Misr J. Ag. Eng., 26(3): 1092 - 1103 FARM MACHINERY AND POWER

RELATION BETWEEN DIFFERENT PLANTING METHODS AND RICE VARIETIES ON YIELD AND WATER REQUIREMENTS

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ABSTRACT

Different planting methods were used (Mechanical drilling, Mechanical transplanting and manual transplanting) and two rice variety (Giza 177 and Sakha 101) was used in this study to evaluate machine performance and water requirements. The experimental carried out in Rice Mechanization Center, Meet El-Dyba, Kafr El-sheikh, governorate during summer season of 2007.

Increasing the forward speed for all planting machines tends to increase the effective field capacity, fuel consumption rate, power consumption, energy required and slip ratio and decrease field efficiency and specific fuel consumption.

Also, the water requirement for different planting methods were (5686.2, 4500.8 and 5300.0 m^3/fed) and (5858.5. 5091.5 and 5460.0 m^3/fed) for rice variety Giza 177 and Sakha 101 under different planting methods, respectively. The grain yield was (3.300, 3.494 and 2.726 ton/fed) and (3.420, 3.980 and 2.957 ton/fed) for rice variety Giza177 and Sakha101 under different planting methods, respectively. The highest W.U.E value was obtained by using mechanical transplanting methods (0.571 and 0.582 kg/ m^3) for rice variety Giza 177 and Sakha 101, while the lowest value was (0.514 and 0.542 kg/ m^3) for Giza 177 and Sakha 101 under the manual transplanting .

INTRODUCTION

It is well known that rice is one of the major cereal crops in Egypt as well as in the world. The direct - seeded rice area is increased year after year in Egypt as one of the least labour consuming practice. So that, it is needed to look for another methods for rice cultural practice including new land preparation methods and cultivation.

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In Egypt, the manual transplanting is the conventional method for cultivating rice, however it becomes very expensive method because of the shortage of labours. So that, it is needed to look for another economical method for rice cultural practices by using the mechanical solutions such as drilling which requires less number of labour, the saving in labour may substantially reduce production cost particularly in areas where labor cost is high.

The water requirements of rice crops is larger than any other crop of a similar duration, thus planting rice in salt affected soils is the most important element in reclamation processes .Water of the River Nile is not sufficient for both reclaiming and irrigation purposes for the soil. So, saving the water is necessary demand to face this problem. Therefore, evaluating the methods of rice planting concerning water requirements and water use efficiencies is a must be considered .

El-Refaee (2002) investigate the effect of irrigation regimes on some growth attributes, yield and its components, some grain quality as well as some rice water relations of Giza 178 and Sakha 102 rice cultivars under different planting methods. He found that the dibbling method received the highest amount of irrigation (13519.6and 13506.5 m^3/ha), followed by broadcasting (12944.0 and 13269.8 m^3/ha), followed by transplanting (12297.3 and 12098.3 m^3/ha) and drilling method which ranked the last one and received the lowest amount (12170.8 and 11977.0 m^3/ha) in 1999 and 2000 seasons, respectively. Also, he mentioned that the transplanting was considered the best for water use efficiency followed by drilling, broadcasting and dibbling method which gave the lowest values in both seasons.

Ebaid ,et al.(2001) study the effect different nitrogen fertiliza- tion levels and weed control under two planting methods, mechanical and manual transplanting on Giza 177 rice cultivar. They mentioned the rice production cost per hectare in mechanical transplanting increases by 15.76 % comparing with manual transplanting. In the other hand the rice production in manual transplanting per hectare increases by 11.8 % comparing with mechanical transplanting.

El- Khateeb (1999) stated that total rice production cost can be calculated as the sum of the total cost per use of the tractor and implement. So, the total by using mechanical drilling in dry condition, wet condition, mechanical transplanting and manual transplanting reached 369.62, 387.16, 401.31, and 423.96 LE/fed, respectively. Generally, it is obvious that the production of rice by using the mechanical drilling in dry condition gives lowest cost, in (87.48 LE/Mg), highest net profit, in (412.52 LE/Mg) and highest net grain yield, in (4.23 Mg/fed). This is due to electronic control system efficiency.

El-Gibali and Mahrous (1970) found that the transplanting increased rice grain yield by 23.56 % , saved 18.7 % of the water requirements and gave the highest water use efficiency.

Hegazy, et al . (1992) found that the superiority of transplanting method over the other methods (dibbling, seed drill and broadcasting) which gave the highest grain yield, saving irrigation water and achieved the highest values of water use efficiency.

El-Mowelhi, et al. (1995) studied that the water use efficiency as affected by different method of planting show that transplanting method achieved the highest value (0.50 kg/m^3 of water delivered), followed by broadcasting method while the lowest value resulted from seed drill.

These findings may be attributed to the following :

a)Transplanting method recorded the highest grain yield as compared with the other methods.

b)Puddling process is considered the normal practice which decrease the percolation losses, therefore the transplanting received the less amount of irrigation water as compared to other methods.

Abo-Soliman, et al. (1996) found that the water requirements for rice under such conditions at north delta were 8059.9, 9167.7, 8148.5 and 7149.7 m^3/fed, for methods of planting dibbling, seed drill, broadcasting and transplanting, respectively. Also, the transplanting method achieved the highest value of water use efficiency (0.57 kg/m^3), followed by the broadcasting method (0.34 kg/m^3), while the other two methods recorded equal value (0.22 kg/m^3).

MATERIALS AND METHODS

An area of about two feddans has been selected at experimental Rice Mechanization Center, Meet El-Dyba, Kafr El-Sheikh during the summer season 2007 to evaluate the different methods of rice planting and rice variety on rice yield and water requirements. Two rice variety Giza 177 and Sakha 101 was used in this study.

Materials:-

Different planting methods were used the were mechanical drilling, mechanical transplanting and manual transplanting.

1- Mechanical drilling:-

Paddy grain were mechanically drilled at 20 cm row spacing and 2 cm below soil surface. The machine was adjusted before planting to gave the rate 45 kg/fed. This method requires dry land preparation without puddling. Land was plowed by chisel plough two- passes + scraper.

The required chemicals for fertilizer was add as recommended in this area. Super phosphate 100kg/fed was added to the soil after the plowing. Urea 100 kg/fed was added to the soil after the plowing.

Chemicals for weed control was added as follow : Saturn 2 lit/fed mixed with 100-120 litters of water was used to weed control after 2-3 days from planting.

The first irrigation was directly after planting and then at 5 day interval up to the first four weeks until the germination percentage of seeds in maximum and then the plots were flooded until the crop reached maturity.

2- Mechanical transplanting :-

Seed were soaked in a salt solution to get a good seed by flotation of undesired seed on the surface of a salt solution. After carrying out the soaking operation a wet clothes will cover the seed for three days to get germinated seeds. The seedlings are grown in nursery boxes demensions of planting trays are ($58 \times 28 \times 3$ cm^3) with small holes in the bottom. It has a small holes on bottom which covered by newspaper to prevent soil to be lost. 250 grams of germinated seeds were uniform sown on the tray which has a quantity of fine soil of about 1.5 cm height. After seeding, seed were covered with thin layer of soil of about 0.5 cm and the cover was moistened by water sprayer. The trays were covered and incubated from 24 to 48 hours for helping the seeds to grow fast. Then transferred to the nurseries and irrigated two times a day. Seedlings were transplanted after 15-20 day old when the seedling height reached from 15 to 20 cm. The water depth in the main land during transplanting operation was 2 cm. The nursery area is considered 20 square meter per one feddan. The land preparation system carried out in the main land was chisel plough two passes + puddling.

Fertilization for the nursery 8.0 gm from super phosphate per tray was added to the soil before seeding and 5.0 gm from urea per tray was added also. Fertilizing for the main land was the same for the mechanical drilling.

Weed control for the main land was carried 2.0 litter/fed mixed with 100-120 litters of water was used as a weed control after 7 days from transplanting. The nursery was irrigated by water level 2-3 cm for five days after that the nursery drained in the evening and irrigated again in the morning for another five days. The water was drained from nursery for two days after that the nursery was irrigated at five days interval until the seeding were transplanted in the main land after 20 days from sowing. After transplanting by three days the main land was irrigated to a level of 3-5 cm this level increased gradually to 7-10 cm until the crop matures.

3- Manual transplanting :-

For the manual transplanting system, germinated seeds were uniformly sown by hand in the nursery at a rate of 60 kg/fed. The rice transplanting were manually transplanted in the main land after 30-40 days in the nursery at spacing of 20×20 cm.

land preparation system carried out in the main land was the same for the mechanical transplanting.(Area of nursery was 350-400 m^2 per feddan). The water depth in the main land during transplanting operation was 2 cm.

Fertilizing for the nursery 10.0kg super phosphate was added to the soil after the plowing and 8.0kg urea was added to the soil after the plowing. The Fertilizing, weed control and irrigation system in the main land for the manual transplanting was the same as followed for the mechanical transplanting.

Harvesting time:

The crop was harvested when the panicles became yellow, which the stems and leaves still having some green colour. The moisture content of grains at this (18-25%).

Miscellaneous equipment:

Stop wash, wooden square scale of 1×1 m^2 , electrical balance ,drying oven, ruler and measure tape and calibrated cylinder.

Equipment specification:

Seed drill machine type Tye-source of manufacture American, row spacing 20cm, number of tubes 15, total mass 500 kg, hopper capacity 140 kg. Tractor power used 45 kW.

Rice transplanter type 8-row riding rotary, model S1-800R; max. out-put hp 8.5, total width 278.5 cm, total mass 425 kg. No. of planted rows 8, fuel type diesel and fuel tank capacity 8 litters.

The soil of experimental field was clay loam. Mechanical analysis for soil of the experimental sites is given in Table 1. The preceding crop was barseem.

Table 1: mechanical analysis of soil experimental.

Mechanical analysis				
Clay,%	**Silt,%**	**Fine sand,%**	**Coarse sand,%**	**Soil texture**
53.0	**20.9**	**24.1**	**2.0**	**clay**

Machine performance:

a) Actual field capacity:

The actual field capacity (AFC) was calculated as follows:

$$AFC = \frac{1}{\text{Actual total time in hours required per feddan}}, \text{ fed/h}$$

b) The field efficiency ($\acute{\eta}_f$) was calculated as follows:

$$\acute{\eta}_f = \frac{AFC}{TFC} \times 100 , \%$$

TFC = Theoretical field capacity

c) Slippage (S %)

$$(S\,\%) = \frac{L_1 - L_2}{L_1} \times 100$$

Where L_1 = advance per 10 wheel revolution under no load, m.

L_2 = advance per 10 wheel revolution under load, m.

d) Energy requirements (E_r):

Energy requirements was calculated using the following equation:

$$E_r = \frac{\text{Power required, (kw)}}{\text{Actual field capacity (fed /h)}} \quad \text{, kW.h/fed}$$

$$EP = \left(F_c \times \frac{1}{60 \times 60}\right)\rho_f \times L.C.V. \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} \text{ , kW}$$

F_c= Is the fuel consumption, l/h,

ρ = density of the fuel, kg/l,(0.85 and 0.73 kg/l for diesel and gasoline

L.c.v.= lower calorific value of fuel, kcal/kg,

(10000 and 11030 kcal/kg for diesel and gasoline, respectively).

427= thermo – mechanical equivalent, kg.m/kcal,

η_m = mechanical efficiency of the engine, (considered to be 80% for diesel and gasoline engine).

η_{th} = thermal efficiency of the engine, (considered to be about 35 and 25% for diesel and gasoline engine, respectively).

e) Specific fuel consumption (S.F.C):

$$S.F.C = \frac{\text{fuel consumption, L/h}}{\text{Power required, kW}} \quad \text{, L /kW.h}$$

f) Irrigation water measurements :

The amount of irrigation water delivered to each main plot was measured and controlled by using a flow meter before and after irrigation.

g) Water Use Efficiency (WUE) :

It is defined as the amount of rice grains in kg per one cubic meter of the water applied.

$$WUE = \frac{\text{Rice grain yield (kg/fed)}}{\text{Water applied (m}^3\text{/fed)}} \text{ , kg /m}^3$$

Results and Discussion

1-Power and energy requirements for planting machines:

Studying the different parameters of power requirementand the total time of any field operation assist in the energy requirements calculation for each machine.

Data in Table 2 shows the effect machine type and forward speed on the effective field capacity, field efficiency, specific fuel consumption, power, energy required and slip ratio.

The results indicate that the increase in the forward speed from (3.61 to 7.22 km/h) and (1.50 to 2.20 km/h) for seed drill machine and transplanter machine tends to increase power from (14.0 to 33.20 kW) and (4.9 to 6.20 kW) for seed drill and transplanter, respectively. This trend may be due to that the fuel consumption in L/h increased by increasing the forward speed. Also, increased energy required from (9.33 to 11.44 kW.h/fed) and (7.90 to 8.28 kW.h/fed) for seed drill and transplanter, respectively.

From the same table it is clear that the estimated specific fuel consumption decreased from (0.316 to 0.280 l/kW.h)and (0.317 to 0.275 L/kW.h) by increasing the same forward speeds.

Table 2 shows that the effective field capacity increased from (1.50 to 2.90 fed/h) when the forward speed increased from (3.61 to 7.22 km/h) for the seed drill machine. Also, the field efficiency was decreased from (89.5 to 82.0 %) by increasing the forward speed. While the effective field capacity increased from (0.62 to 0.75 fed/h) when the forward speed increased. Also, the field efficiency was decreased from (75.0 to 64.2 %) by increasing the forward speed of transplanter machine from (1.50 to 2.20 km/h).

There is no doubt that the slip ratio increases as the forward speed for different planting machine is increased. It is obvious that the increase the forward speed from (3.61 to 7.22 km/h)and (1.50 to 2.20 km/h) for seed drill and transplanter machine tends to increase slip ratio from (2.99 to 7.50%) and (10.0 to 20.0%) for seed drill and transplanter , respectively.

Table2:Effect of machine type and forward speed on the effective field capacity, field efficiency, specific fuel consumption, power, energy required and slip ratio.

Planting machine	Forward speeds km/h	Effective field capacity fed/h	Field efficiency (%)	Specific fuel Consumption L/kw.h	Power required kw	Energy Required kw.h/fed	Slip ratio (%)
Seed drill machine	3.61	1.50	89.5	0.316	14.0	9.33	2.99
	5.83	2.40	86.3	0.300	25.0	10.42	5.40
	7.22	2.90	82.0	0.280	33.2	11.44	7.50
Machine transplanter	1.50	0.62	75.0	0.317	4.9	7.90	10.0
	1.80	0.70	71.4	0.299	5.7	8.14	15.0
	2.20	0.75	64.2	0.275	6.2	8.28	20.0

Crop water relation : -

Table 3 presents the data of water applied and water use efficiency as influenced by different planting methods and rice varieties. The water applied for rice under different methods of planting were (5686.2, 5858.5), (4500.8, 5091.5) and (5300, 5460 m^3/fed) for mechanical drilling, mechanical transplanting manual transplanting, respectively under two rice varieties (Giza 177 and sakha 101). These findings may be attributed to puddling process (Talweet) is considered the normal practice which decrease the percolation losses, there for the transplanting received the less amounts of irrigation water m^3/fed to the other methods. Similar results were obtained by **El-Gibali and Mahrous (1970), Hegazy, et al. (1992) and El-Mowelhi, et al. (1995).**

Table3:Water requirement and water use efficiency (W.U.E) as influenced by different planting methods and rice cultivars.

Planting methods	Applied water m^3/fed		Grain yield kg/fed		Water use efficiency (W.U.E) kg/m^3	
	Giza 177	Sakha101	Giza 177	Sakha101	Giza 177	Sakha101
Mechanical drilling	5686.2	5858.5	3071	3187	0.540	0.544
Mechanical transplanting	4500.8	5091.5	2570	2963	0.571	0.582
Manual transplanting	5300.0	5460.0	2724	2959	0.514	0.542

From the same table it is clear that the W.U.E for the different planting methods were found to be (0.540, 0.544), (0.571, 0.582) and (0.514, 0.542 kg/m^3) for mechanical drilling, mechanical transplanting and manual transplanting, respectively under two rice varieties (Giza 177 and sakha 101). Similar results were obtained by **El-Refaee (2000).**

Mechanical transplanting gave the highest W.U.E (0.571 and 0.582 kg/m^3) for Giza 177 and Sakha 101, respectively and manual transplanting gave the least W.U.E (0.514 and 0.542 kg/m^3) for Giza 177 and Sakha 101, respectively. These findings may be attributed to mechanical transplanting recorded the lowest applied water as compared with the other methods.

REFERENCES

Abo-Soliman, M.S. ; M.M. Saied ; E.Giza and S. Barbary(1996). Water soil and rice crop management relating to the improvement of salt affect soils at North Deltta. Misr J.Ag. Eng., Cairo univ. irri. Conf., 3-4. April : 62-74.

Ebied, R.A. ; G.H. El-Sayed ; A.A. Mohamed and A.A.khadr (2001). Comparative study between mechanical and manual rice transplanting methods under different nitrogen fertilization levels and weed control. Misr J.Ag.Eng., 18(3):769 - 780.

El-Gibali,A.A.and F.N. Mahrous(1970). Water requirements for rice crop in North Delta. First Agric. Rice Res. Conf. Cario, Jan 24-26.

El-Khateeb, H.A. (1999). A study on mechanization of rice planting. Ph.D. Dept. of Agric. Mech. Fac. of Ag. Kafr El-Sheikh, Tanta univ.

El-Mowelhy, N.M.; M.H. Hegazy ; F.N. Mahrous and I.Benjamen (1995). Evaluating some important agric. Practices of rice to maximize water utilization efficiency in Northern Delta. Second conf. , ARC, Giza, Cairo, April 9-11.

El-Refaee, I.S.H. (2002). Studies on irrigation systems for some rice cultivars. Ph. D. Ag. Sc. of Agronomy Fac. of Ag. Agro. Dept. Kafr El-sheikh, Tnata univ.

Hegazy,M.H.,M.S.Abo-Soliman;M.A.AboEl-SoudandS.AAbdEl-Hafez(1992). Evaluating different planting methods of rice grown under salt affected soil proc. 5th conf. Agron. Zagazig, Vol.(1) : 64 - 70.

Conclusions

1-Increasing the forward speed from (3.61 to 7.22 km/h) and (1.5 to 2.2 km/h) tends to increase power consumption from (14.0 to 33.2 kW) and (4.9 to 6.2 kW) for seed drill and transplanter, respectively.

2-Increasing the same forward speed tends to increase energy requirements from (9.33 to 11.44 kW.h/fed) and (7.90 to 8.28 kW.h/fed) for seed drill and transplanter, respectively.

3-Increasing the same forward speed tends to increase the effective field capacity from (1.50 to 2.90 fed/h) and from (0.62 to 0.75 fed/h) for seed drill and transplanter, respectively. Also, the field efficiency decreased from (89.5 to 82.0 %) and (75.0 to 64.2 %) for seed drill and transplanter, respectively.

4-Increasing the same forward speed tends to decrease the specifc fuel consumption from (0.316 to 0.280 L/kW.h) and (0.317 to 0.275 L/kW.h) for seed drill and transplanter, respectively.

5-The water consumption for rice planting methods were (5686.2, 4500.8 and 5300.0 m^3/fed) for rice variety Giza 177 and were (5858.5, 5091.5 and 5460.0 m^3/fed)for rice variety Sakha 101 under different rice planting methods mechanical drilling, mechanical transplanting and manual transplanting, respectively.

6-The mechanical transplanting gave the highest WUE (0.571 and 0.582 kg/m^3) for Giza 177 and Sakha 101, respectively. While the manual transplanting gave the least WUE (0.514 and 0.542 kg/m^3) for Giza 177 and Sakha 101, respectively.

الملخص العربي

العلاقة بين الطرق المختلفة لزراعة محصول الأرز والأصناف علي الإنتاجية والاحتياجات المائية

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أجريت التجربة بالمزرعة البحثية لمركز ميكنة الأرز بميت الديبه في مساحة ٢ فدان موسم صيفي ٢٠٠٧م لتقييم الطرق المختلفة لزراعة محصول الأرز وتم زراعة صنفين مختلفين لمحصول الأرز جيزة ١٧٧ وهو مدة بقاءه في الأرض حوالي ١٢٥ يوم والصنف الثاني هو سخا ١٠١ وهو مدة بقاءه في الأرض حوالي ١٤٥ يوم وقد أستخدم الطرق التالية لزراعة محصول الأرز .

١ ـ تسطير ميكانيكي في الحالة الجافة   ٢ـ الشتل الميكانيكي   ٣ـ الشتل اليدوي

<u>وكانت النتائج المتحصل عليها كالأتي</u> :-

١ـ زيادة السرعة الأمامية من (٣,٦١ إلي ٧,٢٢ كيلو متر /ساعة) ومن (١,٥ إلي ٢,٢٠ كيلو متر /ساعة) أدت إلي زيادة القدرة المستهلكة من (١٤ إلي ٣٣,٢٠ كيلو وات) ومن (٤,٩ إلي ٦,٢٠ كيلو وات) وذلك لا له التسطير والشتالة علي التوالي .

٢ـ زيادة نفس السرعات الأمامية أدت إلي زيادة الطاقة اللازمة من (٩,٣٣ إلي ١١,٤٤ كيلو وات. ساعة / فدان) ومن (٧,٩٠ إلي ٨,٢٨ كيلو وات . ساعة / فدان) وذلك لآلة التسطير والشتالة علي التوالي .

٣ـ زيادة نفس السرعات الأمامية أدت إلي زيادة نسبة الانزلاق من (٢,٩٩ إلي ٧,٥٠٪) ومن (١٠إلي ٢٠٪) وذلك لآلة التسطير والشتالة علي التوالي .

٤ـ زيادة نفس السرعات الأمامية أدت الي زيادة السعة الفعلية الحقلية من (١,٥٠ إلي ٢,٩٠ فدان . ساعة) ومن (٦٢, إلي ٧٥, فدان / ساعة) وذلك لآلة التسطير والشتالة علي التوالي .

٥ـ زيادة نفس السرعات الأمامية أدت الي نقص الاستهلاك النوعي للوقود من (٣١٦, إلي٢٨٠ , لتر /كيلو وات ساعة) ومن (٣١٧, إلي ٢٧٥, لتر/ كيلو وات ساعة) وذلك للسطارة والشتالة علي التوالي .

٦ـ الاستهلاك المائي لطرق زراعة الأرز المختلفة كانت (٥٦٨٦,٢ – ٤٥٠٠,٨ – ٥٣٠٠ م٣/ فدان) وذلك للصنف جيزة ١٧٧ وكانت (٥٨٥٨,٥ – ٥٠٩١,٥ – ٥٤٦٠م٣/ فدان) وذلك للصنف سخا ١٠١ مع التسطير الميكانيكي في الحالة الجافة – الشتل الميكانيكي – الشتل اليدوي علي الترتيب .

٧ـ أعطي الشتل الميكانيكي أعلي قيمة لكفاءة استخدام المياه (٥٧١, ـ ٥٨٢, كيلو جرام / م٣) وذلك للصنف جيزة ١٧٧وسخا ١٠١ أما طريقة الشتل اليدوي أعطت أقل قيمة لكفاءة استخدام المياه (٥١٤, ـ ٥٤٢و كيلو جرام / م٣) وذلك لنفس الصنفين علي التوالي .

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