PERFORMANCES EVALUATION OF A SELF-PROPELLED MOWER DURING SURFACE CLEANING OPERATION IN URBAN GREEN AREAS

Parenti A.1, Baldi F.1, Masella P.1, Nannucci L.1, Specogna G.1
1Dipartimento di Ingegneria Agraria e Forestale, Facoltà di Agraria – Università degli Studi di Firenze, Piazzale delle Cascine 15, 50144, Firenze, Italia

keywords: self-propelled mower, urban green area, mowing deck, sweeper system

Abstract
Aim of this work was to evaluate the performances of a self propelled mower during a surface cleaning operation in urban green areas. At this purpose the machine was equipped both with a conventional mowing deck and with a hydraulic sweeper system. The trials were performed on two different surfaces placed in Florence (Italy) urban public parks, i.e. turf surface and asphalt concrete road surface for the mowing deck, only asphalt concrete surface for the sweeper system. The results allowed to ascertain the feasibility of the use of the conventional mowing deck instead of the conventional sweeper system for surface cleaning operation in the tested areas. The implement gives better performances both in terms of operating work capacity and unit fuel consumption as compared to the conventional sweeper system. Such chance could help the users to limiting the costs especially for management and maintenance of urban contests. The multipurpose character of the tested self-propelled mower was confirmed.

Introduction
Currently, an important attribute of modern self-propelled mowers was the multipurpose character. The use of this type of machine was in expansion especially in urban green areas, i.e. a wide range of vegetation types placed within or close to the human habitations. Along with grass mowing the maintenance of these areas require specific installation and maintenance procedures and, thus, special instruments for operations (Biocca, 2007; Piccarolo, 2000). Generally, several attachments can be fitted to these machines thus increasing their flexibility. In this way these machines are able to provide solutions to the most varied operational needs and allow professional landscapers to be immediately productive. An example of this class of machines was the self-propelled mower model Turbo4 by Gianni Ferrari srl. Has declared by the manufacturer, this mowers was able to fit a wide range of implements including different type of mower decks for a wide variety of operating conditions and other implements such as an aerator (to remove moss and weeds and to help the grass breathe), a vacuum hose (to allows collecting of large quantities of leaves, paper, etc.), a front grader blade (to level sand and soil, or clean snow), a snow thrower (to remove snow) and an hydraulic sweeper system to collect leaves, litter and other waste materials. This last operation, i.e. surfaces cleaning operation, could be alternatively performed by means of the conventional mowing deck designed for grass mowing and collecting clippings. Such chance could help the users to limiting the costs especially for management and maintenance of urban green areas. Aim of this work was to evaluate the performances of a self propelled mower during a surface cleaning operation. At this purpose the machine was equipped either with a conventional mowing deck and a hydraulic sweeper system.

Materials and Methods
The trials were performed using a self-propelled mower model Turbo4 by Gianni Ferrari srl (Gianni Ferrari web site). Basically, the machines consist of a front-mounted grass mower, endowed with a batchtype cotter-pin manual device to regulate cutting height; a ventral suction system for collecting the cut grass; a grass collector that can be lifted and dumped hydraulically; a 3-cylinder diesel engine (displacement of 1123 cm³); a hydrostatic transmission and steering system; an electric system and front-wheel braking system. The machine was designed to mount a wide range of implements to perform different operations. The conventional mowing deck consists
of two contra-rotating discs, each endowed with two pairs of articulated blades, set at an angle of 90° to those of the other disc. The lower blade makes the first cut, while the upper blade provides a second cut, useful when the grass is wet, reducing the possibility of deck flooding, with positive effects in terms of the quality of mowing, suction and collection. An opening has been made on the centre front of the mower deck’s guard, with a portable bulkhead, to make the edge of the casing higher than the blade cutting level. The suction system consists of a rapid rotation turbine and a vacuum hose that connects the mower deck to the turbine, which in turn is connected by piping to the grass collector. The grass collector, having a storage capacity of 1100 liters, was endowed with a metal filter, plastic casing to reduce filter cleaning operations, a rear door that opens automatically when the collector is dumped and a dispenser of the cut grass, operated via an electric motor, with an acoustic warning sounding when the collector is full. Instead of the conventional mowing deck the machine can be fitted with a hydraulic sweeper system with collection, filter and water spraying kit. The hydraulic sweeper system allows the operator to collect leaves, litter and other waste materials in the machine’s storage collector. The self-cleaning filter prevents dust from flowing out of the storage collector while the water spraying kit wets the work surface limiting the amount of dust raised by the rotation of the brushes.

The machine was tested both with the conventional mowing deck and with the sweeper system on two different surface placed in Florence (Italy) urban public parks, i.e. turf surface (naturalized grass) and asphalt concrete road surface for the mowing deck, only asphalt concrete surface for the sweeper system. The trials scheme was reported in Table 1.

<table>
<thead>
<tr>
<th>Implement</th>
<th>Surface</th>
<th>Material humidity (% w/w)</th>
<th>Mean density of waste material (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweeper system</td>
<td>asphalt concrete road</td>
<td>47</td>
<td>162</td>
</tr>
<tr>
<td>Mowing deck</td>
<td>asphalt concrete road</td>
<td>55</td>
<td>515</td>
</tr>
<tr>
<td>Mowing deck</td>
<td>turf</td>
<td>49</td>
<td>280</td>
</tr>
</tbody>
</table>

During each trial the machines performances were evaluated in terms of operating work capacity (m²*h⁻¹) and unit fuel consumption (per unit of removed material, g/kg, and per unit of surface area, g*m⁻²) (Pellizzi, 1996).

**Results and Discussion**

Cleaning operation of surfaces such as turf surface and asphalt concrete road in urban green areas can be considered a good example to achieve information about the multipurpose character of the tested self-propelled mower. The machine was set to optimize its work by Ferrari staff. The performances results recorded during the trials were reported in Table 2.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Surface</th>
<th>Operating work capacity (m²/h)</th>
<th>Unit fuel consumption (g/kg, g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweeper system</td>
<td>asphalt concrete road</td>
<td>1828</td>
<td>15.75, 3.49</td>
</tr>
<tr>
<td>Mowing deck</td>
<td>asphalt concrete road</td>
<td>2129</td>
<td>5.24, 2.70</td>
</tr>
<tr>
<td>Mowing deck</td>
<td>turf</td>
<td>3678</td>
<td>7.56, 2.11</td>
</tr>
</tbody>
</table>
As showed in Table 1 there were some differences in the characteristics of the materials, mainly leaves, among the trials. Comparing the two implements on the same surface, i.e. asphalt concrete road, the material corresponding to the mowing deck trial showed both greater humidity content and a greater mean density per unit surface than the material corresponding to the sweeper system trial, conditions that generally negatively influence the machine working capacity. Despite of this when the mowers was equipped with the conventional mowing deck its operating work capacity results considerably higher than with the sweeper system, i.e. an increment of about 300 m²/h. Further, it was to underline the lesser unit fuel consumption which corresponds to the mowing deck implement trial. Such considerations can be extended to the trial performed on turf surface by the conventional mowing deck. In this case the implement allows attaining the better performances both in terms of operating work capacity and unit fuel consumption when referred to unit working surface. The greater unit fuel consumption per unit of removed material recorded in this trial as compared to the others was probably to ascribe to some characteristic of the tested area such as the presence of slope tracts, wood fragments and lesser density of material per unit surface along with the major extension of the tested area.

Conclusions
The work allows to ascertain the feasibility of the use of a conventional mowing deck instead of a conventional sweeper system for surface cleaning operation in urban green areas. The implement give better performances both in terms of operating work capacity and unit fuel consumption as compared to the conventional sweeper system. However, was to underline that when the operation was performed on asphalt concrete road some marks were observed on the treated surface. Therefore, the possible use of this implement should be considered in relation to the esthetic character of the areas to be cleaned.

The multipurpose character of the tested self-propelled mower was confirmed.

Acknowledgements
The Authors would to thank Gianni Ferrari srl.

References