J Krishi Vigyan 2022, 11 (1) : 381-385 DOI : 10.5958/2349-4433.2022.00161.1

Utility of Tractor Operated Mobile Shredder for Cotton Residue Management

Vikram Simha H V, Basavaraj K, Manjunath N, Shruti N and Bellad S B

ICAR-Krishi Vigyan Kendra, Kalaburagi-II, Raddewadgi, Kalaburagi (Karnataka)

ABSTRACT

The crop residue after cotton picking is burnt creating environmental pollution. This problem can be addressed by shredding the crop residue in the field which is a source of nutrition and organic matter. Cotton growing farmers under irrigation condition from Rasanagi Village, Jewargi taluk, Kalaburagi district, Karnataka were randomly selected. Immediately after completion of cotton picking, the mobile shredder was operated in the field. The cotton plants were 190-200 d old. The moisture content of the cotton stalk was 41.80 per cent. The effective field capacity of the tractor-operated mobile shredder was found to be 0.34 ha/h. The field and uprooting efficiency was 80.90 and 92.70 per cent, respectively. The shredding efficiency in terms of length of cut was recorded as 42.7 mm. This length of shredded particles was easily decomposed and mixed well in the soil. A total of 7.85 t/ha of shredded cotton stalk was added to the field. The time consumed to complete one hectare of shredding of cotton field was less than 3 h. The economics of operation was Rs. 2358.00 which is 63 per cent less than the expenditure incurred by the farmers.

Key Words: Cotton, Evaluation, Field efficiency, Management, Mobile shredder, Residue.

INTRODUCTION

India leads in the cultivation of cotton in the world and it is one of the most important oil seed (Gill and Bhatt, 2015). Cotton is cultivated with an area of 8.76 Mha in the country (Bawane and Kedkar, 2018) and wider area of cotton is in the Northeastern dry zone of Karnataka. In spite of the Kalaburagi district called as pulse bowl of India, during 2017-18, the area under cotton cultivation was 62,289 ha. The total production of cotton was 47,975t while, the average lint production of Kalaburagi was 811 kg/ha (Anonymous, 2020).

The cotton plant residues after picking the cotton consists of main stem, branches, leaves and unopened boll and cotton lint with seeds which is usually left in fields (Huang *et al,* 2012). The farmer faces difficulty in removal of the plant remains and converting them to useful form in the field leads to burning which causes environmental pollution. In Addition to this, the health of the soil is debated due to excessive use of chemical fertilizers as well (Jadav *et al,* 2018). Few researchers have proved that cotton plant residue can be a good source of nutrition and energy (Gemtos and Tsiricoglou (1999), Sutaria *et al* (2016) and Senthikumar and Thilagam (2015)). The cotton stalk contains 34 kg nitrogen (N), 16 kg phosphorus (P) and 11 kg potassium (K) followed by 39 kg, 3 kg, 56 g, 35 g and 27 g of sulphur, copper, iron, manganese and zinc, respectively (Bawane and Kedkar, 2018).

The management of cotton plant residue in the field is a challenging task to a farmer. The conversion of cotton plant residue to manure or compost requires chopping or shredding into small pieces. The fine size reduction of the cotton stalk is possible through shredder. The shredded material enhances the soil properties by incorporating the shredded stalk in terms of nutrition, organic carbon and water holding capacity. Further, the use of stationary machines is laborious and time consuming. Vyas (2019) developed the tractor-operated mobile shredder and mixer to eliminate

Corresponding Author's Email: vikramsimha.hv@gmail.com

Table 1. Specification of tractor-operated mobile shredder

Sl. No.	Particulars	Description
Power Source		
1	Power source used	Tractor
2	Make	Mahindra
3	Model	575 DI
4	Drive wheels	
5	Type of tyres	Pneumatic, Traction
6	Size, cm	14.9 - 28
7	Track width, mm	1425
Mobile Shredder		
8	Drive	Central
9	Number of feed rows	One
10	Length, mm	1525
11	Width, mm	1115
12	Disc cutter, No.	2
13	Shredding blade, No.	6

the problem of burning cotton stalks on fields. Senthikumar and Thilagam (2015) studied the effect of incorporation of shredded cotton stalk using tractor-operated cotton stalk shredder and *in-situ* application in soil. They reported that the incorporation of shredded material increased the available N (199 to 252 kg/ha), P (12.6 to 20.1 kg/ha) and K (541 to 640 kg/ha) and organic carbon (0.36 to 0.54 kg/ha) in soil. Therefore, keeping the above aspects in mind, frontline demonstration of cotton plant residue management through tractor-operated mobile shredder was organized at farmers' fields. The evaluation was determined in terms of effective field capacity, field efficiency, and shredding efficiency and cost economics of the operation was calculated in this study.

MATERIALS AND METHODS

The frontline demonstration was organized in the farmer's cotton fields of Rasanagi Village, Jewargi Taluk, Kalaburagi District, Karnataka, India. The cotton crop grown in irrigated farming situations was considered for the study. The shredding operation was carried out after cotton picking in the month of January. Forty farmers were chosen to conduct this study during 2021 and 2022 each, respectively. Each demonstration field was marked as T1: Removal of cotton stalk with tractor operated mobile shredder T2: Farmer's practice (Traditional method of removal of cotton stalk)

Tractor-operated mobile shredder

Tractor-operated mobile shredder from the College of Agricultural Engineering, Raichur was procured for this study. The specification of the tractor and implement was given in Table 1. The mobile shredder was mounted to a 2 wheel drive farm tractor capable of generating 33.6 kW (45 HP) power with a constant PTO speed of 540 rpm. The shredder was mounted on the tractor using three-point hitching system. During the operation, only one row of cotton crop was fed. The shredder comprised central driven feeder roller system and shredding system. The feeder roller system had 4 feeder drums in which front drums are equipped with disc cutter to enhance the feeding efficiency. This is followed with shredding system having a large flywheel with 6 blades which is completely

enclosed with an outlet on top. The outlet allowed the shredded material to blow out evenly on the field.

Physical parameters of cotton crop

The physical parameters of the crop on all demonstration fields was recorded. The row to row and plant to plant distance of the crop was measured. The physical parameters of cotton plants such as the height in mm and weight in kg was recorded by randomly picking 10 plants from fields. The moisture content of the cotton plant has significant effect on performance of the mobile shredder. The parameters such as field capacity and length of cut are dependent on the moisture content of the plant (Sonde *et al*, 2015). The moisture content of the cotton plant residue was determined using the hot air oven method. The collected samples were cut into small pieces from different parts of the plants and exposed to 105°C for 8 h. The initial and final weight of the samples were recorded. The moisture content is expressed in per cent (d.b).

Effective field capacity

The effective field capacity of the tractor-operated mobile shredder was calculated by the ratio of area covered by time consumed (Hunt, 2013). The actual time taken by the implement to complete the operation of one hectare was calculated by eliminating the time taken for activities such as turning and cleaning of blades when clogged with weeds. The field efficiency of the machine was also evaluated and expressed in Percentage.

$$\text{Effective Field Capacity, ha/h} = \frac{\text{Area.ha}}{\text{Actual time taken for shredding operation,h}}$$

Uprooting efficiency

The uprooting of the cotton roots was performed using the uprooting unit of the shredder. It is the ratio of number of cotton roots uprooted during the shredding operation to the total number of roots in field. The uprooting efficiency is expressed in percentage.

$$\text{Uprooting Efficiency} = \frac{\text{Number of roots uprooted}}{\text{Total number of roots}} \times 100$$

Shredding efficiency

The shredding efficiency in terms of the average length of cut of the cotton stalk is one of the important parameter. The average length of cut of the cotton stalk was examined as per the procedure outlined by Prince (1972). An area of one sq. meter was marked in the field. The random sampling of the shredded cotton stalk is collected and measured for the length of the cut. The peripheral velocity of the shredder blade is assumed constant in this study.

Fuel consumption and cost economics of operation

The actual fuel consumption is measured to by filling the tank to it maximum capacity before the operation and again filled to same level after completion. The actual fuel consumed was recorded. The operational cost of tractor-operated mobile shredder was worked out. The cost of the tractor and the machine was considered during the calculation. The fixed cost consists of depreciation, interest, tax, insurance and shelter. The variable cost includes the cost incurred by consumables and daily wages of operator for the tractor and the machine. It includes the cost of fuel, cost of oil, cost of repair and maintenance and cost of wages. The comparison of cost of shredding operation and traditional method of removing of cotton residues was calculated. The cost-benefit ratio was calculated as per the procedure outlined by Deva *et al* (2019).

RESULTS AND DISCUSSIONS

Crop parameters

The physical properties of randomly selected cotton stalks were determined to assess the number of shredded particles spread on the field. It was observed that the average length and the weight

Table 2. Economics of tractor operated mobile shredder and control

Particulars	Demo	Control
Yield, q/ha	18.75	18.75
Cost of removal of cotton stalk (Rs./ha)	2358.00	5800.00
Cost of cultivation (Rs./ha)	51500.00	54900.00
Gross returns (Rs./ha)	112500.00	112500.00
B: C Ratio	2.18	2.04

of the cotton stalks were 1653 mm and 0.387 kg, respectively. The moisture content of the cotton plant residue at the time of shredding operation was found to be 41.80 per cent.

Effective field capacity

The average speed of the tractor has a major role in effective field capacity. The row-to-row spacing of the crop was measured to be 120 cm. The average speed of operation in the field was found to be 3.8 km/h. The effective field capacity of the tractor-operated mobile shredder was determined to be 0.34 ha/h. Vyas and Mathur (2019) reported that the field capacity varied with tractor speed. The field capacity increased linearly with an increase in the speed of the tractor. The field efficiency was 80.90 per cent which is acceptable in field conditions. The results obtained were on par with the finding of Sridhar and Surendrakumar (2018) for shredding cotton stalks by using Rotary and flail shredders.

Uprooting efficiency

The root count was taken in a specific marked area in the field. The total number of roots and uprooted roots are counted. The average uprooting efficiency of the tractor operated mobile shredder was found to be 92.70 per cent for cotton. It was understood that the uprooting is dependent of the speed of operation. The same was reported by Solanki and Yadav (2009) and Vyas (2019).

The average length of cut

The shredding efficiency in terms of the average length of cut of cotton stalks was found to be 42.7 mm. The length of the cut of the cotton stalk varied from 19.2 mm to 64.5 mm. Ahmad *et al* (2020) evaluated the shredding efficiency of cotton stalk puller-shredder. They found that the shredded cotton stalk was distributed in the range of <30 mm to <90 mm wherein the highest number of the particle distribution was below <30 mm in all the forward speed. Vyas (2019) reported that the average length of cut of the cotton stalk was in the range of 51.50 to 83.50 mm. He also reported that more than 50 percent of the shredded particles were less than 50 mm in length. The length of the cut varied according to the speed of tractor, number of knives and shredder blade speed.

Fuel consumption

The fuel utilized by the tractor during the operation was recorded at a specific time period. The average fuel consumed during the operation of found to be 4.55 l/h. This was due to the fact that the higher rotary speed of shredder was achieved with higher speed of tractor. The shredding efficiency was dependent of the speed of travel of tractor.

Cost economics of operation

The cost of operation of shredding was Rs. 2358/-ha in the demo plot whereas, the cost of removal of cotton stalks in control was found to be Rs. 5800/- ha. The saving of Rs. 3650/- ha was reported in comparison to control was noticed which accounts to 63% saving in expenditure to the farmer. The cost economics of the operation of mobile shredder was on par with the findings of Vyas (2019). The gross returns of Rs. 112500/- were obtained with respect to both demo and control as the yield remained the same in both conditions. The cost of cultivation was found to be Rs. 51500/- for demo whereas it was Rs. 54900/- in control. The

cost-benefit ratio of the demo was found to be 2.18 in comparison to 2.09 in control (Table 2).

CONCLUSION

The study revealed that Cotton stalk shredding was an effective measure to control the burning of the stalk and the pollution caused by it. The total quantity of organic matter incorporated into the soil was valued to be 7.85 t/ha. The shredding operation was completed in less than 3 h/ha. The same with the traditional method would take 2-4 days with loss of organic matter. It is very beneficial to farmers as they can take summer crops immediately after the shredding operation. The farmers opined that the shredding operation successively increased the fertility and also water holding capacity of the soil.

REFERENCES

Anonymous (2020). Fully revised estimates of area, production and yield of principal crops in Karnataka for the year 2017-2018, *Directorate of economics and statistics*, Govt of Karnataka.

Ahmad F, Jamil M T, Khan A A, Khan Z M, Qiu B, Ma J and Chandio F A (2020). Field performance evaluation and finite element simulation of cotton stalk puller-shredder: a sustainable mechanical solution to control pink bollworm (Pectinophora Gossypiella). Sustainability 12: 3407.

Bawane M S and Khedkar S S (2018). Review paper on different aspects for management of cotton stalk residue. *Int J Mech Prod Engg* **6**(6): 53-56.

Deva S, Rao G M V P, Vinayalakshmi P and Rao C V (2019). Micronutrients spray on yield and economics of cotton in rainfed areas of Prakasam district in Andhra Pradesh. J Krishi Vigyan 8(1): 208-211.

Gemtos T A and Tsiricoglou T H (1999). Harvesting of cotton residues for energy production. *Biomass & Bioenergy* **16**: 51-59.

Gill K K and Bhatt K (2015). Development of agrometeorological models for estimation of cotton yield. *J Krishi Vigyan* **3**(2): 27-34.

Huang W, Bai Z, Hoefel D, Hu Q, Xin L V, Zhuang G, Xu S, Qi H And Zhang H (2012). Effects of cotton straw amendment on soil fertility and microbial communities. *Front Environ Sci Engg* **6**(3): 336–349.

Hunt D (2010). *Farm power and machinery management. Waveland Press Inc.*

Jadav N B, Undhad S V and Sharma P S (2018). Growers knowledge and adoption of chemical fertilizer in Bt. cotton. *J Krishi Vigyan* **7** (Special Issue): 69-73.

Prince G R (1972). Extension of covariance selection mathematics. *Ann human genetics* **35**: 485-490.

Senthilkumar T and Thilagam K V (2015). Study on effect of incorporation of shredded cotton stalks by cotton stalk shredder on soil properties. *Madras Agric J* **102** (4-6): 193-195.

Solanki and Yadav (2009). Development and Performance evaluation of a tractor operated plant uprooter for castor crop. *Agril Mech Asia Africa and Latin Americ,* **40:**65-67.

Sonde V M, Belkhode P N and Sakhale C N (2015) Physical And Mechanical properties Of Cotton As Agriculture Residue. *Int J Applic Innov Engg Manage* **4**(7): 156-169.

Sridhar N and Surendrakumar A (2018). Performance evaluation of rotary and flail shredders. *Int J Agril Engg* **11**(1): 23-29.

Sutaria G S, Vora V D, Vekariya P D and Akbari K N (2016). Technology for rapid composting of cotton stalk. *Int J Agri Sci Res* **6**(1): 211-216.

Vyas S S (2019). Development and performance evaluation of tractor operated cotton (Gossypium spp.) stalk shredder-mixer. *Thesis, Maharana Pratap Uni Agric Tech, Udaipur.*

Vyas S S and Mathur S M (2019). Effect of tractor speed, number of knives and shredding plate speed on mixing efficiency of cotton stalk shredder-mixer. *Green Farming*, **10**(3): 360-363.

Received on 30/3/2022 *Accepted on 25/7/2022*