FINAL REPORT

Project Title: New woven pesticide applicator protective garments with repellent

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Percentage time per crop: Apple: 65% Pear: 10% Cherry: 20% Stone Fruit: 5%

Other funding sources: None

Total Project Funding: $15,000

Budget History

Item	**2013**		
Salaries	0		
Benefits	0		
Wages	1500		
Benefits	30		
Equipment	0		
Supplies	3470		
Travel	10000		
Miscellaneous	0		
Plot Fees	0		
Total	15000		

Footnote: Plan to continue efforts, but travel funding supported by WSU Urban IPM and Pesticide Safety Education Program.

OBJECTIVES

Year 1 Objectives

1. Assess current requirements of pesticide manufacturers and EPA by categorizing garment, headgear and glove label statements for products used in tree fruits.
    a. complete
2. Conduct training meetings (extension in-service and grower) to discuss the risk mitigation provided by garment/glove requirements found on pesticide labels for tree fruits, current protective clothing use practices, and the concerns for overprotection (heat stress), as well as the need for applicators to be protected from wetness due to airblast sprayers
    a. worked directly with industry to assess common practices and reasons for decisions
    b. developed draft presentation on risk assessment, tree fruit pesticide labels, and the disconnect between label requirements and garments worn in industry
3. Use audience response systems to survey the interest in this new technology to protect applicators and any needs for specific style and function of the apparel during grower meetings -- present garment materials (textiles) used by pesticide applicators in Europe and Brazil.
    a. worked directly with industry to assess common practices and reasons for decisions
    b. conducted wear study of disposable garments and worked directly with small group of applicators instead of participating in winter training meetings.
    c. discussed risk assessment issues.

Year 1 – Change in process to a wear study for disposable garments

After meeting with managers, supervisors, and applicators from eleven different orchards, it was obvious that the research team (see list of cooperators) needed to better understand why applicators made their protective garment decisions. One operation also grew many other crops, and we visited one vineyard. By conducting an intermediate wear study of disposable garments, we could assess lighter weight materials and better understand durability and comfort factors. It also provided the opportunity to develop trust. The group of applicators from the 12 farms we worked with was initially not interested in wearing the garments with water-repellent finish. At the end of the season, those who participated in the wear study were ready to give garments with water-repellent finish a try.

For your information – project will continue

Funding provided by WSU Urban IPM and Pesticide Safety Education – 2014 garments/travel

1. *Evaluate for comfort, durability, quality, and cleaning for water-resistant, two-piece garments produced in Brazil that meet the ISO 27065 Level 2 requirements. .*
2. *2014 Schedule and Anticipated Findings*
    a. *March – obtain garments from Brazilian collaborator*
    b. *March – obtain IRB clearance from WSU*
    c. *March - Develop protocol and data collection methodology that will work for the cooperating applicators*
    d. *May – Deliver garments and instructions to cooperating applicators*
    e. *June – Visit with applicators*
    f. *July – Visit with applicators*
    g. *August – Collect garments and applicator reports*
    h. *September – Analyze findings and write final report*
    i. *November – Meet with applicators to share findings and discuss garment styles/design for improvements.*

SIGNIFICANT FINDINGS

Tree Fruit Pesticide Label Assessment;
Insecticides, fungicides, miticide labels from the Crop Protection Guide for Tree Fruits in Washington (EM0419) were analyzed; a subset of Dr. Shaw's database of 1,868 labels from Crop Data Management Systems (Shaw 2013).

- Signal words on tree fruit pesticide fruit insecticide, fungicide, and miticide labels (n=129)
  - 7% Danger-Poison (9)
  - 8% Danger (10)
  - 20% Warning (26)
  - 65% Caution (84)
- PPE garment requirements on tree fruit labels (n=130)
  - Chemical Resistant Coverall –Guthion® Solupak was the only product requiring chemical resistant coverall.
  - 11% Coverall over long-sleeved shirt, long pant
  - 7% Coverall over short-sleeved shirt, short pant
  - 82% Long sleeved shirt, long pant
- 42% of labels with chemical-resistant headgear requirements, only require long-sleeved shirt, long pant

Pesticide Label Issues

- Term "chemical resistant" for headgear or garments is poorly defined by EPA in relation to the spray solution or concentrated product – The federal Worker Protection Standard (40 CFR 170.240) defines "chemical resistant" as "made of material that allows no measurable movement of the pesticide being used through the material during use." Plan to continue dialogue with EPA on this significant shortcoming – meetings scheduled for March and Mary 2014.
- The term "coverall" is also poorly defined – type of fabric, quality, finish, thickness. etc.
- There is a glaring disconnect between the risk assessors' determination of required PPE (as stated on the labels) and most pesticide handlers who are required to comply with the requirements.
- Risk assessment applicator training must address protections of key routes of exposure: head, body, arms, legs, feet, and hands and why different PPE is required on labels.

Assessment of PPE Practices in Orchards - April 2013

- Protection is #1 priority
  - Farm supervisor – support applicators' desires to be protected (comfort/expense) but in some cases recognize overprotection in practice.
  - Most farm supervisors have at some point been applicators themselves.
  - Applicators – want to feel protected against wetness and pesticide exposure and want an impermeable barrier; they desire zero exposure. Risk assessment is not based on zero exposure, but wetness is an issue that must be addressed (PPE, application volumes, equipment, and methods).
- Becoming wet from spray was a significant concern by applicators
- Most applicators wore relatively thick rain suits (hood and bibs) for protection. Disposable Tyvek™-like suits were worn by some applicators (choice of applicator themselves) for low toxicity blossom thinning sprays or micronutrient (leaf-feed) applications.
  - Protection, comfort and clean-ability were the major concerns when rain suits are worn.

        - One applicator wore a disposal Tyvek® suit over his rain suit to prevent its contamination/grime from an organic nutrient application.
        - One vineyard had applicators wear an extremely heavy-duty PVC coverall, approx. 0.35 mm.
    - Heat was managed by stopping spraying when temperature thresholds were met, such as 80-85°F.
    - Oil added to spray mixture affects ability to clean PPE.
    - Greatest exposure zones were noted as back, head, forearm, neck and the crotch area in contact with the tractor seat.
    - Ball cap contamination is a significant issue. Binder clip on hood was a great idea.

Disposable Coverall Wear Study - July 2013

Four disposable garments were worn by 12 tree fruit applicators

- New taped garments now in US marketplace
- One garment was removed from study when "too much heat" was noted.
- Reported design features to manufacturers to assist them in design changes.
    - Taped seams were durable and performed well.
    - Glued zipper covering was a failure since it ripped the fabric when opened during the day – must be addressed, but realize to meet international spray-tight performance standards the manufacturers must eliminate penetration from zipper area.
    - Preference for lighter colors, not dark colors
- Considerations and needs for the future.
    - Developing two-piece, disposable spray-tight suits could improve comfort by offering a better potential for cooling. It would also improve fit because differences in height can be better adjusted in two-piece suits. Two-pieces would also eliminate the need to unzip a one-piece suit to go to the bathroom.
    - Consider a design feature that relies on separate spray-tight headgear, like a Sou'wester or one that covers the cap's brim since most people wear ball caps or.
    - In some garments, crotch area needs to be addressed to ensure adequate roominess.
    - A durability test is needed for rubbed areas, tears and punctures.

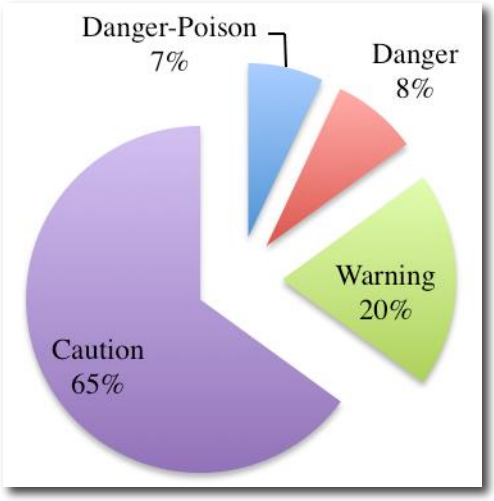
Education is Needed

- EPA and product manufacturers
    - Need to receive the findings for this work and address term "chemical resistant" related to garments, headgear and footwear and the term coverall
    - Need more information from the risk assessment process for "typical number of hours" for the application process to address the reported wetness, especially in the tractor seat
- Educators – university, regulatory, industry
    - Provide more in-depth professional development training for educators on the risk assessment process, applicator exposure/protections, and low toxicity products to improve risk management education.
    - Develop resources, like brochures, to convey dermal exposure/toxicity information using non-technical terms.
- Garment industry
    - Provide garment industry with input for the applicators about preferred design styles and features for PPE

RESULTS & DISCUSSION

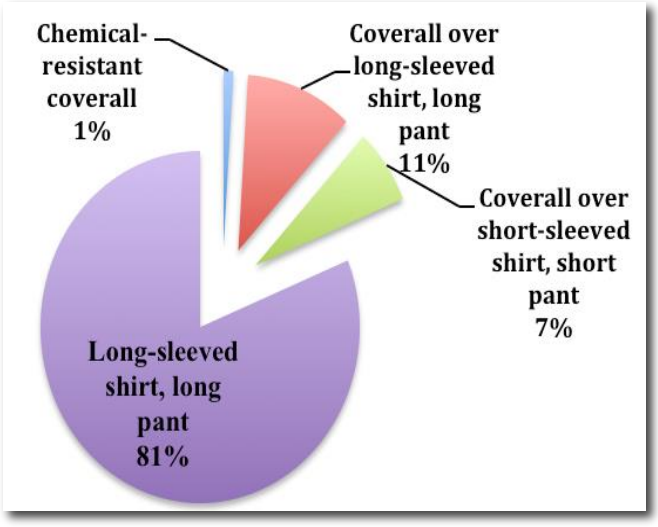
Several definitions are important to best understand the scope of the project and the collaborators involved.

- PPE - personal protective equipment
- Farm Supervisor – oversees and directs the spraying operations
- Applicator - the person mixing, loading and applying pesticides who is working under the supervision of a farm supervisor – may or may not be a WSDA-certified applicator
- Garment types
    - "Chemical-resistant" garment is not based on performance standards by US Environmental Protection Agency. *EPA 40 CFR 17.240: When "chemical-resistant" personal protective equipment is specified by the product labeling, it shall be made of material that allows no measurable movement of the pesticide being used through the material during use.*
    - Water-impermeable garment allows no measurable movement of water or aqueous solutions through the material during use.
    - Disposable garments – worn for the day, then discarded. The performance of these garments is dependent on the material and garment design, such as Kleenguard™, Microguard®, or Tyvek™.
    - Rain suit – washable, reusable and water-impermeable; most are made of coated fabric or sheeting that may also be chemical resistant.



<u>Label Data for Personal Protective Equipment</u>

Dr. Shaw maintains a label database detailing the PPE requirements for 1,868 product labels, which were provided by Crop Data Management Systems (CDMS) in 2012 (Shaw 2013). She extracted the PPE data for most pesticides in the Crop Protection Guide for Tree Fruits in Washington (EM0419). The data from 130 insecticide, fungicide, and miticide labels were analyzed for signal word and PPE requirements. The majority (65%) of product labels analyzed were low-hazard products with the signal word Caution. Twenty percent were moderately toxic with the signal word Warning. Fifteen percent were highly toxic with signal words 8% Danger and 7% Danger-Poison.



Signal words do not directly correlate with the PPE requirements on labels. The basic requirement for long-sleeved shirt and long pants was on 81% of the insecticide, miticide, and fungicide labels analyzed. Coveralls over short-sleeved shirt/short pant or long-sleeved shirt/long pants were 7% and 11%, respectively. Only one product,

Guthion® Solupak, required a chemical-resistant coverall.

Of the 130 products, 31 required chemical-resistant headgear. These 31 were paired with 13 requiring long-sleeved shirt/long pants, 8 requiring coverall over short-sleeved shirt/short pant, and 10 requiring coveralls over long-sleeved shirt/long pants. Thus, 42% of labels required minimal dermal protection, but required significant head protection.

These tree fruit label PPE findings were very similar to the findings that Shaw found with the 1,868 labels analyzed. There was no indication that the tree fruit industry product labels required products with greater protective levels of PPE when compared to the sample of labels analyzed nationally. However, the question remained as to why the applicators were typically wearing high levels of protection when the risk assessments that drive the label language did not result in requirements for impermeable garments.

Applicator Garment Selection

To assess why the applicators chose their selections of PPE, eleven operations were visited in April 2013 in the following areas: Wenatchee, Quincy, Royal Slope, Gleed, Moxee, Sunnyside, Alderdale, Burbank, and Prescott. They produced the following crops: apples, cherries, pears, hops, blueberries, and grapes. Acreages varied from 9 to 4,500 acres. Open cab airblast sprayers are still commonly used for tree fruit application; however, a couple ranches had all or some enclosed cabs. Rears sprayers were the most common for foliar conventional or organic insecticide, fungicide and micronutrient (leaf feed) applications. Typically, foliar applications were made for 6 - 12 hours from 1-3 days/week; however, large operations or emergencies, such as fireblight, pest outbreaks, or late season hops, required continuous applications. An application rate of 200 gallons per acre by airblast sprayer was quite common (range: 100-400 GPA). As a result there is considerable exposure.

High exposures occur at turns and when wind is blowing the same direction/speed as the tractor. Wetness is a concern especially when applying at 400 GPA even for one load that typically takes 20 minutes to apply. Some applicators and farm supervisors mentioned that they get very wet, and the liquid starts collecting on the tractor seat (we were not there long enough to evidence this). There was no visible evidence of "running of liquids" (but dry droplets) on the safety glasses or windows of enclosed tractor cabs. Greatest exposure zones were noted as back, head, forearm, neck and the crotch area in contact with the tractor seat.

The majority of applicators stated it was their choice to wear either rain suits or disposable coveralls when applying insecticides, fungicides, and micronutrients through airblast equipment. Some preferred reusable as the overall cost of the garment is lower; whereas, others preferred disposable garments for convenience.

Most applicators wore relatively thick rain suits (hood and bibs) for protection. All rain suits were made of multi-component materials - polyurethane or PVC coating on top of the fabric, inside, or on both sides. Rain suits were typically washed by placing them onto concrete and then scrubbing with a brush. Applicators in one farm wore extremely heavy suits for emergency spraying as the farm supervisor was under the impression that 0.35mm thick garments are required to be "chemical resistant." This was the only location with extra-heavy-duty suits. (This practice is not representative, but of significant concern)

- **FINDING – Sales catalogs do not reference the term "chemical-resistant" in relation to pesticides, but do for other toxic hazards. This is problematic and EPA needs to address it.**

Disposable Tyvek®-like suits were worn by some applicators (choice of applicator themselves) for low toxicity blossom thinning sprays or micronutrient (leaf-feed) applications. Typically, applicators in enclosed cabs wore disposable garments and those in open cabs wore reusable clothing. Those using ground booms for herbicides did not wear rain suits. The durability of the materials, leakage through seams, and tears were the main concerns expressed by the farm supervisors and applicators. In one farm, two applicators were wearing disposable coveralls that were ripped in the crotch area. The crotch in these coveralls was very low. The top coating of the coverall was also ripped and punctured. Different types of Tyvek®, Kleenguard® and other brands were called "tyvek," so it was not possible to obtain feedback about the different types of disposable garments. All disposable garments used were one-piece coveralls.

Most applicators wore hooded rain suit/coveralls over either a fabric ball cap or waterproof hat (Sou'wester). In most cases, wearing a cap under the hood provides for visibility when the head is turned, as compared to having the view blocked by the hood when looking back at the spray system (one orchard used a binder clip to secure the rain suit hood to their ball cap). In many cases the hat helps block the sun and prevents spray from running off down the hood onto the respirator or face.

The applicators reported they would like protective, affordable and lighter-weight garments that are durable. New garments would need to provide for comfort and prevent heat stress. Heat was managed by stopping spraying when temperatures exceeded 80°F.

Garments with repellent finish were passed around and discussed with the applicators at the 11 operations. Though curious, the majority stated they still wanted a garment that was water-impermeable and would keep wearing their rain suits and disposable coveralls. Also not a single person would wear just pant and shirt, even with repellent finish. The majority of applicators do not trust that the PPE on labels provides sufficient protection. Some questioned why the regular pant and shirt is required for whole body when chemical-resistant material is required for headgear. The WSDA-trainers also mentioned that some labels have contradicting requirements (maximum protection for one part and minimal for another). An example is stringent requirements for gloves and headgear and lenient requirements for the body.

- **FINDING – Applicators showed no interest garment with garments with repellent finish (except the hat) during the visit/discussions; thus, we refocused our efforts by conducting a "wear study" in July 2013 for light-weight, disposable garments that might provide sufficient protection.**
- **FINDING – The risk assessment process addresses the fact that the head area contributes significantly to exposure; thus, educational resources on dermal exposure and PPE should be developed for the tree fruit industry.**

WSDA-trainers, farm supervisors and pesticide applicators believe that for airblast spraying, work-attire (coveralls and/or long pants and long-sleeved shirt) does not provide sufficient protection for wetness and pesticide exposure, regardless of what the product label states. Often total protection was the goal that applicators and farm supervisors tried to achieve due to concern of health implications as a result of lifetime (chronic) exposure. Individuals expressed concern about the adequacy of PPE required by pesticide labels considering exposure scenarios (deposition amounts, applications methods and length of exposures).

- **FINDING - There is a glaring disconnect between the risk assessors' determination of required PPE (as stated on the labels) and most pesticide handlers believe they needed for protection from wetness or product hazard.**

Protection, comfort and clean-ability were the major concerns when rain suits are worn. Protection (against pesticides, oils, sticky materials, and wetness) provided by these suits is the main reason for

wearing them despite the comfort issues. At one operation a disposable Tyvek® suit was worn over the rain suit to prevent the rain suit from getting dirty; at the end of the day the disposable suit was discarded and the reusable rain suit reused the next day without washing.

From the farm supervisors' perspective, protection of the applicator was their top priority – over comfort and expense. All those we interviewed stated they would provide any PPE their applicators desired to have available. They noted concerns for both acute and chronic effects from pesticide exposures. Two supervisors commented they wanted some training classes to educate their crew about the safety of wearing fewer layers since they were unable to effectively communicate the message.

- **FINDING: There is a need for risk communication education.**

Applicators stated they want to feel protected against wetness and pesticide exposure and want an impermeable barrier. They stated zero tolerance for any penetration of spray. They also noted that when oil is added to spray mixture, it significantly affects their ability to clean PPE.

- **FINDING: If garments with water-repellent finish are to be considered in the future, the effects of oil in the spray solution must be addressed.**

Disposable Coverall Wear Study – July 2013

After learning that durability and protection provided by the disposable suits were mentioned as the major concerns and there was little interest in garments with water repellent finish, we planned and conducted a wear study to determine the user acceptance, durability and overall performance of new-to-the-market spray-tight garments (European certified Type 4 – spray tight) as these coveralls could potentially provide a balance between protection and comfort. In the study, 12 experienced operators wore four different types of disposable, one-piece coveralls for their regularly-scheduled applications to tree fruits. Also, the garment was worn over their regular clothing. The applicators performed their normal application duties that included starting at their normal times and stopping when the job was complete or cut-off temperatures (heat concerns) were reached.

Responses were collected from the applicators on the positive and negative attributes of the garments as well as performing visual inspections and photographing all garments. Findings were reported back to the manufacturers for them to consider improvements. In addition, the garments are being tested at the Instituto Agronômico in Campinas, Brazil, to determine the performance level in accordance with ISO 27065. Lessons learned from the wear studies will be used for ongoing discussions to revise the standard.

	Coverall A	**Coverall B**	**Coverall C**	**Coverall D**
Material Description	Flash spun high density polyethylene	Microporous film laminated to spunbond nonwoven	Polyethylene coated bi-component PP/PE spunbond nonwoven	Microporous film laminated to spunbond nonwoven
EN Type	4/5/6	4/5/6	4/5/6	4/5/6
Weight (GSM)	41.5	65	65	65±5%
EN ISO 13934 Tensile Strength (N)	>60	108.1 MD)/48.3 (CD)	110 (MD)/63 (CD)	48.3 MD
EN ISO 9073- 4 Tear Resistance (N)	>10	40.7 MD/18.6 CD	32.6 MD/63.3 CD	108.1 CD

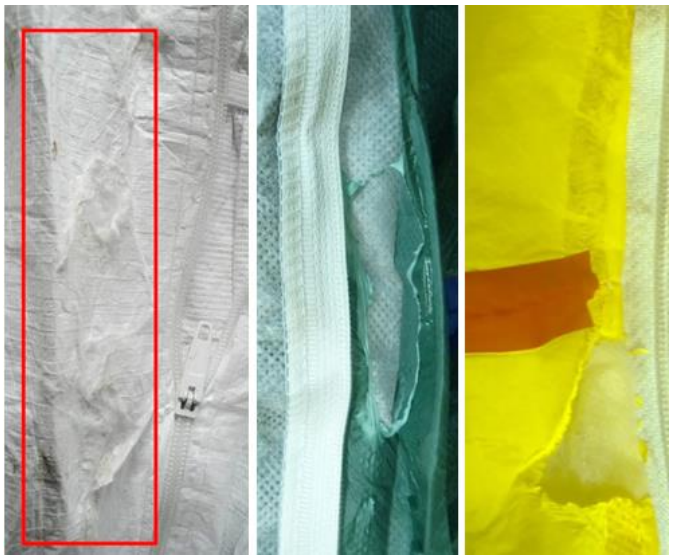
EN 863 Puncture Resistance (N)	>10	8.2	10	6.95

Table 1. Coverall details.

Scenarios varied considerably from orchard to orchard. Tree ages varied widely, which affects droplet dispersion, thus applicator exposure. Canopy densities/style varied as well; some orchards had open tree rows while others had dense canopies and closed tree rows, which caused branches to drag across garments. Applications were made in July with daily temperatures from lows of 54, 63, 51 °F to highs of 87, 99, 97 °F measured at nearby WSU AgWeatherNet stations. Applicators made typical decisions on when to start and stop an application based on air temperatures and wind speeds. Humidity was below 40% during the entire week.

Overall condition of the garments - Dirt/deposit on the garments ranged from minimal to very dirty. Some were very clean, whereas some had visible dirt and grease. In colored, especially green garments, spray deposit when calcium was being applied was very visible. As expected, the calcium deposit was not visible on the white garment.

Garment Design/Fit – The overall garment design of all four coveralls was very similar. In general the participants liked the garment fit over the body. There is sufficient design ease to allow them to move freely. Participant responses also reflected some examples about fit as it related to certain parts of the body. For example, applicators felt that one type of coverall leg "rode up." Some of the participants commented on the fit of the hood over the baseball cap. Some were satisfied by the way the hood covered their cap, whereas some found the hood too small. The satisfaction varied even for the same type of garment. The elasticized cuff was a feature that they liked.



The flap with glue along the edge to secure the flap over the zipper was one feature that all applicators found problematic. Participants removed or partially removed garments to have lunch or to go to the bathroom during the 2 to 5 hours of making applications. In several coveralls, glue from the flap stuck to the fabric, resulting in fabric damage/tear on the non-glued surface. After experiencing this with multiple garments, some applicators opted to leave the paper strip over the glue strip in tact to avoid the problem with the glue ripping the garment. It is strongly recommended that the manufacturers consider ways to resolve the issue with the glue strip (quality of seal is important internationally where garment certification is required).

Garment Protection – Most noted the garments provided sufficient protection as they could not feel the spray. However, they also said they would use it while applying calcium but not for pesticides. On the one windy day, some operators claimed they could feel the wet spray. Note: Garment penetration cannot be assessed accurately using applicator response.

Garment Durability – Garment durability varied considerably based primarily on garment material. Garment damage could be broadly grouped into four categories. 1. Abrasion due to rubbing against a surface such as seat belt connector on the tractor. 2. Tear as a result of garment getting caught on a branch or in one case a piece of barbed wire near a water spigot. 3. Damage along the seam in the crotch area. 4. Minor scratch marks that did not tear the garment. Garment material and quality of garment construction affected durability. The frequency of tear was higher in Coverall 4. Some of the tears were significant enough to affect the protection of the garment. In some of the garments made with microporous film laminated to spunbond material, damage due to stress was observed in the crotch area.

Garment Comfort – The normal work attire for participants was typically long sleeved knit or woven shirt and jeans or pants. Some wore sweatshirts or fleece the entire day, even when the temperature was relatively high. Since they wear the same attire during regular work days, they were not asked to make any changes in the work attire for the study. Response to comfort varied considerably. Comfort is a complex phenomenon to measure. Although each individual wore the same types of garments, other factors such as climatic conditions and duration of work varied. As a result, comments related to comfort may not be applicable for other scenarios where the regular work attire or climatic conditions are different.

In general, material did not matter on Day 1 when the temperature was cooler than on other days. No comfort issues were reported on Day 1. On subsequent days the responses related to comfort varied for three garments.

Being hot was a complaint with the garment coated with polyethylene and the garments with microporous membrane. Testing of the garment coated with polyethylene had to be discontinued due to excessive sweating reported by two participants. One of the participants discontinued the use of that garment after approximately 1 hour, and the other took measures to cool down during the day. Some of the individuals who wore garments with microporous membrane also complained of it being hot. One participant mentioned that comfort is the same as when he is wearing his rain suit. A two-piece suit may assist in dissipating the heat in hot weather. Several garment labels were damaged from being wet (sweat).

CONCLUSIONS

The trend in tree fruits is to use lower toxicity pesticides today. Application volumes are commonly 200 gallons per acre or higher. Applicators state they get wet from spray. The perception of high risk is prevalent in the applicator community. The lack of understanding dermal exposure principles has resulted in confusion for why chemical-resistant headgear is required when the label only requires long-sleeved shirt and long pants.

The disconnect between labeling language and PPE-use practices needs to be addressed. EPA and chemical manufactures must be engaged to assess their current use of label terminology and the risk assessment process. Both parties also need to provide evidence that the risk assessment process adequately measures the exposure concern for applicators using open cab tractors with airblast sprayers at high volumes and applying many consecutive hours. The term “chemical-resistant” on labels needs to be defined for headgear, boots, and garments and this then conveyed to the marketplace so they can respond and provide appropriate PPE. Use of the term coverall needs to be discussed and better defined.

To improve concerns for heat and comfort, applicators applying with open cab tractors and airblast sprayers should consider wearing two-piece disposable garments to provide more air movement and

cooling when off the tractor and to improve fit of the pants (crotch/pant length). The industry should engage suppliers to locate/make two-piece disposable, water-resistant or water-impermeable garments that might improve cooling.

Risk assessment education curricula need to be developed and educators trained in the science of dermal exposure (head, arms, trunk, legs, neck). Trainers need the resources and information to explain the differences in PPE requirements on labels.

Garment manufactures who design garments must continue to strive to maintain protections from liquid penetration with considerations for the comfort of the wearer. Applicators currently wear two-piece rain suits when concerned about excessive spray deposition (wetting) or toxicity. Development of two-piece, disposable suits could improve comfort and provide for a wider choice of protective gear. The two-piece design offers a better potential for cooling of the fabric types that were found to be most-heat prone. There was a preference for lighter colors. When designing the garment, designers must understand that there are times the suits are temporarily removed, at least from the upper torso, and consider other options for protecting the zipper area other than glue, such as a wider flap or snaps. Since most people wear ball caps, consider independent headgear styles or a hood that could cover the cap's brim but provide for visibility when turning to look back. The elasticized cuff was a preferred feature. The crotch area needs to be addressed to ensure adequate roominess. A durability test is needed for rubbed areas, tears and punctures.

WSU, University of Maryland Eastern Shore, and WSDA Farmworker Education plan to continue the work in 2014 by conducting a wear study with water-resistant, two-piece garments and headgear that are manufactured in Brazil. The study will begin in May 2014 after dormant oil and chlorpyrifos treatments. The water-resistant garments will be used for water-based spray solutions.

LITERATURE

A. Shaw. 2013. Analysis of Personal Protective Equipment Requirements on Labels of Pesticides for Agricultural Use. JPSE 15:17-19.

EXECUTIVE SUMMARY

Project Title: New Woven Pesticide Applicator Protective Garments with Repellent

PI: Carol Black, Washington State University

This project analyzed the personal protective equipment (PPE) required on insecticide, fungicide, and miticide labels from the Crop Protection Guide for Tree Fruits in Washington (EM0419); from a subset of Dr. Shaw's database of 1,868 labels from Crop Data Management Systems (Shaw 2013). The basic pesticide label requirement for long-sleeved shirt and long pants was on 82% of the tree fruit labels analyzed. Chemical-resistant headgear was required on 31 labels and 42% of those required only long-sleeved shirt and long pants. The tree fruit industry is using more low-toxicity pesticides today with little change in their use patterns for protective garments.

In April 2013, the research team visited 11 agricultural operations to discuss PPE use practices and the possibility of wearing garments with repellent finish. For open cab tractors with airblast sprayers, not a single applicator would wear just pant and shirt or a garment with repellent finish (except the hat); thus, in July we refocused our efforts by conducting a "wear study" of 4 light-weight, disposable coveralls with taped seams that might provide sufficient protection and be cooler than rain suits.

From the discussions in April, we learned there is a glaring disconnect between the risk assessors' determination of required PPE (as stated on the labels) and those who are required to comply with the pesticide label requirements (risk managers, farm supervisors, and applicators); this needs to be addressed. The perception of high risk and the wetness factor from any exposure is prevalent in the applicator community. The lack of understanding about dermal exposure principles results in confusion for why pesticide labels require chemical-resistant headgear and only long-sleeved shirt and long pants. Wetness is an issue that was not sufficiently assessed and was faced by applicators using airblast sprayers; more information is needed to address this.

EPA and chemical manufactures must be engaged to assess their current use of label terminology and the risk assessment process; both parties need to provide evidence that the risk assessment process adequately measures the exposure concern for applicators applying many consecutive hours. The term "chemical-resistant" on labels needs to be defined for headgear, boots, and garments and this conveyed to the marketplace so it can respond and provide appropriate PPE. Sales catalogs do not reference the term "chemical-resistant" in relation to pesticides, but do for other toxic hazards; this is problematic and EPA needs to address it through label changes. Coveralls also needs to be addressed.

Risk assessment education curricula need to be developed and educators trained in the science of dermal exposure (head, arms, trunk, legs, neck) and PPE.

For the wear study, all findings were reported, including images, to the three manufacturers. One disposable coverall was removed from study when "too much heat" was noted. Taped seams were durable and performed well. Glued zipper covering was a failure since it ripped the fabric when opened during the day. The zipper closure must be addressed, but are needed to meet spray-tight performance standard - manufacturers must eliminate penetration from zipper area. Applicators preferred lighter colors. The manufacturers could develop/modify two-piece, disposable suits for pesticide applicators to improve comfort by offering a better potential for cooling when the applicator is off the tractor. A two-piece suit could improve fit because it adjusts for differences in height of the applicator. Two-piece suits would also eliminate the need to unzip to go to the bathroom. Manufacturers should consider a design feature that covers the cap's brim since most people wear ball caps or have a separate headgear. In some single-piece coveralls, the crotch area needs to be addressed to ensure adequate roominess. Lastly, a durability test is needed for disposable garments to address for rubbed areas (seatbelt), and the potential for tears (limbs) and punctures.