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Soybean Response to Mechanical - Planting methods in a Clay-loam Soil

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ABSTRACT

The experiments were performed at El-Gemmeiza Research Station during 1999 season to investigate factors relevant to cultivate soybean mechanically planting . The experiments were conducted on clay loam soil. Two types of pneumatic and mechanical planters, were used . Four forward speeds namely: 3.6, 4.7, 5.6 and 6.9Km/h, three levels of soil moisture contents 34.22, 28.60, and 22.30 % were investigated .

Manual planting was studied for comparison. Soybean crop (variety of Giza 111) was planted. Some technical indicators were determined as the germination ratio,%; uniformity of seed distribution in row,%; field efficiency,%; power requirement, kW; tractor wheel slip, %; and total yield, Mg/fed.

The field experiments showed that the proper planting method producing the optimum germination ratio and uniformity of seed distribution, adequate depth planting and the highest productivity was pneumatic planter use. The optimum soil moisture content and foreword speed which gave the highest germination ratio, uniformity of seed distribution and the total yield were 34.60% and 3.6km/h, respectively. The mechanical planting of soybean saved 22% of seeds rate compared with the manual planting.

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INTRODUCTION

Soybean is considered one of the most important industrial and nutrient product. Its seeds contain high percentage of both protein (40%) and oil (about 20%) [Ministry of Agriculture Bulletin, 1980].

The planted area with soybean crop reached about 36349 feddan in 1997. Most of theses areas were manually planted. Meanwhile, the mechanical methods used in planting this crop were rarely compared with the other important seeds and grain crops.

Srivastava (1993) showed that planting mechanism and machine have been developed and carryout any planting method. He mentioned that, in the pressure-disk planters, the positive pressure in the seed reservoir is used to hold seeds in the prockets of the rotating seed plate. The pressure-disk planter has a separate seed reservoir and plate for each row. Gravity moves the seeds from the hopper to the metering unit, where differential pressure holds a seed in each cell. While each cell is closed to the drop tube, a soft brush cuts off the air supply to the cell and the seed falls into the tube by gravity.

El-Shal (1987) concluded that the pneumatic planter is too effective for all seeds and grains of different sizes and shapes under special suction pressure and feed plate speed to produce high uniformity of seeds distribution and high filling percentage. As well as, Inbabi (1996) indicated that the planting by machine in flate soil surprised the planting in furrow soil in all the mechanical criteria evaluation.

Wahby (1976) found that the area per seed affects the yield. To increase the yield, it is required to have a uniformity in seed horizontal distribution and a constant depth of planting. The suitable shape of area for each seed was found to be an equilateral stated that the emergence and stand pattern for cotton is more uniform at higher forward speeds. Therefore, the yield is greater at higher forward speeds, i.e., at higher rate of performance. In other words, the seed drill should be operated at the highest pratical forward speed in order to minimize the costs and increase the yield.

Frisby and Summers (1979) found that the fuel consumption rate increased by increasing forward speed and tractor power had an important effect on the work time and fuel requirements per unit of agricultural area. Moreover, Lando (1990) studied the interaction of soil moisture content (m.c.) and ploughing depth. They were 10, 15, 20, 25 and 30% at ploughing depth of 10 , 15 , and 20 cm using 4 wheel drive and 33.75 kW (45 hp) tractor. Slip was lowest (15%) and highest at 25 cm depth and 30% soil moisture content. At 20 cm depth, slip did not differ significantly at 10, 15, and 20% moisture content while it was less at 15 than at 10% m.c. this is may be due to lower draught resistance.

Mousafa (1993) mentioned that the highest number of vegetative branches and the highest yield were obtained under pneumatic planter. Mechanical planting (pneumatic planter and seed drill) saved about 67.6 and 31.6%, respectively of seeds per feddan compared by manual planting. He also added that the mechanical planting treatments produced heavy grains. The objective of the present work of this work is mainly concentrated on

the machine performance. The field tests was carried out by using two types of planters to evaluate the factors affecting the total yield of soybean. Manual planting of soybean was studied for comparison.

MATERIALS AND METHODS

Field studies were conducted in 1999 season at El-Gemmeiza Research Station, Gharbia Governorate (clayey - loamy soil texture) to evaluate the factors affecting the total yield of soybean. The experimental design was split-split plot with three main strips. The plot area was $120m^2$. (2.4 m x 30 m) which contained a soil moisture content, (d.b. %), a planting methods and a four forward speeds. The plots was replicated three times. Preliminary experiments were carried out to measure soil moisture content. the soil was irrigated to its field capacity for each plot. Soil samples were taken to check soil moisture content before planting immediately. Two different planters were used. One of them was a foiur units pneumatic planter made in Germany. The seeds are sucked on the disk side by means of a fan, powered from the PTO shaft, and leave it at non-suction zone. The other was a four units mechanical (traditional) planter (Italy made).

The Nasr tractor 37.5 kW (50 hp) was used for operating the two planting machines. Manual planting and the other farming practices were conducted according to the agricultural recommendations followed in the experimental zone.

MEASUREMENTS

A) Soil Measurements:

1- Soil mechanical analysis was determined according to the hydrometer method.

2- Soil moisture content (M.C.) based on the dry weight is used as the following equation:

M.C = weight wet sample - dry sample weight / dry sample weight. ...(1)

B) Field work performance:

1 - Field efficiency for each operation was calculated as follows:

$$\eta_f = EFC/TFC \times 100, (\%). \ldots (2)$$

where : AFC = Effective field capacity

EFC = 1/ Teff, Teff = Effective total time

2 – Power requirement (RR) was calculated by the following formula :

$$PR = (Fc \cdot 1/3600) \cdot P_f \cdot LCV \cdot 4270 \cdot \mu_{th} \cdot \mu_m \cdot 1/1000, kW \ldots (3)$$

3 - Wheel slip percentage (S) was calculated according to the following formula:

$$S = [(L_1 - L_2) / L_1], \% \ldots (4)$$

Where

L1 = distance of 10 revolution for tractor wheel on farm road , m

L2 =Distance of 10 revolutions for tractor wheel on the field , m .

C) Planting Measurement:

Total grain yield: A frame of (x) m^2 for measuring the yield was used. The average grain yield and straw yield were calculated in all treatments in Kg/feddan. And the uniformity of seed distribution in row (UH) in percent.

The factor governing the uniform along the rotors can be expressed in form of the coefficient of variation[(C.V), σ10].

$$C.V = \sigma / M \ldots (5)$$

Where:

σ = The standard deviation,

M = The average of the math. mean of seed spacing.

RESULTS AND DISCUSSION

1- Agro - technical aspects:

Data demonstrated in Figs. I a, b, 2 a, b and s a, b show the effect of planting machines performance at different moisture contents and forward speeds on the germination ratio, (GR)%, the uniformity of seed distribution in row%, and total yield, ton/fed. The results indicated that the germination ratio, uniformity and total yield decreased by increasing forward speed. Meanwhile increasing moisture contents, tends to increase germination ratio uniformity and yield. When moisture content decreased from 34.22 to 22.3% at forward speed of 3.6, 4.6, 56 and 6.9km/h, the following points can be seen: germination ratio by using pneumatic planter is bigger than that by using mechanical planter. These ratios were 1.96, 2.52, 2.56 and 3.27% , respectively (Fig. 1 a , b). Moreover, the statistical analysis indicated that, each of moisture content and types of planter and forward speed had highly significant effect on germination ratio. As well as the effect of interaction between each of moisture content and forward speed and planter types had highly significant effect on germination ratio. Uniformity of seed distribution resulted from the pneumatic planter is bigger than for mechanical planter 2.87, 3.62, 3.71 and 3.27%, respectively (Fig. 2 a, b).The analysis of variance showed that each of moisture content, planter types and forward speed gave highly significant effect on uniformity. Also the effect of interaction between each of moisture content and planter types and forward speed was highly significant. The combination of the moisture content, planter types and forward speed had a low significant effect on the uniformity of seed distribution. And the pneumatic

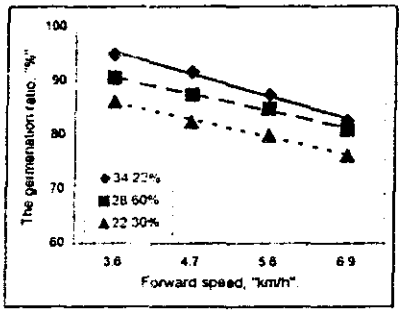

Fig. 1a: Effect of forward speed and soil moisture content on the germination ratio (%) for pneumatic planter.

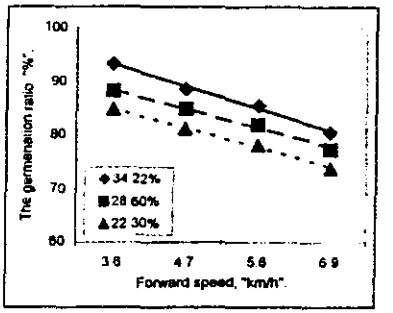

Fig. 1b: Effect of forward speed and soil moisture content on the germination ratio (%) for mechanical planter.

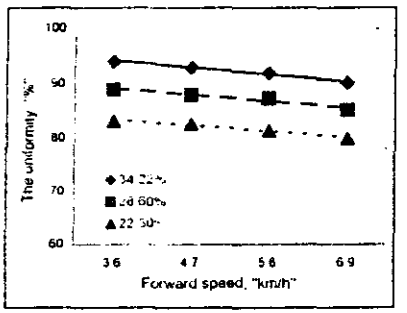

Fig. 2a: Effect of forward speed and soil moisture content on the uniformity (%) for pneumatic planter.

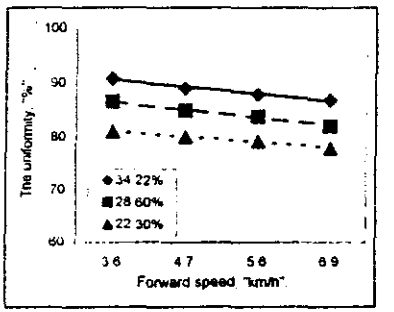

Fig. 2b: Effect of forward speed and soil moisture content on the uniformity (%) for mechanical planter.

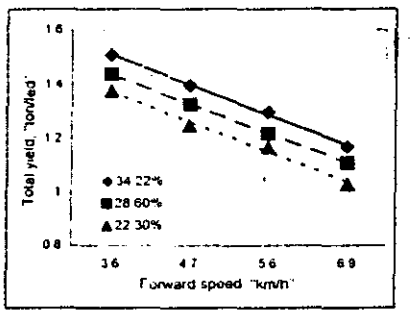

Fig. 3a: Effect of forward speed and soil moisture content on the total yield (ton/fed) for pneumatic planter.

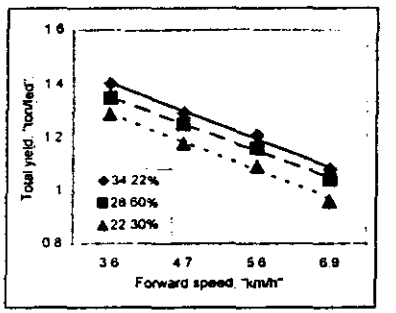

Fig. 3b: Effect of forward speed and soil moisture content on the total yield (ton/fed) for mechanical planter.

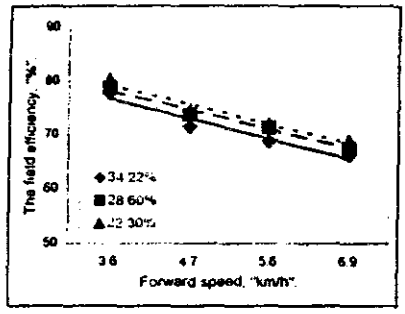

Fig. 4a: Effect of forward speed and soil moisture content on the field efficiency (%) for pneumatic planter.

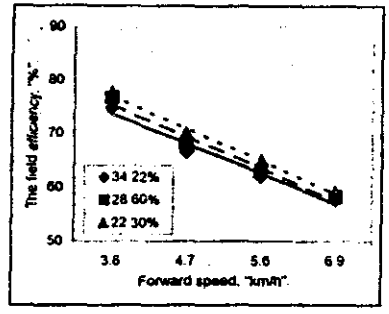

Fig. 4b: Effect of forward speed and soil moisture content on the field efficienc (%) for mechanical planter.

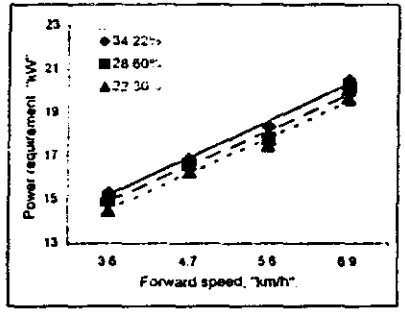

Fig 5a: Effect of forward speed and soil moisture content on the power requirement (kW) for pneumatic planter.

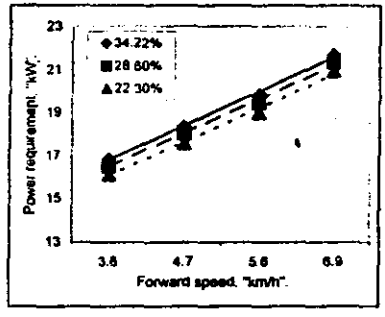

Fig. 5b: Effect of forward speed and soil moisture content on the power requirement (kW) for mechanical planter.

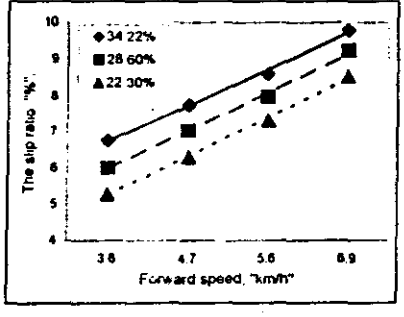

Fig. 6a: Effect of forward speed and soil moisture content on the slip ratio (%) for pneumatic planter.

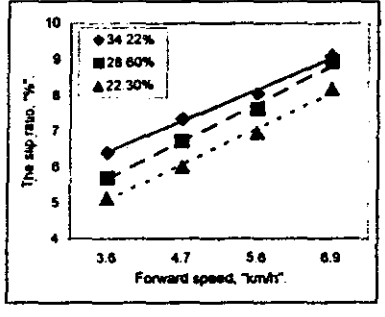

Fig. 6b: Effect of forward speed and soil moisture content on the slip ratio (%) for mechanical planter.

planter gave total yield more than the mechanical planter by 7.12, 6.85, 22.24 and 17.4% (Fig. 3 a, b) respectively. The analysis of variance showed that each of moisture content planter types and forward speed gave highly significant effect on the total yield. Moreover the interaction between forward speed and each of moisture content and planter types showed highly significant effect on the total yield. The mechanical planting methods at 3.6 and 4.7Km/h had a higher total yield compared with the manual planting for all moisture contents, but at forward speed 5.6 and 6.9 Km/h manual planting gave a higher total yield compared with the planters. This can be attributed to the fact at high speeds plate cell of feeders filling percent decreased, the in sufficient depth recovery of seeds or seed damage. The total yield 1.373, 1.439 and 1.101 ton/fed. achieved by manual planting method soil moisture content 34.22, 28.60 and 22.30%.

2-Technical aspects.

Figs. (4a, b), (5 a, b) and (6 a, b) showed the effect of forward speed and soil moisture content on field efficieney, the power requipement (KW) and tractor wheel slip (%) for both pneumatic and mechanical planters. From the obtained data, it is seen that. For both planting machines the field efficiency deceased with increasing the forward speed. This may be due to the increasing rate of the actual field capacity was smaller than the increasing rate of the theoretical field capacity. The results iIndicated that when forward speed increased from 3.6 to 6.9Km/h tended to decrease the field efficiency from 77.78 to 66.19%, from 78.76 to 67.46% and from 80.21 to 68.73% at soil moisture content 34.22, 28.60 and 22.30% respectively with total average

from 78.92 to 67.46% for pneumatic planter. While for mechanical planter the change in the forward speed renilted. In the change in field efficiency from 74.87 to 57.83%, from 76.81 to 58.33% and from 77.78 to 39.09% at soil moisture content of 34.22, 28.60 and 22.30% respectively with total ranyed from 76.49 to 58.42 %. Analysis of variance indicated that forward speed and soil moisture content had highly significant effect of field efficiency.The power requirement for both planting machhines increased by increasing forward speed and decreased by increasing moisture content. For pneumatic planter when forward speed increased from 3.6 to 6.9Km/h the power requirement increased from 16.87 to 21.71, from 16.51 to 21.35 and from 16.13 to 20.97(kw) soil moisture content 34.22, 28.60 and 22.30% respectively. Mean while for mechanical planter the power requirement increased from 15.32 to 20.49, from 14.97 to 20.06 and from 14.51 to 19.68 (kw) at soil moisture content 34.22, 28.60 and 22.30% respectively. The power required by preumatic planter is more than the power required by mechanical planter. Analyses of variance intrated that planter types and forward speed had a highly significant effect on the required power (KW), and the interaction between them is also a significant effect. For both planters and for all soil moisture content tractor wheel slip increased as the forward speed increased. For all forward speed the tractor wheel slip with preumatic planter was higher than tractor wheel slip with mechanical planter. This may be duets heavy man of pneumatic machine. However it is obvious that the differente between the slip for the machines was small.

CONCLUSION

From the previous results it can be concluded to :

1- the proper planting methods producing the optimum germination ratio, un uniformity seed distribution, correct depth planting and highest yield can be obtained with pneumatic planter .

2- Increasing planter forward speed, the germination ratio and the uniformity decreased while increasing moisture content (from 22.30 to 34.22%) the germination ratio, uniformity and total yield increased .

3- Field efficiency increased as the for ward speed from 6.9 to 3.6 Km/h and soil moisture content decreased from 34. 22 to 22.30 % for two tested machines.

4- The Power required by pneumatic planter is more than the power required by mechanical planter.

5- Increasing planter forward speed from 3.6 to 6.9 km/h and soil moisture content from 22.30 % 34.22 % to 34.22 %, the tractor wheel slip increased.

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المخلص العربى

استجابة محصول فول الصويا لطرق الزراعة الآلية فى تربة طينية طميية القوام

م / صابرين خليل أحمد بيبارس

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يعتبر محصول فول الصويا من المحاصيل الغذائية والصناعية الهامة لإحتواء بذوره على نسبة مرتفعة من البروتين بالإضافة إلى نسبة لا بأس بها من الزيت لذا كان من أهم أهداف السياسة الزراعية فى مصر تحقيق مستوى أفضل من الأمن الغذائى من خلال الرقعة الزراعية المحددة وذلك بالتوسع فى المساحات المزرعة بفول الصويا . فقد تم زراعة حوالى ٣٦٣٤٩ فدانا من فول الصويا فى عام ١٩٩٧ تكاد تكون معظم هذه المساحة قد تم زراعتها يدويا ويتضح من ذلك أن المساحة التى يتم زراعتها آليا بفول الصويا تحتل نسبة تكاد لا تذكر بالنسبة للمساحة

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الكلية المحصولية على مستوى الجمهورية. لذا كان الهدف من هذا البحث هو دراسة إمكانية زراعة فول الصويا فى أرض طينية طمية باستخدام الميكنة الزراعية. أجريت هذه التجربة فى محطة البحوث الزراعية بالجميزة – محافظة الغربية خلال موسم ١٩٩٩م .

✪ وكانت أهم أهداف الدراسة كالتالى:

(١) اختيار أنسب محتوى رطوبى للتربة وأخذت فى هذه الدراسة ثلاثة مستويات رطوبة للتربة هى ٣٤,٢٢و ٢٨,٦٠ و ٢٢,٣٠%.

(٢) اختيار أنسب طريقة للزراعة من حيث انتظام توزيع البذور والإنتاج الكلى للمحصول (ميجاج / فدان) حيث أخذت طريقتان للزراعة هما (الزراعة الآلية والزراعة اليدوية). وتضمنت الزراعة الآليه نوعيان من الآلات (آله الزراعة الهوائية وآله الزراعة الميكانيكة).

(٣) اختيار انسب سرعة تشغيل للجرار أثناء الزراعة وقد أجريت الإختبارات باختيار أربع سرعات أمامية للجرار وهى ٣,٦ ، ٤,٧ ، ٥,٦، ٦,٩ كم / س على التوالى .

✪ وقد بينت النتائج الآتى:-

(١) أفضل طريقة للزراعة من حيث إنتظام توزيع البذور ونسبة الإنبات وأعلى انتاجية للمحصول الآلية باستخدام آله الزراعة الهوائية.

(٢) أفضل سرعة تشغيل أمامية للآله هى ٣,٦كم / س تعطى أعلى نسبة اثبات وأعلى انتظام لتوزيع البذور ويقل هذان المؤشران فى حالة زيادة السرعة عن ٣,٦كم / س .

(٣) أفضل محتوى رطوبى للتربة يعطى أعلى انتاجية محصول وأعلى انتظام لتوزيع البذور هو ٣٤,٢٢%.

(٤) استخدام آله الزراعة الهوائية يعطى نتائج أفضل من آله الزراعة الميكانيكية وذلك لإرتفاع كلا من نسبة الإنبات والإنتاجية للآلة الهوائية .

(٥) استخدام الزراعة الميكانيكية لمحصول فول الصويا يوفر ما يقرب من ٢٢ % من معدل التقاوى .

(٦) الزراعة الميكانيكية تقلل من تكاليف زراعة فدان فول الصويا .