Al-Azhar Journal of Agricultural Engineering 6 (2024) 39

Contents lists available at Egyptian knowledge Bank (EKB)

Al-Azhar Journal of Agricultural Engineering

journal homepage: https://azeng.journals.ekb.eg/

Full length article

Performance evaluation of a portable machine for Egyptian clover mowing

Zaalouk A. K. [a], Hafez S. M. [a], Werby R. A. [a], Elkot M. [b,*]

[a] Department of Agricultural Machinery and Power Engineering, Faculty of Agricultural Engineering, Al-Azhar University, Cairo, Egypt.
[b] Master's degree researcher.

ARTICLE INFO

Handling Editor - Dr. Hassan A. A. Sayed

Hassan2712@azhar.edu.eg

Keywords:
Egyptian clover
Mowing
Cutting efficiency
Cutting speed

Agricultural Machinery and Power Engineering

ABSTRACT

This study investigates the performance evaluation of a portable mower for harvesting Egyptian clover. The main objective of this study is to evaluate and develop a cutter blade for the portable machine for harvesting Egyptian clover to increase its mowing efficiency. Field experiments were conducted to investigate some parameters affecting the performance of a portable mower. The tested parameters were: three cutting-blade speeds of 2500, 3000, and 3500 rpm (10.58, 12.70 and 14.82 m/s), three types of cutting blades: 2-edge, 3-tooth, and 40-tooth, plant-three intensities of ≤ 800, 800-1200 and ≤ 1200 1200 plant/m², and plant three inclined-angles of ≤ 45, ≤ 60 and ≤ 90° with a land plane. The obtained results can be summarized in the following points: The maximum cutting efficiency of 99.33% was obtained using a 2-edge cutting blade with a speed of 3500 rpm, plant intensity of ≤ 800 plant/m² and plant inclined angle of 90°. Meanwhile, the minimum cutting efficiency of 88.67% was obtained using a 3-tooth cutting blade with a speed of 2500 rpm, plant intensity of ≤ 1200 plant/m², and plant inclined angle of ≤ 45°.

1. Introduction

Egyptian clover (Trifolium alexandrinum L.) is the most important annual winter forage and legume crop. Egyptian clover has high nutrition for animal feeding. Also, Egyptian clover increases soil fertility and improves soil structure (Graves et al., 1996). Egyptian clover is a strategic forage crop in the sustainability of agriculture production systems because of decreasing input requirements and regenerated nature (Iannucci, 2001). Berseem is the most crucial legume fodder in Egypt; it has high vegetative growth, multi-cut nature, good forage yield, continuing for a long time of forage saving, and notable fodder yield with outstanding delicious and high crude-protein of 20-21% and total edible-food of 62% (Yadav et al., 2015). Different yield components are attributed to Egyptian clover crop yield, but the genotype and harvesting management are the crucial factors affecting the forage quality and seed yield (Sardana and Narwal, 2000; Iannucci and Annicchiarico, 2011). Also, Egyptian clover is cultivated for forage and seeds. Egyptian clover is a major seed export crop in Egypt. The exported seeds of Egyptian crops were about 12000 tons in 2001. Also, Egyptian clover is the main honey-producing crop (El-Nahrawy, 2005). The rural livestock smallholders contribute to the meat

* Corresponding authors.
E-mail address: mahmoudelkot87@gmail.com (Elkot M.)

https://azeng.journals.ekb.eg/article_249641.1007.html
Peer review under responsibility of Faculty of Agricultural Engineering, Al-Azhar University, Cairo, Egypt.
Received 12 November 2023; Received in revised form 03 December 2023; Accepted 06 December 2023
Available online 1 January 2024

and milk supply based on Egyptian clover. Egyptian clover is a high-quality leguminous crop for winter forage (Muhammad et al., 2014). Egyptian clover is involved in rotation with non-leguminous crops to increase crop productivity (Salama, 2015).

Crop harvesting is the last stage of farm operations, with a maximum time compared to other farm operations. Alfalfa and wheat stems are cut close to the soil. It used a sharp sickle for stem cutting. There are many harvesting machines that agricultural engineering scientists have brought (Hayat et al., 2018). In order to obtain a high alfalfa production, a suitable mower must be used for harvesting. The efficiency indicators of the mower are crop-cutting height and losses. The mower efficiency depends on many factors: crop properties and conditions, machine-operation parameters, technical accuracy, and operator skills (Barać et al., 2012). Choosing a suitable mower for alfalfa harvesting affects protein and fiber content, which are essential forage quality indicators (Rade et al., 2019).

Egyptian farms have a shortage of skilled labor to operate big crop harvesters. Some problems faced by farm mechanization include a wide range of soil types, small landholdings, and weather, which require customized harvesting machines. The crop harvesters are available for purchase but not affordable because of their high costs. Small-scale farmers need a compact and comparatively cheap machine. So, the present study evaluates the performance of a portable, compact, low-cost crop mower. The mower tested in this study is famous for the name brush cutter. The brush cutter is widely used at home and on farms. The brush cutter is mainly used in landscaping, gardens, forest clearing, tending, and crop harvesting. A small gasoline engine powers the brush cutter. It has rotating cutting blades that are driven by the transmission shaft. The advantages of brush-cutter are low mass, easy transporting, simple construction and installation, reduced labor intensity, and very efficient and high-quality work (Beg, et al., 2022). Beg et al. (2022) designed a moiled grassmower for cleaning forests, gardens, and playgrounds. It was concluded that the operator could operate for a minimum of 1.5 hours, cut height be regulated, resolving pain in the neck, shoulder, upper arm, and finger by shoulder strapped grass cutter. Parthasarathy et al. (2022) developed a multipurpose brush cutter by adding multiple attachments like a sugarcane leaf stripping attachment, blower, and vacuum cleaner.

The main objective of this investigation is the performance evaluation of a portable mower for harvesting Egyptian clover under different operating parameters (cutting-blade speed and type, crop intensity, and inclined angle) in terms of cutting height, cutting efficiency, machine capacity, and efficiency.

2. Materials and methods

The main experiments were carried out through the agricultural season of 2022-2023 at a private farm, Dakoda Valley, El-Gharbia Governorate, Egypt, to test the portable mower suitable for harvesting the small farms of Egyptian clover.

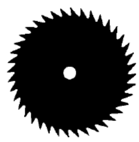
2.1. Materials

2.1.1. Egyptian clover

Egyptian clover "Giza 1" crop variety, which is suitable for the middle delta, was used in this study. Egyptian clover gives over five cuttings. The first Egyptian clover cutting was done 55 days after seed planting, and other cuttings were done after 45-50 days. Egyptian clover at cutting number three was harvested in this study, and some physical properties of Egyptian clover stalks are presented in Table 1. The Egyptian clover stalk's height range was 50-75 mm, the outside diameter range was 4-6 mm, the stalk-mass range was 4.2-5.7 g, the moisture content (dry basis) range was 83-85%, and plant intensities range were 600-1240 plant/m^2.

Table 1

The main specifications of tested cutting blades.

Specification	3-teeth blade	40-teeth blade	2-edge blade
Shape			
Tooth length, mm	72	12	75
Tooth width, mm.	48	26.7	39.2
Working width, mm.	255	255	255

2.1.2. Field Layout

The experiments were carried out in about 0.173 fed (729 m^2) of Egyptian clover, which was panted by hand. Each area of three plant intensities and three plant inclined angles was divided to equal three main plots. Each main plot area was divided into three equal subplots, "9×9 m" for different cutting-blade shapes of 3-teeth, 40-teeth, and 2-edge. Each subplot was divided into three equal pieces of "3 ×3 m" for three different cutting-blade speeds of 2500, 3000, and 3500 rpm.

2.1.3. Mechanical analysis of experimental soil

The mechanical analysis of the experimental soil was performed at the Land and Water Research Institute, Agricultural Research Center at a depth of 30 cm using the hydrometer method, which was classified as clay soil with portions of 49.2% (clay), 40.6% (silt), and 10.2% (sand).

2.1.4. The tested portable reaper

The portable reaper of BC520, which was made in China, was used in this study. Figure 1 shows the tested portable reaper's main components. The main specifications of the tested portable reaper are: total dimensions of 183 cm length, 61 cm width, and 42 cm height, machine mass of 7.4 kg, and engine mass of 4.7 kg.

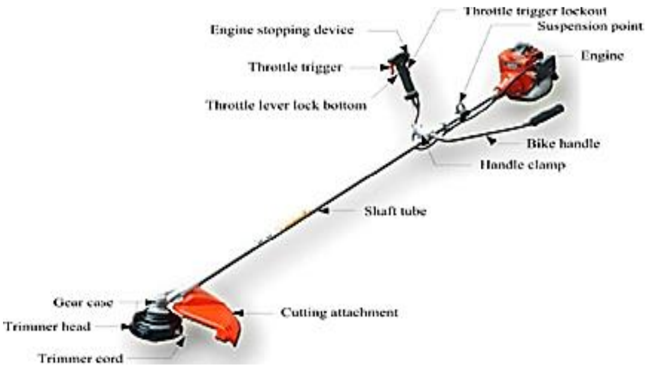


Fig. 1. Schematic drawing and photograph of the main components of the portable reaper.

2.1.5. Instrumentations

A digital speedometer was used to measure the cutting-blade speed. Other instruments include a stopwatch, digital dial caliper, digital balance, and graduated cylinder.

2.2. Methods

2.2.1. Study factors

The tested parameters were three cutting-blade speeds of 2500, 3000, and 3500 rpm (10.58, 12.70 and 14.82 m/s), three cutting-blade shapes of 2-edge, 3-tooth, and 40-tooth with 25.4 cm diameter, three plant intensity of ≤ 800, 800-1200, and ≤ 1200 plant/m^2, and three plant inclined angles of ≤ 45, ≤ 60, and ≤ 90° with a land plane. Consequently, the total number of treatments was 81. Each treatment was replicated three times to determine the mean value for each treatment.

A. Physical and mechanical properties

A square wood with dimensions of 1×1 m was used to determine some physical properties of Egyptian clover stalks. The determination was repeated fifty randomly to obtain the mean. Stalk length was measured using a measuring tape with a length of 2 m and an accuracy of 1 mm; the stalk diameter was measured using a vernier caliper with an accuracy of 0.1 mm. The stalk mass was measured using the digital electrical balance with an accuracy of 0.1 g. The clover stalk moisture content was measured by using the oven method.

B. Cutting height

The average height of 100 clover stalks was calculated by measuring their cutting heights following each treatment with different parameters.

C. Cutting efficiency

Cutting efficiency using the portable reaper was calculated according to Arafat (2019), as follows:

$$C_e = \frac{N}{N_t} \times 100$$

Where:

C_e = Cutting efficiency in (%).

N = Number of cut plants.

N_t = Total number of plant population.

D. Field capacity

(1) The theoretical field capacity was calculated according to Ahmed (2018), as follows:

$$T_c = \frac{W_m \times S}{4.2}$$

Where:

T_c = Theoretical field capacity in (fed/h).

W_m = Working width of the machine in (m).

S = Working forward speed in (km/h).

(2) The effective field capacity is the actual average time consumed during the operation (lost time + productive time), and it was calculated according to Awad et al. (2022), as follows:

$$E_c = \frac{60}{P_t + L_t}$$

Where:

E_c = Effective field capacity in (fed/h).

P_t = Productive time in (min).

L_t = Lost time in (min).

3. Results and discussions

This section presents the performance evaluation of the portable machine for Egyptian clover harvesting under the effect of different rotary speeds, the shape of cutting blades, plant intensity, and inclined angle on cutting height, cutting efficiency, effective field capacity, and field efficiency.

3.1. Cutting height

Figure 2 shows the influence of different rotary-speed, the shape of cutting blades, plant intensity, and inclined angle on cutting height. The results illustrate that the plant cutting height increased by increasing plant intensity and decreased by increasing cutting-blade speed and plant inclined angle on soil using all tested cutting-blade types. Data show that the maximum cutting height of 5.8 cm was obtained using a 40-tooth cutting blade at a speed of 2500 rpm, plant intensity of ≤ 1200 plant/m^2, and an inclined angle of ≤ 45°.

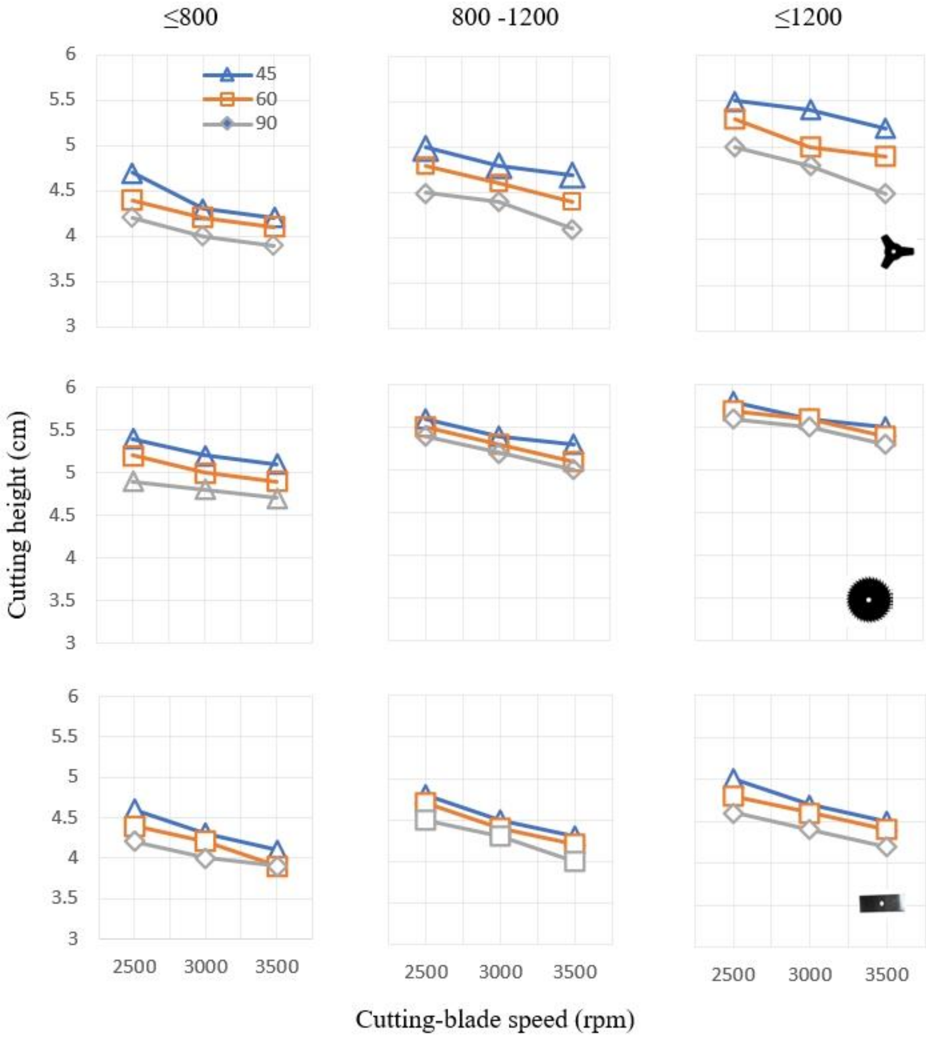


Fig. 2. Effect of different rotary-speed, shape of cutting-blades, plant intensity and inclined-angle on cutting height (cm).

Meanwhile, the minimum height of 3.9 cm was obtained using a 2-edge cutting blade with a speed of 3500 rpm plant intensity of ≤ 800plant/m², and plant inclined angle of ≤ 90°. The results are similar to the results obtained by Arafat (2019). Increasing Egyptian-clover plant cutting height by increasing plant intensity is probably due to the increased upward lift of the plant acting on the cutter blade.

3.2. cutting efficiency

Figure 3 shows the effect of the parameters mentioned above on cutting efficiency. The results show that the plant cutting efficiency increased by increasing the cutting-blade speed plant inclined angle and increasing plant intensity on the soil using all tested cutting-blade types. Data show that the maximum cutting efficiency of 99.33% was obtained using a 2-edge cutting blade with a speed of 3500 rpm, plant intensity of ≤800 plant/m² and plant inclined angle of ≤ 90°. Meanwhile, the minimum cutting efficiency of 88.67% was obtained using a 3-tooth cutting blade with a speed of 2500 rpm, plant intensity of ≤ 1200 plant/m², and plant inclined angle of 45°.

3.3. Effective field capacity

Figure 4 shows the effect of different rotary speeds, cutting blade shapes, plant intensity, and inclined angle on effective field capacity. Results show that the field capacity increased the cutting-blade speed plant inclined angle and decreased plant intensity on the soil using all tested cutting-blade types. Data show that the maximum field capacity of 0.083 fed/h was obtained using a 3-tooth cutting blade with a speed of 3500 rpm, plant intensity of ≤ 800plant/m², and plant inclined angle of ≤ 90°. Meanwhile, the minimum field capacity of 0.024 fed/h was obtained using a 40-tooth cutting blade at a speed of 2500 rpm, plant intensity of ≤ 1200 plant/m², and plant inclined angle of ≤ 45°.

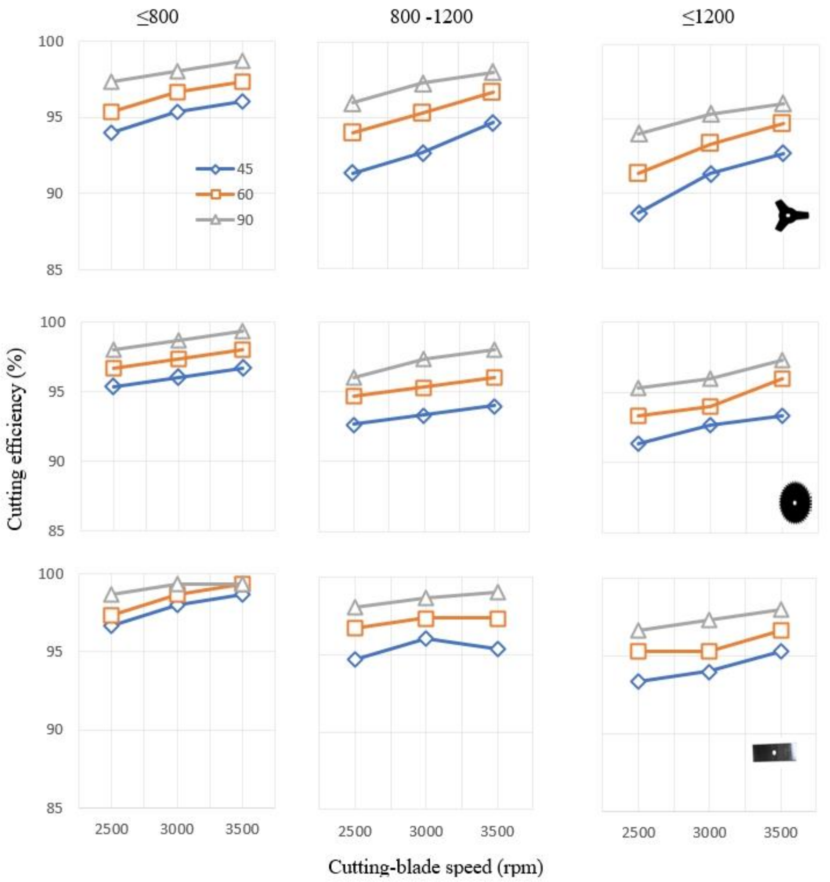


Fig. 3. Effect of different rotary speeds, the shape of cutting blades, plant intensity, and inclined angle on cutting efficiency (%).

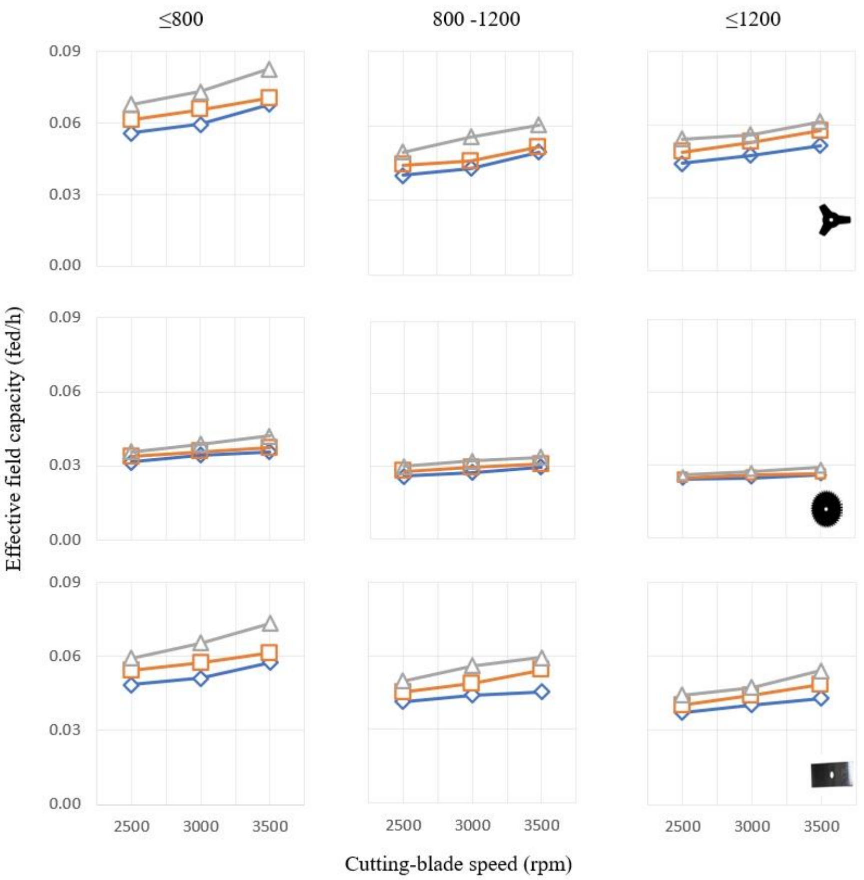


Fig. 4. Effect of different rotary speeds, the shape of cutting blades, plant intensity, and inclined angle on Effective field capacity (fed/h).

3.4. *Machine productivity*

Results show that machine productivity increased by increasing cutting-blade speed, plant inclined angle, and plant intensity using all tested cutting-blade types. Data show that the maximum machine-productivity of 400.47 Mg/h was obtained using a 3-tooth cutting blade with a speed of 3500 rpm plant intensity of ≤1200 plant/m², and plant inclined angle of ≤ 90° (Figure 5). Meanwhile, the minimum machine productivity of 102.30 Mg/h was obtained using a 3-tooth cutting blade with a speed of 2500 rpm, plant intensity of ≤ 800 plant/m², and plant inclined angle of ≤ 45°. Results show that Increasing machine productivity by increasing cutting-blade speed and increasing plant intensity is due to decreasing the harvesting time and increasing the mass of harvested plants. The results are similar to those obtained by Arafat (2019); Al-Gezawe et al. (2023).

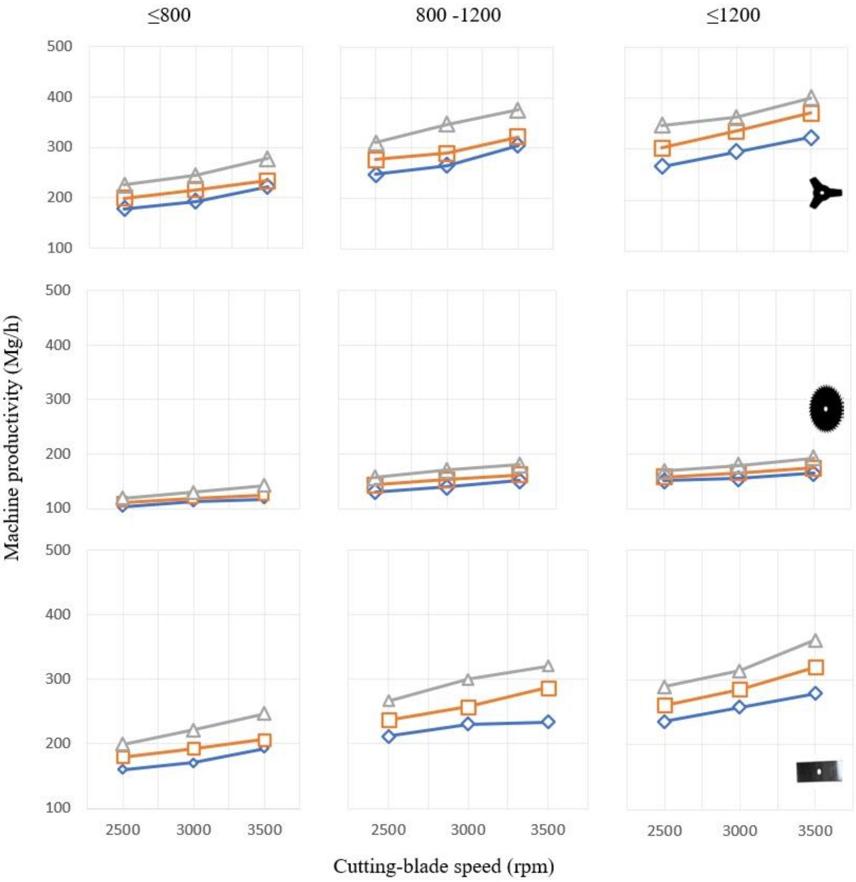


Fig. 5. The effect of different rotary speeds, cutting blade shapes, plant intensity, and inclined angle on machine productivity (Mg/h).

3.5. *Costs of using the tested portable mower*

The hourly cost of using the tested portable mower, according to the price of February 2023 was 23.75 L.E./h (Egyptian pound/h). Results show that operation and production-unit costs decreased by increasing plant inclined-angle and plant intensity using the optimum cutting-blade speed of 3500 rpm (14.82 m/s), and all tested cutting-blade types. At the optimum cutting-blade speed of 3500 rpm (14.82 m/s), the minimum operation mean costs of 324.2 L.E./fed and production mean costs of 65.6 L.E./Mg were obtained using a 3-tooth cutting blade, plant inclined angle of ≤ 90 degrees for plant intensities of ≤ 800, 800 – 1200 and ≤ 1200 plant/m² respectively.

4. Conclusions

This research aims to evaluate the performance of a portable machine for mowing Egyptian clover. This research studied several factors affecting the performance of the portable machine for mowing Egyptian clover, such as cutting blade speed, cutting blade type, plant density per square meter, plant inclination angle on the soil, and their effect on cutting height, cutting efficiency, actual field capacity and efficiency, and machine productivity. The tested parameters were three cutting blade speeds of (2500, 3000, and 3500 rpm), three types of blades of 3-toothed, 40-serrated, and double-edged, three plant densities of ≤ 800, 800 – 1200, and ≤ 1200 plant/m², and three plant inclination angles regarding the soil of ≤ 45°, ≤ 60°, and ≤ 90°. The results revealed that the minimum cutting-height of 3.9 cm was obtained using a 2-edge cutting-blade with speed of 3500 rpm (14.82 m/s), plant intensity of ≤ 800 plant/m² and plant inclined angle of 60 - 90 degree, and a plant inclination angle of ≤ 45°. The highest cutting efficiency for Egyptian clover plants was 99.33%, achieved using a 2-edge cutting blade with a speed of 3500 rpm, plant density ≤ 800 plant/m², and a plant inclination angle of ≤ 90°. The highest actual field capacity obtained was 0.083 fed/h using a 3-tooth blade with a speed of 3500 rpm, plant density ≤ 800plant/m², and a plant inclination angle of 90°. The highest machine productivity was 400.47 Mg/h achieved using a 3-tooth blade with a speed of 3500 rpm plant density ≤ 1200 plant/m², and a plant inclination angle of 90°.

- Operate the tested portable-mower at cutting-blade speed of 3500 rpm (14.82 m/s), using different blades of different types (3 - tooth), plant-intensities (≤ 800, 800 – 1200, and ≤ 1200 plant/m²) and plant-inclined-angles (≤ 45, ≤ 60 and ≤ 90 degree).

References

Ahmed, R. A. A. (2018). Performance evaluation of portable machine for turf grass shear, Misr J. Ag. Eng., 35 (1): 57 – 68.

Al-Gezawe, A., Cottb, M., Abd El Gawad, F., Awad, M., Fouda, O., Okasha, M. (2023). Manufacture of a device for pruning fruit branches. INMATEH - Agricultural Engineering, 69(1): 379–388. https://doi.org/10.35633/inmateh-69-35.

Arafat, M. W. (2019). Evaluation using solar energy for operating disk mower in one of new valley farms, M.Sc., Fac. Agric. Ain Shams Univ. Agric. Eng. Dept.: 38-53.

Awad, M., Fouda, O., Fathy, W., El Balkemy, W., Egela, M., El-Fakhrany, W., Okasha, M. (2022). A combined machine for collecting and chopping rice straw. Heliyon, 8(8), e10412. DOI: https://doi.org/10.1016/j.heliyon.2022.e10412

Barać, S., Vuković, A., Milenković, B., and Biberdžić, M. (2012). Testing results of mower with different cutting devices in alfalfa mowing, Agricultural Science Research Journal, 4(1): 241-248.

Beg, A., Gupta, N., Verma, P., Latif Khan, M. and Saxena, K. (2022). Design of shoulder strapped grass cutter, International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE), 9(7): 21-22.

El-Nahrawy, M. A. Z. (2005). The vital role of Egyptian clover in agriculture, Proceedings of the 11th Conference of Agronomy, Assiut University, Assiut, Egypt: 55-62.

Graves, W. L., Williams, W.A. and Thomsen, C. D. (1996). Berseem clover: A winter annual forage for California agriculture, University of California Division of Agriculture and Natural Resources, Publication No. 21536: p.12.

Hayat, M. S., Shende and P. N., Narnaware, P. H. (2018). Design and performance evaluation of wheat crop cutting machine, International Research Journal of Engineering and Technology (IRJET), www.irjet.net, 5(4): 2526-2530.

Iannucci, A. (2001). Effects of harvest management on growth dynamics, forage and seed yield in berseem clover, European Journal of Agronomy. 14: 303–314.

Iannucci, A. and Annicchiarico, P. (2011). Seed and forage yield of advanced generation synthetics of berseem clover derived from partly inbred parents under different harvesting regimes, Plant Breeding, 130: 694–700.

Muhammad, D., Misri, B., El-Nahrawy, M., Khan, S. and Serkan, A. (2014). Egyptian clover (*Trifolium alexandrinum*) king of forage crops, FAO Rep 1: 1– 110.

Parthasarathy, M. E., Pradeep, D., Kuma, P. S. and Sivakumar, M. (2022). Design and development of multipurpose brush cutter for agricultural operations, International Journal of Engineering Research and Technology (IJERT), 10(8): 252-255.

Rade, S., Aleksandar, V., Sasa, B., Rade, R., Dagoslav, D. and Dargan, P. V. (2019). Influence of harvesting on quality of alfalfa forage used for haylage and hay, Tarým Bilimleri Dergisi, Journal of Agricultural Sciences, www.agri.ankara.edu.tr/journal, 25: 384-390.

Salama, H. A. S. (2015). Interactive effect of forage mixing rates and organic fertilizers on the yield and nutritive value of berseem clover (*Trifolium alexandrinum* L.) and annual ryegrass (*Lolium multiflorum* lam), Agric, Sci., 6: 415–425.

Sardana, V., Narwal. S. S. (2000). Influence of time of sowing and last cut for fodder on the fodder and seed yields of Egyptian clover, Journal of Agricultural Science. 134: 285–291.

Yadav, P. S., Vijay, D. and Malaviya, D. R. (2015). Effect of cutting management on seed yield and quality attributes of tetraploid berseem, Range Management and Agroforestry, 36: 47-51.

تقيم أداء آلة محموله لحش البرسيم المصري

أشرف كامل زعلوك [١] ، سمير محمد حافظ [١] ، رأفت على وربي [١] ، محمود القط [٢]

[١] قسم هندسة الآلات والقوى الزراعية، كلية الهندسة الزراعية، جامعة الأزهر، القاهرة، مصر.
[٢] باحث ماجستير.

الملخص العربي

يعتبر البرسيم محصول العلف الأخضر الرئيسي في مصر وهو محصول شتوي ذو طبيعه خاصة حيث تتم عملية الحش في ظروف مناخيه تكثر فيها الامطار بالاضافه الي انه يحش علي فترات متفاوته حسب احتياج الحيوان وتتم عملية الحش من (٤-٥) مرات في الموسم تقريبا وكذلك عملية الحش الآلي غير منتشر خاصة في المساحات الصغيرة. وغالبا ما يتم الحش بالطرق اليدويه التي تزيد من تكاليف الإنتاج وتحتاج إلي مجهود لإتمام عملية الحش وعمالة مدربة. لذلك يهدف البحث إلى تقييم أداء آلة محمولة لحش البرسيم المصرى. وتتكون الآلة من محرك قدرته ١,٤٦ كيلو وات، عمود لنقل القدرة وماسورة حاملة، تروس لنقل الحركة، رأس الحش ، ذراعى توجيه، حزام لحمل المحرك.

وتم فى هذا البحث دراسة تاثير المتغيرات الآتية على أداء الآلة المحمولة لحش البرسيم المصرى مثل:

١-شكل سكينة الحش: وتم استخدام ٣ اشكال للسكينة (السكينة ذو الحافتين تم تصنيعها محليا – السكينة ذو ٤٠ سنه – السكينة ذو ٣ سنن).

٢-سرعة سكينة الحش: وتم استخدام ٣ سرعات (٢٥٠٠ لفه/دقيقة ، ٣٠٠٠ لفة/دقيقة ، ٣٥٠٠ لفة/دقيقة)

٣-كثافة النباتات بالمتر المربع: وتم استخدام ثلاثة كثافات (الأقل من ٨٠٠ نبات/م^{٢} ، من ٨٠٠ - ١٢٠٠ نبات/م^{٢} ، الأكبر من ١٢٠٠ نبات/م^{٢})

٤- زاوية ميل النبات على التربة : وتم دراسة ٣ ميول (زاوية ≤90 ، زاوية ≤٦٠ ، زاوية ≤٤٥)

وتاثير ذلك على ارتفاع وكفاءة القطع ، السعة الحقلية الفعلية والكفاءة الحقلية، انتاجية الآلة ، وكذلك تكلفة عملية الحصاد

وقد تم تجميع هذه العوامل فى معادلات إنحدار تنبؤية معبرة عن تفاعل تلك العوامل ، **وتم الحصول على النتائج التالية:**

(١) **ارتفاع القطع:** وجد أن أقل ارتفاع قطع لنبات البرسيم المصرى هو ٣,٩ سم تم الحصول عليه باستخدام سكينة ذات حافتين سرعتها ٣٥٠٠ لفة/د وكثافة نبات ≤ ٨٠٠ نبات/م٢، وزاوية ميل ٩٠-٦٠ درجة.

(٢) **كفاءة القطع:** وجد أن أعلى كفاءة قطع لنبات البرسيم المصرى هو ٩٩,٣٣ % وتم الحصول عليه باستخدام سكينة ذات حافتين سرعتها ٣٥٠٠ لفة/د وكثافة نبات ≤ ٨٠٠ نبات/م٢، وزاوية ميل نبات ٩٠ درجة. وكانت أعلى سعة حقلية فعلية هى ٠,٠٨٣ فدان/ساعة تم الحصول عليها باستخدام سكينة ذات ٣ أسنان سرعتها ٣٥٠٠ لفة/د وكثافة نبات ≤ ٨٠٠ نبات/م٢، وزاوية ميل نبات ٩٠ درجة.

(٣) **إنتاجية الآلة:** وجد أن أعلى إنتاجية للآلة هى ٤٠٠,٤٧ كج/ساعة تم الحصول عليها باستخدام سكينة ذات ٣ أسنان سرعتها ٣٥٠٠ لفة/د وكثافة نبات ≤ ٨٠٠ نبات/م٢، وزاوية ميل ٩٠ درجة. بينما وجد أن أقل إنتاجية للآلة هى ١٠٢,٣٠ كج/ساعة تم الحصول عليها باستخدام سكينة ذات ٤٠ سنة وسرعتها ٢٥٠٠ لفة/د وكثافة نبات ≥ ١٢٠٠ نبات/م٢، وزاوية ميل ٤٥ درجة.