PAN Germany
Pestizid Aktions-Netzwerk e.V.

How to Grow Crops without Paraquat

Field Guide

to Non-chemical Management of Grasses, Sedges and Broadleaf weeds

for small scale farmers

Barnyard grass, Bermuda grass, Cogongrass, Crowfoot grass, Crabgrass, Goosegrass, Saramollaagrass, Torpedograss. Globe fringerush, Nutsedge. Arrowleafed monochoria, Black nightshade, Common purslane, Gooseweed, Horseweed, Lambsquarters, Pigweeds, Striga weed, Water hyacinth.

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Pesticide Action Network (PAN) Germany
Hamburg, November 2008

Pesticide Action Network (PAN)

Founded in 1982, the Pesticide Action Network is an international coalition of over 600 citizens groups in more than 60 countries, working to oppose the misuse of pesticides and to promote sustainable agriculture and ecologically sound pest management.

PAN Germany was established in 1984 as part of this global network and has continually been involved in initiatives to reduce the use of hazardous pesticides and to promote sustainable pest management systems on national, European and global levels.

Acknowledgements

First, we want to express our gratitude to the universities and organizations that have given the permission to use their photos for the OISAT project. (For more details see p. 27)

We also wish to thank all the individuals, groups and organizations that have prepared the bases of the most control measures presented in this field guide, may it have been by preserving traditional experience, on field trials, on field research or in the lab.

Last but not least we want to thank KEMI/SENSA who financially contributed to this publication through PAN Asia/Pacific and Misereor for their financial support.

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Hamburg
November 2008

Table of contents

Prologue

Pesticides worth more than 30 billion US dollar are intentionally released into the global environment every year. Many of these pesticides are highly toxic and have immediate adverse effects on human health, wildlife, local food sources such as cattle or fish, beneficial insects and biodiversity. Several of them have chronic effects including cancers, reproductive problems, birth defects, hormonal disruption and damage to the immune system. Impacts come from direct exposure in use, spray drift, washing work clothes used while spraying, home pesticide storage, pesticide dumps, and persistence in the environment. One of these highly problematic pesticides is paraquat.

Paraquat is one of the most widely used chemical herbicides. It is a quick acting compound used to control broad-leaved weeds and grasses. It is also used as a defoliant for cotton and hops (before harvest) and as a desiccant for pineapples, sugarcane, soybeans, and sunflower (after harvest). Trade names of paraquat formulations are Gramoxone, Herbaxon, Cyclone, Total, Weedless, Goldquat, among other 20 or so brand names. It is also available as Paraquat + Diquat and Paraquat + Urea herbicides.

Paraquat is acutely toxic and has serious and irreversible effects if absorbed. Farmers and agricultural workers exposed to paraquat during mixing and spraying often experience both immediate toxic effects and long-term health problems. Short-term health effects among paraquat users include eye injury, nosebleeds, irritation and burns to the skin and other parts of the body. Other symptoms of acute poisoning include nausea, vomiting or pains, and difficulty in breathing, and may develop with a delay of two to three days. Chronic exposure to paraquat can affect the lungs, nervous system or brain, skin and reproduction with possible birth defects. Epidemiological studies link the long-term exposure to low doses of paraquat resulting in decreases in lung capacity. Paraquat was also associated with an increased risk of developing Parkinson's disease.

The continuous use of paraquat makes weeds resistant to it. Examples are Goose grass, Saramollagrass, Black nightshade, Horseweed, Pigweeds, among others. But lots of weeds are in the list which are resistant to herbicides in general. These are the weeds commonly found in agricultural lands and they lessen the crop’s yield as high as 50%.

Pesticide Action Network (PAN) is working towards reducing the overall use and risks of pesticides as well as the dependence on pesticides and to increase support for community-based control over a sustainably produced food supply. PAN is committed, in its projects, strategies and campaigns to place pesticide concerns in the broad political and economic context in ways that will advance the fight against rural poverty and enhance pro-poor development and ethical trade.

PAN aims to help local communities use initiatives to benefit their day-to-day lives. One of the various activities of PAN to detox plant protection and pest management is to call for the global elimination of the use of paraquat and to provide information on alternatives to the use of this toxic pesticide. Paraquat is one of the PAN International "Dirty Dozen" pesticides that must be eliminated worldwide. Agricultural workers unions across the world also have been calling for a ban on paraquat for years.

PAN Germany is part of the international Pesticide Action Network. Being part of this alliance PAN Germany is working on the national, European and international level and is among others

supporting non-chemical pest management on tropical crops that are commonly grown by small landholder farmers through the project *Online Information Service for Non-chemical Pest Management in the Tropics (OISAT)*.

The PAN Germany website www.oisat.org is part of a web-based system to distribute information on non-chemical pest management in the tropics and sub-tropics. The information presented at www.oisat.org is scientifically based and at the same time easy to read. Information provided via www.oisat.org is relevant to small-scale farmers who intend to produce crops using safer and more affordable non-chemical pest management and crop production practices. It provides varied information on how to lower the costs of production based on recommended insect/mites pests, disease, and weeds control methods.

The content of this publication is based on the information provided at www.oisat.org. It enables to provide farmers with practical guides to avoid the use of paraquat.

By this publication we want to contribute to efforts to avoid harm to men and environment caused by the use of paraquat. If you know about well working additional methods and approaches to avoid the use of paraquat please do not hesitate to send the information to oisat@pan-germany.org as we regularly update the website for the benefit of all users.

Carina Weber
(PAN Germany Director)

I. Introduction

This handbook provides farmers alternatives on NOT to use synthetic herbicides, such as paraquat, butachlor, profanil, atrazine, 2,4-D, etc.

How to use the handbook?

“How to Grow Crops without Paraquat” introduces the concept of weed management like the preventive, cultural, physical and mechanical methods. The basic principles are provided with definitions and practical examples.

This handbook provides readers guidance on identifying and controlling different types of weeds. This is divided in three categories namely: grasses, sedges, and broadleaf weeds. The weed information includes the scientific name, common names, habitat, crops affected, distribution, description, its effect and impact to the crops, and its control methods. Each weed has an accompanying photo for ease in the identification.

Flip into the following pages and see the weeds that you are looking for and also read about general pest management practices.

II. General Weed Management Practices

Pest management in general is preventing, suppressing, or eradicating unwanted organisms such as insect pests, mites, snails and slugs, rodents, diseases, weeds, vertebrates, etc., that are causing problems to agricultural crops. The general pest management practices are classified according to the approaches or the methods used to deal a pest problem. The approaches used can either be prevention, suppression, or eradication of the problem pests.

The methods can be chemical; cultural and physical; biological; and legal.

Since PAN Germany does not support the use of synthetic chemical pesticides in pest management practices, it promotes the integration of approaches and methods that take into consideration the environmental ecology and health and economic gains of the farmers.

The following are the general recommendation on the preventative, cultural, and mechanical management of weeds. A combination of the various methods will surely give you better results. When in doubt, always ask for assistance from your local agriculturist office for advice.

II.A Preventative methods

1. Be able to identify the weeds either these are annual, biennial or perennial
2. Have healthy, biologically active soil
3. Properly select the seeds. When possible use high quality seeds and certain crop varieties
4. Thorough land preparation with the use of appropriate farm tools
5. High seeding rate. The extra plants allow the crop to shade weeds and make it more difficult for them to access nutrients and water. Narrow row spacing makes the crop more competitive than the weeds
6. During the seed bed preparation, make sure that the seed bed is free of weeds. In the case of rice, some grasses are very similar to rice seedlings and they are often transplanted by mistake
7. Apply the fertilizer when the main crop has access to it but the weeds do not for example after weeding. This allows the crop to be more competitive with weeds
8. Maintain cleanliness on the irrigation canals
9. Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitats for natural enemies
10. Regularly monitor the status of your crops. Refer to the annexes for a sample monitoring form

II.B Cultural practices

1. Soil tillage

Soil tillage is a method of soil preparation for seedbed preparation, sowing or transplanting, and for crops' growth. It could be Conventional tillage which is the cultivation of the soil using plow, harrow and other farm tools or mechanical implements to prepare the field for crop production or Conservation tillage which is the planting or sowing in the previous crop's residues that are purposely left on the soil surface.

2. Mulching

Mulching is using of mulch as a protective layer of either organic or inorganic material that is spread on the topsoil to: improve soil condition, act as barrier against pests, prevent rainfall and irrigation water from splashing soil borne pathogens onto the plants that cause plant diseases, prevent weed growth, provide home for earthworms and natural enemies found in the soil, retain soil moisture, educe soil compaction from the impact of heavy rains, maintain a more even soil temperature and prevent soil erosion.

There are two kinds of mulch – organic and inorganic. Organic mulch includes cut grasses, leaves, straws, hays, bark chips, animal manures, seaweeds, corncobs, pieces of corn stalks, coffee berry pulps, saw dusts, old newspapers. Inorganic mulch is made of colored aluminized plastic and aluminium foil.

3. Green manuring

Green manuring is the plowing under or soil incorporation of any green manure crops while they are green or soon after they flower. Green manures are forage or leguminous crops that are grown for their leafy materials needed for soil conservation

Table 1. Green Manure Crops

	Seeding rate kg/ha	*Green biomass t/ha*	*Dry biomass t/ha*	*Nitrogen content %*	*Nitrogen kg/ha*	*When to incorporate in the soil? (days after planting)*
Azolla	50-90	8-10	4,8-3		52	35
Cowpea	40	9-10	3-4	1.4-1.5	140-150	40-60
Lablab	7-18		5-7		220	45-60
Mustard	5-12			3.5		21-37
Sesbania	20-90		1.5-4	4.3	250-360	45-50
Soybean	30-56		5-7.4		310	45-60
Sun hemp	35-40	5-19	5.5-6	1.7	108	50-60
Sweet clover	30-40	12	6	2		40-50
Pigeon pea	45-67	9-10	5-7			45-60

4. Intercropping

Intercropping is the cultivation of two or more crops simultaneously on the same field. It also means the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development.

Types of intercropping practices

- Mixed or multiple cropping is the cultivation of two or more crops simultaneously on the same field without a row arrangement
- Relay cropping is the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development
- Row intercropping is the cultivation of two or more crops simultaneously on the same field with a row arrangement
- Strip cropping is the cultivation of different crops in alternate strips of uniform width and on the same field. It has two types; contour strip cropping and field strip cropping. Contour strip cropping follows a layout of a definite rotational sequence and the tillage is held closely to the exact contour of the field. Field strip cropping has strips with uniform width that follows across the general slope of the land

5. Field sanitation

Field sanitation is an important and highly effective farm practice to keep most weeds under control. What to do?

- Use sterilized or diseased-free seeds for sowing.
- Properly select healthy plants for transplanting.
- Keep weeds under control at all times. Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitat for natural enemies.
- Make yourself 'clean'. Always bear in mind that you might be the carrier of the pests while you move from one plant to another.
- Plow-under the crop residues and organic mulches. This improves the soil condition and helps disrupt the weeds' lifecycle. The seeds are exposed to extreme temperature, mechanical injury, and predators.

- Maintain cleanliness on the irrigation canals.
- Make your own compost. Your compost pile is where you can place your plant trimmings and other plant debris.
- Clean your farm tools. Wash plows, harrows, shovels, trowels, pruning gears, bolos after use. Lightly oil pruning gears.

6. Crop rotation

Crop rotation is one of the oldest and most effective cultural control strategies. It means the planned order of specific crops planted on the same field. It also means that the succeeding crop belongs to a different family than the previous one. The planned rotation may vary from 2 or 3 year or longer period. The rationally behind crop rotation is to break the lifecycle of some of the weeds.

Table 2. Example of Crop Groups

Family	***Common Names***
Allium	Chive, garlic, leek, onion, shallot
Cucurbit	Bitter gourd, bottle gourd, chayote, cucumbvrer, ivy gourd, luffa gourd, melons, pumpkins, snake gourd, squash, wax gourd
Crucifer	Bok choy (petchay), broccoli, Brussels sprout, cabbage, Chines cabbage, cauliflower,collard, kale, kohlrabi, mustard, radish,turnip, watercress
Legume	Common beans, black bean, broad bean (Fava), clover, cowpea, garbanzo, hyacinth bean, kidney bean, Lima bean, lintel, mungbean, peanut, pigeon pea, pinto bean, runner bean, snap pea, snow pea, sybean, string bean, white bean
Aster	Lettuce, artichoke
Solanaceous *(Nightshade family)*	Potatoe, tomatoe, pepper, eggplant
Grains and cereals	Corn, sorghum, rice, wheat, oat, barley, millet
Carrot family	Carrot, celery, dill, parsnip, parsley
Root crops	Cassava, sweet potatoe, taro, yam, water, chestnut
Mallow family	Cotton, okra

II.C Mechanical and physical practices

1. Hand weeding. The weeds are easier to control during their earlier growing period. If possible, do not let the weeds flower. Remove them from the field before they start to flower. Pulled weed bearing seeds should not be placed in compost pile for the seeds may not be killed in the process of decomposition. Compost might be the source of the reintroduction of weeds onto your fields.
2. Hoeing, mowing, and cutting
3. Off-barring and hilling-up
4. Regular cleaning of farm tools
5. Shading. Most weeds require high light intensity to grow, and high levels of shade prevent them from manufacturing their food.
6. Burning/flaming
7. Grazing. Bringing farm animals to graze directly on the weeds

II.D Management requirements

1. Know how to identify the weeds. This is a very important aspect of weed management so that you are able to plan and execute the appropriate weed control activities
2. Develop a monitoring plan. Monitor your field to know the kinds of weed and other pests currently present in the area, as well as the status of your crop
3. Always keep farm records

III. What are weeds?

Weeds are the unwanted plants found in your fields and gardens. They compete with your main crops for nutrients, moisture, and sunlight which can decrease the crop quality, raise production costs due to increased cultivation and hand weeding, and considerably reduce the crop yields. They also serve as the alternate hosts for insect/mite pests and diseases.

Weeds are classified as annual, biennial and perennial.

Annual weeds are weeds that live less than a year or a year.

Biennial weeds live for two years. It normally requires two seasons to complete their lifecycle, growing usually as a rosette in the first season and producing flowers and fruits and then dying in the second season.

Perennial weeds live on, year after year. Their roots are dormant during the extreme weather conditions but will give foliage as the weather condition favors.

Type of weeds

A: Grasses

Grasses are monocots with a single cotyledon (one seed leaf that usually appear during germination) and are characterized by their long narrow leaves, parallel veins, paired husks, and tubular and jointed stems. The leaves are aligned in two rows on the stem.

B. Sedges

Sedges are grass-like and are characterized by their solid, jointless, and triangular stems. The stem has three rows of narrow grass-like leaves. The flower head is composed of spikelets of non-showy flowers.

C. Broadleaf weeds

Broadleaf weeds are dicots with paired cotyledons (two seed leaves that usually appear during germination) and are characterized by their broad leaves with a network of veins.

IV. The Weed Information

A. Category 1: Grasses

Barnyard grass

Scientific name: *Echinochloa spp. B*

Habitat

Moist soils and both cultivated and uncultivated areas

Affected crops

Rice, corn, vegetables, orchards, and other agricultural crops

Distribution

Worldwide

Description

Barnyard grass (*E. crusgalli*)

Synonyms: Barnyard millet, Common barnyard grass, Water grass

The stem is flat and erect with roots at its nodes. The leaves are linear with a broad round base narrowing at the tip. The flower head is reddish, purplish, pinkish or greenish. The seed head is windmill-shaped and the seeds are short with stiff awns. The plant can grow up to 2 m tall. It completes its development in 42-64 days. Each plant can produce up to 40,000 seeds. The young weeds resemble rice seedlings and they are often transplanted by mistake.

Junglerice (*E. colona*)

Synonyms: Awnless barnyard grass; Jungle grass. The stem is reddish-purple or green with a reddish base. The leaves are linear with the basal often giving off a red coloration. The flowers are green to purple and are found throughout the year. Each plant can produce up to 42,000 seeds. Like the other species, the seedling looks like rice seedling and are often transplanted by mistake. As the name implies, the seeds are without awns.

Effects and impacts

Studies show that a single barnyard grass per square foot can reduce rice yields by about 25%, and 25 barnyard grasses per square meter can cause about 50% yield loss. The mature plant grows higher than rice, so that it competes for sunlight, besides soil nutrients. It is also an alternate host for tungro and rice yellow dwarf viruses. Barnyard grass can reduce corn yields by 20%. It is an alternate host for corn's pests. Barnyard grass is used as fodder for livestock, young leaves are used as vegetables, and the seeds are used as human food. Research indicates that Barnyard grass is found to be resistant to Butachlor and Propanil onsome rice fields in Sri Lanka and Thailand. Junglerice is found to be resistant to Propanil on some rice fields in Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, and Venezuela.

Methods of control

1. Proper selection of seeds
2. Thorough seedbed preparation to prevent the weeds from growing on the seedbed. Remember that the weeds look like rice seedlings and are always transplanted by mistake.
3. Thorough land preparation by plowing and at least harrowing twice
4. For rice, it is better not to practice direct seeding. Transplanted seedlings are more competitive than directly sowed ones.
5. Closer planting to prevent the germinating weed's seeds from receiving sunlight
6. Regular plant monitoring
7. Hand weeding during the early days of growth
8. Removing the weeds before they flower
9. Deep flooding (submerging the whole plant)
10. Crop rotation

Bermuda grass

Scientific name: *Cynodon dactylon*

Synonyms: Bahamagrass, Common stargrass, Couch grass, Dhubgrass, Devilgrass

Habitat

Cultivated and uncultivated areas

Affected crops

Most agricultural crops

Distribution

Asia, Africa, Europe, South America, USA

Description

The stem creeps at full-length along the ground. The leaves are small, linear and blue-green with rough margins. The undersides are smooth but hairy on the upper surfaces. The flowering stalks bear many slender and purplish spikelets. The fruit is reddish-brown or orange-red. The seeds are flattened, oval and straw-colored. The weed can be propagated through seeds, runners, rooting nodes, or underground rootstocks. It is mat forming. A single plant can produce up to 720 seeds. It can endure both extensive flooding and drought.

Effect and impact

The weed is an alternate host of some plant diseases such as brown spot, leaf spot, early blight, stripe disease of rice, barley yellow dwarf, lucerne dwarf, and of nematodes. Bermuda grass is used as a cover crop to control erosion and for soil stabilization, feed for livestock, lawn beautification, and herbal medicine.

Methods of control

1. Proper selection of seeds
2. Thorough land preparation. Cultivation can destroy the seedlings
3. Regular plant monitoring
4. Hand weeding
5. Mowing

Cogongrass

Scientific name: *Imperata cylindrica*

Synonyms: Alang-alang, Bladygrass, Japanese blood grass, Satintail, Speargrass, Swordgrass

Habitat

Sub-humid and humid grassland, open woodland, and cultivated areas

Affected crops

Most agricultural crops

Distribution

Asia, Australia, tropical Africa, Europe, South America, and USA

Description

The stem is erect and arises from an extensive system of tough and scaly un-branched, white, and succulent rhizomes (rootstock). The leaf is flat and linear, narrowing at the tip. It has a razor sharp margin with a hairy base. The flower head is composed of dense creamy-white or silvery-white silky hairs. It can produce up to 3,000 seeds and can be propagated by seeds and rhizomes. The plant can reach up to 1.5 m in height.

Effects and impacts

Cogongrass forms a dense mat and produces plenty of leaves that make it nearly impossible for other plants to coexist. It can invade and overtake disturbed ecosystems by displacing a large variety of native plant species. The plants can easily attract fire. Burning them encourage new shoots. It is an alternate host forrust, damping-off, leaf blight, and for root knot nematode. It can reduce yields by up to 90% when not properly controlled. It is a very strong competitor for

water, nutrients, and light because it sprouts and grows faster than most crops. Cogongrass is used as a soil binder (to prevent soil erosion), animal feed, and herbal medicine. Studies show that cogongrass contains chemicals (has the allelopathic ability) that prevent the growth of other plant species and contribute to its invasiveness and extreme competitiveness.

Methods of control

1. Regular field monitoring
2. Breaking up the rhizomes into small pieces
3. Frequent cultivation using hand tools and other farm implements
4. Cutting or slashing every two weeks to kill the rhizomes
5. Bending the stems at ground level followed by plowing to place soil over the bent stems

Crabgrass

Scientific name: *Digitaria spp.*

Habitat

Cultivated and uncultivated areas

Affected crops

Most agricultural crops

Distribution

Africa, Asia, Europe, South America, USA

Description

Large crabgrass (*D. sanguinalis*)
Synonym: Finger grass

The stem has a spreading, branching structure, bending abruptly at a sharp angle. It roots at its nodes. The leaves are linear, hairy, and turn dark-red or maroon as they mature. There are plenty of leaves near the base of the plant and scattered loosely along the stem. The flower head is finger-like and is composed of 4-6 thin spikes. It can produce as many as 150,000 seeds.

Smooth crabgrass (*D. ischaemum*)

The weed is very similar to large crabgrass except that the node does not have roots and the leaves do not have hairs. The flower head is composed of 2-6 spikes.

Effects and impacts

Large crabgrass competes directly for soil nutrients and moisture. It can reduce corn yield by 20%. It is an alternate host for leaf blast, mosaic virus, and nematodes. The infected weed becomes the source of infestation in the following cropping season. Studies show that the weed is found to be resistant to Fluazifop-p-butyl, Haloxyfop-methyl, and Imazethapyr on onion and vegetables growing in some parts of Australia; to Atrazine on corn fields and orchards in some parts of France and Poland; and to Fluazifop-p-butyl, and Sethoxydim on carrot and onion farms in some parts of Wisconsin, USA.

Methods of control

1. Proper selection of seeds
2. Thorough land preparation by plowing and harrowing twice to expose and/or bury the seeds
3. Closer spacing
4. Hand weeding or hoeing
5. Regular field monitoring

Crowfoot grass

Scientific name: *Dactyloctenium aegyptium*
Synonyms: Beach wiregrass, Button grass, Duck grass, Giant button grass, Finger comb grass

Habitat

Cultivated and uncultivated areas, especially sandy soils

Affected crops

Most agricultural crops

Distribution

Asia, Australia, Africa, South America, USA

Description

The stem has a spreading, creeping and mat-forming structure. It roots at the lower nodes. The flower head has 2-7 spikelets borne at the tip of the stem. The seed head looks like a crow's foot, hence the name. Each plant may produce up to 60,000 seeds.

Effect and impact

The weed reduces yields as it competes in the nutrient uptake, moisture, and light during the growing season. It also interferes in the harvesting operation.

Methods of control

1. Proper seed selection
2. Thorough land preparation
3. Regular field monitoring
4. Hand weeding/hand pulling when the weeds are young
5. Cultivation using farm or mechanical implements
6. Removing weeds before they start to flower
7. Mulching
8. Closer planting
9. Intercropping

Goosegrass

Scientific name: *Eleusine indica*

Synonyms: Bullgrass, Crow's foot grass, Goosefoot, Indian goose grass, Silver crabgrass, Wire grass

Habitat

Cultivated and uncultivated areas

Affected crops

Corn, upland rice, sweet potato, cassava, sugarcane, cotton, vegetables, soybean and other legumes, and other crops

Distribution

Worldwide

Description

The stem is erect, flattened, and branching, with smooth few long hairs along the edges. It is whitish or pale-green in color. The leaves are smooth and dark-green with laterally flattened or folded blades. Mature leaves are very difficult to cut unless with very sharp farm implements. The flower head is windmill-like. The flowers are composed of 2 -10 flattened, finger-like spikes that look like a zipper, which emerge from a common point. The roots are strong and can easily grow in compacted soil. The weed is propagated by seeds and flowers the whole time. Each plant can produce up to 40,000 seeds.

Effects and impacts

Goosegrass can reduce yields for it competes with the main crop for water, nutrient, and sunlight uptake. It is an alternate host for tungro, ragged stunt, and rice yellow mottle diseases and for numerous insect pests like; aphids, armyworm, cutworm, hairy caterpillar, leaf folders, leafhoppers, mealybugs, plant hoppers, rice bugs, among others. Once established, this weed is difficult to eradicate. The weed, as studies show, is found to be resistant to Paraquat on vegetables; Tluazifop-p-butyl and Glyphosate in orchards; and Fluazifop-p-butyl and Propaquizafop on croplands and vegetables in some parts of Malaysia.

Methods of control

1. Proper seed selection
2. Cutting the weeds (using sharp-bladed farm implements) before flowering, can reduce their population.
3. Hand weeding of seedlings- it is difficult to do handweeding once the plant is mature and well-established due to its rough root system.
4. Mulching (2-3 inches layer mulch) prevents the seeds from germinating. Germination occurs mainly on the soil surface. Seeds rarely germinate deeper than 8 cm.
5. Proper plowing and harrowing before planting
6. Regular field monitoring

Torpedo grass

Scientific name: *Panicum repens*

Synonyms: Bullet grass, Couch panicum, Creeping panic, Panic rampant, Quack grass

Habitat

Swamps, moist, coastal, and sandy soils

Affected crops

Rice, sugarcane, citrus, and vegetables

Distribution

Worldwide

Description

The stem is rigid, erect or leaning, and grows up to a height of 3 feet. The leaves are grayish-green, narrow, often rolled inward and with hairs on the upper surface. The flower head is branched, open, with white to yellow flowers. The weed is propagated by rhizomes (rootstocks) which have running tips that are sharp-pointed and torpedo-shaped, hence the name. The rhizomes are creeping structures and their tips and buds are covered with hard, whitish to brownish scales.

Effects and impacts

The weed is very difficult to control once established it affects the yield of rice. It also affects the harvesting operations and the quality of produce. It is, however, good for holding the soil along the riverbanks.

Methods of control

1. Use clean seeds
2. Make sure that the seedbed is free of weeds
3. Proper land preparation
4. Keep the surroundings (bunds, levees, irrigation canals) free of weeds
5. Hand weeding or hoeing
6. Regular field monitoring

B. Category 2: Sedges

Globe fringerush

Scientific name: *Fimbristylis miliacea, F. littoralis*

Synonyms: Grasslike fimbry, Grasslike fimbristylis, Lesser fimbristylis

Habitat

Wet soils

Affected crops

Rice

Distribution

Worldwide

Description

The stem is erect and hairy with two sharp edges. The leaves are stiff and thread-like and do not have prominent midribs. They have short blades and the basal leaves are composed of overlapping leaf sheaths. The flower head is somewhat rounded wherein the flower stalks radiate from a common point. The weed is propagated by seeds. Each plant can produce up to 10,000 seeds that can easily germinate upon reaching maturity.

Effects and impacts

The root system of Globe fringerush is fibrous, growing in all directions to easily compete with other plants for moisture and soil nutrients. It is an alternate host for armyworm, hairy caterpillars, rice bugs, nematodes, and fungal and bacterial diseases. Studies show that Globe fringerush is found to be resistant to 2,4-D on rice fields in Kedah, Malaysia, and to Pyrazosulfuron-ethyl, also on rice fields, in Santa Catarina, Brazil.

Methods of control

1. Proper seed selection
2. Deep plowing and proper field level
3. Repeated tillage or soil disturbance
4. Hand weeding

Nutsedge

Scientific name: *Cyperus spp.*

Synonym: Flatsedge

Habitat

Cultivated crops and of gardens

Affected crops

Most agricultural crops

Distribution

Worldwide

Description

Important nutsedge species

Purple nutsedge, Nutgrass (*C. rotundus*).

The stem is erect, smooth, sharply triangular, slender, and thickened at the base. The leaves are linear but shorter than the flowering stem. There are 3 rows of leaves near the plant base. The leaf-like bracts under the flower clusters are shorter than the flowers. The flower is simple and occasionally produces seeds. The seed head is red or purplish-brown. The plant is propagated by tubers which are ovate, black, and have a bitter taste. The rhizome (root-like and horizontal-growing stem growing just below the surface of the soil) is wiry and bears connected tubers.

Rice flatsedge (*C. iria*)

The stem is sharply angled, hairy, smooth, and occurrs in bunches. The leaves are three-ranked, dark-green, shiny, linear and taper abruptly to a point, and have rough margins toward the leaf tips. The leaf-like bracts under the flower cluster are longer than the flowers. The flowers are yellowish. The roots are fibrous and yellowish-red. The plant is propagated by seeds. Each plant can produce up to 5,000 seeds.

Smallflower Umbrella sedge, Rice sedge (*C. difformis*)

The stem is green, solitary, erect, and triangular. It has 3-4 basal leaves. The leaves are short and thin. The flowers are yellowish, very numerous, and crowded ovoid masses. The plant is propagated by seeds. Each plant can produce up to 50,000 seeds.

Yellow nutsedge, Yellow nutgrass (*C. esculentus*)

The stem is usually solitary and produces terminal spikelets. The leaves are erect, yellow to green and shiny with distinct ridges, arrowing gradually to a sharp point. The seed head is yellow. The plant is propagated by tubers which are round, white, and sweet in taste. The rhizome bears only one tuber.

Effects and impacts

Nutsedge is one of the world's worst weeds. It can reduce rice yields by 50%. It serves as an alternate host for blast, bacterial leaf blight, armyworm, crickets, nematodes, paddy bug, plant hoppers, thrips, rice caseworm, and rice stemborer. Studies show that Smallflower umbrella sedge is found to be resistant to Azimsulfuron, Bensulfuron-methyl, Cinosulfuron, Cyclosulfamuron, Ethoxysulfuron, Halosulfuron-methyl, Imazosulfuron, and Pyrazosulfuron-ethyl on rice fields in South Korea.

Methods of control

1. Deep plowing and proper field level
2. For seed bearing species, cut the weeds before they flower
3. Repeated tillage or soil disturbance
4. Flooding
5. Proper seed selection
6. Mulching
7. Crop rotation with pigeon pea. Pigeon pea has the ability to control the emergence and growth of nutsedge.

C. Category 3: Broadleaf Weeds

Arrowleafed monochoria

Scientific name: *Monochoria vaginalis*

Synonyms: Heartshape false pickerelweed, Monochoria, Pickerelweed

Habitat

Irrigated fields

Affected crops

Mostly irrigated rice

Distribution

Worldwide

Description

The stem is slightly erect and fleshy. The leaves are heart-shaped, shiny, and with rounded bases. The flower head is clustered and composed of up to 25 flowers. The flowers are lilac or violet-blue. The roots are submerged under water or rooted in the mud and the rest parts are above the water surface. The plant is propagated by seeds or whole plants.

Effects and impacts

Monochoria can reduce rice yield as high as 82%, when left uncontrolled. Sixty individual plants/sq. m. can reduce yield by up to 35%. In India, the plant is used as vegetable and the roots are used for medicinal purposes. Studies show that when the weeds infest some rice fields in South Korea, they are found to be resistant to Bensulfuron-methyl.

Methods of control

1. Proper seed selection
2. Regular field monitoring
3. Thorough land preparation by plowing and harrowing
4. Keeping seedbeds free of weeds
5. Hand weeding
6. Crop rotation

Black nightshade

Scientific name: *Solanum nigrum*

Synonyms: Common nightshade, Deadly nightshade, Garden nightshade, Wonderberry

Habitat

Cultivated and disturbed areas with dry and moist soils

Affected crops

Crops that belong to the nightshade family (tomato, eggplant, pepper, potato), beans, corn, and other agricultural crops

Distribution

Worldwide

Description

The stem is erect and smooth. The leaves are egg-shaped with wavy margins. The flowers are white to pale-blue and arranged in clusters. The berries are round, green when young and turn black when ripe, hence the name. The green berries are poisonous. A nightshade plant can produce as much as 5,000 seeds.

Effects and impacts

Black nightshade is an alternate host of pests found on corn, tomato, eggplant, pepper, potato, legumes, and other crops. Its seeds are easily mixed with beans during harvest. The juice of the ruptured seeds stains and causes the soil to stick on the harvested crop. It also disrupts the harvest operation and lowers the quality of the produce. The plant is eaten as a vegetable and for its ripe fruits. It has medicinal properties, with the leaves, stems and roots used as a poultice on open wounds, boils, and sores. Studies show that the Black nightshade weeds become resistant to Paraquat on some vegetable fields in Malaysia and also resistant to Atrazine when infesting some corn fields in Belgium, Czech Republic, Germany, Italy, New Zealand, Spain, Switzerland, and UK; cropland in France; and orchards in Poland (Weed Science, 2005).

Methods of control

1. Thorough land preparation by plowing and harrowing
2. Regular field monitoring
3. Corn gluten meal. Apply ca. 10 kg of corn gluten meal to an area of 1,000 sq ft, to prevent the black nightshade's seeds from germinating. Ask for assistance from your local agriculturist office for this control method.
4. Hand weeding at the early stage of growth
5. Practice crop rotation

Common purslane

Scientific name: *Portulaca oleracea*

Synonym: Purslane

Habitat

Warm and moist soils

Affected crops

Rice, corn, cotton, crucifers, potato, tomato, and many other agricultural crops

Distribution

Worldwide

Description

The stem is fleshy, smooth, branched, and purplish-red or green with reddish coloration. The leaves are thick, smooth and fleshy, and green to reddish in color. They have broad-rounded tips with smooth margins. The flowers are yellow, found solo at the leaf axils and clustered at the end of the branches. A single plant can produce as much as 10,000 seeds.

Effects and impacts

Common purslane serves as an alternate host for various plant diseases and nematodes. Its ability to produce plenty of seeds can result in the easy colonization of your farm. It forms a dense mat that prevents seedlings from germinating, and competes for soil moisture and nutrients. It can reduce yield from

20-40%, depending on the crops. It is used as vegetables and also for medicinal purposes. It is also used as hogs' feed. The seeds are made into flour and are a source of blue dye. Studies show that the weed is found to be resistant to Atrazine and Linuron in some carrot fields in Michigan, USA (Weeds Science, 2005).

Methods of control

1. Proper soil tillage or thorough land preparation by plowing and harrowing at least two times
2. Hand weeding
3. Regular plant monitoring
4. Corn gluten meal. Apply ca. 10 kg of corn gluten meal to an area of 1,000 sq ft, to prevent purslane's seeds from germinating. Ask for assistance from your local agriculturist office when using this control method.
5. Crop rotation with sorghum. Sorghum has the ability to reduce the emergence or growth of pigweeds.
6. Mulching at least 3 inches thick prevent the seeds from germinating

Gooseweed

Scientific name: *Sphenoclea zeylanica*

Synonym: Chickenspike

Habitat

Irrigated rice fields, swamps, and stagnant waters

Affected crops

Mostly irrigated rice

Description

The stem is erect, branched, smooth, and hollow. The leaves are smooth and spoon-shaped and grow opposite each other. The flower head is a distinctive cylindrical crowded terminal spike that bears whitish to greenish flowers. The roots are long and have cord-like appearance. The plant has a fleshy appearance. It is propagated by seeds.

Effects and impacts

Gooseweed competes with rice for soil nutrients and sunlight. It can lower the yield by up to 50% when left uncontrolled. The young plants and leaves are eaten as vegetables. Studies show that the weed is found

resistant to 2,4-D on some rice fields in Malaysia, Thailand, and the Philippines.

Methods of control

1. Proper seed selection
2. Thorough land preparation by plowing and harrowing
3. Rice seedbeds should be free of weeds
4. Regular plant monitoring
5. Proper water and fertilizer management
6. Closer plant spacing to prevent the germinating seeds of the weeds being exposed to sunlight
7. Hand weeding
8. Crop rotation

Horseweed

Scientific name: *Conyza canadensis, Erigeron canadensis*

Synonyms: Canadian horseweed, Canadian Fleabane, Mare's tail

Habitat

Cultivated and uncultivated soils

Affected crops

Almost all agricultural crops

Distribution

Worldwide

Description

The stem is simple, erect, and has no branches. It is covered with hairs. The leaves are clustered radiating the stem and becoming smaller at the top. The margins are toothed. The flower head is highly branched that arising at the top of the main stem with white or yellow or pink flowers.

Effects and impacts

Horseweed infests most agricultural lands. Its numerous seeds easily mix with the harvested cereals and beans and are the source of infestation for the next cropping season. It is an alternate host for most agricultural pests. Its stem has medicinal properties. It is made into a tea to treat diarrhea and kidney and respiratory problems. Oil of erigeron is taken from the fresh plants and used against intestinal parasites. Studies shows that horseweeds become resistant to Paraquat, Atrazine, Glyphosate at some corn, cotton, and soybeans farms, pastures, orchards, vineyards in some parts of Europe, USA, and Japan (Weed Science, 2005).

Methods of control

1. Proper seed selection and proper choice of cultivars
2. Thorough land preparation
3. Regular field monitoring. Scout your field to identify the weeds and to know what immediate actions to undertake.
4. Hand weeding
5. Cutting the weeds before they flower

Jimsonweed

Scientific name: *Datura stramonium*

Synonyms: Angel's trumpet, Devil's trumpet, Jamestown weed, Stinkweed, Thorn apple

Habitat

Cultivated and non-cultivated areas

Affected crops

Corn, sorghum, cotton, legumes, potato, banana, and other summer crops

Description

The stem is smooth, pale-green, and fully branched. The leaves are irregularly cut and toothed, egg-shaped, and with green or purplish coloration. The flowers are white or purple and funnel-shaped. The fruit is green, oval, hard, and spiny. Each fruit may

contain about 100 seeds. The seed is black and kidney-shaped.

Effects and impacts

Jimsonweed competes with sunlight, moisture, and soil nutrients. It slows down harvesting operation. All parts are highly poisonous. It is advisable to pull the weeds once spotted on the field. Studies show that the weed is found to be resistant to Atrazine on solanaceous crops (tomato, pepper, eggplant, potato, etc) in some fields in Indiana, USA (Weed Science, 2005).

Methods of control

1. Proper seed selection
2. Proper soil tillage or thorough land preparation by plowing and harrowing
3. Regular plant monitoring
4. Field surrounding should be free of weeds
5. Hand weeding before the weeds start to set seeds. Once matured, they are difficult to pull by hand as the stems become woody.

Lambsquarter

Scientific name: *Chenopodium album*

Synonyms: Common lambsquarter, White goosefoot, Fat hen,

Habitat

Cultivated areas mostly rich in nitrogen

Affected crops

Corn, soybean, potato, and other agricultural crops

Distribution

Worldwide

Description

The leaves are light-green, narrow, with almost parallel sides, and diamond-shaped. The undersides are covered with white powder. The flowers are green, tiny, without petals, and located at the tip of the branches. The flowers' undersides are also covered with white powder. Each plant can produce up to 75,000 seeds. This weed is easily mistaken as pigweed and vice-versa.

Effects and impacts

Lambsquarter is an alternate host to beet leafhoppers that transmit viruses. The leaves are eaten as vegetable and the seeds are a good source of protein when prepared as hot cereals or baked goods. Studies show that Lambsquarters are found to be resistant to Atrazine, Metribuzin, Thifensulfuron-methyl, Simazine, Cyanazine at some corn, soybean, and potato farms, croplands, and orchards in some parts of Europe and USA.

Methods of control

1. Proper seed selection
2. Through land preparation
3. Proper weed management. The weed is easy to pull as it is shallow rooted.
4. Regular plant monitoring
5. Corn gluten meal. Apply ca. 10 kg of corn gluten meal for an area of 1,000 sq ft, to prevent the weed's seeds from germinating. Ask for assistance from your local agriculturist office for this control measure.
6. Vinegar at 10, 15, or 20% concentrations control smooth pigweed up to 6 inches tall. Avoid contact with the main crop when using vinegar for the pigweed control. Ask for assistance from your local agriculturist office for this control measure.

Pigweeds

Scientific name: *Amaranthus spp.*

Redroot pigweed

Habitat

Dry, disturbed ground, especially cultivated or abandoned fields, and burned areas

Affected crops

Almost all agricultural crops

Distribution

Worldwide

Description

Important pigweed species

1. Redroot pigweed (*A. retroflexus*) Other names: Careless weed, Common amaranth, Common pigweed, Rough pigweed, Pigweed

The stem is round with white longitudinal veins, light-green, and covered with light fine hairs. The leaves are diamond-shaped, rough, and reddish-green. The flower head is branched, tall, and is composed of very small greenish-white to green flowers. The weed has a pinkish to red taproot, hence one of its known common names.

2. Livid amaranth (*A. lividus, A. blitum*) Other names: Purple amaranth, Slender amaranth

The stem is erect or ascending and has reddish or yellowish coloration. The leaves are ovate and smooth. The flowers are green in tight clusters, located at the end of the branch

3. Spiny amaranth (*A. spinosus*) Other name: Thorny pigweed

The stem is stout, fleshy, smooth, and reddish. The leaves are simple and arranged alternately and often have v-shaped variegation (coloration). The flower head is composed of closely-packed clusters of small purplish or green flowers. Sharp spines are present at the leaf nodes and at the base of the flower head, hence the name.

4. Smooth pigweed (*A. hybridus*)

The stem has small fine hairs and green or reddish-purple at maturity. The flower head has more branches that are compacted and much longer than the other species. It also has the green or reddish-purple color at maturity.

5. Waterhemp (*A. rudis*)

The stem is smooth, without hairs and erect. Its color varies from light-green to dark-red with multiple shades, sometimes on the same plant. The leaves are smooth, glossy, long and narrow, and somewhat rounded. *It is not easy to identify the various amaranth species. Ask for assistance from your local agricultural offices or from weed experts*.

Effects and impacts

The weed is an alternate host for beet armyworm and other insects, nematodes, and viral diseases. It can reduce yield by up to 40% on corn and soybean if not properly controlled. The plant is edible and has medical value. The leaves are eaten raw or cooked. The whole plant is used to cure wounds. Seed oil is used as an ointment for burns, rashes, and acnes. Several studies show that most amaranth species are resistant to most herbicides. Livid amaranth is found to be resistant to Atrazine on some corn fields in France; to Paraquat on vegetables in Penang, Malaysia; and to Imazethapyr on cabbage, lettuce, and onion in New Jersey, USA. Redroot pigweeds are found to be resistant to Atrazine, Metribuzin, Diuron, Linuron, Simazine, Imazaquin, Cyanazine on some asparagus, corn, potato farms, croplands, orchards, and vineyards in some parts of China, Europe, and USA. Smooth pigweed is found to be resistant to Atrazine on some corn farms and croplands in France, Israel, Italy, Spain, and South Africa; to Simazine in some vegetables areas in Switzerland; and to Chlorimuron-ethyl, Imazamox, Thifensulfuron-methyl, and Imaze-thapyr on corn, soybean, vegetables, and croplands in some states of US. Waterhemp is found to be resistant to Atrazine, and Imazethapyr on soybean in Canada; to Acifluorfen-Na, Atrazine, Fomesafen, Imazamox, Lactofen, Chlorimuron-ethyl, Imazethapyr, and Thifen-sulfuron-methyl on alfalfa, corn, grain sorghum, soybean, and croplands in some states of US.

Methods of control

1. Proper selection of seeds
2. Thorough land preparation by plowing and harrowing at least two times
3. Regular plant monitoring
4. Proper weed management

5. Vinegar at 10, 15, or 20% concentrations control smooth pigweed up to 6 inches tall. Avoid contact with the main crop when using vinegar for the pigweed control. Ask for assistance from your local agriculturist office when using this control method.
6. Corn gluten meal. Apply ca. 10 kg of corn gluten meal for an area of 1,000 sq ft, to prevent the redroot pigweed seeds from germinating. Ask for assistance from your local agriculturist office when using this control method.
7. Crop rotation with sorghum. Sorghum has the ability to reduce the emergence or growth of pigweeds.

Striga weed

Scientific name: *Striga hermonthica, S. asiatica, S. aspera, S. forbesii, S. gesnerioides*

Synonyms: Witchweed

Striga hermonthica

Affected crops

Corn, millets, rice, sorghum, and sugarcane are the hosts for the first 4 Striga species, while *S. gesnerioides* is a parasitic weed of cowpea and wild legumes

Distribution

Mostly in Africa but also found in Asia and the USA

Description Important pigweed species

1. *S. asiatica*

The stems are hairy, hard, quadrangle-shaped, and fibrous. The leaves are about 4 cm long and 1.5 -3.5 mm wide. The flowers are alternately arranged in the spike, much smaller than those of *S. hermonthica* but more prominent. The colors vary from red, pink, orange, yellow, white, or purple.

2. *S. aspera*

The stems are delicate and profusely branched. The plants never grow more than 50 cm tall. The leaves are linear, opposite, spreading, or ascending and usually very narrow, 1-3.5 cm long and up to 5 mm wide. The flowers are very similar with those of *S. hermonthica*.

3. *S. gesnerioides*

As compared to the other species, the plant is often pale-green with many closely packed stems at the ground level. The flowers are usually purple but are sometimes white or yellow.

4. S. hermonthica

The stems are hairy, hard, quadrangle-shaped, and fibrous. The leaves are narrow and gradually decreasing towards the tip. The size is 2.5-7.5 cm long and up to 2 cm wide. The flowers are found in a dense spike. Each spike may contain 6-10 open flowers. The colors vary from bright pink, rose-red, and white.

Effect and impact

The symptoms on corn are difficult to distinguish from those caused by lack of water (drought), like wilting and curling of leaves at an early stage. The infected plant may also show stunting and a pronounced burning of the leaf borders. The leaves are 'burnt' when the parasitic weed dominates over the corn plant. Striga weeds are difficult to control once they are established on corn plants. Because they get their nutrients from corn, they contribute to the latter's very low production in most countries in Africa.

Conditions that favor development

1. Overused, depleted, and infertile soil
2. Poorly manage soil
3. Monocropping, planting of the same crop on the same area for a long period of time
4. Improper weed management
5. Seeds from the previous harvest are mixed with Striga seeds

Methods of control

1. Proper seed selection
2. Use seeds that are Striga seeds-free. Avoid using seeds from the previous harvest if the crops were infested with Striga. Buy the seeds for your next cropping from an agricultural seed store in your locality.
3. Regular plant monitoring
4. Intercropping sorghum with cowpea
5. Intercropping corn with silver leaf desmodium (*Desmodium uncinatum*) or green leaf desmodium (*D. intortum*). Desmodium is a leguminous plant that is a good source of fodder for the farm animals. When planted as an intercrop, it covers the surface in between the rows of the main crop (corn, sorghum, or millet). Desmodium emits chemical into the soil that is unfavorable for Striga's growth. 2.5 kg of seeds are needed for 1 ha.
6. Hoeing and hand weeding before Striga plants start to flower. Late weeding requires the burning of collected plants to kill the seeds. Never put them in your compost pile or pit.
7. Off-barring and hilling-up the rows
8. Apply both organic and inorganic fertilizers to improve the crop's stand.
9. Crop rotation with legumes such as soybean, mungbean, and other leguminous crops, to improve the soil condition and deprive the parasitic weeds from favored host plant

Water hyacinth

Scientific name: *Eichhornia crassipes*

Synonyms: Witchweed

Habitat

Freshwaters

Affected crops

Mostly irrigated rice

Distribution

Worldwide

Description

The stem is erect and bears the flowers. The flowers are blue-violet or lilac, large, and attractive. They have six petals and one bears a yellow spot. The leaves are green to dark-green, round to oval, and glossy with leathery blades. The leafstalks (petioles) are thick and spongy and contain some amounts of air that enable the plant to float. Masses of fine branching roots hang underneath the floating plant. The plant is propagated by seeds and vegetative offshoots.

The weed forms a dense mat that interferes with the flow of water in irrigation canals and serves as a breeding ground for mosquitoes. It competes with rice for soil nutrients reducing the yield when left uncontrolled. Water hyacinth is the most damaging aquatic plant worldwide.

Methods of control

1. Proper soil tillage and/or thorough land preparation
2. Hand weeding. Water hyacinth can be used as feed to swine and water buffaloes (carabaos), mulch, and compost material
3. Regular plant monitoring
4. Rotate rice with legumes
5. Biological control with the use of weevils, *Neochitina eichhorniae and N. bruchi*. Ask for assistance from your local agricultural office for more information on this control measure.

V. Photo credits

page

01 **Titel:** Foto: Carina Weber, Montage: R. B.
14 **Barnyard grass**. Jewel Bissdorf
15 **Bermuda grass.** Jewel Bissdorf
15 **Cogongrass.** Jewel Bissdorf
16 **Crabgrass.** Randall Prostak, University of Massachusetts
16 **Crowfoot**. Jewel Bissdorf
17 **Goosegrass**. Jewel Bissdorf
18 **Torpedograss**. Fatima Guerra
19 **Globe fringerush.** IRRI and University of Queensland
19 **Nutsedge**. Jewel Bissdorf
21 **Arrowleafed monochoria**. IRRI and University of Queensland
21 **Nightshade.** Jewel Bissdorf

page

22 **Common purslane.** Dr. James Altland, Oregon State University
22 **Gooseweed.** IRRI and University of Queensland
23 **Horseweed**. Dr. James Altland Oregon State University
23 **Jimsonweed**. Dr. James Altland Oregon State University
24 **Lambsquarter.** Randall Prostak, University of Massachusetts
25 **Pigweeds**. Randall Prostak, University of Massachusetts
26 **Striga weed**. A. Larsen
27 **Water hyacinth**. Jewel Bissdorf

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Non-chemical weed control.
http://www.wssa.net/s

UC Davis: Weed photo gallery
http://www.ipm.ucdavis.edu/PMG/weeds_common.html

VII. Annex: Sample forms for monitoring activities & record keeping

Table 3. Monthly cropping calendar of activities

Management practices	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
I. Seed procurement												
II. Land preparation												
III. Fertilization												
IV. Irrigation												
V. Pests/weed monitoring												
VI. Pests/weed control												
VII. Harvesting												
VIII. Post harvest												

Table 4. Weekly activities

Field activities	- 4	- 3	- 2	- 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Care of seedlings																				
Land preparation																				
Fertilizer application																				
Cultivation and weeding																				
Irrigation																				
Weeding																				
Control of insect pests and diseases																				
Harvesting																				

Table 5. Crop lifecycle

Growth stages	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Seedling												
Vegetative												
Reproductive												
Maturation												

Table 6. Brand names of Paraquat

Brand names of Paraquat	Paraquat only	Paraquat + Diquat	Paraquat + Urea Herbicides
	Barclay Total(R) Actor(R) Crisquat(R) Cyclone(R) Dextrone X(R) Dragocson(R) Esgram(R) Efoxon(R) Goldquat(R) 276 Gramoxone(R) Herbaxon(R) Herbikill(R) Katalon(R) Osaquat(R) Parakill(R) Pilarxone(R) Plusquat(R) Priquat(R) R-Bix(R) Scythe(R) Speeder(R) Speedway(R) Starfire(R) Sweep(R) Total(R) Weedless(R)	Dukatalon(R) Opal(R) Pathclear(R) PDQ(R) Preeglox L(R Preglone(R) Weedol(R)	Anuron(R) Dexuron(R) Gramonol(R) Gramocil(R) Gramuron(R) Tota-Col(R)

Source: *INCHEM http://www.inchem.org/documents/pims/chemical/pim399.htm*

PAN Germany
Pestizid Aktions-Netzwerk e.V.

For more information on non-chemical pest management see:

www.oisat.org

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