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Kaimi Spanish Clover For Humid Lowland Pastures of Hawaii

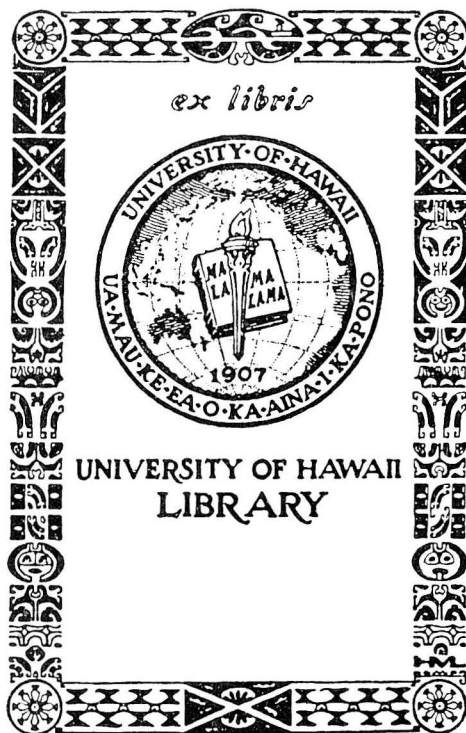
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HONOLULU, U.S.A.

CIRCULAR 22
FEBRUARY 1945



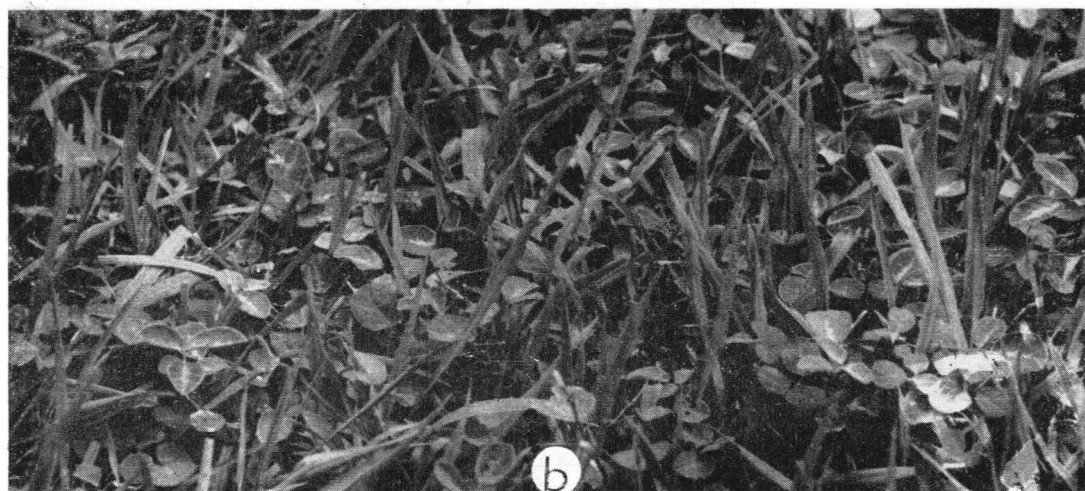


Figure 1. Kaimi Spanish clover in association with sward-forming grasses.
a, with kikuyu grass; *b*, with paspalum.

INTRODUCTION

Kaimi Spanish clover, *Desmodium canum* (Gmel.) Schinz and Thellung, a native of the West Indies, is an accidental immigrant to Hawaii. It was first collected in 1916. Only very recently has its importance as a forage plant been recognized and the pasture value of this species is here recorded for the first time. Elsewhere no attention is given this plant as a pasture legume. Because of its growth, habitat requirements, and distribution, it could become an important grazing legume in the humid lowland regions of the tropics. Its common name is derived from Spanish clover, which it resembles, and the Kaimi Farm on windward Oahu, where the first studies of its pasture value were made.

The genus *Desmodium*, to which the Kaimi Spanish clover belongs, is a large one with hundreds of species distributed throughout the temperate and tropical regions of the world. In spite of the large number of species, only a few are known for their forage value. The best known species is the Florida beggarweed, *Desmodium tortuosum* (Sw.) DC., found in the tropics.¹ No *Desmodium* species of the temperate regions are regarded as good pasture plants, although many are useful for soil conservation and as food for game birds.²

The writer first saw a few plants growing along the roadside near Hanalei, Kauai, in 1931. In 1936 three plants were seen growing in a pasture under a large mango tree at Kaimi Farm, Kailua, Oahu.³ In about four years natural spread to all the paddocks had occurred, and the clover in places had formed a conspicuous part of the sward. For the last few years, the Hawaii Agricultural Experiment Station and the University of Hawaii Agricultural Extension Service have sent to ranchers small packets of seeds for trial in zones C₁ and D₁.^{4 5} on the various islands.

¹ LEACH, C. F. BEGGARWEED. Suppl. Florida Quart. Bul., Dept. Agr. 34: 1-24. 1924.

² GRAHAM, E. H. LEGUMES FOR EROSION CONTROL AND WILDLIFE. U.S.D.A. Misc. Publ. 412. 1-153. 1941.

³ This farm is located in a low, wet region where the annual rainfall is about 80 inches.

⁴ Zone C₁—Found on both leeward and windward sides of the islands from sea level to about 2,500 feet. The annual rainfall is about 40 to 60 inches. Since much of the rainfall is of trade-wind origin it is sufficient in amount to support a dense and varied plant population. Most of the zone was probably once forested. Cleared lands support a vigorous growth of perennial grasses, as well as numerous perennial and annual herbs. The summer months are normally dry enough to permit normal ripening of the seeds, which germinate the following winter or spring. Both temperate and tropical species are adapted to growth in this zone. Most of the temperate species make seasonal growth in the winter and spring, while the tropical species tend to be perennial in growth.

Zone D₁—Lies principally on the windward side of the islands from sea level to 1,500 feet or less. With 60 inches or more of annual rainfall, this phase is not conducive to growth of desirable legumes, because the soils are generally quite acid, leached, and poorly aerated. This phase has probably the greatest need for good forage legumes to balance the grass forage, which is commonly low in protein, minerals, and total dry matter.

⁵ RIPPERTON, J. C., and HOSAKA, E. Y. VEGETATION ZONES OF HAWAII. Hawaii Agr. Expt. Sta. Bul. 89. 1-60. 1942.

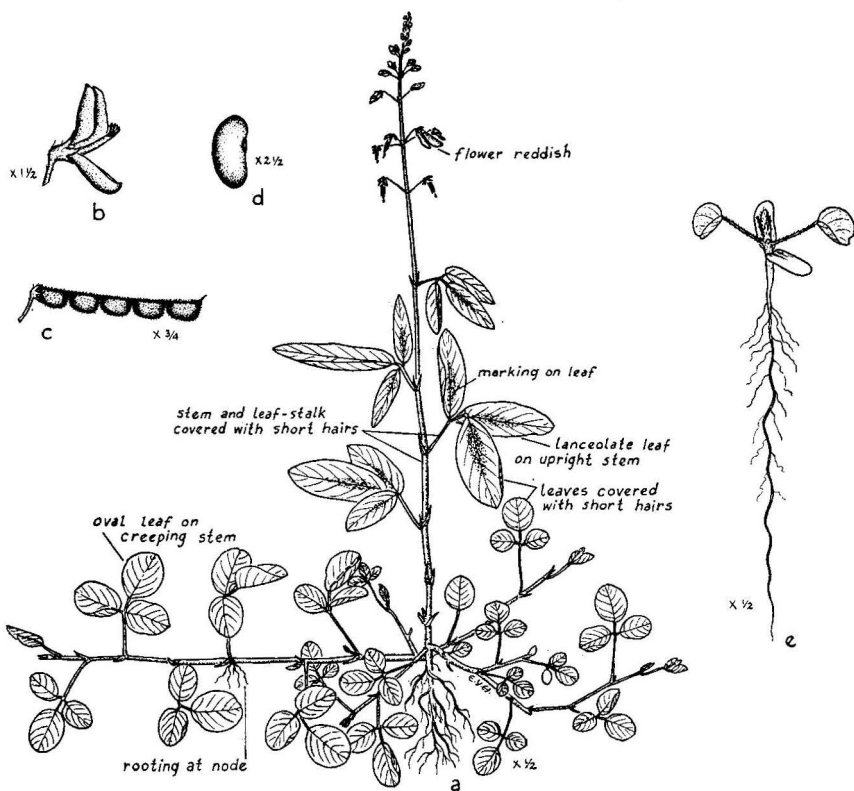


Figure 2. Kaimi Spanish clover (*Desmodium canum*). a, habit; b, flower; c, pod; d, seed; e, seedling.

DESCRIPTION OF THE PLANT

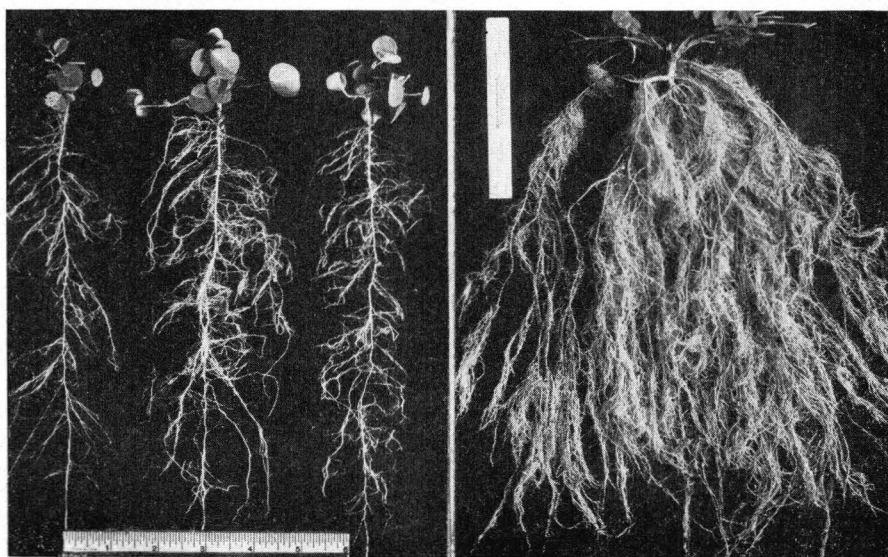
Kaimi Spanish clover is a long-lived, prostrate-to-upright plant with two kinds of stems (figure 2) each of which bears a distinctive type of leaf. On upright stems, lanceolate (longer than broad) leaves with a white marking in the center are produced. On decumbent to creeping stems, oval to round leaves without leaf-markings develop, and at some distance the plant often resembles white clover. When the plant is cut or trampled, there is a development of strong decumbent and prostrate stems. These root at the nodes where they lie on moist ground. Kaimi Spanish clover grows rather slowly in the early stages. In the first month it spreads about eight inches, but after six months it grows more rapidly by rooting and branching at the nodes. In a few years a plant may attain a spread of fifteen feet or more. Under natural growth and free from grazing or clipping, the plant grows upright into a diffuse undershrub with an undergrowth of a few trailing stems. In the young plant the primary root is fairly long with few branches (figure 3 left). With increased age many lateral roots develop and by the time the plant is five months old, it has developed an extensive root system (figure 3 right).

When the plant is about four months old, numerous reddish or lavender flowers are produced on the upright stems. The calyx is small and the lobes are pointed. Each flower is complete and self-fertile and gives rise to a 4-to-7-seeded pod. The pods are 1 to 1½ inches long and about ⅛ inch wide. The upper suture is straight and the lower margin is indented. The whole pod, which is covered with short brown hairs, clings to clothing and to hair of animals. The pod easily breaks apart at the joints. The light brown seed is kidney-shaped and is about ⅛ inch long and 1/16 inch wide.

Kaimi Spanish clover resembles the common, widely distributed Spanish clover, *Desmodium uncinatum* (Jacq.) DC., but it can be distinguished easily from that species. Kaimi Spanish clover has oval to round leaves on the prostrate stem; flowers about ¼ inch long and reddish or lavender in color; seed pod with a straight upper suture. Spanish clover has lanceolate leaves only; flowers ¼ to ⅜ inch long and white, greenish-white, or slightly pink in color; seed pod indented on both sutures.

Spanish clover makes its best growth in locations between 1,000 and 3,000 feet in altitude with 35 to 55 inches of rainfall, whereas the Kaimi Spanish clover is best adapted to zones below 1,000 feet with 50 or more inches of rainfall a year. This legume probably will not become a troublesome weed in cultivated fields. One farmer at Kailua, Oahu, reports that it is easily controlled whenever it gets into papaya and vegetable fields. Since the pods stick to clothing, it should not be planted in lawns.

Figure 3. Root systems of Kaimi Spanish clover. *Left*, root systems of 2-month old plants showing pronounced tap roots and few lateral branches. *Right*, root system of a 5½-month plant showing profuse branching. Six-inch rules give scale.



DEVELOPMENT OF FLOWERS AND PODS

An average of 44 flowers are borne on a single terminal inflorescence. The extremes recorded were 20 and 83 flowers. To study the development of pods, hundreds of inflorescences in bloom at the Pensacola Station grass nursery were tagged at random. It was found that, on the average, 39 out of 44 flowers on an inflorescence developed into pods.

The length of time from the opening of the flower to the maturing of the pod was found to differ depending on the length of day—the longer the day, the shorter the maturing period. The flowers tagged on May 2 took 19 days to mature their pods, those tagged on May 28 took 15 days, and those tagged on June 6 took only 12 days to develop mature pods. In May it took an average of 26 days for all the flowers on an inflorescence to develop mature pods, whereas in June it took an average of only 19 days.

ADAPTATION

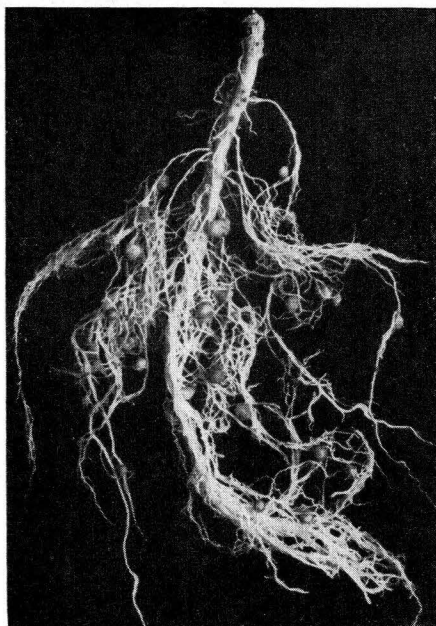
Under natural conditions, Kaimi Spanish clover flourishes in the lower elevations (below 1,000 feet) of zones C₁ and D₁ as shown in figure 7. The plant thrives best under conditions of adequate moisture, although plants growing in the lower phase of zone C, which has hot, dry summers, are not killed and produce new shoots and green up again with the first rains.

Although this legume is tolerant to soils of relatively high acidity and low lime and phosphorus content as indicated by its development in many parts of zone D₁, it responded remarkably to calcium and phosphate fertilizers at Kaupakulua, Maui, in zone D₁ at 1,000-foot elevation. The soil of this area has a pH range of 4.3 to 4.7. It contains about 450 pounds of available calcium and about 60 pounds of available phosphorus per acre foot and is rather typical of the poorer leached soils of this high rainfall zone.

SPECIES AS A PASTURE PLANT

Kaimi Spanish clover has all the qualities of a first-class pasture plant: palatability, persistence, growth habit, recovery, and seed production. Cattle and horses relish Kaimi Spanish clover at all stages of growth. It establishes itself first in open spaces between clumps and runners of grasses and covers the bare ground. Most of the roots are shallow, but some penetrate to greater depths than those of most grasses. This quality enables Kaimi Spanish clover to compete favorably with associated grasses for moisture. Some stems creep on the surface of the ground and develop shoots so readily that the growing point is seldom injured by grazing animals. The decumbent stem, which roots at joints where it touches the ground, produces numerous branches. The plant withstands grazing remarkably well and flourishes in association with sod-forming perennial grasses such as kikuyu, *Pennisetum clandestinum* Hochst.; buffalo, *Stenotaphrum secundatum* (Walt.) Kuntze; carpet, *Axonopus affinis* Chase; Bermuda, *Cynodon dactylon* (L.) Pers.; and paspalum, *Paspalum dilatatum* Poir. (figure 1). It produces many healthy nodules which enrich the soil (figure 4). A proximate analysis of leaves, stems, flowers, and green pods of Kaimi Spanish clover, parts that are normally eaten by grazing animals, was made by the Chemistry Division of the Experiment Station. The feeding value of the plant was found to compare favorably with that of alfalfa and koa haole. Kaimi Spanish clover is a valuable addition to the pastures of the low, moist zones because there is no other good forage legume in such locations.

Figure 4. Nitrogen-fixing nodules on roots of Kaimi Spanish clover. The oval to round nodules on a mature plant are about $\frac{1}{8}$ inch in diameter.



ESTABLISHMENT AND MAINTENANCE IN PASTURES

Experiments were initiated at Kaupakulua, Maui, to study the methods of establishing Kaimi Spanish clover in Hilo grass (*Paspalum conjugatum* Bergius) and paspalum pastures. Plots ten feet square were staked out in four pastures. Two pastures were of closely grazed paspalum, one of tall Hilo grass, and one of closely grazed Hilo grass. About 1,200 seeds of Kaimi Spanish clover were scattered in each plot. One quadrat of paspalum sod was roughly hoed and the seeds lightly raked in, while in the other, the seeds were broadcast on the grass. In the Hilo grass stands, the seeds were broadcast on the surface without any treatment.

Results after one year indicate that in order to get a fair stand of this legume the ground should be fairly open so that seedlings can get a foothold. Associated grasses should be kept short by clipping or light grazing, as the seedlings do not develop normally in shade. For this reason, Kaimi Spanish clover should be grown in association with short grasses. In establishing the legume in poor pastures of Hilo grass, ricegrass (*Paspalum orbiculare* Forst.), and yellow foxtail (*Setaria geniculata* [Lam.] Beauv.), the area should be grazed closely and the seed broadcast a few days before removing the animals. The open spaces between clumps of grasses will favor the growth of the legume. The initial stage of establishment in a pasture is rather slow. At Kaimi Farm, where the best stand is found, it took about three years for this legume to become a conspicuous component of the pasture sward. In pastures where Kaimi Spanish clover is established, it has been observed that moderate to relatively heavy grazing may be practiced throughout the year. This phase of study needs further investigation.

SUCCESION

The succession of Kaimi Spanish clover was studied at Kaimi Farm under natural pasture conditions.⁶ Four permanent 3-foot quadrats were staked out and charted in well established paspalum-Kaimi Spanish clover and kikuyu-Kaimi Spanish clover association pastures (figures 5, 6). In two and a half years there has been a decided increase in the cover of Kaimi Spanish clover in the two associations, but with no indication of the legume crowding out the companion species. This shows that Kaimi Spanish clover reaches more or less of an equilibrium with established sod-forming grass species. Similar indications have been observed in other established pastures. When the plant first establishes itself in a new pasture it infiltrates the grass stands and eventually attains an equilibrium with the grasses.

SEED COLLECTION AND THRESHING

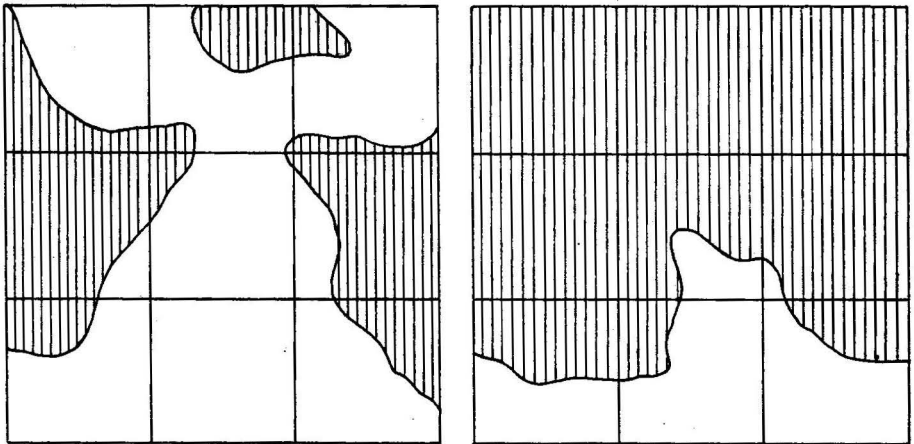
As yet no mechanical methods of harvesting Kaimi Spanish clover pods have been developed. Hand picking of seed is easy and relatively fast because the pods come off the flower stalk readily. By running the inflorescence through the fingers, all the mature pods may be collected in one motion. The brown and yellow pods are satisfactory for seed.

The pods adhere to one another and planting is much easier if seeds are removed from the pods. For small lots of seed an ordinary hand-operated meat grinder is useful. In using this machine it is important to adjust the opening of the grinder so that the seeds are not crushed.

As a source of seed supply of Kaimi Spanish clover, the rancher or dairyman can grow plants in a small plot. An area 50 by 50 feet will yield perhaps 5 to 10 pounds of seed a year. For seed purposes, row-planting was found preferable to broadcasting. Plants grown for seed should not be cut back and the development of upright stems, which always produce the flowers, should be encouraged.

⁶ Appreciation is extended to Dr. C. M. Cooke, Jr., owner, and Mr. Isaac I. Iwanaga, superintendent, for their interest and kind help.

Figure 5. Quadrat in a grazed pasture. *Left*, charted in September, 1941. *Right*, charted in February, 1944. Kaimi Spanish clover-paspalum mixture indicated by hatching; paspalum by white area.



GERMINATION OF SEED

The relative germinative capacity of seed from brown, yellow, and green pods was determined at time of harvest and after a period of storage under ordinary conditions.⁷ The effect on germination of planting threshed seed versus seed in pods was also studied. The germination period was one week in this study.

Table 1. Germination of freshly collected Kaimi Spanish clover seed at room temperature

KINDS OF PODS	THRESHED SEED			UNTHRESHED SEED
	Germination	Hard seed	Immature seed	Germination
	Percent	Percent	Percent	Percent
Brown	82	18	0	88
Yellow	97	0	3	96
Green	56	0	44	60

It is seen in table 1 that the unthreshed seed germinated as well as the threshed seed. There was some hard seed present in mature pods. Low germination of seed from the green pods was due to immaturity.

Hard seed, in which germination is greatly delayed, is characteristic of many legumes such as alfalfa, crotalaria, lespedeza, and koa haole.⁸ It was found that after three months of storage under ordinary conditions, the percentage of hard seed in Kaimi Spanish clover increased from 18 to 72 percent. In seeds that were stored for a year, however, hard seeds decreased to 30 percent. It has been found that hard seed coats of some legume seeds break down after a period of storage. Water then enters the seed and germination results.⁹

Seeds a few weeks to a year old gave the highest (90 to 96 percent) germination when treated for 9 to 13 minutes with 55 percent sulphuric acid. Seeds rubbed with sandpaper for a few minutes gave equally good germination. Hot water treatment is not recommended because of the danger of killing the embryo. For treating only a few seeds, sulphuric acid may be used. This treatment is not advisable, however, except for use of those familiar with the handling of this acid. Mechanical scarification is highly recommended when dealing with a large quantity of seed. There are several kinds of seed-scarifying machines sold and any one of them could be adapted with minor adjustments. Ranchers who do not have access to sulphuric acid or to a mechanical scarifier can obtain satisfactory germination by planting the seed soon after harvesting.

⁷ For this information, thanks are due to Ernest K. Akamine, Junior Plant Physiologist, Hawaii Agricultural Experiment Station.

⁸ AKAMINE, E. K. METHODS OF INCREASING GERMINATION OF KOA HAOLE SEED. Hawaii Agr. Expt. Sta. Cir. 21. 1-14. 1942.

⁹ MIDDLETON, G. K. HARD SEED IN KOREAN LESPEDEZA. Jour. Amer. Soc. Agron. 25: 119-122. 1933.

INSECT PESTS

Kaimi Spanish clover is relatively free from insect pests in comparison with many other forage legumes. The leaves are rarely eaten by grasshoppers and beetles, although young pods of plants growing adjacent to abandoned fields are chewed by insects. Flowering stems of mature, partly dried, or weak plants are occasionally attacked by the cottony cushion scale (*Icerya purchasi*);¹⁰ but the damage is not serious.

¹⁰ Identified by Dr. F. G. Holdaway, Entomologist, Hawaii Agricultural Experiment Station.

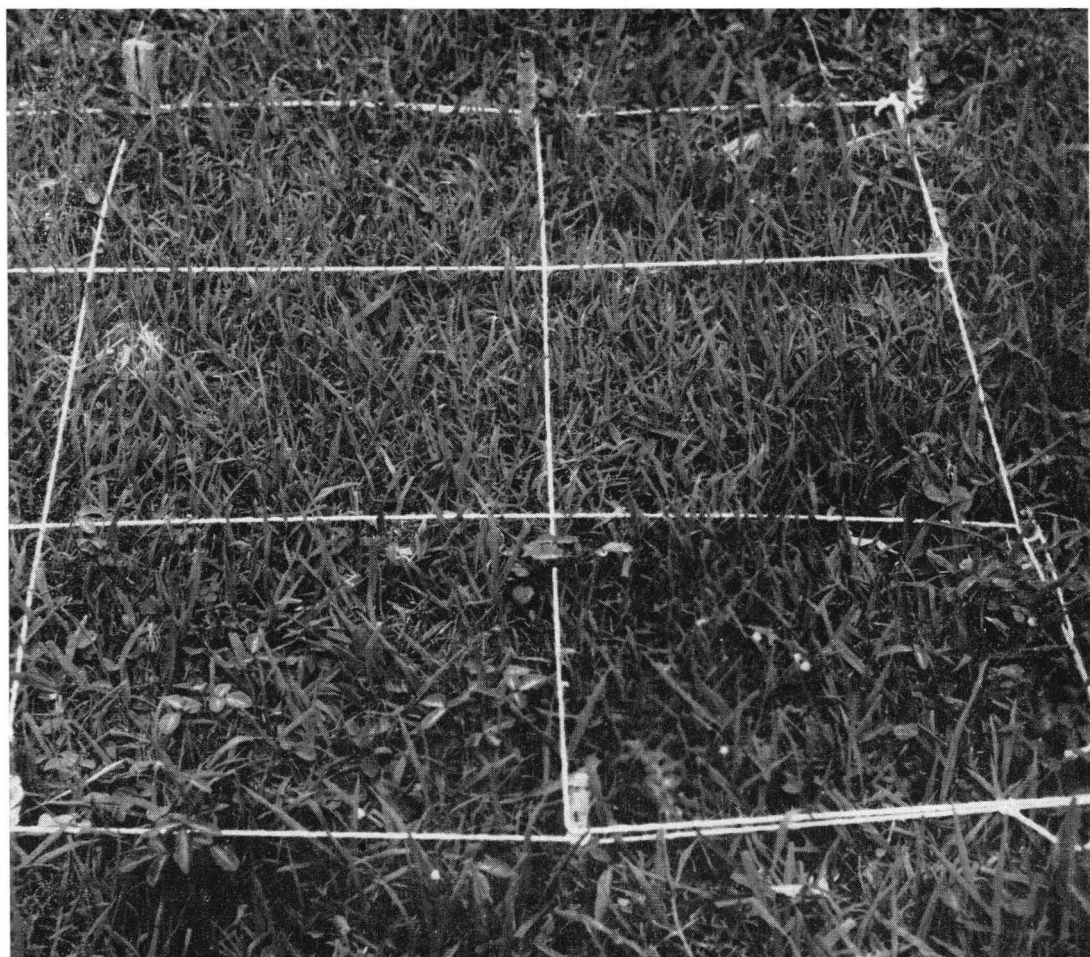


Figure 6. Quadrat installed at Kaimi Farm to study the succession of Kaimi Spanish clover in a paspalum sward.

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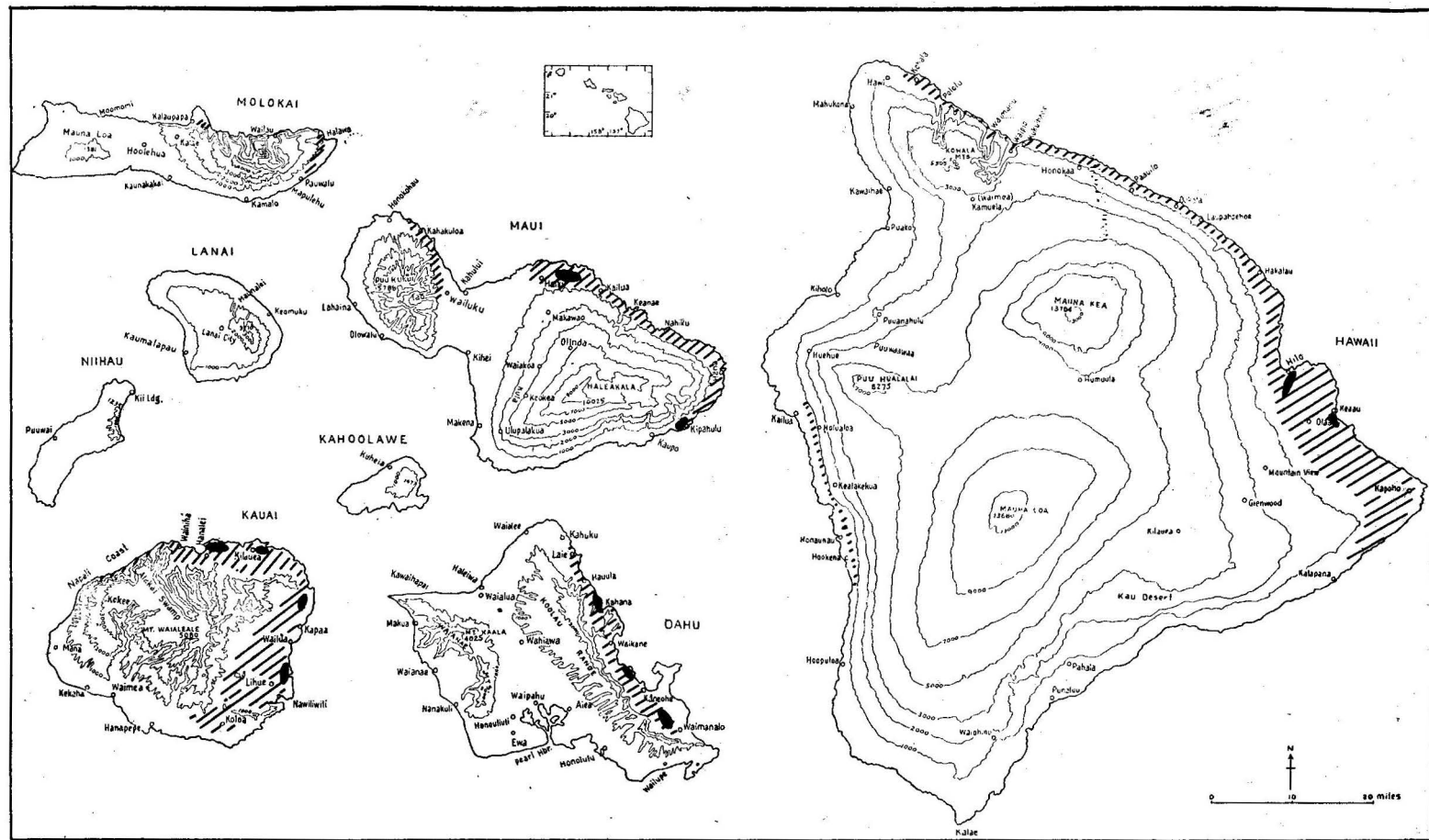


Figure 7. Black areas indicate present occurrence of Kaimi Spanish clover. Regions of potential distribution are shown by diagonal hatching.
(Base map courtesy Bernice P. Bishop Museum.)