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# The Effects of Irrigation and Fertilizer on Vetiver Establishment

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**Summary**

Vetiver is touted for use in many soil and water conservation practices to reduce runoff, soil erosion, and to stabilize steep slopes. In order to perform these functions the plants must close in and form a barrier that will channel water and hold soil. Experiments at Kunia, Mililani and Waimanalo show the effects of irrigation and fertilizer on vetiver establishment. Irrigation was shown to have the greatest effect with only slightly noticeable changes due to fertilizer. Irrigation was most important in dry weather and less in the areas that received greater annual rainfall, but it was still necessary for rapid growth in order to form an adequate barrier in time for the winter rains at the three sites.

## Introduction

Vetiver (*Chrysopogon zizanioides*, syn. *Vetiveria zizanioides*) is an infertile, perennial clump grass with no rhizomes or runners. The 'Sunshine' variety used in Hawaii is native to South India, although it is widely cultivated in tropical and semi-tropical regions of the world. Due to its sterile seeds it must be propagated asexually, and was evaluated for invasiveness by the Hawaii-Pacific Weed Risk Assessment and Pacific Island Ecosystems at Risk and received a very low score (-8) for potential to become invasive.

Vetiver is central to many soil and water conservation applications, erosion control, slope stabilization, prevention and treatment of contaminated waste water, phytoremediation and bioremediation, as well as wetland and marginal land restoration. After seven years at Kunia, irrigated Sunshine cultivar grew to a maximum height of 6 ft and a width of 3.5 ft. No seedling has ever been observed at Kunia. Vetiver has been reported to grow to a height of up to 8 ft and unlike most grasses does not grow to form a horizontal mat of roots, but rather has a deep vertical root system with an estimated depth up to 12 ft. Deep roots helps to stabilize steep slopes, stream banks, and terraces and greatly reduces the risk of soil erosion by runoff. Depending on soil conditions and spacing, vetiver fills in to form a barrier after several months that can be used in place of permanent

more costly structures. The barrier can be used to channel and divert water, as well as catch soil to prevent runoff. Once established, vetiver is easy to grow and requires very little maintenance aside from weeding, some irrigation, and occasional pruning to maintain a healthy looking hedge.

## Methods

Vetiver slips were collected from existing plantings at Hawaii Agriculture Research Center in Kunia, which were originally obtained from the USDA Hoolehua Plant Material Center on Molokai. Vetiver tillers were collected and rooted in water for 7 to 10 days before planting. Monthly plantings started in March 2009 and continued to March 2010 at three sites: Kunia, Mililani, and Waimanalo. Four treatments consisted of factorial combinations of irrigated (I), unirrigated (NI), fertilized (F) and unfertilized (NF) plots. Each plot was 10 feet in length and contained 20 vetiver plants evenly spaced 6 inches apart, and planted about 4 inches deep (Picture 1). The unirrigated plots were hand watered for the first 14 days after transplanting to help minimize transplant shock and allow them to root into the soil. The irrigated plots were drip-irrigated as required at 85 percent of USDA Class A open pan evaporation at the Kunia site. Irrigation was estimated from the weather data at the Mililani NOAA station 516261 and the Waimanalo University of Hawaii weather station. Data consisted of weather, height measurements, tiller counts, and rate of close-in (as determined by the space occupied by the stools relative to the 10 ft row). The fertilized plots received a single application at transplanting of 16-16-16 and gypsum at 300 lb/acre.

Picture 1. Vetiver plant spacing.

## Results and Discussion

Environment, irrigation and fertilizer were studied for their effectiveness in rapid establishment of a living barrier and maintaining the vigor of vetiver. The three sites have different rainfall amounts but similar distribution patterns, with a wet winter and a dry summer. During the trial period Waimanalo received the most rainfall of 47.06 inches, followed by 25.33 inches at Mililani and about 10.88 inches at Kunia (Figure 1). Areas with higher rainfall than

Kunia had more clouds, less sunlight and less evapotranspiration. The different rainfall amounts affected the level of irrigation needed for vetiver to become established and close in to form a barrier. Higher rainfall generally resulted in quicker growth in height as well as new tiller growth for both irrigated and unirrigated plots. Rainfall also contributed to the overall health of the plant which was improved with higher rainfall in earlier stages, and increased the rate at which it closed in to form a barrier.

Fertilizer was shown to have little effect at all three sites, likely due to the location and history of the soils. Soils at all three sites have been under crop production previous to vetiver plantings. The soil series at Kunia is the Molokai silty clay loam, Mililani is the Wahiawa silty clay, and Waimanalo is the Waialua clay.

Irrigation had the most significant effect on plant height growth as well as tiller growth which resulted in a quicker rate of close-in. At all three sites, there were measureable differences in height, tiller count, and rate of close-in between the irrigated and unirrigated plots (Picture 2). Most unirrigated plots at the Kunia site were dead after 18 months.

Picture 2. Unirrigated fertilized and unirrigated unfertilized plots (left) vs. irrigated unfertilized and irrigated fertilized plots (right) respectively at Kunia.

The average number of tillers in a 10-ft plot with evenly spaced plants needed to achieve the desired rate of 100% close-in is approximately 400 (Table 1). The first planting of vetiver in March of 2009 achieved this rate after an average of 5 months at all sites (Table 1, Picture 3). The rate of vetiver growth and close-in also varies by season. In all three locations faster growth and establishment were seen during the spring and summer months, as compared to fall and winter when growth rates fell (Figures 2, 3, and Table 4). It is recommended in Hawaii that vetiver be planted no later than July to allow enough time for the plant to establish and form a barrier before the winter rains. One farm on Oahu planted vetiver in the fall and heavy rains in December of the same year uprooted most of the vetiver.

**Picture 3**. March planting of vetiver after 5 months of growth, picture taken in August at the Mililani site.

## Conclusion and Recommendations

Irrigation had the most dramatic effect on the overall growth, health and survival of vetiver. As demonstrated in Picture 2, the effect of irrigation is significant, especially in areas of low rainfall. It is recommended that vetiver planted in areas of low rainfall be irrigated until a barrier is fully established at about five months at most sites. Vetiver that is not irrigated will survive if planted during the rainy season, but will have high mortality rates if planted during the dry season. Although the effect of irrigation was more dramatic in the drier climate of Kunia than at Mililani and Waimanalo, the data show similar results with regards to seasonal growth. When planted in spring and summer, vetiver tends to grow at much faster rates with optimum irrigation. When planted at least five months before expected winter rains, irrigated vetiver will serve as an effective erosion control mechanism. It should be noted that vetiver under very dry conditions may not survive without occasional irrigation during the dry summer months. Fertilizer did not seem to have as strong of an effect on vetiver growth and health, likely due to the fertile soils at each location. A soil analysis is recommended for infertile soils (eroded areas, exposed subsoils, sandy soils, etc.) to identify and supplement the limiting plant nutrients.

**Table 1.** Average temperatures and rainfall totals for 3 sites from March 2009 through March 2010.

| | Kunia | | | Mililani | | | Waimanalo | | |
|---|---|---|---|---|---|---|---|---|---|
| Months | Max °F | Min °F | Rainfall (inch) | Max °F | Min °F | Rainfall (inch) | Max °F | Min °F | Rainfall (inch) |
| Mar-09 | 78.3 | 63.9 | 2.95 | na | na | 4.90 | 76.1 | 66.6 | 6.03 |
| Apr-09 | 79.7 | 64.0 | 0.86 | na | na | 2.38 | 77.1 | 66.8 | 8.78 |
| May-09 | 84.7 | 65.6 | 0.62 | na | na | 0.37 | 80.8 | 68.4 | 5.24 |
| Jun-09 | 86.0 | 70.0 | 0.07 | na | na | 0.52* | 83.0 | 73.1 | 0.52 |
| Jul-09 | 86.2 | 71.1 | 0.14 | na | na | na* | 84.0 | 73.9 | 1.57 |
| Aug-09 | 87.0 | 72.1 | 0.30 | na | na | 1.18* | 84.5 | 74.9 | 3.05 |
| Sep-09 | 87.5 | 70.6 | 0.14 | na | na | 0.77 | 85.3 | 73.7 | 0.70 |
| Oct-09 | 88.3 | 70.7 | 0.44 | na | na | 1.64 | 85.0 | 74.0 | 5.32 |
| Nov-09 | 82.7 | 69.5 | 1.61 | na | na | 4.22 | 81.2 | 72.2 | 3.01 |
| Dec-09 | 82.0 | 63.7 | 1.25 | na | na | 1.88 | 79.2 | 64.7 | 3.41 |
| Jan-10 | 81.4 | 64.5 | 1.08 | na | na | 1.60 | 79.4 | 66.0 | 5.94 |
| Feb-10 | 79.8 | 62.3 | 0.61 | na | na | 1.37 | 78.1 | 64.1 | 1.48 |
| Mar-10 | 79.6 | 65.1 | 0.81 | na | na | 4.50 | 78.3 | 67.9 | 2.01 |
| Totals | | | 10.88 | | | 25.33 | | | 47.06 |

* Mililani had missing rainfall data from June 23 to Aug 3, 2009.

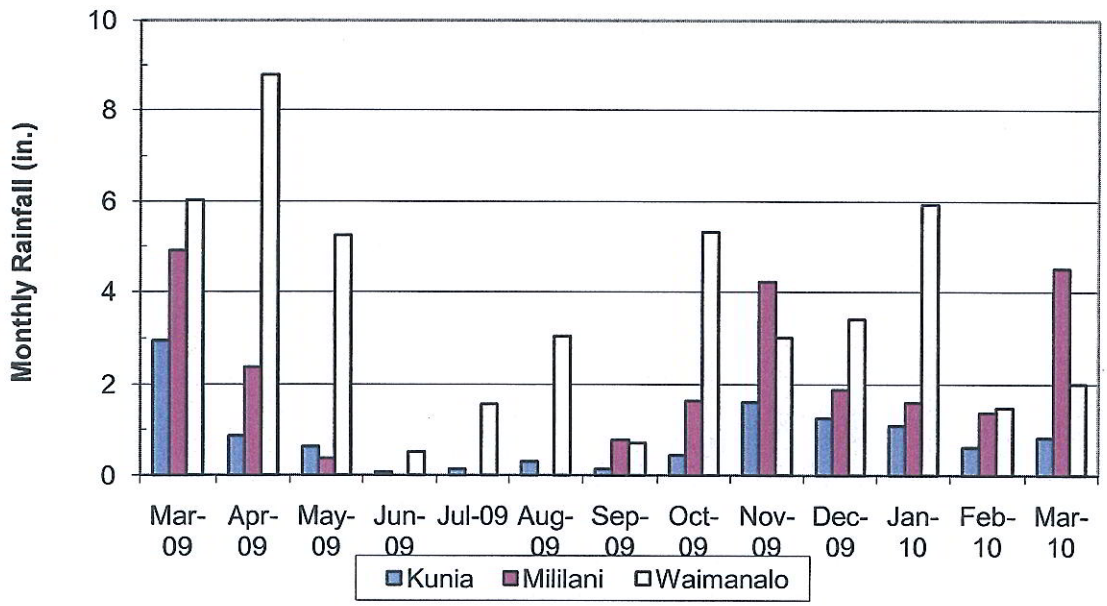


**Figure 1.** Rainfall totals from Table 1.

**Table 2. Tillers at 100% close-in for March and May plantings.**

| | | Mililani | | Waimanalo | | Kunia | |
|---|---|---|---|---|---|---|---|
| Plant Date | Trt | Time (months) | Tiller at close-in | Time (months) | Tiller at close-in | Time (months) | Tiller at close-in |
| **March** | I/F | 4 | 465 | 5 | 317 | 6 | 300 |
| | I/NF | 4 | 502 | 5 | 271 | 6 | 272 |
| **May** | I/F | 4 | 418 | 4 | 335 | 7* | 506 |
| | I/NF | 4 | 347 | 4 | 348 | 7* | 480 |

* No data for 6th month for Kunia, which is likely time of close-in. This probabaly skewed the numbers slightly higher than normal.

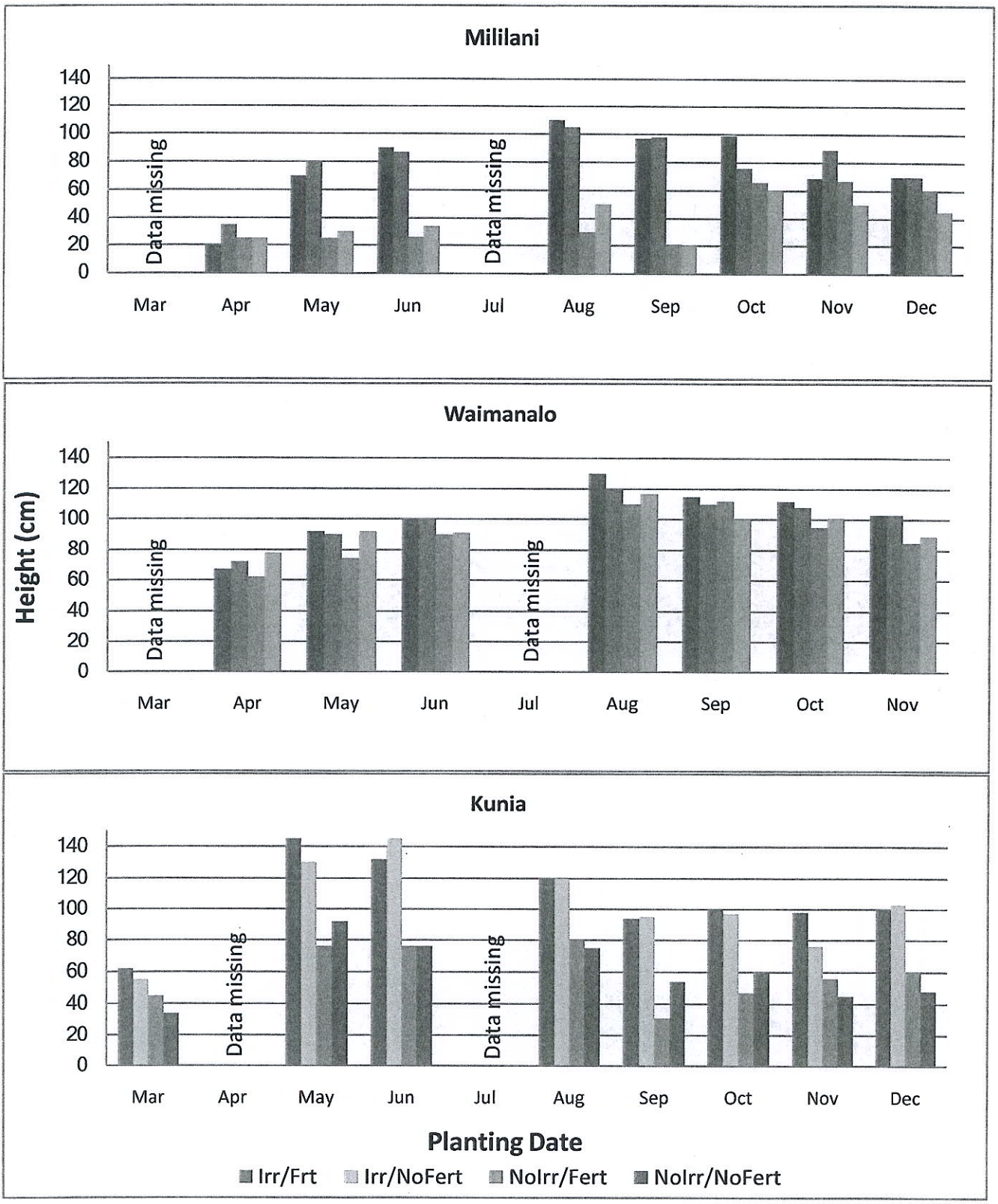


**Figure 2.** Height (cm) after 90 days after each months planting for 3 sites.

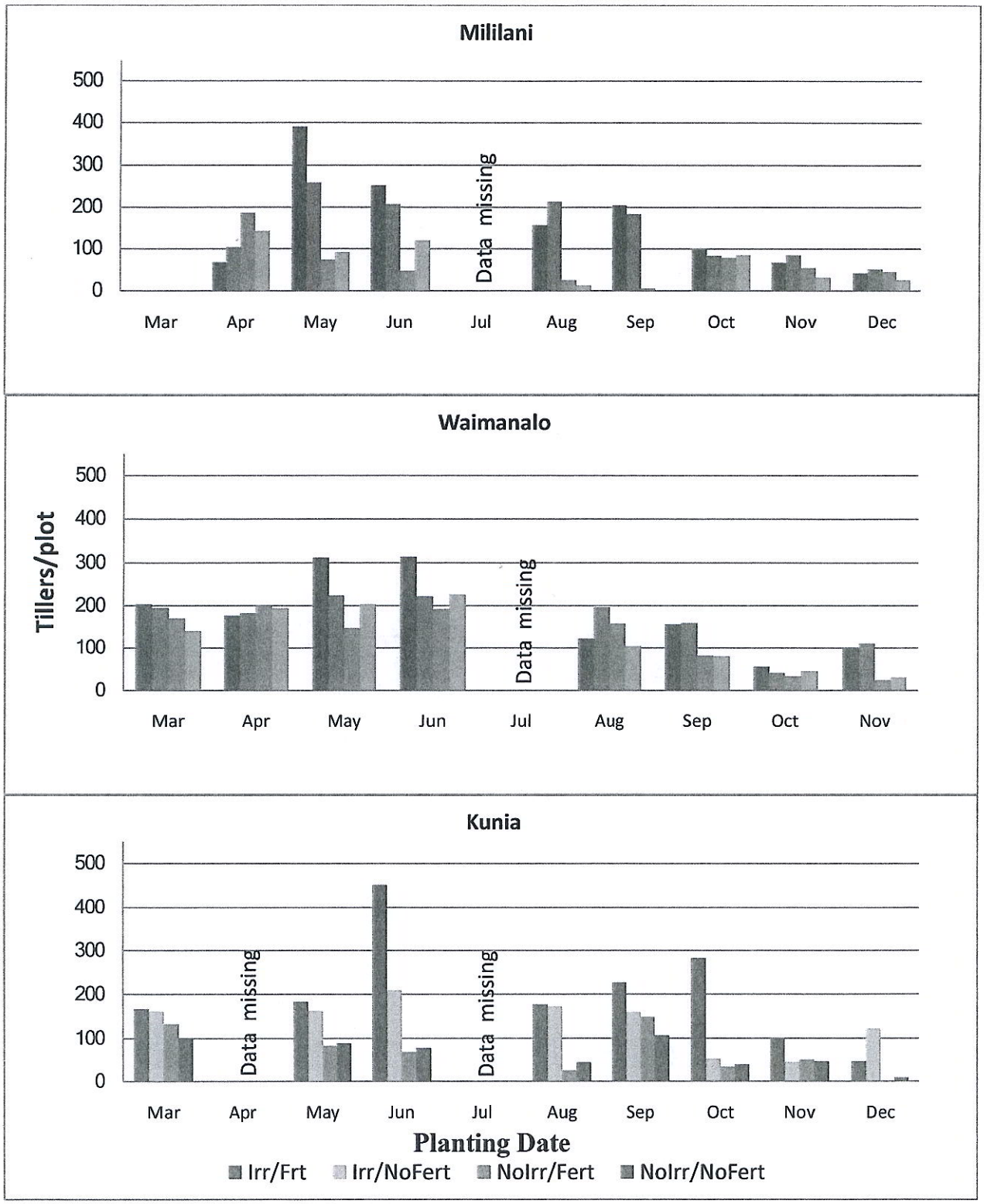


**Figure 3.** Tiller counts of 1 row x 20 plant plots 90 days after each month's planting at 3 sites.