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August 8, 2005

TO: Kee Kitayama Research Committee

FROM: Julie Newman

RE: Final Report- ***"Evaluation of Technologies and Practices for Control of Non-Point Source Pollution and Storm Water Runoff"***

Attached is the Final Report for *"Evaluation of Technologies and Practices for Control of Non-Point Source Pollution and Storm Water Runoff"*.

Over the past five years water quality issues have had a major impact on the viability of the floriculture and nursery industries in Ventura and Santa Barbara Counties. We obtained a 2.5 million dollar State Water Resources Control Board (SWRCB) Proposition 13 grant, which was intended to be the major funding source for this project. Although this grant was originally scheduled to begin in March 2003, because there were numerous obstacles in getting the SWRCB and the University of California to come to agreement about the terms of the contract, there was a one-year delay in its execution.

For this reason, prior to spring 2004, KKRF and the Hansen Trust were the sole source of funds for nursery water quality programs in Ventura and Santa Barbara counties. By the time the Proposition 13 multi-campus award was completed with the University so that we could purchase monitoring and analyzing equipment, there were only a few months left in the KKRF contract, even with the extension to September 2004. The biggest problem was the delay in getting award monies to growers so that they could install the water quality improvements at the nurseries.

The Proposition 13 grant delay had a major impact on the KKRF project. It meant that our grower runoff project evaluations were limited due to lack of equipment and lack of sites where improvements were implemented during this grant cycle (with the exception of the biofilter project in a Carpinteria nursery). Since the money that was meant to accomplish much of the work was not awarded until the end of the KKRF contract, we had to rely on the use of one borrowed automatic sampler/data logger for collecting monitoring data. We were short on staff assistance for the project, especially during an extended maternity leave of the UCCE Water Coordinator, who had been conducting most of the field work, and we had no funds for extra help.

Although we had finished collecting data from the Carpinteria biofilter site some time ago, it was only recently, after establishing another site using this equipment, that we were able to calibrate the flow meter and make sense of the data. Flow readings from the Carpinteria site were too low to properly calibrate this equipment, except during one storm event when the computer malfunctioned. There was a delay in establishing another site where we could calibrate the equipment because we had to first return it to the researcher who lent it to us, as he needed it for another project. These problems, plus the tremendous amount of paperwork involved with the Proposition 13 contract resolution and with getting our monitoring plan approved, were the major reasons for the long delay in writing this report.

In spite of these set-backs, the KKRF grant contract was a tremendous help to growers in Ventura County who were faced with having to make major changes in their practices to meet increased water quality regulations and could not wait until the Proposition 13 grant was awarded to start the planning process for change. In addition, it was extremely beneficial to growers in Santa Barbara County who were faced with a zero-runoff mandate or NPDES permit requirements with no assistance available to make changes. In fact, the KKRF financial contribution became a bridge between a Hansen Trust grant and the larger Proposition 13 grant, and it has certainly helped growers in the area cope with increasing water regulations.

We very much appreciate the support we obtained from Kee Kitayama and from the California Cut Flower Commission in implementing this project. Thank you so much for your patience.

CALIFORNIA CUT FLOWER COMMISION
FOR THE KEE KITAYAMA RESEARCH FOUNDATION
Final Report

Title: Evaluation of Technologies and Practices for Control of Non-Point Source Pollution and Storm Water Runoff

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Objectives:

1. Develop economical solutions to runoff problems through on-site evaluations in nurseries and cut flower fields.

2. Evaluate the efficiency and cost-effectiveness of Best Management Practices (BMPs) and improved technologies at test site nurseries.

3. Evaluate the use of biofilters as a solution to runoff.

Budget:

$10,000 from KKRF. (There were also some joint funds that were used from a matching Hansen Trust grant. The $2,678,765 from the Proposition 13 grant did not come in until the end of the project).

Executive Summary:

We collected baseline data from Ventura County nurseries so that we can measure reduced runoff after BMPs or new technologies are adapted. A total of 155 nurseries were contacted, and 26 went through the consultation process and irrigation system evaluation. We collected baseline monitoring data at two container nurseries in Ventura County and one field flower nursery in Carpinteria. In the Carpinteria site, runoff data were later compared to runoff after a vegetative biofilter was established in spring 2004.

Regulators require education concerning the ornamental production industry and scientific documentation of environmental stewardship. To address this need, we developed a strong relationship with the Los Angeles Regional Water Quality Control Board (LARWQCB) in order to foster a cooperative spirit between regulators and growers and avoid unnecessary governmental regulation. We provided guidance so that these regulators could develop more rational water quality policies without seriously undermining the industry's economic sustainability in Ventura County. We continue to take an active part in the TMDL process that is rapidly progressing for local watersheds. We are involved in the Agricultural Oversight Committee, which is serving as an advisory group to the Regional Board and other stakeholder organizations regarding impacts of agricultural activities to surface and groundwaters. We are also working with the Central Coast Regional Water Quality Control Board that has jurisdiction in Santa Barbara County. Participation of staff at these important meetings was partially funded by this KKRF grant.

The KKRF grant was originally intended as a supplement to a larger State Water Resources Control Board (SWRCB) Proposition 13 grant. However, because of numerous obstacles in getting the SWRCB and the University of California to come to agreement about the terms of the contract, there was a one-year delay in the execution. As a result, KKRF and the Hansen Trust were the only sources of University grant funds for nursery water quality programs in Ventura County until spring 2004, and they remain the sole funding source for expansion of the water quality project into Carpinteria. Except for some limited Natural Resources Conservation Service grants, there were no other agencies providing funds to flower and nursery growers to meet increasing water quality regulations in these two counties during this period.

Background

Nursery growers must implement 'Best Management Practices' (BMPs) to mitigate runoff and leaching of pollutants. However, there is little data on the effectiveness of BMPs, and further research is needed. Growers require training to minimize runoff and capital to comply with evolving regulations.

Existing water regulations are not being enforced consistently in California because most of the regulatory changes are driven at a local level rather than a statewide level and because each regional water quality control board is developing separate agriculture waiver policies. The variability in local enforcement of water regulations mandates that specific management plans need to be developed by each agricultural region. For this reason, although research regarding runoff management in one region can benefit another, demonstrations, field days, and other extension activities are more effectively developed on a regional basis.

Regulatory agencies in Ventura County are planning water quality regulation changes that will greatly impact agriculture. Without input from growers and from the University, slated TMDL and new ag waiver regulations could drive nursery operators out of business or into other areas where regulations are not as restrictive.

For the past two years the Central Coast Regional Water Quality Control Board has regulated Carpinteria greenhouses as point pollution sources, requiring "0" runoff. They mandated some of

the harshest regulations thus far imposed on growers in the state. This has necessitated that these greenhouse growers recycle or document no runoff in order to avoid stiff fees to meet NPDES permit requirements.

Use of vegetative filter strips can be a lower cost alternative to recycling for certain growers. Much of the research, however, has not been examined in ornamental production situations.

Specific Results

Objective 1: Develop economical solutions to runoff problems through on-site evaluations in nurseries and cut flower fields

We developed a 29-page survey of Best Management Practices (BMPs) to reduce runoff and contamination, which was used to survey grower practices. The survey also served as a self-evaluation that growers can use to determine improvements that can be made in their nurseries to limit runoff. On-site assessments included a nursery tour (looking for leaks and other obvious problems) and a preliminary plan of action to improve efficiency developed with each grower.

During the KKRF funding cycle we contacted 155 ornamental crop producers, collecting survey baseline data from 45 container nurseries and cut flower operations. We evaluated irrigation uniformity at cooperating sites using catch cans. 20+ measurements were taken by quantifying how much water was delivered for a given time. The average was calculated, and the average of the 'low quarter' (lowest 25% of the measurements) was determined. The Distribution Uniformity value was calculated as: DU = 100 X (Average of the 'Low Quarter'/Average of All Measurements).

These data will measure the number of BMPs used by growers, obtain a current "snapshot" of the industry, and document the effectiveness of implemented runoff solutions. We are collecting cost data related to implemented practices so that the economic feasibility can be measured.

Objective 2: Evaluate the efficiency and cost-effectiveness of Best Management Practices and improved technologies at test site nurseries.

We implemented a 1.2 million dollar cost-share program through the Proposition 13 grant. After completing the survey, 20 growers applied for funds to implement improved technologies for reducing runoff and/or conserving water. Because of the delay in the Proposition 13 contract award process, funding for UCCE staff to work with growers in developing improvement plans and for developing project proposals was almost entirely through the KKRF grant. A committee of growers and agricultural leaders, spearheaded by the California Cut Flower Commission, chose projects for award based on potential benefits to the environment and to the ornamental production industry, and based on the grower's readiness to proceed with implementation. We identified 20 grower projects.

During the KKRF review cycle, except for one biofilter project (see Objective 3) that was not tied to Proposition 13 funding, we were limited to collecting baseline monitoring data from two

nursery sites, which we used as a current "snapshot" of each nursery. We plan to use this data at a later time to document the effectiveness of future BMP implementation in improving water quality after the Proposition 13 project improvements are implemented.

Flow monitoring and water quality sampling were conducted at these two sites with KKRF and Hansen Trust funding. At Nursery Site A, continuous flow monitoring at ten-minute intervals was conducted for three months to determine daily and monthly variation (see Figures 1-3.) One hundred samples of the runoff were taken at four separate occasions. Nitrate, chloride and sulfate ranged from 98.1 to 531.1 ppm, 43.6 to 119.0, and 135.9 to 277.1 ppm, respectively. The high values for each nutrient coincided during late afternoon when runoff flows were reduced.

The hourly average nitrate concentration (Figure 1) and the runoff flow rate (Figure 2) were used to calculate hourly nitrate load and the daily nitrate load from this nursery for a 24-hour period (Figure 3). The data revealed little variation over the three-month season that data was collected. Data will be used to compare the efficiency and efficacy of a recycling system, which was implemented after the KKRF grant cycle with Proposition 13 funding.

At Nursery Site B, the attached graph (Figure 4) summarizes the flow data during the monitoring period of October 2002 to March 2003. During this period, hand watering was ended and an improved automated irrigation system installed. There is a marked difference in runoff after the new installation. Runoff that did occur after installation was due to rain events. During the period after installation of the new watering system, runoff was measured for nitrate, chloride and sulfate over a one month period at five hour intervals on three days. Nitrate ranged from a low of 85.0 ppm to a high of 408.2 ppm, chloride from 31.6 to 89.6 and sulfate from 195.3 to 706.6 ppm. Again as in a Site A, high values occurred during late afternoon when runoff flows were low.

Objective 3. Evaluate the use of a biofilter as a solution to runoff

We evaluated the effect of vegetative filter strips in reducing irrigation runoff in one commercial cut flower nursery in Carpinteria. The grower constructed three vegetative basins that were built at successively decreasing elevation so that water would flow through the top basin and down to the lower basins. Two of the basins were approximately 15' x 45' and the third was approximately 15' x 60'.

One-gallon *Cyperus papyrus* was planted beginning in August 2003. Fescue was also started by seed, and oats were used as a cover crop during the establishment of the grasses. Later, native grasses naturally established in the area. It took until the following spring for the vegetation in the filter strips to fill in and become effective.

We measured irrigation runoff using a flow meter connected to a lap top computer adjacent to a cut flower field of iris. Continuous flow monitoring was conducted at ten-minute intervals. An automatic sampler collected samples on nine separate weeks when there was measurable runoff. The number of samples collected depended on the volume of runoff and varied from 3-24

samples. Samples were analyzed at the UCR Soil and Environmental Sciences laboratory using EPA approved practices. Nitrate ranged from a low of 16.2 ppm to a high of 563.3 ppm, chloride from 34.9 to 119.0, and sulfate from 72.7.1 to 277.1 ppm.

Data was collected from August 19, 2003 to December 1, 2003 prior to the effective establishment of the biofilter. The flow rate (gallons per hour) for Aug. 19 to October 16, 2003 is shown in Fig. 5. Most of the time there was essentially no flow, but on occasions, the runoff was quite significant. All of the runoff that we measured during that period was from irrigation. Following October 16 the flow was too low to measure. There was only one storm event during that period which occurred on December 1. Unfortunately it occurred during a computer malfunction, so we were not able to measure any storm runoff.

The following spring 2004, following the effective establishment of the vegetation in the biofilter and the planting of crops of dahlia and *Ornithogalum umbellatum*, we again made several attempts to measure flow and collect runoff samples but were not successful. At this point there was no longer any runoff from the cut flower fields.

Although it appeared that the vegetative strips were effective in eliminating runoff in the adjoining nursery fields following establishment of the biofilter, it is also likely that changes in irrigation practices played a role. The nursery irrigator attended several water management training meetings, including training in Spanish provided by CORF. As a result, the irrigation efficiency was improved at this facility and water consumption was reduced. Therefore, it is likely that the change in irrigation practice, coupled with the filter strips, led to the success of the project.

We had planned to evaluate filter strips in 1-2 other nurseries as well but when funding was delayed from the Proposition 13 grant, growers were not able to install these improvements in time and we were not able to purchase the necessary equipment for monitoring. We relied on borrowed equipment for the one nursery we sampled in Carpinteria.

Dissemination of Findings

On-farm consulting, a telephone help line, and seven educational meetings (with funding from another KKRF grant and the Hansen Trust) provided grower information concerning BMPs for mitigating runoff, resources/assistance programs, and regulation requirements. We cooperated with the Santa Barbara County Resource Conservation District (RCD) in the planning of a series of irrigation meetings targeted for Hispanic irrigators.

The project has also resulted in five separate articles in CORF News, a statewide newsletter for the floriculture and nursery industry, as well as four articles in Greenhouse Management and Production (GMPRO), a national industry trade magazine

In addition, information concerning the project was extended to growers at two Pesticide Applicators Professional Association (PAPA) meetings held in Oxnard, at two California

Association of Nurseries and Garden Centers (CANCG) meetings in Ventura, and at one Santa Barbara Flower Growers Association meeting in Carpinteria.

We have participated in numerous meetings held by various agencies, where we have extended information concerning this project to regulators and others involved in water quality issues. The farm advisor office is represented on the Agricultural Oversight Committee, which is serving as an advisory group to the Los Angeles Regional Water Quality Control Board (RWQCB) and other stakeholder organizations regarding impacts of agricultural activities to surface and groundwaters. We provided scientific input at local meetings held by various agencies regarding development of water quality regulations, including the Central Coast RWQCB. This included work on forthcoming TMDLs, e.g. the Santa Clara River and Calleguas Creek nutrient TMDLs, and new ag waiver policies.

Development and Coordination of Statewide Meetings Held Locally

DATE	TITLE OF MEETING	TOPIC	LOCATION
7/03	CORF Maintenance of Irrigation Systems in Spanish	Hands-on irrigation maintenance	Ventura/Oxnard
7/03	CORF Maintenance of Irrigation Systems in Spanish	Hands-on irrigation maintenance	Carpinteria
1/04	CORF Irrigation Container Nursery & Greenhouse Potted Plants	Irrigation & leaching container plants	Somis
3/04	CORF Hands-on Irrigation Training Greenhouse & Field Grown Cut Flowers	Irrigation & leaching cut flowers	Oxnard
4/04	CORF Hands-on Irrigation Training Spanish	Irrigation	Santa Paula
7/04	CORF Pesticide Runoff Meeting English	Pesticide runoff	Ventura
7/04	CORF Pesticide Runoff Meeting Spanish	Pesticide runoff	Ventura

Publications

Newman, J. 2002. Carpinteria Valley Greenhouse Program. CORF News 6(1):8.

Newman, J. 2002. Proposed runoff regulations affecting Santa Barbara County agriculture. CORF News 6(4):8

Newman, J. 2002. Avoid public complaints by creating a positive image. CORF News 6(2):8

Newman, J. 2002. It pays to be a good neighbor. Greenhouse Management & Production (GMPro Magazine) 22(2): 57-58.

Newman, J. 2003. Dealing with runoff rules. Greenhouse Management & Production. 23(2):53

Newman, J. 2003. Water availability in Ventura & Santa Barbara Counties. CORF News 7(3):8

Newman, J. 2003. Growers share recycling experiences. CORF News 7(4):7

Newman, J. 2003. Ways to reduce runoff. Greenhouse Management & Production. 23(6):74-75

Newman, J. 2003. Irrigation practices can substantially reduce runoff. Greenhouse Management & Production (GMPRO Magazine) 23(10) 58-60

Newman, J. 2004. Recycling irrigation water. Greenhouse Management & Production. 24(2):49-51.

Benefits/Impacts

It is clear that California flower and nursery growers are coming under closer scrutiny by regulatory agencies in regards to compliance with water quality regulations. However, KKRF and the Hansen Trust were the only sources of University grant funds for nursery water quality programs in Ventura County until spring 2004, and they remain the sole funding source for expansion of the water quality project into Carpinteria. Except for some limited Natural Resources Conservation Service grants, there were no other agencies providing funds to flower and nursery growers for meeting increasing water quality regulations in these two counties during this period.

Funding from KKRF and the Hansen Trust is leading to far-reaching beneficial impacts by helping growers demonstrate good environmental stewardship. Although the data we collected is limited to base-line data, we will be able to use it later to measure improvements.

By educating regulators and developing a strong working relationship with the Los Angeles Regional Water Quality Control Board (LARWQCB), we were able to facilitate conflict resolution, foster a political climate where agricultural producers were seen as environmental stewards, and foster a cooperative spirit between regulators and growers. We worked with the LARWQCB to identify methods that will reduce runoff while still maintaining agricultural sustainability. This project helped prevent an agency imposed 'one size fits all' set of stringent requirements for Ventura County by working proactively with the LARWQCB. Without active, aggressive work with growers to reduce runoff, the alternative will be increased lawsuits, future regulations, fines and citations, permitting, and eventually inability of growers to do business in the locations affected.

Our educational programs have been a convenience for growers who in the past had to travel to San Diego County to obtain training information. This is saving them considerable distance, expense, and time spent away from their nurseries.

We elevated grower awareness considerably concerning regulations and options for reducing runoff. Results from participant surveys following each educational meeting indicate that we were successful in helping growers improve utilization of water resources and reduce runoff. In addition, growers will be able to collect data about fertilizer use, water consumption, and runoff water quality that can be used to document good production practices; such information may be helpful when growers need to provide information to government agencies. Third, growers will be able to develop a large body of information about crop fertilizer and water needs; this information is not available for most of the ornamental crops grown in California.

Figures

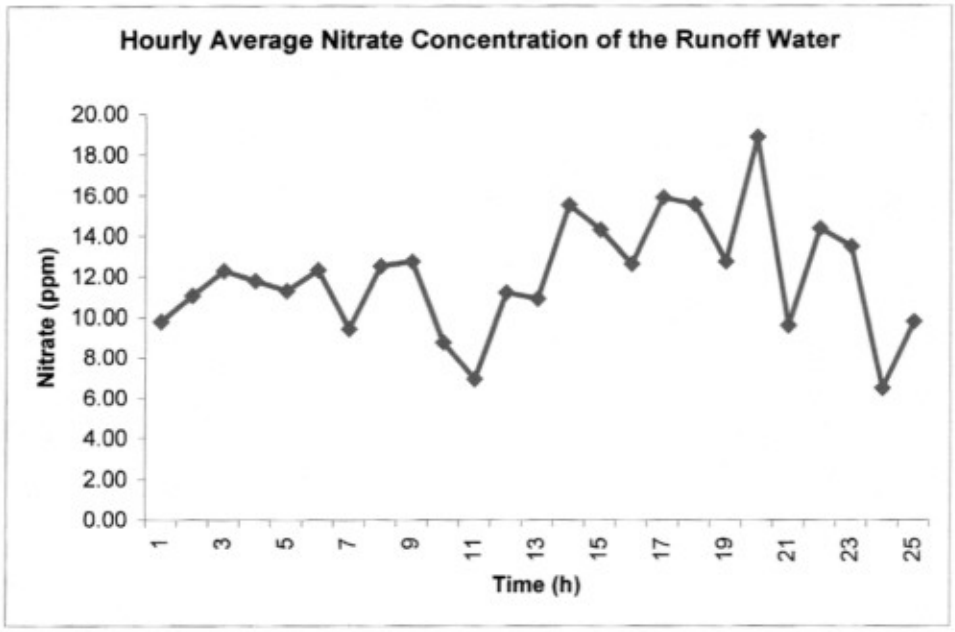

Figure 1. The hourly average nitrate concentration runoff sampled in 4 days at Nursery Site A. The average nitrate concentration does not change very much during a day.

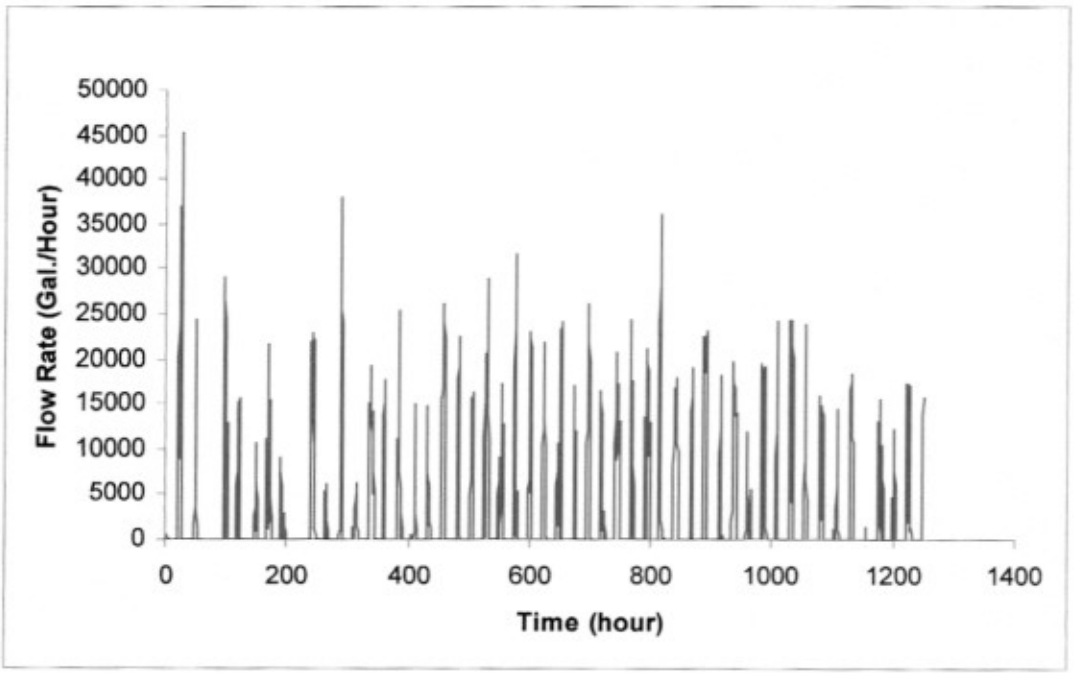

Figure 2. The runoff flow rate observed at Nursery Site A.

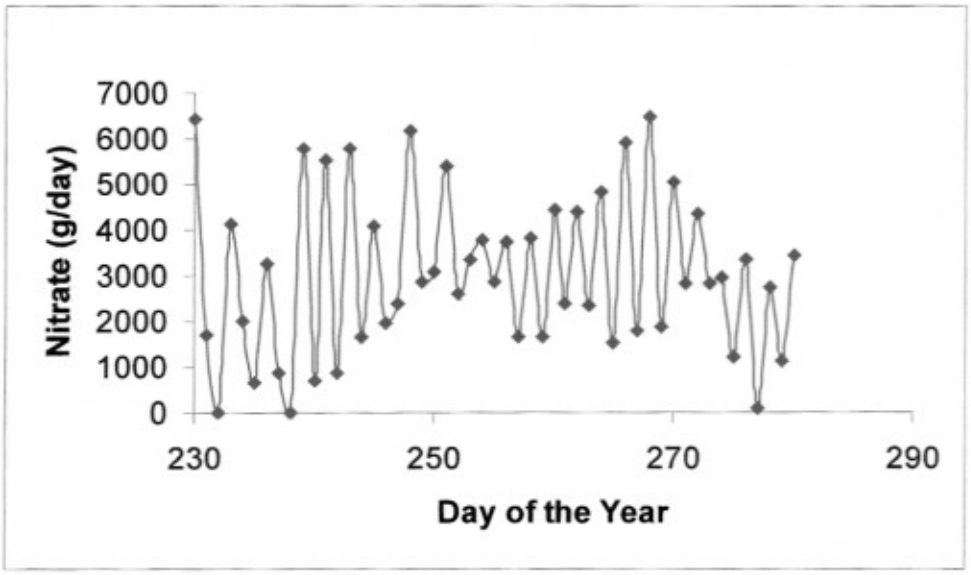

Figure 3. Nitrate daily load from Nursery Site A. Substantial daily variation was observed from the data. The maximum daily load was 6494 g, minimum was 1.4 g, and the average during the period was about 3 kg.

The hourly average nitrate concentration (Figure 1) and the runoff flow rate (Figure 2) were used to calculate daily nitrate load (Figure 3). The data revealed little variation over the three-month season that data was collected, which implies that weekly rotation of the sampling device is not essential.

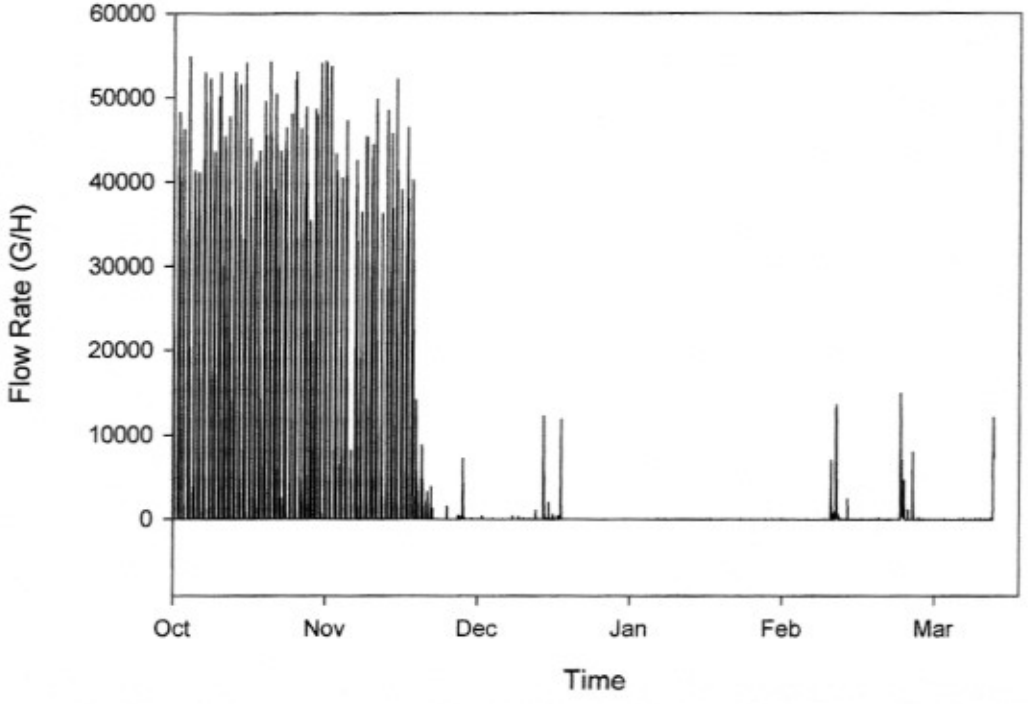

Figure 4. Irrigation runoff before and after installation of automatic irrigation system in Nursery Site B. System was installed in December and the only runoff after was from rainfall.

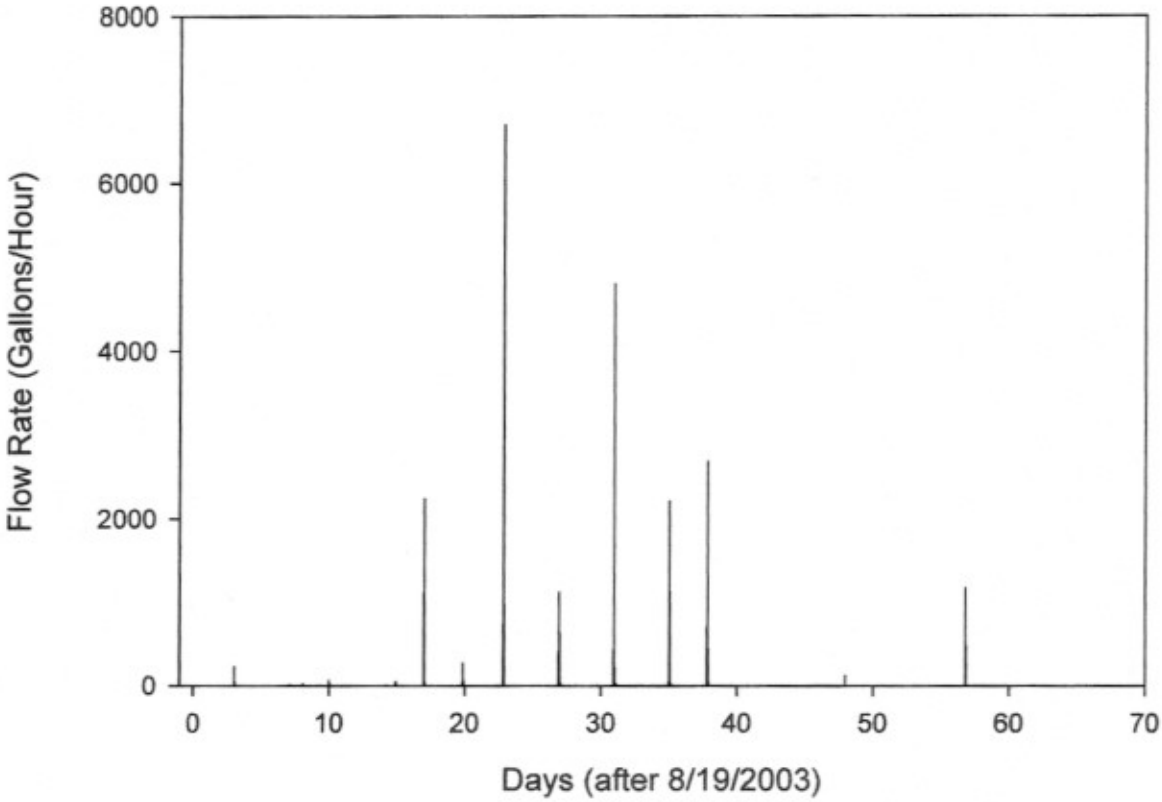

Fig 5. Effect of a vegetative biofilter in Nursery Site C. Aug. 19 to October 16, 2003, prior to establishment of a biofilter. Most of the time there was essentially no flow, but on occasions, the irrigation runoff was quite significant.