Weeds and Weed Management in Sudan*

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Key words: Sudan, agriculture, weeds, weed management

Introduction

Sudan with an area of 2.5 million km² is the largest country in Africa. Agriculture is the backbone of Sudan’s economy where it provides livelihood for about 80% of the population (estimated at 30 million) and accounts for over 80% of the exports. The total contribution of agriculture to Gross Domestic Product (GDP) is about 33.4% (irrigated sector (12.4%), rain-fed sector (7.3%), livestock (10.9%) and others (2.8%)}. Agriculture provides food for the people, raw material for industry, and commodities for export. However, Sudan imports most of the agricultural inputs including fertilizers, pesticides and machineries. With its fertile soil, different climatical regions and abundance of natural resources, Sudan has been supposed to be the breadbasket of the Arab World6).

Agricultural natural resources and climate

Although about 84 million ha of cultivable land is suitable for growing a variety of crops, only 14% (12 million ha) of arable land is utilized for crop and animal production. About 10 million ha are under rain-fed production and 2 million ha are under irrigation. It is planned that one million ha more will eventually be irrigated in near future.

Major topographical features of the country are the Nile River, its headstreams the White Nile and Blue Nile, and the tributaries of these rivers (Annual discharge of the Nile River water is about 85.6 × 10⁸ m³). Currently, Sudan is using between 15-16 × 10⁹ m³/year of water for irrigation compared with its allocation of 18.5 × 10⁹ m³/year under the 1959 Nile Water Agreement with Egypt. Other sources of water are natural surface water (3 × 10⁹ m³/year) and underground water (13 × 10⁹ m³/year). Thus the total annual available water is about 34.5 × 10⁹ m³. The total amount of water used annually is estimated at 18 × 10⁹ m³. Irrigated agriculture is the major user of water and will continue to be so in the coming decades. The country has a huge livestock wealth estimated at 3 million camels, 37 million sheep, 33 million goats and 30 million cows. Forest resources supply 70% of the country's total energy - a fact that should not be overlooked. However, the most important forest crop in the country is Gum Arabic and Sudan produces about 80% of the total world production. Soils vary from sandy in the North to clayey in the Central region, lateritic in the South and alluvial along the Nile River basin. Climate of Sudan varies from arid in the Northern region, semi-arid in the Central region and equatorial in the Southern region.

Crops and constraints

The principal crops are sorghum (55.6% of
the total cultivated area), millet (21%), sesame (10%), groundnut (3.8%), vegetables and fruits (3.5%), cotton (2.8%), wheat (2%), sugar cane (0.8%), maize and sunflower (0.5%). Farmer’s crop yield is always 50% lower than the potential yield obtained under research conditions (Table 1). The low yields in the rain-fed sector could be attributed to low rainfall or bad distribution of rains, use of traditional low yielding crop varieties and weeds particularly Striga hermonthica; In the irrigated sector, however, improper husbandry practices including sowing date, water management and pest control are the major causes (Table 2).

Weeds and weed managements

Weeds are the major constraint to crop production in all cultivated areas in Sudan. Unrestricted weed growth promotes soil degradation in cultivated lands and reduces yield of the main crops by 50–100% (Table 3)\(^ {14}\). Striga hermonthica and Orobanche ramosa (Figs.1 and 2) are the most important parasitic weeds on cereals and vegetables, respectively. Losses in grain yield of sorghum

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area (ha)</th>
<th>Farmer yield (kg/ha)</th>
<th>Potential yield (kg/ha)</th>
<th>% of potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>(6667)</td>
<td>2570</td>
<td>5783</td>
<td>44</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>667</td>
<td>643</td>
<td>1285</td>
<td>50</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>6000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**Wheat</td>
<td>(250)</td>
<td>2856</td>
<td>5236</td>
<td>55</td>
</tr>
<tr>
<td>-North Sudan</td>
<td>80</td>
<td>1428</td>
<td>2856</td>
<td>50</td>
</tr>
<tr>
<td>-Center Sudan</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Millet</td>
<td>(2500)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>25</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>2475</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>(12.5)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>1.8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>10.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundnut*</td>
<td>(375)</td>
<td>1085</td>
<td>4522</td>
<td>24</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>165</td>
<td>476</td>
<td>904</td>
<td>53</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>210</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sesame*</td>
<td>(1250)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>12.5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>1237.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton*</td>
<td>(333)</td>
<td>2182</td>
<td>3691</td>
<td>59</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>300</td>
<td>714</td>
<td>1342</td>
<td>53</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower*</td>
<td>(83)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Irrigated</td>
<td>1.7</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>-Rain fed</td>
<td>81.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables and fruirs**</td>
<td>(417)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Sugar cane***</td>
<td>(83)</td>
<td>71400</td>
<td>142800</td>
<td>50</td>
</tr>
</tbody>
</table>

*Crop yield under research conditions; **Crops produced only under irrigated system; *Cash crops; NA-Not available up to date data, and ( ) Crop total area.
Table 2. Some factors influencing crop production under farmer conditions

<table>
<thead>
<tr>
<th></th>
<th>Sowing date</th>
<th>Variety</th>
<th>Plant density</th>
<th>Land preparations</th>
<th>Fertilizers</th>
<th>Weeds</th>
<th>Insects and diseases</th>
<th>Irrigation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Cotton</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Groundnut</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Wheat**</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Vegetables</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Maize</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sesame</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sunflower</td>
<td>+</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+++ Very strong; ++ strong; + moderate; - weak*; rain fed farming system is highly influenced by amount and distribution of rain; **wheat production is highly influenced by prevailing temperature and cold duration during winter-time (growing season).

Table 3. Crop yield losses (%) due to unrestricted weed growth and critical period of weed competition of some selected crops (weeks after crop planting*)

<table>
<thead>
<tr>
<th>% losses</th>
<th>Cotton</th>
<th>Groundnut</th>
<th>Sorghum</th>
<th>Onion</th>
<th>Coriander</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Critical periods of competition</td>
<td>4-8</td>
<td>4-8</td>
<td>3-8</td>
<td>3-8</td>
<td>2-5</td>
</tr>
</tbody>
</table>

Fig. 1. The life cycle of *Striga* species
(Sorghum bicolor) and millet (Pennisetum glaucum) due to Striga hermonthica damage are more than 70% in heavily infested fields. Orobanche ramosa threatens tomato and egg plant main production areas in the northern region and along the Nile bank. Aquatic weeds, on the other hand, reduce the efficiency of irrigation canals by hindering water flow and encouraging siltation. The efficacy of the main canal in Rahad Agricultural Scheme has been reduced from 8.5 to 5.5 million m$^3$ of water per day. According to Obeid, the water loss due to evaporation of Eichhornia crassipes is about 2 to 8 times higher than the evaporation of an open water surface, amounting to $7.12 \times 10^9$ m$^3$ in the infested area of the White Nile in Sudan. Many weeds have been reported as alternate hosts for some economically important pests and as poisonous plants to man and animals. A negative allelopathic potential has associated with a number of weeds including Cyperus rotundus and Cynodon dactylon. Cultural and chemical methods of weed control are in use. However, the decision to adopt a particular method is determined by socioeconomic factors. Weeds are not always harmful. Evidence has accumulated that some of the weed species such as Trifolium alexandrinum, Rhynchosia memonia, Phaseolus trilobus, Cassia senna and C. occidentalis induce suicidal germination of Striga hermonthica. This may lead to depletion of Striga hermonthica seed bank in the soil and consequently reduces the potential damage inflicted by the parasite. Weeds can also help in recycling soil nutrients and the beneficial effect of one season weedy fallow on the following crop was estimated by 45 kg N/ha. In addition, weeds are used as human food. In some parts of the country wild Okra, wild Jews mallow, Sonchus coruntus and wild purslane are used as major food sources. Moreover, some weed species such as Cassia senna and Colocynthis vulgaris are important in traditional medicinal.
Table 4. Weed control methods in different crops and habitats

<table>
<thead>
<tr>
<th>Method</th>
<th>Cotton</th>
<th>Groundnut</th>
<th>Sorghum</th>
<th>Millet</th>
<th>Wheat</th>
<th>Sugar Cane</th>
<th>Vegetables</th>
<th>Rivers &amp; Canals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand weeding</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Herbicides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Pre-em</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>-Post-em</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Mechanical</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Inter-row cultivator</td>
<td>+</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>N.ap</td>
</tr>
<tr>
<td>Pre-watering + tillage</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>N.ap</td>
</tr>
<tr>
<td>Solarization</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>*</td>
<td>N.ap</td>
</tr>
<tr>
<td>Biological control</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>*</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Sowing date</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>N.ap</td>
</tr>
<tr>
<td>Plant density</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>N.ap</td>
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<tr>
<td>Variety</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>N.ap</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>N.ap</td>
</tr>
</tbody>
</table>

+++ Intensively practiced; ++ moderately practiced; + occasionally practiced; - not practiced; * research in progress and N.ap = not applicable.

Fig. 3. Determination of weed control methods

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