EFFECTS OF SHADING ON VETIVER GROWTH

A Photo Essay

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1. Introduction

It is well established that vetiver grass *Chrysopogon zizanioides* L. Roberty, is tolerant to extremely adverse growing conditions, it can be established and performs well under various habitat. As with all C4 plants, vetiver growth is sensitive to shading. Therefore shading is one of the limiting factor in Vetiver various applications. However due to its phenomenal growth rate under favourable conditions, the effect of shading on its growth is more noticeable. But this adverse effect of shading can be one of its advantages as well.

The followings show the effect of shading and its effect on Vetiver growth, so that we can have a better understanding to enhance its application potential. Attempt will also be made to determine the minimum light requirement

2. Literature Review

To determine the effect of shading or sun light requirement on Vetiver growth, experimentation under strictly controlled light duration and intensity are needed. So far literature search has failed to find recent studies on this topics.

In 1990 Dr PK Yoon of the Malaysian Rubber Research Institute (RRIM) Kuala Lumpur, conducted a meticulous study on the *Effect of Shade on Vetiver Growth* over the period of 2 years, under both shade house and natural light in rubber plantation.

Treatments include:

- 80% shade (similar to rubber plant nursery)
- Intense shade (87%)
- Recovering rate of vetiver growth following a period under shade
- Growth retardance when moving form open to shaded environment

Collected data include:

- Leaf area
- Leaf weight
- Specific Leaf Area (Leaf area/leaf weight)
- Tiller number
- Plant weight
- Shoot weight
- Root weight

Results (after 3-4 months growth)

1. *Plant growth,* shading significantly reduces:

- Tiller number,
- Plant weight,
- Shoot weight
- Root weight

2. *Long term plant performance*:
    - Plants in shade conditions continue to grow poorly with poor tillering under continuous shade
    - Plants grew poorly when moving from open full sun to shade
    - Plants from shade conditions performed well when moving to open full sun
3. *Long term plant performance under extreme shade*:
    - Vetiver hardly survived under 87% shading and eventually died off.
    - Light in fully grown rubber plantation is normally lower than 87%, so its growth is much reduced

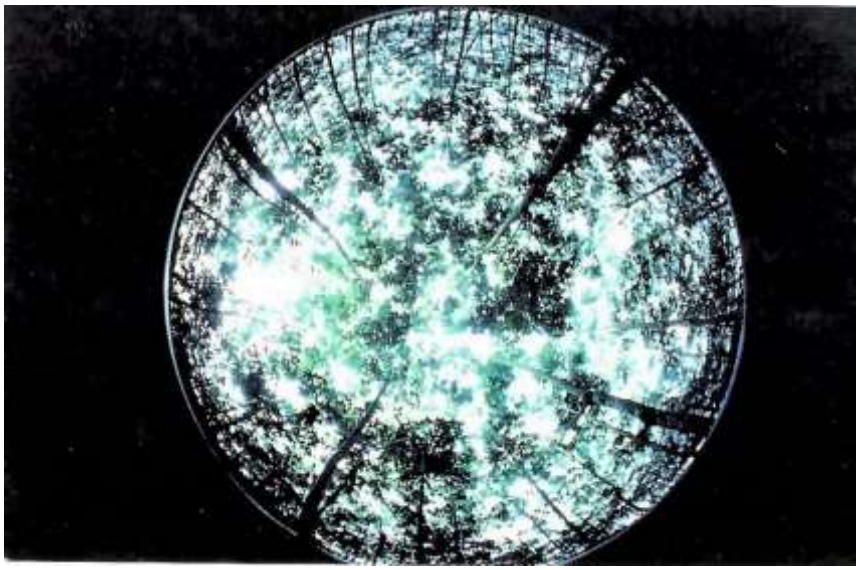
Conclusions

- Vetiver is not shade tolerant (as with most climax plant) but can survive under shade, but levels of minimum light and duration are unknown.
- Because of its shade sensitivity, potential competition between vetiver and tall perennial crops such as rubber, palm oil, orchard etc. should be considered and it should be planted first before the development of full canopy cover of the main crops
- The above point would make it ideal for soil and water conservation in the early stage of plantation crop establishment
- It could be easily rejuvenated if shading canopy is removed
- The above point suggests shade survival dependent on the degree of shading and periodic dose of more light would ensure its survival
- Vetiver will not be shaded out in crops which do not produce dense canopy or relatively short such as cocoa, tea etc.
- The percentage of root/shoot stayed rather constant, indicating shading affects vetiver physiology and morphology profoundly.

*Shoot and root growth under shade (80%) (**L**) and in open after 4 month growth (**R**)*

*Shoot and root growth of plants when moved from open to shade (**L**) and from shade to open after 3 month growth (**R**)*

Vetiver very poor growth after 2 months under shade of advance rubber trees



Hemispherical photo showing canopy of rubber nursery with intense shade of 87%

A study related to the topics reported by Chuntana Suwanthada and Jarunee Panekoksoong in Chiang Mai, Thailand: ***Observation on growth performance of four vetiver varieties grown under natural shade.*** This study was conducted under natural shading in a forest. But the cultivars used: HKPW 07, HKS 04, HKU 05 and HKUH 03 may be from the native *Chrysopogon nemoralis* rather than *Chrysopogon zizanioides.*

Results showed all these varieties grew well under shade, though with slight difference in some aspects among varieties, and after four year of growth with no signs of dying back. Increases of clump thickness and number of tillers per clump indicated their potential of being shade tolerant varieties applicable for soil conservation in shaded areas.

Cultivar: HKPW 07

Cultivar: HKS 04

Cultivar: HKPW 05

Cultivar: HKS 03

A more recent study published in the Journal of New Sciences in August 2017, **Effects of shading on vetiver development (*Chryopogon zizanioides L.*) under greenhouse,** Ben Romdhane *et al* compared the growth and development of vetiver under 40% of shade in the greenhouse and open conditions. Results showed that vetiver growth was significantly influenced by shading, which induced an increase of 50% of tiller number per plant, 86% of plant growth, 14% of root length, 8% of leaf number and 50% of dry matter as compared with control. Moreover, vetiver has a very important nutritional value (0.8 UFL). The followings are details of some results not reported before:

- Plant height increased from 136cm to 254cm under shade (86%)
- Leaf number /plant: Increased from 190 to 206 under shade
- Leaf surface area/plant: Reduced from 3 220mm^2 to 2 109mm^2 under shade
- Indicating that *to counteract shading, vetiver produces more of smaller leaves*. This is in contrast with other plants, which often enlarge the existing leaves.
- Shading affects the nutritional values of Vetiver:
    - Increase in Crude Protein content by 7%
    - Increase in Mineral content by 38%
    - Increase in Cellulose content by 25%
    - Increase in Organic Matter content by 5.4%
    - The Energy Value (UFL) of vetiver under shade is 0.8 as compared with Oat – 0.71, Rye grass – 0.73, sorghum – 0.68
- ***This makes Vetiver a very valuable fodder for livestock even under shade***

There was also a report from Trinidad in the Caribbean that vetiver hedges established decades before for erosion control in forest plantation, was shaded out but persisted and returned in the secondary forest,

3. Special Vetiver Attributes

Vetiver Shoots

Vetiver has an unusual leaf and shoot architecture. Unlike most of other grasses, Vetiver has a V shaped leaf with a prominent mid rib, which can control the opening or closing of the leaf. Under moist or wet conditions, the leaves open up, resulting in higher transpiration rate, and Liao et al (2003) found that leaf blades of vetiver grown in wetlands became thinner and the density of stomata increased – an ideal combination for wastewater disposal. But under dry conditions, the leaves close up resulting in lower transpiration rate to conserve moisture, so it is very drought tolerant.

V shape leaves with a prominent mid rib which can open or close leaf blade

Vetiver Canopy

The stiff and erect shoots form a dense funnel shape canopy with leaf angles varying between 45° and 135°, not flat or horizontal like broadleaf plants or most grasses such as Lemon grass and Panicum. This shoot architecture has several important implications: the longer sunlight interception of individual leaves as the sun moves from east to west, sunlight interception from both sides of the individual leaf, exposing most of the leaves simultaneously to sunlight, with minimal shading of leaves within the canopy as most other plants.

Another unique feature of vetiver leaf is that it only bends almost at the tip, unlike other grass, such as lemon grass, the whole leaf bends down and shading lower leaves. Consequently, larger leaf surfaces of Vetiver are exposed to sunlight over a longer time for photosynthesis, leading to better growth as compared to other plant species.


Stiff and erect shoots with 45°-135° angle (left) and its bent tips (centre), forming a thick hedge when planting close together (right)

Lemon grass canopy, note internal shading caused by upper and outer leaves.



Side view *Top view*

Panicum grass canopy, note internal shading caused by upper and outer leaves.



Mature plant *Side view of young plant* *Top view of young plant*

4. Impact of Shading on Vetiver Growth

These photos show the direct impact of shading on vetiver growth in orchards in Thailand (left) and Australia (right)

The impact was more severe in low rainfall area

5. Impact of Shading on Vetiver Growth under Various Applications

Drainage stabilisation in Australia

Growing very well under different degrees of shading (2002)

As the tree canopy advanced, shading became more severe and vetiver was badly affected and dying out (2014)

Canal bank stabilisation in Thailand (Taweesak Klinkong)

Under almost totally shaded conditions *In the open*

Philippines (Yang Bajamunde Dulce)

Trinidad & Tobago (Jonathan Barcant)

On residential projects where, in neighbouring sites with similar soils, the growth difference has been tremendous due to shading. On one of the sites which was an earlier project, the plants after 2-3 years expanded to only about 4-5 "slips wide", with strong root depths not estimated much deeper than 1-2 feet. For a while it was thought it was a sure sign of poor soil, so fertilizers and amendments were applied, because it was not immediately thought of the area could be totally shaded since it was in a fairly open area.

But when the effects of shade was recognised on other projects, it was realized that there is a massive "samaan" tree on the hillside above, and though it is a long way above, it casted a lot of shade and so vetiver plants was never really got direct sunlight. Later as a comparison, more vetiver was planted on other parts of the same property and neighbouring properties, in open sunlight, and in just one year the vetiver has grown significantly to sizes of between 40-60 slips. Since the soils at these other sites are the same, the shade can be the only explanation for slow growth in our original location.

As a result it must be very careful with new sites, especially at residential areas, when recommending vetiver grass use; and as such more shade tolerant plant species should be consider as a companion plant with vetiver.

The following photos show that although the site doesn't appear to be too shaded as it's got a lot of open space, but there is a big tree way above casting shade.


These Vetiver plants are about 3 years old, and they are clearly stunted in the shade.

Under various conditions around the world (Jaimie Cervantes Calderas)









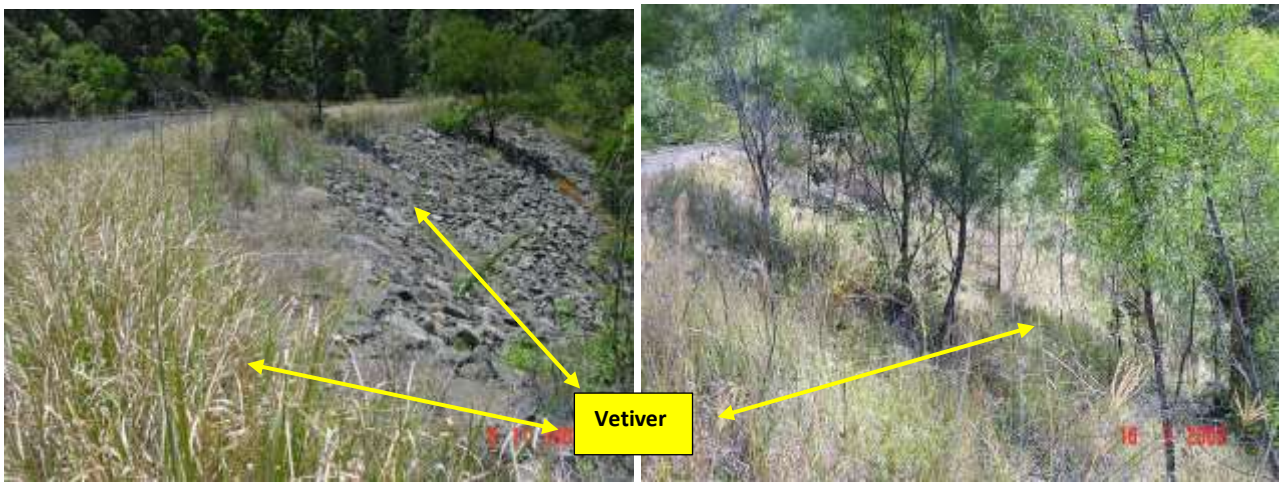
Vetiver growth is less affected by shade on more fertile top soil (background) than on poorer subsoil (foreground)

6. Some Advantages of Shade Sensitivity of Vetiver

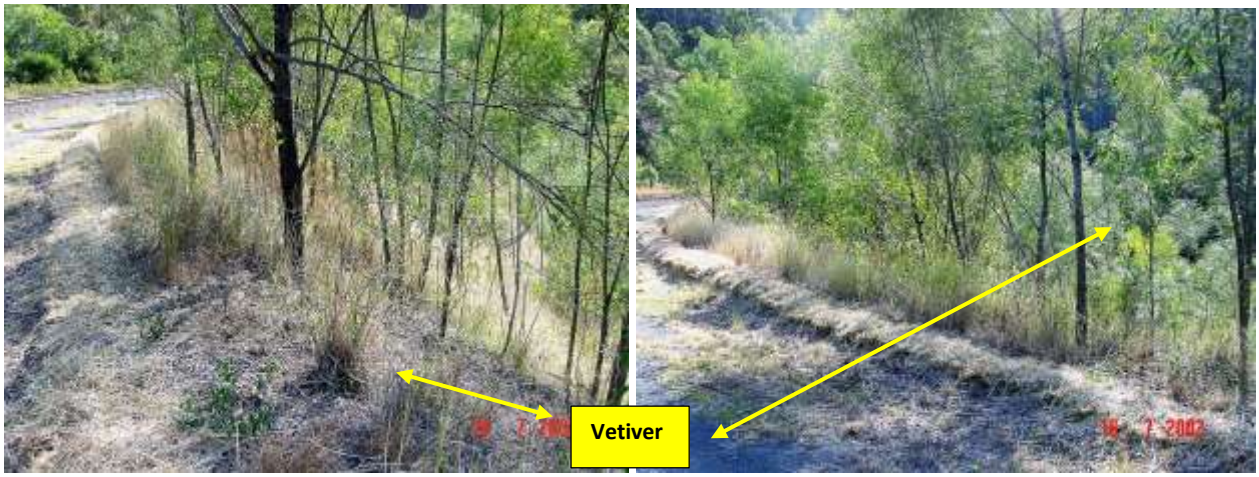
As mentioned in the introduction, the shade sensitivity of Vetiver provides some advantages in some applications such as the rehabilitation of eroding slopes which required the return of native or endemic plants to the sites. The followings are three examples of such situations.

- A major landslip occurred in a rainforest National Park-***Palmerston***- in tropical Australia, which blocked the only access road to the Park. Due to the steepness of the site and high rainfall, several attempts had been carried out to stabilise it but all failed. Vetiver bioengineering would be accepted only if it could be assured that Vetiver is non-invasive. Vetiver was planted and within 3 years, endemic rainforest vegetation returned by itself and totally shaded the vetiver out.
- Vetiver was used to stabilise the highly erodible cut and fill batters of a new railway line in subtropical Australia at ***Murphy Creek.*** For long term stability the return of endemic trees was a priority. The following photos show vetiver had satisfied this requirement

fully due to its shade sensitivity.



Vetiver was first planted on the edge of the track and then on contour lines down the slope (left). As soon as the slope was stabilised, native trees returned to the site and started shading out the vetiver (right)



Vetiver was badly affected on the shaded section of the edge of the track (left), but the whole slope was completely covered by native trees within 5 years after planting (right) and had shaded the vetiver out.

- Vetiver was used to stabilise a highly erodible cut and fill batters of the ***Ho Chi Minh Highway*** in Vietnam, which was exposed to several severe typhoons every year.

Horrific erosion on a cut batter *Vetiver planting on a fill batter*

The whole hill was covered with native vegetation 14 years after planting. But on closer examination pocket of vetiver in area where local species did not re-established, vetiver persisted and continue to provide protection.

Vetiver planting created favourable conditions for local species to come back and faded away due to shading, but it persisted where local species could not come back.

Vetiver planting remained effective by itself 14 years after planting (left), but it persisted where local species could not come back (right).

Most importantly, these photos show in area where the conditions were more favourable, native species re-established and shaded vetiver out, but under more hostile environment vetiver persisted and continue to provide protection

7. Other Impacts of Shade Sensitivity of Vetiver Grass

Self- shading of old Vetiver plants

In some very old vetiver plants, their centres are often dead. Although the plants look normal and growing, on trimming a hollow ring is exposed. This is caused by its outer growth shaded its inner shoots. To avoid this effect the big old clumps need to be trimmed back every few years.

A 10-12 year old vetiver plant

The plant after trimming, no dead centre

Regrowth in spring

Climbing Weeds

The most adverse effect of its low tolerance to shade is the impact of climbing weeds, which can covered and pull down fully grown vetiver – 1 to 2m – high plant and killed it over time.

Fully grown vetiver up to 2m before weed infestation.

Covered by climbing Madeira vines in the summer

Climbing Madeira weed

Dead vetiver under the weed

Vetiver after weed removal

6. Conclusions

The information above shows that Vetiver survival in shaded areas depends not only on sunlight intensity and duration but also on soil fertility. Although available information to date does not provide the minimum light intensity and duration for vetiver to survive and persist under natural light conditions, the information shown above indicates its light threshold is

relatively low and as long as it has a few hours of sunlight a day it can persist, albeit at a much lower growth rate.

This knowledge will provide us with some confidence in using this extraordinary plant in various applications.