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# Determination of mechanization properties in Switchgrass (*Panicum virgatum* L.) Agriculture

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**ABSTRACT**

In this study, the determination of mechanization characteristics in the production of the plant of the *Panicum virgatum* L. was intended within the scope of TÜBİTAK project no. 114 O 941for the first time in Turkey. The study was carried out at trial sites belonging to the Karapınar Soil, Water and Desertification Research Institute Directorate. Soil has been made ready for cultivation by tillage plough and afterwards using horizontal spindle rotovator + rotary rake combination in the preparation of seed bed followed by pulling flat rollers for soil cultivation and pneumatic peeseding seeding machine which can sow small seeds was used for cultivation. In this three-recurrent study, three different varities of Switchgrass (Kanlow, Shawne, Cave In Rock) were used. According to the results obtained in the study, the consumption of fuel consumed in soil application and as far as the harvest was 5,89-0,476-0,538 l / da for tillage, sowing and harvest respectively. When field values of field shoots were examined, the highest field shoot yields were obtained in the Kanlow variety with 78.88% and the Shawne variety with the lowest value of 31.77. When the MED(Mean Emerge Duration) and ERI( Emerge Ratio Index) values were examined according to the data obtained from the application, it was seen that it ranged between 10,73-12,25-13,07 days and 6,61-2,32-4,59 m/day respectively. In the survey, The green biomass yield values for the Kanlow, Shawne and Cave In Rock varieties which were determined in the 2nd year following the establishment year ranged from 5566, 3046 and 3666 kg / da respectively in the study.

## 1. Introduction

Recently entrance into energy bottleneck is foreseen due to even wrong consumption policies and consumability of fossil fuels. As result renewable energy becomes foreground. Biomass production and subsequently transforming biomass into energy has great importance within framework of energy sources.

Developed countries increase their energy diversity and continue their energy research by trying to decrease dependence to certain energy sources. Biofuels are leading alternative sources which are new and popularizing rapidly(Eser et al., 2007).

Recently agriculture is not only performed for food production, agriculture for energy plants become more popular. Plants which can be raw material of biofuel can be grown where plants with food purposes can not be cultivated and thereby these areas can included into agricultural production. 30% of agricultural areas are planned to be allocated to forage plant and 20% of agricultural areas are planned to be allocated energy plants (Eser et al., 2007).

There is lack of knowledge even cultivation and physiologic manner regarding with switch grass plant which is very new for our country. First information regarding with agronomy of switchgrass was presented by Soylu et al., 2009, homeland for Switch grass (*Panicum virgatum* L.) which is multiyear C4 plant is Northern America. It is very good soil protective plant with its deep root structre (2m) and underground biomass production around 8 ton /ha. Soil structure would be improved together with improvement of deep root structure and it becomes important for fighting against erosion (Soylu et al., 2010b).

Annual 6-25 ton/ha ground net biomass production is obtained from Swichgrass. Its importance is great in recent years since it is tolerant against drought, and it is

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a good bioenergy (bioethanol) raw material for development of regions where there is restricted opportunities for cultivation. High net energy production in unit area, low production costs, low ash content, high water usage efficiency, ability for adaptation to vast geographical areas, easiness for establishing in marginal areas with seed, high potential for carbon storage in soil makes switch grass to be recommended for energy and feed production (Samson and Omielan, 1992; Sanderson et al., 1996).

Implementation of mechanization for first time and determination of mechanization is necessary within scope of project for switch grass which has is alternative energy potential for fossil fuel need in our country. Any study was not observed regarding with mechanization of this plant. In the event that agriculture of this plant can be realized based on farmer in our country it will make contribution to energy generation animal feeding and soil protection. In this study determination of mechanization properties for producing switch grass (*Panicum virgatum* L.) plant is aimed.

## 2. Materials and Methods

Tests were implemented in Station for fighting against Erosion in Soil and Water which is present in Konya-Karapınar town. Dimensions for parcels were executed according to random block test as being 3 replications where each parcel will have 5x100 m dimensions for each type of switch grass. Meteorologic data for some soil properties for test area where study was implemented were given in table 1 and table 2.

Table 1
Soil properties regarding with test area

| | Depth | | |
|---|---|---|---|
| | 0-30 | 30-60 | 60-90 |
| Structure class | Clayed loam | Clayed | Clayed-Loam |
| EC.$10^{-3}$ | 0,426 | 0,439 | 0,453 |
| Salt | 0,016 | 0,020 | 0,020 |
| $CaCO_3$ | 33,35 | 28,70 | 29,38 |
| Organic substance | 1,33 | 1,10 | 0,62 |
| Phosphor | 14,53 | 5,74 | 2,61 |
| Potassium | 33 | 26 | 24 |
| pH | 7,65 | 8,30 | 8,60 |
| Volumetric weight | 1,43 | 1,47 | 1,53 |
| Penetration resistance | | | 0,51 |
| Soil cut off resistance | | | 0,014 |
| Surface roughness value | | | 17,15 |

Table 2
Meteorological data for test area (Anonymous, 2015)

| Months | Weather temperature (°C) 2015 | Humidity(%) 2015 | | Rain (mm) 2015 |
|---|---|---|---|---|
| July | 23,0 | 44,8 | | 0,0 |
| August | 23,4 | 53,5 | | 5,2 |
| September | 20,6 | 48,4 | | 0,8 |
| October | 13,8 | 69,2 | | 3,6 |
| November | 5,4 | 70,6 | | 1,6 |
| Average | 12,4 | 66,1 | Total Rain | 185,7 |

New Holland TT95 D tractor was used in tests. Agricultural machines and their properties were given in Table 3.

Land within test area was ploughed by plough with lug. Then rotary tiller was used for secondary treatment. Subsequently testing land was irrigated since plantation depth for seed should be minimum 1cm and rollers was applied for compacting soil and plantation evenness was maintained. Plantation year for kinds of switch grass which is multiyear plant was made on 22$^{nd}$ july 2015 by pneumatic peeseding seeding machine. Distance between rows was adjusted as 26 cm, distance over row was adjusted as 1.1 and plantation depth was adjusted as 1cm during plantation by pneumatic peeseding seeding machine. Germination values which were obtained from organization which is located abroad was consider and thousand grain weight considered plantation norm was calculated as there will be 400 living seed per square meter. Thousand grain weight for switch grass which were used in tests were given in table 4.

Testing area was irrigated 8 times until harvesting period by sprinkling irrigation starting from spring development according to need in testing area and total 490 mm water was delivered.

Fuel consumptions for machines which are used in applications started after completely filling tractor tank and tanks were filled at the end of work and fuel consumption for machines depending on area where machines have worked were calculated in terms of l/da.

Profile meter was used for determining surface roughness of soil. Profile meter consists of rods which are placed over profile having 1 m length with 2.5 m interval. Surface profile was measured with 2.5 cm interval by profile meter which is placed vertically at working direction and field surface roughness was calculated by following equation(Çarman, 1997).

$$R = 100\,Log_{10} S$$

Here ;

R: Surface roughness of field (%)

S: Standard deviation of measured values

Soil penetrometer with tapered end and memory Measurements were taken from 0-20 cm depth. 3 repeating penetrometer readings were taken from testing area. Average of 10 measurements were taken for each testing area both before plantation and after plantation.3 strips which are randomly selected having 1 m length were selected in each parcel for observing average germination date, index and field sprouting time and sprouts going out of ground were counted and following equation was used (Konak and Çarman, 1996).

$$MED = \frac{N_1 D_1 + N_2 D_2 + ... + N_n D_n}{N_1 + N_2 + ... + N_n}$$

$$ERİ = \frac{uumberofseedwhichhasger \min atedin1meter}{MED}$$

$$TFÇ = \frac{Numneroftotalseedwhi chhasger \min ated1onemeer}{Numberoftotalseedwhi chhasplantedinonemeter} x100$$

In this equation;

MED: Mean Emerge Duration (day)

N: Number of seed which germinated in each count

D: Number of days which have elapsed after plantation (days )

ERİ: Emerge Ratio Index (piece/m. day)

TFÇ: Field sprouting rate (%)

First plantation year was not taken into account for calculation of green grass productivity or each switch grass and 2nd year green grass harvesting which is growing year was implemented in 15 September 2016. Those types of switch grass which were harvested in following years were transformed in decade and green grass productivity was calculated over kg/da.

Table 3
Agricultural machines and which are used in tests and their technical properties

| Machine /Tool | | Number of foot/body (Pcst) | Structural work width (m) | Type (-) |
|---|---|---|---|---|
| Plough |  | 5 | 1,60 | Suspended |
| Horizontal spindle rotovator + rotary rake combination |  | 12 | 2,65 | Suspended |
| Cylınder roller |  | 1 | 2,90 | Pulled |
| Pneumatic peeseding seeding machine |  | 6 | 1,65 | Suspended |
| Rotary drum mower |  | 2 | 1.90 | Suspended |

## 3. Results and Discussion

Mechanization properties of switch grass (*Panicum virgatum* L.) plant of which mechanization was made in Turkey within scope of TUBITAK project numbered 1140941 was presented in this research.

Counts were implemented over switch grass seeds which were germinated after plantation and MED (Mean Emerge Duration) and ERI( Emerge Ratio Index) and TFÇ, field sprouting rate were calculated and results are given in table 4.

Table 4
Mean germination period (M.E.D.), Germination rate index (E.R.I.) field sprouting (T.F.Ç.)

| Types | Average values | | |
|---|---|---|---|
| | M.E.D. (day ) | E.R.I. ( Piece/m.day ) | Field G. (%) |
| Kanlow | 10,73 | 6,61 | 78,88 |
| Shawne | 12,25 | 2,32 | 31,77 |
| Cave ın Rock | 13,07 | 4,59 | 66,88 |

Table 5
Fuel consumption values for some machines which were used in tests

| Machine /Tool | Fuel consumption (L/da) |
|---|---|
| Plough | 2,200 |
| Horizontal spindle rotovator + rotary rake combination | 3,040 |
| Pneumatic peeseding seeding machine | 0,476 |
| Cylınder roller | 0,650 |
| Acrobat rake | 0,179 |
| Rotary drum mower | 0,185 |
| Baler Machine | 0,174 |

Types were compared according Field sprouting rate which is one of important indicators (table 5. First appearance occurred in Kanlow type. Highest sprouting for the types which are periodically observed occurred in 78,88%kanlow type and lowest rate was obtained in Shawnee type with 31,77 ratio.

It can be seen that MED and ERI values vary between 6,61-2,32-4,59 piece/.day according to data which are obtained from application area.

Fuel consumption, working speed, work success, submerging into soil a soil cutoff resistance were determined as data for mechanization operations.

Fuel consumption values for machines which are used in tests were given in table 5 and operational properties of machines were given in Table 6.

Table 6
Operational properties of some machine which are used

| Machine/tool | Working depth (cm) | Average speed (km/h) |
|---|---|---|
| Plough | 18 | 5.5 |
| Horizontal spindle rotovator + rotary rake combination | 12 | 1,6 |
| Pneumatic peeseding seeding machine | - | 4,5 |
| Cylınder roller | 1 | 6,5 |
| Acrobat rake | 1,9 | 10 |
| Rotary drum mower | 2,2 | 7,5 |
| Baler Machine | 1,63 | 6 |

According to results which were obtained in study, fuel consumptions for applications in soil processing until harvest was calculated as 5,89-0,476-0,538 l/da.

Average green grass productivity values which were determined in switch grass types were given in Table 7.

Table 7
Green grass productivity values which are determined in 2nd year after plantation in switch grass kinds (kg/da)

| | Average green biomass productivity values (kg/da) |
|---|---|
| Kanlow | 5566 |
| Shawne | 3046 |
| Cave In Rock | 3666 |

Productivity values varied between 5566, 3046 and 3666 respectively for Kanlow, Shawne and Cave in Rock. Different ecotype in Kanlow kind (low land), having more height, and cultivation for bioethanol lead having higher green grass productivity values. As Shawnee and Cave in Rock types belong to upland ecotype, these kinds are shorter and has thinner stem. Thereby their productivity is less with respect to callow type. These kinds are mostly used for animal feeding.

Distance between rows is other factor which effect productivity of switch grass. Most important problem in plantation year of a plant is the competition with weeds. Frequent plantation, power of competition of plant with weeds and decrease in productivity of biomass encourage single and week plant growing. (Ocumpaugh ve ark., 1997) studied over 13,30 and 50

cm intervals regarding with row distance and reported that larger intervals increase productivity. Commonly recommended row interval is 15-20 cm in literature (Başer et al., 2008).

There is not any study regarding with mechanization of switch grass growing. This study which was implemented within scope of TUBITAK project no 114 0941 presented that mechanization applications can be implemented successfully in growing successfully. That switch grass is multiyear plant and it can have lifetime up to 15 years and seeds are very small makes its plantation year very important. Benefit with highest yield will be obtained for long years from switch grass plantation area where most suitable plantation technique and method was used. Biomass and morphologic data which we will obtain in 2nd year when mechanization values will indicate actual performance of plant presented conformity of mechanization chain to be used in switch grass plantation.

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