

## Biodiversity of Weed Species in Crop Fields of North Coastal Andhra Pradesh, India

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### ABSTRACT

The present paper focuses on the weed flora of crop fields of North Coastal Andhra Pradesh, via survey conducted during 2006-09. A total of 532 plant species belonging to 308 genera and 80 families were identified as crop land weeds. Of these 382 were dicots, 149 monocots and one pteridophyte. Out of 532 species 396 were herbs, 36 undershrubs, 51 shrubs and 49 falls under climbing category. One species belonging to Solanaceae is the new record to Andhra Pradesh. Poaceae, Fabaceae, Asteraceae, Acanthaceae, Euphorbiaceae, Cyperaceae, Rubiaceae, Lamiaceae, Convolvulaceae, Malvaceae, Amaranthaceae, Commelinaceae, Asclepiadaceae, Scrophulariaceae and Solanaceae were among the largest families represented by more than 10 species each.

**Keywords:** Weed species, crop fields, North Coastal Andhra Pradesh, India

### INTRODUCTION

A weed is an unwanted plant growing in a place where some other plants are also growing or no other plant has grown at all. The plants growing in a wrong place i.e. in agriculture fields are often referred to as weeds. The unwanted plants which are growing in crop fields and competing with the crop plants have a short vegetative phase with high reproductive potential. There are many weeds in India, some of which grow widely in crop fields and were not known until recent years. Weeds are genetically labile and phenotypically plastic; such characters enable them to pass through successfully in adverse habitats. They easily invade crop fields which are favourite grounds for their quick growth.

Weed-crop competition is critical in obtaining crop yields because of greater competitive ability of weeds than the crops. Weeds deplete large quantities of mineral nutrients and moisture more efficiently than the crop plants and thrive better over the crops in drought conditions. They shade the crop seedlings and occupy space where crop plants should grow their roots. Weeds have higher contents of nutrients than crop plants; they grow faster and absorb nutrients more efficiently and thus limiting the availability of the same to crop plants. Besides, the weeds inflict allelopathic effects on crop plants which are large through their depressive root exudates.

#### Study Area

North Coastal Andhra Pradesh is situated between  $17^{\circ} 10'$  to  $19^{\circ} 10'$  N latitudes and  $81^{\circ} 53'$  to  $84^{\circ} 50'$  E longitudes. It is bounded on the North by Orissa state, on the South by East Godavari district, on the eastern part bordering with Bay of Bengal and on the West by East Godavari district and part of Orissa comprising

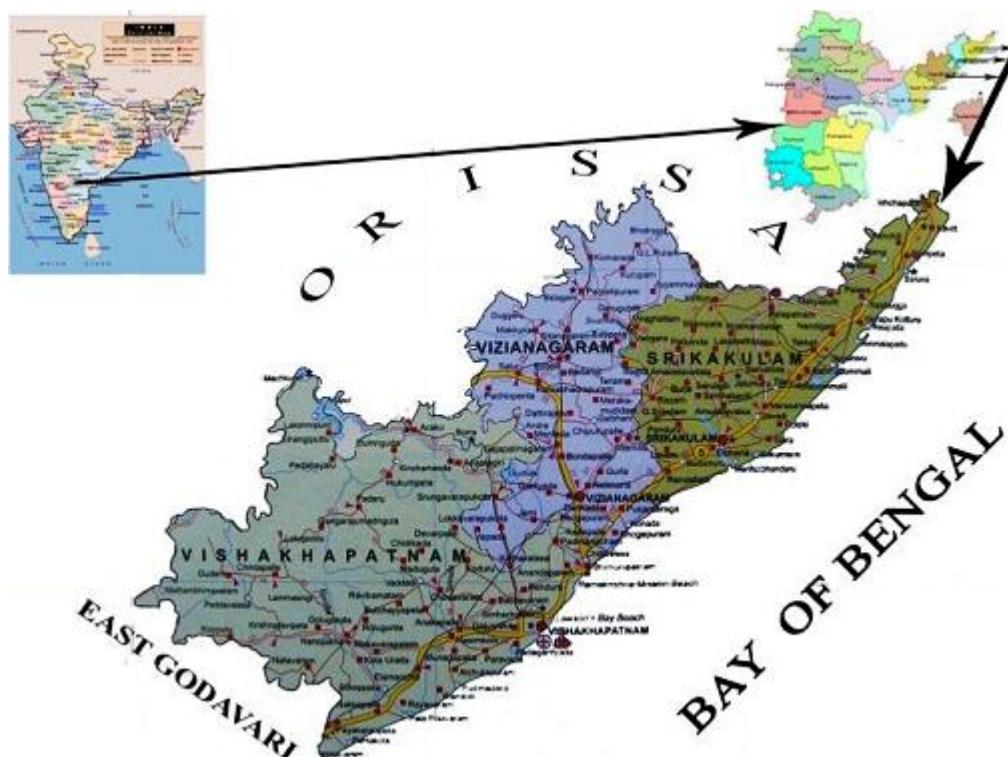
Srikakulam, Vizianagaram and Visakhapatnam districts (Fig-1). The irrigated and rain fed areas of North Coastal Andhra Pradesh with a total area of about 85,2700 hectares is under cultivation from the total geographical area of 23,48,612 hectares of the three districts. The major river systems are Vamsadhara, Nagavali, Janjavathi, Champavathi, Vegavathi, Vattigadda, Gosthani, Sarada, Varaha and Thandava. The soils are red loamy and alluvial. The area is divided into coastal, plain and hilly land areas. The main crops are rice, sugarcane, groundnut, finger millet, sesamum, jowar, bajra and mesta etc. The cultivated fields of the region are infested with a large number of weeds causing heavy losses to crop yield. It is pertinent to note that the presence of weeds in herbaceous crops like rice, sugarcane, groundnut, finger millet, sesamum, jowar, bajra and legume implicit major losses.

### MATERIALS AND METHODS

The present study is aimed to provide an inventory of the arable land weeds of different cultivars. The methodology adopted is as follows.

#### Floristic Studies-Inventory of Weed Flora

**Field Study:** The exploration of the area under study includes the planned field trips to various places for crop weed collection. It was carried out during 2006-09. The random sampling method was adopted for this study to note down the presence of weed species among the crop fields. Several field trips were made to cover the interior villages of various mandals of plain and forest areas. Each field trip includes 5-10 days covering a particular area, during the kharif and rabi seasons. Collections were



**Figure 1. Map of Study area**

made from a wide range of crop fields in plain, forest and coastal areas. Notes were written on habitat, habit, flower colour, aroma, associated plants, abundance and general distribution.

**Identification of Specimens:** After completing the weed collection from the crop fields the specimens were identified by comparing with the authentic certified specimens at the Andhra University Herbarium, Department of Botany and Central National herbarium (CAL) Howrah (for some grasses). Later these identifications were checked again at the regional Herbarium or in the laboratory with the help of floras, monographs and other relevant literature and the correct name was provided to each plant. Each plant was critically studied and identified using the Flora of British India (Hooker, 1872-1897), Flora of Presidency of Madras (Gamble, 1915-1936). The grasses of Burma, Ceylon, India and Pakistan (Bor, 1960), Forest flora of Andhra Pradesh (Reddy *et al.*, 1991), Flora of Andhra Pradesh (Pullaiah and Chennaiah 1997) and district floras of Srikakulam (Rao and Hara Sriramulu, 1986) and Visakhapatnam (Subba Rao and Kumari, 2002). Vizianagaram (Venkaiah, 2004). As far as possible the correct and currently accepted botanical names were

used. Nomenclature of each species was updated as per the rules given in International Code of Botanical Nomenclature.

## RESULTS AND DISCUSSION

In the present study, a total of 532 plant species belonging to 308 genera and 80 families were identified as crop land weeds. Of these 382 are dicots, 149 monocots and one pteridophyte. The taxonomic categorization of weed species is presented in Table 1. These species are recorded exclusively from the cultivated fields of herbaceous crops. The fruit crop fields surveyed randomly indicates that there is no presence of any additional species. Since weed impact on tree crops is negligible therefore no special emphasis was made. The present investigation also included plants found in field edges. The predominant weeds of this category are *Cissampelos pareira* (Menispermaceae), *Cissus quadrangularis* (Vitaceae), *Dodonaea viscosa* (Sapindaceae), *Opuntia spp* (Cactaceae), *Clerodendrum spp* (Verbenaceae), *Dioscorea spp* (Dioscoreaceae) and *Calamus rotung* (Arecaceae).

### Weed Families and Genera

The total weed families recorded in the present study are 80 (Table 1). Out of these 26 were monotypic; Nineteen were dicots families viz., Papaveraceae, Fumariaceae, Brassicaceae, Violaceae, Elatinaceae, Zygophyllaceae, Vitaceae, Crussulaceae, Passifloraceae, Begoniaceae, Apiaceae, Plumbaginaceae, Primulaceae, Menyanthaceae, Hydrophyllaceae, Cuscutaceae, Nyctaginaceae, Chenopodiaceae and Lauraceae and six are monocot families viz., Hydrocharitaceae, Smilacaceae, Arecaceae, Typhaceae, Alismataceae and Euriocalaceae and one Pteridophyte, Marsileaceae.

The first 15 largest families with more than 10 species are presented in Table 2. Poaceae is the largest representing 73 species followed by Fabaceae (50), Asteraceae (33), Acanthaceae(28), Euphorbiaceae (22), Cyperaceae (21), Rubiaceae (19), Lamiaceae (17), Convolvulaceae (16), Malvaceae (14), Amaranthaceae (12), Commelinaceae (12), Asclepiadaceae (11), Scrophulariaceae (11) and Solanaceae (10).

Grasses and sedges (94) represent 17.67% of the total weed flora of the region. The first five largest families represent 38.72% of the total weed species. A focus on grasses and legumes, the important components of weeds in terms of their gregarious growth in crop fields in both dry and irrigated fields indicated that they cover 23.12% of the total weeds. Seven weed families are represented by more than ten genera. Poaceae is the largest family with 45 genera followed by Asteraceae (30), Fabaceae (18), Acanthaceae (18), Euphorbiaceae (10), Rubiaceae (10), and Lamiaceae (10). Twenty genera represent more

than five species. The largest genus is *Crotalaria* with 11 species followed by *Ipomoea* (9), *Indigofera*, *Cassia* and *Eragrostis* each with 8 species; *Solanum*, *Dioscorea* and *Cyperus* each with 7 species, *Hedyotis* with six ; *Cleome*, *Corchorus*, *Tephrosia*, *Ludwigia*, *Heliotropium*, *Merremia*, *Leucas*, *Ocimum*, *Polygonum* and *Phyllanthus* each with 5 species.

### Longevity and Life-Forms

Out of 532 species 396 are herbs, 36 undershrubs, 51 shrubs and 49 falls under climbing category. The analysis on life span of the weeds of cultivated fields region revealed that 61.84% (329 species) are annuals and 38.16% (203 species) are perennials. The longevity and life-forms of the weeds category-wise are presented in Table 3. It is interesting to note that monocots are equally divided in terms of longevity. Pertaining to grasses 32 species are annuals and 41 are perennials. Sedges are also following the same pattern: 13 are annuals and 8 are perennials. Of the remaining monocots, 27 are annuals and 28 perennials.

### New Distributional Record

*Solanum sisymbriifolium* L. was identified as new distributional record to Andhra Pradesh.

### District -Wise Analysis of Weeds

The present study on the weed flora of North Coastal Andhra Pradesh pertaining to individual districts has revealed interesting results. Of the 532 species recorded Visakhapatnam district harbours 513 ranking first among the three districts. This may be attributed

**Table 1. Analysis of weed species**

Traditional plant group	Families	Genera	Species
<b>Dicotyledons</b>			
Polypetalae	32	76	152
Gamopetalae	20	113	181
Monochlamydeae	9	27	49
<b>Monocotyledons</b>	18	91	149
<b>Pteridophytes</b>	1	1	1
<b>Total</b>	<b>80</b>	<b>308</b>	<b>532</b>

**Table 2. Largest weed families**

S.No	Name of the family	No. of species	No. of genera	% species to the total weed flora
1	Poaceae	73	45	13.90
2	Fabaceae	50	18	9.39
3	Asteraceae	33	30	6.20
4	Acanthaceae	28	18	5.26
5	Euphorbiaceae	22	10	4.13
6	Cyperaceae	21	9	3.94
7	Rubiaceae	19	10	3.57
8	Lamiaceae	17	10	3.19
9	Convolvulaceae	16	3	3.00
10	Malvaceae	14	7	2.63
11	Amaranthaceae	12	9	2.25
12	Commelinaceae	12	5	2.25
13	Asclepiadaceae	11	9	2.07
14	Scrophulariaceae	11	7	2.07
15	Solanaceae	10	3	1.88

to large geographical area and vast coverage of rain fed crop fields. Srikakulam district is presently known to encounter 452 weed species followed by Vizianagaram with 438 species. A maximum of 62 species are exclusively found in the fields of Visakhapatnam district, 6 in Vizianagaram district and 5 in Srikakulam district. A total of 408 weed species are commonly present in all the three districts.

#### **Area -Wise Distribution of Weed Species**

The plain area harbours 185 species (34.8%), followed by hilly area with 144 species (27.1%), hilly and plain area with 128 species (24.1%), hilly, plain and coastal areas with 47 species (8.83%), plain and coastal with 26 species (4.89%) and coastal area with only 2 species (0.376%) (Fig.2)

#### **Crop-Weed Association**

Critical analysis has been made regarding the weeds encountered with reference to five major crops viz., rice, sugarcane, groundnut, finger millet and sesamum. Further the weed species common to different crop combinations were also analyzed. The analysis of the distribution pattern of weed species encountered with respect to different crop fields are presented in Table 4.

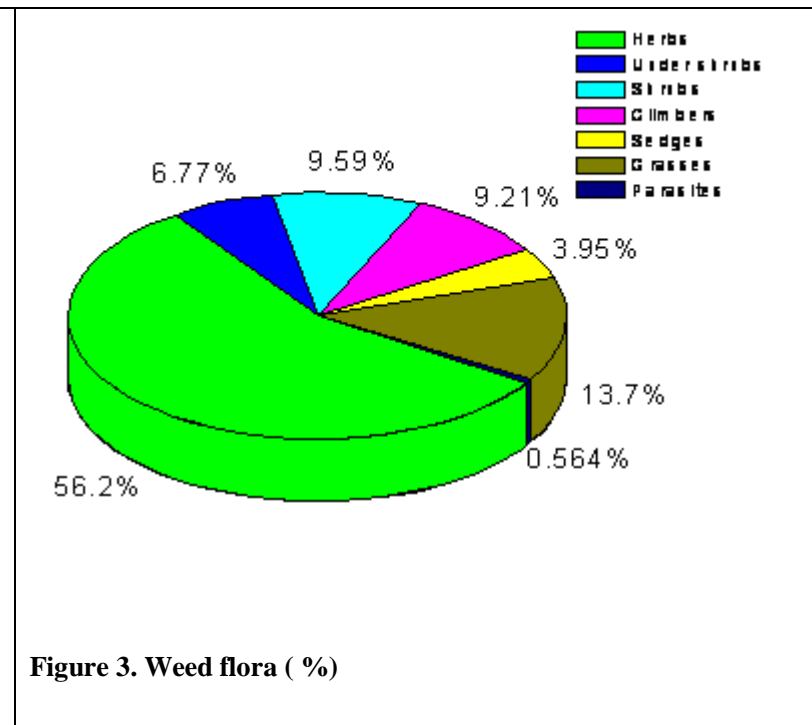
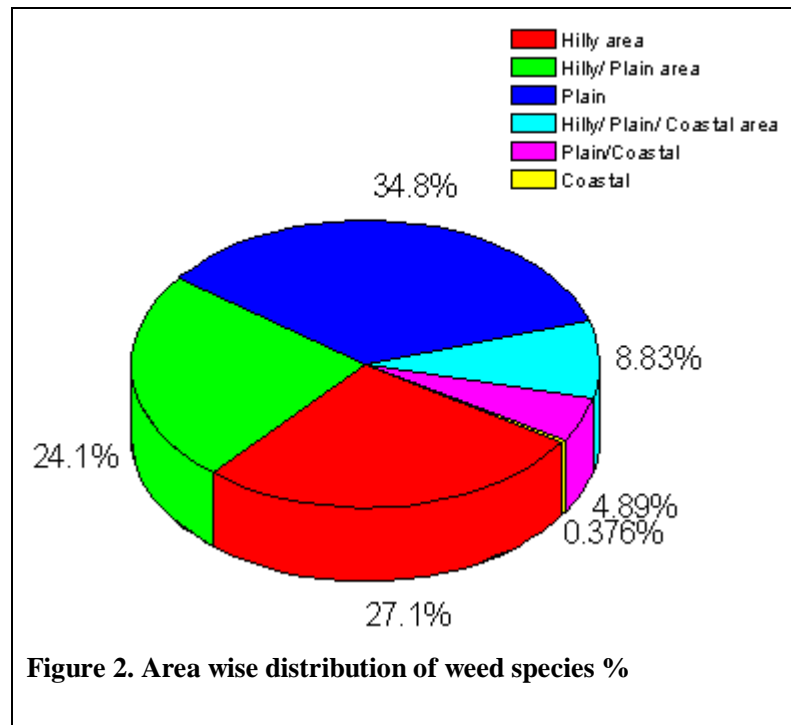
#### **Weeds Common to All Crops**

Of the 532 weed species, 325 were found in all crop fields. Of these 152 species were common in distribution, 135 were occasional and 38 were seen rarely.

Out of total of 532 weed species reported 300 were herbs (56.2%), 36 undershrubs (6.77%), 51 shrubs (9.59%), 49 climbers (9.21%), 21 sedges (3.95%), 73 grasses (13.7%) and 3 parasites (0.564%) (Fig. 3)

#### **Common Weeds in Major Crops**

Of the five major crops rice and sugarcane are irrigated and groundnut, finger millet and sesamum are dry crops. Rice fields harboured exclusively 68 weed species of which 23 were common. *Echinochloa crusgalli*, *Dentella repens*, *Bacopa monnieri*, *Fimbristylis miliacea*, *Panicum repens* and *Polygonum barbatum* are dominant among them. *Marsilea quadrifolia* is the only pteridophyte commonly infested in rice fields. Thirty three species were occasional including *Ludwigia octovalvis*, *Portulaca quadrifolia*, *Ottelia alismoides*, *Basilicum polystachyaon*, *Lindernia ciliata* and *Monochoria vaginalis*. *Ludwigia adscendens*, *Hydrolea zeylanica*, *Limnophylla indica*, *Lindernia parviflora*, *Pistia stratiotes* and *Fimbristylis bisumbellata* were rare.



**Table 3. Life form and longevity categories of weeds**

Group	Longevity		Life-forms			
	Annuals	Perennials	Herbs	Undershrubs	Shrubs	Climbers
<b>Dicotyledons</b>						
Polypetalae	96	56	88	25	15	24
Gamopetalae	124	57	132	7	29	13
Monochlamydae	37	12	37	3	6	3
<b>Monocotyledons</b>						
Grasses	32	41	73	-	-	-
Sedges	13	8	21			
Others	27	28	44	1	1	9
<b>Pteridophytes</b>		1	1	-	-	-
Total	329	203	396	36	51	49

**Table 4. Analysis of crop-wise distribution pattern of weed species**

Crop category	Common	Occasional	Rare	Total
All fields	152	135	38	325
<b>Major crops</b>				
Rice	23	33	12	68
Sugar cane	28	19	9	56
Ground nut	11	9	5	25
Finger millet	10	20	5	35
Sesamum	7	12	4	23

In sugarcane crop, a total of 56 weed species were exclusively recorded. Of these 28 were common including *Cardiospermum halicacabum*, *Clitoria ternatea*, *Coccinia grandis*, *Centella asiatica*, *Sphaeranthus indicus*, *Merremia gangetica* and *Indoneesiella echioides*. Nineteen species are occasional including *Cocculus hirsutus*, *Cleome chelidonii*, *Passiflora foetida*, *Heliotropium indicum*, *Physalis minima*, *Cymbopogon coloratus* and *Digitaria ciliaris*. *Emilia sonchifolia*, *Wattakaka volubilis*, *Ipomoea pestigridis*, *Merremia hederacea* and *Digitaria sanguinalis*

In the groundnut fields, a total of 25 weed species were exclusively recorded. Of these 11 were common including *Gisekia pharnaceoides*, *Evolvulus nummularius*, *Digera muricata*, *Goniogyna hirta* and *Indigofera aspalathoides*. Nine species are occasional including *Cleome aspera*, *Corchorus aestuans*, *Martynia annua* and *Ocimum gratissimum*. *Alysicarpus*

*buplueurifolius*, *Mollugo cerviana*, *Blainvillea acmella*, *Grangea maderaspatana* are rare.

In the fingermillet crop, a total of 35 weed species were exclusively recorded. Of these, 10 species are common including *Sida cordata*, *Zaleya decandra*, *Euphorbia indica* and *Cyanotis cristata*. Twenty species were occasional including *Citrullus colocynthis*, *Mollugo disticha*, *Heliotropium curassavicum* and *Cyperus pilosus*. Five species viz., *Hedyotis gracilis*, *Hedyotis nitida*, *Rostellularia prostata* and *Eragrostis riparia*. were rare.

In the sesamum crop, a total of 23 weed species were exclusively recorded. Of them seven species are common including *Malvastrum coromandelianum*, *Atylosia volubilis*, *Acanthospermum hispidum* and *Fimbristylis cymosa*. Twelve species were occasional including *Pavonia odorata*, *Crotalaria ferruginea*, *Justicia glauca* and *Luecas stricta*. Four species are rare including *Drymaria cordata*, *Indigofera trifoliata*, *Hedyotis pumila*

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and *Thecagonum biflorum*. The exclusive weed species of major crops were categorized into different life-forms such as herbs, undershrubs, shrubs, climbers, sedges and grasses.

#### **Rice (*Oryza sativa*) fields**

Sixty eight weed species were found exclusively in the rice fields of the study area during kharif season. All (47 herbs, 2 undershrubs, 1 shrub, 1 climber, 4 sedges and 13 grasses) of them were found in the Visakhapatnam district alone. Sixty species each were found in Vizianagaram (42 herbs, 1 under shrub, 1 shrub, 1 climber, 4 sedges and 12 grasses) and Srikakulam (39 herbs, 1 undershrub, 1 shrub, 1 climber, 4 sedges and 14 grasses) districts. Forty four weed species were found exclusively during rabi season. Of these 42 (28 herbs, 2 under shrubs, 1 shrub, 1 climber, 2 sedges and 8 grasses) were found in the Visakhapatnam district, 41(27 herbs, 1 under shrub, 1 shrub, 1 climber, 3 sedges and 8 grasses) each in Vizianagaram and Srikakulam (26 herbs, 1 undershrub, 1 shrub, 1 climber, 3 sedges and 9 grasses) districts.

#### **Sugarcane (*Saccharum officinarum*) fields**

Of the 56 weed species 54 were found exclusively in Vizianagaram district (38 herbs, 4 under shrub, 4 shrub, 6 climbers and 2 grasses) followed by 53 each in Visakhapatnam (37 herbs, 3 under shrubs, 4 shrubs, 6 climbers and 3 grasses) and Srikakulam (37 herbs, 4 undershrub, 4 shrub, 6 climbers and 2 grasses) districts were found.

#### **Groundnut (*Arachis hypogaea*) fields**

During kharif season 25 weed species each were found in both Visakhapatnam (18 herbs, 4 under shrubs, 1 shrub, 1 climber and 1 grass) and Srikakulam districts 24 (17 herbs, 4 under shrub, 1 shrub, 1 climber and 1 grass) in Vizianagaram district. During rabi season 18 weeds species were found. Of these 15 each and (10 herbs, 2 under shrubs, 1 shrub, 1 climber and 1 grass) were found in Visakhapatnam and Vizianagaram (9 herbs, 3 under shrub, 1 shrub, 1 climber and 1 grass) districts. In Srikakulam 16 (herbs 11, 2 undershrubs, 1 shrub, 1 climber and 1 grass) were found.

#### **Fingermillet (*Eleusine coracana*) fields**

During kharif season 35 weed species were found. Of these 33, 30 and 29 were found in Visakhapatnam (25 herbs, 3 under shrubs, 1 shrub, 1 climber, 1 sedges and 2 grasses), Srikakulam (22 herbs, 3 undershrubs, 1 shrub, 1 climber, 1 sedges and 2 grasses) and Vizianagaram (21 herbs, 3 under shrub, 1 shrub, 1 climber, 1 sedges and 2 grasses) districts respectively. During rabi season the number of weed species decreased (26) and 23, 22 and

21 were found in Visakhapatnam (16 herbs, 2 under shrubs, 1 shrub, 1 climber, 1 sedges and 2 grasses), Vizianagaram (15 herbs, 2 under shrubs, 1 shrub, 1 climber, 1 sedges and 2 grasses) and Srikakulam (14 herbs, 2 undershrubs, 1 shrub, 1 climber, 1 sedges and 2 grasses) districts respectively.

#### **Sesamum (*Sesamum orientale*) fields**

The number of weed species found, were less in this crop (23) during kharif season. Of these 21 (18 herbs, 2 climbers and 1 sedge) were found in the Visakhapatnam followed by 17 (14 herbs, 1 under shrub, 1 climber and 1 sedge) in Vizianagaram and 16 (14 herbs, 1 sedge and 1 climber) in Srikakulam districts. During rabi season of the 15 weed species 13 (11 herbs, 1 climber and 1 sedge) were found in Visakhapatnam district, 12 (9 herbs, 1 under shrub, 1 climber and 1 sedge) in Vizianagaram and 10 (8 herbs, 1 sedge and 1 climber) in Srikakulam districts.

Of the 2,50,000 plant species in the world about 6700 weed species of flowering plants are recorded in different agro ecosystems of the world (Holm *et al.*, 1977) of which 715 are present in Andhra Pradesh. It has been argued in the literature that of the 30, 000 species considered as weeds world wide and 50-200 of them may considerably damage. Majority of food crops of with 76 weeds categorized as the worlds worst weeds (Holm *et al.*, 1977). Ten species causing heavy crop losses including *Cyperus rotundus*, *Echinochloa crus-galli* and *Imperata cylindrica* were found in the present study area and occur in common crop fields.

Of all the 532 weed species, 396 are herbs, 36 undershrubs, 51 shrubs and 49 are climbers. Analysis on the life span of the weeds of cultivated fields shows that 329 species (about 61.84% of the total species) are annuals and 203 (about 38.16%) perennials. In the studies on the phenological behaviour of the weeds of major crops of western Uttar Pradesh, (Sudhir Kumar and Singh, 1994) recorded 128 weeds of which 90% are annuals.

Majority of the weed species noted in this work have found a place among the agrestals recorded as common weeds in Andhra Pradesh and India general (Tadulingam and Venkata Narayana 1932; Chandra Singh and Narayana Rao, 1973; Sen 1981; Rao, 1986)

A critical study on the Flora of Andhra Pradesh (Pullaiah *et al.*, 1997) revealed the presence of 715 taxa as weeds in the crop fields of the state. The crop land weeds of the study area comprise 532 species (74.4%) of the total weeds that are encountered in the Andhra Pradesh state crop fields. Of the 284 total grass species recorded from the state, 73 (25.7%) are recorded from the fields of



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North Coastal Andhra Pradesh alone (Lakshmaiah, 2006) reported 508 weed species in the Rayalaseema region comprising 71% of total Andhra Pradesh weeds. *Parthenium hysterophorus*, *Cyperus rotundus*, *Cynodon dactylon*, *Tridax procumbens*, *Euphorbia hirta*, *Echinochloa crus-galli*, *Wolfia globosa* are the heavily infesting weeds of the crop fields.

A total of 124 weed species are exclusively recorded in the major irrigated crops rice and sugarcane. Rice fields harbours exclusively 68 weed species of which 23 are common species viz., *Echinochloa crus-galli*, *Cyperus rotundus*, *Bacopa monnieri*, *Fimbristylis miliacea*, *Panicum repens*, *Polygonum barbatum*, *Phyla nodiflora*, *Eclipta prostrata*, *Dentella repens* etc. Of these *Echinochloa* and *Cyperus* species are most noxious in rice fields (Shetty *et al.*, 1975).

Of the 56 weed species in sugarcane fields 28 are common viz., *Cardiospermum halicacabum*, *Clitorea ternatea*, *Coccinia grandis*, *Centella asiatica*, *Sphaeranthus indicus*, *Merremia gangetica*, *Indoneesiella echioides*, *Mimosa pudica*, *Sida cordifolia*, *Spermacoce hispida* etc. (Adishesu, 1997) reported 32 species of weeds in the sugarcane fields of Anakapalli.

The results obtained regarding the taxonomy of weeds have clearly established the fact that the weed diversity in this region is high and significant. A thorough perusal of literature pertaining to other weed floras of different regions of Andhra Pradesh and India in general has also revealed the high concentration of weeds in the study area when compared to other regions. In Rayalaseema region 508 weed species were reported by (Lakshmaiah, 2006) which include 89 weed species in all dry crops and 46 in groundnut crop in Agrestals of Rayalaseema region. (Pullaiah, 1997) reported a total of 715 weed species in Andhra Pradesh state.

It is well known that weed competition in the food crops is one of the major causes of low productivity and therefore it become essential to protect the crop from the weed infestation. Most of the crops infested with heavy weeds during the irrigation period and due to the adequate supply of nutrients. These factors like irrigation and supply of nutrients causes enormous growth of weeds. During this period their uptake of water and nutrients will be high and competition with the crop will be expected to be high. Based on the data of the number of species in vegetative phase, it is suggested to remove the entire weed flora in 30 to 60 days intervals after sowing. The documentation of the weed flora in North Coastal Andhra Pradesh (NCAP) has brought valuable information on weed flora of Andhra Pradesh. The

present information on the distribution of various weed species in different crop fields of the three districts is an important investigation and has an applied significance in effective weed management and crop yield improvement process. The weed flora work at regional level would be of good source of information on technical and taxonomic data.

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