Towards Optimal use of Sulphuric Acid in Delinting Cotton Seed for Mechanical Planting

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Abstract

The experiment was conducted during the season 2004-2005 at Rahad Research Station to evaluate the use of 0.2 m^3 blender size steered by Tractor power-take-off (PTO) shaft in delinting cottonseed chemically. The blender was found quick, safe and economical method of delinting cottonseed. There is a positive correlation between the acid volume and the amount of seed and between the time of mixing and seed weight. A significant high capacity and economic use were obtained when mixing weigh of 36 kg seeds using 2.5 liters of the acid at mixing time of 10 minutes. However, delintng operation did not affect the seed germination percentage. Based on the economical evaluation, a 0.2 m^3 blender could be recommended for delinting 36 kg of cottonseeds with 2.5 liters of the concentrated sulphuric acid for the mixing time of 10 minutes.

Introduction

Cotton crop occupies the highest acreage in the crop rotation throughout the irrigated schemes (Gezira, Rahad, Halfa and Suki). Rahad project started with full mechanization of all agricultural practices and the mechanical planting of cotton crop found special attention in the late seventies to the mid eighties. Later on, due to some practical difficulties it was discontinued. One of these difficulties was the unavailability of well- delinted seeds that can be drilled easily by the machine.

Manual seeding is associated with the problems of using high seed rate because of seed clogging. Manual seeding sometimes leaves the seed without enough soil cover and then it will be exposed to washing out during irrigation. It is very difficult to control the spacing between the hills to reach the right plant population and when practicing manual sowing. It is worth mentioning that manual sowing is associated with the disturbance of ridges by the movement of working labourers and this hinders the easy flow of water through furrows. All these mentioned facts favor the use of mechanical planting. Machine planter has a high capacity of work and this assists in applying sowing date as recommended and so contributes largely to the final yield. Also, it helps place the seeds uniformly at the correct spacing and correct rate to obtain the correct plant population. It also places the seed at good depth and firms the soil around the planted seeds for excellent soil and moisture contact. Well- delinted seeds raise efficiency of the planter and this will save about 3 kg per each feddan compared to the seeds that will be used when practicing hand sowing. Economically, this will save millions kg of cottonseeds. Depending on the area planted by the machine. Also if mechanical planting out yields the hand sowing by only 0.5 Kantar, billions of Sudanese pounds will be obtained as a benefit for the farmer and the national economy.

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Hairs remaining on the surface of the seed after ginning (fuzz), clog the seed together and make it difficult to be planted by the machine. To get rid of these hairs, a manual chemical delinting method is practiced.

This method is associated with primitive way of mixing because some seeds might be exposed to the acid for a longer period than others, in addition to the cost of the operation, the danger of dealing with the concentrated acid during manual mixing and the slowness of the process.

To plant a sizable area mechanically there is a need for quick, cheap and safe method of delinting the seed chemically.

The objectives of this study are to replace the manual method of cottonseed delinting by mechanical acid delinting as an intermediate technology and also, to evaluate the use and the efficiency of a blender that will be used as the mechanical method in delinting cottonseed.

Material and Methods

A mounted type Blender of 0.2 m^3 total size designed for cement- gravels mixing was used in this study (Figure 1). It is constructed of galvanized steel. There are three traverse bars located at the inner surface for agitation and steering of the cottonseed for good mixing. Each has a length of 68 cm and positioned five cm apart from the inner blender wall as a clearance. A toothed sprocket gear is attached to the base of the blender as a driven gear. A drive gear with tooth equal to one- tenth of the driven one brings the motion to the blender from the tractor power-take-off shaft (pto.) through the universal joint.

Other materials were cottonseed variety Barac 67 B, Sulphuric acid (98%), Tractor (Case International 685 of 70 hp), Telescopic universal joint, a barrel (cut longitudinally with a tap as an outlet for washing), graded cylinder, sacks, balance, source of water, wood sticks for manual steering during washing; Stop watch and a rake.

In this experiment, the weight of the seed to be mixed, the volume of the acid sprayed and the time of mixing were the variables that formed all blender mixing units and these were:

1. Seed weight in kilograms: 40, 36, 30, 26, 22,16 and 12
2. Acid in liters: 3, 2.5, 2, 1.5 and 1.0
3. Time of mixture in minutes: 20, 15 and 10

The work was carried during a time not exceeding midday. With the use of balance, a sample of known weight of cottonseed was put in the blender. Then a known volume of the acid measured by the graded cylinder was sprayed over the seed. The tractor tank was filled and the power was transferred to the blender through the telescopic universal joint from the power take off shaft for mixing. The speed of the blender was adjusted to 33 revolutions per minute that was one-tenth of the pto. shaft revolutions. The speed of the blender was determined by making a mark on the wall of the blender. Following that, counting and adjusting the revolutions per each minute and keeping the throttle valve of the tractor fuel system at a certain position. The fixed speed of the blender was chosen for proper steering and agitation. The blender was laid horizontally and parallel to the direction of the joint shaft. After the elapse of the mixing time counted by the stopwatch, small amount of water was added to the blender

to facilitate the unloading and transferring of the mixed sample to the washing barrel. On the washing barrel suitable water was poured, steered by sticks then the seeds were taken to dry up on the stretched sacks in an open area. Also at this time another loading of other sample on the blender was started. The same procedure was repeated for other seed weights and about three minutes were needed for loading and unloading of the blender. At the end of each mixing the tractor fuel tank was refilled using the graded cylinder to calculate the consumed fuel.

The effective machine capacity, which is the weight of seeds delinted per each hour were calculated. The cost of delinting one kg was calculated by adding the cost of the acid used, the cost of the hired tractor and the cost of operating labourers. Then these values were divided by the weight of delinted seeds. From each sample a small amount of seeds was taken for the study of the following: -

1. Degree of delinting and degree of clogging (visual assessment).
2. Germination percentages for well delinted seeds using the blender, manually-delinted seeds and untreated seeds with the chemical.

The well-delinted seeds obtained at the end of the blender mixing will form the effective experimental treatments together with the manually delinted seeds taken as control.

The seed washing solution which contained diluted acid was allowed to drain in the soil. Soil samples from treated or untreated soils with the washing solution were collected to the depths 0-25 and 25-50 cm. These samples were prepared and analyzed for N, P and SO_4. The pH of the washing was determined.

Results and Discussion

Results showed that when mixing all seed weights with different acid volumes together with the three times allowed for mixing, different visually evaluated results of treated seeds appeared. Some samples were well delinted (WD) and loose in attachment due to the presence of suitable values of the mixed units and to the homogeneity of the mixing by the blender. Others were poorly delinted (PD) and clogged because the acid did not fully cover the seed surface or the weight of the seeds was more than the capacity of the blender and other samples were burnt (B) and clogged by the action of using more acid.

Table 1 shows that in a fixed time of 10 minutes at acid volume of one liter and 16 kg. of seed weight the mixture gave well delinted seeds. Lower or higher weights of seeds gave burnt and poorly delinted seeds, respectively. This led to the finding that when the volume of the acid increased the weight of the seed used increased also. i.e. 1.5 liters of acid increased the seed weight to be delinted from 16 to 22 kg. Increase of the volume of the acid to 2.5 or 3 liters raised the weight of the seed to 36 kg. The effect changed gradually when the time increased to 15 minutes. Addition of two and 2.5 liters of the acid increased the weight of well delinted seed to 26, 34 kg, respectively compared to the action of the same amount of acid at 10 minutes of mixing time. When the time increased to 20 min the well delinted samples obtained at less time of mixing had become burnt (16 and 36 kg). Using weights of 26 and 36 kg gave well delinted seeds when two and three liters of the acid were added respectively. Notably at both extremes of seed weights used in this trial (12 and 40 kg), whatever volumes of the acid used they either burnt the first or poorly delinted the second, respectively.

When mixing high weights (40 kg), it was observed that there was a difficulty in obtaining a homogeneous mixing and this was related to the poor relation between the seed weight and the blender size. This means that the size of the blender determines the weight of the seed to be delinted and is clear that 36 kg of seed weight is the maximum capacity of this blender.

From the results, taking the three variables used (seed weight, acid volume and time of mixing), increasing time of mixing slightly increased the amount of seed to be delinted in limited variables levels. There appeared the clear correlation between the acid volume added and the amount of the seed to be mixed, that means, when the volume increased from one to three liters the seed weight increased from 16 to 36 kg, respectively.

Table 2 depicts the units that were well delinted using the blender in addition to the manually delinted one, and all were considered as the experimental treatments. Table 2 also, shows the fuel used at every mixing, the capacity of the blender when operated for an hour and the cost of one kg of delinted seed. Analysis of variance showed highly significant differences in the values of the effective capacities in hour and in the fuel used. There was a trend of an increase in the actual capacity of the blender when the weights of the seeds to be delinted were increased. Using the combination of 36 kg, 2.5 liters of acid and a mixing time of 10 minutes, gave the highest amount of delinted weight of seeds with least cost compared to the manual and other combinations. An optimum combination of the variables used was reached concerning the capacity of the blender and the cost of each one kg of delinted seeds. This combination was to use 2.5 liters of the acid for every 36 kg of the seeds at 10 minutes of mixing time (Table 2). Table 2 also shows the fuel consumed per hour in ml for every combination of the variables. There was a trend of an increase in the fuel consumption when the weight of the seed to be delinted increases. This is true because increasing the weight of the blender increases the power required for the rotation. Also, increasing time of mixing increased the amount of fuel used.

Analysis of variance showed no differences in germination % values between the experimental treatments and also, between experimental treatments and the untreated seeds (Table 3). Acid did not affect the germination vigor of well delinted seeds even at different times of mixing for the same seed weight, and this may be due to the good time for seed to acid contact and to the homogeneity of the blender in mixing. This homogeneity in mixing was also related to both the agitation action of the traverse bars and to the downward motion of the seed according to the gravity when the blender was in rotation. In manual delinting, during mixing some water was added to help in distribution of the acid to avoid seed injury. This may be the reason in having no differences in the percentage of the germination.

Field observations showed no differences in the crop vigour during all growth stages when different treated seeds (blender acid- delinted, manual acid- delinted and undelinted seeds) were used in planting. These indicate that proper use of the acid in delinting has no effect on the viability of the cottonseeds (Fadlalla, 2005).

Table 4 shows the laboratory analysis of washing solution and soil samples. The soil analysis showed that Nitrogen (N) and available Phosphorus (P) were increased in the washing solution- treated soil in the top 25 cm. The Sulphate ($SO_{4)}$, increased up to the depth of 50 cm. The pH of washing solution was fount to be 6.8 and this can reduce the alkalinity of the soil.

Conclusions

1. Due to its safe dealing with the chemical the blender is suitable for delinting cottonseed using sulphuric acid and can replace the manual method.
2. Use of the blender in delinting is economically cheap, of high efficiency of mixing and high capacity of work in hour.
3. Use of the blender in cotton seed delinting will assist in proper seed dressing (Ibrahim, 2005).
4. When mechanical planting is practiced, it will reduce the amount of seeds used per one feddan by more than three kg. Also, it helps attaining the right plant population that increases the yield.
5. Also, it can be concluded that the washing solution of cottonseed acid delinting can be discharged into the field resulting in improving the soil fertility status.

Recommendations

We recommend the use of a blender for chemical delinting of cottonseed using the mechanical acid delinting rather than the manual method to avoid the hazards of the chemical.

For proper mechanical acid delinting with 0.2 cubic meters blender size, the following values of the variables are recommended to be used:
For every 36 kg of seeds, 2.5 liters of acid should be added for mixing time of 10 minutes.

References

1. Fadlalla, A. S. 2005. Personal communication.
2. Ibrahim, G. 2005. Personal communication.

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Table 1. Visual Evaluation of Delinted Seeds of the Different Mixing Units.

Acid volume *(litres)*	Mixing time *(min)*	Seed weight (kg)						
		12	**16**	**22**	**26**	**30**	**36**	**40**
10	1	B	WD	PD	PD	PD	PD	PD
	1.5	B	B	PD	PD	PD	PD	PD
	2	B	B	B	B	PD	PD	PD
	2.5	B	B	B	B	B	WD	PD
	3	B	B	B	B	B	WD	PD
15	1	B	B	PD	PD	PD	PD	PD
	1.5	B	B	WD	WD	PD	PD	PD
	2	B	B	B	B	WD	PD	PD
	2.5	B	B	B	B	B	WD	PD
	3	B	B	B	B	B	B	PD
20	1	B	B	PD	PD	PD	PD	PD
	1.5	B	B	B	WD	PD	PD	PD
	2	B	B	B	B	WD	PD	PD
	2.5	B	B	B	B	B	B	PD
	3	B	B	B	B	B	B	PD

WD=Well- Delinted seeds, B = Burnt seeds, PD = Poorly delinted seeds

Table 2. Some Machine and Manual Delinting Parameters and the Cost of Delinting One kg of Seeds.

Seed weight (kg)	Mixing time (min)	Acid volume (liter)	Fuel used (ml)	Effective capacity in hr (kg)		Cost of delinting 1kg (SDD)
				WTBD	**WTAD**	
16(WD)	10	1	256	70	66	50.0
22(WD)	15	1.5	277	71	67	60.2
26(WD)	15	1.5	363	84	79	58.8
26(WD)	20	1.5	535	67	63	43.1
30(WD)	15	2	373	98	92	46.3
30(WD)	20	2	570	77	72	41.5
36(WD)	10	2.5	330	160	150	35.6
36(WD)	15	2.5	547	117	110	35.4
36(WD)	10	3	377	161	151	37.3
41(MD)	25	3		82	77	40.0
SE±			22.2	1.3		

WD = Using the Blender, MD= Using the manual delinting, WTBD = Weight before delinting, WTAD = Weight After delinting

Table 3. Seed Germination Percentages (%).

Seed weight (kg)	Acid volume (liter)	Time (min)	Germination (%)
16(WD)	1	10	78
22(WD)	2	10	81
26(WD)	2	15	82
26(WD)	2	20	78
30(WD)	2.5	10	78
30(WD)	2	20	77
36(WD)	2.5	10	77
36(WD)	2.5	15	78
36(WD)	3	15	79
41 (MD)	3	25	79
Untreated seeds			80

WD = Well delinted using the blender, MD = Manual delinting

Table 4. Results of soil samples analysis.

Soil depth (cm)	Soil without washing solution				Soil with washing solution			
	N(ppm	P (ppm)		SO_4 (ppm)	N(ppm)	P(ppm)		SO_4 (ppm)
		avail	total			avail	total	
0-25	400	4.0	325	355	590	44.2	686	1460
25-50	400	3.4	289	283	350	3.8	344	1310

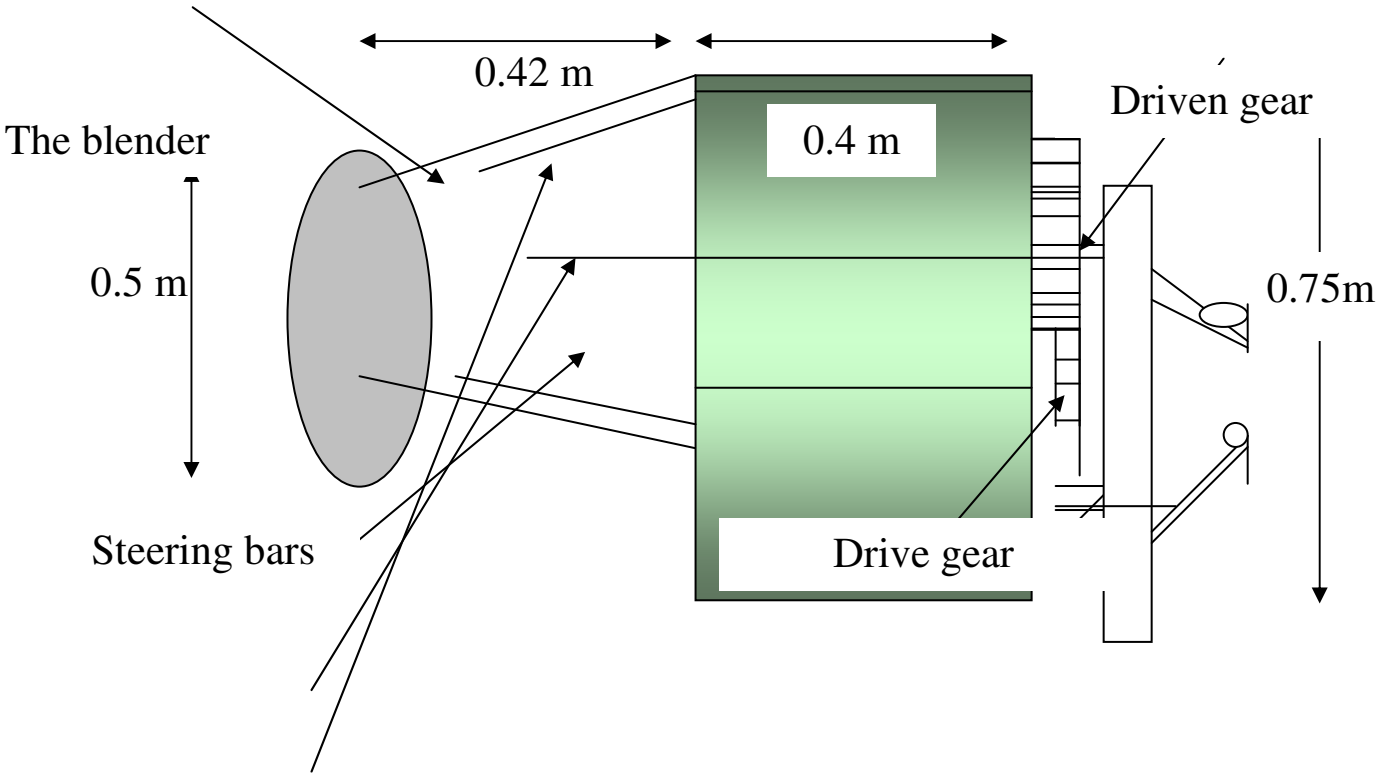

Figure 1: sketch of the blender used