WEEDS IN SUGARCANE FIELDS

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One of the most important aspects of successful weed control is a knowledge of weed species and the reservoir of viable weed seeds present in the soil. Sugarcane in Thailand is cultivated in the following four widely dispersed regions: the Central, Northeastern, Western and Eastern, and weed species common throughout these regions were surveyed first. The floristic composition of weed populations is known to be influenced not only by geographical factors but also by changes in environmental conditions and cultivation practices. Therefore, seasonal and annual shifts in weed populations were also determined.

Another important factor which regulates actual weed populations is the seed reservoir in the soil, so the amount of viable weed seeds in the surface layer of the soil was also estimated.

1. Survey of Common Weed Species

Weed species in sugarcane fields were surveyed during cane growing seasons, from May to November in each year from 1986 to 1988. Observations were made in 30 randomly placed quadrats (1.0 x 1.0 m), 5 km apart. Percentage frequency was calculated by the following equation:

$$\text{Frequency} = \frac{\text{No. of quadrats where the species is present}}{\text{Total number of quadrats}} \times 100$$

Conventional weed control practices and the environmental situation in the observation areas were determined using a questionnaire sent to both farmers and extensionists.

Weed species whose frequency values were 50% or more are shown in Table 1 and were viewed as common weeds. Twenty broadleaves, 16 grasses and 4 sedges belonging to 16 families are listed. Some annual weeds which complete their life cycles only within 45-60 days were also common in sugarcane fields, although their frequency was less than 50% in each location and they are not listed in Table 1.

The results are also discussed from some points of view of weed control practices and environmental situations based on information obtained through the questionnaires.

1) Variation of soil type, moisture and fertility of soil in the four regions where sugarcane is planted seem to affect weed species and the density of distribution. In the Northeastern and Eastern regions where the soil type is sandy loam low in organic matter and poor in soil moisture, although the species present were similar to those in the Central and Western regions, they were less abundant. Drought susceptible species such as *Alternanthera frutescens, Commelina benghalensis* and *Tribulus terrestris* were found at less than 50% and disappeared altogether at some observation points. In areas of low soil moisture content, the drought tolerant perennial weeds *Paederia foetida, Cynodon dactylon* and drought tolerant annual weeds *Amaranthus viridis* and *Chloris barbata* were more frequent than in other areas.

2) Some weed species seem to adapt to all soil types. *Cyperus rotundus, Eleusine indica, Dactyloctenium aegyptium, Echinochloa colona, Digitaria ciliaris, Leptochloa chinensis, Pennisetum pedicellatum* and *Pennistum polystachyon* were found in all areas observed. However, they were quite susceptible to shading and were found only in the early stage of cane growing before the cane canopy covered them. During the mature stage of cane, these weeds thrive at the edge of the fields where there is more light, being replaced by the shade tolerant species *Ageratum conyzoides, Commelina benghalensis, Jussiaea linifolia* and *Passiflora foetida* in the field.

3) Weed flora can also change itself with the

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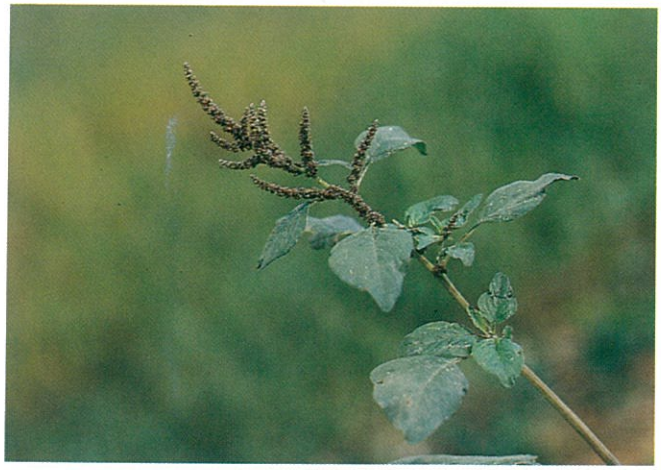
Trianthema portulacastrum L.

Alternanthera frutescens R.Br.



Amaranthus viridis L.

Ageratum conyzoides L.

Tridax procumbens L.

Euphorbia geniculata

Figure 1. Some weeds in sugarcane fields

Euphorbia hirta L.

Cenchrus echinatus L.

Digitaria ciliaris (Retz.) Koel.

Echinochloa colona L. (Link.)

Eleusine indica (L.) Gaertn.

Tribulus terrestris L.

Figure 1. (cont.)Some weeds in sugarcane fields

Table 1. Weed Species in sugarcane fields in four different regions.

Family	Species	Region			
		Central	Northeastern	Western	Eastern
Aizoaceae	*Trianthema portulacastrum*	x	x	x	x
	Molugo pentaphylla	x	x	x	x
	Amaranthaceae	-	-	x	-
	Alternanthera frutescens	x	x	x	x
	Amaranthus spinosus	x	x	x	x
	Amaranthus viridis	x	x	x	x
Compositae	*Ageratum conyzoides*	x	x	x	x
	Tridax procumbens	x	x	x	x
Convolvulaceae	*Ipomoea gracilis*	x	x	x	x
	Merremia tridentata	x	x	x	x
Euphorbiaceae	*Euphorbia geniculata*	x	x	x	x
	Euphorbia hirta	x	x	x	x
Labiatae	*Hyptis sauveolens*	x	x	x	x
Malvaceae	*Abutilon indicum*	x	x	x	x
	Nyctaginaceae	x	x	x	x
Onagraceae	*Jussiaea linifolia*	x	x	x	x
Passifloraceae	*Passiflora foetida*	x	x	x	x
Rubiaceae	*Paederia foetida*	x	x	x	x
Sterculiaceae	*Melochia corchorifolia*	x	x	x	x
Tiliaceae	*Corchorus aestuans*	x	x	x	x
Commelinaceae	*Commelina benghalensis*	x	x	x	x
Gramineae	*Brachiaria distachya*	x	x	x	x
	Brachiaria reptans	x	x	x	x
	Cenchrus echinatus	x	-	x	x
	Chloris barbata	x	x	x	x
	Cynodon dactylon	x	x	x	x
	Dactyloctenium aegyptium	x	x	x	x
	Digitaria ciliaris	x	x	x	x
	Echinochloa colona	x	x	x	x
	Eleusine indica	x	x	x	x
	Eragrostis tenella	x	x	x	x
	Leptochloa chinensis	x	x	x	x
	Pennisetum pedicellatum	x	x	x	x
	Pennisetum setosum	x	-	-	x
	Rhynchelytrum repens	x	-	x	x
	Rottboellia exaltata	-	x	x	-
Zygophyllaceae	*Tribulus terrestris*	x	-	x	x
Cyperaceae	*Bulbostylis barbata*	x	x	x	x
	Cyperus iria	x	x	x	x
	Cyperus rotundus	x	x	x	x
	Fimbristylis miliacea	x	x	x	x

continuous use of herbicides. Gradual elimination of species susceptible to certain herbicides results in the survivors becoming dominant.

2. Seasonal and Annual Population Shifts

The study was carried out in a Suphan Buri sugarcane planting area located in the Western region where the soil type is heavy clay loam and average annual rainfall is 1,027 mm. Heavy rain usually occurs from June to October, while soil.moisture from December to April is low. In 1975 observations were made on 16 hectares of fields in three different periods: December to April (dry season), May to August (rainy season) and September to November (late rainy season). Density, percentage frequency and biomass (dry weight/plant) of each species were determined at 25 randomly placed permanent quadrats (1.0x1.0 m) during each season. Percentage frequency of weed distribution was calculated by the same algebraic equation as described in 1.

In 1985 the same observations during the three periods were made to determine changes in weed populations from 1975.

As shown in Figure 2, the frequency of the species *Ageratum conyzoides, Amaranthus viridis, Dactyloctenium aegyptium, Eleusine indica* and *Cyperus rotundus* was over 90% in the rainy season. Species present in moderate frequency were *Trianthema portulacastrum, Brachiaria distachya, Echinochloa colona* and *Leptochloa chinensis.*

During the late rainy season (September to November), which is generally the maturation period of cane, an alternation in the dominant weed species was observed. Some species completed their life cycles and died, while others such as *Mollugo pentaphylla, Hyptis sauveolens, Chloris barbata* and *Rhynchelytrum repens* appeared to become dominant. These latter species seemed to be more adaptable to low humidity judging from their increased freqency during the dry season (December to April). In the rainy season, however, sedges were more frequent than grasses and broadleaves, while in the dry season grasses seemed more tolerant to a drought condition than broadleaves or sedges (Figure 3).

Dry weight of individual weed plants is shown in Figure 4. In the dry season, weeds tended to have less dry weight than in the late rainy and rainy seasons. However, some species had higher dry

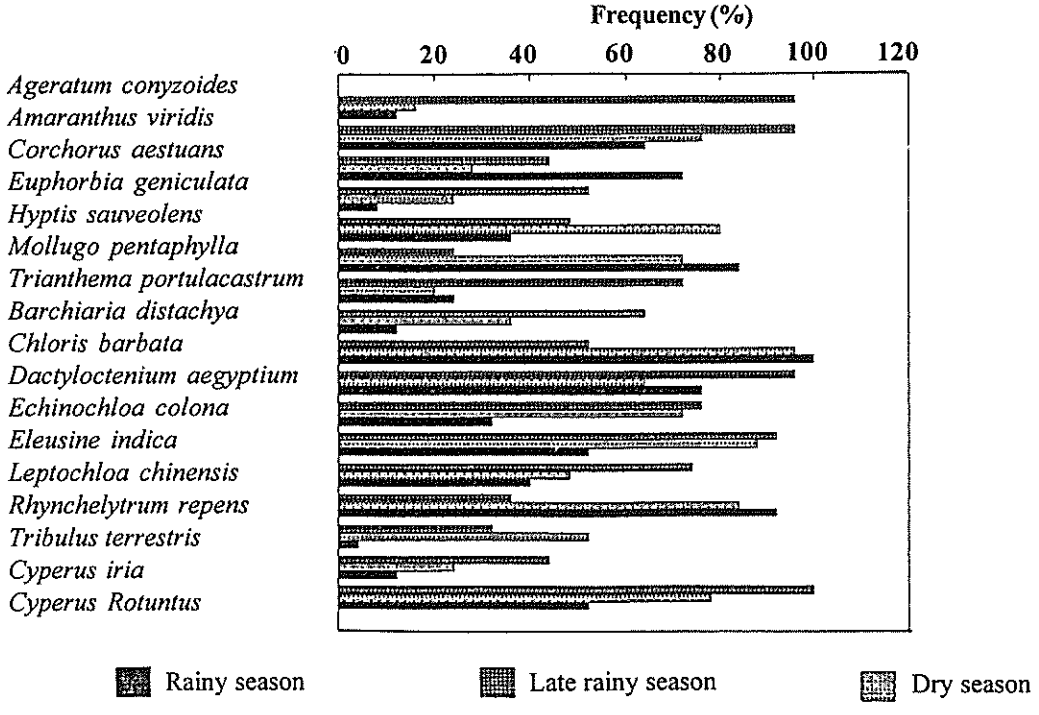


Figure 2. Frequency of weed species in different seasons (Suphanburi, 1975)

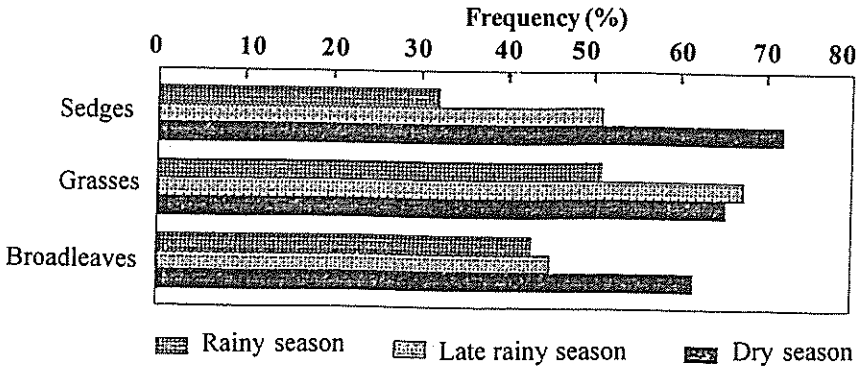


Figure 3. Average percent frequency of distribution of broadleaves, grasses and sedges in different seasons (Suphan Buri, 1975).

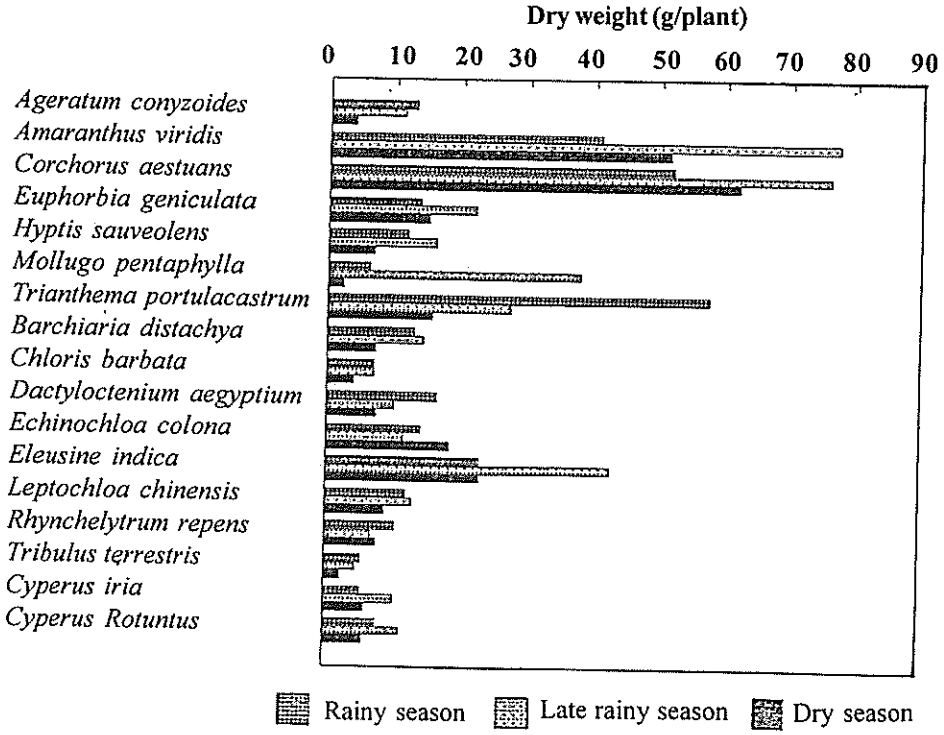


Figure 4. Dry weight of weed species in different seasons (Suphan Buri, 1975).

weight in the dry season than in the rainy season because of continuous growth form rainy season to dry season. Such deep-rooted species as *Amaranthus viridis* may actually be resistant to a drought condition.

In Suphan Buri in 1975, the frequency of grasses, broadleaves and sedges was 61.3, 51.7 and 49.9%, respectively, although biomass in dry weight was highest in grasses followed by broadleaves and was lowest in sedges (Table 2). This suggests that the grass weeds are a very serious problem but the sedges are not as important in cane cultivation.

Observations in 1985 (Table 4) revealed that dominant weed species shifted from grasses to sedges. *Cyperus rotundus* was found in 100.0% frequency with a density of 18.9 plants/m^2 compared with the 81.3% and 89.7% frequency and 10.6 and 8.2 plants/m^2 density of *Eleusine indica* and

Table 2. Average percentage frequency, density and dry weight of weed distribution in the year 1975.

Weed classification	Frequency (%)	Density (plants/m^2)	Weed dry weight (kg/ha)
Broadleaves	49.9	13.2	3,108.4
Grasses	61.3	33.2	4,509.0
Sedges	51.7	7.5	597.6
Total	-	53.9	8,215.0

Table 3. Average percentage frequency, density and dry weight of weed distribution in the year 1985.

Weed classification	Frequency (%)	Density (plants/m^2)	Weed dry weight (kg/ha)
Broadleaves	83.3	8.2	2,445.0
Grasses	87.5	33.9	8,544.0
Sedges	100.0	18.9	1,399.0
Total	-	61.0	12,388.0

Table 4. Comparison of average frequency and density of individual weed observations in 1975 and 1985.

Weed species	Frequency (%)		Density (plants/m^2)	
	1975	1985	1975	1985
Ageratum conyzoides	41.3	52.7	2.1	1.2
Amaranthus viridis	78.7	73.7	2.4	2.3
Corchorus aestuans	48.0	26.3	1.1	0.4
Euphorbia geniculata	28.0	37.7	1.3	1.8
Hyptis sauveolens	54.7	29.7	1.5	0.4
Mollugo pentaphylla	60.0	36.0	3.9	0.5
Trianthema portulacastrum	38.7	42.7	0.9	1.6
Brachiaria distachya	37.3	38.7	1.6	2.3
Chloris barbata	82.7	57.3	8.2	5.1
Dactyloctenium aegyptium	78.7	89.7	4.6	8.2
Echinochloa colona	60.0	67.0	2.4	4.4
Eleusine indica	77.3	81.3	7.4	10.6
Leptochloa chinensis	54.0	53.3	2.3	3.0
Pennisetum spp.	21.4	54.7	1.8	2.6
Cyperus rotundus	76.7	100.0	7.2	18.9

Dactyloctenium aegyptium, respectively. Although sedges tended to increase in percentage frequency, grasses continued to show higher potential coverage than either broadleaves or sedges based on density and biomass (Table 3).

These results can be explained as follows:

1) Frequency, density and biomass of weed species shift, according to climatic changes within a year and over a period of years.

2) The highest frequency does not always mean the dominance of a species ; density and biomass per area are more essential concerns.

3) Distribution of a weed species and its density increase may depend upon environmental factors and the weed control practices employed.

4) Weed quantity expressed as average density and biomass increased for the ten years from 1975 to 1985 : 53.9 plants/m^2 and 8,215 kg/ha in 1975, and 72.8 plants/m^2 and 12,388 kg/ha in 1985 (Tables 2 and 3).

5) From 1975 to 1985, main weed species in the Suphan Buri sugarcane field shifted from common annuals to vigorous annuals and the new threatening perennials *Pennisetum* spp. and *Cyperus rotundus*.

3. A Survey of Seed Bank

Weed seed populations in soil were investigated from November, 1986 to March, 1987. Soil samples of 0.24 x 0.30 m and 5 cm deep were collected at 10 points in a Suphan Buri sugarcane field. This area was heavily infested, the main weeds being *Dactyloctenium aegyptium, Eleusine indica, Echinochloa colona, Pennisetum polystachyon* and some broadleaved species. All the soil collected was mixed, air-dried indoors for two days and placed in plastic boxes (0.24 x 0.30 m). The boxes were watered daily to maintain adequate moisture, and were placed in a greenhouse where the average temperature was 30°C. The number of seedlings was recorded 1, 2, 3, 4 and 5 weeks after the start of the experiment. Weed species were identified in the fifth week.

In Table 5 the number of viable seeds per area of soil collected is expressed in terms of the number of emerged seedlings. Seedling numbers in each plot successively increased on an average of 711, 944, 1,035, 1,064 and 1,106 seedlings/m^2 when measured at the end of 2, 3, 4 and 5 weeks. The viable weed seeds in a sugarcane field to a depth of 5 cm were thus estimated to be more than 11,005,000 seeds/ha.

Primary weed species identified the fifth week are illustrated in Table 6. Seedlings of each species were arranged in the order of their average number: 48.6, 43.0, 27.8, 26.4 and 20.8 seedlings/m^2 for the species of *Dactyloctenium aegyptium, Eleusine indica, Ageratum conyzoides, Pennisetum* spp. and *Trianthema portulacastrum,* respectively. Seedlings of more than 45 other species were also found in the boxes. The number of seeds in this trial was dramatically less than either the report by Cook (1980) in which 7,600 seeds/m^2 were found in tropical crop fields, or that by Kellman (1987) where viable seed density was recorded as 9,800 and 12,960 seeds/m^2 in a corn field and pasture, respectively.

Table 5. Amount of viable seeds in soil collected from a Suphan Buri sugarcane field, estimated from the number of emerged seedlings.

Timing (weeks) [1]	Number of seedlings [2] per 0.072 m^2
1	51.2
2	68.0
3	74.5
4	76.6
5	9.6

1) Weeks of measurement.
2) Average of 10 replications

Table 6. Number of viable seeds of each species in soil estimated from the number of emerged seedlings over five weeks.

Weed species	Seedlings/m^2
Ageratum conyzoides	27.8
Amaranthus viridis	6.9
Euphorbia geniculata	4.2
Trianthema portulacastrum	20.8
Chloris barbata	13.9
Dactyloctenium aegyptium	48.6
Digitaria ciliaris	22.2
Echinochloa colona	16.6
Eleusine indica	43.0
Pennisetum spp.	26.4

This difference was probably due to ungerminated dormant seeds not being counted in this study.

Not only the environmental requirements of light, soil temperature and soil moisture content but also the collection date may have an essential role in the germination of the viable seeds in soil (Taylorson, 1970). Mechanical cultivation, the conventional tillage used in cane fields may incorporate most weed seeds into a deeper soil layer, thus reducing either the number of viable seeds in the surface soil or the size of the weed seed bank by stimulating seed germination. Furthermore, the successive application of herbicides to complement cultivation practices can drastically reduce the population of weed seeds in soil (Cuthbertson, 1970; Harper, 1977; Edwards, 1980; Roberts and Neilson, 1981).

4. Summary

Weed Species and their distribution throughout the sugarcane cultivated areas were surveyed from 1975 to 1988. At least 20 broadleaves, 16 grasses and 4 sedges belonging to 16 families were compiled and viewed as common weeds.

Variation of soil type, moisture and fertility of soil in the different planting regions seems to affect weed species and the density of distribution. Species such as *Cyperus rotundus, Eleusine indica, Dactyloctenium aegyptium, Echinochloa colona* and *Pennisetum* spp., however can adapt to a wide range of environmental changes and so become the dominant weeds throughout the sugarcane cultivating areas. Most weed species tend to have higher density and biomass per area in the rainy season than in the late rainy and dry season. Weed density and biomass increased from 53.9 plants/m^2 and 8,215 kg/ha in 1975 to 72.8 plants/m^2 and 12,338 kg/ha in 1985. Even though in 1985 the percent frequency of sedges was higher than that of grasses and broadleaves, the potential coverage of grasses was greatest of the three when evaluated by the density and biomass per area.

The seed reservoir in soil is generally the main source of new infestation by annual weeds. Soil collected from a Suphan Buri sugarcane field at the depth of 0-5 cm was tested for the amount of viable seeds, the number was estimated to be 1,106 seeds/m^2 based on the number of emerged seedlings at the end of the fifth week of the emergence period. This number was much smaller than that described in other reports, perhaps because some viable seeds did not emerge because the environment and/or time of collection were not optimal. Conventional tilling practices as well as long term use of herbicides may also be involved, however. This study could be an important first step in understanding the dynamics of weed populations in order to manage them successfully in sugarcane.