LECTURE -7: LIVING MULCH FOR VEGETABLE CROPS

Major topics to be discussed:

- Justification for using grasses as living mulch
- Benefits of living mulch
- Problems with living mulch

Ecological basis for using grasses as a living sod

Grasses dominate in old field successions in Hawaii

- Plant succession from a disturbed site to a biologically stable one
- Perennial grasses dominate after early succulent weedy stage and before woody shrubs and trees
- Grasses can add large amounts of organic matter, above and below the ground

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Ecological basis for using grasses as a living sod

- Since grasses occupy a long time period during old field succession, they also represent a stable community of plants, in terms of composition and density
- Plants in succession are different in different climatic zones
- Each distinct ecosystem has a climax species
- Climax species and succession towards it are dependent on soil type, rainfall pattern and all other climatic variables

Grasses as living mulch in vegetable cropping systems

Energy options for weed control

- Human labor for manual weed control
- Fossil fuel for tractors with mechanical cultivators
- Chemical energy to produce synthetic herbicides
- Solar energy to produce organic mulch for chemical and physical weed suppression

Grasses as living mulch in vegetable cropping systems

Grass selections for living sods in vegetable crop production

- Grasses usually constitute a more stable succession phase
- Perennial grass fits between vigorous succulent weeds and woody shrubs during succession
- Grass seed is usually cheaper than legume seeds

Grasses as living mulch in vegetable cropping systems

Grass selections for living sods in vegetable crop production

- Grasses are quick to germinate and can produce large amounts of biomass
- Most vegetables are broad leaf plants; herbicides for grass control are currently available in many crops
- Grass living mulch suppresses weeds with a combination of competitive and allelopathic influences
- Grasses act as a conduit for converting solar energy into weed controlling energy

Herbicides for manages living mulches

- Assure II
- Fusilade DX
- Prism
- Poast

Potential Benefits of Living Mulch

- Heavy grass cover can mask the presence of vegetable crops that can reduce insect feeding
- Grass and other upright ground covers can harbor spiders that limit insect spread
- Grasses in general harbor fewer pathogenic nematode species than broadleaf plants.
- Non-host grass roots in the same soil environment of susceptible crops provide opportunity for nematodes to select the wrong roots

Potential Benefits of Living Mulch

- In rainy weather, grasses keep nutrients at the soil surface and prevent leaching into the water table.
- Living mulch also reduces rain splashing of the soil to reduce the spread of soil born diseases, also reduces the need to wash fruits before market
- Some grasses can promote beneficial root and microorganism associations
- Mychorrhizal fungi aid in P absorption
- Antibiotic production in root rhizosphere

Potential Benefits of Living Mulch

- Living mulches provide a protected microclimate for succulent transplants thus reducing shock from wind (soil blasting) and intense sunlight
- An established living mulch allows for nutrient loading of a site with reduced potential for loss through erosion and downward leaching with heavy rainfall
- Chemical nutrients applied to a living mulch are incorporated into plant tissues
- Nutrients released to the crop whenever stunting herbicides are used and mulch contacts the soil

Potential Benefits of Living Mulch

- Herbicide rates for stunting grass sods can be as low as half to a quarter of the recommended kill rates.
- Herbicides are applied to living grass as opposed to bare ground in conventional plantings; thus reducing movement with runoff.
- Grass species with greatest sensitivity to selective herbicides used as living mulch to minimize chemical inputs

Potential Problems With Living Mulches

- Dense stand of living mulch may become a fire hazard
- Preharvest interval of selective herbicides may result in over ripe fruits. Details are provided on product labels
- Poast, interval from last application to harvest ranges from 7 days with artichoke to 60 days with sweet potatoes, most others in the 15-30 day range
- Fusilade DX, preharvest interval ranges from 1 day for coffee to 55 days for sweet potatoes and yams

Potential Problems With Living Mulches

- Prisim: PHI 20 days for fruiting vegetables, 45 days for dry bulb onions.
- Assure: PHI 30 for mint, 15days for snapbean, and 160 days for pineapple

Potential Problems With Living Mulches

- Thick sods may mask the damage caused by soil rodents or chewing insects on stems.
- Rodent populations can increase in grass due to protection from predators; rodents will eat more vegetable fruits because they can reach higher parts of the plant
- Rodents very damaging with direct seeded cucurbits

Potential problems with living mulches

- Shading soil may delay the yields, thus delaying the income generating phase of the crop cycle
- Productive bearing life of crops can be extended because soil borne diseases are slowed due to cooler conditions and plants get larger before fruiting begins

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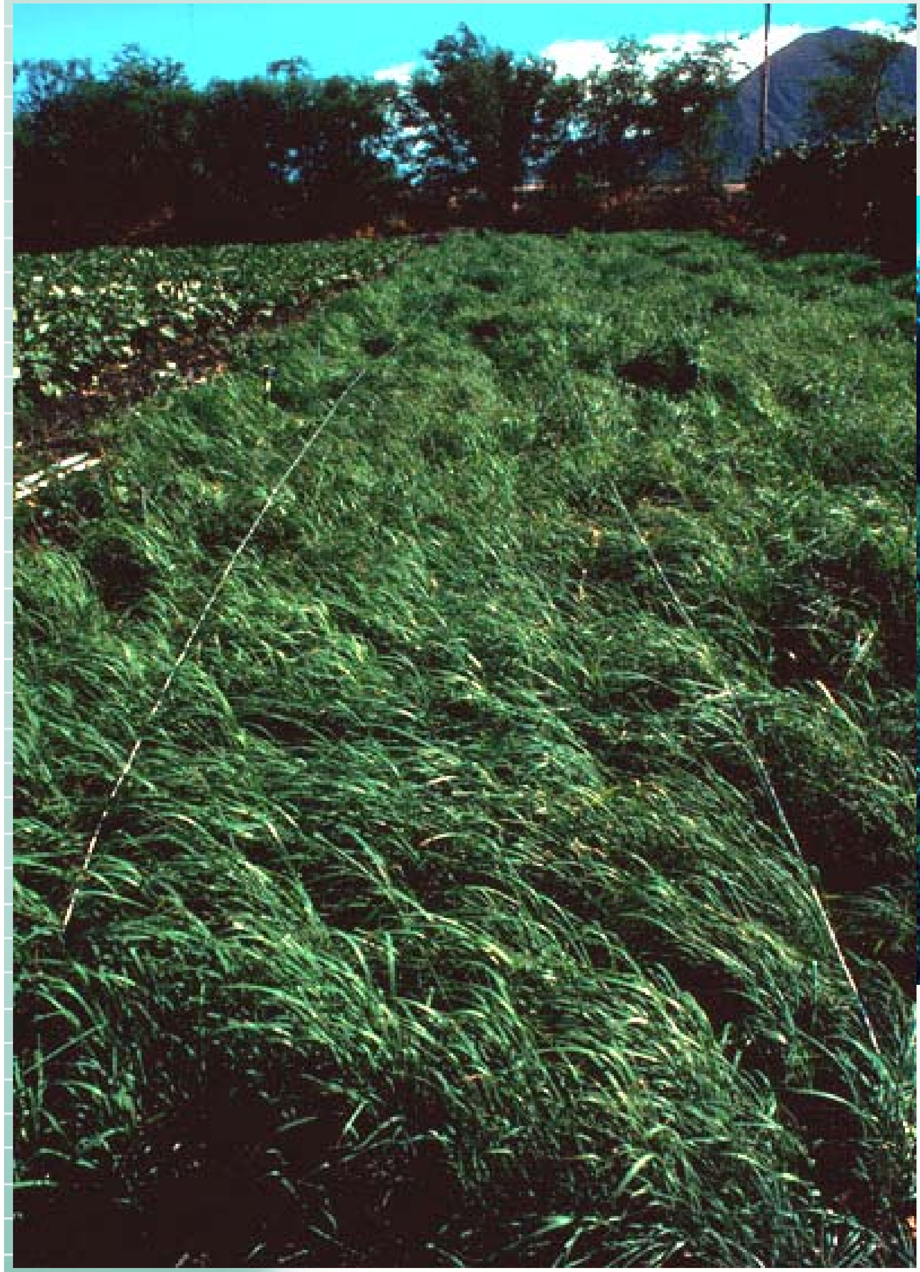


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Rhodes Grass

Bare ground

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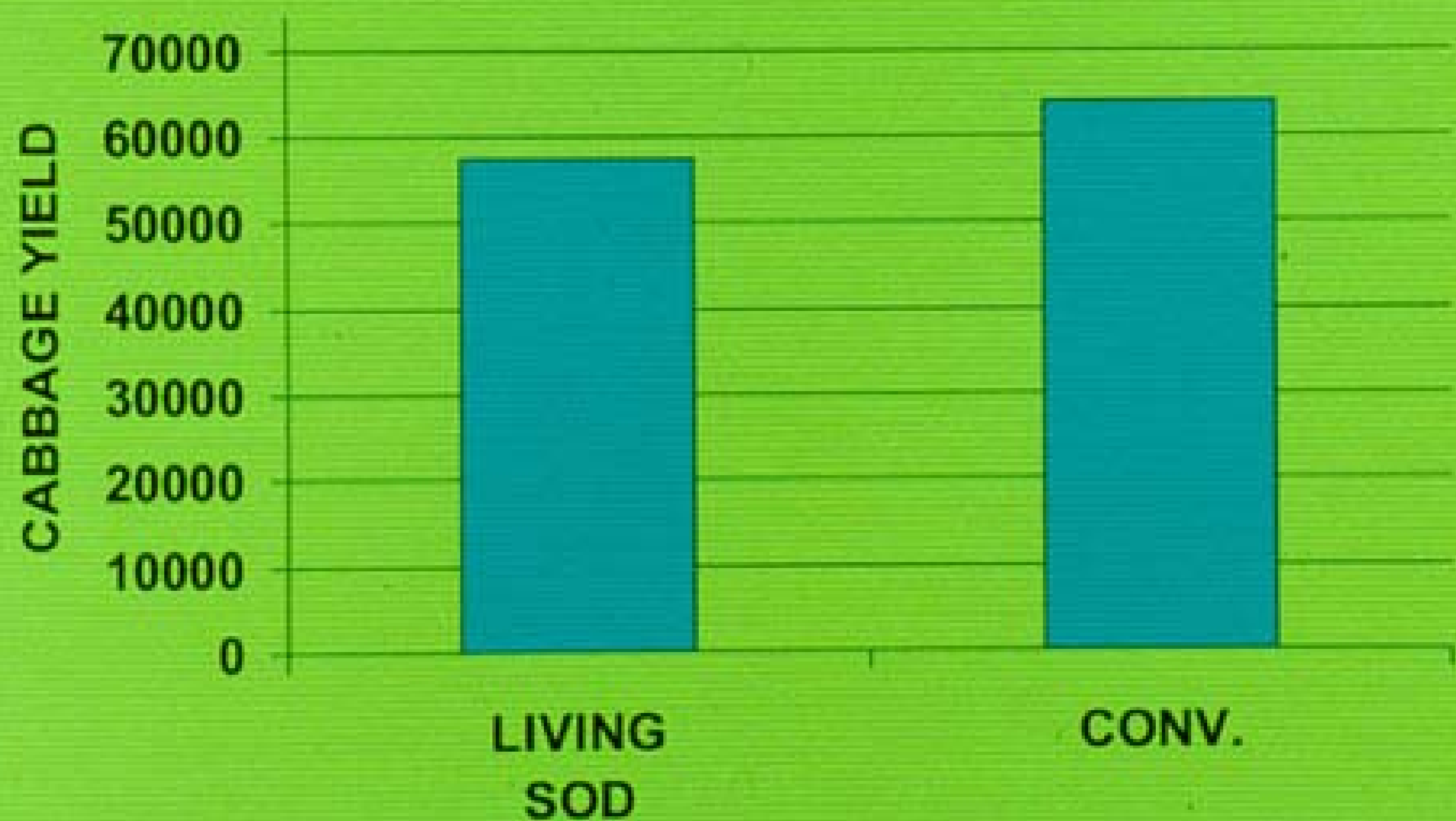
HEAD CABBAGE YIELD
68 DAT



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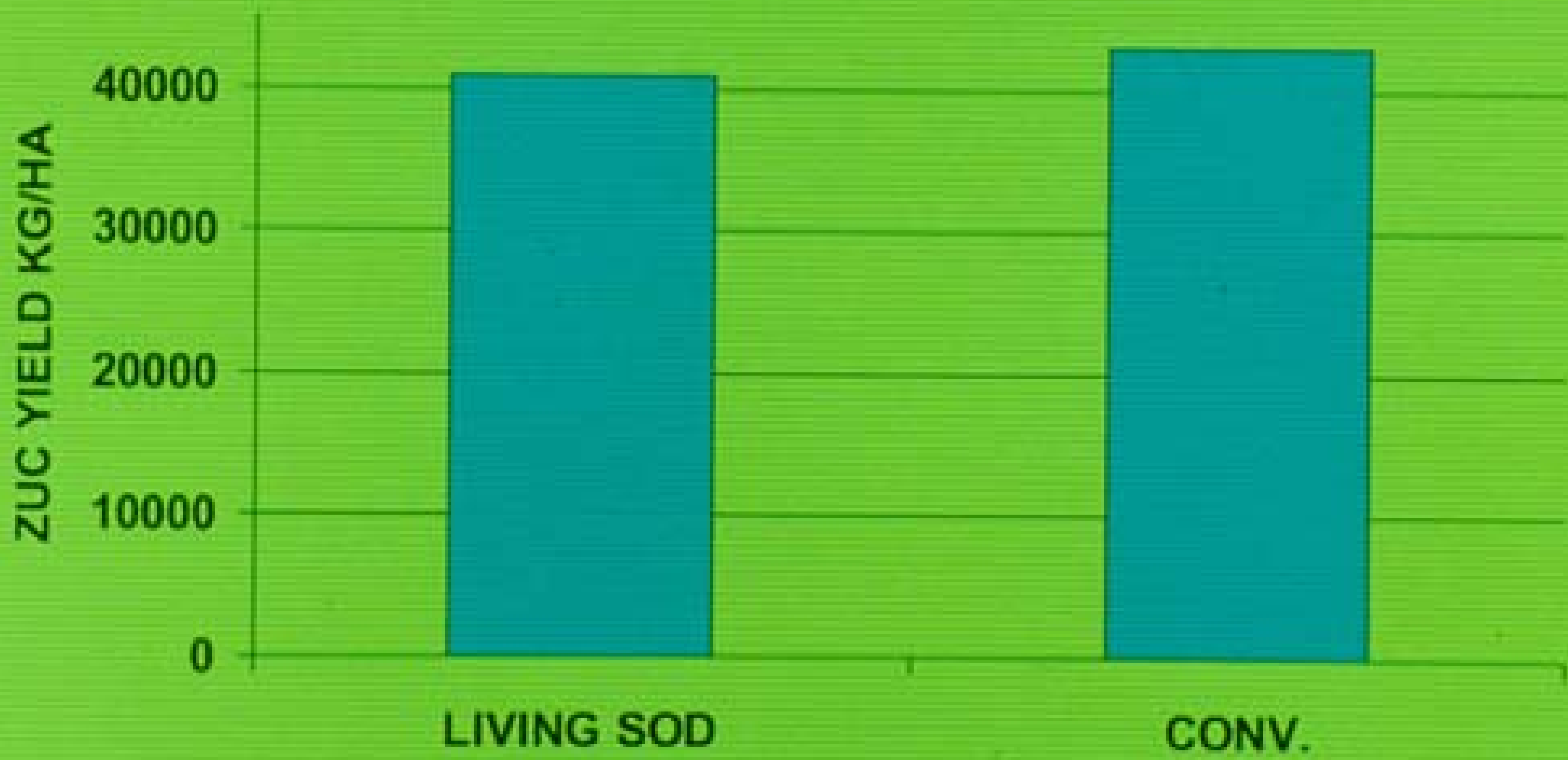
ZUCCHINI YIELD TOTAL OF 8 HARVEST 28 DAT WITH 4 DAY INTERVAL



Land preparation

Prior to piligrass planting:

pre plant weed control

- Installing overhead irrigation:
  (April 25, 2008)

- Spraying pre-&post-emergence
  (June 4, 2008)
  Goaltender 4F® (oxyflourfen 0.89 kg a.i./ha) and Roundup® (glyphosate 0.15 kg/ha) mixed with MSO (methylated seed oil 0.12 kg a.i./ha).

Establishment of piligrass LM (Feb-June 2008)


Germination seed in trays


Cutting piligrass flower prior to growing in the field


Transplanting 4 MAS 6/12/08


Fertilizing 112 kg N/ha as 18-0-18 (0 DAT)


Spraying oxyflourfen 0.45 kg a.i./ha (1 WAT)

Conditioning of piligrass


Mowing 1 (47 DAT)


Mowing 2 (68 DAT)


Spraying fluazifop 0.14kg a.i./ha (75DAT)


Stunting: 75 DAT

Crop I: Cabbage Fall 2008

Seeding in trays (8/12/08)

Transplanting cabbage 17 DAS

Fertilizer injection 90 kg N/ha
as 19-19-19 (34 DAT)

Snails & ants damage, 15 DAT

Living mulch & bare ground 30 DAT
space in row: 0.3 m

Pest control:

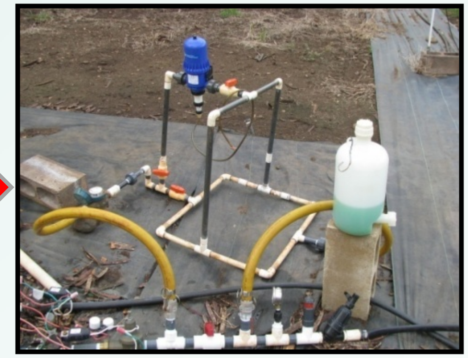
- Metahldehyde 1.34 kg a.i./ha for controlling slugs and snails (7 DAT)
- Diazinon 5.25 kg/ a.i./ha for controlling ants (17 DAT)
- Malathion 0.8 kg a.i./ha for controlling cabbage looper, cabbageworm & aphids   (34 DAT)

Crop II: Zucchini (Winter 2008)

Mowing, 14 DPT

Spraying Fusilade®
(fluazifop
0.14 kg a.i./ha)
(7 DAM)

Transplanting zucchini with space
0.9m in row (12 DAS)



Fertilizer 90 kgN/ha as 19-19-19
(14& 28 DAT)

LM & BG at 15 DAT

Pest control:

- Methaldehyde 1.34 kg a.i./ha for slugs and snails (0 & 7 DAT)
- Malathion 0.8 kg a.i./ha for aphids, leafhoppers, and cucumber beetles (30 DAT)

At 28 DAT of zucchini in winter 2008

Living mulch 28 DAT

Bare ground 28 DAT

At 39 DAT of zucchini in winter 2008

Living mulch 39 DAT

Bare ground 39 DAT

Crop III: Cabbage (Spring 2009)

Mowing I (14 DPT)
(1/23/09)

Spraying fluazifop 0.14kg
a.i./ha (7DPT)

Media for seeding:
promix+fertlizer (1/27/09)

Transplanting seeds to
trays (1 WAP)

Transplanting 9 DAS

Fertilizer 90 kgN/ha
as 19-19-19
(O & 33 DAT)

Spraying spinetoram 0.09
kg a.i./ha (12 DAT)

Spraying indoxacarb
0.08 kg a.i./ha
(38 DAT)

Mowing II (42 DAT)

Mowing III (69 DAT)

Pests control:

- Metahldehyde 1.34 kg a.i./ha for snails and slugs (7 DAT)
- Spinetoram 0.09 kg a.i./ha for cabbage looper, diamondback month, and imported cabbageworm (12DAT)
- Indoxacarb 0.08 kg a.i./ha for cabbage looper and cabbageworm(38 DAT)

Cabbage in spring 2009 (56 DAT)

Living mulch

Bare ground

Crop IV: Zucchini (Summer 2009)


Mowing (18 DPT)


Spraying fuazifop 0.14 kg a.i./ha (11 DPT)


Seeding trays prior to transplanting (10 DAS)

Transplanting in LM & BG 4/27/09 (0 DAT)


Spraying bifenthrin 0.13 kg a.i./ha (7 DAT)


Spraying spinetoram 0.09 kg + bifenthrin 0.13 kg a.i./ha (23DAT)


Fertilizer 90 kgN/ha as 19-19-19 (O, 7 & 23 DAT)


Mowing, (52 DAT or 63 DA stunting)

Pest control:

- Malathion 0.8 kg a.i./ha for aphids, leafhoppers, and cucumber beetles (0 DAT)
- Metarex® (methaldehyde 0.91 kg a.i./ha) for slugs and snails (14 DAT)

Zucchini plant and fruit damage due to ZYMV in Winter 2008

Bare ground (39 DAT)

Living mulch (39 DAT)

Zucchini yellow mosaic viruses (ZYMV)

Symptoms of plant: : yellow mosaic, severe malformation and severe plant stunting
Symptoms of fruit: distortion, deformation and blistering

I. Weed control

Weed biomass on <u>cabbage</u> Fall 2008 and Spring 2009

Treatments	Weed biomass (gram/plot)	
	Fall 2008 (15 DAT)	Spring 2009 t) (33 DAT)
LM	215	275
BG	**767 ***	**1 387 ****

Weeding, 33 DAT of cabbage spring'09

Weed biomass on <u>zucchini</u> Winter 2008 and Summer 2009

Treatments	Weed biomass (gram/plot)	
	Fall 2008 (28 DAT)	Spring 2009 (55 DAT)
LM	57.3	400
BG	**340.5 ***	**1 630 ****

Symbol (*) indicates significant different (P<0.05) and (**) highly significant difference (P<0.01) between mean of treatments (t) transformation data).

III. Marketable yield

Cabbage in living mulch, fall 2008, block IV

Cabbage in bare ground fall 2008, block IV

Cabbage in Spring 2009, harvest I

Total marketable yield of <u>cabbage</u> fall 2008 and spring 2009

Treatments	Total head (per ha)		Total weight (kg/ha)	
	Fall 2008	Spring 2009[np)]	Fall 2008	Spring 2009
LM	14’027	8’320	7’048	4’796
BG	14’682	**18’353 ***	11’286	**16’767 ***

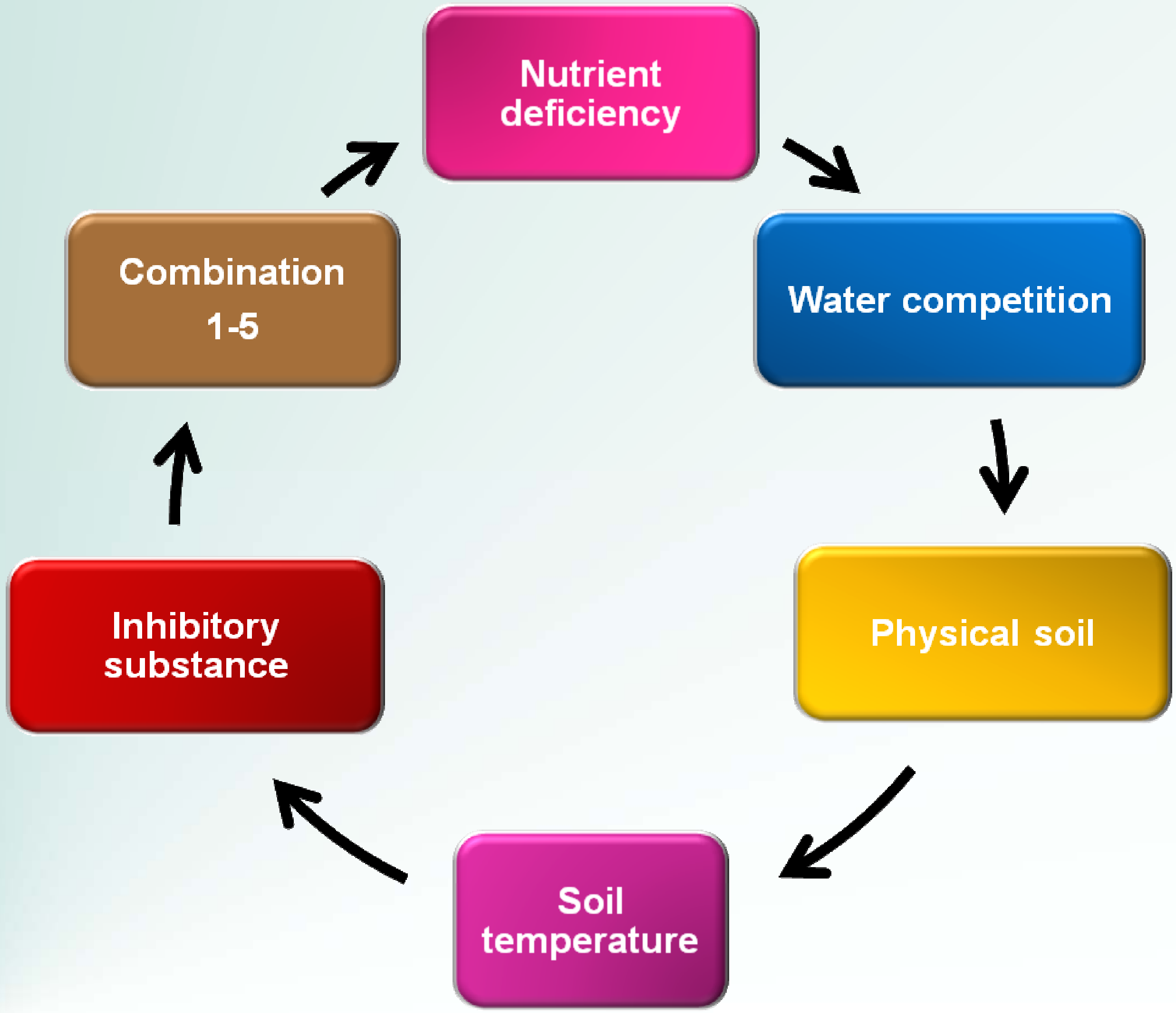
Symbol (*) indicates significant different ($P<0.05$) between mean of treatments ([np)] non-parametric)

Total yield of zucchini in summer 2009

Treatments	Total marketable yield	
	Total fruits (per ha)	Total weight of fruits (kg/ha)
LM	2’936	930
BG	**6’607 ***	**3’768 ***

Symbol (*) indicates significant different (P<0.05) between mean of treatments

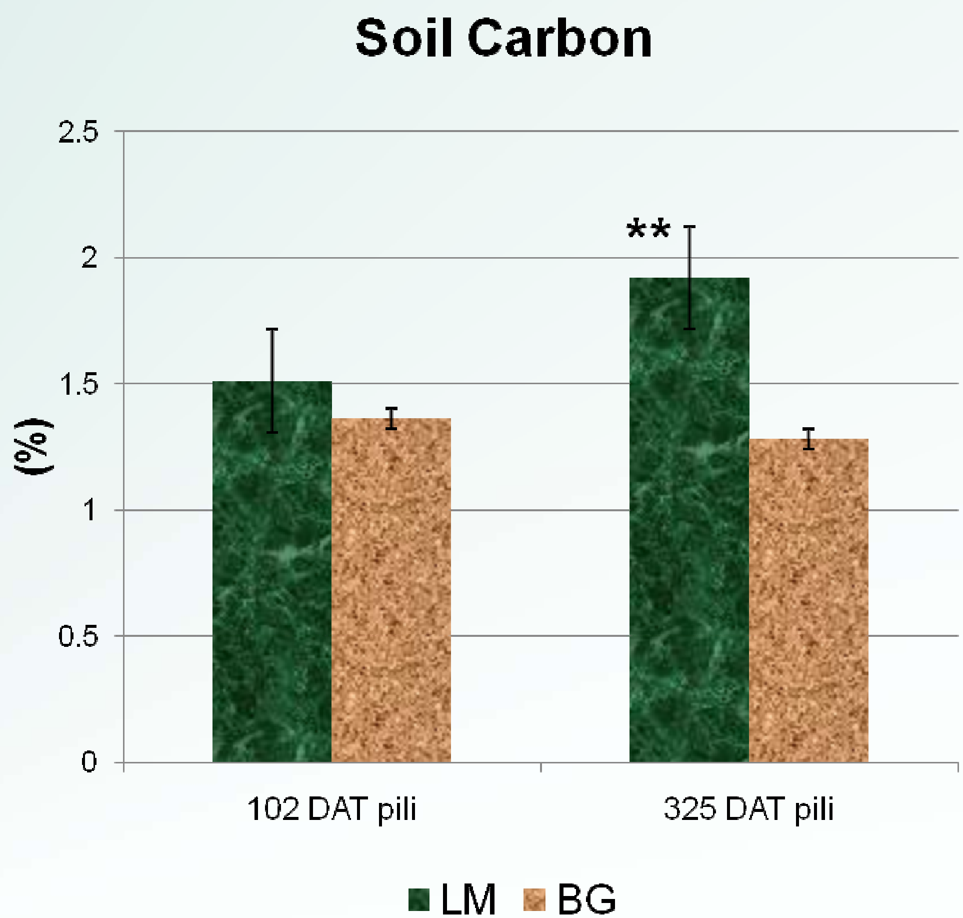
What is causing the yield reduction in LM?



Chemical properties of soil

Piligrass (*H. contortus*) 68 DAT

Nutrients	Compound (%)
N	1.08
C	**43.03**
P	0.18
K	1.70
Ca	0.23
Mg	0.23
Na	0.01
Fe	129
Mn	47
Zn	17
Cu	6
B	3
Dry biomass (Mg/ha)	6



Soil sample from 0-2 cm

I. Soil nutrients

Table. The changes of Nitrogen in soil and plant

Treatments	Soil (crop row at 0-2 cm depth)			Plant tissue of zucchini
	Total Nitrogen (%) 325 DAT pili	NH_4^+(mg/kg) 390 DAT pili	NO_3^-(mg/kg) 390 DAT pili	N (%) 372 DAT pili
LM	**0.14 ***	**3.04 ***	12.18	1.7
BG	0.11	1.97	13.53	**3.5 ***

Table. The soil nutrients and pH at 325 DAT piligrass

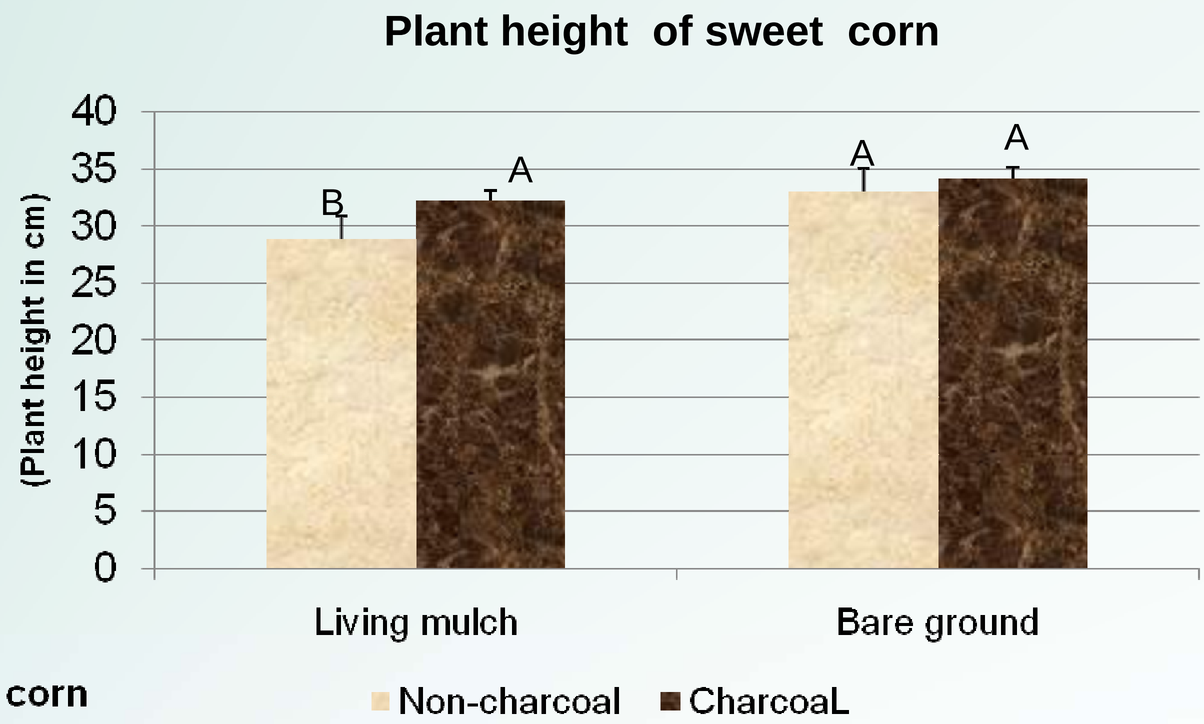
Treatments	P	K	Ca	Mg	pH
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
LM	366.5	816.5	3498	2416	6.45
BG	305	619.5	3371	2354	6.43

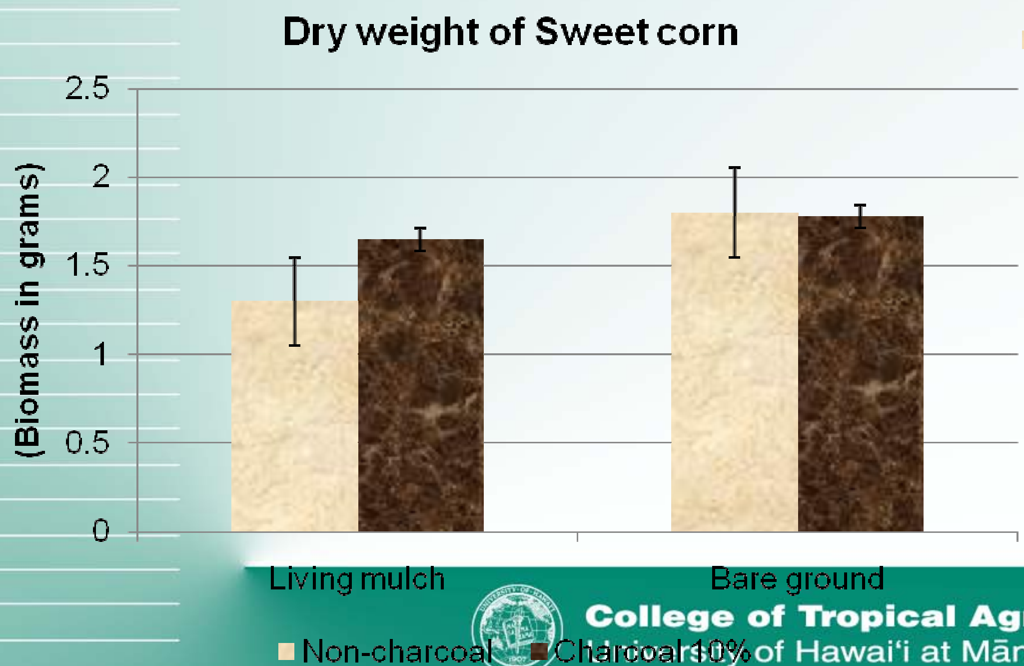
II. Phytotoxicity analyses

Charcoal test

- To determine if activated charcoal can relieve inhibitory nature of LM soil.
- Two Treatments: systems (piligrass LM and BG), Charcoal levels (0 & 10%) with 4 replications
- Indicator plant: super sweet corn 108 improved

b. Charcoal test





Summary of piligrass used as LM for tropical vegetable crop

Pro-

- Increased weed suppression
- Increased population & biodiversity of insects
- Increased soil N-input
- Improved soil structure & maintained soil moisture
- No clear detectable toxic compounds

Cons-

- Reduced crop yield
- Increased N-immobilization: N-deficiency
- Cooler soil

Recommendations for future research

1. Extend LM evaluation period to allow for the mineralization of N from soil microbes (3-5 yrs).

2. Evaluate piligrass LM with legume crops (beans) or crop with less N requirement (cassava).

3. Improve piligrass LM management: less piligrass more crop rows, more frequent mowing and chemical stunting during the crop

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