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Research Article

Weed Community Composition, Structure and their Quantitative Evaluation under Tropical Conditions in Garhwal Region

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Abstract

An inclusive knowledge of weed biology is essential for identification and management in order to develop both economically and environmentally acceptable weed management systems. A comprehensive documentation of weed communities is essentially required for inventorization, taxonomic identification and effective management. Present experiment was conducted on composition and their vegetation analysis of weed species through collection of specimens from destructive sample plots in HNB Garhwal University, Chaurus Campus, Uttarakhand. A total of 26 weed species belonging to 24 genera and 18 families were recorded from the 13 plots. Total Number of Individuals (TNI) was observed highest in *Murraya koenigii* (221±7.10) and least for *Ziziphus Mauritiana* (13±0.48). Important Value Index (IVI) was highest for *Murraya koenigii* (137.44) and *Cannabis sativa* (66.73), while the lowest was recorded for *Ziziphus mauritiana* (22.33) and *Cissampelo spereira* (2.41). *Oxalis corniculata* (69.23) showed the highest frequency, while *Cannabis sativa* showed both density=13.09 and abundance=21.27 to be the highest. Both *Cissampelo spereira* and *Solanum nigrum* species recorded lowest frequency, density and abundance was with value F=7.69 each. On basis of IVI, *Murrayakoinigii* and *Cannabis sativa* species marked the highest level of domination in the observation plots. The Asteraceae (4) followed by Amaranthaceae (3) and Malvaceae (3) were observed to be dominant family at the sites. The family such as Apocynaceae, Canabaceae, Caryophyllaceae, Boraginaceae showed least number of species. The range of abundance-frequency ratio was between 0.02 – 0.35, which indicate regular and random distribution pattern, signifying a suitable management system for weed regime in the area.

Keywords: Community; Dominance; Diversity; Species; Weeds

Abbreviations

IVI (Important Value Index), RD (Relative Dominance), RF (Relative Frequency). RA (Relative Abundance), RDom (Relative Dominance).

Introduction

Weeds are the unwanted plants species that grow in any kind of environment. In nature, around 8000 weeds have been reported so far. A plant may be considered as weed in some places but may be useful at another place, asan important component of various agro-ecosystems in supporting biodiversity. Weeds differ from other plants for being more aggressive, having peculiar characteristics that make them more competitive over other plant communities. Weeds decrease the crop yield by competing for water, nutrients,

space and light (10). Reductions in abundances of weeds which act as hosts may affect the associated beneficial insects and other taxa.

It is assumed that a more diverse weed community is less competitive. Regardless of how weeds are perceived, the common ecological principle should be involved in management of weed communities. To this context, in field, weed diversity could be advantageous environmentally. The first step in effective weed management is the accurate identification of weeds which in turn will helps in a basic understanding of the weed's life cycle. Correct taxonomic identification can be an important step in deciding that new weeds can be eradicated before their establishment. The types of weeds can also highlight about the field conditions and the required management regime with best form of direct control. Proper weed identification also helps in selecting specific herbicide to control a particular weed species during the different stages of its life cycle Weeds also disturb other plants. This is an important constraint needed to be overcome through adopting the management strategies.

Weeds are one of the critical factors in nurseries, agricultural lands and plantation sites. Specific weed species compete with the different desirable species. The composition and abundance of weeds are influenced by number of environmental variables as well as management practices in an ecosystem. Under different environmental conditions, many weed species grow depending upon their adaptability to the environment. Based on their seasonal occurrence and their diversity, the appropriate weed control program for obtaining satisfactory results needed to be considered first. Thus, the aim of the study was to analyze the weed communities in tropical environment of Chauras region in Garhwal Himalaya. An assessment of their quantitative cover is done for their frequency, density, abundance and important value index in relation to the area. This will be helpful in exploring the distribution and diversity of weed species. It provides baseline information about the important weed species during the season which will be helpful in formulating effective measures for controlling and managing the weed species within the periphery of the study area.

Materials and Methods

The present investigation was conducted in the Chaurus campus of HNB University, Uttarakh and. The study was carried out during spring and early summers from Feb., 2021 to May, 2021. The study area is situated at a longitude of 78°48′03′′E and latitude of 30°13′26′′N and at elevation of 560 meter (1,837 feet) amsl. The study site is located in dry tropical climate and lies at the eft bank of Alaknanda River. The average annual temperature range is 18.5- 38.5°C. Major trees species in the area are *Dalbergiasissoo*, *Lauceanalecoecephala*, and *Melia azedarach*, etc. The shrub species like *Murraya koenigii*, *Lantana camra*, *Carrissa carandas* and *Asparagus acutifolius* and herbs species like *Cannabis sativa*, *Oxalis corniculata*, *Vicia hirsuta*, and *Sida acuta*, etc.

The vegetative analysis of weed species was carried out using the quadrates method. Tools used in the research were squared meters, scissors, hoes, meter tapes, plastic bags, analytical scales, etc. and random sampling method was adopted. Quadrates were randomly demarcated by measuring 5x5m quadrate for the shrub species. Each quadrate was further subdivided into 1x1m sample plot for recording the herb species (8). A total of 13 quadrates were laid randomly on different disturbed and undisturbed site in the study area. The distance between the quadrates were different, all quadrates were laid randomly using satellite map which was taken from google map. The sampling plots were being analyzed twice on monthly.

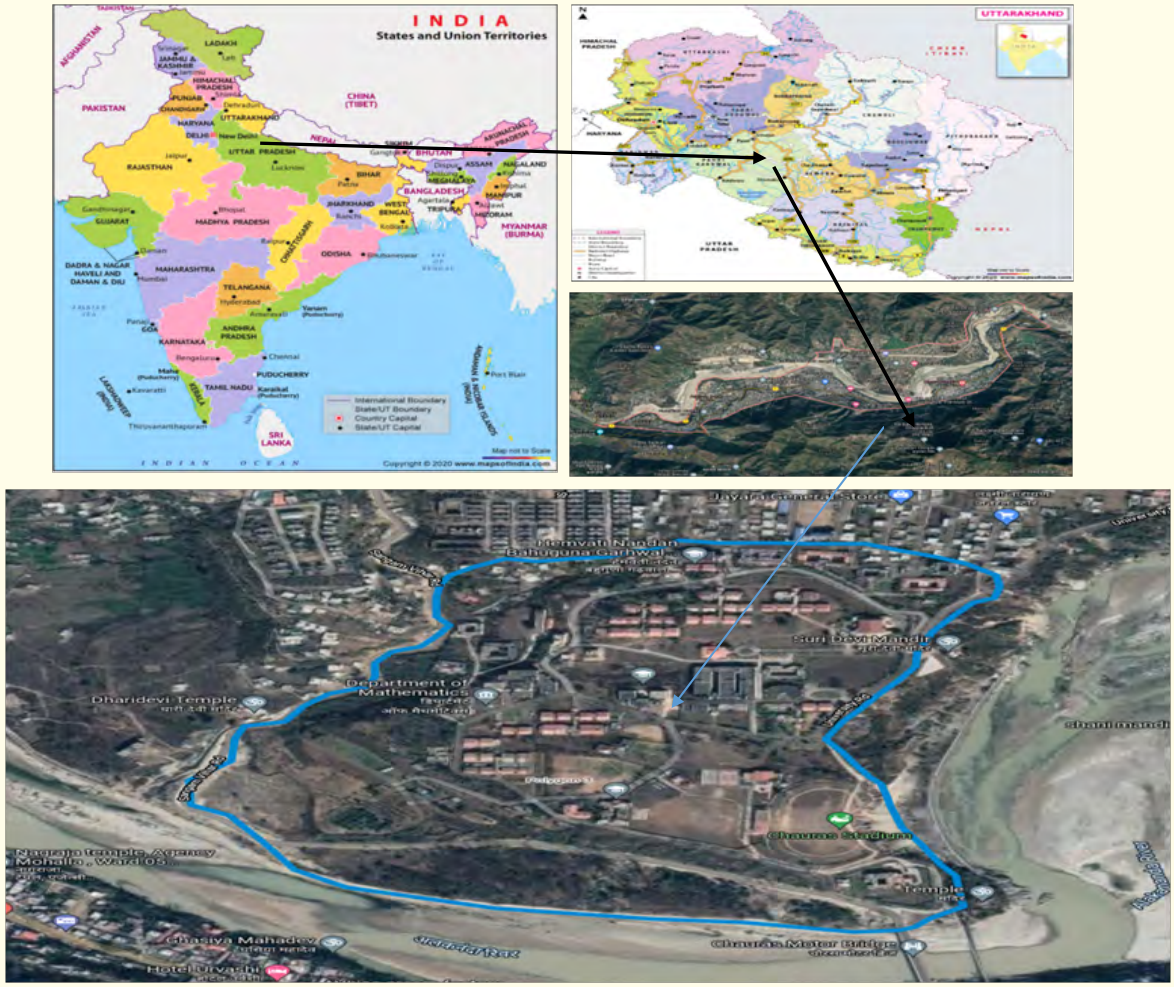

Figure 1: Google map of the study area (www.mapofindia.com).

Estimation of quantitative parameters

Weed analysis was performed by taking weeds from destructive plots of 5*5 meter and grouped/weed species. Furthermore, the quantitative parameters including frequency, density, abundance and IVI were recorded. The quantitative analysis was performed as per Curtis and Mc Intosh (5), (8) on the following aspects:

Frequency: The proportion of sampling units (e.g. quadrates) that contains the target species (2) and was expressed as a percentage.

$$\text{Frequency (\%)} = \frac{\text{No. of quadrate in which individual occured}}{\text{Total no. of quadrate}} \times 100$$

Relative Frequency: The degree of dispersion of target species in the sampling unit in relation to the number of all the species occurred and was expressed as a percentage.

$$\text{Relative Frequency (R.F.)} = \frac{\text{Frequency of an individual species}}{\text{Frequency of all species}} \times 100$$

Density: The number of target species per given area (e.g. square meter or hectare). Brix and Andreasen (2000) proposed the McCullagh model for prediction of the mean weed density from the frequency data by calibration.

$$\text{Density} = \frac{\text{Total no. of individuals of a species in all quadrates}}{\text{Density of all species}}$$

Relative Density: The numerical strength of a target species in relation to the total number of individuals of all the species occurred.

$$\text{Relative Density (R.D.)} = \frac{\text{Density of an individual species}}{\text{Density of all the species}} \times 100$$

Abundance: The measure of the number or frequency of individuals of the same species, whereas diversity demonstrates the number of species present (species richness) and their abundance (species evenness) in an area or in a community (2).

$$\text{Abundance} = \frac{\text{Total no. of individual of a species in all quadrates}}{\text{Total no. of quadrate in which species occured}}$$

$$\text{Relative Abundance (R.A.)} = \frac{\text{Abundance of a species}}{\text{Abundance of all species}} \times 100$$

Important Value Index: The IVI reflects the importance of population within the weed community which correlates with the analysis of the number of individuals and produce mass and allow the inference of the species importance.

IVI of woody species = R.F. + R.D. + R. Dom, and IVI for herbaceous species = R.F. + R.D. + R.A.

$$\text{Mean } (x) = \frac{\sum f}{n}$$

Whitford's Index (WI) (Whitford, 1949): If A/F ratio: regular distribution (< 0.025), random distribution (0.025 – 0.05) and contagious or clumped distribution (>0.05).

$$\text{WI} = \frac{\text{Abundance}}{\text{Frequency}}$$

Results and Discussion

Family distribution of weed species

In 13 quadrates, 26 species were recorded during the study phase belonging to 18 families, in which Asteraceae family showed maximum number of species followed by Amaranthaceae (3) and Malvaceae (3). The least counted species family were Apocynaceae, Asparagaceae, Canabaceae, Caryophyllaceae, Boraginaceae, etc (Table 1).

S No.	*Family*	*Species Count*	*Total no. of quadrates*
1.	Amaranthaceae	3	5
2.	Apocynaceae	1	5
3.	Asparagaceae	1	8
4.	Asteraceae	4	6
5.	Canabaceae	1	8
6.	Caryophyllaceae	1	6
7.	Boraginaceae	1	4
8.	Euphorbiaceae	1	3
9.	Fabaceae	2	7
10.	Laminaceae	1	2

11.	Malvaceae	3	9
12.	Menispermaceae	1	1
13.	Oxilidaceae	1	9
14.	Papaveraceae	1	2
15.	Rhamnaceae	1	3
16.	Rutaceae	1	11
17.	Solanaceae	1	1
18.	Verbenaceae	1	5

Table 1: Family distribution of weed species in the study area.

No any new shrub species were found, probably because of less variations in climatic factors. Distribution of weeds in any number of plots might be affected due to different microclimatic conditions in the area. Out of 13 no. of quadrate, Rutaceae was the predominantly occurred family which was also present in 11 no. of quadrate and Solanaceae family was the least, which occurred only in 1 quadrate.

Occurrence of weed species

A total of 26 weed species were recorded from the sampling quadrates, out of which 5 species were shrubs and 21 species were herb (Table 2). The result showed that *Murraya koenigii* (11) has the highest number of occurrences in plotted quadrates followed by *Asparagus acutifolius* (8). For the herbaceous species *Oxalis corniculata* (9) has maximum numbers followed by *Sida acuta* (8) and *Cannabis sativa* (8). The species which has least number of occurrences was *Ziziphus mauritiana* (3) and *Cissampelos Pereira* (1).

Frequency is a useful index for monitoring and comparing plant community changes over time (1). Frequency reflects both species presence or absence and how much it is distributed within a community. The occurrence of the species was reported diminishing by no new species raise after the 3rd revisit in every quadrate because of changing seasonal conditions. This may be caused by factors like soil conditions, quantity and dispersal of gemmules, vegetative propagation, grazing, predation, diseases and other biotic activities which determine the composition and diversity of species at a site (8).

S No.	***Scientific Name***	***Common Name***	***Family***	***Sampling Plots***													***Quadrates***
				1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***	
1.	*Lantana camara*	Lantana	Verbenaceae	+	+	+	-	-	-	+	-	-	-	+	+	+	7
2.	*Carriss acarrandas*	Caranda	Apocynaceae	+	+	-	+	-	+	-	-	-	-	-	+	-	5
3.	*Murraya koenigii*	Khari Pata	Rutaceae	+	+	+	+	+	+	+	-	-	+	+	+	+	11
4.	*Asparagus acutifolius*	Wild Asparagus	Asparagaceae	+	+	-	+	+	+	+	-	-	-	+	+	-	8
5.	*Ziziphus mauritiana*	Indian Plum	Rhamnaceae	-	-	-	-	-	+	+	-	+	-	-	-	-	3
6.	*Sida acuta*	Wire Weed	Malvaceae	+	+	-	+	+	-	+	-	+	-	-	+	+	8
7.	*Sida cordifolia*	Heart shaped leaf	Malvaceae	+	+	-	-	+	-	+	-	-	-	-	+	-	5
8.	*Malvestrum spp.*	False Mallow	Malvaceae	-	+	-	-	+	-	+	-	+	-	+	+	+	7
9.	*Achyranthus aspera*	Divil's house whip	Amaranthaceae	-	+	-	-	-	-	+	-	-	-	-	-	+	3
10.	*Cannabis sativa*	Hemp	Cannabaceae	+	+	+	+	-	-	+	-	-	-	+	+	+	8

11.	*Oxalis corniculate*	Flannel Weed	Oxaliclaceae	-	+	-	-	+	+	+	-	+	+	+	+	+	9
12.	*Cissampelos Pereira*	Velvetleaf	Menisperma-ceae	-	+	-	-	-	-	-	-	-	-	-	-	-	1
13.	*Aerva*		Amaranthaceae	-	+	-	+	-	-	-	-	-	-	-	+	+	4
14.	*Cynoglossumlance-olatum*	Hound's Tongue	Boraginaceae	-	-	-	+	-	-	-	-	+	-	+	-	+	4
15.	*Euphorbia hirta*	Asthma Plant	Euphorbiaceae	-	-	-	-	+	-	-	+	-	-	-	+	-	3
16.	*Ageratum housto-nianum*	Floss Flower	Asteraceae	-	-	-	-	+	-	-	+	-	-	-	-	+	3
17.	*Parthenium hys-terophorus*	Congress Grass	Asteraceae	-	-	-	-	+	-	-	+	-	-	-	-	+	3
18.	*Artemisia abin-thium*	Wormwood	Asteraceae	-	-	-	-	-	-	-	+	+	-	-	-	+	3
19.	*Erigeron sumat-rensis*	Horseweed	Asteraceae	-	-	-	-	-	-	-	+	+	+	+	-	+	5
20.	*Vicia hirsute*	Hairy Vetch	Fabaceae	-	+	-	-	-	-	+	+	-	+	+	+	+	7
21.	*Vicia tetrasperm*	Smooth Vetch	Fabaceae	-	-	-	-	-	-	-	-	-	+	-	+	+	3
22.	*Stellaria media*	Chickweed	Caryophyllaceae	+	+	-	-	-	-	-	-	-	+	+	+	+	6
23.	*Ajuga*	Bugleweed	Lamiaceae	-	-	-	-	-	-	-	-	-	-	+	-	+	2
24.	*Chenopodium album*	Goosefoot	Amaranthaceae	-	+	-	+	-	-	+	-	-	-	-	+	-	4
25.	*Fumaria muralis*	Ramping Fumitory	Papaveraceae	-	+	-	-	-	-	+	-	-	-	-	-	-	2
26.	*Solanum nigrum*	Black Night-shade	Solanaceae	-	-	-	-	-	-	+	-	-	-	-	-	-	1

'+' denotes the occurrence of weed species at a particular quadrat.

Table 2: Occurrence and their distribution of weed species in sample plots.

Total Number of Individual (TNI)

TNI was found highest in *Murraya koenigii* (221±7.10) and least in *Ziziphus Mauritiana* (13±0.48) for the shrub species. In herb species, the TNI (Table 3) was counted maximum on Cannabis sativa (170±5.16) and least in *Cissampelospereira* (1±0.08).

S No.	Plants	Name of the Species	Total number of individuals (TNI)	Mean (x)	Standard Error
1.	Shrubs	*Lantana camara*	67	5.16	2.34
2.		*Carrissacarrandas*	21	1.63	0.85
3.		*Murraya koenigii*	221	17.02	7.10
4.		*Asparagus acutifolius*	49	3.77	1.35
5.		*Ziziphus mauritiana*	13	0.99	0.48
1.	Herbs	*Sida acuta*	26	1.99	0.64
2.		*Sida cordifolia*	4	0.34	0.19
3.		*Malvestrum spp.*	17	1.29	0.43
4.		*Achyranthus aspera*	6	0.47	0.25
5.		*Cannabis sativa*	170	13.09	5.16
6.		*Oxalis corniculate*	44	3.37	1.06
7.		*Cissampelospereira*	1	0.08	0.08
8.		*Aerva*	11	0.81	0.35
9.		*Cynoglossumlanceolatum*	11	0.88	0.42
10.		*Euphorbia hirta*	6	0.46	0.27
11.		*Ageratum houstonianum*	6	0.44	0.27
12.		*Parthenium hysterophorus*	8	0.61	0.32
13.		*Artemisia abinthium*	11	0.86	0.49
14.		*Erigeron sumatrensis*	14	1.04	0.45
15.		*Vicia hirsute*	61	4.69	1.94
16.		*Vicia tetrasperm*	23	1.80	1.02
17.		*Chickweed*	52	3.99	2.58
18.		*Ajuga*	5	0.38	0.28
19.		*Cynopodium album*	12	0.93	0.46
20.		*Fumaria muralis*	5	0.41	0.30
21.		*Solanum nigrum*	3	0.20	0.20

Table 3: TNI, Mean and SE of weed species.

Success of weed management regime is based on sufficient knowledge on their biological parameters. A comparison of the present study with other regions of Uttarakhand gives interesting outcomes that the order of dominance is different. Asteraceae occupy the first dominated family which is the largest family of medicinal and aromatic plants in Uttarakhand. The findings are confirmed by earlier studies (12) which reported Asteraceae as the dominant family in Oak dominated forests in Nainital catchment area contributing most of the exotic weeds. The species from the Asteraceae family was also recorded to be collectively dominant (4), (11) and (7) reported dominance of Asteraceae on the wheat diversity in rabi crops, India.

Vegetation Analysis

Plants which grow together, exhibit mutual relationships among themselves and with the environment. The group of plants in an area represents a community. Vegetation analysis is a way to study species composition and their structure in any community. In reported species, frequency, density and abundance was found highest in *Murraya koenigii* with F=84.62, D=17.02 and A=20.1 respectively and the least were *Ziziphus mauritiana* with F=30.77, D=0.99, and A=3.22 respectively. For the herb layers, the highest frequency

was recorded for *Oxalis corniculata* (F=69.23) followed by *Cannabis sativa* and *Vicia hirsute* with each value of F=61.54. The higher value of frequency of *M. koenigii* and *O. corniculata* was because of their uniform distribution compared to the other species. *Murraya koenigii* also possessed higher relative frequency (31.43), relative density, (59.56), relative abundance (46.46) and IVI (137.44) while shrub species *Ziziphus mauritiana* showed least values of R.F. (11.43), R.D. (3.47), R.A. (7.43) and IVI (22.33). Further, *Oxalis corniculata* had the highest frequency (69.23) and *Cannabia sativa* showed highest densityof 13.09 and abundance of 21.27. The species holding least frequency, density and abundance were *Cissampelos pereira* and *Solanum nigrum* each representing F value of 7.69. The species which shows highest relative frequency was *Oxalis corniculata* (9.89) and the least was *Cissampelos pereira* and *Solanum nigrum* (1.10). The relative value of each species depends on their frequency, density and abundance value. The highest relative density, relative abundance and IVI were shown by the species *Cannabis sativa* (R.D=34.33, R.A=23.61 and IVI=66.73).

The dominance of plant species was determined using the important value index of the species. The IVI of *Murraya koenigii* (IVI=137.44) was the highest among the shrubs species followed by *Lantana camara* (IVI=60.22). it hasindicated as the most dominated species as these were found growing on road side, waste areas and open places in the shrub layer. For herb species, *Cannabis sativa* showed the highest IVI value (66.73) followed by *Vicia hirsute* (29.68). In the shrub layer, *Murrayakoenigii* was the highest value (F, D, A, and IVI) recorded whereas lowest or least value was recorded for *Ziziphus muaritiana*. It means that *Murraya koenigii* and *Cannabis sativa* has the highest level of domination in the observation plots. The distribution pattern of all species on the studied site was regular for all shrub species which values lies between 0.10 to 0.24. On the other hand, *Cannabis sativa* being the most dominated species while *Cissampelos pereira* and *Solanum nigrum* was least dominated species with each having frequency value of F= 7.69. *Cissampelos pereira* showed highest density and Sida cordifolia showed highest abundance.

In herbaceous layers, most of the species showed regular distribution (18 species) and only fewer species showed random distribution and their overall values was ranged between 0.02 to 0.35. Frequency values of *Asparagus acutifolious* (F=61.54) was higher than *Lantana Camara* (F=53.85), whereas the density, abundance and IVI of *Lantana camara* was higher than *Asparagus acutifolious*. Similarly, frequency of *Oxalis corniculata* (F=69.23) was higher than *Cannabis sativa* (F=61.54). This variability might be due to the influence by micro-habitat conditions, irrigation, topographic and edaphic conditions, grazing and anthropogenic influence etc on the species.

The species showing highest important value index are considered dominant species in a plant community (6). It indicates that *Murraya koenigii* and *Cannabis sativa* has the highest level of domination in the observation plots. Same species dominance is noted in a number of studies by the other reseachers. The findings also supported by Naithani et al. (9) who also recorded the highest IVI value for *Murraya koenigii* (58.28) and highest density value for *Cannabis sativa* (57.05). Sharma et al. (13) also concluded that *Murraya koenigii* as dominant species in among natural populations of *Terminalia chebula* Retz. Having density (1920 individual/ha) followed by *Lantana camara* as (1120 individual/ha).The findings are further supported by Singh et al. (13) who recorded IVI value of 133 for *Murraya koenigii* (dominating shrub) and of 111.35 for *Lantana camara* in natural population of *Terminalia chebula*.

The distribution pattern of the species was studied by using Whitford's Index (Whitford, 1948). The A/F ratio of the weed species was ranged between 0.02 – 0.35, thus showing regular and random distribution pattern. Out of which, most of the weed species has value less than 0.25 (23 weed species) which indicates regular distribution, whereas few herb species showed random distribution. Most of the weed species possessed regular distribution pattern which suggests that the area is well managed in terms of its weed population and their invasiveness.

Scientific Name	*Plants*	*Frequency*	*Density*	*Abundance*	*R.F.*	*R.D.*	*R.A.*	*I.V.I.*	*A/F*
Lantana camara	Shrubs	53.85	5.16	9.59	20.00	18.07	22.15	60.22	0.18
Carrissacarrandas		38.46	1.63	4.25	14.29	5.72	9.82	29.82	0.11
Murraya koenigii		84.62	17.02	20.11	31.43	59.56	46.46	137.44	0.24
Asparagus acutifolius		61.54	3.77	6.13	22.86	13.19	14.15	50.19	0.10
Ziziphus mauritiana		30.77	0.99	3.22	11.43	3.47	7.43	22.33	0.10
Total		269.23	28.58	43.30	100	100	100.	300	
Sida acuta	Herbs	61.54	1.99	3.23	8.79	5.22	3.59	17.60	0.05
Sida cordifolia		38.46	0.34	0.88	5.49	0.88	0.97	7.35	0.02
Malvestrum spp.		53.85	1.29	2.39	7.69	3.38	2.66	13.73	0.04
Achyranthus aspera		23.08	0.47	2.04	3.30	1.24	2.27	6.80	0.09
Cannabis sativa		61.54	13.09	21.27	8.79	34.33	23.61	66.73	0.35
Oxalis corniculata		69.23	3.37	4.86	9.89	8.83	5.40	24.12	0.07
CissampelosPereira		7.69	0.08	1.00	1.10	0.20	1.11	2.41	0.13
Aerva		30.77	0.81	2.63	4.40	2.12	2.91	9.43	0.09
Cynoglossumlanceolatum		30.77	0.88	2.84	4.40	2.30	3.16	9.85	0.09
Euphorbia hirta		23.08	0.46	2.00	3.30	1.21	2.22	6.73	0.09
Ageratum houstonianum		23.08	0.44	1.92	3.30	1.16	2.13	6.58	0.08
Parthenium hysterophorus		23.08	0.61	2.63	3.30	1.59	2.91	7.80	0.11
Artemisia abinthium		23.08	0.86	3.71	3.30	2.25	4.12	9.66	0.16
Erigeron sumatrensis		38.46	1.04	2.70	5.49	2.72	3.00	11.22	0.07
Vicia hirsute		53.85	4.69	8.71	7.69	12.31	9.67	29.68	0.16
Vicia tetrasperm		23.08	1.80	7.79	3.30	4.72	8.65	16.66	0.34
Chickweed		46.15	3.99	8.65	6.59	10.47	9.60	26.66	0.19
Ajuga		15.38	0.38	2.50	2.20	1.01	2.78	5.98	0.16
Cynopodium album		30.77	0.93	3.03	4.40	2.45	3.36	10.21	0.10
Fumaria muralis		15.38	0.41	2.69	2.20	1.08	2.98	6.27	0.17
Solanum nigrum		7.69	0.20	2.63	1.10	0.53	2.91	4.54	0.34
Total		700.00	38.12	90.08	100	100	100	300	

Table 4: IVI, density and their distribution pattern of weed species.

Conclusion

A total of 26 weed species were documented from study area. The recorded species belonged to 24 genera and 18 families in 13 examined sites. The findings confirmed that the area is rich in weed species species diversity Weed occurred in the study sites were dominated by Asteraceae, followed by Amaranthaceae family. However, Fabaceae was the most common species during the selected seasons. Malvaceae occurred in higher number of quadrates (9). The 26 weed species was identified by means of quantitative analysis. The result showed that *Murraya koenigii* (60.22±7.10) and *Cannabis sativa* (66.73±5.16) showed the maximum IVI value which suggest that these species were most dominating in the area. The value of abundance-frequency ratio ranged between 0.02-0.35 which mostly shows regular pattern that signifies that the area is well managed.

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