FIELD PERFORMANCE OF A DEVELOPED MACHINE FOR DIRECT SEEDING OF SOAKED AND INCUBATED RICE GRAINS

Abo EL-Naga, M.H.M

ABSTRACT
The direct seeding of soaked and incubated grains is an ideal and alternative method to overcome the labor scarce problems, reduce the cost, reduce the energy requirements and contributes in improve production. The main objective of this work is to evaluate the field performance of a developed direct seeding machine and compared with the common systems for direct seeding, Sakha 101 the variety of rice grains was used in this work. Measurements of the revealed properties in grown plants characteristic crop yield, the energy consumptions and the cost were taking. By using a developed direct machine with furrow opener at seed rate of 40 kg/fed the germination ratio was 78.4%, plant population was 208.69 plants/m², the values of C.V were 9.37 and 13.73 % at lateral and longitudinal direction respectively and grain yield was 3.225 tons/fed too, the energy consumed and the cost were 0.514 kW.h/fed and 22.12 L.E/fed. However the net benefit earn of 86.49 LE from differences in costs and 0.172 ton/fed by use a developed direct seeding with furrow opener at seed rate of 40 kg/fed comparing with hand direct seeding in hills with furrow opener at seed rate of 60 kg/fed. In addition to providing 20 kg of seeds from seed rate.

INTRODUCTION

Rice is the staple food for more than half of the world’s population and generally grown under wetland condition. The high yielding rice varieties had been growing in transplanted condition since its innovation. Several studies have reported that there is no yield difference between direct seeding and transplanting practices of rice production if the weed control and other intercultural operations are done properly. Khan and El-Sahrigi (1990) reported that the direct seeding in rows does not only save transplanting labor but also facilitate mechanical weeding, plant protecting operations and efforts. They

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showed that Egypt still need to develop simple row seeders for direct seeding for paddy under wet and dry field conditions. Gupta and Herwanto (1992) designed and developed a direct paddy seeder to match a two-wheel tractor. The machine had a field capacity of about 0.5 ha / h at a forward speed of 0.81m/s. Damage due to the metering mechanism was nil for soaked seeds and 3% for pre germinated seeds. Shekar and Singh (1991) stated that direct seeding of sprouted seeds under puddle condition resulted in significant improvement in yield attributes like number of effective tillers and grain yield. Md. Syedul Islam and Desa Ahmad (1990) modification and evaluation drum type seeder for lowland paddy and the result showed that, the unwanted seed dropping at the headlands during turning which saved 5 – 7 kg of seed per hectare. Owing to the incorporation of seed collector assembly, the weight of the seeder increased by 20 percent compared to the previous prototype, but still within the capability of an average size labor. The effective field capacity of machine seeding ranged between 0.12 to 0.15 ha/hr and that of hand broadcasting was 0.22 ha/hr. The partial budget analyses revealed that by using drum type seeder and a rotary type seeder and rotary type weeder, a farmer could earn a net benefit of US$55.06 per hectare compared to hand seedling followed by hand seeding. Borlagdan and Yamauchi (1995) developed a drum seeder at IRRI for sowing pre-germinated seeds on the surface of puddle soil. The seeder was tested with five rice varieties with varying seed rate of 38 to 80 kg / ha. The shapes of the drums were cylindrical. The number of tillers per unit area and the leaf area index were more in row sown rice than in broadcast and transplanted rice. Griepentrog (1999) stated that the placing quality of seeders influences field emergence, plant development and crop yield. Both the seeding depth and the horizontal distribution over the area must be considered to assess placing quality. Optimizing plant distances increased field emergence and yield, and decreased the competition effects of growth factors, light, water and nutrients. The seed distribution over the area depends on the quality of longitudinal distribution, row width, and on seed rate as a non-technical parameter. These three parameters determine the quality of horizontal seed distribution and the available single area for plant growth and development. Anbumozhi, et
al. (2002) found that the distance away from neighboring seedlings had effects on rice yield because there were localized variations in the competition. The existence of an optimum enters row spacing of 2 cm with a crop density of 100 plants /m² which could be applied in row sowing methods. Too the crop yield can be increased markedly with increased plant density and a significant yield advantage can be obtained from regular over random sowing. Further, random patterns cause a range of micro scale variations in grain yield. Thakur et al. (2004) Evaluated different planting methods in irrigated rice they found that, wet seeding spot method of rice planting is an improved method that gives higher yield with fewer requirements of water and labor and easy weed management than the existing methods. Rao et al. (2007) stated that in Europe, Australia and united states encourage rice direct seeding owing to facility applied mechanization, and the risk of yield due to weeds competition can be decreased as the result of size differential between rice plants and weeds, and from the other side to the suppressive effect of standing water on weed growth. Sudhir et al. (2007) evaluate the effect of different seeding techniques, cultivars and seed rates on the performance of rice direct seeding. They found that the grain yield was 30% higher in direct seeding compared with other methods under their study. So far in Egypt the direct seeding of soaked and incubated rice grains are still an ideal and alternative method to overcome the Labor scarce problems. Therefore, the main objective of this research is to evaluate the field performance of a developed direct seeding machine with compared two traditional methods for direct seeding and estimate the cost and energy required for all seeding operations.

**MATERIALS AND METHODS**

The field experiments were carried out during two sequence summer seasons 2008/2009 after wheat crop at a private farm in Nawasa EL-Gheet village, Dakahleia Governorate. The tested Rice crop variety was Sakha 101. The mechanical analysis of the experimental soil was carried out in Mansura plant nutrition Lab., Soil, Water and environment Res. Institute A.R.C.Giza, Egypt. The mechanical analyses of the experimental soil are summarized in **Table (1).**
Table (1): The mechanical analysis of the experimental soil

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>Clay %</th>
<th>Silt %</th>
<th>Coarse sand %</th>
<th>Fine sand %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay-Silt loam</td>
<td>41.97</td>
<td>31.60</td>
<td>03.83</td>
<td>22.60</td>
</tr>
</tbody>
</table>

Materials:

The direct seeding machine:

Fig. 1 and 2 indicate the photograph and prototype sketch of the machine developed, the machine consists of four grain box at dimension (L= 30, W= 40 and H = 60 cm) and capacity of 9 kg. In the bottom half of each grain box have been installed barrier as a pyramid form at dimensions of base width = 14 cm, length = 30 cm and height = 7.5 cm to divide the grains into the box. Eight feed discs at diameter of 30 cm and thickness of 4 cm, every disc have six feed cells as a hemisphere form at diameter of 2.25 cm and distributed at equal distance of 15.7 cm on the circumference disc. Each pair of feed disc set vertically down the bottom of each grain box at equal distance of 30 cm by a central steel bar, on the two ends of the bar a pair of ground wheels with rubber cushions at diameter of 90 cm was fixed. hand push were fixed in a central bar in addition wooden furrow opener at length of 210 cm with eight pieces of wood at uniform of trapezoidal, at small base of 5 cm, large base of 7 cm and a height of 5 cm and was fixed with hand push. The overall dimensions of machine were Total length of 210 cm, Total width of 240 cm, Total high of 115 cm, Total mass without rice grains of 24 kg and Total mass with rice grains of 60 kg.

The hand wooden furrow opener:

Fig. 3 show the photograph of the hand wooden furrow opener at width of 180 cm, length of 100 cm and high of 15 cm and it have a seven opener units at uniform of trapezoidal, at small base of 5 cm, large base of 7 cm and a height of 5 cm and was fixed at equal distance of 30cm.

Scale of the wood frame: The scale was used to calculate the number of rice grains per unit area (1cm²) in two directions consequently determine the uniformity of seed distribution on the field. The scale was formed by a pieces of wood at section of 2.5 x 2.5 cm square-shaped. The length
and width of scale was 25 cm and were divided by wire iron at equal distance of 1 cm and fixed by a nails to obtain a square shape units at dimensions of 1 x 1 cm.

**Fig (1) Photograph of a developed direct seeding rice machine**

**Fig (2): The prototype sketch of a developed direct seeding rice machine**
Methods:
The field experiments were carried out on a Clay-Silt loam soil at area of one feddan by using a soaked rice seeds for about 24 hours and incubated about 48 hours, the experimental treatments were classified as follows:

\( T_1 \) = the developed direct seeding machine with a wooden furrow opener at seed rate of 40 kg/fed.

\( T_2 \) = the developed direct seeding machine without a wooden furrow opener at seed rate of 40 kg/fed.

\( T_3 \) = hand direct seeding (randomized hills) with hand wooden furrow opener at seed rate of 60 kg/fed.

\( T_4 \) = hand direct seeding without hand wooden furrow opener at seed rate of 60 kg/fed.

\( T_5 \) = Hand direct seeding (the broadcast method) at seed rate of 80 kg/fed.

The treatments namely \( T_1 \), \( T_2 \), \( T_3 \), \( T_4 \) and \( T_5 \) were carried out and replicated three times in a completely randomized block design.

Germination ratio:
The germination ratio \((Gr)\) was calculated by using the following formula;

\[
Gr = \frac{NP}{NS} \times 100, \ldots \ldots \ldots \ldots (1)
\]

Where:

- \( NP \) = number of emergence grains at length of 1 mm.
- \( NS \) = number of non-emergence grains.

1. Number of piles and plants per m\(^2\):
Number of piles and plants calculated by using a square wooden frame at dimension of one meter.

2. Uniformity of grain distribution:
Uniformity of grain distribution was estimated in both direction transverse and longitudinal by calculating the coefficient of variation by dividing the standard deviation to the arithmetic mean of the number of grains per unit according to the following equation:

\[
C.V = \frac{\sigma_{n-1}}{\bar{X}} \times 100 \quad \ldots \ldots \ldots \ldots (11)
\]

Where:
C.V = coefficient of variation in the longitudinal or lateral direction.

σ_{n-1} = standard deviation

\bar{X} = arithmetic mean of grains per unit area.

\[ \sigma_{n-1} = \sqrt{\frac{\sum x^2 - (\sum x)^2}{n}} \]

Where:

\[ \sum x = \text{summation of number of grains on the longitudinal or lateral direction.} \]

\[ \sum x^2 = \text{summation of square numbers of grains on the longitudinal or Lateral direction.} \]

n = number of reading.

The coefficients of variation under 10% are considered excellent and with values, fewer than 20% generally considered acceptable for most field application as reported by Coates (1992).

**Human Energy**

It was calculated by using the following equation: (Hunt, 1983)

\[ E_h = \frac{0.746 \times N_l}{A.F.C.} \text{ (kW.h / fed)} \]

Where:

N_l = number of laborers, (man).

0.746 = coefficient of changing from hp to kW

A. F. C = actual field capacity (fed / h)

**RESULT AND DISCUSSION**

**Germination ratio and plant population:**

In Fig. 3, the results indicated that, the highest percentage of germination field was 78.4 and 78.2% with the treatment T_1 and T_3 due to the retention of the groove with a wealth of water for as long as possible, too, the seeds are not exposed directly to the sun and attack birds, While the lowest percentage of germination field 63.58 % with T_5 However, in fig. 4 the data indicated that, the highest number of plants per sq. m after seeding period of 18 days of 344.73 plant/m^2 with T_5 While the lowest number of plants/m^2 of 208.69 plants/m^2 with T_1.
Uniformity of plant distribution:
The results in Figure 5 and 6 indicate to optimize the distribution of plants in lateral direction achieved with T1 where the value of the coefficient of variation of 9.37%, while that value was 13.58% in the longitudinal direction due to the accuracy of the settings in the fall of the seed from a feed disc. While, the acceptable value of the coefficient of variation of 11.35 and 14.13 % at lateral and longitudinal direction respectively, achieved with T3 This is due to accuracy of the settings in the fall of the seed from hand to the groove.
Fig.(5): Effect of direct seeding methods on uniformity of plant distribution at lateral direction

Fig.(6): Effect of direct seeding methods on uniformity of plant distribution at longitudinal direction

The grain yield:
The grain yield associated with the increase in number of active tillers, spikelet’s, panicles and grain fullness ratio. Therefore the data in fig 7 and 8 indicated that the highest value of grain yield 769.23 g/m² (3.225 ton/fed) were achieved by T₁ this attributes to the best uniformity of distribution hills, uniformity of seeds within each hill. While the lowest value of grain yield 718.73 g/m² (3.020 ton/fed) were obtained by T₃.
The cost and energy estimated for direct seeding methods:
Tabular data in Table 2 shows the actual and theoretical field capacity, field efficiency, the cost and energy estimated for direct seeding methods. Therefore, the highest value of field efficiency 82.67% achieved by T₁. While the lowest value of energy consumed, 0.20 kW.h/fed with T₅ and sequence by 0.41 and 0.514 kW.h/fed with T₂ and T₁ respectively, meanwhile the highest value of energy consumed, 13.32 and 13.419 kW.h/fed achieved by T₄ and T₃ respectively. On the other hand, the criterion cost of direct seeding methods were 13.4, 19.42, 22.12, 119.05 and 108.61 LE/fed under using T₅, T₂, T₁, T₄ and T₃ respectively. From the partial budget analysis, it revealed that, a farmer can earn a net benefit of 86.49 LE from differences in costs and 0.172
ton/fed by use $T_1$ comparing with $T_3$. In addition to providing 20 kg of seeds from seed rate.

Table (2) cost and energy requirement for direct seeding methods

<table>
<thead>
<tr>
<th>Operations</th>
<th>Direct seeding methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$T_1$</td>
</tr>
<tr>
<td>Effective field capacity (fed/hr)</td>
<td>0.36</td>
</tr>
<tr>
<td>Theoretical field capacity (fed/hr)</td>
<td>0.50</td>
</tr>
<tr>
<td>Field efficiency (%)</td>
<td>72</td>
</tr>
<tr>
<td>Energy consumption kW. h/fed</td>
<td>0.41</td>
</tr>
<tr>
<td>Costs required, LE / fed</td>
<td>19.42</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The developed direct seeding machine is a simple and inexpensive to construct and easy for using and suitable direct seeding soaked and incubated rice seeds. The results of field experiments for evaluate the field performance of a developed direct seeding machine showed the following:

- the highest percentage of germination field was 78.4 and 78.2% with the treatment $T_1$ and $T_3$ While the lowest percentage of germination field 63.58 % with $T_5$
- the highest number of plants per sq. m after seeding period of 18 days of 344.73 plant/m$^2$ with $T_5$ While the lowest number of plants/m$^2$ of 208.69 plants/m$^2$ with $T_1$.
- The best uniformity of plant distribution was obtained by using $T_1$ at C.V value of 9.37 and 13.73 % at lateral and longitudinal direction respectively.
- the highest value of grain yield 769.23 g/m$^2$ (3.225 tons/fed) were obtained by using $T_1$ while, the lowest value of grain yield 718.73 g/m$^2$ (3.020 tons/fed) were obtained by using $T_3$.  

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The lowest value of energy consumed and cost required 0.20 kW.h/fed and 11.7 L.E/fed were obtained by using T₅, while in T₁ the energy consumed of 0.514 kW.h/fed and the cost required of 22.12 L.E/fed.

The net benefit earn of 86.49 LE from differences in costs and 0.172 ton/fed by use T₁ comparing with T₃ In addition to providing 20 kg of seeds from seed rate.

REFERENCES


الملخص العربي
الإداء الحقيلي لآلة مطورة للزراعة المباشرة لحبوب الأرز المنقوعة والمكمورة

محمد حمزه مخيمر أبو النجا

يتم محصول الأرز الغذاء الرئيسي لأكثر من نصف سكان العالم ويحتل المرتبة الأولى من حيث المساحة والأهمية على المستوىين العالمي والمحلي، وتمثل عملية الزراعة الجانب الأعظم في إنتاجية محصول الأرز لمنطقة تلبية من طاقة وتكاليف وقدر كبير من التقائي، وتعتبر الزراعة المباشرة أحد جوانب المساهمة في النموذج المحصول الأرز وعليه تمثل الهدف الرئيسي لهذا البحث في تقييم الأداء الحقيلي لآلة زراعة مطورة لزراعة مباشره لحبوب الأرز المنقوعة والمكمورة ومنقارتها بنظام الزراعة المباشرة التقليدية وتم تنفيذ التجارب الحقلية بمزرعة خاصة بقرية نوسا الغيط – أجا - دقلية خلال موسمي الزراعة الصيفي لعام 2008 و 2009 م على مساحة واحد فدان حيث تم تقسيمه إلى ثلاث قطعات رئيسية تمثل المكررات، ومثل تقييم كل مكررة إلى خمسة قطاعات فرعية متساوية وزعت عليها معاملات الدراسة عشوائيا والتي تمثلت في خمسة معاملات:

- المعاملة الأولى (T1): آلة الزراعة المطورة بمعدل تقاوي 40 كجم / فدان مع استخدام فجاج خشبي للخدمة الأحادية صغرية.

- المعاملة الثانية (T2): آلة الزراعة المطورة بمعدل تقاوي 40 كجم / فدان بدون استخدام فجاج خشبي لخدمة الأحادية صغيرة.

- المعاملة الثالثة (T3): الزراعة بدوى بالفجاجة في جور عشوائية بمعدل تقاوي 60 كجم / فدان مع فجاج خشبي بدوى لخدمة أحادية صغيرة.

- المعاملة الرابعة (T4): الزراعة بدوى بالفجاجة في جور عشوائية بمعدل تقاوي 60 كجم / فدان بدون فجاج خشبي لخدمة أحادية صغيرة.

بحث أول By MEAD بحوث الهندسة الزراعية – الدقي – الجيزة – مصر
المعاملة الخامسة ($T_5$): الزراعة المباشرة يدوياً بالنثر بمعدل تقاوي 80 كجم / فدان.

- الصنف المستخدم سخاء 101 وتم نقع التقاوي لمدة 44 ساعة وكمراً لمدة 48 ساعة وتم إعداد الأرض المستدامة جيداً من حراثة وري وتلوين.
- أظهرت التجارب النتائج التالية:

  - بلغت أعلى نسبة للإنبات 48,8% مع المعاملة ($T_1$) بينما أقل نسبة للإنبات 63,88% مع المعاملة ($T_5$).

  - بلغت أعلى كثافة نباتية 44,8 نبات / م² مع المعاملة ($T_3$) بينما أقل كثافة نباتية 24 نبات / م² مع المعاملة ($T_5$).

  - تحققت أفضل درجة لانتظام توزيع البذرة بالجورة في الاتجاه العرضي والطولي مع المعاملة ($T_1$) حيث كانت قيمة معامل الاختلاف 37 و 113،73% على التوالي.

  - بلغ أكبر مقدار لمحصول الحبوب في المتر المربع والفدان 176،24 طن / فدان مع المعاملة ($T_1$) بينما أقل مقدار لمحصول الحبوب في المتر المربع والفدان 206،12 طن / فدان مع فدان على التوالي مع المعاملة ($T_4$).

  - بلغ أقل مقدار للطاقة المستهلكة 514،1 كيلوواط.ساعة / فدان مع المعاملة ($T_5$) حيث بلغت الطاقة 514،1 كيلوواط.ساعة / فدان مع المعاملة ($T_1$) بينما بلغ أكبر مقدار للطاقة المستهلكة 13،419 كيلوواط.ساعة / فدان والتكاليف 201،12 جنيه / فدان مع المعاملة ($T_5$) حيث بلغت التكاليف 201،12 جنيه / فدان مع المعاملة ($T_1$) بينما بلغت التكاليف 119،000 جنيه / فدان مع المعاملة ($T_4$).

  - باستخدام المعاملة ($T_1$) انخفضت التكاليف بمقدار 4،82 جنيهًا للفدان وازداد محصول الحبوب بمقدار 176،12 طن / فدان وانخفض معدل التقاوي بمقدار 20 كجم / فدان مقارنةً بالمعاملة ($T_4$).