Sida hermaphrodita Rusby

(*Sida hermaphrodita Rusby*), also known as Virginia fanpetals, originates from the southern parts of North America where it occurs in its natural environment.
The plant belongs to the mallow (*Malvaceae*) family and is a polycarpic perennial with shoots which die out annually. Harvesting and further liquidation of its plantation are much easier than in the case of the currently dominating species used as energy crops, which include trees, e.g. poplar or willow (wicker)[1].

The growth buds located on the roots in the stalk area allow the plant to regenerate and increase the number of stalks during each successive year, from one in the first year, to 20-30 in the fourth and following years[2].

Being a perennial, one planting can continue the cultivation for 20 to 30 years. The first commercial yield can be produced already in the 2nd year, and considering this plant's low soil requirements, cultivation with high and stable yield is viable on soils of valuation class IV or even V, provided that the following criteria are met and proper pre-cultivation preparations have been accomplished[3]:

- all valuation soil classes, except for class VI and poor soils in class V;
- optimal soil pH: neutral, slightly acidic is permitted;
- optimal soil concentration of elements: high or at least moderate concentrations of P, K, Mg;
- the field should be free from persistent weeds.

Cultivation, fertilisation, harvesting of and care for the plant involves traditional farming methods and conventional agricultural machinery, which is a major advantage for farmers who would like to grow the plant.

Sida exhibits slow growth in the first year of cultivation, which may unfortunately favour weed infestation of the plantation and require thorough care during that period. The successive years give high growth of the green mass; the shoots reach 3 to 4 metres high[4] (the registered record height is 4.75 m). This allows the plant to fend off any weeds on its own.

Sida can be reproduced with its seeds, the most common method, or vegetatively by using various parts of the plant, mainly its root cuttings.

The seeds' germination capacity is 50-75%. Field sprouting capacity has been established at 20-40%, depending on the soil and weather conditions (temperature, precipitation)[5].

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[1] Halina Borkowska, Bolesław Styk, edited by Piotr Lewandowski, *Rozwój energii odnawialnej na Pomorzu Zachodnim :[conference materials]*, Koszalin, 2004 p. 279
[2] *Biopaliwa*, Collective work, edited by Piotr Gradziuk, edition by „Wieś Jutra" Sp. z o.o., Warsaw 2003, p. 68
[3] www.biotek.pl
[4] Op. cit. P. Gradziuk, p. 69
[5] Op. cit. Halina Borkowska, Bolesław Styk, edited by Piotr Lewandowski, Koszalin, 2004, p. 280

According to the recorded experience of Ostrowąs Farm, the recommended sowing rate should be 1 kg/ha to obtain 40-100 thousand plants per hectare; increasing this amount further is unnecessary.

The plant resists frost well; thanks to its extensive root system, it also bears periodic drought with little effort, which enables its cultivation in Polish climatic conditions[6].

The standard yield for Sida is established at 15 tons; however, proper fertilisation and farming procedures may result in 20 to 25 tons of dry mass per hectare, which suggests that the plant is extremely effective in cultivation.

Sida, cultivated for energy production, should be harvested in winter or in early spring, since drying out of the shoots, following the vegetative period, ensures the lowest humidity of material, i.e. between 15% and 25%, a huge advantage over the aforementioned tree species, like willow, which usually exhibit approximately 50% of humidity[7].

This enables direct processing of the plant without the need for additional (and often time consuming and costly) drying, unlike in the case of tree species; the harvested chaff can be readily stored outdoors, since it neither develops mould nor absorbs humidity. Also, the plant is not readily humificated during storage.

Another advantage of Sida is that it can be harvested with legacy farming equipment, i.e. corn (maize) harvesters and trailers to ship the shredded sida; the first yield is available in the second year of cultivation.

The physical and chemical properties of Sida make it useful as a renewable source of electrical power and heat energy. The estimated calorific value of the Sida is 18 MJ/kg, which has been confirmed by scientific research, including examinations carried out at the Wood Technology Institute in Poznań. This parameter makes the plant comparable to oak wood or spruce wood[8].

In order to facilitate distribution and storage of this plant, Sida chips can be processed into solid fuels, e.g. in the form of pellets or briquettes which are characterised by a high concentration of pure energy and freedom of harmful substances.

The process can be easily performed with the use of commercially available pressing units and without binders of any kind. The physical and chemical properties, taking into consideration the European standards on solid biomass fuels, are presented in the table below.

[6] Op. cit. H. Borkowska, B. Styk, Lublin 2006, p. 40
[7] Ibidem, p. 29
[8] Ibidem, p. 31

Physical and chemical properties of solid biomass fuel made of Sida

Quantity/Component	Unit (titre)	Standards of qualitative requirements for plant sawdust briquettes and pellets				Sida biomass pellets (briquettes have similar values)
		Önorm M 7135 (Austria)		Standard DIN 51731 (Germany)		
		min	max	min	Max	
Density	kg/dm³	1	-	1	1.4	**1.09**
Humidity	%	-	12	-	12	**9.7**
Ash	%	-	0.5	-	1.5	**2.0**
Calorific value	kJ/kg	18,000	-	17,500	19,500	**17,850**
Sulphur	%	-	0.04	-	0.08	**0.02**
Chlorine	%	-	0.02	-	0.03	**0.01**
Nitrogen	%	-	0.30	-	0.3	**0.13**
Arsenic	mg/kg	-	-	-	0.8	**0.21**
Cadmium	mg/kg	-	-	-	0.5	**0.37**
Chromium	mg/kg	-	-	-	8	**0.12**
Copper	mg/kg	-	-	-	5	**3.47**
Mercury	mg/kg	-	-	-	0.05	**0.03**
Lead	mg/kg	-	-	-	10	**0.64**
Zinc	mg/kg	-	-	-	100	**7.23**
EOX	mg/kg	-	-	-	3	**n/d**

Source: www.biotek.pl

Use

Sida is a plant which can be used in several industries:

- **power generation** – production of solid biomass fuel for generation of electrical power and heat, which can make Sida the energy plant of the future
- its strong root system makes it fit for **reclamation of sewage sludge**
- it can also be used as a **fibre or honey crop** (long florescence period: from July to September) or a **high protein fodder** (young plants have high content of proteins, vitamin C, carotene, calcium and phosphorus)
- it can be used by medicine as a **healing plant**[9], since its substance composition resembles *Symphytum officinale*
- its high content of cellulose and hemicellulose is comparable with spruce and the pine, which makes the plant suitable for use **in the cellulose and paper industry** – this is confirmed in the expert opinion of the former Institute of Cellulose and Paper Industry in Łódź
- it can also serve as input material **for the manufacture of agglomerates** (i.e. furniture wood derivative boards)

[9] Gradziuk, p. 68

Comparison of energy crop yields

This table lists the yields from the research conducted at the Institute of Soil Science and Plant Cultivation.

Species	2004	2005	2006	2007	2008
Heavy black earth: Class 2-3A on a scale of 6 classes					
Miscanthus – average from 5 clones	10.2	19.2	15.6	15.8	15.2
Willow – average from 4 clones	14.7	12.8	11.1	12.7	12.8
Sida – planting of 10 thousand/ha*	7.4	10.0	10.3	9.3	9.2
Sida – planting of 20 thousand/ha*	14.8	20.8	20.4	17.1	18.3
Moderate soil: Class 3B-4A					
Miscanthus – average from 5 clones	13.9	20.7	16.7	21.0	18.1
Willow – average from 4 clones	13.3	10.8	11.5	12.4	12.0
Sida – planting of 10 thousand/ha*	6.4	9.0	11.4	9.6	9.1
Light soil: Class 4B-6					
Willow – average from 8 clones	-	10.1	11.9	12.3	11.1
Sida – planting of 20 thousand/ha*	11.2	20.5	12.9	11.1	13.9

* - Ostrowąs Farm proposes the planting of Sida seeds as follows: 40 thousand/ha (1 kg of seeds/ha); this will double the results estimated by the Institute of Soil Science and Plant Cultivation in Puławy.

Source: Proprietary work based on research by ISSPC http://www.vattenfall.pl/pl/porownanie-plonow-roslin-energetycznych.htm

Requirements for establishing 1 ha of energy crop plantation[10]:

- 1-2 kg of Sida seeds
- 10 thousand Miscanthus rhizomes
- 30 thousand willow cuttings

Preparing the plantation

1. Soil and climate requirements

- No specific requirements
- All soil valuation classes, except for class VI and poor soils in class V
- Optimal soil pH: neutral, slightly acidic is permitted
- Optimal soil concentration of elements: high or at least moderate concentrations of P, K, Mg
- Resistant to low winter temperature when sown in spring

2. Preparation of the breeding site

- Land for the plantation shall be free from persistent weeds
- Spread manure or other organic fertilizer prior to sowing (sewage sludge is also recommended)

[10] *Rośliny energetyczne*, ed. by Bogdana Kościska, WAR, Lublin 2003, pp. 88 and 61.

- Dress the seeds against fungal diseases prior to sowing
- Pioneer crops for Sida can be root crops (avoid sunflower)
- Plough before winter
- Harrow in spring
- In case of threat by emerginf weeds plantation should be treated by herbicide against weed according to beet protection program

3. Planting the crops

- Recommended sowing spacing: 0.62 m x 0.075 m (distance between rows: 62 cm, distance in the row: 7.5 cm)
- Seeds can be sown when the soil heats up to approx. 7-8ºC
- Sowing depth is 1-1.5 cm

4. Fertilization

- Nitrogen fertilizers (100-250 kg/ha)
- Phosphate-potassium fertilization. Optimum dosage of P_2O_5 is 80-120 kg/ha; optimum dosage of K_2O is 100-150 kg/ha
- It is recommended to enrich the soil with organic ingredients by spreading manure, compost or peat every several years; it is critical to perform the procedure prior to planting

5. Harvesting

- Winter harvesting keeps the stalks less humid and richer in dry mass content; this makes them suitable for direct combustion as chaff in furnaces with feeders adapted to wood chips
- Harvesting is best done in the period when snow cover is thinnest or completely gone
- Use of corn chaff cutter outside of the harvesting season will provide better results in the use of crops at the farm