Role of agricultural engineering in environmental and sustainable development for the valley and delta areas: 1111- 1124 FARM MACHINERY AND POWER

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

Abo EL-Naga, M.H.M[1]

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/m^2, 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

[1] Senior Researcher, Agric.Eng. Res. Inst., Dokki, EL- Giza, Egypt.

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 /m^2 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

Fine sand %	Coarse sand %	Silt %	Clay %	Soil texture
22.60	03.83	31.60	41.97	Clay-Silt loam

Materials:

The direct seeding machine:

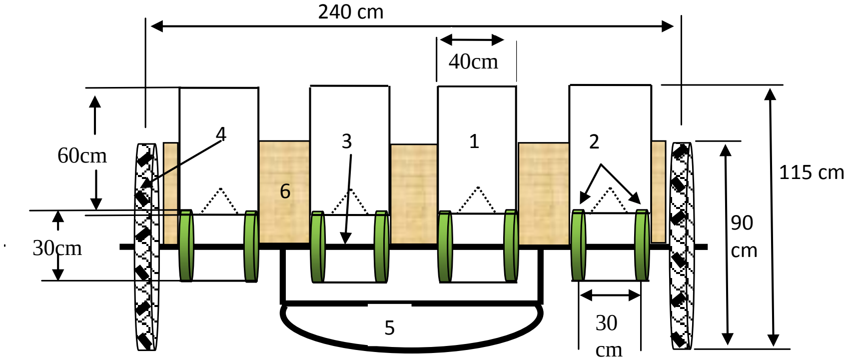
Fig. 1 and 2 indicate the photograph and prototype sketch of the machine developed, the machine consists of four grain box at dimension (L= 30, W= 40 and H = 60 cm) and capacity of 9 kg. In the bottom half of each grain box have been installed barrier as a pyramid form at dimensions of base width = 14 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 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 ($1cm^2$) 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 1cm 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



1	Grain box	2	Feeding disk
3	Axial bar	4	Land wheel
5	Pulling hands	6	Wooden pillars
7	Portal mobile	8	The disk cover

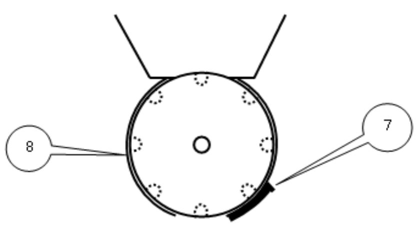


Fig (2): The prototype sketch of a developed direct seeding rice machine

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;

$$Gr = \frac{NP}{NS} \times 100, \ldots\ldots\ldots\ldots\ldots\ldots . (1)$$

Where:

NP = number of emergence grains at length of 1 mm.

NS = number of non-emergence grains.

1. Number of piles and plants per m²:

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:

$$C.V = \frac{\sigma_{n-1}}{\bar{X}} x100 \text{ ---------- } (11)$$

Where:

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

σ_{n-1} = standard deviation

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

$$\sigma_{n-1} = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}} \text{ ---------------- (12)}$$

Where:

Σx = summation of number of grains on the longitudinal or lateral direction.

Σx^2 = 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 must field application as reported by **Coates (1992).**

Human Energy

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

$$E_H = \frac{0.746 \times N_L}{A.F.C.} \text{ (kW.h / fed)----------------(13)}$$

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.

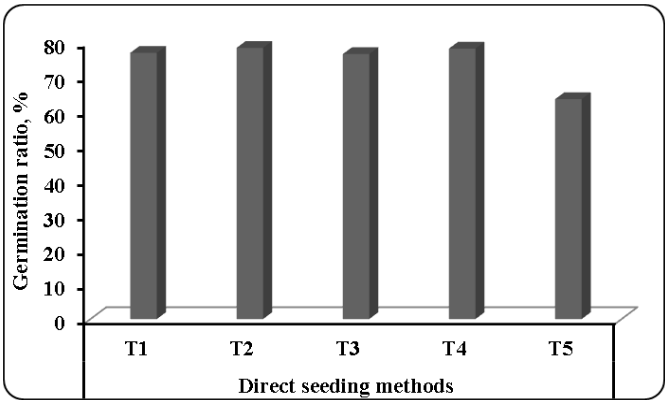


Fig.(3):Effect of direct seeding methods on germination ratio,%

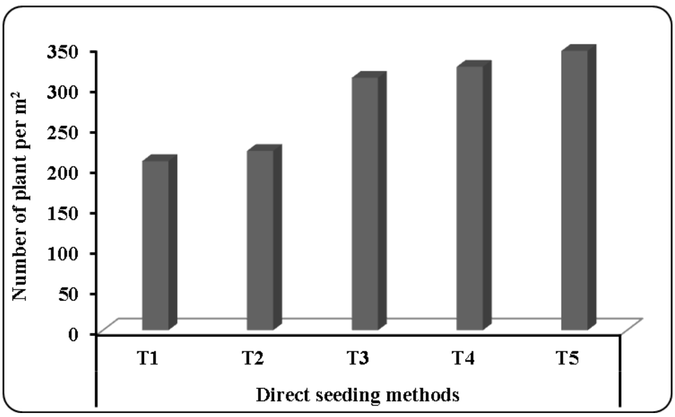


Fig.(4):Effect of direct seeding methods on plant population per m^2

Uniformity of plant distribution:

The results in Figure 5 and 6 indicate to optimize the distribution of plants in lateral direction achieved with T_1 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 T_3 This is due to accuracy of the settings in the fall of the seed from hand to the groove.

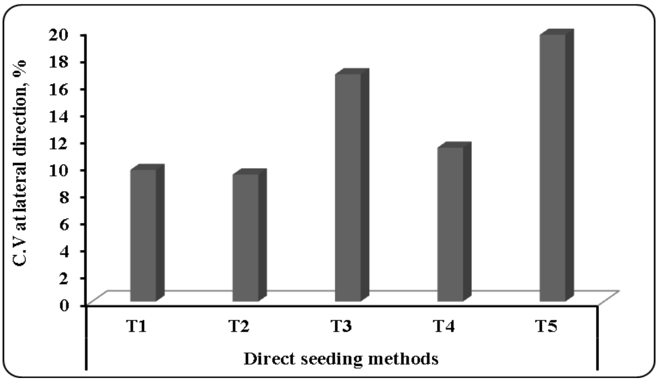


Fig.(5):Effect of direct seeding methods on uniformity of plant destribution at lateral direction

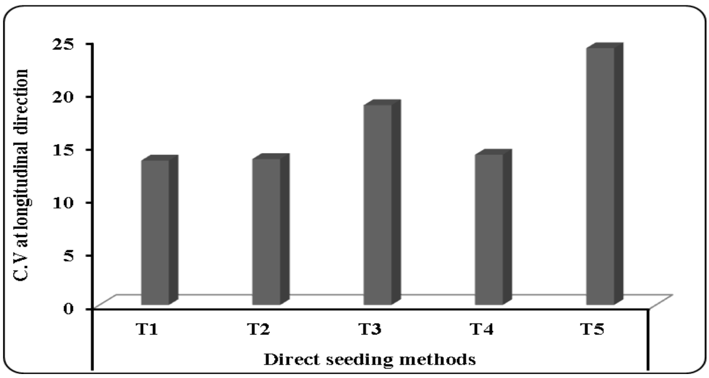


Fig.(6):Effect of direct seeding methods on uniformity of plant destribution at longitudinal direction

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/m^2 (3.225 ton/fed) were achieved by T_1 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/m^2 (3.020 ton/fed) were obtained by T_3.

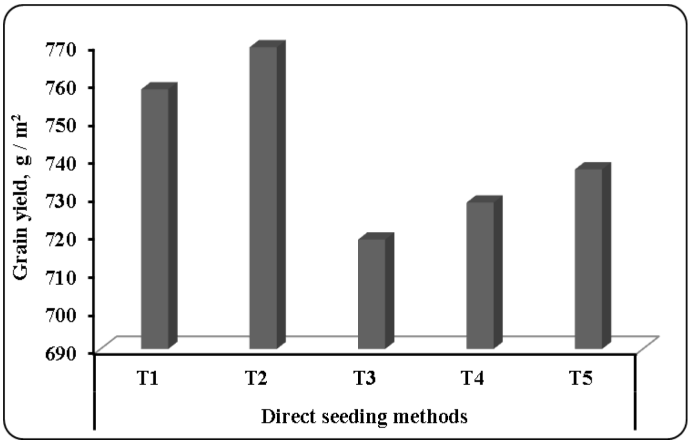


Fig.(7):Effect of direct sowing methods on grain yield per m^2

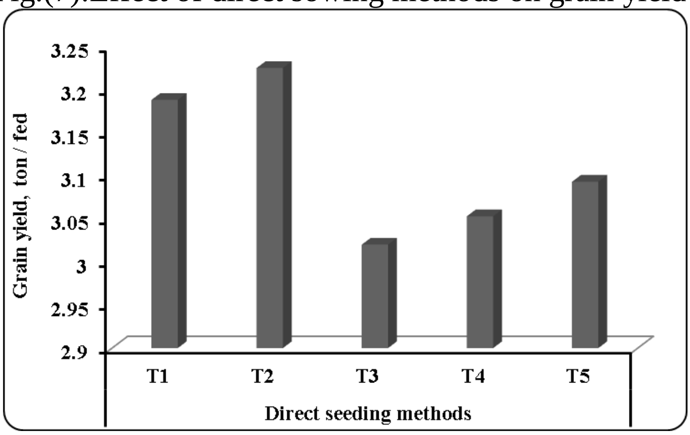


Fig.(8):Effect of direct sowing methods on grain yield per feddan

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 T_1While the lowest value of energy consumed, 0.20 kW.h/fed with T_5 and sequence by 0.41 and 0.514 kW.h/fed with T_2 and T_1 respectively, meanwhile the highest value of energy consumed, 13.32 and 13.419 kW.h/fed achieved by T_4 and T_3 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 T_5, T_2, T_1, T_4 and T_3 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

Operations	**Direct seeding methods**				
	T_1	**T_2**	**T_3**	**T_4**	**T_5**
Effective field capacity (fed/hr)	0.36	0.31	0.028	0.032	0.373
Theoretical field capacity (fed/hr)	0.50	0.375	0.039	0.071	0.476
Field efficiency (%)	72	82.67	71.79	45.07	78.36
Energy consumption kW. h/fed	0.41	0.514	13.32	13.419	0.20
Costs required, LE / fed	19.42	22.12	119.05	108.61	13.4

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.

- The lowest value of energy consumed and cost required 0.20 kW.h/fed and 11.7 L.E/fed were obtained by using T_5, while in T_1 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 T_1 comparing with T_3 In addition to providing 20 kg of seeds from seed rate.

REFERENCES

Anbumozhi, V.; Yamaji, E.; Tabuchi, T.2002 Determination of optimum spatial arrangement of rice plants in direct seeding methods. Acta Agronomica Hungarica, 2002, Vol.50, No.1, pp.35-42, 9 ref.

Borlagdan.P.C., and M. Yamauchi . 1995. Seeder developed for direct sowing of rice under the puddled soil surface. *IRRN.* 20(1) 29 –30.

Coates, W. (1992) Performance evaluation of a pendulum spreader. Trans. ASAE, 8 (3): 285-288.

Griepentrog, H. W.1999. On assessing seed distribution over area. Agrartechnische Forschung, 1999, Vol.5, No.2, pp.117-124, 19 ref.

Gupta, C. P. and Totok Herwanto(1992). Design and development of a direct paddy seeder. Agricultural Mechanization in Asia, Africa and Latin America. Vol. 23, No. 1, Pp. 23-27.

Hunt, D, (1983). Farm power and machinery management 8 th Ed., Iowa state Univ., Ames, U. S. A.

Khan, A.U. and A.F. El-Sahrigi, (1990). Selective mechanization of rice farming system in tropical Asia. Agric. Eng. Today 14(3,4): 40,52.

Md. Syedul Islam and Desa Ahmad (1990) Modification, test and evaluation of manually operated drum type seeder for lowland paddy. Pertanika J. Sci. & Technol. 7(2): 85 – 98 (1999).

Rao, A.N. ; D.E. Johnson ; B. Sivprasad ; J.K. Ladha and A.M. Mortimer (2007). Weed management in direct-seeded rice. Advances in Agronomy, volume 93(2007): 152 - 255.

Shekar, J. and C.M.Singh, 1991. Influence of methods and dates of stand establishment on growth and yield of rice. *Oryza*, 28:45-48.

Sudhir Y.; M.S.Gill and S.S.Kukal (2007)" performance of direct-seeded basmati rice in loamy sand in semi-arid sub-tropical India" Soil and tillage research, Volume 97, Issue2,December 2007 : 229-238.

Thakur AK, S. Roychowdhury, DK Kundu and Ravender Singh(2004) Evaluation of planting methods in irrigated rice. Archives of Agronomy and Soil Science, Volume 50, Issue 6 December 2004, pages 631 - 640

الملخص العربى

الأداء الحقلي لآلة مطورة للزراعة المباشرة لحبوب الأرز المنقوعة والمكمورة

محمد حمزه مخيمر أبو النجا[١]

يمثل محصول الأرز الغذاء الرئيسي لأكثر من نصف سكان العالم ويحتل المرتبة الأولى من حيث المساحة والأهمية على المستويين العالمي والمحلى، وتمثل عملية الزراعة الجانب الأعظم في إنتاجية محصول الأرز لما تتطلبه من طاقة وتكاليف وقدر كبير من التقاوي، وتعد نظم الزراعة المباشرة أحد جوانب المساهمة في النهوض بمحصول الأرز وعليه تمثل الهدف الرئيسي لهذا البحث في تقييم الأداء الحقلي لآلة زراعة مطورة للزراعة المباشرة لحبوب الأرز المنقوعة والمكمورة ومقارنتها بنظم الزراعة المباشرة التقليدية وتم تنفيذ التجارب الحقلية بمزرعة خاصة بقرية نوسا الغيط – أجا - دقهلية خلال موسمي الزراعة الصيفي لعامي ٢٠٠٨ و ٢٠٠٩م على مساحة واحد فدان حيث تم تقسيمه إلى ثلاث قطاعات رئيسية تمثل المكررات، وتم تقسيم كل مكررة إلى خمسة قطاعات فرعية متساوية وزعت عليها معاملات الدراسة عشوائياً والتي تمثلت في خمسة معاملات :-

- المعاملة الأولى (T_1): آلة الزراعة المطورة بمعدل تقاوي ٤٠ كجم / فدان مع استخدام فجاج خشبي لعمل أخاديد صغيرة.
- المعاملة الثانية (T_2): آلة الزراعة المطورة بمعدل تقاوي ٤٠ كجم / فدان بدون استخدام فجاج خشبي لعمل أخاديد صغيرة.
- المعاملة الثالثة (T_3): الزراعة يدوياً باللقمة في جور عشوائية بمعدل تقاوي ٦٠ كجم / فدان مع فجاج خشبي يدوى لعمل أخاديد صغيرة.
- المعاملة الرابعة (T_4): الزراعة يدوياً باللقمة في جور عشوائية بمعدل تقاوي ٦٠ كجم / فدان بدون فجاج خشبي لعمل أخاديد صغيرة.

---

[١]باحث أول بمعهد بحوث الهندسة الزراعية – الدقي – الجيزة – مصر

- المعاملة الخامسة (T_5): الزراعة المباشرة يدوياً بالنثر بمعدل تقاوي ٨٠ كجم / فدان.

الصنف المستخدم سخا ١٠١ وتم نقع التقاوي لمدة ٢٤ ساعة وكمرها لمدة ٤٨ ساعة و تم إعداد الأرض المستديمة جيداً من حراثة وري وتلويط.

وأظهرت التجارب النتائج التالية:

- بلغت أعلى نسبة للإنبات ٧٨,٤٪ مع المعاملة (T_1) بينما أقل نسبة للإنبات ٦٣,٥٨ % مع المعاملة (T_5).
- بلغت أعلى كثافة نباتية ٣٤٤,٧٣ نبات/ م٢ مع المعاملة (T_5) بينما أقل كثافة نباتية ٢٠٨,٦٩نبات/م٢ مع المعاملة (T_1).
- تحققت أفضل درجة لانتظام توزيع البذرة بالجورة في الاتجاه العرضي والطولي مع المعاملة (T_1) حيث كانت قيمة معامل الاختلاف ٩,٣٧ و ١٣,٧٣٪ على التوالي.
- بلغ أكبرمقدار لمحصول الحبوب في المتر المربع والفدان ٧٦٩,٢٣ جم / م٢ و ٣,٢٢٥ طن / فدان على التوالي مع المعاملة (T_1) بينما أقل مقدار لمحصول الحبوب في المتر المربع والفدان ٧١٨,٧٣ جم / م٢ و ٣,٠٠٢ طن / فدان على التوالي مع المعاملة (T_4).
- بلغ أقل مقدار للطاقة المستهلكة ٠,٢ كيلووات.ساعة / فدان والتكاليف و١١,٧٠ جنيه / فدان مع المعاملة (T_5) حيث بلغت الطاقة ٠,٥١٤ كيلووات. ساعة /فدان والتكاليف ٢٢,١٢ جنيه / فدان مع المعاملة (T_1) بينما بلغ أكبر مقدار للطاقة المستهلكة ١٣,٤١٩ كيلووات.ساعة / فدان والتكاليف ١١٩,٠٥ جنيه / فدان مع المعاملة (T_4) .
- باستخدام المعاملة (T_1) انخفضت التكاليف بمقدار ٨٦,٤٩ جنيهاً للفدان وازداد محصول الحبوب بمقدار ٠,١٧٢ طن / فدان وانخفض معدل التقاوي بمقدار ٢٠ كجم / فدان مقارنةً بالمعاملة (T_4).