A SURVEY ON WEED DIVERSITY IN COFFEE ESTATES WITH PROLONGED USE OF GLYPHOSATE IN KIAMBU COUNTY, KENYA.

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ABSTRACT

A weeds survey was conducted in ten different coffee estates in the main coffee growing zones within Kiambu County in the central highlands of Kenya covering different elevations and agro ecological zones of UM1, UM2 and UM3. These estates are characterized by prolonged use of glyphosate for weed control. The aim was to identify the most common and prevalent weeds associated with coffee during the months of November and December 2014. Fields surveyed were done according to the quantitative survey method by using 1.0 m x 1.0 m size quadrat with ten (10) farms representing ten sampling sites. Out of seventy-eight farms, fourty eight farms were established be managed under a routine weed management program. Weeds present in each field were identified and counted by species. The data was used to calculate the frequency, field uniformity, density and relative abundance values for each species. Tables were used to summarise the classifications and quantitative calculations. A total of 47 different weed species including 31 annuals and 16 perennials which comprised of 39 broadleaved weeds 7 grasses and 1 sedge were established. On the basis of relative abundance, the most prevalent and abundant weed species was selected to thereafter determine the tolerance to glyphosate herbicide. Bidens pilosa L (black jack) was found to be the most abundant weed species. Based on relative abundance, the results indicated that annuals were more dominant than perennials. Regular survey is needed to identify possible problematic weeds and weed population shifts to direct research and improve control measures.

Key words: survey, weed diversity, glyphosate, coffee. Kiambu, Kenya.

INTRODUCTION

Coffee is one of the most important cash crops in Kenya and the second most traded produce in Kenya. Kiambu area under coffee covers an area of 12,814 Ha under estates. Coffee is Kenya's
fourth leading foreign exchange earner with horticulture leading followed by tourism and tea. Kenya is the leading producer of Arabica coffee in Africa**.** Weeds in coffee have been reported to reduce yields by over 50% (Nyabundi *et al*, 1998). The use of non-selective herbicides has resulted to bare lands which become a principle avenue for soil erosion as well as a landing ground for new weeds species which establish and may re-establish thus becoming common weeds. This subsequently antagonizes the flora and fauna balances in the environment. Increased cost of production has been a principle item in coffee production caused by weed species dominant and prevalent in areas where they are common, where otherwise were previously efficiently and effectively managed. Costs associated with weed control in coffee and the losses caused by weeds vary from one location to another, depending on the predominant weed flora, the timing on weed control interventions especially necessitated by prior application of ground fertilizers and on the control methods practiced by farmers during the wet seasons. Agronomic costs and concerns accrued due to weed competition are significant and these vary with the rainfall levels, emergent of persistent and difficult to control weed species or populations as well as across the Agro-ecological zones such as UM1, UM2 and UM3 coffee growing zones.

The drier UM3 has fewer concerns as compared to the wetter zones of UM2 into UM1. The fact that the common weeds in coffee are shallow rooted than the main root zone of coffee makes planning for ground fertilizer application a nightmare. There is occasional overhead irrigation that occurs in these estate farms during extensive dry spells and this promotes weeds establishment and related concerns to the growers. Uddin *et al*, 2010 observed that surveys are commonly used to characterize weed populations in cropping systems. Weed succession and distribution patterns in coffee fields are dynamic in nature. The main factors for which crops and weeds compete are light, water and nutrients. Weeds as any other plant normally absorb added nutrients as much and more rapidly than crops and also competing for nutrients, light, space and moisture throughout the growing season (Hussain *et al*., 2008 and Uddin *et al*., 2010 observed that the composition of the weed flora may differ depending on location.

Information on the up todate presence, composition, abundance, importance and ranking of weed species is needed to formulate appropriate weed management strategies. The distribution and nature of the weeds in coffee estates area could be different due to the different agronomic practices employed and the altitudes across the main coffee growing areas. Specific sound knowledge on the nature and extent of infestation of weed flora in the coffee growing area through weed surveys is essential for planning of their control and a precursor to formulate recommendations on the standard practices as well as appropriate herbicides doses under ideal management. However, detailed information on the presence, composition, abundance, importance and ranking of weed species especially in main coffee growing areas in Kenya is lacking. Therefore, the present study was undertaken to investigate the distribution and severity of weed flora prevailing in the large estate coffee growing area of Kiambu County in Kenya.

MATERIALS AND METHODS

The survey was conducted in some selected coffee farms in Kiambu County, Kenya (Table 1) to identify and evaluate the major weed species during the period of 25th November to 5th December 2014. Ten coffee fields were surveyed covering each block ranging from 1-2 Ha representing the sampling area. To achieve the 75% target of farms to be surveyed, the farms were listed alphabetically and every 4th farm was picked for the exercise. In cases where the 4th entry was not accessible for the survey, the following farm was picked to achieve the sampling interval. A questionnaire was also used to collect information weed management from every farm. Mapping (each survey location) was determined by posing (standing stationary) at a convenient point within the sampling area for one minute to allow for full searching stability of the positioning gadget to give the GIS value of each area that was then recorded and tabulated (Table 1) by use of a Global Positioning Satellite (GPS) tool (Model:(GARMIN GPS Maps 62S).

Table 1. Elevation and GIS values of the surveyed area.

Site	Altitude (MASL)	GIS values
Ibonia Estate	1,717	S 01° 10.901' & E 036° 49.170'
Cianda Estate	1,880	S 01° 08.211' & E 036° 46.652'
Gatatha Estate	1,926	S 01° 07.687' & E 036° 45.639'
Nyala Estate	1,640	S 01° 08.069' & E 036° 52.049'
Kays Estate	1,411	S 01° 05.573' & E 036° 54.261'
Karunguru Estate	1,477	S 01° 03.807' & E 036° 57.644'
Benvar Estate	1,536	S 01° 03.306' & E 037° 00.906'
Mutoma Estate	1,585	S 01° 01.433' & E 036° 58.334'
Bendor Estate	1,553	S 00° 58.150' & E 037° 02.550'
Koorali Estate	1,566	S 00° 59.514' & E 037° 01.189'

Sampling:

A normal man walking speed was adopted making 20 steps in an inverted 'W' shape direction to establish the sampling points. A quantitative survey method using 1m x 1 m size quadrat was used by establishing 20 sampling sites for each field (Hakim *et al*., 2013), as shown in figure 1.

The quadrat was thrown backwards from a standing position at each of the sampling point and a weed log established for the weeds falling within the quadrat by identifying, counting and recording. Species that were not immediately identified were tagged with a 16 cm PVC plant tags, labelled and taken to botanical and taxonomic laboratories for authentic identification as described by Chancellor and Froud-Williams, 1982 and 1984.

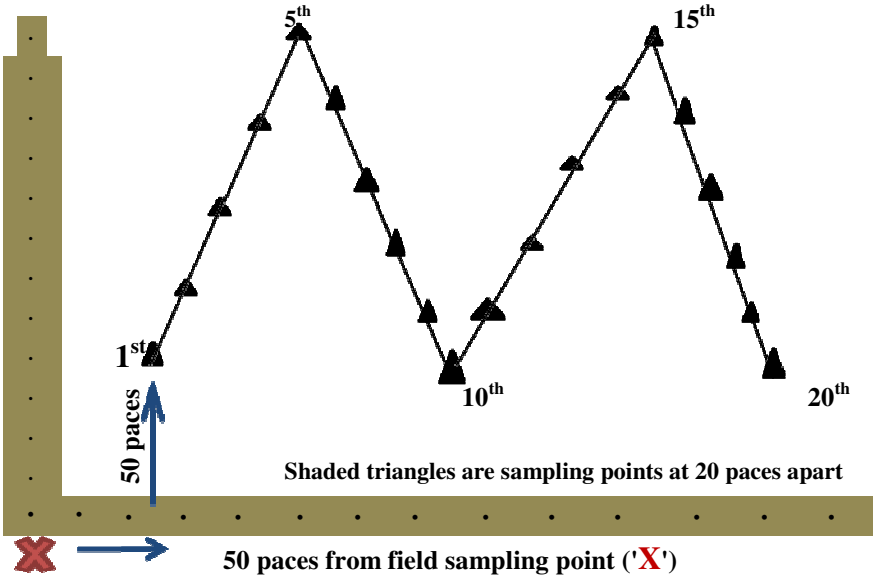

Figure 1. Sampling scheme used in every field/site surveyed.

Data was collected and presented in weed species taxonomy tables. It was quantitatively analysed and summarized in tables. The data generated was used to determine the quantitative parameters which were presented in summary tables with the five (5) quantitative measures being, frequency, field uniformity over all fields, density over all fields, density occurrence fields and relative abundance (Thomas, 1985). Probable anomalies that were carefully avoided while sampling included shoulder and foot slopes, pot holes, ditches, bluffs, power lines, roadsides and paths, shaded areas and valley bottoms.

DATA COMPUTATION:

Weed frequency (F);

Weed frequency was determined as the percentage of the total number of fields surveyed in which a species occurred in at least one quadrat in the following formulae;

$$F_k = \frac{\sum_{i}^{n} Y_i}{n} \times 100$$

Where; F*k* = frequency value for species k; Yi = presence (1) or absence (0) of species *k* in field *i* and *n* being the number of fields surveyed.

Field uniformity (FU):

The field uniformity was calculated as the percentage of the total number of quadrats sampled in which a species occurred, as below;

$$FU_k = \frac{\sum_{i}^{n} \sum_{i}^{20} Yij}{20 \times n} \times 100$$

Where; *FUk* = field uniformity value for species k, *Yij* = presence (1) or absence (0) of species *k* in quadrat *j* in field *i* and *n* being the number of fields surveyed.

Field density (*D*):

The field density of each species in the field was calculated by summing the number of plants in all the 20 quadrats per site and dividing by their area.

$$D_{ki} = \frac{\sum_{i}^{20} Z_i}{A_i} \times 100$$

Where; *D*ki = density (in numbers m^2) value of species *k* in field i, *Z*i = number of plants of a species in quadrat j and *Ai* being the area in m^2 of 20 quadrats in field *i*.

Mean field density (MFD).

This value was obtained by totalling each field density (D) and dividing by the total number of fields. MFD is the mean number of plants per m^2 for each species averaged over all fields sampled and it was determined as below;

$$\mathbf{MFD}k = \frac{\sum_{i}^{n} \mathbf{D}Ki}{\mathbf{n}}$$

Where MFD*k* = mean field density of species k, D*ki* = density (in numbers m^{-2}) of species k in field *i* and *n* being the number of fields surveyed.

Dominance (D) is the measure of mean field density of species k (MFD_k) expressed as a percentage of the total mean field density of all weed species (MFD_l) and was established as;

$$\mathbf{D} = (\mathbf{MFD}k) / \sum \mathbf{MFD}l) \times 100$$

Relative abundance (RA):

This value was used to rank the weed species in the survey and it was assumed that the frequency, field uniformity, and mean field density measures were of equal importance in describing the relative importance of a weed species. This value has no units but the value for one species in comparison to another indicates the relative abundance of the species (Thomas and Wise, 1987). Relative abundance values quantify the predominance of a given weed species in an environment by calculating the frequency, field uniformity, and density of a particular weed species relative to all other species observed. This value is an index that is calculated using a combination of frequency, field uniformity, and field density for each species, as described by Thomas (1985). Relative abundance allows for comparison of the overall abundance of one weed species versus another.

The relative frequency **(*RF*)**, relative field uniformity **(*RFU*),** and relative mean field density **(*RMFD*)** shall be calculated by dividing the given parameter by the sum of the values for that parameter for all species and multiplying by 100 as illustrated below.

The relative frequency for species k (RFk) as;

$$\mathbf{RF}k = \frac{\text{Frequency value of species}}{\text{Sum of frequency values for all species}} \times 100$$

Relative field uniformity for species k (RFU*k*)as;

$$\mathbf{RFU}k = \frac{\text{Field uniformity value for species K}}{\text{Sum of field uniformity values for all species}} \times 100$$

Relative mean field density for species k (RFU*k*)as;

$$\mathbf{RMFD}k = \frac{\text{Mean field density value for species K}}{\text{Sum of mean field density values for all species}} \times 100$$

The relative abundance of species *k* (RA*k*) was calculated as the sum of relative frequency, relative field uniformity, and relative mean field density for that species as;

$$\mathbf{RA}k = \mathbf{RF}k + \mathbf{RFU}k + \mathbf{RMFD}k$$

RESULTS:

Weed species taxonomy:

Generally, the weed vegetation of a particular area is determined not only by the environment but also by edaphic and biological factors that include soil structure, pH, nutrients and moisture status, associated crops, weed control measures and field history especially in local geographical variation (Hakim, *et al*, 2010). A total of 47 different weed species including 31 annuals and 16 perennials which comprised of 39 broadleaved weeds 7 grasses and 1 sedge (Representing by 83%, 15% and 2% respectively, by habitat) were identified in coffee farms of Kiambu County (Table 2). The annual species were greater in number than perennial species and overall annual broadleaved species were more prevalent than perennial broadleaved species and grasses.

The weed species represented 19 families in the surveyed area where Asteraceae family had the highest number of weed species (12), followed by Poaceae (7), Solanaceae (4), Fabaceae (3), Convolvulaceae (3), Acanthaceae (3), Oxalidaceae (2), Malvaceae (2). The rest of the 11 families were represented by one species each. Asteraceae and Poaceae and Solanaceae families accounted together for 50% of the species established. Based on percentages, represented families were at; Asteraceae (26%), Poaceae (15%), Solanaceae (9%), Cyperaceae (7%), Acanthaceae (6%), Convolvulaceae (6%), Fabaceae (6%) Malvaceae (4%) Oxalidaceae

(4%) Amaranthaceae (2%), Brassicaceae (2%), Chenopodaceae (2%), Commelinaceae (2%), Cucurbitaceae (2%), Cyperaceae (2%), Euphorbiaceae (2%), Portulacaceae (2%), Rubiaceae (2%) and Zygophyllaceae at 2%.

Species frequency (F):

The frequency values and in a descending order established that the top ten weed species were, black jack, double thorn, wandering jew, asthma weed, purslane, pig weed, horse weed, love grass, star grass and finger grass with a frequency value equal to or greater than 42.5%. Black jack was found to have the highest relative abundance (RA) value of 46.69%, the highest frequency (F) value of 89.00%, frequency uniformity (79.21%), relative frequency (RF) of 8.69% as well as the highest relative field uniformity (RFU) value of 16.92% (Table 3). Nine (9) broadleaved weeds and three grass weeds species topped in the cluster of weeds whose frequency (F) value was ≥ 40%. Black jack topped overall in frequency (F) value at 89% followed by double thorn, asthma weed, wandering jew, purslane, pig weed, horse weed, love grass, star grass, finger grass, gallant soldier & common groundsel with 79.5%, 65.5%, 65.00%, 58.00%, 52.50%, 50.00%, 45.50%, 45.00%, 42.50%, 41.00% & 40.00% in descending order respectively in the top 11 species. The rest of the broadleaved and grass weed species had a frequency value ranging between 1% and 40% (Table 3).

Field uniformity (FU):

In a similar descending order of field uniformity values, the same seven (7) broadleaved and three (3) grass weed species in the top ten weeds species had their frequency uniformity (FU) values being ≥ 18.06% where black jack was leading at 79.21% followed by double thorn (63.20%), wandering jew (42.90%), asthma weed (42.25%), purslane (33.64%), pig weed (27.56%), horse weed (25.00%), love grass (20.70%), star grass (20.25%) & finger grass at 18.06%. The other thirty-two (32) broadleaved species had their frequency uniformity values being ≤ 16.81% with the least being wild lettuce at (0.01%). Among the grasses, the highest field uniformity was reported in love grass at 20.70%, followed by star grass at 20.25% and finger grass at 18.06%. The lowest field uniformity in grass weed species was found to be in foxtail at 0.06 % (Table 3).

Table II. Weed species observed in the survey of large scale coffee farms in Kiambu County in Kenya.

Family	Common Name	Scientific Name	Life Cycle	Morphology
Acanthaceae	Climbing asystasia	*Asystasia schimperi* L.	A	Broadleaf
	Water willow	*Justicia Calyculata* (Deflers) T. Anders	P	Broadleaf
	Jacobinia	*Justicia elliotii* S. Moore	P	Broadleaf
Amaranthaceae	Pig weed	*Amaranthus graecizans* L.	A	Broadleaf
Asteraceae	Black jack	*Bidens pilosa* L.	A	Broadleaf
	Gallant soldier	*Galinsoga parviflora* Cav.	A	Broadleaf
	Horse weed	*Conyza floribunda* H.B.& K.	A	Broadleaf
	Common groundsel	*Senecio vulgaris* L.	A	Broadleaf
	Goat weed	*Ageratum conyzoides* L.	A	Broadleaf
	Parthenium weed	*Parthenium hysterophorus* L.	A	Broadleaf
	May weed	*Matricaria spp*	A	Broadleaf
	Sow thistle	*Sonchus oleraceus* L.	A	Broadleaf

	Mexican marigold	*Tagetes minuta* L	A	Broadleaf
	Spiny sow thistle	*Sonchus asper* (L.) Hill	A	Broadleaf
	Hairly rupturewort	*Acanthospernum hispidum* D.C.	A	Broadleaf
	Wild lettuce	*Lactuca capensis* Thunb	A	Broadleaf
Brassicaceae	Ethiopian kale	*Erucastrum arabicum* Fisch. & Mey	A	Broadleaf
Chenopodaceae	Common lambsquarters	*Chenopodium album* L.	A	Broadleaf
Commelinaceae	Wandering jew	*Commelina benghalensis* L.	P	Broadleaf
Convolvulaceae	Carolina ponysfoot	*Dichondra carolinensis* L.	P	Broadleaf
	Coast morning glory	*Ipomea mombassana* Vatke	P	Broadleaf
	Kidney weed	*Dichondria rapens* (J.R. & G. Forst)	P	Broadleaf
Cucurbitaceae	Garden cucumber	*Cucumis hirsutus* Sond	A	Broadleaf
Cyperaceae	Nut grass	*Cyperus rotundus* L.	P	Sedge
Euphorbiaceae	Asthma weed	*Euphorbia hirta L.* L.	A	Broadleaf
Fabaceae	Falcon's claw acacia	*Acacia polyacantha* Willd.	P	Broadleaf
	Kenya clover	*Trifolium semipilosum* Fres.	P	Broadleaf
	Silver leaf desmodium	*Desmodium sp.* A	P	Broadleaf
Malvaceae	Common wire weed	*Sida ovata* Forsk	P	Broadleaf
	Egyptian Mallow	*Malva verticilata* L.	A	Broadleaf
Oxalidaceae	Garden pink sorrel	*Oxalis latifolia* H.B. & K.	P	Broadleaf
	Creeping wood sorrel	*Oxalis corniculata* L.	P	Broadleaf
Poaceae	Star grass	*Cynodon dactylon* (L.) Pers.	P	Grass
	African coach grass	*Digitaria abyssinica* (A. Rich.) Stapf	A	Grass
	Love grass	*Setaria verticilata* (L.) Beauv.	P	Grass
	Goose grass	*Eleusine indica* (All.) Gaertn	A	Grass
	Stink grass	*Eragrostis cilianensis* (All.) Lut	A	Grass
	Hairy crab grass	*Digitaria diagonalis* (Nees) Stapf	A	Grass
	Foxtail	*Setaria sphacelata* (Schumach)	A	Grass
Polygonaceae	Double thorn	*Oxygonum sinuatum* (Meisn.) Dammer	A	Broadleaf
Portulacaceae	Purslane	*Portulaca oleracea* L.	A	Broadleaf
Rubiaceae	Tropical American clover	*Richardia brasiliensis* Gomes	P	Broadleaf
Solanaceae	Black nightshade	*Solanum nigrum* L.	A	Broadleaf
	Thorn apple	*Datura stramonium* L	A	Broadleaf
	Apple of peru	*Nicandra physaloides* (L.) Gaertn	A	Broadleaf
	Bitter apple	*Solanum incanum* L	A	Broadleaf
Zygophyllaceae	Puncture vine	*Tribulus terestris* L	A	Broadleaf

Table 3: Frequencies (F), Field uniformity (FU), Relative Frequency (RF), Relative Field Uniformity (RFU), Mean field density (MFD), Relative mean field density (RMFD) and Relative abundance (RA) of the weed species surveyed.

Weed Species	F*k* (%)	FU*k* (%)	RF*k* (%)	RFU*k* (%)	MFD*k* P/m²	RMFD*k* (%)	RA*k* (%)
Black jack	89.00	79.21	8.69	16.92	462.00	21.08	46.69
Double thorn	79.50	63.20	7.76	13.50	259.60	11.85	33.11
Wandering jew	65.50	42.90	6.40	9.16	132.00	6.02	21.58
Asthma weed	65.00	42.25	6.35	9.02	157.80	7.20	22.57
Purslane	58.00	33.64	5.66	7.18	93.00	4.24	17.09
Pig weed	52.50	27.56	5.13	5.89	132.20	6.03	17.05
Horse weed	50.00	25.00	4.88	5.34	63.20	2.88	13.11
Love grass	45.50	20.70	4.44	4.42	78.60	3.59	12.45
Star grass	45.00	20.25	4.39	4.32	112.00	5.11	13.83
Finger grass	42.50	18.06	4.15	3.86	80.00	3.65	11.66
Gallant soldier	41.00	16.81	4.00	3.59	106.80	4.87	12.47
Common groundsel	40.00	16.00	3.91	3.42	28.20	1.29	8.61
Nut grass	35.00	12.25	3.42	2.62	74.20	3.39	9.42
Black nightshade	34.00	11.56	3.32	2.47	38.60	1.76	7.55
Mexican marigold	25.00	6.25	2.44	1.33	6.60	0.30	4.08
Goat weed	22.00	4.84	2.15	1.03	20.20	0.92	4.10
Common wire weed	20.50	4.20	2.00	0.90	21.40	0.98	3.88
Garden pink sorrel	19.50	3.80	1.90	0.81	44.80	2.04	4.76
Goose grass	18.50	3.42	1.81	0.73	37.40	1.71	4.24
Common lambsquarters	18.00	3.24	1.76	0.69	38.00	1.73	4.18
Apple of peru	14.50	2.10	1.42	0.45	15.40	0.70	2.57
Sow thistle	13.00	1.69	1.27	0.36	8.80	0.40	2.03
Thorn apple	11.00	1.21	1.07	0.26	36.00	1.64	2.98
Coast morning glory	10.50	1.10	1.03	0.24	11.80	0.54	1.80
Parthenium weed	10.50	1.10	1.03	0.24	15.80	0.72	1.98
Stink grass	10.50	1.10	1.03	0.24	10.60	0.48	1.74
Tropical Mexican clover	10.00	1.00	0.98	0.21	8.20	0.37	1.56
Ethiopian kale	9.00	0.81	0.88	0.17	14.40	0.66	1.71
Spiny sow thistle	6.50	0.42	0.63	0.09	5.40	0.25	0.97
Creeping wood sorrel	6.00	0.36	0.59	0.08	10.60	0.48	1.15
Water willow	5.50	0.30	0.54	0.06	1.20	0.05	0.66
Hairly rupturewort	5.50	0.30	0.54	0.06	1.20	0.05	0.66
Carolina ponysfoot	5.50	0.30	0.54	0.06	17.20	0.78	1.39
Golden wattle	5.00	0.25	0.49	0.05	4.00	0.18	0.72
May weed	4.00	0.16	0.39	0.03	12.20	0.56	0.98
Puncture vine	4.00	0.16	0.39	0.03	4.80	0.22	0.64
Hairy crab grass	4.00	0.16	0.39	0.03	7.20	0.33	0.75
Garden cucumber	3.50	0.12	0.34	0.03	3.80	0.17	0.54
Dollar weed	2.50	0.06	0.24	0.01	2.20	0.10	0.36
Foxtail	2.50	0.06	0.24	0.01	2.00	0.09	0.35
Bitter apple	2.50	0.06	0.24	0.01	2.60	0.12	0.38
Silver leaf desmodium	2.50	0.06	0.24	0.01	0.80	0.04	0.29

Jacobinia	2.50	0.06	0.24	0.01	0.80	0.04	0.29
Kenya clover	2.00	0.04	0.20	0.01	4.20	0.19	0.40
Egyptian mallow	2.00	0.04	0.20	0.01	1.00	0.05	0.25
Climbing asystasia	2.00	0.04	0.20	0.01	2.00	0.09	0.30
Wild lettuce	1.00	0.01	0.10	0.00	0.40	0.02	0.12

Mean Field density (MFD): Black jack was at the top of the analysis list with a mean field density (MFD) value of 462 plants per m² followed by double thorn (259.60), asthma weed (157.80), pig weed (132.20), wandering jew (132), star grass (112) and gallant soldier (106.8) in the top seven (7) weed species. All the other 40 weed species had their mean field densities below 100 plants per m² with the lowest being the wild lettuce at 0.4 plants per m² (Table 3).

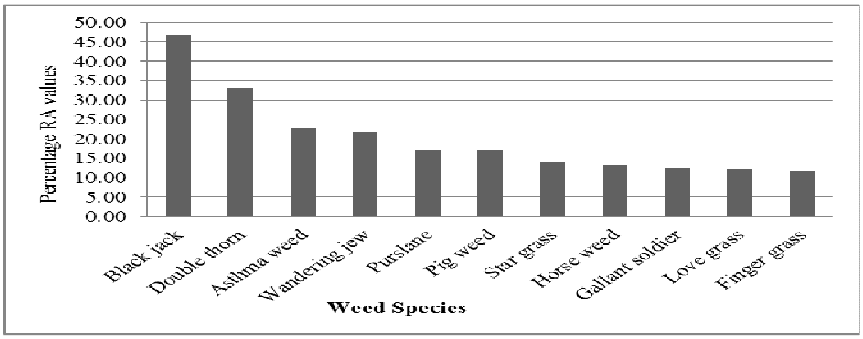

Figure 2. Relative abundance levels of the 11 most prevalent weed species established in the survey.

Relative abundance (RA):

Black jack had a relative abundance (RA) value of 46.69% and was thus significantly outstanding among the forty-seven weed species identified in the surveyed. It topped both as a broadleaf weed species as well as in the overall top eleven (11) weeds species that were established to have a relative abundance (RA) value ≥ 11.66%. In descending order, black jack was followed by double thorn *(*33.11%), asthma weed (22.57%), wandering jew (21.58%), purslane (17.09%), pig weed (17.05%), star grass (13.83%), horse weed (13.11%), gallant soldier (12.47%), love grass (12.45%) & finger grass at 11.66%. All the other 36 weed species had their relative abundance values being > 11.66% where the wild lettuce was found to have the lowest relative abundance of 0.12% (Table 3).

DISCUSSION:

In this study, most of the abundant weed species were annual and broadleaved in nature. The methodology used highly borrowed from the description by Kuchler and Zonneveld (1988) on the forms of field surveys being; exploratory survey, reconnaissance survey, extensive and intensive types of surveys which allowed for the linear technique used in this survey. The observations made in this survey reflected the usefulness for determining the occurrence and relative importance of the established weed species in large scale coffee production defined as a cropping system (Thomas in 1985, McCully *et al*., 1991 and Frick & Thomas 1992). The rankings of these weed species differed on the list based on their frequency (F), field uniformity (FU) and

mean field density (MFD). Within the weed type, the higher RA value reflected its respective higher values of frequency (F), field uniformity (FU) and means field density (MFD) (Table 3).

Bidens pilosa L. was found to be the most prevalent weed species with a relative abundance value of 46.69% followed by double thorn *(*33.11%), asthma weed (22.57%), wandering jew (21.58%), and purslane (17.09%) in the top five species whose relative abundance values were ≥ 17.09%. The same weed species had in the same order leading in their frequency values of 89, 79.5, 65.5, 65 and 58% respectively. Cardina *et al.* in 1999 made related weed species compositions findings and their observations were based on an agricultural land where compatible techniques were employed in managing weeds.

In related studies done by Kimemia *et al.* in 1998 on different weed control methods in coffee in Kenya, the observations indicated that *Cynodon dactylon* was the most common grass species while *Bidens pilosa* and *Galinsoga parviflora* were the most abundant broad leaved weed species where *Tagetes minuta* recorded zero dominance. It was also noted that the broadleaved weeds were more in number of species as compared to the rest of the weed species. These findings compare closely with the observations made by Thomas (1985) who observed that in weeds survey, the relative abundance value clearly indicates very few dominated weed species in a given cropping environment. Similarly, Moody and Drost (1983) observed that the dominant weed flora in any crop field is usually about ten (10) species of which the dominant species are rarely more than three (3) to four (4). These observations closely related in the survey findings on the relative abundance values as tabulated in table 3.

CONCLUSION:

In this study, most of the abundant weeds species were annual and broadleaved in nature. The ranking of weed species differed on the list based on frequency (F), field uniformity (FU) and mean field density (MFD) but, within the weed type, the higher RA value reflects its respective higher values of frequency (F), field uniformity (FU) and means field density (MFD). No grass species or sedge was found to have >53% frequency value. However, the top 12-14 weed species significantly indicated a range for their frequencies, uniformities, their related means and their relative abundance values (Table 3). *C. rotundus,* the only sedge established by the studies was ranked 13th overall in the 47 species with a RA value at 9.42%.

The results of the survey provide a quantitative comparison of the common weed species in large scale coffee growing estates in Kiambu County in Kenya. These estates have had a common history of prolonged use of glyphosate for weed control. Is it possible then that *Bidens pilosa* L has developed tolerance/resistance to glyphosate? On the basis of relative abundance, the most prevalent weed species (*Bidens pilosa* L) was selected to determine the lowest doze at which the weed is susceptible to glyphosate in a subsequent dose response study.

RECOMMENDATION:

Overall, more survey work is needed on a regular basis to establish a coffee weed log for the area and identify possible problematic weeds and weed population shifts and thus direct research towards new or improved control measures.

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