Delaware Soybean Board

Report for Kleczewski, 2014

Project Title: **Evaluating the Distribution and Potential Impacts of Soybean Vein Necrosis Virus in Delaware**

Background and Objectives:

Soybeans are susceptible to viruses, non-living packets of genetic code encapsulated within a protein coat. Viruses are unique pathogens in that they grow and reproduce only inside living plant cells, using the plants own molecular machinery to reproduce. Infected soybeans tend to be stunted and produce fewer pods. Foliage may be distorted and have a mottled or mosaic appearance. Seed may also be mottled and deformed. Many symptoms of viral infection in soybeans resemble damage due to common fungal and nematode pathogens, insects, nutrient deficiencies, and even herbicide injury and often go unnoticed in fields. If left unmanaged, severe yield losses can occur with some viruses.

In 2011 a new soybean virus was detected in soybean fields in Maryland and Delaware. This virus has recently been named Soybean Vein Necrosis Virus (SVNV), and it has been found throughout Eastern and Midwest soybean growing regions. Currently SVNV is considered the most widespread virus of soybeans in the United States. Although we know little about this virus, we do know that it is vectored by thrips and has several alternate hosts, such as Ivy leaf Morning Glory. In 2013 several samples brought into the Delaware Plant and Pest Diagnostic Clinic tested positive for the disease, and I personally observed the disease in 5-10% of fields. According to agents, this may be less than what was observed in years past. However, no focused surveys of this virus have been conducted in the Midatlantic and the distribution of this virus and its potential impacts on Delaware soybean yields are unknown. A better understanding of the distribution and effects of the virus in Delaware are required to determine if soybean yields are being affected, what practices favor the disease, and if needed, potential management options. Research on SVNV is necessary to ensure maximum yields of full season and double cropped soybeans in Delaware.

The project has multiple general goals

1) Estimate the incidence and severity of Soybean Vein Necrosis Virus (SVNV) in Delaware soybeans over multiple growing seasons.
2) Estimate reductions in yield or quality due to SVNV.
3) Obtain information on practices and conditions that may be associated with SVNV incidence, severity, and yield loss.

Report on Progress/Activity

Objective 1

During the 2014 season, I dedicated 13 days to visit soybean fields across Delaware in order to observe and identify virus symptoms, confirm the relationship between symptoms and SVNV, and collect data on the incidence of this disease within and between fields. In order to reduce costs and to increase efficacy, leverage other funding sources, and utilize existing labor and expertise, surveys were conducted in collaboration with Joanne Whalen, EIPM Specialist, who also monitored the same fields for insects, as well as thrips, throughout most of growing season. Costs were further reduced by utilizing Agdia® testing services to confirm SVNV in suspect samples.

Symptom Development

A total of 29 growers across Delaware allowed fields to be surveyed for SVNV (Table 1). I scouted 64 fields (28 double crop) from June-September, making 128 total field visits. Forty-nine of the fields were surveyed at least twice, once early in the growing season, between VE and R1, and a second time between R3 and R6. Thirty-three samples of soybean foliage covering a range of different symptoms were sent for confirmation of SVNV. All samples that were assumed to be infected with the virus tested positive (31/31) and two samples assumed to not be infected tested negative. This indicated that my in-field diagnostics were accurate. Therefore, visual diagnosis was used to confirm SVNV during the remainder of growing season. Symptoms from virus-infected plants varied from clearing of leaf tissue to bleeding of leaf veins, to presence of necrotic lesions and defoliation (Figure 1. A-H).

Figure 1. Examples of symptoms of Soybean Vein Necrosis Virus in Delaware soybeans. A) Initial symptoms appear as small areas, light green in color, associated with veins. At this stage symptoms may resemble downy mildew; B) As symptoms progress, veins may "clear"; C-E) Over time, the light green lesions start to turn yellow; F) Lesions of multiple ages can be found on the same leaf [old lesion (blue circle) and a younger lesion (red circle)]; G) Over time lesions become brown and if symptoms are severe, defoliation may occur; H) From a distance SVNV may resemble brown spot or other foliar diseases.

Table 1. Breakdown of survey sites based on county and cropping system

County	# Growers	# Fields	# Full season
Newcastle	7	12	10
Kent	16	27	12
Sussex	14	26	6

SVNV Incidence by County and Cropping System

Of the 64 fields included in this survey, 60 (94%) were infected with SVNV (Table 2). Overall, field severity averaged 11%, and ranged from 0-100%. Although field-level incidence was high, the majority of fields (88%) had severity levels less than 5% (Table 2). Field incidence differed by county (Table 2). When averaged across counties, severity was greater in Kent (16.5%) compared to Newcastle (14%) and Sussex counties (3%). Symptoms of SVNV appeared as early as July 15 and increased over the course of the growing season (Figure 2). The field level incidence detected in 2014 was greater than what was previously reported by consultants and agents in Delaware. Observed levels of severity suggest that the 2014 season was not severe for SVNV in the majority of Delaware fields, but significant variability in severity was evident. However, survey results indicate that SVNV can appear early in the growing season. In general, the potential for yield reduction from viruses increases when infection occurs early in plant growth and development. **Studies that manipulate thrips arrival by utilizing insecticides and examining different planting dates is one means to address these issues in the future.**

Table 2. Overall incidence and severity of Soybean Vein Necrosis Virus in Delaware for the 2014 soybean growing season.

County	**Field Incidence**	**Average Severity**	**No. <5% Severity**
Newcastle	9/11 (82%)	14%	8 (89%)

Kent	26/27 (96%)	16.5%	23 (85%)
Sussex	25/26 (96%)	3%	22 (88%)
Total	**60/64 (94%)**	**11%**	**53 (88%)**

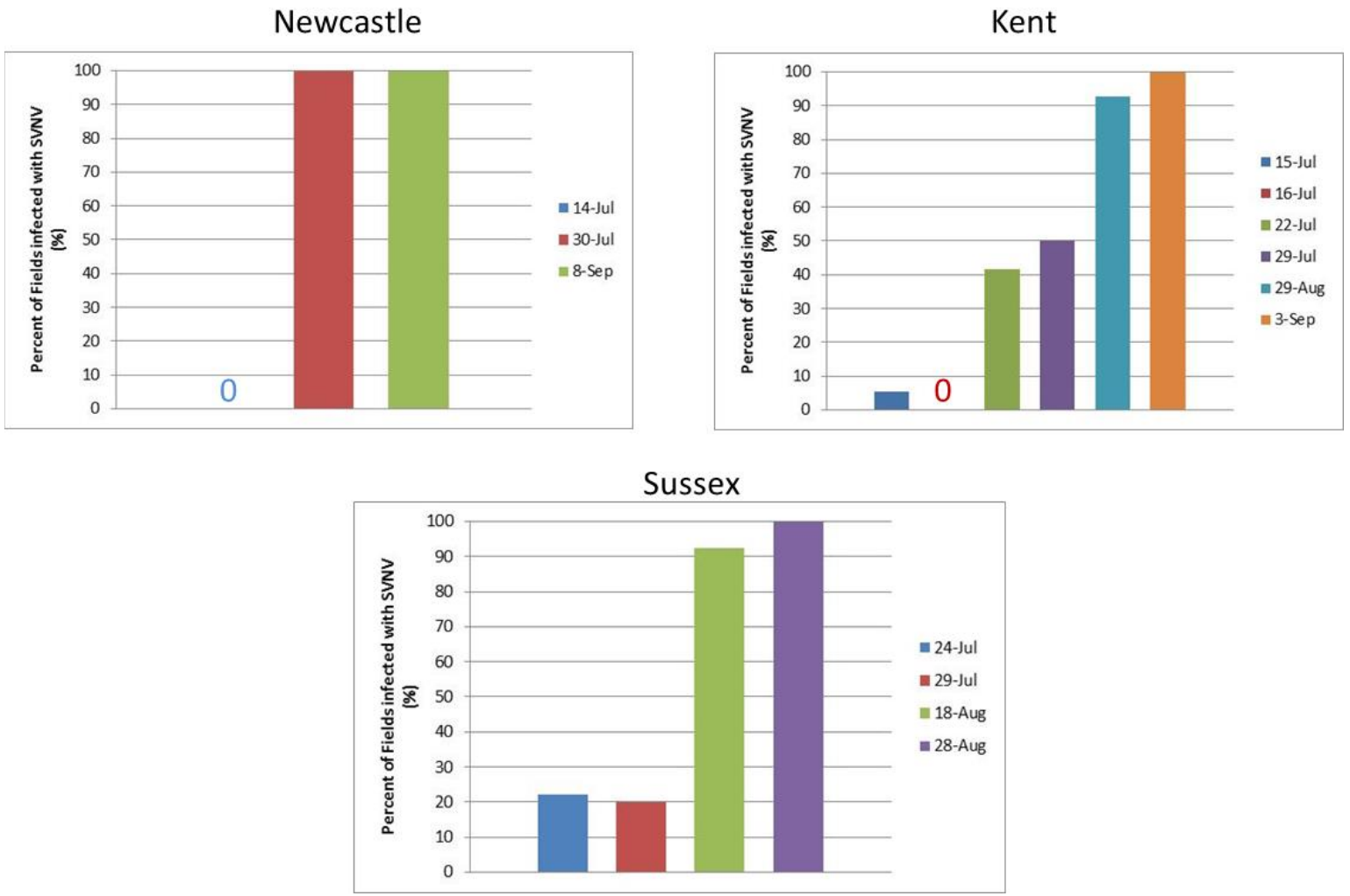

Figure 2. The percent of fields with Soybean Vein Necrosis Virus (SVNV) increased over time across all three counties.

Thrips Surveys

Of the 58 fields that were surveyed for both SVNV and thrips, 95% were infested by R3 (Table 6). Three fields in Sussex County did not have detectible levels of thrips when surveyed; however, these sites were assessed the fewest number of times during the growing season. Levels of fields infested by thrips varied by county, with 11 (100%) of fields infested in Newcastle County, 20 (74%) infested in Kent County, and 15 (56%) infested in Sussex County. Overall, 72% of fields were infested with thrips by V5 (Table 6). Thrips were detected from June through August when surveys ceased. These data indicate that Thrips can be found to some degree in nearly all fields in Delaware and that they may arrive early in plant growth if they contain the virus. Currently the source of SVNV in Delaware thrips populations is unknown nor is the source of the virus in the region. Potential sources include weeds and cucurbit crops, which have been shown to host the virus in greenhouse studies. Assessing the presence of the virus in weeds associated with SVNV infested fields would provide cultural information that would have implications in management, if required.

Table 3. The number of fields infested with thrips (incidence) was high in 2014.

County	**Field Incidence**	**No. Infested By V5**
Newcastle	11/11 (100%)	11 (100%)
Kent	27/27 (100%)	20 (74%)
Sussex	23/26 (88%)	15 (56%)
Total	**61/64 (95%)**	**46 (72%)**

Objective 2.

Initially it was assumed that SVNV would be hard to come across in Delaware due to input from local agricultural professionals. However, as shown under **Objective 1**, this was not true in 2014. Consequently, soybeans were collected from only two sites.

Full-season soybeans (Dynagro- 39RY43; Pioneer 93Y84) were harvested at R6 from research/demonstration trials at the Middletown Research and Demonstration Field (Dynagro) and a Newcastle County grower field (Pioneer). A total of 175 plants with varying degrees of SVNV symptoms were harvested, stored in a walk in cooler at 4°C and processed within 10 days. Several different soybean data were collected that might be impacted by the presence of a virus (Table 3).

Table 3. Soybean measurements made on 175 full-season soybeans (Dynagro- 39RY43; Pioneer 93Y84) harvested at R6 from the Middletown Research and Demonstration Field located in Middletown Delaware and a Newcastle grower field. Plants were selected that had a range of SVNV symptoms.

Measurement	Purpose
Plant height	Some viruses can reduce internode length
Number of nodes with virus vs total nodes on plant	Indicates severity of SVNV on entire plant. Individual leaf severity not rated.
Pod number	Related to yield
Beans per pod	Related to yield
Average bean weight	Related to yield and quality

Relationship between measured variables

Correlations were conducted to assess the overall relationship between SVNV and other measured variables. Correlations quantify the degree that two variables are related. To do this a correlation coefficient (r) is computed that tells us how much one variable changes when the other one does. When r is 0, no relationship exists. When r is positive, there is a trend that one variable increases as the other one increases. When r is negative, there is a trend that one variable increases as the other one decreases. Analysis of the 175 soybean plants indicated that there was a significant, slightly negative correlation between the percent of SVNV infected nodes and plant height, and a significant positive correlation between average bean weight and SVNV severity. Average bean size was significantly negatively correlated with pods per plant and plant height (Table 4).

Table 4. Non-parametric correlations between variables indicated a slightly negative correlation between the SVNV severity and plant height and a significant positive correlation between SVNV severity and average bean weight. Reduced plant size was correlated to fewer pods and beans per pod. * = significant at P = 0.05; ** = significant at P = 0.01. **Green text indicates a correlation associated with SVNV severity.**

		SVNV Severity	Plant height	Beans per pod	Avg bean weight
Pods per plant	r	.043	.261**	.129	-.164*
	Sig. (2-tailed)	.575	.000	.089	.031
	N	175	175	174	174
SVNV Severity	r		**-.160***	-.123	**.343****
	Sig. (2-tailed)		**.034**	.106	**.000**
	N		**175**	174	**174**
Plant height	r			.179*	-.376**
	Sig. (2-tailed)			.018	.000
	N			174	174
Beans per pod	r				.144
	Sig. (2-tailed)				.058
	N				174

In an effort to determine how SVNV severity ratings related to plant measurements, linear models were fitted between SVNV and measured variables. The ability of SVNV severity to predict changes in measured, independent variables was tested using ANOVA (Table 5). Weak, statistically significant linear relationships were found between SVNV and plant height (Figure 4) and average bean weight (Figure 5), which supported results generated from non-parametric correlations. SVNV explained approximately 28% of the variation in plant height and 43% of the variation in average bean mass, respectively. The results here suggest that there is a relationship between SVNV and plant height, and bean weight, but other factors not measured accounted for a great deal of plant to plant variability. The association between pod number per plant and SVNV severity approached significance at P = 0.10. SVNV severity only explained approximately 14% of variability in pod number per plant (Figure 6). Part of this can be explained by innate variation between fields and varieties. However, it is also important to note that the amount of severely infected plants (more than 50% severity) was fairly low and only 11 plants had severity levels greater than this level. It is likely that the effects of SVNV are more pronounced when plants express severe symptoms. Currently, I am a member of our national working group on SVNV and our data is being incorporated into a national database to

determine potential yield and quality impacts of this virus across soybean production regions. Data from this study provides key information on this disease from the Mid-Atlantic and also increases the visibility of the Delaware Soybean Board and its commitment to addressing plant disease issues at a national level.

Table 5. Linear regression analysis for SVNV severity and measured plant variables. Regression analysis indicated that SVNV severity had a linear relationship with plant height and average bean weight.

Independent variable	ANOVA Significance
Plant height	**0.0001**
Pods per plant	0.120
Beans per pod	0.433
Average bean weight	**0.0001**

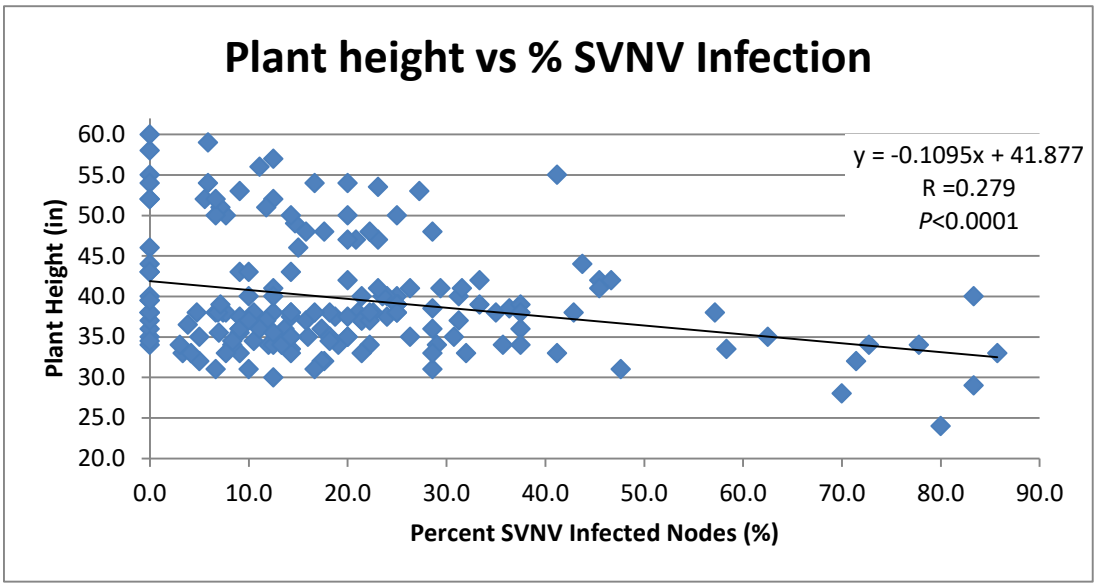

Figure 4. The linear relationship between SVNV severity and plant height. SVNV infection explained approximately 28% of the variation in plant height.

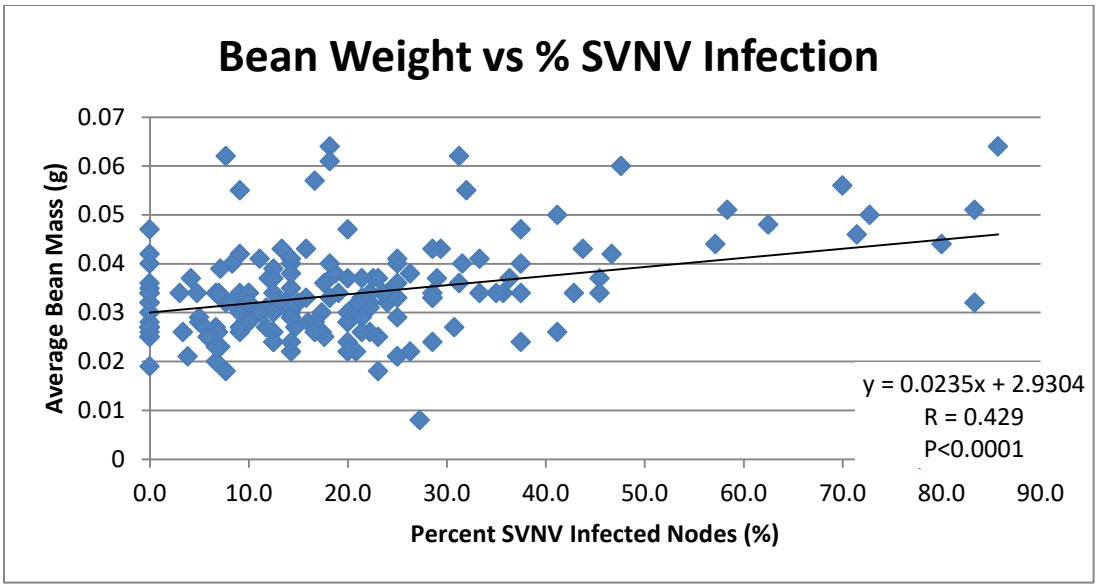

Figure 5. The linear relationship between SVNV severity and average bean weight. SVNV infection explained approximately 43% of the variation in average bean weight.

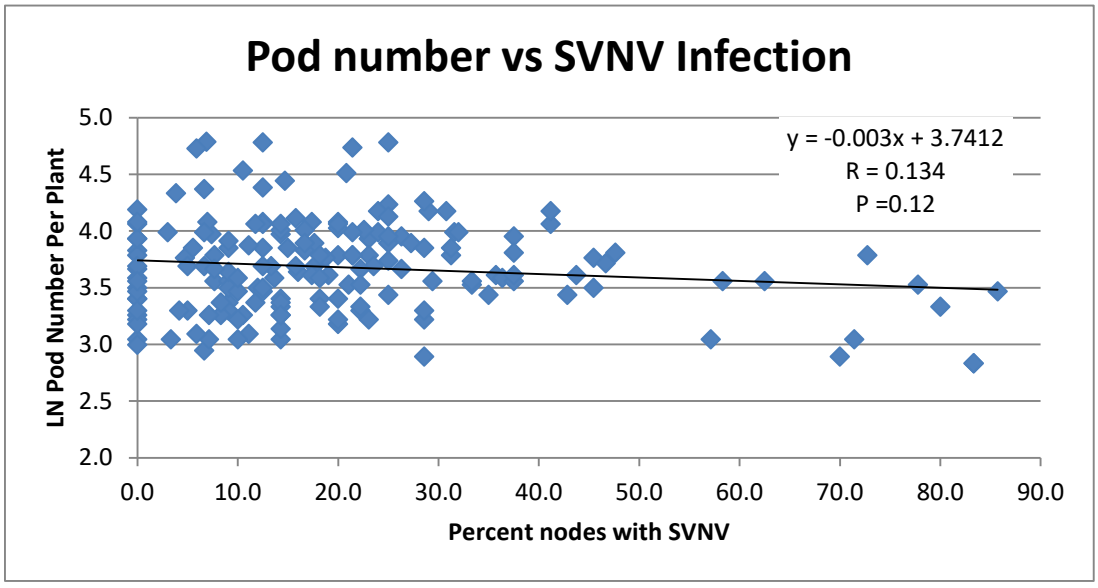

Figure 6. The linear relationship between SVNV severity and pod number per plant. A natural log (LN) transformation was used to linearize the data. Only 13% of variability in pod number per plant was explained by SVNV severity. In this model a SVNV free soybean plant would be predicted to produce roughly 45 pods per plant, whereas a plant with 85% SVNV severity is predicted to produce approximately 31 pods per plant.

Objective 3.

Observations were taken in fields throughout the growing season on patterns and other items of note that may be related to SVNV symptom development, incidence, or severity. First, symptoms were most evident, and often most severe, along field edges. Field edges near forest lines appeared to have more severe symptoms than those near ditches. Second, in most cases increased symptom severity was observed in plants in close proximity to weeds such as Ivyleaf Morning Glory. The field with the most severe symptoms was located near a creek where a large amount of Ivy Leaf Morning Glory could be found. There was no apparent association between SVNV symptoms and other foliar diseases, such as Septoria brown spot, Frogeye leaf spot, and Downy mildew. Irrigation did not appear to be a factor in symptom development. **As mentioned previously, surveying weeds in infected fields for SVNV and conduction replicated trials that manipulate thrips arrival and populations through insecticides and planting is likely to provide more useful management data than surveys alone.**

Outputs.

This survey and the support of the Delaware Soybean Board has been mentioned in two articles published in the Weekly Crop Update, and partial data were shared at the Maryland Crop school in November, 2014. Results for individual fields were shared with participating growers through a mailer sent in late November, 2014. Data generated will be shared at county meetings in DE and MD, Ag Week, and the New Jersey Crop Management School. Yield and quality impact data and DSB support is slated to be discussed at the 2014 Soybean Disease Working Group, NCERA-200, in March 2015.

Summary

This survey showed that SVNV can be prevalent in Delaware soybeans, and that symptoms can be found early in plant development for both full and double crop soybeans. The correlations between SVNV severity and aspects of soybean growth were consistent with results from the Mid-West. However, because Thrips may overwinter in the Mid-Atlantic there is a greater likelihood for SVNV-related damage due to earlier arrival of the vector and virus. Symptoms of SVNV are variable and can be easily misdiagnosed as other disorders. However,

based on this survey it is possible to accurately diagnose SVNV based on visible symptoms once the eye is attuned to the subtleties of the virus. More work needs to be conducted to determine the relationship between Thrips arrival and disease symptoms, the potential impacts of SVNV on crop yields, and weeds as viral reservoirs. An understanding of these factors will assist in constructing management guidelines if they are required.