Evaluation of mechanical sowing of medium staple cotton seed

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Abstract

Manual sowing is the traditional method for cotton production in irrigated schemes. Improper crop geometry in farmers' fields is considered as one of the main factors behind reduced cotton productivity. Administrators in irrigated schemes have placed more emphasis on mechanical sowing of various field crops, which is now practiced in a very limited scale. This work was carried out to evaluate technically, economically and agronomically the mechanical sowing operation performance of medium staple cotton with mechanically delinted seeds, and to compare and evaluate mechanical sowing of chemically delinted seeds with manual sowing operation.

Results indicated a complete failure of emergence with mechanical sowing of mechanically delinted seeds of medium staple cotton, suggesting that medium staple cottonseeds should be chemically delinted if mechanical sowing is to be practiced.

Comparison of mechanical sowing of chemically delinted seeds with manual sowing operation indicated that the required time of manual sowing was 19 times the requirement of mechanical sowing. Mechanical sowing resulted in savings of about 40% of the seed rate and in significantly narrower spacing of about 24 cm with approximately similar plant population to the recommended one, with 1–2 seeds/hill. On the other hand, manual sowing operation resulted in spacing between plants of about 46 cm with 5–6 plants/hole. However, mechanical sowing resulted in insignificantly greater yields of cotton for the two seasons. Hence, despite the savings in time and seed rate, mechanical sowing should be recommended only if chemically delinted cotton seed is available, otherwise, the crop has to be sown manually.

Introduction

Field crops other than wheat are sown using dibbling method with the use of "Garaiya" and "Toriya" as in the New Halfa scheme. This manual sowing method results in a variable distance between holes, a variable number of seeds per hill and a high number of uncovered seeds. Hence, an optimum plant population with optimum spacing between plants could not be achieved in farmers' fields. Therefore, the improper crop geometry under farmer conditions is considered as one of the main reasons behind reduced crops yields in irrigated schemes.

A report prepared by the department of Social Planning and Economics Studies (1999) for comparison of farmer's practice with the research recommendations, indicates that farmer's practice for cotton resulted in 88, 98 and 119% for the number of holes/ha, number of plants/ha and number of plants/hole respectively in comparison with the research recommendations. This indicates wider spacing between holes and higher number of seeds/hole, which leads to high competition of plants/hole, and consequently, low crop yield per unit area.

The Rahad Scheme was designed to be a fully mechanized scheme, but studies in 1984 indicated that the mechanization of field crops was not acceptable socially and economically. Recently, the general trend in all irrigated schemes is towards the mechanization of all cultural operations of field crops, especially the mechanical

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sowing, which is now practiced in a limited scale compared to the huge cultivated area in the irrigated schemes.

The objectives of this study were to evaluate technically, economically and agronomically the mechanical sowing of mechanically delinted medium staple cotton seeds and to compare mechanical sowing of chemically delinted seeds with manual sowing operation.

Materials and methods

Planter Types

Experimental work on different planter types showed a similar effects on crop growth performance and yields(Dafala, 2003; Dinar, 2005). This is true since the planter will be calibrated for the required plant population. Therefore, mechanical sowing of cotton was performed with available planter types during the period of the study. The following seeding machines, which were of plate type seed metering system, were used:

1. Monosem planter (French make); It is a pneumatic planter. the seed metering system operates through air suction and gears. The aspirator fan is powered through the tractor P.T.O. shaft.
2. Marchesan planter (Brazilian make).
3. 12MX Multiflex planter (American make).
4. TATU planter (Prazilian make).

Each planter consists of four seeding units attached to the tool bar. These units were placed 80-cm apart to sow the crop on the top of ridges. The seed metering device consists of rotating gears and plates, which are powered through the seed-press wheel. The regulation of seed rate is carried through selection of the suitable tooth gear number (seed distance gear) and a plate with a suitable number of seed cells.

Field test

The study was carried out in the New Halfa scheme, where the soil type is vertisols and the climatic condition is semi-arid.

The research recommendations for manual sowing of cotton crop is to drop 5-7 seeds/hole at spacing of 50 cm between holes and 80 cm between ridges for early sowing in July. The seedlings should be thinned to three plants/hole some four weeks after sowing. For late sowing in August the plant spacing should be reduced to 30 cm between holes (Technical packages, 1991).

Trial I

In 1997-98 season, Monosem and Marchesan planters had been introduced by the scheme's administrators for sowing the mechanically delinted cottonseed of the upland cotton variety Barac(67)B in farmers' fields. For the two planters, preliminary investigations indicated difficulties in dropping of seeds as the result of the remaining fuzz on the seed coat. In order to mitigate seeds clogging and to facilitate the seed dropping, mud was used as adhesive substance for fuzz sticking to the seed coat, which is a farmer practice for manual sowing, and the seed plate openings for Marchesan planter were drilled to increase the size for 3 seeds per hill. Therefore, it was decided to conduct the trial in the Research Station Farm and not in farmer's fields, so as to overcome this problem and to evaluate the performance of each planter separately with the following two treatments:

1. Mechanically delinted cottonseeds.
2. Mechanically delinted cottonseeds with dry mud coating.

Each planter experiment was a randomized complete block design with three replications. Subplot size was 8 rows x 6 m long.

Trial II

In 2000-01 season, another experiment was undertaken at the Research Station Farm with a little amount of chemically delinted seeds of Barac(67)B. Chemical delinting was carried out with the use of concentrated sulphuric acid. The experiment layout was a randomized complete block design with five replications. Delinted seeds were sown with the use of the 12MX Multiflex planter for comparison with the manual sowing of fuzzy seeds. The planter was equipped with 8-tooth gear and a plate of 12 cells. No thinning was done for manual sowing operation so as to represent the farmer's practice. The crop was irrigated fortnightly and fertilizer of 143 kg N/ha as urea was applied after four weeks from crop emergence. The crop was sprayed by insecticides when necessary using knapsack sprayer. The picked area was 32 m^2 (4 rows x 10 m).

Trial III

In 2001-02 season, four farmer's fields, each with 2.1 ha (5 fed), at El-Madina block, were selected to compare the effect of planter sowing with chemically delinted seeds and manual sowing with mechanically delinted seeds on cotton yield. Mechanical sowing was performed with the use of TATU planter. The planter was equipped with 14-tooth drive sprocket and 26-tooth driven one. The experiment was randomized complete block design with two replications.

Collected Data

Only crop emergence was counted for trial I to determine the efficiency of sowing operation. For trial II, the required time for completing the sowing of 1 ha with the use of planter and hand labour was calculated. The seeds of cotton were weighed before and after mechanical and manual sowing methods to determine the used amount of the seed rate with each operation. The crop yields for the two sowing methods were compared. Also for the trial III, the obtained crop yields were analyzed for comparison of the two sowing methods.

Results and discussion

Any planter should satisfy the following requirements for crop sowing on the top of ridges:

1. To be a tractor-mounted planter so as to mitigate the breaking down of the ridges.
2. To place the seeds in the middle of the ridge.
3. To place the seeds to the required depth.
4. To achieve the required plant population through the suitable spacing between seeds and required number of seeds per hill.
5. Tighten chain of tractor lower links to prevent side-swinging and slipping-off the ridge.

However, one of the prerequisites for operating a planter to sow the seeds on the top of 80-cm spaced ridges is the proper setting of ridges to the specified distance, or to follow the track of the tractor that used in 80-cm ridges setting.

The obtained results from trial I indicated a complete failure of this trial with Monosem planter for the two treatments (Table 1). No crop emergence occurred. This was due to the failure in seeds dropping as the result of seeds clogging by fuzz in the first treatment (mechanically delinting seed) and probably due to the increase in seed weight and friction force between the seeds as the result of mud coating effects for the second treatment (mechanically delinted seeds + dry mud coating) to be sucked by air through the plate openings. For Marchesan planter, a high significant increase ($P >$

0.001) in crop plants were obtained with the treatment of mechanically delinted seeds with dry mud coating compared to the treatment of mechanically delinted seeds. This was due to the increase in plate opening size to drop three seeds per hill. However, the intended plant population for the sown area (8 rows x 6 m) is 288 plants, but seedlings emergence for the treatment of mechanically delinted seeds with dry mud coating was only 135 plants, which amounted to 50% of the recommended plant population. This clearly indicated the difficulties in performing sowing operation with mechanically delinted cottonseed. Hence, the mechanical delinting of medium staple cotton seed was not suitable for mechanical sowing. However, severe mechanical delinting to remove more fuzz from the seed coat causes seed breakage and seed coat cracking. This leads to the death of seed embryo with subsequent operation of chemical delinting. This occurred in 2004-05 season, in southern group of the Gezira scheme, as all mechanical sown area had been re-sown, because of cotton growth failure.

Based on the above findings, the mechanical sowing in subsequent trials were undertaken with chemically delinted seeds for the comparison with manual sowing method.

Pattern of crop emergence

The crop growth with the use of planters revealed seed drilling pattern in terms of the distance between plants. Therefore, any two plants with a distance of less than 10 cm were considered as hill. The drilling action was due to the length and vibration of the seed tubes. Based on agronomic research recommendations, the optimum number of holes and plants per 3 m row for cotton is 6 and 18, respectively. A significant difference ($P = 0.05$) between the two sowing methods was evident only for spacing between plants (Table 2). A significant narrower spacing (24 cm) was obtained for the mechanical sowing with approximately similar plant population to the optimum (20 plants/3 m row with 1-2 seeds/hill). Manual sowing resulted in an average of 46 cm between plants to give 7 holes/3 m row and 37 plants with an average of 5-6 plants/hole, which was double the intended plant population.

Operational data of sowing methods

The required average time for mechanical sowing of cotton was 0.5 machine-h/ha. However, manual sowing required an average time of 9.5 man-h/ha, which is about 19 times the average time requirement of planter sowing (Table 2).

The use of planter saved about 8.0 kg/ha of cotton seeds, which is about 40% lower than that used with manual sowing method (Table 2). However, the total sown area of cotton in irrigated schemes is about 204 000 ha (El-Awad, 2000), therefore, the savings in cotton seeds would be equal to about 1 632 tons which could be used for oil production and the byproducts of cakes could be used for animal feeds. Additionally, savings in seeds could reduce the cost of seed dressing by pesticides and insecticide, handling, storage and transportation of cottonseed stock for sowing. Hence, planter sowing of cottonseeds would be economically feasible with the use of chemical delinted cottonseeds.

Seed Cotton Yield

The obtained crop seed cotton yield yields for the two seasons (2000-01, trial II and 2001-02, trial III) are shown in Table 2.

Compared to manual sowing, planter sowing resulted in 18 and 10% increase in seed cotton yields in the first and second seasons respectively. But the differences were not significant.

Conclusions

1. Results indicated a complete failure of mechanical sowing operation with mechanically delinted seeds of medium staple cotton, Barac (67)B, even with dry mud coating. Hence, mechanical delinting is not a suitable method for mechanical sowing.
2. Mechanical sowing of cotton with chemically delinted seeds saved a lot of time (9 man-h/ha) and reduced about 40% of the amount of seed rate in comparison with manual sowing method.

Recommendation

Though mechanical sowing saves a lot of time and cotton seed, the mechanical sowing operation of medium staple cotton should only be executed with chemically delinted seeds.

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Table 1. Effect of seed fuzz on mechanical planting of cotton with two planter types.

Treatment	Crop emergence per 38.4 m^2	
	Monosem	**Marchesan**
Mechanically delinted seeds	Failure	8
Mechanically delinted seeds + mud		
Means	Failure	135
SE ±	/	72
	/	16.3 (**)

(**) = Significant at the 0.1% significance level.

Table 2. Operational data of sowing method and its effects on cotton crop performance.

Sowing method	Time required (h/ha)	Seed rate (kg/ha)	Plant spacing (cm)	No. of plants/3m long	Seed cotton yield (kg/ha)	
					2000/01 season	**2001/02 season**
Planter sowing	0.5	12	24	20	2030	1625
Manual sowing	9.5	20	46	37	1722	1483
Means	5.0	16	35	29	1876	1554
SE ±			5.3 (*)	4.7 (NS)	263 (NS)	137 (NS)
CV%			(ND)	(ND)	(ND)	9

(NS) = Not significant, (*) = Significant at the 5% significance level, (ND) = Not determined.