Mexican Wild Subflower (*Tithonia diversifolia*) for dairy and soil fertility improvement

Tithonia diversifolia also known as Mexican sunflower or Wild sunflower is a quick growing and soft shrub. It grows to a height of 1-3 metres and bears alternately positioned leaves along most of the stem. The flower of Tithonia is about 3 cm in diameter and has yellow petals. The lightweight seeds can easily be dispersed by wind, water and animals. Tithonia adapts to a wide range of conditions like acidity and low soil fertility. Tithonia grows widely in all districts of Uganda.

Tithonia diversfolia plants

Uses of Tithonia

Tithonia is a multi-purpose shrub, the foliage from which has many uses: a potential green forage plant that can be utilized as feed resource for animals due to its high protein content, in poultry feeds, compost, soil fertility improvement and building material. In addition, extracts from Tithonia plant parts protect crops from termites and contain chemicals that inhibit plant growth and control insects. Tithonia has been a subject of research interest because of the relatively high nutrient concentrations found in its biomass and because of its ability to extract relatively high amounts of nutrients from the soil.

Establishment and management

Tithonia can be propagated by direct seeding. The best method is to make a furrow for the seeds and cover them lightly with sandy soil. Then apply mulch to prevent the seeds from being washed away and to retain the soil moisture. Tithonia can also be established using cuttings. For successful propagation, make cuttings 20-30 cm long from mature wood and place them in the soil the right way up. Avoid split cuttings, as they do not sprout. Plant the cuttings with 1 or 2 nodes below ground level and 2 or more nodes above. Place the cuttings in the ground slanting at an angle of 45-60 degrees using a spacing of 0.5-0.75 m x 0.75 m. It is easy to grow and does not require fertilizer or special attention. External inputs of nutrients would eventually be required to sustain production of tithonia when biomass is continually cut and transferred to agricultural land.

It tolerates regular heavy pruning. Post-flowering cuttings result in higher yields than pre-flowering cuttings. Annual biomass yields of 60 t/ha have been obtained at cutting intervals of 4 months.

Biomass yield and feeding value of Tithonia

The biomass production of Tithonia is influenced by establishment methods, frequency and height of cutting, stand density and site conditions. Tithonia has rapid growth, its biomass production varies between 30 and 70 tonnes/ha of green forage. Nguyen et al. (2010) reported 172 tonnes/ha/year in fresh form equal to 25 tonnes dry matter (DM) with 6 tonnes crude protein (CP)/ha/year of edible biomass yield of Tithonia after 12 months growth. Dry matter production is highest (7.2 tonnes/ha/yr) when Tithoniaias pruned bi-monthly at 50 cm height. Green biomass is higher for stands established from woody than from soft stem cuttings – 4.2 compared to 2.6 tonnes DM/ha/cutting averaged for three cutting times. The biomass production of Tithonia can be influenced by soil fertility. For example, Tithonia established from stem cuttings produced more biomass on soil fertilized with 50 kg Phosphorus (P) per ha than on severely P-deficient soil receiving no P application. Phosphorus fertilization increased stem biomass (green + woody material) more than leaf + litter biomass (Jama et al., 2000).

The crude protein level in the leaves of Tithonia ranges between 15 to 25 percent. Tithonia leaf meal has 18.9% crude protein. The leaves and petioles of Tithonia are low in lignin. The Nitrogen concentrations is comparable to those found in Nitrogen-fixing leguminous shrubs and trees such as Calliandra , whereas the Phosphorus (0.2 to 0.5%) and Potassium (2.3 to 5.5%) concentrations are higher than those typically found in shrubs and trees. The concentration of nutrients in Tithonia is influenced by plant part, age, position of the leaf within the plant canopy, soil fertility and provenance. The nutrient concentration tends to be lower in senesced than green leaves. Fresh leaves and young stems of Tithonia have high levels of anti-nutrients such Phytin, Saponin, tannins and oxalate and alkaloids. These can be reduced by drying the leaves and young stems.

Tithonia as a source of protein supplement for dairy cows

Tithonia foliage can be collected from waste land at the sides of the highway chopped and dried in the sun for 3 to 5 days. It is then packed into polypropylene bags and stored for use in feed formulations. Tithonia leaf meal is a valuable supplement in dairy cattle diets. Tithonia leaf meal has an average crude protein of 18.9%. Tithonia may therefore be able to be used to provide the deficient nutrients in the crop residues and low-quality forage grasses

Sun-dried Tithonia foliage (leaves and tender shoots) as a supplement for lactating dairy cows fed a basal diet of Napier grass fodder and a dairy concentrate increased milk yield by over 20%. Tithonia foliage could replace 25 to 35% of the concentrate fed to milking cow grazed on pasture, with no effect on both quantity and quality of the milk. These findings indicate that Tithonia foliage has potential as a protein supplement to low quality roughages for dairy cattle. Live weight gains have also been shown to increase when Calliandra is supplemented to dairy cattle which is an indication of the beneficial effects of tannins where they bind to proteins and facilitate the escape of the protein for digestion in the lower gut. Tithonia leaf meal can be incorporated into dairy meal or dairy pellet supplement (Table 1).

Like Calliandra and other fodder trees, Titonia has a number of anti-nutrients such as tannins. However, all major anti-nutrients in fresh *Tithonia* leaves can gradually decrease with lengthening duration of ensiling or drying.

Table 1: Formulation for Tithonia protein supplement

Ingredient	**Proportion (kgs)**	**crude protein content**	**Contribution of crude protein (kg**	**Cost (shs/kg)**	**Total cost (Ushs)**
Sorghum stover	40	6	2.4	300	12,000
Tithonia leaf hay	32	22	7.04	500	16,000
Cotton seed cake	20	22	4.4	1,200	24,000
Maize bran	10	10	1	500	5,000
Fuel (Petrol)			0	4,240	0
Sugarcane molasses	32	0	0	1,200	38,400
Total	134		14.84		**95,400**
Cost per kg					**954**

Tithonia diversifolia as a green manure for soil fertility improvement

Tithonia diversifolia has been recognized as a useful plant for improving the general fertility of the soils, mainly when handling it as green manure, either buried on the soil or as a companion crop. This plant avoids the erosion. It can be left to decompose on the field or it can be turned into green manure. In the latter case, leaves and soft twigs should be cut and chopped into small pieces before flowering and the resulting mixture evenly spread on the ground before being incorporated in the soil.

The biomass of *T. diversifolia* used for soil fertility improvement generally includes both green tender stems and leaves but not the woody stem. Application of Tithonia either alone or in combination with fertilizer can increase yield by 24% and 54% respectively compared to plots which received no inputs.

The tithonia green manure decompose rapidly upon being incorporated into the soil providing an effective source of N, P and K for crops. The high N content coupled with a rapid decomposition of the tithonia green manure makes it an attractive source of N in the soil. Tithonia green manure enhanced P availability and uptake by maize resulting in an improvement on stover and grain yields. Besides, tithonia green manure contains substantial amounts of available quantities of K and P that are comparable to inorganic sources, and upon

decomposition, it adds organic matter into the soil which improves water holding capacity of the soil, reduces leaching, enhances P-absorption and ameliorates soil acidity.

The effects of Tithonia residue mulch on soil properties, growth and tuber yield of cassava were investigated and compared by Kolawole et al. (2014). In the tested soils which were sandy loam, soils were deficient in available P but adequate in soil organic matter, N, K, Ca and Mg. The pH was moderate. Soil organic matter, available P and exchangeable K and number of leaves increased with mulch rate up to 20 tonnes/ha. Soil temperature was reduced accordingly. Mulch increased cassava establishment and tuber weight significantly. The 10 tonnes/ha mulch gave highest tuber weight and increased tuber weight by 20% thus 10 tonnes/ha is recommended.

Boundary hedges of sole tithonia can produce about 1 kg biomass (tender stems + leaves) m/yr on a dry weight basis. In addition to providing nutrients, tithonia incorporated at 5 tonnes DM/ha can reduce P sorption and increase soil microbial biomass (Jama et al., 2000). Because of high labor requirements for cutting and carrying the biomass to fields, the use of tithonia biomass as a nutrient source is more profitable with high-value crops such as vegetables than with relatively low-valued maize. The transfer of tithonia biomass to fields constitutes the redistribution of nutrients within the landscape rather than a net input of nutrients.