Mechanization of Potato Production in the Libyan Jamahiriya II. Effect of Seed Tuber Sizes on Mechanical Planting Efficiency, Labor Requirement, Seed Tuber Rate and Yield

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ABSTRACT

An experiment was conducted at the Faculty of Agriculture Farm, University of Al-Fateh, Tripoli, S.P.L.A.J., during the spring of 1977. The objective was to study the effects of seed tuber sizes on the mechanical planting efficiency, labor requirement, seed rate and the yield.

Mechanical planting of small seed tubers (35–45 mm) and halves of large seed tubers (45–60 mm) was efficient and labor saving than the planting of large seed tubers. The latter plugged the planter and reduced the planting capacity. The weight of small and halves of large size seed tubers planted per hectare was 28 and 43% less than the large seed tubers.

Sprouting time and tuber yield was significantly affected by the potato cultivars. Arran Banner took significantly less time to sprout compared to Mirka and Vittorini. The sequence was: Arran Banner < Mirka < Vittorini. Tuber yield of Cv. Arran Banner was significantly higher than Mirka and Vittorini. The order of yields was: Arran Banner > Mirka = Vittorini. Sprout emergence and tuber yields were not affected by the seed tuber sizes. Potato cultivars and seed tuber sizes exhibited no interaction for sprout emergence and the tuber yield.

INTRODUCTION

The potato (*Solanum tuberosum* L.) is a major vegetable crop in the Libyan Jamahiriya. It is mostly grown in the coastal areas as the fall and the spring crops. Imported seed tubers are used for planting the spring crop (4, 9, 10). The area and production of potatoes has increased by about four and six-times from 1971 to 1979, respectively (FAO, 1979a).

There is acute shortage of farm labor in the Jamahiriya. This makes the production of labor-consuming crops like potatoes very expensive and uncertain. The farmer's profits are reduced which hampers the expansion of area under this crop. Land and capital are abundant. The adverse effects of labor shortage can be minimized by the

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introduction of farm machines. Mechanization increases the yields and farmer's profits through efficient, timely, and proper crop production operations. The availability of farm machines is becoming easier every year due to increased imports. The machinery units operating in this country have increased about ten-folds since 1968 (FAO, 1979b). This indicates a rapid move towards farm mechanization. The commensurate research information for the effective use of different farm machines under the Libyan conditions is insufficient.

Potato producing countries have completely mechanized the potato planting operations because of efficiency and higher yields. Many types of potato planters are being used depending upon the soil, crop, labor and power considerations (3, 18). A few workers have studied the effects of mechanical planting under the Libyan conditions. Munir *et al.* (17) found mechanical planting efficient and economical than semi-mechanical and horse-drawn wooden-plow planting. Chaudhry and Sherif (1) concluded that mechanical planting was more efficient and less laborious than semi-mechanical and manual planting. It also significantly improved the tuber yield.

Mechanical planting of potatoes increases the tuber yields. The reasons have been explored by many workers. Evans (5) found irregular seed tuber spacing to adversely affect the tuber yields. It led to a loss of tuber yield upto 7%. Jarvis *et al.* (11) observed that tuber yields decreased with the increase in seed tuber spacing irregularity. The decrease was 1.7 t/hectare when the coefficient of variation of seed tuber spacing was increased from 0 to 60%.

Imported potato seed tubers are very expensive. Minimum possible quantity of seed tubers should be used to get optimum tuber yields and profits. Unnecessary wastage will increase the expenditure per unit area and will reduce the farmer's returns. The potato seed tubers are sold in many standard sizes. Many workers have studied the effect of seed tuber sizes on the potato yields. Grachev (8) observed that the use of small potato tubers (tuber weight 15–30 g) decreased planting rate by 1.7–2.3 times and markedly increased the net profits compared with large tubers (60–80 g). Jarvis (12) found small seed tubers of potato to give higher yields than large tubers when the same weight of seed tubers per unit area was planted. Similar conclusions were made by Karimova (14). The small seed tubers (tuber weight 30–50 g), medium (51–80 g) and large (> 80 g) were planted at 1.0 t/hectare. The average tuber yields were 14.1, 8.8 and 6.2 t/hectare, respectively. Meshcheryakov (16) planted small seed tubers (20–50 g), medium (70–90 g) and large (120–150 g) tubers. He found higher tuber yield from small seed tubers and similar percentage of emergence for all sizes of seed tubers. Zaretskaya (19) reported that the tuber yields were similar whether grown from small (15–49 g) or from large (50–100 g) seed tubers.

Potato seed tubers of different certified grades according to weights and/or sizes are imported every year from Europe for the main or spring crop in the Jamahiriya. This experiment was initiated to observe the effects of seed tuber sizes on the mechanical planting efficiency and the tuber yields. The studies were further aimed to earmark a suitable range of seed tuber sizes for imports to reduce the costs of transport and storage etc., without affecting the tuber yields.

MATERIALS AND METHODS

The experiment was carried out at the Faculty of Agriculture Farm, University of Al-Fateh, Tripoli, S.P.L.A.J. The field had been a fallow since May, 1976 after growing alfalfa for three years. Planting was done on January 26, 1977. A split plot design with four replications was used. The main plots were assigned to three potato cultivars viz: Arran Banner, Mirka and Vittorini, of similar source and physiological age. The subplots were assigned to three seed tuber sizes of 35–45 mm, 45–60 mm cut into halves and 45–60 mm. Each subplot was 120 m^2. The ridges were 80 m long and 75 cm apart.

A tractor-drawn and drive-wheel driven two-row potato planter (Cramer, Model SD, West Germany) was used for planting. Its feed mechanism has single-size feed cups and a manually-filled compensating device. If the feed cup misses a potato tuber, the compensating device tips a tuber in the cup from the upper feed tray. The planter units are independently mounted onto the suspension frame. A quick and easy change in depth of planting, ridge width and ridge spacing is possible in the workshop and/or field.

The seed tubers were planted 30 cm apart and 10–12 cm deep in the ridges. Phosphorus as single superphosphate (20% P_2O_5) at 60 kg P_2O_5/hectare was broadcasted before cultivation. Nitrogen was also applied at 125 Kg N/ha as ammonium sulphate (21% N). The nitrogen application was divided into three doses: 45 kg N before cultivation, 40 kg N side-dressed after complete emergence of sprouts and 40 kg N before the last earthing up i.e. about 50 days after planting. Chemical pest control and manual weeding were practised. The crop was sprinkler irrigated at 6 to 10 days intervals depending upon the crop condition and the amount of rainfall.

Theoretical field capacity (TFC) or spot working rate of planter in hectares per hour and labor requirement in man-hours per hectare were determined from the time taken for planting a 50 meter long ridge with different seed tuber sizes (1, 2). The effective field capacity (EFC) or overall working rate was calculated by multiplying TFC and field efficiency of the planter (2). The weight of seed tubers used for 50 meters ridge was taken and computed on hectare basis. The time taken for sprout emergence was recorded when more than half of the sprouts had emerged. Harvesting was done after about 100 days from planting. Mature tubers were lifted from an area of 50×1.5 m^2 of each subplot and weighed to determine the tuber yields per hectare. The data were analysed according to LeClerg *et al.* (15).

RESULTS AND DISCUSSION

The theoretical field capacity (spot working rate) and effective field capacity (overall working rate) of planter for using different sizes of seed tubers alongwith labor requirement and weight of seed tubers per hectare is presented in Table 1. The effect of seed sizes on sprout emergence and tuber yield is reported in Table 2 and 3.

The planter capacity (Table 1) was 0.212 and 0.217 hectares/hour when seed tuber size 35–45 mm and halves of 45–60 mm were used, respectively. It was adversely affected with the use of large seed tubers (45–60 mm). The field capacity was reduced to 0.157 hectares/hour. The large tubers choked the machine frequently. The time spent on stopping the machine to clear the blocked tubers increased the operational time per unit area and reduced the field capacity of the planter. The small seed tubers (35–45 mm) and the halves of large tubers (45–60 mm) passed through the planter quite conveniently. The machine required no stoppage for adjustment during operation due to choking. The use of small seed tubers, thus improved the field capacity of the planter.

Small size and halves of large size seed tubers required less labor for planting compared to large seed tubers (Table 1). Planting of the former seed sizes needed 9.43 and 9.22 man-hours per hectare but the latter required 12.74 man-hours per hectare.

Table 1. Effect of seed tuber sizes on the field capacity of the mechanical planter, labor requirement* and seed tuber rate.

Seed tuber size	TFC hectares per hour (spot working rate)	EFC hectares per hour (overall working rate)	Man-hours per hectare	Seed tuber rate per hectare (tons)	Tuber yield per hectare (tons)
35–45 mm	0.212	0.127	9.43	2.215	14.54
Halves of 45–60 mm	0.217	0.130	9.22	1.750	14.09
45–60 mm	0.157	0.094	12.74	3.075	14.04

*Number of workers: 1 tractor operator and 1 for attending the planter.

Large size seed tubers required about 36.6% more labor because it was wasted in clearing and adjusting the choked planter. The large size (45–60 mm) seed tubers could not pass freely from the planter mechanism en route to the soil. They repeatedly plugged the planter, needed labor for clearance and thus increased the man-hours per hectare.

Seed rates per hectare were 2.215, 1.750 and 3.075 tons for seed tuber sizes 35–45 mm, halves of large size (45–60 mm) and large size, respectively (Table 1). The rate of small seed tubers and halves of large size used per hectare was about 28 and 43% less than the rate of large seed tubers. Procurement of seed tubers from foreign countries is very expensive. An enormous reduction in seed tuber imports would be possible if potatoes in the Jamahiriya are planted with halves of the large size and/or small size seed tubers.

Time taken for sprout emergence by different potato cultivars for different sizes of seed tubers is given in Table 2. Sprouts of Cv. Arran Banner took the minimum time to emerge (27 days). It was highly significant compared to Mirka (30 days) and Vittorini (31.33 days). Cultivar Mirka sprouted significantly earlier than Vittorini. The sequence of days taken for sprouting was: Arran Banner < Mirka < Vittorini. Seed tuber sizes did not affect the sprouting time. The differences among the sprouting time of different seed tuber sizes were not significant. The small (35–45 mm), halves of the large (45–60 mm) and the large seed tubers took about 30 days to sprout. There was no interaction between the cultivars and the seed tuber sizes for sprout emergence.

Table 2. Effect of seed tuber sizes on the number of days taken for sprout emergence by potato cultivars.

Potato cultivars	Seed tuber sizes (mm) 35–45	Halves of 45–60	45–60	Mean[a]
Arran Banner	27.25[c]	26.50	27.25	27.00
Mirka	30.75	29.00	30.25	30.00
Vittorini	31.50	31.00	31.50	31.33
Mean[b]	29.83	28.83	29.67	—

[a] Cultivars: L.S.D. (0.05) = 1.31 and (0.01) = 1.98 days
[b] Seed sizes: Non-significant
[c] Interaction: Non-significant

Table 3. Effect of seed tuber sizes on the tuber yields (tons/ha.) of potato cultivars.

	Seed tuber sizes (mm)			
Potato cultivars	35–45	Halves of 45–60	45–60	Mean[a]
Arran Banner	15.83[c]	15.57	15.78	15.73
Mirka	13.37	13.48	13.88	13.58
Vittorini	14.41	13.23	12.47	13.37
Mean[b]	14.54	14.09	14.04	—

[a] Cultivar: L.S.D. (0.05) = 1.21 and (0.01) = 1.83 tons/ha.
[b] Seed sizes: Non-significant
[c] Interaction: Non-significant

The effect of potato seed tuber sizes on the tuber yield is presented in Table 3. The highest yield (15.73 t/ha) was of Cv. Arran Banner and the difference was highly significant from Mirka (13.58 t/ha) and Vittorini (13.37 t/ha). The tuber yield of Cv. Mirka was not significantly different from Cv. Vittorini. The seed tuber sizes did not affect the tuber yields significantly. The tuber yields were similar whether grown from small (35–45 mm), halves of the large (45–60 mm) or from the large seed tubers. The respective tuber yields from small, halves of large and the large tubers were 14.54, 14.09 and 14.04 tons/hectare. This indicates that tuber yields were not affected by the use of small seed tubers and/or halves of the large seed tubers. The use of large seed tubers has not showed an edge over small seed tuber sizes. The use of large size seed tubers could be avoided. This will save expenses of procurement, transport and storage without affecting the potato production.

The results of the present studies clearly indicate that a considerable part of the present potato seed tuber imports can be avoided without affecting potato tuber yields of the spring crop in the Jamahiriya. Mechanical planting of small seed tubers and halves of large seed tubers was more efficient than the large seed tubers. The seed tuber sizes did not affect sprouting time and the tuber yield. Potato Cv. Arran Banner was superior to Mirka and Vittorini regarding the sprout emergence and the tuber yields.

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ميكنة محصول البطاطس في ليبيـا

٢) تاثير حجم درنات البذور على كفاءة البذر الآلي واحتياجات العمالة بمعدل البذر والإنتاج

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مستخلـــص

أجريت التجربة في محطة أبحاث كلية الزراعة جامعة الفاتح. بطرابلس للعروة الربيعية خلال الموسم الربيعي ١٩٧٧ م وكان هدف التجربة دراسة تأثير حجم درنات البذور على كفاءة البذر الآلي واحتياجات العمالة ومعدل البذور والإنتاج .

كفاءة البذر الآلي لحجم الدرنات الصغيرة (٣٥ — ٤٥) مم وأنصاف الدرنات الكبيرة (٤٥ — ٦٠) مم وتقليل عمالة أعلى من بذر الأحجام الكبيرة . الأحجام الكبيرة تعمل على انسداد رقبة التلقيم بآلة البذر وتقلل من سعة البذر ووزن الدرنات الصغيرة وأنصاف الأحجام الكبيرة اللازمة لزراعة هكتار أقل ما بين ٢٨ و٤٣٪ من زراعة الدرنات الكبيرة .

وقت الإنبات وإنتاجية الدرنات له تأثير معنوي على أصناف البطاطس . وصنف ارن بنز إحتاج لوقت أقل للإنبات إذا ما قورن بصنفي ميركا وفيتوريني، وعلى الترتيب ارن بنر ميركا وفيتوريني وإنتاجية الدرنات ارن بنر معنوياً أعلى من ميركا وفيتوريني . وترتيب الإنتاجية ارن بنز أعلى من ميركا وميركا تعادل فيتوريني فترة الانبات والإنتاجية لم تتأثر بحجم البذور ولم يتوضح إرتباط بين أصناق البطاطس وحجم الدرنات على عملية الإنبات والإنتاجية .