "V", and different metering chamber volume "MCV" on the seeds discharge rate "SDR" by the follow equation, which illustrates the relation as see in Eq. (1):

SDR = 0.0129 V + 0.0964 MCV (R^2 = 0.972) (1)

The regression analysis declares that air stream velocities and metering chamber volume are directly proportional to the seed's discharge rate. The factors affected the "SDR" arranged in ascending on relative to the analysis of variance as follows. Metering chamber volume (the p-value from analysis as $Pv_1=4.075\times10^{-18}$ > air stream velocities (the p-value from analysis as $Pv_2=1.01\times10^{-7}$). Finally, Data analysis showed a high significant effect for both metering chamber volume and air stream velocity on the discharge rate, and ($p<0.001$).

Seeds air stream length, (SASL)

Fig. (7) shows the effect of air stream velocities on air stream length loaded with soaked paddy at different tilt angles of seed blowing duct and metering chamber volume of 24cm^3. The relationship between seed airstream length and air velocities has a direct proportion but it has an inverse proportion with the tilt angle of the seeds blowing duct.

It may be attributed to the increase in the air stream velocity. The seeds are exposed to push force, which leads to the transport of the seeds to the longest distance. However, increasing the tilt angle of the seed blowing duct upward reducing the seed's airstream length. The highest value of air stream length was 6.5m at an air velocity of 86m/s and zero tilt angle, while the lowest air stream length was 4m at an air velocity of 55m/s and a tilt angle of 10º.

Also, at an air velocity of 68m/s level, and when adjusting the tilt angle of the seeds blowing duct at 5º, the seed's airstream length was 5.3m. It is recommended for use in the experiential field because it achieves a suitable field capacity and more uniform distribution. Finally, the data analyzed showed a high significant effect of the air stream velocity and tilt angle of the seed blowing duct on the air stream length with all treatments ($p<0.001$).

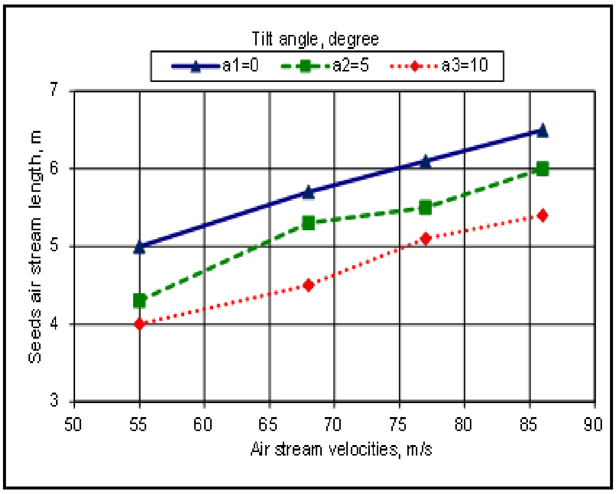

Fig. 7. Effect of the different air stream velocities and tilt angle of seeds blowing duct on the seed airstream length

The multiple regression analysis shows the effect of air stream velocities "V", and different tilt angles "Ta" on the seeds air stream length "SASL" by the follow equation, which illustrates the relation as see in Eq. (2):

SASL = -0.0909 Ta + 0.0795 V (R^2 = 0.9953) (2)

The regression analysis declares that tilt angles and air stream velocities are inversally and directly proportional to the seeds air stream length respectively. The factors affected the "SSL" by highly segnifficant which the coeffiecent of regression is 0.9953. Also arranged effects of the studied variables are the air stream velocities followed by the tilt angles.

Uniformity of seeds distribution, (USD)

Fig (8) describes the relationship between the tilt angle of the seeds blowing duct and the coefficient of variation of seed distribution uniformity (USD) at different air stream velocities (V, m/s) on a seeds discharge rate (SDR, kg/m) of 3.16kg/min. In general, by increasing the air stream velocity from 68 to 86m/s the seeds distribution uniformity decreased at zero and 10º of the seeds blowing duct tilt angles.

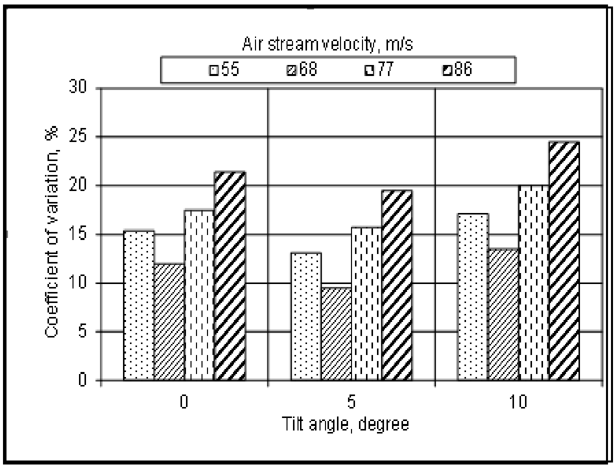

Fig. 8. Effect of the tilt angle of seed blowing duct at different air stream velocities on the coefficient of variation of seed distribution uniformity

This result may be due to increasing the velocity of the air stream that leads to more frequent collisions of seeds with the walls of the seeds blowing tube, which causes more random distribution. Also, increasing seeds blowing duct tilt angle from zero to 10º upward, more time needed throughout the seeds from the blowing tube and shortens the length of the seed stream, which leads to more randomness in the seed distribution regularity. The best fit of the seed distribution uniformity was achieved at an air stream velocity of 68m/s and a seed blowing tube tilt angle of 5º. The optimum distribution uniformity of seeds was achieved when the air stream velocity and inclination angle were set at 86m/s and 5 degrees, respectively where the coefficient of variation value (CV) was 9.5%. While, the acceptable values of the (CV) 15.4 and 20%, were achieved by the air stream velocity of 55 and 77m/s and tilt angle of zero and 10º respectively. The multiple regression analysis shows the effect of air stream velocities "V", and different tilt angles "Ta" on the coefficient of variation of uniformity of seeds distribution "USD" by the follow equation, which illustrates the relation as see in Eq. (3):

$$\mathbf{USD = 0.212Ta + 0.218\ V \quad (R^2 = 0.9693) \quad (3)}$$

The regression analysis declares that air stream velocities and tilt angles are directly proportional to the coefficient of variation of uniformity of seed distribution "USD". The factors affected the "USD" by highly segnifficant which the coeffiecent of regression is 0.9693. Also arranged effects of the studied variables are the air stream velocities followed by the tilt angles.

Field performance experimentation

Optimal operating parameters of the air-blast duster (ABD) are adjusted at air stream velocity of 68m/s, discharge chamber volume of 24cm^3 and seeds blowing duct tilt angle of 5º, then a comparison was carried out with a sowing manually method (SMM) by a skilled farmer in flooded fields. The data presented in Table 2 show the coefficient of variation, CV%, seeding density; seeds/m^2, sowing efficiency; %, effective field capacity; fed/h and costs requirement; LE/fed estimated for both methods. The percent of the coefficient of variation was 18.5% achieved at ABD. But it was 26.5% for SMM. Meanwhile, the seeding density was 643 and 514 seeds/m^2 at ABD and SMM, respectively. On the other hand, the sowing efficiency was 76.01 and 60.74%, obtained by ABD and SMM, respectively. The field capacity increased by 1.67 times for using ABD with a decrease of 35% in the total operating costs.

Table 2. Performance comparison between air-blast duster and a sowing manually method

Field performance measurements	Air-blast duster	Sowing manually method
Coefficient of variation, CV %	18.5	26.5
Seeding density, seeds/m^2	643	514
Sowing efficiency, %	76.01	60.74
Effective field capacity, fed/h	1.88	0.67
Specific energy, kW.h/fed	1.18	0.36
Costs requirement, LE/fed	130	200

Cost analysis:

The fixed and variable costs including labour cost of the sowing operation with the air-blast duster (ABD) were calculated and found to be about 140 LE/h in total (40 LE/h machine costs and 100 LE/h worker cost), and by taking into account the value of the effective field capacity of about 1.88 fed/h, thus the total costs of cultivating one feddan is about 75 LE/fed. By adding a 75% profit margin, the total costs become 131 LE/fed, While the worker got 200 LE/fed in case of manual broadcasting.

CONCLUSION

The utilization of an air-blast duster (ABD) for sowing soaked paddy rice in a flooded field is recommended. The best combination set of the operating parameters were 68m/s for air stream velocity flow from the blower, 24cm^3 for discharge chamber volume, and 5º for seed blowing duct tilt angle to achieve the acceptable seed distribution uniformity with a coefficient of variation value of 18.5%, 643 seeds/m^2 for seeding density and 1.88 fed/h for the field capacity. The total operating cost decreased by 35% for the air-blast duster compared with the traditional method.

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إمكانية إستخدام معفر الدفع الهوائي في بدار الأرز المنقوع

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الملخص

إلى الآن تتم الزراعة المباشرة للأرز في الأراضي المغمورة بالماء بطريقتين النثر يدويا بواسطة فلاح متمرس بمعدل تقاوي 80 كجم/للفدان وتكلفة حوالي 200 جنيها للفدان أو الزراعة باللقمة بمجموعات مكونة من أربعة عشر عامل بتكلفة 1120 جنيها ومعدل تقاوي 100كجم/للفدان. ويعاب على طريقتي الزراعة السابقتين عدم انتظامية توزيع البذور وإهدار التقاوي المنتقاة والتكلفة العالية. لذا أجريت الدراسة لاستخدام معفر الدفع الهوائي Air-blast duster (موتور الظهر) والاستفادة من تيار الهواء كحامل للبذور ونثرها بانتظام على وحدة المساحة. وقد أجريت هذه التجربة حيث تم اختبار الموزع المقترح عند أربع سرعات لتيار هواء الدفع (55، 68، 77، 86 م/ث) من خلال أربع أحجام مختلفة لغرفة تصريف البذور من قاع الخزان (17، 24، 31، 38 سم^3) مع ثلاث زوايا لأنبوب دفع الهواء المحمل بالبذور (0، 5، 10 $^{\circ}$) مع الوضع الأفقي والموازي لسطح الأرض وتم اختبار هذه المتغيرات وتحليلها إحصائياً فكانت النتائج كما يلي:- وتحققت أفضل انتظامية لتوزيع البذور عند معامل اختلاف نسبته 18.5% و كثافة 643 بذرة/م^2 مع حجم لغرفة التصرف مقدارها 24 سم^2 و سرعة هواء 68 م/ث. كما كانت السعة الحقلية للموزع 1.88 فدان/للساعة عند نفس فتحة التغذية السابقة ونفس سرعة الهواء. كما بين التقييم الاقتصادي جدوى استخدام الموزع كبديل للطرق التقليدية بانخفاض مقداره 35 % في التكاليف الكلية للزراعة.