# DISTRIBUTION OF COMMERCIAL MOBYDICK (*GOMPHOCARPUS SPP*) GROWN IN KENYA AS REVEALED BY MORPHOLOGICAL CHARACTERIZATION

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## Abstract
The genus Asclepias of Gomphocarpus subspecies commonly known as mobydick is currently grown commercially as a cutflower in Kenya. Asclepias refers to milkweed species grown in America and other Western worlds while Gomphocarpus refers to Asclepias species in Africa and Arabia continents. The varieties are distinguished mainly by boll characteristics which include size, shape, and plant height. In the farmers' fields, Gomphocarpus physocarpus and Gomphocarpus fruticosus integrate to form a continuum and are difficult to distinguish. However, there is no precise data on the available commercial varieties of Gomphocarpus species grown and exported from Kenya. The species has recently been domesticated in Kenya but characterization has not been done. The objective of the study was to determine the distribution of major Gomphocarpus varieties in Kenya. A preliminary survey was done using the morphological characteristic of height to determine the prevalent type among farmers. The survey was conducted between April and June, 2011. The sampled areas were Machakos, Murang`a, Nandi, Nyeri, Bomet, Embu, Laikipia, Kisumu, Meru, Kajiado, Migori and Makueni districts. In order to get accurate information on the data collection sites, each farm was mapped by Global Positioning System (GPS) receiver; this instrument gave the altitudes (elevations), latitudes and longitudes of the sampled areas. A line level was used to establish the slope of the various sampled sites. Using boards graduated in the metric system, a distance of 10 metres between the boards was used. The board was moved up and down the slope until the spirit level showed that the string was horizontal. In this case, a difference in height of 10 cm would mean a slope of 1 %, whereas a height difference of 5 cm meant a gradient of 0.5% and 2.5 cm difference in height represented 0.25% gradient. A total of 145 farmers were selected at random and interviewed using a questionnaire. Soil samples were collected from sampled farms and analyzed in JKUAT laboratory using the hydrometer method. Materials used for soil structural analysis were water, sieves, hydrometer, sodium hexametaphosphate solution, amyl alcohol, soil dispersing stirrer, reciprocating shaker and soil textural triangle. The results showed that of the 145 farmers, 84.8% grew tall mobydick variety while 15.6 % grew the short variety. The results also indicate that 30.9% of all farmers growing the tall variety are in Machakos, Muranga (6.5 %), Nandi (11.4 %), Nyeri (14.6 %), Bomet( 7.3%), Embu (4.9 %), Laikipia ( 6.5%) , Kisumu (4.1%) , Meru (11.4 %) and the least were in Kajiado, Migori and Makueni each recording 0.8 %. As regards altitude, 84.8 % of all mobydick farmers grow the tall variety between 887-1388 m above sea level. Data collected on agro-ecological zones indicate that mobydick grows across UM4, LU4, UM2, LM4, SU3, LM3, LM1 and LM5 with 84.8 % of all farmers growing the tall variety. In conclusion, the tall variety is the most dominant of the commercial mobydick varieties among the Kenya farmers. The variety also dominates all agro-ecological zones at the current status.

**Key words**: Asclepias, characterization, cutflower, distribution, Mobydick

## 1.0 Introduction

The milkweeds or Gomphocarpus genus consists of over 140 species. The term Gomphocarpus is derived from the Greek gomphos meaning a club, and karpos, fruit. Asclepias is used to refer to milkweed species grown in America and other Western worlds while Gomphocarpsus refers to Asclepias species found in Africa and Arabia continents (Hodkiss, 2009). Gomphocarpus comprises about twenty two (22) species in tropical Africa and Peninsular Arabia. Gomphocarpus fruticosus grows wild throughout in African countries (Gurib-Fakim et al., 2011). These countries include East Africa, Southern Africa and South Africa, Senegal, Guinea, Côte d'Ivoire, Cameroon, Sudan, Madagascar and Mauritius. The plant also occurs in Yemen, northern Africa, southern Europe, eastern Australia, Oman and Saudi Arabia. Gomphocarpus cancellatus and Gomphocarpus filiformis occur in Namibia and South Africa. Gomphocarpus glaucophyllus occurs from Uganda south to South Africa. Gomphocarpus semilunatus occurs from Nigeria east to Ethiopia, East Africa to southern Congo, Zambia and Angola. Gomphocarpus solstitialis occurs throughout West Africa. Gomphocarpus stenophyllus appears in the semi-arid regions of southern Ethiopia, Kenya and Tanzania. Gomphocarpus tomentosus appears throughout southern Africa (Baerts and Lehmann, 2009).

On the other hand, *Gomphocarpus physocarpus* is widespread in America, Europe, Asia and Africa. Although naturalised and widespread in South Africa for some time, it is an introduced weed native to tropical Africa (Muller, 2005).
Both Gomphocarpus fruticosus and Gomphocarpus physocarpus occur in well-drained, dry sandy soils. They are also found in grasslands, along road sides, railway lines and abandoned fields; they are frequently on river banks, in full sun or partial shade. However, some species are also found in shady forest understories although these are few (Eigenbrode and Espelie, 1995). The two grow from sea-level up to 887-2191 m altitude.

Cutflower constitutes a major section of the horticultural export market in Kenya. Over the years, the cutflower industry has undergone rapid expansion placing Kenya as the biggest supplier of cutflowers in the international market. However, the market is still dominated by traditional flowers while the indigenous ornamentals account for 0.01% of the Kenya cutflowers market (Waiganjo *et al.,* 2008). Over dependence on traditional flowers is unsustainable because of stiff market competition, production challenges and breeders rights requirements in the global market. So far, research activities have mainly concentrated on exotic crops for many years in Kenya. Studies have revealed that most indigenous crops have fewer challenges in the field compared to the existing traditional crops (Waiganjo *et al.,* 2008). Thus, extra efforts are essential in order to increase the diversity of cutflower exports and remain competitive in the international market through collection, domestication and development of production packages for indigenous cutflower.

Some visits were made before the year 2008 headed by the Kenya Agricultural Research institute (KARI), Thika researchers in collaboration with the wildlife officers to the Mount Kenya forest, bush lands in central Kenya, Aberdares and Coast Province. The aim of this mission was to look for plants with outstanding ornamental features for possible domestication.

Commonly known as Mobydick, *Gomphocarpus* is currently grown commercially as a cutflower in Kenya. In the farmers' fields, *G. physocarpus* and *Gomphocarpus fruticosus* integrate to form a continuum and are difficult to distinguish. The species could be distinguished mainly by boll characteristics which include size, shape, and plant height. Some *Gomphocarpus* have relatively large green bolls while others have small green bolls.
*Gomphocarpus physocarpus* is known to hybridize with *Gomphocarpus fruticosus* (Goyder, 2001). When *Gomphocarpus* was introduced into the export market in central Kenya in the year 2001 as cutflower, it became particularly popular among consumers. The crop has had phenomenal growth in export markets from 13 kg valued at Ksh.1287 in the year 2001 to 288,707kg valued at Kshs. 50,000,000 in the year 2006 (Waiganjo *et al.,* 2008).
However, there is no precise data on the available commercial varieties of *Gomphocarpus* species grown and exported from Kenya. The species has recently been domesticated in Kenya but characterization of the useful lines has not been done. The species is also grown commercially and therefore there is need to improve it and develop varieties with better utility locally and at international market.

An investigation was carried out between April and June 2011 in the famers' fields to study the major *Gomphocarpus* variety grown in Kenya. The main objectives of the project were to determine the distribution of major Gomphocarpus among small scale growers in Kenya. The information obtained from this study shall be used for the documentation of the *Gomphocarpus* germplasm available in Kenya and determine their distribution in the various growing regions.

## 2.0 Materials and methods

A survey was conducted to collect information on the distribution of commercial Mobydick in Kenya between April and June, 2011. In order to get accurate information on the data collection sites, each farm was mapped by Global Positioning System (GPS) receiver; this instrument gave the altitudes (elevations), latitudes and longitudes of the sampled areas. The sampled areas were selected at random to give a more realistic statistic data on the distribution of commercial mobydick grown in Kenya. A line level was used to establish the slope of the various sampled sites. A line level was used to establish the slope of the various sampled sites. Using boards graduated in the metric system, a distance of 10 metres between the boards was used. The board was moved up and down the slope until the spirit level showed that the string was horizontal. In this case, a difference in height of 10 cm would mean a slope of 1 %, whereas a height difference of 5 cm meant a gradient of 0.5% and 2.5 cm difference in height represented 0.25% gradient. In total, 145 farmers were selected and later interviewed. Soil samples were also collected from sampled farms and analyzed at Jomo Kenyatta University of Agriculture and Technology (JKUAT) laboratory using the hydrometer method. Materials used for soil structural analysis were water, sieves, hydrometer, sodium hexametaphosphate solution, amyl alcohol, soil dispersing stirrer, reciprocating shaker and soil textural triangle. A soil sample weighing 50g collected from each sampled farm was subjected to analysis using Bouyoucos method. The survey was carried out in twelve mobydick growing areas namely, Machakos, Murang`a, Nandi, Nyeri, Bomet, Embu, Laikipia, Kisumu, Meru, Kajiado, Migori and Makueni districts of Kenya.

## 2.1 Sampling

A targeted sampling procedure was used in which farmers growing Mobydick were identified. In the survey, consultation with local *Gomphocarpus* farmers was used as a guide to accurately locate sampled sites.

## 2.2 Data collection

Data collection involved individual interviews of Mobydick-growing farmers at targeted sites. A semi-structured questionnaire was used as a tool in the study to get relevant information from the respondents. The sampled farms were mapped using Global Positioning System (GPS) receiver to get accurate position of the mobydick farms. Soil samples were also collected at random from various positions on the farms. These samples were then analysised for soil mapping at JKUAT laboratory to establish the soil textures of mobydick growing areas. To establish the gradient of the sampled farms, a line level consisting of two sticks (boards) was used. Using boards graduated in the metric system a distance of 10 metres between the boards was used. Information concerning the mobydick varieties grown by the farmers, acreage under each variety, constraints to mobydick production, altitude, longitude and latitude was collected using a questionnaire. Data on planting materials (seed sources), soil textures, gradient (%) of sampled farms and market for Mobydick were also captured.

## 2.3 Data analysis

Data analysis was carried out using Statistical Package for the Social Sciences (SPSS). This package produced percentages of the Mobydick varieties found grown by farmers in the sampled farms. Descriptive characteristics were obtained for various attributes. Such attributes included altitude, soil texture and agro-ecological zones. A likelihood ratio test or chi-square probability distribution was employed to determine whether the distribution of Mobydick varies significantly or not across agro-ecological zones, districts, altitude and soil texture.

## 3.0 Results

### 3.1 Mobydick distribution in Kenya

This distribution is displayed in the map (Figure 1). Farmers in these districts grew either of two commercial mobydick varieties or both. The two varieties were a six month and three months long maturity types (Table 1).

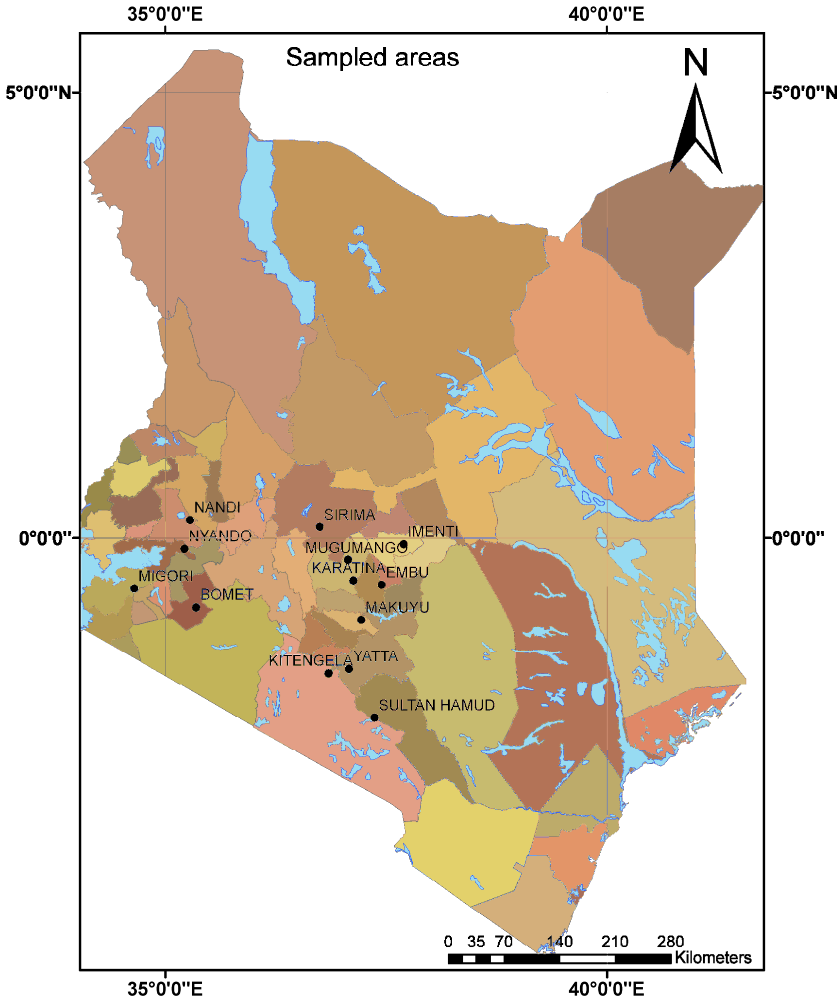


*Figure 1: Map showing prevalent areas commercial Mobydick are currently grown in Kenya*

*Key: The colors represent different administrative boundaries and water points*

*Water points (rivers, streams. lakes)*

*All other colors inclusive referring to administrative boundaries*

*Table 1: Mobydick variety frequencies in sampled district farms*

| Locality | variety | Mobydick count |
|---|---|---|
| Machakos | Tall, short | * ( 38 , 4 ) |
| Muranga | Tall, short | (8, 2 ) |
| Nandi | Tall, short | (14 , 4 ) |
| Nyeri | Tall, short | (18 , 3 ) |
| Bomet | Tall, short | (9 , 2 ) |
| Embu | Tall, short | ( 6 , 1) |
| Laikipia | Tall, short | ( 8, 2 ) |
| Kisumu | Tall, short | ( 5 , 1 ) |
| Meru | Tall, short | (14, 3 ) |
| Kajiado | Tall, short | (1 , 0 ) |
| Migori | Tall, short | (1 , 0 ) |
| Makueni | Tall, short, | (1 , 0 ) |

**Number of farmers growing the Tall and Short Mobydick. The first and second figures in the brackets stand for Tall and Short varieties respectively*

In the survey, the six month varieties were identified to be more popular than the three months type in all visited farms (Table 1). The three months Mobydick was relatively shorter in height compared to the six months variety. The bolls of the six months variety were globular unlike the three months variety bolls which had a tapered end.

The six months mobydick occupied 84.8 % of mobydick farms while the three months variety occupied 15.2 % only (Table 2). Survey results indicated that current mobydick farms range between 0.1 to 3 acres in size in which 97.2 % of farmers hold 0.1 to 1 acres of mobydick production (Table 3). The type of the planting material used by all the farmers was seed which were sourced from contracted commercial company/Wilmar (97.9%), farmer's own farm (1.4%) and from neighbors (0.7%) (Table 3). Constraints to mobydick farming were pests, diseases and capital (Table 3). Mobydick farming was prevalent at altitudes 887 to 1388 meters above sea level. Similarly, soil types ranged from sand to red loam while the popular gradient was moderate slope. The total percentage attribute against each parameter is shown in the last column (Table 3).

As shown in Table 4, there were no significant differences in the distribution of Mobydick varieties across agro-ecological zones, districts, altitudes and soil texture (P= 0.05).

*Table 2: Mobydick distribution across districts and agro-ecological zones (AEZ)*

<table>
<tr><th colspan="2" rowspan="2">Attribute</th><th colspan="2">% within Mobydick</th><th colspan="2">% of Total</th><th colspan="2">Gross %</th></tr>
<tr><td>Tall</td><td>Short</td><td>Tall</td><td>Short</td><td>Tall<br>( 6 Moths Variety)</td><td>Short<br>(3 Moths Variety)</td></tr>
<tr><td rowspan="12">District</td><td>Machakos</td><td>30.9</td><td>18.2</td><td>26.2</td><td>2.8</td><td rowspan="20">84.8%</td><td rowspan="20">15.2%</td></tr>
<tr><td>Muranga</td><td>6.5</td><td>9.1</td><td>5.5</td><td>1.4</td></tr>
<tr><td>Nandi</td><td>11.4</td><td>18.2</td><td>9.7</td><td>2.8</td></tr>
<tr><td>Nyeri</td><td>14.6</td><td>13.6</td><td>12.4</td><td>2.1</td></tr>
<tr><td>Bomet</td><td>7.3</td><td>9.1</td><td>6.2</td><td>1.4</td></tr>
<tr><td>Embu</td><td>4.9</td><td>4.5</td><td>4.1</td><td>0.7</td></tr>
<tr><td>Laikipia</td><td>6.5</td><td>9.1</td><td>5.5</td><td>1.4</td></tr>
<tr><td>Kisumu</td><td>4.1</td><td>4.5</td><td>3.4</td><td>0.7</td></tr>
<tr><td>Meru</td><td>11.4</td><td>13.6</td><td>9.7</td><td>2.1</td></tr>
<tr><td>Kajiado</td><td>0.8</td><td>0.0</td><td>0.7</td><td>0.0</td></tr>
<tr><td>Migori</td><td>0.8</td><td>0.0</td><td>0.7</td><td>0.0</td></tr>
<tr><td>Makueni</td><td>0.8</td><td>0.0</td><td>0.7</td><td>0.0</td></tr>
<tr><td rowspan="8">AEZ</td><td>UM4</td><td>44.7</td><td>36.4</td><td>37.9</td><td>5.5</td></tr>
<tr><td>LU4</td><td>10.6</td><td>18.2</td><td>9.0</td><td>2.8</td></tr>
<tr><td>UM2</td><td>20.3</td><td>18.2</td><td>17.2</td><td>2.8</td></tr>
<tr><td>LM4</td><td>12.2</td><td>13.6</td><td>10.3</td><td>2.1</td></tr>
<tr><td>SU3</td><td>4.1</td><td>4.5</td><td>3.4</td><td>0.7</td></tr>
<tr><td>LM3</td><td>6.5</td><td>9.1</td><td>5.5</td><td>1.4</td></tr>
<tr><td>LM1</td><td>0.8</td><td>0.0</td><td>0.7</td><td>0.0</td></tr>
<tr><td>LM5</td><td>0.8</td><td>0.0</td><td>0.7</td><td>0.0</td></tr>
</table>

*Table 3: Mobydick distribution and attributes in sampled districts*

| **Attribute** | | **% of gomphocarpus in attribute** | | **Gross ( % of sub-attribute in main attribute )** |
|---|---|---|---|---|
| Main attribute | Sub-attribute | Tall | Short | |
| soil texture | sand | 81.8 | 18.2 | 7.6 |
| | sand loam | 84.1 | 15.9 | 30.3 |
| | loam | 86.1 | 13.9 | 24.8 |
| | alluvial black | 85.7 | 14.3 | 4.8 |
| | clay loam | 82.4 | 17.6 | 11.7 |
| | black cotton | 87.0 | 13.0 | 15.9 |
| | red loam | 85.7 | 14.3 | 4.8 |
| Slope | Flat (0-1%) | 100.0 | 0.0 | 2.1 |
| | Gentle (1-2.5%) | 84.6 | 15.4 | 18.1 |
| | Moderate (2.5-5%) | 84.3 | 15.7 | 79.9 |
| Altitude(m) | 887-1388 | 87.0 | 13.0 | 47.8 |
| | 1389-1690 | 81.0 | 19.0 | 14.5 |
| | 1691-2191 | 83.6 | 16.4 | 37.9 |
| Farming duration(yrs) | 1-5YRS | 83.6 | 16.4 | 80.0 |
| | 6-10YR | 89.7 | 10.3 | 20.0 |
| Latitude(°) | -2.9 to -1 | 100.0 | 0.0 | 0.7 |
| | -0.9 to 0 | 81.8 | 18.2 | 7.6 |
| | 0.1to 2 | 85.0 | 15.0 | 91.7 |
| Longitude(°) | 34.5 -35.9 | 80.6 | 19.4 | 24.8 |
| | 36 - 37.4 | 83.3 | 16.7 | 29.0 |
| | 37.5-38.9 | 88.1 | 11.9 | 46.2 |
| Planting material source | One's own farm seeds | 100.0 | 0.0 | 1.4 |
| | Commercial company (Wilmar) seeds | 84.5 | 15.5 | 97.9 |
| | Neighbor seeds | 100.0 | 0.0 | 0.7 |
| Farm size(Acres) | 0.1-1 | 85.1 | 14.9 | 97.2 |
| | 1.1-2 | 100.0 | 0.0 | 1.4 |
| | 2.1-3 | 50.0 | 50.0 | 1.4 |

*Table 4: Gomphocarpus distribution test of significance across key attributes*

| **Attribute** | **Chi-Square Tests value (Likelihood Ratio)** | **Pvalue** |
|---|---|---|
| Altitude | 0.542 | 0.762 |
| Soil texture | 0.310 | 0.999 |
| Districts | 3.298 | 0.986 |
| Agro ecological zones | 2.038 | 0.958 |

There was no significant difference in the distribution of Mobydick varieties across agro-ecological zones, districts, altitude and soil texture (P=0.05).

*Table 5: Features of commercial Gomphocarpus varieties*

| **Gomphocarpus species** | **Boll shape and size** | **Leaf shape** | **Canopy density** | **Duration to maturity** | **Plant height** | **Height range of tall and short varieties** |
|---|---|---|---|---|---|---|
| Gomphocarpus physorcarpus | Larger more globular bolls | Broader leaf shape | Giant /bush canopy | Takes 6 months to mature | Has potential to grow to 2.5 m. | 0.5m |
| Gomphocarpus fruticosus | Smaller bolls with tapering short curved beak. | Narrow leaved shape. | Light canopy | Takes 3 months to mature. | Grows up to 2 meters high. | |

Adapted from Goyder and Nicholas (2001)

*Gomphocarpus fruticosa* bolls were smaller with curved beak end whereas the *Gomphocarpus physorcapus* bolls were larger and globular in shape. The two Mobydick plants differed in their canopy appearance. *Gomphocarpus fruticosacould* grow to a height of 2.0 m with a light canopy compared to *Gomphocarpus physorcarpus* bush canopy having a potential to grow to a height of 2.5 metres, hence giving a height range of 0.5m between the tall and short Mobydick varieties (Table 5).

## 4.0 Discussion

In order to determine the distribution of commercial Mobydick varieties in Kenya, a survey was conducted targeting the Mobydick growers in various areas. Results indicate that currently Mobydick is grown between 887m to 2191m above sea level (Table 3). These results confirm previous findings on Mobydick growing areas giving an altitude range of between sea level up to 2500 m (Gurib-Fakim *et al.,* 2011). At least 62% of Mobydick farmers were concentrated in the lower hot altitude between 887 m-1690 m above sea level in Machakos, Migori, Kisumu, and Makueni. A few farmers, 38%, were in higher altitudes above 1700 m in cooler environments of Nandi, Nyeri, Laikipia and Embu. These altitude levels agree with Körner and Renhardt (1988) work that lower temperatures at higher altitudes delay plants growth thus fewer farmers preferring to grow this crop. The optimum growing temperatures for Mobydick are considered to be between 22-27˚C (Waiganjo et al., 2008). In cooler regions such as tea growing zones (over 1800m above sea level), it takes a longer time to mature.

Two commercial Mobydick varieties were found on farmers' fields, *Gomphocarpus physocarpa* and *Gomphocarpus fruticosus*. Farmers use duration to maturity as a criterion in describing the two Mobydick varieties. Hence, the six months variety is referred to as taller and takes a longer time to mature whereas the three months variety is dwarf and matures earlier. The six months variety was more superior against browning of the bolls, which is a big challenge in Mobydick industry (Waiganjo et al., 2009). Over 68% of the narrow leaved variety was found in the drier agro-ecological zones 4 and 5, matching the results by Garnish (2004) that leaf size decreases with environmental aridity.

Both pests and diseases are common mostly on dry weather (Coakley *et al.,* 1999). Mobydick grew in a wide range of soil textures from sand, sandy loam, loam, alluvial black, clay loam, black cotton and red loam (Table 3). The survey results also showed that Mobydick was grown between latitude 2.90 South to 20 North and longitude 34.50 East to 38.90 East. According to survey results, most growers were small scale farmers with farm size ranging from 0.1 to 3 acres (Table 3). The tall or six month maturity variety was still prevalent from topographical point of view, which is at flat (0-2.5%) slope, gentle (2.5-5%) slope and moderate (2.5-5%) slope (Table 3). The results also showed that Mobydick farming has been in existence at least for the last 10 years in Kenya (Table 3). Analysis results revealed that there were no significant differences in the distribution of Mobydick varieties across agro-ecological zones, altitude, districts and soil texture (Table 4).

Morphological characteristics revealed that the tall and six months maturing variety had larger, more globular bolls with broader leaves. The canopy of the six months maturity variety was denser compared to the shallower three months maturity Mobydick (Table 5). This confirms similar findings by Goyder and Nicholas (2001) and similar description of morphological characteristics of giant swan or Gomphocarpus physocarpus (Lazarides and Hince, 1993). The three months variety is an erect narrow leaved plant, growing up to 2.5m high, with smaller bolls tapering into a short curved beak. These morphological features of the three months variety matched Gurib-Fakim *et al.,* (2011) description of *Gomphocarpus fruticosus* or Swan plant; the six months variety is very similar to *Gomphocarpus fruticosus* except for its broader leaves and a more globular fruit that stands on a straight stalk; the fruit in the six months variety doesn't taper into the short curved beak. The six months variety has the potential to grow upto 2.5m (Coombs *et al.* 2008), giving a height difference of 0.5m between the short and tall Mobydick varieties (Table 5).

## 5.0 Conclusion and recommendations

The study aimed at determining the distribution of major Mobydick varieties in Kenya. Farmers commented that they chose to grow the six months variety because the variety seemed to be less affected by boll discolouration than the three months variety. The two Mobydick varieties have been identified as *Gomphocarpus physorcarpus* and *Gomphocarpus fruticosus* for six months and three months maturing plants respectively.

*Gomphocarpus physorcarpus*, the vigorous growing, broad leaved Mobydick was more prevalent in the field situation with an occurrence of 84.8% of the total commercial Mobydick count. *Gomphocarpus fruticosus*, the dwarf, narrow leaved swan plant, which was observed to be more susceptible to boll pigmentation but less prevalent occupied the remaining 15.2 %.

Since the distribution of Mobydick varieties was not significant across agro-ecological zones, districts, altitude and soil texture, it means that there were other covariants which could have better explained Mobydick distribution other than agro-ecological zones, districts, altitude and soil texture. There is an opportunity, therefore, to introduce Mobydick to other areas in Kenya where the crop has not been grown before.

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