

## 5.0 CONCLUSION

Landscaping is not a field that is usually scrutinized for occupational exposures, but should receive more attention independent of agricultural occupations. It is clear from this study that the employees that work with wood mulch are subject to exposures to known respiratory irritants. In this study the workers were not exposed to significant amounts of irritant compared to other agricultural studies that have been conducted, though there was still a presence of many pulmonary irritants and allergens.

### 5.1 Exposure Responses

The levels of fungal spores and endotoxins are dependent on many things including the contents of the wood mulch, storage, temperature, humidity, etc. This study was a small cross section of the landscaping industry and the mulching task. Elements such as different types of wood, which can support certain species of fungus and bacteria, would effect the findings of this type of field study. Also, the season in which the study is conducted in will alter the levels and types of fungal spores and endotoxin in the mulch. In the spring and summer there is a greater amount of growth throughout the mulch pile then in the winter. The duration of time that the wood mulch is allowed to rest without being disturbed also effects the amount of live organisms sustained in the pile. These are considerations for further field studies of landscaping and other industries that use wood mulch.

The trace amounts of fungal spores that were identified from the air samples in this study are lower than levels found in other studies that resulted in acute pulmonary responses by several factors of ten. However, the majority of the participants complained of cough with phlegm (88.9%); nasal irritation (100%); sinus trouble (87.5%); tiredness (88.9%) at least one third of the time at work. These ailments are in conjunction with the symptoms associated with many of the fungal spores present. Therefore there is a need for further investigation in this industry to determine if these reactions are developed by the minimal exposures or other environmental factors which may also be occupational hazards for these sorts of employees.

## **5.2 Exposure Limits**

After reviewing the data obtained in this study and reviewing the current literature, there does appear to be a need for noninfectious microorganisms exposure limits. Even though the levels in this study are lower than other studies that report an acute respiratory response, the known irritants are still present in this workplace and certainly in other agricultural settings. The presence of these organisms are causing harm to the respiratory systems of employees such as the wheat harvesters in Colorado (Viet et al., 2001) and also some employees that suffer from poor indoor air quality.

Organizations like the ACGIH have established suggested limits for some non infectious microorganisms in general terms, but these suggestions need to be made law so that the limits can be enforced. One of the main reasons that these types of limits have not been enforced is the inability to control and monitor these microorganisms. Jobs like landscaping are hard to monitor since the job site is constantly changing along with the environment and there are no engineering or administrative controls that can be taken to protect the afflicted workers. A possibility to remedy this situation is to require all individuals that work in an environment that is known to have the presences of noninfectious microorganisms that cause pulmonary responses to wear personal protective equipment.

## **5.3 Respirator Design**

The Moldex respirator used in this study was not acceptable according to the participants, but when other similar models were explored only one other manufacture was found using printed available catalogs. After searching the internet similar findings were generated, very few N-100, disposable, half-face respirators are currently available. For this industry based on the levels in this study an N-100 particulate respirator may be more than enough protection and an N-95 particulate respirator may be ample protection. Currently there are several manufactures of N-95 commercial respirators with varying styles and sizes. This would allow for more design issues being addressed other than just the desire for an adjustable nose piece.

### **5.3.1 Recommended Respirator Design Guidelines**

The three questions that resulted in significant p-values (relative to the other p-values) were all age dependent. Excluding the question concerning communication, there was a relationship between the remaining two responses. Unfortunately, from the information gathered the older segment of the population was interested in protecting their respiratory system by wearing a respirator, but this segment was also the most uncomfortable when using the disposable respirator. The manufactures are not targeting the compliant working population, so even the workers that are willing to comply do not due to discomfort they experience when using the product.

Several general respirator design guidelines were derived from the questionnaires and other employee comments. These guidelines are areas of concern and should be addressed in future respirator designs.

1. Adjustable nose piece
2. More variation in respirator size and face shape, to accommodate differences in facial anthropology (i.e. ethnicities)
3. Respirator lining that does not wear away or off onto user's face
4. Target older workers (more compliant segment of population)
5. Increase durability of respirators for full shift use (i.e. exhale hole filling with moisture by termination of shift)

### **5.4 Further Research**

This study of landscaper workers is very preliminary, but is representative of a need for further investigation. There are several fundamental aspects to this study that would need revisions before executing this type of field study again. A larger sample size is needed along with more dependable equipment and procedures.

March is the prime month for the mulching task in the New River Valley in Virginia, but companies have expressed that crews will mulch small jobs and touch ups will occur throughout the summer and into early Fall. A more in depth study is needed to determine how the levels of fungal spores and endotoxin fluctuate during the year in

wood mulch. More days of data collection during these different seasons would also give a better feel for the types of exposures that occur throughout this task.

#### **5.4.1 Data Collection Tools**

There were some slight discrepancies between the responses from the participants on the Likert-type questions versus the same or similar open ended questions. Both types of questions were asked after the participants completed their work shift and were asked by volunteers reading them the questionnaires. The reasons for these discrepancies are unknown though there were a few possible explanations. The Likert-type scale required that the individual remember which end to the scale was a positive and which end was a negative response. The scale was defined in the initial instructions that the volunteer read to the participants, but may not have been reiterated the scale during the questioning by the volunteer assuming the participant retained the anchor definitions. After a long day of work, the participants may not have had the necessary cognitive resources to listen and retain the vital information required to responses to the questions honestly, or they may have initially but forgotten the proper anchor definitions during the questioning.

The open ended questions, even though the environment was the same, required less thinking on the part of the employee. It can be difficult to hear a question formulate a response and then determine a numerical value that concisely represents the response, like in the case of using a Likert-type scale question. The open-ended questions allowed the worker to speak freely expressing his response, while a volunteer recorded his words. Since the employees were not asked to write their own answers to the questions also is believed to have helped gain more thorough answers to the open-ended questions.

#### **5.5 Summary**

The pitfalls along with the preliminary findings from this study should be learned from and built upon for future investigations of employees in the landscaping industry. More exposure information needs to be gathered before a statement can be made whether respirators should be required during this task and at what times of the year the respirator is most needed. Regardless of the exposure levels, many of the individuals in this study, were still suffering from allergens and it is recommended that respirators be made

available to employees to minimize the adverse mucous membrane responses to the work environment.