

QUALITY OF ROTARY MOWER SIP RK 135 MOWING PROCESS IN MOUNTAINOUS AREA

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Abstract

The paper presents research results of tractor rotary mowers SIP RK 135 in cutting the first swath in natural landmeadow. The average yield of green mass was 20.66 t/ha. The aim of this research was to determine the productivity, quality of work and losses using the tractor rotary mower in cutting the first cut landmeadow. In the first experiment tractor operated at an average speed of 5.89 km/h achieving performance of 0.69 ha/h. In the second experiment the tractor operated at an average speed of 9.29 km/h achieving a performance of 1.01 ha/h. At a given speed, efficiency of work operations ranged from 0.78 to 0.93, averaging 0.86 in the first version and 0.70 to 0.93, averaging 0.81 in the second version. With the increasing speed of operation it has been observed an increase in the average height of cut by 1.35 cm and also increase in total losses of 2.73 % to a maximum of 4.45 % of the total yield.

Keywords: rotary mower, mowing, operational productivity, cutting height, losses.

Introduction

Mowing is the first work operation - phase in the procedure of storage of the hay, green forage and silage. Mowing is performed as a separate work operation or in combination with other work operations such as crushing or conditioning. Mowing of the biomass is performed at the time when the plant contains the most nutrients in order to preserve the value of the biomass and mowing should be done in the shortest possible time. The machines that are used for mowing grass should meet several general requirements, such as:

- universal use;
- cleanliness of the cut;
- prevention of pollution of biomass with soil;
- high operating speed - efficiency;
- easy, simple maintenance - technical and aging;
- work with minimal losses.

Almost all types of tractors and mowers meet the above requirements. In storing of hay obtained from meadowland the aim is to absorb as much biological yield of green mass, among other things, in order to reduce losses. In alfalfa in order to prevent damage to the cluster optimum cutting height is considered to be 6 to 8 cm, ie. it should not be mowed under 6 cm, while in the natural meadowland this height is somewhat lower up to 4 cm, which in turn depends on how the parcel is leveled plot and floristic composition of natural meadows. Today, in practice most commonly used are two types of tractor mower, that is oscillating and rotating. No matter what

the mowers are being used in mowing losses arise. Losses may arise due to the large height of cut and as a result of fragmentation of mowed mass, which during handling the hay can not be collected, but remain on the land. If we bear in mind that the greatest amount of chopped mass consists of leaves containing the highest amount of nutrients, thus a special attention must be paid to this type of loss. The speed of mower affects the increase in losses. (Tanevski, 1990), in examining the self-propelled mowers-hay crusher, quoted the average speed of 5.35 km/h. The same author states that the efficiency of work procedures amounts to average 95.5% of the yield. With the increasing speed of the mower an increase in losses due to cutting height occurs, but there is also reduction in losses that occur as a result of fragmentation. (Gašparac, 1988) in examining the SIP 165 rotary mowers at speeds from 8,5-12 km/h achieved the cutting height from 4.30 to 6.28 cm and width of 132-154 cm. According to Potkonjak (1986) the self-propelled mower "Fortschritt" substantially deviated from the optimal height adjustment. Deviation amounted to 9.47 cm, and consequently an increase in alfalfa mass loss in cutting height, with an average of 1.63% of yield. Koprivica (1996) in examining the self-propelled mowers and hay crusher in mowing alfalfa quoted the speed of the mower in the range of 3.71 to 6.41 km/h. To prevent damage to the cluster, optimum cutting height of 6 - 8 cm is considered to be optimal for alfalfa, which can be accomplished at working speeds of 5-8 km/h for conventional mower, and for the rotational 8-15 km/h (Zoranovi, 1995). According to Zoranovi and Potkonjak (1996), the total losses when mowing varied in the range from 0.90 to 2.29% of the yield, i.e. at average 1.59% of the yield. Height of cutting was the 6.42 cm at average. As recommended by Wiersma and Wiederholt (2001), alfalfa should be mowed to a height of 2 inches (5.08 cm). Potkonjak et al. (2009), suggest that the classical mowers accomplish the most favorable cutting height, as they better maintain the set cut-off level. According to the same authors classical mower has incurred the lowest total losses (approximately 1.27% of the green mass yield). Rotary mowers have achieved higher overall losses, i.e. mower with 6 discs of 3.16%, and 2.75% with 14 disks. Vukovic (2009) states that, with the increase of movement speed mower working width is reduced, which results in an increase in total losses. Also, the losses incurred due to cutting height increase, and losses incurred due to fragmentation decrease. Total losses recorded in the classic cutting apparatus amounted to 1.18% of the yield of alfalfa, while in self-propelled by 1.52% and 2.99% in rotary mower, says the same author. Losses of the mowing should not exceed 5%. The accomplished productivity varied in the range of 0.72 ha/h (oscillatory) to 1.00 ha/h (rotary mower). (Vukovic et al., 2011). According to researches performed by Bara (2012) the lowest cutting height was observed in rotary mowers with the drums and was 5.83 cm, with an average operating speed of 9.53 km/h. The minimum cutting height of the mower was measured at the velocity of 8.40 km/h and was 5.19 cm, and the maximum one of 6.48 cm at a speed of 10.84 km/h.

Mower with classic cutting apparatus accomplished a slightly higher cutting height in relation to the rotary, and it averaged 6.32 cm, with the tractor average operating speed of 5.79 km/h. The lowest cutting height of 5.42 cm was at 3.72 km/h, and the maximum speed of the tractor of 8.23 km/h was 7.38 cm.

According to research of Sila-Bogosavljev (1985 drawn mower Dubrava, Gramip TSK Superior, at working speed of 6.0 to 14.8 km/h achieved the effect of 0.81 to 2.00 ha/h, the coefficient of utilization of constructional working width is 89-97%, and the cutting height varied from 7.0 to 8.6 cm.

Materials and method

Experiments were carried out on the family farm in Mokro, near Pale, when mowing natural meadow with tractor rotary mower with drums SIP RK-135, at parcel with an average yield of 20.66 t/ha. Green mass yield was determined by measuring the green mass of meadow in the length of one meter of mowing width, calculated per hectare. The mower speed is determined using chronometric method. Using hand-held stopwatch the speed is measured on the length of 50 m. The cutting height is determined at the point where the loss is being determined, in such way that, for each test on the corresponding surface, measured was height of all stubbles on the basis of which the average was determined. Losses during mowing, measured from the surface of one meter long swath, at the working width of the mower, at the same place where the cutting height is determined. Total losses are presented as the sum of losses incurred due to cut height and losses incurred due to fragmentation. Determination of losses was performed in four tests.

Results and Discussion

Rear side drum rotary mower SIP RK 135 is one of the classical mower intended for small and medium-sized farms. They are characterized by simple construction and transmission of power to drive the drums through the belts and gears in the carrier housing. Rotary mower SIP RK 135 cuts grass mass on the principle of free cutting. This mower has a vertical drums or cylinders, with the cutting blades at the bottom. Drums or cylinders are placed in such position so that they work in pairs, and both drums have 3 blades.

Table 1. Technical characteristic of rotary mowers SIP RK 135

Parameter	Unit	Value
Suspension Point Category	-	I + II
Working width	m	1,35
Weight	kg	325
Transport width	m	1,20
Vehicle length	m	2,50
PTO Shaft rpm	min ⁻¹	540
Drum rotation rpm	min ⁻¹	2250
Number of drums	-	2
Number of knives	-	6
Required tractor power	kW	18
Cutting height	mm	40-70
Mowing capacity	ha/h	1,2

In the course of operation drums have opposite directions of rotation one towards other in pairs when moving, blades are cutting off the biomass and dispose it in swath between the two drums. Researches were carried out on parcels of natural meadowland in the first swath. The average yield of green mass was 20.66 t/ha and varied in the range from 17.95 to 27.06 t/ha. Height of grass mass ranged from 50 to 140 cm, on average 87.36 cm. Technical characteristics of the rotary mowers SIP RK 135 are given in Table 1. Side tractor rotary mower SIP RK 135, supported at three points, represents standard equipment for mowing primarily on small and medium-sized farms. The model which was tested has two rotating drums driven by pair of gears.

They are equipped with safety device and the bracket connection of the cutter bar for unhooking. This mower is characterized by a simple but strong construction and exceptional durability. During testing rotary mower SIP RK 135 was combined with the tractor IMT 540 Deluxe. In the first test, the tractor while moving in first gear achieved an average speed of 5.89 km/h with a CV of 3.11%, while in the second test, while moving in the second speed gear achieved an average speed of 9.29 km/h with a CV of 11.45%. (Table 2).

Mower constructive working width is 1.35 m and during testing efficiency of work procedures varied from 0.78 to 0.93, on average of 0.81 of the constructive, whereas in the second version observed was a tendency to reduce the coefficient of utilization of working width with increasing speed and is 0.70 to 0.93, average of 0.81.

Table 2. Operation Productivity SIP RK 135

Parameters	Speed I			Speed II		
	Average	SD	CV%	Average	SD	CV%
Operating speed (km/h)	5,89	0,18	3,11	9,29	0,58	6,24
Working width (cm)	116,5	6,42	5,51	108,8	8,97	8,24
The coefficient of utilization of working width	0,86	0,05	5,51	0,81	0,07	8,24
Production capacity (ha/h)	0,69	0,04	5,99	1,01	0,12	11,45

Table 3. Stem cutting height (cm)

Mower type	Parameter	Speed I	Speed II	Average
SIP RK 135	Cut-off height (cm)	5,15	6,50	5,83
	Speed (km/h)	5,89	9,29	7,59

Optimum height of alfalfa cut off, to prevent damage to the cluster, is considered cutting height to be from 6 to 8 cm, i.e. it should not be cut off under 6 cm, while in the natural meadowland this height is somewhat lower up to 4 cm and even lower, which in turn depends on how flat the surface of the parcel is and on floristic composition of natural meadowland. The results presented in Table 3 indicate that the change of moving speed has a significant impact on the cutting height of the tested mower. The average height of cutting of stems was 5.83 cm at an average speed of 7.59 km/h, the minimum cut-off height was 5.15 cm while moving in first gear at a speed of 5.89 km/h and the maximum height of cut-off was 6.50 cm at a speed of 9.29 km/h.

Table 4. Operating losses (% of yield)

Mower Type	Type of loss	I speed	II speed	Average
SIP RK 135	Cutting height incurred losses	1,67	3,63	2,65
	Losses due to fragmentation	1,06	0,82	0,94
	Total losses	2,73	4,45	3,59

It has been noticed on the mover which is being tested that, with increase of the moving speed, there is a tendency to increase losses due to cutting height and to decrease losses due to fragmentation. The results presented in Table 4 suggest that losses due to height of cut with rotary mowers varied depending on the speed in the range of 1.67 to 3.63 %, at average of 2.65%, and the losses due to fragmentation were ranged from 0.82 to 1.06 % at average of 0.94 %. The total losses incurred are the sum of the previous two types of losses and during the testing of

rotary mowers average value of total losses amounted to 3.59 % of yield, which is in accordance with other authors who have dealt with this issue.

Conclusion

Based on the results of testing the rotary drum mowers SIP RK 135 quality of cutting we can say that the same achieved optimum and uniform losses in tested variants. Thus, the lowest cutting height of 5.15 cm at speed of 5.89 km/h and with increasing speed of 9.29 km/h it was 6.50 cm. Cut-off heights of 4 cm in the meadowland depends solely on how flat the surface of the parcel is, condition of the and to which extent the land is weedy. SIP RK 135 has made losses incurred by height adjustment of 2.65 %, whereas the losses due to fragmentation decreased with increasing speed of 1.06 to 0.82 % and the total average losses were 3.59 %. If we bear in mind that the maximum allowed value of losses is 5 % of the yield, it can be concluded that the rotary mower SIP RK 135 has achieved the optimum value of losses and quality of mowing.

References

- Bara , S., Vukovi , A., Biberdži , M., Koprivi a, R. (2012): Results of mower when mowing alfalfa in the environmental conditions of northern Kosovo. XVII Conference on biotechnology-with international participation-Journal-Vol.17. (19) 2012 a ak p.161-165
- oki , D., Dini , B., Lugi , Z., Sokolovi , D. (2007): Mowers in the preparation of Fodder, Journal - Vol. 44, No. I, Institute of farming and truck-farming in Novi Sad, 515-522.
- uki , D. (2005): Status and Perspectives of alfalfa in Europe and in our country. Journal. Institute of farming and truck-farming . Novi Sad, Volume.41, 155 – 169.
- Koprivica, R., Stanimirovi , N. (1996): Results of self-propelled mowers 'Fortschritt' E301 tests.Journal Agronomic Knowledge, Novi Sad, 6,1, 25-27
- Gašparac, J. (1988): The results of comparative testing of rotary mowers. Actual tasks of agricultural engineering, Conference Journal I-part 122-128 Opatija.
- Koprivica, R., Veljkovic, B., Stanimirovi , N., Radivojevi , D. (2011): Organizational and technological solutions in the preparation of high quality alfalfa hay self –propelled mowers-mashers, International Scientific Symposium on Agriculture "Agrosym Jahorina 2011", Jahorina, Hotel Bistrica, 10 - 12 November, pp. 603-610
- Potkonjak, M. Zoranovi (1990):Quality of work and driving power for rotary mower with 4, 5 and 6 discs. In Proc. Coference Journal of the XVII Scientific Conference Agricultural Engineering. Opatija, 73-78.
- Potkonjak V, Zoranovi , M, An elkovi , S. (2009): Exploitation characteristics of different mower types in alfalfa mowing. Modern agricultural technique.Vol.35. No1-2, Novi Sad, 73-78.
- Potkonjak V, (1986): Finding the most suitable technological solution for storing and handling of hay, Report on work of the Faculty of Agriculture, Novi Sad
- Tanevski, D. (2009): The study of the working effects on consumption of energy of the line machine for the gathering, transportation, and preparation of forages for cattle. Doctoral dissertation, Skopje
- Sila Bogosavljev (1985): Results of tractor mounted mowers TSK Superior. Actual Tasks on Agricultural Engineering, Conference Journal, Split, p.356-366
- Vukovi A. (2009): Exploitation characteristics of self-propelled mowers compared with classic tractor and rotary mower. Master's thesis. Faculty of Agriculture, Priština. Zubin Potok, 48

- A. Vukovic, S. Bara , Bojana Milenkovi . (2011): Production effectiveness and fuel consumption of various types of mower during alfalfa mowing process. Research Journal of Agricultural Science, Vol. 43 (1), 345 - 349 Romania.
- Vukovic, A. BaraC, S., Stanimirovi , N. (2010): Losses during mowing alfalfa self-propelled mower-masher "Fortschritt" E-302s. Agricultural Engineering, vol. 35, iss. 4, pp. 1-4
- Wiersma, D., Wiederholt, R. (2001).: Alfalfa cutting height to maximize forafe yield and quality. Journal 2,001th University of Wisconsin, USA, http://www.uwex.edu/ces/forage/wfc/proceedings2001/alfalfa_cutt
- Zoranovi M. (1995): Analysis of technical and operational parameters of mowers. Master's thesis. Faculty of Agriculture, Novi Sad, 132
- Zoranovi M. Potkonjak V. (1996): Exploitation characteristics of mower when mowing alfalfa, Modern agricultural technique. Novi Sad, Vol. 22, No. 5, 266-272