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Major Weeds in Pineapple Fields of Hawai'i

At a Glance

Weed growth during pineapple production competes for water, nutrients, and light, and can be a host for pineapple pests and viruses. Early control is achieved with plastic and organic mulches, and herbicides. Later weed growth hampers production practices and harvesting, and increases yield loss. Major weeds are described in this brochure, with two grass species and two vines being the most difficult to control after flowering.

Weed growth during the pineapple's early establishment competes for water nutrients and light, can be a host for pineapple pests and viruses, and lead to yield loss (Reinhardt et al., 2002; Rohrbach and Johnson, 2003; Eshetu et al., 2007; Sipes and Wang, 2017). Later in the pineapple growth cycle, after early growth control measures such as plastic mulch and herbicides are no longer as effective, weed growth can hamper production practices and harvesting, and may cause even further yield loss.

Control measures include soil tillage before planting, using organic and plastic mulch ground covers, pre- and post-emergence herbicides, and manual hand weeding (Kasasian, 1971; Glennie, 1991; Catunda et al., 2005; Eshetu et al., 2007; Maia et al., 2012; Soler et al., 2018).

Management of weeds is more difficult with high pineapple planting density, limited or inadequate mulch cover, high rainfall, poor irrigation, and high weed seed load in the field and surrounding area. Avoidance of weed flowering and seed formation are critical for long-term weed control and reducing costs. An adage for effective continued weed management of grass weeds is "one year's seeding means seven years' weeding" (Broadley et al., 1993).

Herbicides have been used widely in pineapple production, with diuron being a common component to control

Table 1. A partial listing of common herbicides approved by the U.S. EPA for use in pineapple. These chemicals are available with different trade names.

Herbicide by Common Name	Weeds Controlled	Usage
Diuron	Wide variety of annual and perennial broadleaves and grasses	Applied pre-plant. Phenyl-urea inhibits photosynthesis.
Ametryn	Annual broadleaves and grasses	Applied pre-plant. Triazine - inhibits photosynthesis
Bromacil	Perennial grasses	Applied pre-plant. Substituted uracil, inhibits photosynthesis
Hexazinone	Broadleaves, grasses and woody plants	Applied pre-plant. Triazine - inhibits photosynthesis
Quizalofop P-Ethyl	Annual and perennial grasses	Postemergence, Aryloxyphenoxy-propionate - inhibits fatty acid synthesis via acetyl-CoA carboxylase
Trifluralin	Annual grasses and broadleaves	Applied pre-plant. Substituted aniline. Active during germination inhibits cell division in the root
Glyphosate	Broadleaf and grassy weeds	Applied to leaves. Glycine analogue. Inhibits plant development.

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Figure 1. Broadleaved vine and grasses during early pineapple crop development. Plastic and organic mulch are used to achieve early crop weed control.

Figure 2. Weed control starts with land and bed preparation.

Figure 3. Weed control is expensive, with hoeing being used for more densely plant crops, and a mechanical weed-wacker for wider crop spacing. However, these can cause damage to the crop. Failure to control weeds, especially perennial grasses and vines, can cause harvest problems.

broadleaf weeds and grasses (Table 1). However, no single herbicide will control all weeds in all production areas, with some weeds showing tolerance to some herbicides approved in the U.S. for use in pineapple. Perennial grasses, such as Guinea grass, are much more difficult to control than broadleaved weeds. Herbicides are applied pre-planting, with contact herbicides used after crop establishment. Post-plant herbicides include glyphosate and the contact herbicides Paraquat dichloride, Capric acid, Caprylic acid, Hydrogen Peroxide, Peroxyacetic Acid, Pelargonic acid, and Eugenol.

Advances in robotic drone-based point spraying and computer-aided recognition software, based upon a weeds digital image signature, offer hope for new weed-management protocols (Hunt and Daughtry, 2018; Maes and Steppe, 2019; Talaviya et al., 2020).

In 1932, Harold St. John and Edward Hosaka described 82 weeds found in Hawai'i's pineapple fields, with botanical line drawing of each, though Guinea grass was not included in this listing. *A Handbook of Hawaiian Weeds* by Haselwood et al., (1986) gives an expanded list

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with descriptions. Since these publications, the significant weeds of pineapple in Hawai'i have not received much attention, despite widely recognized as causing significant disruption in production and additional costs.

Current weeds that are a significant in pineapple production are two grasses (Guinea grass and Wire weed) and two broad-leaf weeds that are vines (Morning Glory and Bitter melon). In addition, there are a number of secondary broadleaf weeds, some of which are described here. Other weeds found include nut grass (*Cyperus rotundus* L.), other grasses (*Chloris, Digitaria, Eragrostis* and *Paspalum* spp.), and broadleafs such as thistles, prickly poppy, and Solanaceous weeds.

In other pineapple growing regions, the spectrum of weed species varies widely, with upright tillering grasses frequently being a problem, along with vines (Mangara et al., 2016).

Wiregrass

Eleusine indica (L.) Gaertn.

Common names

Indian Goosegrass, Yard-Grass, Goosegrass, Wiregrass, Crowfootgrass, Manieni'i Ali'i, O-Hizawa

Description

This is a fast-growing erect tufts grass with a fibrous root system that can reach 12" to 30" tall. The leaves are flat, 6" to 12" long, and a narrow 3/16" to 5/16" in width. The lower surface of the leaf is smooth, while the upper surface has scattered hairs.

The smooth flowering stalk is flattened and wrapped by the lower portion of the leaf, except at the upper margin. The terminal spikes have 2-8 fruiting branches that are 2" to 4" long. Each spikelet has 3-7 flowers. The elliptic, pointed seeds are 1/16" long, pale with black showing through.

Dispersal

Numerous dry fruit are produced on a single flowering stalk that, at maturity, enclose the seeds. The seeds are readily shed and fall to the ground. The grass can also spread by tillering from the base of the plant.

Importance

This seed and vegetatively-propagated weed rapidly renew growth following periods of rainfall, and is a serious weed in pineapple fields. It is especially a problem after the canopy closing stage, when it can compete and outgrow the cultivated pineapple.

Mechanical removal of the whole plant, including the roots before it sets fruit, can assist in reducing further weed growth. Seed germination will occur after each rain and requires continued control practices.

Figure 4: Wiregrass amongst pineapple crop removal is difficult as the grass breaks up at the nodes, leaving the roots intact. Line drawing from St. John and Hosaka (1932).

Figure 5: Guinea grass at the vegetative and flowering stage in pineapple; such dense clumps impede harvesting. Line drawing of Guinea grass from Hitchcock's (1935) *Manual of Grasses of the United States.* U.S. Dept. of Agriculture.

Guinea Grass

Megathyrsus maximus (Jacq.) B.K. Simon & S.W.L. Jacobs var. *maximus*

Synonyms

Until 2003, it was named *Urochloa maxima* (Jacq.) R.D. Webster var. *maxima* and previously *Panicum maximum* Jacq. var. *maximum*.

Common names

Guinea Grass, Green Panic Grass, Purple Top Buffalo Grass, Tanganyika Grass

Description

This shade-tolerant large clumping perennial bunch grass can grow up to 9 feet tall and shows considerable variation.

Leaves can be up to 3 feet long by 1" to 1½" wide. The leaf surfaces may or may not be hairy, being densely hairy at the nodes. The leaf sheaths can be hairy or not. The ligules at the junction of the leaf blade and sheath have a very short fringed membrane. The stems can be branched and vary from being hairless to very hairy. It has short underground stems that form tufted clumps, with the aboveground stems being usually upright.

The flower head (inflorescences) consists of loosely branched open panicles bearing a large number of small flower spikelets, 1/5" long and normally green but sometimes reddish or purplish. The hairless flower spikelets are green or purplish, and shed entirely when mature.

Dispersal

The flowering heads on a plant are capable of producing 9,000 seeds that are readily dispersed by wind, animals, water, and in soil. Seed germination rate is low and requires storage dry for 6 months or more. Asexually or apomictic seeds lead to genetic uniformity in local populations.

Importance

This long-lived, hardy, rapidly-growing weed is very common in orchards, plantations, pastures, and disturbed sites along roads, as well as in natural areas. It grows into tall dense clumps between pineapple rows, making harvesting very difficult. It is a fire hazard in dry periods.

This weed is frequently controlled by mechanical removal. It is susceptible to glyphosate, including drizzle application. Young plants are susceptible to selective grass-killers (Motooka et al., 2003).

Morning Glory

Convolvulus arvensis L.

Common names

California Morning Glory, Field Bind Weed, Koali, No-Asagao

Description

A rapidly spreading, creeping vine.

The heart-shaped leaves are 2" to 4" long by 2½" to 3½" wide, green above, light-green below. The leaves are lobed at the base and clothed with inconspicuous hairs on both surfaces. The slender leaf-stalks (petiole) are 1" to 3" long, covered with minute hairs. The stem is clothed with hairs.

The plant produces one to two flowers on each node. The single flower stalk is 4" to 5" long and covered with minute hairs. Each funnel-shaped flower is 2½" to 3" long and 3" across. The corolla is slightly 5-angled, blue that changes to pink when old. The corolla-tube is white or yellow and smooth. The calyx is 1" to 1¼" long and ¼" to 3/8" wide, with 3 outer and 2 inner sepals that are broadly lance-shaped and covered with inconspicuous hairs.

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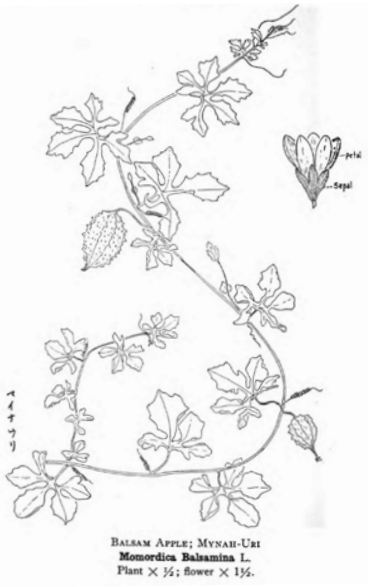
Figure 6: Severe morning glory infestation of pineapple. Two types of morning glory are seen, one with yellow flowers and one with white flowers. Line drawing of morning glory from St. John and Hosaka (1932).

The seed pod (fruit) is rounded and 3/8" long. The dull black, rounded or somewhat flattened seeds are 3/16" long.

Dispersal
At maturity, the pod splits open, exposes and releases the seeds.

Importance
This fast-growing and long-lived plant twines around the crop plants and strangles them. The plants can be pulled out by hand, though finding the rooting point is difficult because of its numerous trailing vines. This weed is naturally tolerant of glyphosate, but it is susceptible to oxyfluorfen.

Figure 7: Bitter melon can become entangled into the crop and compete for light and nutrients. The insert shows the ripe fruit. Line drawing from St. John and Hosaka (1932).



Bitter Melon

Momordica balsamina L.

Common names
Balsam Apple, Mynah-Uri

Description
This is a creeping, freely branching twining vine.

The alternate leaves are deeply 5-lobed, 1½" to 2½" long, and 2" to 3" wide, green on both sides. Both leaf surface are sparsely covered with hairs, with more on the veins. The petioles are ¼" to 1¼" long. The slender climbing stem is covered with short white hairs.

The flowers are ½" to 3/4" across, light yellow, on slender flower-stalks 1½" to 2¼" long. Only one flower occurs on a stalk. The smooth petals are 5-lobed, with the calyx being about half the length of the flower, and the lobes joined below the middle and covered with minute hairs.

The rough orange fruit are 2" to 3" by 1½" to 2" wide, enlarged in the middle and with pointed ends. Several ridges run along the fruit. The oblong, slightly flattened, light-colored seeds are 3/16" to 5/16" long by 1/8" to 3/16" wide.

Dispersal
Many seeds are found in the fruit. The fruit are eaten by Mynah birds and the seeds scattered in their droppings.

Importance
This is a quick-growing and long-lived plant. It twines around the crop plants and chokes them.

It is important to prevent the production of fruit. Young plants can be easily destroyed by pulling.

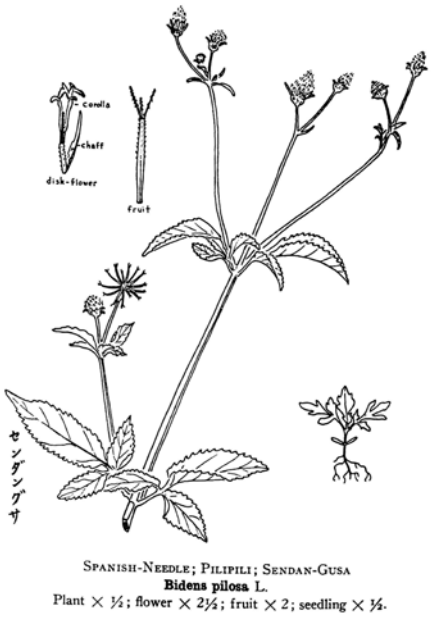


Figure 8: Serious infestations of Bidens are often found at the edges of a field and compete with the crop. Line drawing from St. John and Hosaka (1932).

Figure 9: Nightshade showing black berries and dense growth. Line drawing from St. John and Hosaka (1932).

Bidens

Bidens pilosa L.

Common names

Spanish-Needle, Pilipili, Sendan-Gusa

Description

This is an upright, freely branching plant that is 1½" to 3' tall and can occur in clumps.

The stalked opposite leaves can be from simple to 5-parted. The simple egg-shaped to broadly lance-shaped leaves are 1½" to 2" long and 1¼" to 1½" wide, being green above and light below. The leaf surface is slightly rough on both surfaces, with saw-toothed margins. The angular stem can be smooth or hairy.

The flower heads are ¼" to ½" across by ½" to 3/4" long. The individual tubular yellow flowers on the head are about 3/16" long, 5-lobed, and covered with minute glandular hairs. Flowers in heads are surrounded by 2 or 3 series of greenish paddle-shaped hairy scales that are 3/16" long.

The fruit are ¼" to ½" long, linear, straight to slightly curved, black, angular, and spiny on the ridges. They are provided with three stout spines at the tip, two of them are 1/8" long, with the middle spine being shorter.

The root are moderately deep and branched.

Dispersal

About 30-50 fruit are produced on a single flower head. These are provided with spines, which help them cling to clothing of people or hairs of animals. Dogs and mongooses help scatter the fruit.

Importance

This is a quick-growing and short-lived plant that can be a serious weed of pineapple fields. The weed outgrows the plant crop and chokes it.

Control

It is a good practice to destroy the young seedlings mechanically. Large plants can be eradicated by hoeing, and if possible, the plants should be removed from the field because of their seed production.

Mechanical removal of the whole plant, including the roots before it sets fruit, can assist in reducing further weed growth. Seed germination will occur after each rain and requires continued control practices.

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Nightshade

(Solanaceae)

Solanum americanum Mill (Syn. *Solanum nodiflorum* Jacq.)

Common names

American Black Nightshade, Popolo, Yama-Hoduki (Ya-ma-Hodzuki)

Description

A slightly woody plant, 1 to 3 feet tall, and branches freely. The plant has a long, well-anchored tap-root. The opposite or alternate leaves are 1.5" to 2" long, and ½" to 1" wide, with an entire or wavy margin. The leaves are green and smooth on both sides. The leaf base contracts into a leaf-stalk that is ¼" long. The angular stem with rough or spiny angles, covered with minute hairs that are noticeable only by close observation.

The narrow, white flowers are 5-lobed, 1/8" long, with a 5-parted calyx that is 1/16" long and persistent at the base of the fruit. The drooping round fruit are 3/16" to 5/16" across, occurring in clusters of 3 to 5. The flower-cluster stalk is ¼" to ½" long.

When ripe, the fruit are black, juicy, and edible with many seeds. Each oval brown seed is nearly 1/16" long, flattened and pointed at one end. The fruiting stalk is 3/16" to 1/4" long and radiates from a common center.

Dispersal

The black fruit are eaten by birds, especially doves and Mynah birds, and the seeds scattered in their droppings.

Importance

This long-lived plant grows rather rapidly in moist areas and soon is taller than the pineapple plants, thus becoming a serious weed in some fields.

It is easily removed if attacked during the seedling stage before flowering and the seed set.

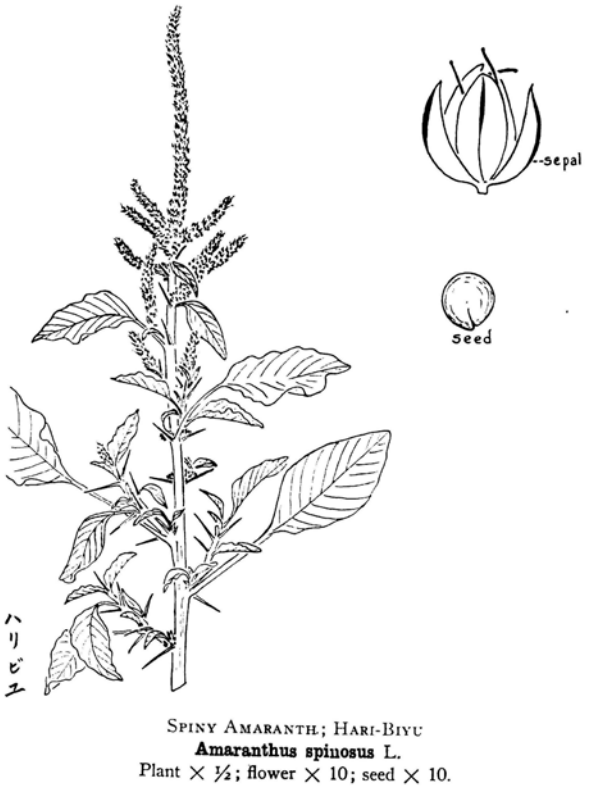

Figure 10: Spiny Amaranth can be a safety issue during field operations, such as harvesting, due to its spines. Line drawing from St. John and Hosaka (1932).

Spiny Amaranth

Amaranthus spinosus L.

Common names

Spiny Pigweed, Prickly Amaranth, Thorny Amaranth, Hari-Biyu

Description

This is an erect freely branching plant, 2 to 3 ft. tall. The broadly lance-shaped leaves are 1½ to 3" long and 3/4 to 1½" wide. The leaves are alternate on the stem and smooth on both surfaces being green above and lighter green below. The leaf-stalks (petiole) are 1" to 2" long with ¼" to ½" long spines at the base of the leaf-stalks. The reddish stem is stout. The plants tap-root is deep.

The flowering stalks arise from the axillary buds and the terminal bud. The flower are about 1/8" long and green with no petals. Five lance-shaped keeled sepals are green. The brown disc shaped seed is 1/16" across and shiny.

Dispersal

Hundreds of seeds are produced on the flowering-stalk. At maturity, the seeds fall to the ground and germinate after a rain.

Figure 11: Three species of fireweed with very similar flowers. The airborne seeds lead to ready dispersal.

Importance

Most commonly found in dry and in moderately wet areas. It can be a problem for field workers and workers harvesting fruit and slips.

This weed is rather quick-growing but long-lived. It is important to prevent the production of seeds. All matured plants should be taken from the fields to prevent seed scattering.

Fireweed

Five species from the Daisy/Sunflower family (*Asteraceae*) have very similar overall flower appearance:

- *Erechtites hieraciifolius* (L.) Raf. Ex DC. – fireweed or burnweed
- *Crassocephalum crepidioides* Benth) S.Moore, – redflower ragleaf or fireweed
- *Emilia fosbergii* Nicolson – Florida Tasselflower or Flora's paint brush
- *Emilia coccinea* – Scarlet Tasselflower
- *Emilia sonchifolia* (L.) DC. ex Wight – Lilac Tasselflower or Lilac Pualele. *Emilia fosbergii* may be a hybrid between *Emilia sonchifolia* and *Emilia coccinea*. The Redflower Ragleaf has drooping flower heads.

Figure 12: Line drawing *Erechtites hieraciifolius* (L.) Raf. Ex DC. - fireweed or burn-weed from St. John and Hosaka (1932).

Description - *Erechtites hieraciifolius*

Erechtites hieraciifolius (L.) Raf. Ex DC. - fireweed or burnweed is a slender, upright plant, 2 to 6 feet tall, with flower heads in a cluster at the top of the plant. Each flower head is about 1/2" long and ¼" across, and swollen at the base. The flower heads are greenish when young, turning purplish when old, with scales around the head, which are slightly shorter than the individual flowers inside.

The fruit are curved and 1/8" long, with a longitudinally groove and upturned spines, and at the tip is a turf of silky hairs ¼" long.

The leaf is oblong to lance-shaped, with some deeply cut to the midrib, while others are saw-toothed on the margin. The leaf surface is smooth on both surfaces. The round rough stem is weak. The roots are shallow.

Dispersal

Thousands of seeds are produced by a single plant, which are readily dispersed by wind and birds that eat the seeds.

Importance

This rapidly growing weed lives for a short time and is found in dry and wet areas. It can be a serious weed in pineapple, as it can outgrow and shadow the crop plant. Its shallow root systems and tender stems make it easy to kill. Avoidance of seeding is critical.

Tasselflower

Emilia sonchifolia (L.) DC. ex Wight

Common names

Lilac Tasselflower, Cupid's Shaving Brush or Lilac Pualele

Description

This is an upright plant that is 1 to 2 feet tall, with leaves mostly on the lower half of the plant. The tap-root is short. The egg to lance-shaped leaves occur with or without a margined petiole. Those without a margined petiole are

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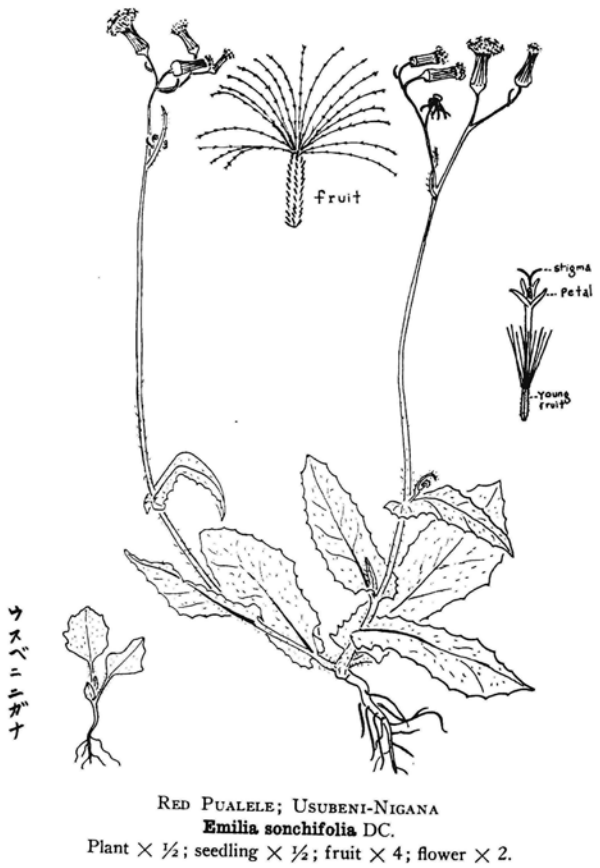

Red Pualele; Usubeni-Nigana
Emilia sonchifolia DC.
Plant × ½; seedling × ½; fruit × 4; flower × 2.

Figure 13: Line drawing *Emilia sonchifolia* (L.) DC. ex Wight -Lilac Tasselflower or Lilac Pualele from St. John and Hosaka (1932).

attached close to the stem and clasp around it. The leaves are slightly hairy with irregularly toothed margins. The stem is hollow, with the lower portion covered with soft hairs. The stem when broken exudes a milky sap.

The flower-heads are ½" to 3/4" long and ¼" to 3/8" across, with many on a common flowering stalk. The flowers are orange-red when young, turning to magenta-red when old. A ring of scales occurs around the flower-head that are slightly shorter than the enclosed flowers. The head is sparsely covered with hairs near the middle.

The fruit are 1/8" to 3/16" long, angled and covered with spines.

Dispersal

Hundreds of seeds are produced by each plant. The seeds have long silky hairs that help in wind dispersal.

Importance

This quick-growing plant is short-lived. The plant is weak and spindly, and is readily removed by pulling up the whole plant. Prevention of seeding is important.

African Tulip Tree

Spathodea campanulata P.Beauv.

Common names

African Tulip Tree, Fountain Tree, Flame Tree, Tulip Tree

Description

The tree can grow up to 50 or 60 feet, with a round spreading crown of 35 to 50 feet that is generally not very regular. The opposite green, oval to oblong, compound pinnate leaves are 2" to 4" long.

The large flowers are reddish-orange to yellow, trumpet -shaped, with five petals; very showy and 4" to 6" long. The bisexual flower has a yellow margin and throat on a 2" to 3" pedicel, mounted on a terminal raceme-type inflorescence.

The dry, brown capsular fruit is an elongated pod 6" to 12" long. The seeds are flat and thin, with a broad wing.

Figure 13: Isolated trees occurring in pineapple fields from wind-dispersed seeds.

Dispersal

The tree favors moist habits that are sheltered with prolific wind seed dispersal and spreads rapidly.

Importance

This has become more widespread, possibly because of the overall reduction of cultivated pineapple acreage and the closure of sugar production. Normally seen as an isolated plant in the fields that can be easily uprooted when young.

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