HHS Public Access

Author manuscript

J Agric Saf Health. Author manuscript; available in PMC 2020 April 01.

Published in final edited form as:

J Agric Saf Health. 2017 January 26; 23(1): 55–66. doi:10.13031/jash.11765.

Utah Regional Differences in Respirator Use and Fit Testing among Pesticide Applicators

M. L. Pate [ASABE Member, Associate Professor], **F. R. Beard [ASABE Member, Associate Professor]**, **K. Hall [Assistant Professor]**

School of Applied Sciences, Technology, and Education, Utah State University, Logan, Utah

Abstract

The purpose of this study was to determine regional differences within Utah in response to piloting a mobile respirator training and fit assessment program for pesticide applicators. The objectives were to describe worker perceptions of respirator use and training experiences. Pilot trainings were offered in two southern counties and two northern counties of Utah. A total of 141 individuals completed the post-training questionnaire regarding use and fit testing experience with respirators as well as perceptions of the benefits to protecting respiratory health. The majority of respondents were male (95.7%, f = 112). The proportion of participants in the southern counties who had respirator training experience (61.0%, f = 25) was not significantly higher ($x^2 = 3.763$, df = 1, p = 0.05) than the proportion of participants in the northern counties (43.0%, f = 43). Three-fourths (73.5%, f = 72) of participants in the northern counties agreed that they expect to wear a respirator in dusty conditions, while two-thirds (61.0%, f = 25) of participants in the southern counties agreed that they expect to wear a respirator in dusty conditions. The results indicated that more training should be done to improve perceptions and beliefs about using respirators. A high priority for this population will be identification of comfortable respirator options as well as communicating the importance of proper fit testing.

Keywords

Agricultural workers; Personal protective equipment; Respiratory; Safety

---

Grain, alfalfa, dairy, and corn silage continue to be major sources of revenue for agricultural producers in the intermountain west (USDA-NASS, 2007). These producers and their employees are faced with tremendous occupational respiratory hazards associated with their work environments (Sprince et al., 2000). Chemicals, dusts, endotoxins, microorganisms, and animal dander have been associated with acute and chronic respiratory diseases among farmers and ranchers, especially when animals are housed in confinement (Dosman et al., 2000; Lee et al., 2005; Pratt and May, 1984; Wilkins et al., 1999). Under 29 CFR 1910.1000 (Table Z-3), the OSHA permissible exposure limit (PEL) for general industry for inert or nuisance dust is 15 mg m^{-3}. Farms and ranches, typically, are unlikely to measure dust concentrations due to limited access to the specialized equipment needed. Research has shown that agricultural workers have an increased risk of developing asthma, histoplasmosis, and hypersensitive pneumonitis (NIOSH, 2006; James et al., 1990). The exposure to endotoxins and dust during harvest season has been linked to cross-shift respiratory changes among workers in northeastern Colorado (Viet et al., 2001). Agricultural workers are

exposed to pesticides when handling, transporting, mixing, and applying pesticides, when entering pesticide-treated locations, when cleaning application equipment, from pesticide drift, and during disposal of waste pesticides (Buhler et al., 2007).

Due to the diverse nature of agricultural settings, the application of engineering controls is limited, and a majority of farmers and employees rely on personal protection from respirators to reduce their exposure to airborne particles (Lee et al., 2005). Sprince et al. (2000) recommended that NIOSH-approved respirators be worn by workers during dusty operations. These respirators have been shown to have significant positive health benefits for agriculture workers in confined animal feeding operations (Donham et al., 2010; Dosman et al., 2000). However, the protection benefits associated with wearing a respirator may be limited by inappropriate selection of respirator type, face-seal leaks due to poor respirator fit, and/or damage to the respirator due to inappropriate maintenance (Lee et al., 2005; Sprince et al., 2000).

Material safety data sheets (MSDS) (OSHA, 2012) and the recently revised versions known as safety data sheets (SDS) are standard safety references for chemical products. Occupational safety and health standards are listed on the comprehensive SDS (also referred to as MSDS) documents, and they include potential hazards of chemicals and communicate appropriate protective measures to employees. Most employees in the U.S. fall under OSHA jurisdiction; however, the agriculture industry remains largely unregulated by OSHA. Worker safety compliance as it relates to pesticide handling and application is regulated by the U.S. Environmental Protection Agency (EPA). Under the EPA's changes to the worker protection standard (WPS), the OSHA respiratory standard has been adopted for respirator requirements for personal protection. This will necessitate a considerable increase in training to support the estimated 23,790 individuals nationwide whose occupation involves mixing or applying pesticides, herbicides, fungicides, or insecticides (BLS, 2015).

Respiratory protective equipment requires specialized care and use, and it appears as a requirement on pesticide labeling much less frequently than other personal protective equipment (PPE), such as gloves, safety glasses, and coveralls. In turn, agricultural workers may have less knowledge about how this specialized equipment should be worn and maintained. This is an important discrepancy because the performance of respirator equipment depends on the fit, equipment care and maintenance, and the type and duration of pesticide exposure (Beseler and Stallones, 2009). Pesticide applicators such as those involved in fumigation and air blast applications, by the nature of their work, have a better knowledge of respiratory protective equipment. In one study in which PPE use was observed during the mixing and application of pesticides for orchards, the researchers reported that gloves and respirators had the highest frequency of use (Hines et al., 2007).

Due to the low level of employer compliance with both WPS and OSHA-mandated standards, increased enforcement and alternate delivery of pesticide training are recommended (Shipp et al., 2005). Understanding and implementing personal protection requirements is of great importance for the health and safety of agricultural workers who are exposed to pesticides. These requirements are also important to the employers of such workers, who can be held responsible for compliance and worker safety.

Greskevitch et al. (2007) found that 27% of agricultural production crop establishments surveyed had a written program to determine what type of respirator to use. Additionally, 69.5% of the production crop establishments that required respirator use had at least three indicators of a potentially inadequate respiratory protection program (Greskevitch et al., 2007). Instances of high pesticide exposure are often under-reported by applicators, and only a small percentage of exposed workers are known to seek medical treatment (Bell et al., 2006). Agricultural workers could be putting themselves in greater danger with inappropriate use of respirators, especially when entering confined spaces such as grain storage structures to unload or apply fumigants.

Agricultural workers and farmers may tend to believe that the inconvenience of wearing a respirator outweighs the hazards associated with their work. A needs assessment survey of Utah farm owner/operators ($n = 328$) indicated that although respirators were the most common piece of safety equipment that the owner/operators ($f = 128$, 37.5%) had access to, only 86 (67%) of those individuals indicated using them (Pate and Merryweather, 2012). There is a significant need to address the use of respirators by agricultural workers who do not have knowledge of respiratory hazards within the work environment and to establish respirator fit assessment and training.

Respiratory hazards have been shown to significantly contribute to the burden of occupational disease among farmers (Beseler and Stallones, 2009). Pesticide exposure has been linked to an increased prevalence of respiratory symptoms in several agricultural populations (Blair et al., 2005). Research has suggested that increased use of respiratory protection would occur if agricultural workers were better informed about long-term respiratory health risks and if protective equipment were made more user-friendly (Mitchell and Schenker, 2008).

Purpose and Objective

The purpose of this study was to determine regional differences within Utah in response to a pilot mobile respirator training and fit assessment program for agricultural workers. The objective was to describe the workers' perceptions of respirator use and their training experiences.

Safety Emphasis

The speed and success in implementing the OSHA respiratory protection standard requirements cannot be evaluated at present, but both the goal and challenge is to improve the health and safety of agricultural workers by reducing their exposure to pesticides. In summary, changes to the EPA's WPS will require additional training to assist with compliance, especially for respirator standards. Continued efforts are necessary to advance programs that are judged by the level of information comprehension rather than just attendance. Participants will need to receive the training and demonstrate comprehension of the information.

Methods and Efforts

This project was reviewed and approved by Utah State University (USU) Human Subjects IRB (Protocol No. 4819). An approved letter of information was provided to participants and reviewed with the principal investigator to provide details about the research program. The training program was piloted in two southern counties and two northern counties of Utah. The geographic region was established using Salt Lake City as the boundary line separating northern and southern counties. Participants were attendees of Utah State University Extension Pesticide Applicator workshops during 2013 and 2014. The training included information on OSHA respiratory standard compliance, including medical clearance and fit testing. The training was guided by frequently asked questions regarding respirators from pesticide applicators who had previously attended Extension trainings in Utah (table 1). These questions were developed from applicators' inquiries to clarify recommendations provided by SDS and EPA-approved pesticide labels (Beard et al., 2014).

Additional training focused on hazard assessment, including the use of MSDS and pesticide labels. Proper selection using the NIOSH classification and labeling system was discussed and demonstrated. Training on respirator care and maintenance was presented at the conclusion of the workshop. Samples of various brands of N95 facemasks and elastomeric facemasks with P100 filters were provided for demonstrations of face-seal checks with agricultural producers. Agricultural employers and employees were instructed to review and complete the 3M medical clearance online questionnaire. Immediate results of this medical evaluation questionnaire were provided by a physician or other licensed healthcare professional. If an individual's medical questionnaire needed further evaluation, a notification was sent, and fit testing did not proceed until clearance was provided by a physician or other licensed healthcare professional. Participants were asked to provide contact information to schedule a respirator fit test at a convenient location, either at a local USU Extension office or in a climate-controlled building at their worksite.

Data collection was conducted through use of a questionnaire following the training session. The questionnaire requested information about participants' use of respirators, perceived barriers and facilitators of respirator use, as well as training and fitting experience. A portion of the questionnaire is provided in figure 1. Additional demographic data were gathered on contact information, age, gender, education, and production operation. Data were entered into SPSS (ver. 20).

Data analysis was completed to compare northern and southern counties. The state was divided into northern and southern regions based on a geographic reference line along Interstate 80. The justification for comparing northern and southern counties was based on the geographic and demographic characteristics of Utah. Counties located north of the Great Salt Lake are characterized by factors such as higher crop sales and higher population estimates within counties (USDA-NASS, 2012; U.S. Census Bureau, 2016). Northern counties are also closer to the main campus of Utah's Land Grant Agricultural College and Extension service. Within Utah, there are variations of climatic features. Precipitation rates have been noted to range from less than 12.7 cm to 101.6 cm (WRCC, 2016). Areas of southern Utah below elevations of 1219.2 m (4,000 ft) typically receive less than 25.4 cm of

moisture annually, while northwestern areas of Utah at higher elevations receive more perception due to normal storm tracks (WRCC, 2016). Additionally, lower air quality conditions, in the form of smoke and haze accumulations, are experienced due to anticyclones settling over Utah for extended periods of time (WRCC, 2016).

Hypothesis

We hypothesized that the northern counties would have greater experience with respirator training due to their location and the higher number of crop production operations in the region. Crop production operations would be more familiar with EPA worker protection standards. Individuals in northern counties with more respirator training experience as well as higher respirator use would have a greater perceived value of respirators.

Data Analysis

Descriptive statistics including frequencies and percentages were used to summarize the quantitative data. The chi-square test of association was used to test for differences between participants in the northern and southern counties on the nominal dependent variable and previous respirator training experience (yes or no). Using the effect size descriptors proposed by Rea and Parker (1992, p. 203), the magnitude of the phi coefficient was used to indicate the level of association between variables. Fisher's exact test was used for analyses with expected cell counts of less than 5. An alpha level of 0.05 was set *a priori* for all tests for significance. Written responses from participants were open-coded by the principal investigator.

Results and Findings

The majority of participants were male (95.7%, $f = 112$, $n = 117$). There were 24 individuals who did not respond to the question regarding gender identification. There were four individuals from the southern counties who identified as female, and only one individual from the northern counties who identified as female. The average age of participants in the northern counties was 51.6 (SD = 16.46), while the average age of participants in the southern counties was 48.1 (SD = 14.4). Overall, the average age of participants responding to the questionnaire was 50 (SD = 15.5). The difference in participant age between northern and southern counties was not statistically significant ($t = 1.132(116)$, $p = 0.260$). A total of 100 (70.9%) participants from northern counties and 41 participants from southern counties (29.1%) completed the questionnaire. A total of 232 individuals attended the presentations in the two northern counties. The response rate for the northern counties was 43.1%. A total of 101 individuals attended the presentations in the two southern counties. The response rate for the southern counties was 39.8%.

Participants were asked to indicate their primary occupation using an open response. The open responses were coded as production agriculture (e.g., farmer), agriculture support industry (e.g., custom sprayer operator), or non-agriculture (e.g., city maintenance worker). The highest proportion (59.0%, $f = 46$) of participants from northern counties indicated production agriculture as their primary occupation. The highest proportion (50.0%, $f = 18$)

of participants from southern counties indicated non-agricultural primary occupations. The differences in primary occupation between regions was statistically significant ($x^2 = 16.754$, df = 2, p = 0.000, Φ = 0.383). There were no cells with expected counts less than 5. There were 22 individuals from northern counties and five individuals from southern counties who chose not to answer the question.

Table 2 provides comparisons between northern and southern counties on education level. A total of 57 individuals from northern counties (72.2%) had attained a two-year college degree or higher. There were 28 participants from southern counties (73.7%) who had attained a two-year college degree or higher.

All participants were asked to indicate their perceptions of having to use a respirator during agricultural work using a 7-point Likert scale ranging from extremely burdensome to extremely helpful. Table 3 provides a comparison of the distribution of responses from the northern and southern counties. There were 20 participants (48.8%) from southern counties who perceived that respirators were slightly helpful to extremely helpful. A total of 60 participants (61.9%) from northern counties perceived that respirators were slightly helpful to extremely helpful. The combined majority (57.9%, $f = 80$) of all participants indicated that wearing a respirator during agricultural work was slightly helpful to extremely helpful.

All participants were asked to indicate if wearing a respirator while working was pleasant using a 7-point Likert scale. Table 4 provides a comparison of the frequency and distribution of responses from northern and southern counties. A total of 37 participants from northern counties (44.1%) indicated that wearing a respirator while working was slightly unpleasant to extremely unpleasant. There were 21 individuals from southern counties (52.5%) who indicated that wearing a respirator while working was slightly unpleasant to extremely unpleasant. A combined total of 58 respondents (46.7%) indicated that wearing a respirator while working was slightly unpleasant to extremely unpleasant. Participants were asked to provide written comments on what they believed were the advantages and disadvantages of using a respirator during agricultural work. The advantages commonly stated by the participants focused on clean air, health protection, prolonged lung function, reduced likelihood of chronic and acute exposure, and safety. Disadvantages commonly stated by the participants focused on comfort, convenience, and vision obstruction. Several comments indicated that respirators were in the way or caused the participant to get hot when working. Other comments indicated that respirators took extra time and were cumbersome to wear.

Participants were asked to indicate if they agreed that they wear a respirator while working in dusty conditions using a 7-point Likert scale (strongly disagree to strongly agree). Table 5 provides a comparison of the distribution and frequencies of responses between northern and southern counties on participants' agreement that they wear a respirator while working in dusty conditions. The responses were collapsed into three categories (agree, neutral, or disagree) for chi-square analysis. Responses were classified "agree" if the participants indicated either slightly agree, agree, or strongly agree. Responses were classified as "disagree" if the participants indicated slightly disagree, disagree, or strongly disagree. There were 72 (72%) participants from northern counties who agreed that they wear a respirator while working in dusty conditions and 25 (61%) participants from southern

counties who agreed that they wear a respirator while working in dusty conditions. The difference between northern and southern counties was not statistically significant (x^2 = 2.140, df = 2, p = 0.343, Φ = 0.124). There were no cells with expected counts less than 5.

Participants were asked to indicate if they had received previous respirator training prior to the workshop. Table 6 shows a comparison between northern and southern counties on previous training experience. The proportion of participants from northern counties who had respirator training experience was 43.0% (f = 43). For southern counties, 25 participants (61.0%) had previous respirator training experience. Although a higher proportion of participants from southern counties had previous respirator training experience, this was not a statistically significant difference (x^2 = 3.763, df = 1, p = 0.05, Φ = 0.163). There were no cells with expected counts less than 5.

Participants were asked if they had been fit-tested for a respirator prior to the workshop. Table 7 provides the frequency and distribution comparison between northern and southern counties on fit testing experience. A higher proportion of participants from southern counties (53.7%, f = 22) had completed a respirator fit test than the proportion for participants from northern counties (34.0%, f = 34). This difference was statistically significant (x^2 = 4.694, df = 1, p = 0.030, Φ = 0.182). There were no cells with expected counts less than 5.

For the question regarding respondents' perception that wearing a respirator during agricultural work was burdensome or helpful, the 7-point Likert scale ranging from extremely burdensome to extremely helpful was collapsed into three categories (burdensome, neutral, or helpful). Chi-square analysis was performed to compare the differences between respondents who had received prior respirator training and those who had not. There were 40 individuals (59.7%) with prior respirator training who indicated that wearing a respirator was helpful and 18 individuals (26.9%) with prior respirator training who indicated that wearing a respirator was burdensome. There were 40 individuals (56.3%) without prior training who indicated that wearing a respirator was helpful, while 18 individuals (25.4%) without prior training indicated that wearing a respirator was burdensome. The difference between individuals with prior training and those without prior training was not statically significant (x^2 = 0.612, df = 2, p = 0.736, Φ = 0.067). There were no cells with expected counts less than 5.

For the question regarding respondents' perception that using a respirator during agricultural work was unpleasant or pleasant, the 7-point Likert scale ranging from extremely unpleasant to extremely pleasant was collapsed into three categories (unpleasant, neutral, or pleasant). Chi-square analysis was performed to compare the differences between respondents who had received prior respirator training and those who had not. There were 24 individuals (40.0%) with prior training who indicated that using a respirator was unpleasant and 17 individuals (28.3%) with prior training who indicated that using a respirator was pleasant. There were 34 individuals (53.1%) without prior training who indicated that using a respirator was unpleasant and 19 individuals (29.7%) without prior training who indicated that using a respirator was pleasant. The difference between individuals with prior training and those without prior training was not statically significant (x^2 = 0.308, df = 2, p = 0.579, Φ = 0.057). There were no cells with expected counts less than 5.

For the question regarding respondents' expectation to wear a respirator in dusty conditions, chi-square analysis was performed to compare differences between respondents who had received prior training and those who had not received prior training. There were 51 individuals (75.0%) with prior training who agreed that they expected to wear a respirator in dusty conditions and 10 individuals (10.3%) with prior training who disagreed that they expected to wear a respirator in dusty conditions. There were 46 individuals (64.8%) without prior training who agreed that they expected to wear a respirator in dusty conditions and 11 individuals (15.5%) without prior training who disagreed that they expected to wear a respirator in dusty conditions. The difference between individuals with prior training and those without prior training was not statically significant ($x^2 = 2.575$, df = 2, p = 0.276, Φ = 0.136). There were no cells with expected counts less than 5.

Discussion and Conclusions

We acknowledge the limited response rate from the training participants. Caution should be used when generalizing the results of this study to other populations.

Based on the findings that participants from southern counties had a significantly higher rate of experience with respirator fit testing ($x^2 = 4.694$, df = 1, p = 0.030, Φ = 0.182) and a higher proportion of previous respirator training experience, approaching a statistically significant difference ($x^2 = 3.763$, df = 1, p = 0.05, Φ = 0.163), we rejected the hypothesis that participants from northern counties would have greater experience with respirator training due to their location within the state of Utah and the higher number of crop production operations in the area. We offer an alternative hypothesis that the differences in respirator fit testing and training experience are due to the respondents' primary occupations. A higher proportion of participants from southern counties indicated a non-agricultural primary occupation ($x^2 = 16.754$, df = 2, p = 0.000, Φ = 0.383). Non-agricultural industries have greater regulatory control for protecting workers. OSHA has limited regulatory authority over production agriculture; therefore, participants from northern counties would have less experience with respirator fit testing and training. The following conclusions were drawn from the results of this study:

- There was a significant difference between northern and southern counties in the percentage of participants who had received respirator fit testing. Although not statistically significant, a higher proportion of individuals with prior training rated the use of respirators as pleasant. These training experiences are helpful for individuals by identifying respirators that provide a greater level of comfort.
- A third (31.0%, $f = 36$, $n = 116$) of all participants perceived the use of respirators as burdensome when performing agricultural work. Although not statistically significant, a higher proportion of individuals with prior respirator training agreed that they expected to wear a respirator in dusty conditions. We conclude that participants' responses indicated that they were aware of the health advantages provided by respirators when they had received prior training.
- We conclude that more training or information campaigns should be done with these participants to increase respirator fit testing and the selection factors to

consider when acquiring a respirator for agricultural work. These participants should complete a fit test if they are using tight-fitting respirators.

- A sustainable cost-recovery model and Extension program for fit testing of participants should be developed. Strategies should be investigated that would help participants reduce the feeling of inconvenience when a respirator is needed. Successful interventions, similar to the public information campaigns for automobile seatbelt use, should be examined to determine the suitability and effectiveness of applying these techniques to achieve meaningful and lasting respirator use. Adapting these types of strategies should be directed toward increasing the appropriate use of respirators, improving knowledge of respirator function, and designing respirators with more comfortable materials.
- The participants should be informed of the recent developments by respirator manufacturers, such as exhaust valves and improved comfort strip materials over the nose bridge, that have improved the comfort of certain respirators.
- Participants' concerns about vision impairment and convenience indicate a need for assistance with proper selection, use, and adjustment for comfort. These individuals should be informed of optional respirator types when selecting for comfort.
- Other suggestions to increase respirator use include storing respirators at multiple sites, especially when agricultural work is spread over various locations.

Summary

Respirators are one of the most specialized pieces of personal protection equipment, and they require an appropriate level of knowledge for effective use. Appropriate training on when to use and how to adjust a respirator may address concerns that respirators are inconvenient. Fewer participants from southern counties indicated having prior training or fit testing. It will be important for participants to understand the health implications of using respirators without proper fit testing. Attempts should be made to complete follow-ups with participants to determine if any changes in perceptions, behavior intentions, or respirator knowledge have occurred. A high priority for these participants will be identifying comfortable respirator options. Ensuring the health benefits associated with respirators should be maximized when agricultural workers know how to appropriately select a respirator type, identify face-seal leaks due to poor respirator fit, and perform appropriate maintenance (Lee et al., 2005; Sprince et al., 2000).

Acknowledgements

This research was developed with support from the Safety Grants Program provided by the Agricultural Safety and Health Council of America (ASHCA) and the Utah Agricultural Experiment Station (Utah State University) and approved as Journal Paper No. 8871. The contents are solely the responsibility of the authors and do not necessarily represent the views of the ASHCA or the Utah Agricultural Experiment Station.

References

Beard FR, Pate ML, & Hall K (2014). Appropriate personal protective equipment: Pesticide label requirements or safety data sheet requirements. ASABE Paper No. 141901542 St. Joseph, MI: ASABE 10.13031/aim.20141901542

Bell EM, Sandler DP, & Alavanja MC (2006). High pesticide exposure events among farmers and spouses enrolled in the agricultural health study. J. Agric. Saf. Health, 12(2), 101–116. 10.13031/2013.20385 [PubMed: 16724787]

Beseler CL, & Stallones L (2009). Pesticide poisoning and respiratory disorders in Colorado farm residents. J. Agric. Saf. Health, 15(4), 327–334. 10.13031/2013.28887 [PubMed: 19967907]

Blair A, Sandler D, Thomas K, Hoppin JA, Kamel F, Coble J, … Alavanja M (2005). Disease and injury among participants in the Agricultural Health Study. J. Agric. Saf. Health, 11(2), 141–150. 10.13031/2013.18180 [PubMed: 15931940]

BLS. (2015). Occupational employment and wages, May 2014: 37-3012 pesticide handlers, sprayers, and applicators, vegetation. Washington, DC: Bureau of Labor Statistics Retrieved from http://www.bls.gov/oes/current/oes373012.htm#nat

Buhler WG, Langley RL, Luginbuhl RC, Jones JP, & Burnette JW Jr. (2007). Violations of pesticide use and worker safety regulations in North Carolina. J. Agric. Saf. Health, 13(2), 189–203. 10.13031/2013.22619 [PubMed: 17555207]

Donham KJ, Lange JL, Kline A, Rautiainen RH, & Grafft L (2010). Prevention of occupational respiratory symptoms among Certified Safe Farm intervention participants. J. Agromed, 16(1), 40–51. 10.1080/1059924X.2011.532761

Dosman JA, Senthilselvan A, Kirychuk SP, Lemay S, Barber EM, Willson P, … Hurst TS (2000). Positive human health effects of wearing a respirator in a swine barn. Chest, 118(3), 852–860. 10.1378/chest.118.3.852 [PubMed: 10988215]

Greskevitch M, Doney B, Groce D, Syamlal G, & Bang KM (2008). Respirator use and practices in agricultural crop production establishments. J. Agromed, 12(3), 25–31. 10.1080/10599240801887801

Hines CJ, Deddens JA, Coble J, & Alavanja MCR (2007). Fungicide application practices and personal protective equipment use among orchard farmers in the agricultural health study. J. Agric. Saf. Health, 13(2), 205–223. 10.13031/2013.22620 [PubMed: 17555208]

James AL, Zimmerman MJ, Ee H, Ryan G, & Musk AW (1990). Exposure to grain dust and changes in lung function. British J. Ind. Med, 47(7), 466–472. 10.1136/oem.47.7.466

Lee S-A, Adhikari A, Grinshpun SA, McKay R, Shukla R, Zeigler HL, & Reponen T (2005). Respiratory protection provided by N95 filtering facepiece respirators against airborne dust and microorganisms in agricultural farms. J. Occup. Environ. Hyg, 2(11), 577–585. 10.1080/15459620500330583 [PubMed: 16234218]

Mitchell DC, & Schenker MB (2008). Protection against breathing dust: behavior over time in Californian farmers. J. Agric. Saf. Health, 14(2), 189–203. 10.13031/2013.24350 [PubMed: 18524284]

NIOSH. (2006). Histoplasmosis: Protecting workers at risk. DHHS NIOSH Publ. No. 2005-109 Atlanta, GA: NIOSH Retrieved from https://www.cdc.gov/niosh/docs/2005-109/

OSHA. (2012). Hazard communication standard: Safety data sheets. Washington, DC: Occupational Safety and Health Administration Retrieved from www.osha.gov/Publications/OSHA3514.html

Pate ML, & Merryweather AS (2012). Utah farm owner/operators' safety practices and risk awareness regarding confined space work in agriculture. J. Agric. Saf. Health, 18(4), 273–284. 10.13031/2013.42329 [PubMed: 23189514]

Pratt DS, & May JJ (1984). Feed-associated respiratory illness in farmers. Arch. Environ. Health, 39(1), 43–48. 10.1080/00039896.1984.10545832 [PubMed: 6712283]

Rea LM, & Parker RA (1992). Designing and conducting survey research. San Francisco, CA: Jossey-Bass.

Shipp EM, Cooper SP, Burau KD, & Bolin JN (2005). Pesticide safety training and access to field sanitation among migrant farmworker mothers from Starr County, Texas. J. Agric. Saf. Health, 11(1), 51–60. 10.13031/2013.17896 [PubMed: 15782888]

Sprince NL, Lewis MQ, Whitten PS, Reynolds SJ, & Zwerling C (2000). Respiratory symptoms: Associations with pesticides, silos, and animal confinement in the Iowa Farm Family Health and Hazard Surveillance Project. American J. Ind. Med, 38(4), 455–462. 10.1002/1097-0274(200010)38:4<455::AID-AJIM12>3.0.CO;2-L

U.S. Census Bureau. (2016). Annual estimates of the resident population: April 1, 2010 to July 1, 2015. Washington, DC: U.S. Census Bureau, Population Division Retrieved from http://www.census.gov/quickfacts/chart/PST045214/49

USDA-NASS. (2007). Farms and land in farms. Washington, DC: USDA National Agricultural Statistics Service Retrieved from http://www.nass.usda.gov/Statistics_by_State/Utah/Publications/Annual_Statistical_Bulletin/Pdf/ab07/pg36.pdf

USDA-NASS (2012). Utah census of agriculture: County profiles. Washington, DC: USDA National Agricultural Statistics Service Retrieved from https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Utah/

Viet SM, Buchan R, & Stallones L (2001). Acute respiratory effects and endotoxin exposure during wheat harvest in northeastern Colorado. Appl. Occup. Environ. Hygiene, 16(6), 685–697. 10.1080/10473220118563

Wilkins JR III, Engelhardt HL, Rublaitus SM, Crawford JM, Fisher JL, & Bean TL (1999). Prevalence of chronic respiratory symptoms among Ohio cash grain farmers. American J. Ind. Med, 35(2), 150–163. 10.1002/(SICI)1097-0274(199902)35:2<150::AID-AJIM7>3.0.CO;2-5

WRCC. (2016). Climate of Utah. Sun Valley, NV: Western Regional Climate Center Retrieved from http://www.wrcc.dri.edu/narratives/utah/

Have you ever received any training on respirator use prior to this workshop?
☐**Yes**, describe your training experience. _____
☐**No**

Have you ever been fit tested for respirator use prior to this workshop?
☐**Yes**, what was the respirator type that you were tested with? _____
☐**No**

What do you believe are the advantages of using a respirator during agriculturally-related work?
_____

What do you believe are the disadvantages of using a respirator during agriculturally-related work?
_____

In the last 12 months, estimate how many times have you worn a respirator for agriculturally-related work?
_____

For Questions below, please circle the number that best describes your personal opinions for each statement. In the example below the individual strongly agrees.
(Example: Strongly disagree 1 2 3 4 5 6 ⑦Strongly agree)

If I wear a respirator while working, I will feel that I am doing something positive for my health:
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Having to use a respirator during agriculturally-related work is:
Extremely burdensome 1 2 3 4 5 6 7 Extremely helpful

Wearing a respirator while working is:
Harmful 1 2 3 4 5 6 7 Beneficial

Bad 1 2 3 4 5 6 7 Good

Unpleasant (for me) 1 2 3 4 5 6 7 Pleasant (for me)

Worthless 1 2 3 4 5 6 7 Useful

I feel under social pressure to wear a respirator during work activities:
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

People who are important to me want me to wear a respirator while working:
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

I wear/use a respirator while working in dusty conditions.
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

I want to identify the work conditions that require the use of respirators in agriculture:
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

I will wear/use a respirator when I feel the conditions require it:
Unlikely 1 2 3 4 5 6 7 Likely

The decision to wear a respirator during work activities is beyond my control:
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Figure 1.
Respirator training experience, fit testing, and perceptions questionnaire

Table 1.

List of frequently asked questions from Utah pesticide applicators.

How many years can (should) a reusable respirator be used?
How can an applicator be sure that the correct respirator is being used?
How should a reusable respirator be cleaned?
How should respirator filters be cleaned or decontaminated after use?
What are the respirator options for people who wear glasses or have a beard?
What is the best way/place to store a respirator?
Is there a local store that sells respirators and replacement filters?
Is it okay if more than one person wears the same respirator?
If a respirator must be put on and off multiple times during the day, how should it be stored between uses, and what should be done to prevent applicator contamination?
If a reusable respirator has not been worn in a couple of years, is it safe to use?
Are there any new regulations applicable to pesticide respirator use?
What is a respirator fit test?
How is the seal of a respirator checked prior to each use?

Table 2.

Comparison of northern and southern counties on participants' education attainment.[a]

Response	Northern Counties (*n* = 79)		Southern Counties (*n* = 38)	
	f	%	*f*	%
High school/GED	16	20.3	7	18.4
Technical certificate	6	7.6	3	7.9
Associates degree	6	7.6	11	28.9
Bachelor degree	38	48.1	12	31.6
Master's degree	13	16.5	5	13.2

[a]There were 21 individuals from northern counties and three individuals from southern counties who chose not to answer the question.

Table 3.

Comparison of northern and southern counties on participants' perceptions of having to wear a respirator during agriculturally related work.[a]

Response	Northern Counties (*n* = 97)		Southern Counties (*n* = 41)	
	f	%	*f*	%
Extremely burdensome	5	5.2	3	7.3
Burdensome	5	5.2	4	9.8
Slightly burdensome	15	15.5	4	9.8
Neutral	12	12.4	10	24.4
Slightly helpful	15	15.5	11	26.8
Helpful	20	20.6	4	9.8
Extremely helpful	25	25.8	5	12.2

[a]Three individuals from northern counties chose not to answer the question.

Table 4.

Comparison of northern and southern counties on perceptions of wearing a respirator.[a]

Response	Northern Counties (*n* = 84)		Southern Counties (*n* = 40)	
	f	%	*f*	%
Extremely unpleasant	11	13.1	10	25.0
Unpleasant	14	16.7	4	10.0
Slightly unpleasant	12	14.3	7	17.5
Neutral	19	22.6	11	27.5
Slightly pleasant	15	17.9	4	10.0
Pleasant	10	11.9	2	5.0
Extremely pleasant	3	3.6	2	5.0

[a]There were 16 individuals from northern counties and one individual from southern counties who chose not to answer the question.

Table 5.

Comparison of northern and southern counties on participants' agreement to wear a respirator while working in dusty conditions.[a]

Response	Northern Counties (*n* = 98)		Southern Counties (*n* = 41)	
	f	%	*f*	%
Strongly agree	32	32.7	12	29.3
Agree	22	22.4	7	17.1
Slightly agree	18	18.4	6	14.6
Neutral	13	13.3	8	19.5
Slightly disagree	2	2.0	1	2.4
Disagree	8	8.2	4	9.8
Strongly disagree	3	3.1	3	7.3

[a]Two individuals from northern counties chose not to answer the question.

Table 6.

Comparison of northern and southern counties on participants' prior respirator training.

Response	Northern Counties (*n* = 100)		Southern Counties (*n* = 41)	
	f	%	*f*	%
Previous training experience	43	43.0	25	65.0
No training experience	57	57.0	16	39.0

Table 7.

Comparison of northern and southern counties on participants' prior fit testing experience.

Response	Northern Counties (*n* = 100)		Southern Counties (*n* = 41)	
	f	%	*f*	%
Previous fit test experience	34	34.0	22	53.7
No fit test experience	66	66.0	19	46.3