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Growth Characteristics of Kongwa Weed (*Astripomoea hyoscyamoides*) Subjected to Different Soil Texture

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Abstract

Kongwa weed (*Astripomoea hyoscyamoides Vatke verdc*) is a native annual noxious species to central party of Tanzania. It is able to grow under wide trophic conditions and forms dense stands, covering the top surface soil and causing change in both flora and fauna. The study was conducted to assess the growth performance and seed yield of Kongwa weed subjected to different soil properties collected from different land use types. The experiment was laid out in split-split plot design where three sites (Kongwa Ranch, Sejeli and Ngomae) were the main factor, while subplots were three land-use types (grazing, bush and croplands) and sub-sub plots contained soil textural types with three levels (Clay, loamy sand and sandy clay loam) replicated three times to make twenty-seven planted pots. Data for seed emergence were collected at an interval of 7 days until 28 days after sowing, while the data for growth characteristics were collected 14 days intervals until 112 days after sowing. General Linear Model (GML) procedure of Statistical analysis system was used to analyze the data and Duncan's test was used to compare the mean at 5% level. Results revealed that seed emergence, leaf length, leaf width and seeds per fruit were not significantly affected by locations, land use types and textural soils. However, the results showed the highest stem girth of Kongwa weed in grazing land (7.4 mm stem girth plant-1) followed by crop land (6.2 mm stem girth plant-1) and the lowest was in the bush land soil (5.8 mm girth plant-1). The mean Kongwa weed height, number of leaves, and branches were highest in sandy clay loam soil texture (81.2 cm height, 155 leaves and 10 branches), followed by loamy sand soil texture (74.3 cm height, 130 leaves and 11 branches) and short plant height (50.1 cm), number of leaves (82) and branches (5) were recorded in clay soil texture . However, the results showed that few numbers of fruits (182), and seeds (728) of Kongwa weed were in the clay textural of soils than the loamy sandy and sandy clay loam textural soils. Poor growth and seed production of Kongwa weed were recorded in land use types and clay soil interaction (Grazing land* clay soil, crop land*clay soil and bush land* clay soil). It is recommended that effective strategic control measures require a knowledge of weed growth characteristics. This can contribute development of effective integrated control and prevention strategies among a wider range of stockholders and policy makers.

Keywords: Land use types; Kongwa weed; Growth; Seed emergence; Textural soils

Introduction

Kongwa weed (*Astripomoea hyoscyamoides Vatke verdc*) is a native annual noxious species to central party of Tanzania. It is able to grow under wide trophic conditions even though the species perform better in nutrient concentration. Kongwa weed forms dense stands, covering the top surface soil and causing change in both flora and fauna [1]. Invasion of weed species indirectly affect other native plant species and change ecosystems by altering soil stability, colonizing open substrate, affecting the accumulation of litter and promoting fire [2]. When space, water, nutrients and light are limited, each plant species will be vigorously forced to compete, not only against other plant species but also against other plants of the same species [3]. Furthermore, the weeds naturally adapt to a more diverse environment and may compete seriously with the natural pastures and crops planted in the same land area. The success of weed invasion on the new environment is often attributed with genotype which implying a level of phenotypic plasticity because plasticity itself is a heritable trait, evolution and plasticity cause weed species proliferation [4].

However, recent finding has shown that many weed species are capable of rapid genetic change as well, enhancing their ability to invade new areas in response to anthropogenic ecosystem modification. According to Davis et al.; Funk et al. reported that, the successful of weeds to the new environment occur in areas of high resources availability or under fluctuating resources conditions where temporal heterogeneity in resources availability opens a window for colonizing of invasive [5,6]. Negative impact between weed and native plant species may be caused by weeds which have biochemical root exudates that act as allelopathic agents [7]. The weed invasive roots can negatively impact native plant species by disrupting of beneficial

relationships between native plants and soil biota. Change of the landscape or disturbance regime can promote weed spread by creating favorable patches for colonization and establishment. The disturbance of the soil can also interact with other factors that influence weed invasive during colonization and establishment. For instance, intensive grazing on the area can increase the invisibility of the native plant communities. The Kongwa weed had been mentioned since 1979's by Peterson and McGinnes, within 10 years, the species spread into Kongwa district, central part of Tanzania [8]. Due to its economic and ecological impacts, the Kongwa weed is considered as serious noxious species in Tanzania [1]. The Kongwa weed is dominated more than 57% to various land-use systems in Kongwa district particularly in lands used for crop grazing and crop production due to human intervention such crop rotation, continuous grazing and deforestation. It has been caused negative impact on pasture growth, development and yield; to date there is only one synchronized research results reported in the area by Nkombe et al. The successive emergence and spread of weed species on its environment are intimately associated with seed production, seed dispersal and accumulation of seeds reserves in the soil, germination of seeds, establishment, and growth of seedlings maturation of the plant to produce seeds [9]. Kongwa weed is an enclosed with greyish hairs attaining a height of 1.8 m with alternate simple leaves and showy, white and purple flowers characterized by rapid growth rate, extensive dispersal ability, large and rapid reproductive and wide range of environment adaptability. It belongs to *Convolvulaceae* family commonly known as morning glory family under *Astripomoea genus* [10]. *Convolvulaceae* family is distinguishable by its plicate corolla, axile placentation with few ovule, bi-collateral vascular bundles and latex usually present. It is recognized by funnel shaped, radially symmetrical corolla, the floral formula for the family has five sepals, five fused petals, five epipetalous stamens and two parts of syncarpous and superior gynoecium. The *Convolvulaceae* family shows the major morphological distinctive basically on the leaf size and arrangement, nature of stem and internodes and floral color and morphology. Seed emergence varies among genera of the *Convolvulaceae* family from the soil. Some genera of the *Convolvulaceae* family take fifth to twenty first days or more of cotyledon emergence from the soil. The dormancy of the seed may cause delay in seed germination of some species; the seed coat have been known to delay germination in many *Convolvulaceae* seeds. Despite the appearance of Kongwa weed in different tropical countries, no studies to date have been conducted on growth characteristics in different soil texture. Therefore, there is an urgent need to understand the attributes of the species in terms of its growth and seed production in different soil texture.

Materials and Methods

Description of the study area

The study was conducted in Tanzania livestock research institute Kongwa (TALIRI-Kongwa), Kongwa district. Geographically, the area is located at 06.0629 S, 36.34148 E and 993 m above see levels. The study area falls under semi-arid areas climate conditions with mean annual precipitation ranging 500 mm to 800 mm and occurs during a single rainy season extending from December to April 30°C [1]. The mean temperature ranges between 20°C-33°C (PORA and LGOVT, 2016). The dominant soil types are classified as *Chromic Luvisols* with a sandy loam texture [11]. The area is dominated by *Cenchrus ciliaris*, *Cynodn* species. *Aristida* species, *Dactyoctenium aegyptium*, *Digitaria* species, *Bracharia* species, *cleome hirta*, *Astripomoea hyoscyamoides*, *Machrotyloma axillare* and vegetation type of Acacia woodland dominated by *Acacia* species, *Commiphora* species, *Albizia* species and *Adansonia digitata* scattered on the area.

Description of experimental materials

The experiment was conducted during the rainy season from January to June 2020. Soils were from three land-use types; grazing, crop and bushland of Kongwa Ranch, Sejeli and Ngomae villages used in this experiment. The seedlings were counted and recorded from day one up to 28 days after sowing. The Kongwa weed stem heights, leaves, branches, stem girth, leaf length and width were measured every two-week interval. Fruits and seeds were counted at the mature stage of the plant and each plant was uprooted for the root length measurement. The Kongwa weed stem girth was measured in millimeters (mm) whereas, plant height, leaf length, leaf width and root lengths were measured in centimeters (cm) using a tape measure.

Experimental design and layout

The experiment was laid out in split-split plot design where three sites (Kongwa Ranch, Sejeli, and Ngomae) were the main factor, while subplots were three land-use types (grazing, bush, and croplands) and sub-sub plots contained soil textural types with three levels (clay, loamy sand and sandy clay loam) replicated three times to make twenty-seven planted pots. Each pot was sown five seeds of Kongwa weed at a depth of 1.5 cm. Pots were watered in absence of rainy by 1.5 liters of water per day for 112 days after sowing (Table 1).

Rep No 01	Rep No 02	Rep No 03
BLB	GLC	BLB
BLA	GLA	BLC
BLC	GLB	BLA

GLC	BLA	CLA
GLA	BLB	CLB
GLB	BLC	CLC
CLB	CLB	GLC
CLC	CLA	GLA
CLA	CLC	GLB

Table 1: Experimental layout.

Key

BLA: Bushland clay soil

BLB: Bushland loamy sand soil

BLC: Bushland sandy clay loam soil

GLA: Grazing land clay soil

GLB: Grazing land loamy sand soil

GLC: Grazing land sandy clay loam soil

CLA: Cropland clay soil

CLB: Cropland loamy sand soil

CLC: Cropland sandy clay loam soil

Data Collection

Three days after sowing, the seedlings that emerged in each pot were counted and recorded at an interval of seven days until 28 days after sowing. The percentage of seedling emergence was determined as the number of seeds that emerged divided by the total number of sown seed*100.

Growth Characteristics

The data for growth characteristics were collected in fourteen days intervals from 28, 42, 56, 70, 84, 98 and 112 days after sowing. The height (cm) of Kongwa weed was measured from the root collar to the epical meristem for two plants per pot and their averages were recorded in centimeters. Data on the number of leaves was obtained by counting leaves per plant for two Kongwa weed plants per pot and their averages were recorded. Data for weed stem girth (mm) was obtained by measuring each weed at the centre of the weed using a vernier calliper. Number of branches was obtained by counting branches of the two Kongwa weeds in each pot and their average was recorded. Data for leaf length and width was obtained by measuring three leaves from lamina tip to the point of intersection of the lamina and the petiole, along the midrib of the lamina. Moreover, three leaves were measured from end to end between the widest lobes to the lamina perpendicular to the lamina midrib by tape measure to obtain leaf width (Figure 1). Three leaves were randomly selected from lower, middle and upper part of each Kongwa weed for length measurements.

Figure 1: Leaf length and width (cm) measured in May 2020.

Fruits were counted from two Kongwa weeds in each pot and their average was recorded. The number of seeds per fruit was obtained by counting seeds from each selected nine fruits per Kongwa weed in each pot and their average were recorded as shown in the Figure 2. The number of seeds per plant was obtained by counting the seeds of the two Kongwa weeds in each pot and their average was recorded. The root length was measured from root collar to epical meristem of each plant for two plants per pot using a tape measure and their average was calculated (Figure 2).

Figure 2: Number of seeds fruit-1 of the Kongwa weed counted on June 2020.

Data Analysis

The data for evaluation of Kongwa weed growth characteristics were summarized using Microsoft Excel Spreadsheet computer program to generate descriptive statistics such as mean and percentage. A General Linear Model (GML) procedure of Statistical Analysis System (SAS) was used to analyze the growth and production parameters of Kongwa weed.

Results

Seedling emergence, growth characteristics and seed production of Kongwa weed under three locations

The results showed that there was no significant (P ≥ 0.5) difference on percentage seedling emergence, stem height, number of leaves, number of branches, stem girth, leaf length, leaf width root length, number of fruits, and number of seeds Kongwa weed-1 among three locations (Table 1).

Parameters	Locations				
	Kongwa Ranch	Ngomae	Sejeli	SE ±	P-value
Seedling emergence (%)	97.8	93.3	91.1	3.1	0.3
Height plant^{-1}	70.3	62.1	73.2	5.4	0.3
No of leaves plant^{-1}	127	103	136	12.2	0.2
Stem girth plant^{-1} (mm)	6.1	6.5	6.5	0.4	0.6
No of branches plant^{-1}	10	8	9	0.6	0.3
Leaf length (cm)	11	10.8	10	0.3	0.1
Leaf width plant^{-1} (cm)	5.9	5.6	5.5	0.3	0.6
Root length plant^{-1}(cm)	36.2	36.3	40.5	3.4	0.6
No of fruits plant^{-1}	370	304	339	43	0.6
No of seeds fruit^{-1}	4	4	4	0.1	0.4
No of seeds plant^{-1}	1479	1214	1356	175	0.6

Table 2: Mean Seedling emergence, growth characteristics and seed production of Kongwa weed under three locations. No: Number cm=centimeter; mm: Millimetres and SE ±: Standard error of mean.

Seedling emergence, growth characteristics and seed production of Kongwa weed under selected three land use type The results showed that all paramenters were none significant among selected land use types; except the weed stem girth (Table 2).

The highest stem girth of Kongwa weed was in the grazing land (7.4 mm stem girth plant^{-1}) followed by crop land (6.2 mm stem girth plant^{-1}) and the lowest was in the bush land soil (5.8 mm girth plant^{-1}).

Parameters	Land-use types				
	Bush	Crop	Grazing	SE ±	P-value
Seedling emerged (%)	95.6	95.6	91.1	3.1	0.5
Height plant^{-1}	67.3	65.9	72.4	5.4	0.7
No of leaves plant^{-1}	113	119	134	12.3	0.5

Stem girth plant^{-1} (mm)	5.8b	6.2ab	7.4a	0.4	0.002
No of branches plant^{-1}	8	9	10	0.6	0.12
Leaf length (cm)	10.3	11	10.5	0.4	0.5
Leaf width plant^{-1} (cm)	5.7	5.7	5.7	0.3	1
Root length plant^{-1}(cm)	37.5	37.8	37.7	3.5	1
No of fruits plant^{-1}	323	354	335	44	0.9
No of seeds fruit^{-1}	4	4	4	0.1	0.4
No of seeds plant^{-1}	1293	1417	1339	178	0.9

Table 3: Seedling emergence, growth characteristics and seed production of Kongwa weed under selected three land-use type. No: Number cm=Centimetre; mm: Millimetres and Values with same letter within a row are not significantly different (P ≥ 0.05) and SE: Standard error of mean.

Effect of soil texture on Kongwa weed growth among three soil textures

The results showed significant differences (P<0.001) on Kongwa weed heights, the number of leaves and branches among soil textures (Figures 3 and 4). The mean Kongwa weed height and number of leaves, and branches were highest in sandy clay loam soil texture (81.2 cm height, 155 leaves and 10 branches), followed by loamy sand soil texture (74.3 cm height, 130 leaves and 11 branches) and height Kongwa weed (50.1 cm), number of leaves (82) and branches (5) were lowest in clay soil texture. However, the results showed that the short plant (25.2 cm), plant stem girth (5.4 mm), few numbers of fruits (182), and seeds (728) of Kongwa weed were in the clay textural of soils than the loamy sandy and sandy clay loam textural soils. The percentage seedling emergence, leaf length, leaf width and seeds per fruit were not significantly affected by three textural soil types (Table 3).

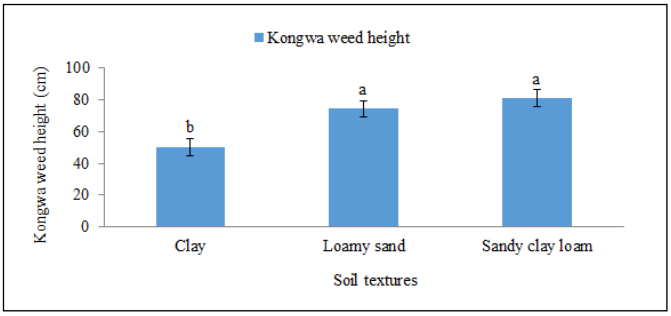

Figure 3: Effect of soil texture on Kongwa weed height among three soil textures.

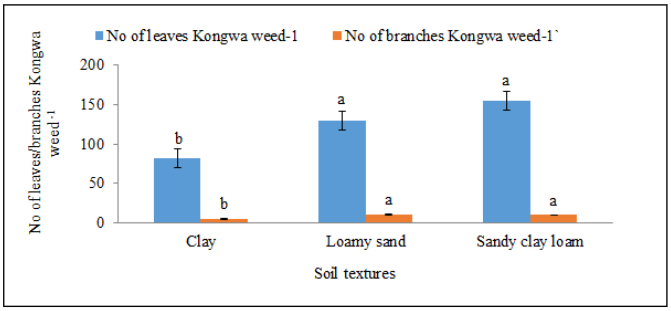

Figure 4: Effect of soil texture on leaves and branches of Kongwa weed among three soil textures.

	Soil texture				
Parameters	**Clay**	**Loamy sand**	**Sandy clay loam**	**SE ±**	**P-value**
Seedling emerged (%)	91.1	95.6	95.6	3.1	0.5
Root length plant^{-1} (cm)	25.2b	45.0a	42.9a	1.5	<.0001
Stem girth plant^{-1} (mm)	5.4b	6.9a	6.9a	0.4	0.003
Leaf length plant^{-1} (cm)	10.2	10.9	10.8	0.4	0.4
Leaf width plant^{-1} (cm)	5.4	6	5.7	0.3	0.3
No of fruits plant^{-1}	182b	440a	390a	21.3	<.0001
No of seeds plant^{-1}	4	4	4	0.1	0.4
No of seeds plant^{-1}	728	1761	1560	85	<.0001

Table 4: Mean effect of soil textures on seedling emerged (%), root, stem girth, leaf length, leaf width, fruits and seeds. Values with different letter within a row are significantly different (P< 0.05).

Interaction effects of land uses with soil textural types on Seed emergence and growth of Kongwa weed

The results indicated that there was significant (P ≤ 0.05) difference on Kongwa weed height, number of leaves and root length among interaction of land use types and soil textural types. The tallest of Kongwa weed was recorded in the interaction of bush land ˣ loamy sand (77.7 cm) fallowed by bushland ˣ sandy clay loam (73.5 cm) and the shortest height of Kongwa weed recorded in bushland ˣ clay soil (50.7 cm). The highest mean number of leaves was recorded in the interaction of bushland ˣ sandy clay loam (147) fallowed by interaction of bushland ˣ loamy sand (109) and the lowest mean number of leaves was in bushland ˣ clay interaction(84). Likewise, the longest of Kongwa weed root was recorded in the interaction of bushlandˣ loamy sand (46.9 cm), bushland ˣ sandy clay loam (43.3) and the shortest root of Kongwa weed was recorded in the interaction of bushland ˣ clay (22.3).

Cropland ˣ soil textural type interactions; The tallest of Kongwa weed was recorded in the interaction of cropland ˣ Sandy clay loam (78.6 cm) fallowed by cropland ˣ loamy sand (71.2 cm) and shortest height was recorded in cropland ˣ clay (48.1 cm). The highest mean number of leaves was recorded in the interaction of cropland ˣ Sandy clay loam (151) fallowed by cropland ˣ loamy sand (128) and shortest mean number of leaves was recorded in cropland ˣ clay (80). Furthermore, the longest root of Kongwa weed was recorded in the interaction of cropland ˣ loamy sand (43.6 cm), bushland ˣ sandy clay loam (41.5 cm) and the shortest plant root was recorded in the interaction of bushland ˣ clay (28.4 cm).

Grazing land ˣ soil textural type interactions; the mean height of Kongwa weed was higher in the interaction of grazing land ˣ Sandy clay loam (91.5 cm) fallowed by grazing land ˣ loamy sand (74.2 cm) and shortest plant height was recorded in grazing land ˣ clay (51.6 cm). The highest mean number of leaves was recorded in grazing land ˣ Sandy clay loam (167) fallowed by grazing land ˣ loamy sand (154) and the lowest mean number of leaves was recorded in grazing land ˣ clay (81). The longest root of Kongwa weed was recorded in the interaction of cropland ˣ loamy sand (44.3 cm), bushland ˣ sandy clay loam (43.9 cm) and the shortest root was recorded in the interaction of bushland ˣ clay (24.8 cm). However, the percentage seedling emergence, number of branches, leaf length and leaf width were not affected by all land use types ˣ soil textural type interactions (Table 4).

Treatment combinations	**SE (%)**	**Kh (cm)**	**NoL**	**WG (mm)**	**NoB**	**LL (cm)**	**LW (cm)**	**RL (cm)**
Bush land ˣ clay	93.3	50.7b	84bcd	5.3	5.3	9.8	5.2	22.3c

Bush land x loamy sand	100	77.7ab	109abcd	6.2	8.3	10.2	6.4	46.9a
Bush land x sandy clay loam	93.3	73.5ab	147ab	6.7	9.7	10.9	5.4	43.3a
Crop land x clay	86.7	48.1b	80d	4.9	6.6	10.8	5.9	28.4bc
Crop land x loamy sand	100	71.2ab	128abcd	7.4	10.5	11.2	5.9	43.6a
Crop land x sandy clay loam	100	78.6ab	151ab	6.3	8.8	11	6.2	41.5ab
Grazing land x clay	93.3	51.6b	81cd	5.9	5.5	9.9	5	24.8c
Grazing land x loamy sand	86.7	74.2ab	154a	7.1	12.3	11.2	5.5	44.3a
Grazing land x sandy clay loam	93.3	91.5a	167a	7.6	10.5	10.4	5.7	43.9a
SE ±	7.7	10.1	19.2	1.2	2.2	1	0.7	3.9
P-value	0.4	0.05	0.05	0.79	0.62	0.83	0.3	0.05

Table 5: Interaction effects of land uses with soil textural types on Seedling emergence and growth of Kongwa weed. SE (%): Percentage seedling emergence percentage; Kh: Kongwa weed height; NoL: Number of leaves; WG: Weed girth; NoB: Number of branches; LL: Leaf length; LW: Leaf width and RL: Root length and SE ± is Standard Error Mean.

Interaction effects of land use with soil textural types on Seed production of the Kongwa weed

According to the results of analysis of variance showed that there was a significant ($P \leq 0.02$) difference in on number of fruits and seeds Kongwa weed-1.Bushland x soil textural type interactions; The highest mean number of fruits was recorded in the interaction of bush land x sandy clay loam (422) followed by bushland x loamy sand (370) and the lowest mean number of fruits was recorded in bushland x clay soil (178). However, the highest mean number of seeds was recorded in the interaction of bushland sandy clay loam (1688) fallowed by the interaction of bushland x loamy sand (1480) and the lowest mean number of seed was in bushland x clay interaction (710). Cropland x soil textural type interactions; the highest mean number of fruits was recorded in the interaction of cropland x loamy sand (480) fallowed by cropland x Sandy clay loam (383) and the lowest mean number of fruits was recorded in cropland x clay soil (200).

However, the highest mean number of seeds was recorded in the interaction of cropland x loamy sand (1919) fallowed by the interaction of cropland x sandy clay loam (1531) and the lowest mean number of seeds was in cropland x clay interaction (810).

Grazing land x soil textural type interactions; the highest number of fruits was recorded in the interaction of grazing land x loamy sand (471) fallowed by grazing land x sandy clay loam (365) and the lowest number of fruits was recorded in grazing land x clay soil (168). However, the highest number of seeds was recorded in the interaction of grazingland^{x} loamy sand (1885) fallowed by the grazing land x sandy clay loam (1461) interaction and the lowest number of seeds was recorded in the interaction of grazing land x clay (672). The number of seeds fruit-1 was not affected by the interaction of land-use type x soil textural types (Table 5).

Treatment combination	No of fruits plant $^{-1}$	No of seeds fruit $^{-1}$	No of seeds plant $^{-1}$
Bush land x clay	178^{c}	4	710^{c}
Bush land x loamy sand	370^{ab}	4	1480^{ab}
Bush land x sandy clay loam	422^{a}	4	1688^{a}
Crop land x clay	200^{bc}	4	801b^{c}

Crop land x loamy sand	480[a]	4	1919[a]
Crop land x sandy clay loam	383[a]	4	1531[a]
Grazing land x clay	168[c]	4	672c
Grazing land x loamy sand	471[a]	4	1885[a]
Grazing land x sandy clay loam	365[ab]	4	1461[ab]
SE±	50.5	0.2	202
P-value	0.02	0.43	0.02

Table 6: Interaction effects of land use with soil textural types on seed production of the Kongwa weed. Interaction values with the same letter within a column are not significantly different (P>0.05) and values within a column are the significant difference (P<0.05) and SE ± is Standard Error Mean.

Discussion

The finding of this study demonstrated that Kongwa weed was no influenced by three location and land use types with exception of weed girth among the land use types. The environmental conditions influence the growth and invasiveness of the weed species in a given habitat [12]. The present results are in line with the results of Chauhan et al. Swanton et al. who reported that the extent of weed invasion in the new environment depends soil type, fertility status and prevailing environmental conditions [13,14]. The variation of Kongwa weed girth among three land use types was probably due to insufficient of incoming sun light in the bush land. The reduction of quantity and quality of sun light by tree canopy cover directly affects the physiological process of the plant [15].

The variation of Kongwa weed on height, number of leaves, branches, number of fruits and seeds among three textural soil types was probably due to clay soil resistance of the root growth to access the water and available nutrients in the soil. Clark et al. reported that the low performance of a plant in clay soils might be due to the lower macroporosity that could have attributed a greater resistance for root growth together with lower aeration of the rhizosphere which could have affect both root growth, vegetative and seed production. The present results are in line with the results of Zhu and Lambers et al. who reported that impaired growth rate, decline in plant heights, low biomass production, reduced reproductive output and disturbed nutrient balances are the general negative effects of abiotic stress on plant. Furthermore, Ozaslan et al. who found that soil with varying particles size provide highly variable amount of water and nutrients due to difference total specific surface area resulted in better performance of the plant [16-20]. The annual weeds do not have roots strong enough to force their way through dense clay soils Clark et al. Kongwa weed produced short roots in clay soil than the roots of Kongwa weed observed in the loamy sand and sandy clay loamy soils might be due to clay soil resistance. Sağlam et al.; Bécel et al. reported that clay soils have high nutrient contents with high root penetration resistance of the plant to access water and available nutrients for the physiological development and plant seed setting [21,22]. The loamy sand and sand clay loam soils have optimum porosity for the extensive root systems such as longer roots, more lateral roots and more root hairs to gain access of those non-bioavailable nutrients for the plant growth and reproduction [23].

Considering the interaction effects, the poor performance of Kongwa weed on plant height, root length, few leaves, few fruits and seeds were recorded in land use type with clay soil as compared with land use type and loamy sand/sandy clay soil interactions. These results could be due to high root penetration resistance which reduced root growth of the Kongwa weed. Bengough et al. reported that too hard soils for roots to penetrate rapidly are the major cause of poor root system growth and development [24]. The reduced root growth not only affects water uptake but also macro and micronutrients absorption required for the plant growth and reproduction since absorption of available nutrients taken at the new root apex zone [25]. Each fruit of Kongwa weed produce four seeds as means of plant regeneration and its seeds are dispersed through livestock animals. Seedless fruit can occur when the ovary develops directly without fertilization or when pollination and fertilization trigger ovary development, but the embryo aborts without producing mature seeds. When seed set fails, the abscission of the flower could be a standard pathway to avoid the wastage of resources in growing structures not fulfilling a biological process [26].

Conclusion and Recommendation

The findings of this study indicated that the Kongwa weed can germinate, grow and reproduce in any land use type if the environmental conditions such as moisture, temperature, light, nutrient resources will favor it. The Kongwa weed grows better and produces many seeds in loamy sand and sandy clay loam soils than in the clay texture soils. This implies that the areas occupied with high percentage clay soil may be less invaded by Kongwa weed. The present finding demonstrated on growth characteristics of Kongwa weed in different textural soils so that to facilitate habitat protection and identification of other areas requiring urgent management. It is recommended that effective

strategic control measures require a knowledge of weed growth characteristics. This can contribute development of effective integrated control and prevention strategies among a wider range of stockholders and policy makers.

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