Spatial and Temporal Effects of Kenaf (Hibiscus cannabinus L.) Cultivation on Weed Dynamics in Southern Agro-ecologies of Nigeria

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

Weed spectrum in Kenaf fields revealed the heterogeneous flora richness of agro-ecologies and potential weed challenges. A study was conducted in the Institute of Agricultural Research and Training (IAR&T), Obafemi Awolowo University Ibadan and other substations (Ilora, Ikenne and Kishi). The effects of varied kenaf planting dates, genotypes and locations on weed dynamics and potential weed problem was investigated. Five Kenaf genotypes (Cuba 108, Ifeken DI 400, Ifeken 100, Ifeken 400 and Tianung 2) were planted. It was a 3 x 4 x 5 factorial experiment arranged in Randomized complete block design (RCBD) with three replicates. Forty five (45) weed species were identified across seventeen (17) plant families. Weed morphology comprised of broad-leaf weeds (71.11%), grass weeds (17.78%), sedge (6.67%) and spiderwort (4.44%). Abundance of broad-leaf weeds (71.11%) mostly annual, reflected regular weed control from frequent cropping patterns and agro-ecological variations. Panicum maximum, Ageratum conyzoides,
1. INTRODUCTION

_Hibiscus cannabinus_ L. commonly known as Kenaf is an herbaceous annual/perennial fast growing crop. It is a valuable fibre and medicinal plant belonging to the family Malvaceae [1]. Its various plant parts have been used in African traditional medicine; peelings from the stem are used to treat fatigue and anaemia as a haematonic agent [2,3] leaves used in treating dysentery, blood and throat disorders, the seeds are used to treat aches and bruises [4], and also yield edible vegetable oil for human consumption. Kenaf has been used as a raw material in substitution of wood in pulp production and paper industries, and in textile processing industry [5]. It is a multipurpose crop with several economical and ethnomedical uses. Kenaf is a highly distinguished plant that has received the greatest valorisation amongst other allied fibre crops because of its great adaptability and ease of handling [6,1].

Cultivation of kenaf scheduled for April-June for fibre production and July-August for seed production in southern agro-ecologies of Nigeria, has been distorted by unpredictable rainfall (amount and distribution) and prolonged dry spell during the crop growth phase with consequential low fibre and seed yields. Weed flora composition varies with agro-ecologies, planting date and cultural practices [7,8,9,10,11,12,13]. Unpredictable weather conditions may further influence weed composition and weed–crop interaction. Surveying weed distributions within a given geographic area was useful for identifying species shifts with time and may be instrumental to the forecast of potential weed problems [14] and directing future studies in weed science. Changes in weed spectrum will guide weed control strategies in crop production. The menace of changing weather may be attended by weed flora dynamics with the emergence of more competitive weed species in cropping systems. Thus, weed management intervention(s) must be re-strategized to reduce weed incursion, ensure season-long weed suppression while profitable kenaf cultivation is guaranteed. The study investigated the weed flora dynamics in relation to time and location of kenaf cultivation in other to re-strategize weed management intervention(s) for season-long weed control.

2. METHODOLOGY

The study was conducted in the Institute of Agricultural Research and Training (IAR & T), Obafemi Awolowo University stations (four locations) (Ibadan 7°38’N, 3°84’E 182 m altitude (alt.) - Forest-savanna transition; Ilora 07 81’ N, 03 82’ E 278 m alt. Derived savanna; Kishi - 08 98’ N, 03 94 ’E 364 m alt.; Southern guinea savanna-northern fringe and Ikenne - 06 85 N, 003 70’ E, 70 m alt.; tropical rainforest in southern agro-ecologies of Nigeria) The land was ploughed and harrowed. Five (5) kenaf varieties (Cuba 108, Ifeken DI 400, Ifeken 100, Ifeken 400 and Tianung 2) were planted using a plant spacing of 50 x 20 cm, in the four locations. The study was conducted during the wet seasons of 2018 and 2019. Planting was carried out at monthly interval from June to August in both years. The plot size was 5 x 5 m. Experiment was arranged in 3 x 4 x 5 factorial design with three replicates. The weed flora

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_Tridax procumbens, Mitracarpus villosus, Spigelia anthelmia L._ and _Mimosa pudica_ were present in the locations. _Commelina erecta, C. bengalensis, Cyperus rotundus, Cyperus esculentus_ and _Maricu alternifolius_, though scanty, they were difficult-to-control weeds. Summary of weed flora richness showed that Ibadan and Ilora had thirty one (31) weed each. This represented 68.89% of the recorded weed flora composition (45) in all locations. Kishi and Ikenne had ≤ 50% of the overall weed composition recorded. This might be due to cultural practices, weed dominance and agro-ecological variance. High percentage of broad-leaf weeds (≥60%) at all locations, might resulted to keen Kenaf-weed competition due to similarity in morphology and narrows weed control option. Cultural practices, high weed fecundity, short weed life cycle (mostly annual weeds), and wide dispersal corridor in the locations maybe implicated. Weed flora dynamics with the emergence of more competitive weed species in cropping systems. Thus, weed management intervention(s) must be re-strategized to reduce weed incursion, ensure season-long weed suppression while profitable kenaf cultivation is guaranteed. The study investigated the weed flora dynamics in relation to time and location of kenaf cultivation in other to re-strategize weed management intervention(s) for season-long weed control.

**Keywords:** Weed dry weight; planting date; genotypes; weed flora.
3. RESULTS AND DISCUSSION

Weed spectrum in kenaf fields across locations revealed weed flora richness and potential weed problems in agro-ecologies (Table 1a & b). Forty five (45) weed species were identified across seventeen (17) plant families. Weed morphology comprised of broad-leaf weeds (71.11%), grass weeds (17.78%), sedge (6.67%) and spiderwort (4.44%) across the locations. Relative abundance of broad-leaf weeds (71.11%) mostly annual, reflected adaptation of weed species to weed control pattern and cropping systems in the agro-ecologies. This corroborated the earlier findings that weed flora composition is influenced cultural practices [9,13].

Panicum maximum Jacq., Ageratum conyzoides L., Tridax procumbens L., Mitracarpus villosus, Spigelia anthelmia L. and Mimosa pudica L. were present in the locations. The predominance of these weeds might be due to wide dispersal corridor and high fecundity. The ecological adaptation may also be implicated as means of survival. Though, the specificity of the weeds to kenaf is not investigated, successful adaptation to varying ecologies of weeds may influence their geographical range as noted in the study. Frequent cropping activities influenced the adaptation of annual weeds to annual cropping systems.

Evidence of Imperata cylindrical (L.) P.Beauv., Commelina erecta L., Commelina bengalensis L., Cyperus rotundus L., Cyperus esculentus L. Cyperus cyperoides (L.) Kuntze in different locations showed the difficult-to-control weeds. Though, they were not predominant in the locations. However, their occurrence and unmanaged cultural practices (land preparation and manual weeding) might widen dispersal corridor and may result in endemic situation if not well managed. Spot control of infested portions of the field will enhance effective control and minimize their spread.

Table 2 showed summary of weed morphology and flora richness in relation to overall weed flora composition. Ibadan and Ilora had thirty one (31) weed species each. This represented 68.89% of the recorded weed flora composition (45) in all locations. Kishi and Ikenne had less than 50% of the overall weed composition recorded. This might be due to cultural practices adopted and agro-ecological differences [16,13,17]. In all the locations, broad-leaf weeds were over 60% (Table 2). This might result to keen kenaf-weed competition due to similarity in morphology and growth factor requirements. Relatively superior abundance of broad-leaf weeds might have resulted from high weed fecundity, short weed life cycle (mostly annual weeds), and wide dispersal corridor in the locations.

Weed density and weed dry weight were similar across genotypes in all locations. Similarity in first weed flushes across genotypes in all locations, is peculiar to newly ploughed and/or herbicide treated farmland. Ibadan had the highest weed density with the lowest weed dry weight, while Ilora and Kishi had comparable weed density. Higher weed flora composition in Ibadan at first flush after land preparation depicted richer weed seedbank density and transitional peculiarity of the agro-ecology. Notwithstanding, highest weed dry weight was recorded in Kishi, while the lowest was recorded in Ilora (Fig. 1). Variations in weed types, growth phase and agro-ecologies might influence weed dry matter recorded. Therefore, previous cropping system and weed control measures might have influenced weed dynamics in this study. Earlier studies discovered that cultural practices and ecological variations significantly influence weed flora dynamics [9,13,16]. Weed density was highest in June with the lowest weed dry weight. This might represent the weed density of early flushes after land preparation. This in line with previous study that density of first weed flush was higher than other weed successions [9]. Lower weed density in July and August across the locations might be influenced by depleting weed seedbank from repeated tillage and land clearing. This is in resonance with the fact that tillage intensity affects weed seedbank [18]. Notwithstanding, weed types and cultural practices might have played significant role in weed dry matter disparity in the study (Fig. 2).
Table 1a. Overview of the effect of kenaf planting dates and locations on weed dynamics

|---------------------------|--------------|------------|------------|-------------|-------------|------------|------------|-------------|-------------|-------------|-------------|
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
Acanthospernum hispidum DC. | " | " | A | - | - | - | - | b | b | - | - |
Ageratum conyzoides L. | " | " | A | a | a | e | e | e | - | e | d |
Tridax procumbens L. | " | " | A | d | d | d | d | d | e | d |
Chromolaena odorata L. | " | " | A/P | e | - | - | e | - | - | - | - |
Bidens pilosa L. | " | " | A | d | d | - | - | - | e | e | - |

Legends: A – annual, P – perennial, A/P – annual/perennial, weed density ranges = a - 250 – 300 plants/m²; b – 200 – 250/ m²; c - 150 – 200/ m²; d - 100 – 150/ m²; e -50 – 100 plants/ m², f - ≤ 50 plants/ m²

Table 1b. Overview of the effects of kenaf planting dates and locations on weed dynamics

--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
Celosia isertii C.C | Amaranthaceae | " | A | - | - | - | - | - | - | - | - |
Hyptis suaveolens (L) | Lamiaceae | " | A | - | - | - | e | - | - | - | - |
Mitracarpus villosus (sw) Dc | Rubiaceae | " | A | b | b | e | d | b | b | - | c |
Oldenlandia corymbosa L. | " | " | A | b | b | e | d | - | - | - | - |
Cleome viscosae L. | Cleomaceae | " | A | d | - | e | d | d | - | - | - |
Physalisangulata L. | Solanaceae | " | A | - | - | e | - | - | - | - | - |
P micrantha Link | " | " | A | - | - | - | d | d | - | - | - |
Spigelia anthelmia L. | Loganiaceae | " | A | d | d | f | d | d | d | e | f |
Talinum fruticosum (L.) Juss. | Portulacaceae | " | P | e | d | - | - | - | d | d |
Centrosema pubescens Benth | Fabaceae | " | A | - | - | - | - | d | e | - | - |
Mimosa pudica L. | " | " | A | e | d | d | d | e | - | d | d |
Mimosa invisa Mart. Ex Colla | " | " | A | d | d | - | e | - | - | - | d |
Calopogonium mucunoides Desv. | Leguminosae | " | P | - | - | e | e | - | - | e | f |
Desmodium scorpiurus (Sw.) Desv. | " | " | P | d | d | - | - | - | - | - | - |
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</thead>
<tbody>
<tr>
<td><em>Euphorbia hirta</em> L.</td>
<td>Euphorbiaceae</td>
<td>&quot;&quot;</td>
<td>A</td>
<td>e</td>
<td>e</td>
<td>d</td>
<td>e</td>
<td>-</td>
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<tr>
<td><em>E. heterophylla</em> L.</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
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<td>-</td>
<td>f</td>
<td>d</td>
<td>d</td>
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<tr>
<td><em>Phyllanthus amarus</em> Schumm &amp; Thonn</td>
<td>&quot;&quot;</td>
<td>A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>c</td>
<td>d</td>
<td></td>
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<tr>
<td><em>Commelina erecta</em> L.</td>
<td>Commelinaceae</td>
<td>Sp</td>
<td>P</td>
<td>d</td>
<td>d</td>
<td>e</td>
<td>e</td>
<td>d</td>
<td>d</td>
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<tr>
<td><em>C. benghalensis</em> L.</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>P</td>
<td>d</td>
<td>d</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>d</td>
<td>d</td>
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<tr>
<td><em>Cyperus rotundus</em> L.</td>
<td>Cyperaceae</td>
<td>S</td>
<td>P</td>
<td>d</td>
<td>c</td>
<td>-</td>
<td>e</td>
<td>-</td>
<td>-</td>
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<tr>
<td><em>Cyperus esculentus</em> L.</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>P</td>
<td>c</td>
<td>c</td>
<td>-</td>
<td>c</td>
<td>c</td>
<td>-</td>
<td>b</td>
<td>b</td>
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<tr>
<td><em>Cyperus cyperoides</em> (L.) Kuntze.</td>
<td>&quot;&quot;</td>
<td>A/P</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

Legends: A – annual, P – perennial, A/P – annual/perennial, weed density ranges = a - 250 – 300 plants/ m²; b - 200 – 250/ m²; c- 150 – 200/ m²; d - 100 – 150/ m²; e -50 – 100 plants/ m², f ≤ 50 plants/ m²
Table 2. Summary of weed flora richness and morphological analysis across locations

<table>
<thead>
<tr>
<th>Locations</th>
<th>Number of weed spp</th>
<th>Relative weed flora richness (%)</th>
<th>Broad-leaf (%)</th>
<th>Grass weeds (%)</th>
<th>Spiderwort (%)</th>
<th>Sedges (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibadan</td>
<td>31/45</td>
<td>68.89</td>
<td>77.42</td>
<td>9.68</td>
<td>6.45</td>
<td>6.45</td>
</tr>
<tr>
<td>Ilora</td>
<td>31/45</td>
<td>68.89</td>
<td>67.74</td>
<td>22.58</td>
<td>3.23</td>
<td>6.45</td>
</tr>
<tr>
<td>Kishi</td>
<td>22/45</td>
<td>48.89</td>
<td>63.64</td>
<td>22.72</td>
<td>4.55</td>
<td>9.09</td>
</tr>
<tr>
<td>Ikenne</td>
<td>21/45</td>
<td>46.67</td>
<td>76.19</td>
<td>9.52</td>
<td>4.76</td>
<td>9.52</td>
</tr>
</tbody>
</table>

**Fig. 1. Summary of weed density and dry weight across locations at harvest**

**Fig. 2. Weed density and dry weight across planting months at harvest**
4. CONCLUSION

Agro-ecologies investigated showed diverse weed species. Hence, kenaf cultivation is confronted with heterogeneous weed composition, which might be challenging to farmers and result into significant kenaf yield penalty. Cultural practices and ecological factors (rainfall and temperature patterns) were implicated. Hence, weed control options may be determined by weed type in the agro-ecology. High density of broad-leaf weeds with similar morphology with kenaf may result to critical competition at the detriment of kenaf plants because of likely similar growth factors requirements and the ability of the weeds to thrive under depleted nutrients.

COMPEting INTERests

Authors have declared that no competing interests exist.

REFERENCES


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