STUDIES ON BEHAVIOUR CHARACTERISTICS OF SUGARCANE STALK INFLUENCED BY ROTARY BLADE

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Abstract: The present practice of harvesting is to use a sickle which is manually operated. Also it will be the solution for labor problem. Hence the present study was aimed to determine the cutting force required to cut the stalks at lower and top section. The cutting mechanism developed for harvesting of sugarcane at two stages i.e stalk at lower section and toppings simultaneously will save the time required for two stage harvesting of sugarcane and will reduce the drudgery involved in harvesting operations. The minimum force (0.023 N) was observed at the combination of blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for the variety Co-99004. The minimum force (0.083 N) was observed at blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for the variety Coc-671. The minimum force (0.072 N) at blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for cutting sugarcane variety of Co-85004. The minimum force (0.156 N) was observed at blade bevel angle 10°, blade shear angle of 25° and blade velocity 550 rpm for the variety Co-86032. As an effect of combination of three blade parameters, the minimum force (0.023N) for cutting lower section of sugarcane stalk with plane blade was recorded for the variety Co-99004 at the combination of blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm.

Key words: Cutting force, bevel angle,shear angle,velocity

Introduction: Harvesting of sugarcane is very difficult and double labours are required for cutting lower stalks and topping separately. The operation is time consuming and involves drudgery also. Mechanized harvesting of sugarcane is a need of a day which reduce the drudgery and time of operation. Hence, the study was under taken with the major objective i.e to determine cutting force of sugarcane stalk. This data will be useful for design and development of cutting mechanism for harvesting sugarcane.

Material and Methods: The experimental material selected for the study was four different varieties Co-99004, Coc-671,Co-85004 and Co-86032 of sugarcane planted in the year 2013 on the experimental field at from Sugarcane Research Unit, Central Research Station, Dr. P. D. K. V, Akola. Stalks of physiologically matured different diameter sugarcane plants were selected.

Rotary cutting mechanism was used in laboratory to estimate the force required to cut sugarcane stalks at bottom and top sections. The set up is equipped with a rotary disc, cutting blades, central shaft, torque sensor, electric motor and variable frequency drive (plate 1and 2).

Plate 1 Cutting blades of different angles

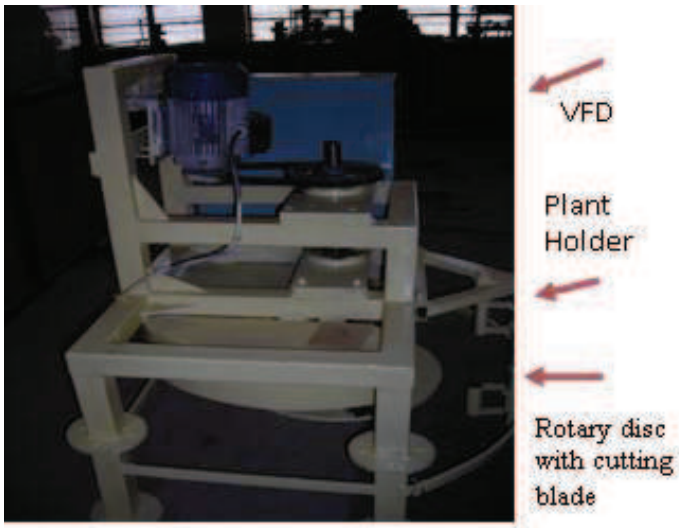


Plate.2 Experimental Set up

Variables for the study: The independent variables were four sugarcane varieties (Co-99004, Coc-671, Co-85004 and Co-86032), selected for studies. Blade shear angle (25° and 30°), and blade bevel angles (10° and 15°) for straight plane blade and at blade velocity 550rpm, 600rpm, and 650rpm.The dependent variable was cutting force. The experiments were replicated thrice and the results were analysed by using Factorized completely randomized design (FCRD).

Results and Discussion:Effect of three blade parameter: The results of combination of three blade parameters on force for cutting bottom section of stalks sugarcane varieties are explained and results are given in table 1.

Blade bevel angle, degree	Blade shear angle, degree	Force, N											
		Variety											
		Co-99004			Coc-671			Co-85004			Co-86032		
		Blade velocity, rpm											
		550	600	650	550	600	650	550	600	650	550	600	650
10	25	0.023	0.732	0.194	0.083	0.145	0.319	0.072	0.137	0.183	0.156	0.175	0.194
	30	1.075	0.442	2.008	1.864	0.905	1.003	0.890	1.198	1.233	0.783	3.001	0.871
15	25	1.485	0.677	1.313	2.353	1.260	1.265	1.580	1.668	0.606	1.488	2.655	1.232
	30	0.439	0.617	0.626	0.391	0.615	0.685	0.356	0.512	1.492	0.500	0.407	0.562
F- Test		S			NS			S			S		
SE (m+)		0.221			0.425			0.203			0.574		
CD (5%)		0.950			1.828			1.482			2.469		

Effect of blade bevel angle, blade shear angle and blade velocity: From the table 1, it is clear that when the variety Co-99004 is considered, at blade bevel angle 10° with blade shear angle 25°, the force increases with increase in velocity from 550 to 600 rpm and decreases significantly with further increase in velocity to 650 rpm. Whereas at blade shear angle 30° reverse trend of force was observed. When the blade bevel angle 15° was taken into consideration, at blade shear angle 25°, force decreases significantly with increase in velocity to 600 rpm and increases significantly with further increase in velocity to 650 rpm. Whereas at shear angle 30°, continuous increasing trend of force was observed. The minimum value of force (0.023 N) was observed at blade bevel angle 10°, blade shear angle 25°and blade velocity 550 rpm, while the maximum value (2.008 N) was observed at blade shear angle 30° and velocity 650 rpm. At blade bevel angle 15° minimum value of force (0.439 N) was observed at blade shear angle 30° and velocity 550 rpm, while the maximum value (1.485 N) was observed at blade shear angle 25° and velocity 550 rpm. The statistical analysis shows significant difference at 5% level of significance in mean values of forces for cutting stalk of variety Co-99004.

When the variety Coc-671 was considered for experimentation, at blade bevel angle 10° with blade shear angle 25°, the force increases continuously with increase in velocity from 550 to 650 rpm. Whereas at blade shear angle 30°, the force decreases with increase in velocity to 600 rpm and increases with further increase in velocity to 650 rpm. At blade bevel angle 15° with blade shear angle 25°, force decreases at velocity 600 rpm and the values obtained at velocity 600 rpm and 650 rpm had non-significant difference whereas at blade shear angle 30° the force had continuous increasing trend. The minimum value of force (0.083 N) was observed at blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm, while the maximum value (1.864 N) was observed at blade bevel angle 10° blade shear angle 30° and velocity 550 rpm. At blade bevel angle 15° with shear angle 25°, minimum value of force (0.391N) was observed at blade shear angle 30° and velocity 550 rpm, while the maximum value (2.353 N) was observed at shear angle of 25°and velocity 550 rpm. The statistical analysis shows significant difference at 5% level of significance in mean values of forces for cutting stalks of variety Coc-671.

In case of variety Co-85004, when the experiment was conducted at blade bevel angle 10° with blade shear angle 25°, continuous increasing trend of force was observed when the velocity was increased from 550 to 650 rpm whereas at blade shear angle 30°, same trend was observed. At blade bevel angle 15° with blade shear angle 25°, it is observed that the force increases with increase in velocity up to 600 rpm and then decreases with further increase in velocity to 650 rpm whereas at blade shear angle 30°, continuous increasing trend of force was observed. At blade bevel angle 10° the minimum value of force (0.072 N) for

cutting sugarcane stalk was observed at blade shear angle 25° and blade velocity 550 rpm, while the maximum value (1.233 N) was observed at blade shear angle 30°and velocity 650 rpm. At blade bevel angle 15° with blade shear angle 25°, minimum value of force (0.356N) was observed at blade shear angle of 30° and velocity 550 rpm, while the maximum value (1.668N) was observed at blade bevel angle 15° shear angle 25° and blade velocity 600 rpm. The statistical analysis shows significant difference at 5% level of significance in mean values of forces for cutting stalks of variety Co-85004.

For the variety Co-86032, after conducting the trials at blade bevel angle 10° with blade shear angle 25°, it was observed that there was non-significant difference in the force values obtained at all levels of velocity whereas at blade shear angle 30°, the force increased at blade velocity 600 rpm and then decreases significantly at blade velocity 650 rpm. When the blade bevel angle 15° was considered at blade shear angle 25°, force increases at velocity 600 rpm and then decreases at velocity 650 rpm. Whereas at blade shear angle 30°, there was non-significant difference in the force values obtained at all there levels of velocity. At blade bevel angle 10° the minimum value of force (0.156 N) was observed at blade shear angle of 25° and blade velocity 550 rpm, while the maximum force (3.001N) was observed at shear angle 30°and velocity 600 rpm. Whereas at blade bevel angle 15° the minimum value of force (0.407N) was observed at blade shear angle 30° and blade velocity 600 rpm, while the maximum value (2.655 N) was observed at blade shear angle 25°and blade velocity 600 rpm for cutting sugarcane stalks of variety Co-86032. The statistical analysis shows significant difference at 5% level of significance in mean values of forces for cutting stalks of variety Co-86032.

After analyzing the data of combine effect of bevel angle, shear angle and velocity, it is observed that the minimum value of force (0.023 N) for cutting the sugarcane stalk was recorded at blade bevel angle 10°, blade shear angle of 25° and blade velocity 550 rpm for the variety Co-99004, while the maximum value

At blade bevel angle 15°, blade shear angle 30°, for the variety Co-99004, minimum force was observed at blade velocity 550 rpm and the force values obtained at blade velocities 600 and 650 rpm. When the variety Coc-671 was considered, minimum value was obtained at the blade velocity 550 rpm and the force values obtained at blade velocities 600 and 650 rpm. In case of variety Co-85004, minimum force was noted at blade velocity 550 rpm and maximum force (3.001 N) was observed at blade bevel angle 10° blade shear angle 30° and blade velocity 600 rpm for the variety Co-86032. Fig. 1 shows the effect of blade bevel angle, blade shear angle and blade velocity on force for cutting stalks of four sugarcane varieties.

From the Fig.1, it is observed that at bevel angle 10°, with shear angle 25° the value of force were observed increasing trend from 550 to 600 rpm and then further decreases from 600 to 650 rpm for variety Co-99004, when variety Coc-671 was considered increasing trend was observed from velocity 550 to 650 rpm. In case of variety Co-85004 same trend was observed, whereas the values of forces obtained for the variety Co-86032 were having non-significant difference. When bevel angle 10° with shear angle 30° was taken in consideration, for the variety Co-99004, minimum force was observed at blade velocity 600 rpm whereas maximum was observed at blade velocity 650 rpm. For the variety Coc-671, minimum force was obtained at velocity 600 rpm and maximum at blade velocity 550 rpm. When the variety Co-85004 was considered for experimentation minimum force was recorded at blade velocity 550 rpm whereas force values recorded at blade velocity 600 and 650 rpm were at par. In case of variety Co-86032, maximum force was noted at blade velocity 600 rpm and force values at 550 and 650 rpm velocity levels were at par.

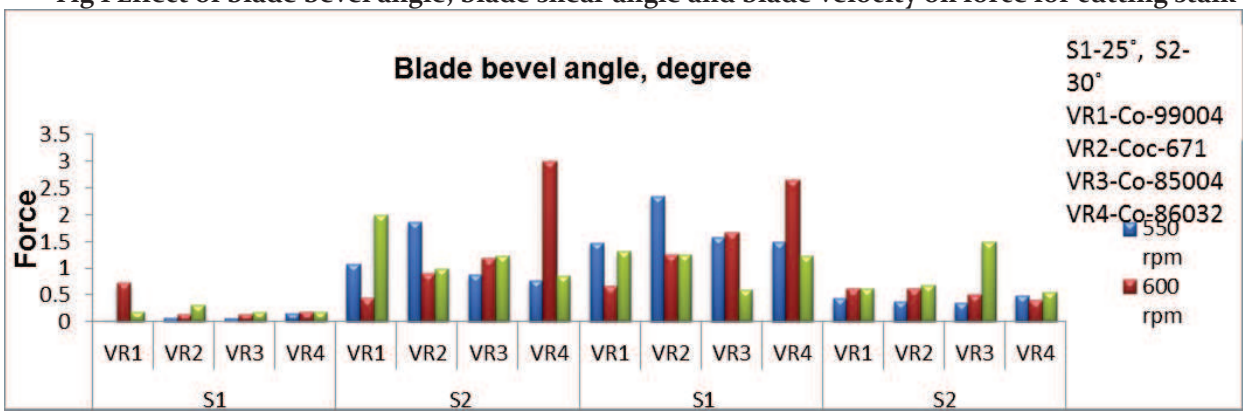
At blade bevel angle 15°, with blade shear angle 25°, the minimum force was obtained at blade velocity 600 rpm whereas force values at other two velocity levels were at par. For the variety Coc-671 maximum force was recorded at blade velocity levels were at par.

In case of variety Co-85004, minimum force was obtained at blade velocity 650 rpm and force values obtained at other two velocity levels were having non-significant difference. When the variety Co-86032 was considered, the maximum force was recorded at blade velocity 600 rpm and minimum at blade velocity 650 rpm. When the variety Co-86032 was considered, the maximum force was recorded at the blade velocity 600 rpm and minimum force at blade velocity 650 rpm.

at blade velocity 650 rpm. For the variety Co-86032, the force values observed at all three velocity levels had non-significant difference. **Person, 1987** also reported that the species related material features which would be expected to influence the maximum cutting force are ultimate tensile strength of the fiber, stiffness of the fiber, thickness of the strong fiber and structure of the stem.

S-significant, NS-Non-Significant

Fig 1 Effect of blade bevel angle, blade shear angle and blade velocity on force for cutting stalk



Conclusion:

1. The minimum force (0.023 N) was observed at the combination of blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for the variety Co-99004.
2. The minimum force (0.083 N) was observed at blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for the variety Coc-671.
3. The minimum force (0.072 N) at blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for cutting sugarcane variety of Co-85004.
4. The minimum force (0.156 N) was observed at blade bevel angle 10°, blade shear angle of 25° and blade velocity 550 rpm for the variety Co-86032
5. As a result of combine effect of three blade parameters, the minimum force (0.023 N) was observed at the combination of blade bevel angle 10°, blade shear angle 25° and blade velocity 550 rpm for the variety Co-99004.

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