Comfort and ergonomics of gloves used by glasshouse workers

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INTRODUCTION

The need for skin protection of glasshouse workers during preparation and application of pesticides is well recognized. Recent research has shown that in many cases this need is also present for workers who handle the plant material during other phases of the growing process. This implies that protective clothing as well as gloves would have to be worn for a considerable fraction of the working hours. Comfort and ergonomical aspects of these clothing items are therefore of great importance, as bad comfort or ergonomical properties can strongly reduce the motivation of workers to actually wear the skin protection. The present study was designed to determine how glove characteristics affect wearing comfort and manual dexterity.

METHODS

Nine subjects performed moderate work in a climate representative for glasshouse work (25 °C, 80% rh) while wearing clothing ensembles, combined with 15 different glove types. Glove types were selected to represent the currently sold range of gloves for glasshouse industry. The ensembles represented a range of levels of skin protection. Comfort of the different ensembles has been evaluated using questionnaires based on ISO/DIS 10551 (1993) and was reported elsewhere (Havenith and Vrijkotte, 1993). Glove comfort was part of this evaluation. Subjects scored comfort on a continuous scale ranging from "very uncomfortable, very bad" via "not comfortable/not uncomfortable" to "very comfortable, excellent". Afterwards, this scale was transformed to numbers from 0 to 100. Also, in separate tests, manual dexterity while wearing the different glove types was determined using the Purdue peg-board test (finger dexterity) and the Minnesota rate of manipulation test (hand dexterity). In the first test, the number of pins put into the board within 30 seconds was measured. This test was done with the right hand only, the left hand only, and both hands together. Performance with gloves was determined as:

$$\text{Performance} = (\text{score with gloves} / \text{score with nude hands}) * 100\%.$$

In the Minnesota rate of manipulation test, the time to fill a board (full of holes) with discs was taken as performance measure. For this test, performance was determined as:

$$\text{Performance} = (\text{score with nude hands} / \text{score with gloves}) * 100\%.$$

Comfort, finger and hand dexterity scores were integrated in a total score as:

$$\text{total score} = (\text{finger performance} + \text{hand performance} + \text{comfort score})/3$$

Results were corrected for training effects. The order of all tests was balanced over conditions. Subjects wore appropriate glove sizes where available.
Further, glove thickness was determined and subjects rated the gloves on flexibility, comfort of interior surface and roughness of the exterior surface. Results for comfort and dexterity were analyzed for their relationships with these glove characteristics

RESULTS

Glove properties as scored by the subjects and the corresponding structure are given in Table 1, together with results for finger and hand performance, comfort rating and overall score. Gloves are listed in order of total scores. Comparison of subject scores with glove type showed the following relations: exterior roughness scores (low to high): 1=smooth rubber, 2=smooth textile, 3=ribbed rubber, 4=rough surface (leather or roughened rubber), 5=very rough surface (sticky rubber); interior surface tactile properties (uncomfortable-comfortable): 1=smooth rubber, 2=rough rubber, 3=coated cotton, 3.5= coated rough cotton, 4=leather, 5=rough cotton (uncoated), 6=nude.

Glove type had a significant effect on comfort rating of the hand and in some cases (impermeable glove) also on whole body sensation. Finger dexterity was reduced by 40% and hand dexterity by 10% when the commonly used types of impermeable gloves were worn. For the worst gloves, the reductions for finger and hand dexterity were 70 and 40% respectively. Regression analysis showed that finger dexterity was mainly related to glove thickness and flexibility, manual dexterity to sizing, flexibility and roughness of the outer surface.

Table 1: glove characteristics and performance and comfort score. thickness=glove thickness, sizes availability of more sizes (0=one only; 1=more sizes); ext=exterior surface roughness at fingers; int=tactile properties of interior surface; flex = flexibility of glove material (0= very rigid; 5=very flexible). Explanation see text. Finger=finger dexterity performance; hand=hand dexterity performance; comfort=comfort rating; total=total score.

material	thickness (mm)	sizes	ext.	int .	flex.	finger (%)	manual (%)	comfort (%)	total (%)
nude	0	1	4	6	6	100	100	100	100
PVC (surgical glove)	0.105	1	1	1	5	91	99	92	94
cotton	0.550	1	2	5	5	77	102	89	89
rubber	0.530	1	3	2	4	66	90	63	73
leather	0.700	1	4	4	4	56	93	69	73
latex-rubber	0.800	1	1	3	3	56	92	60	73
nitrile	0.375	1	3	1	4	69	92	48	70
neoprene	0.660	1	3	2	4	65	90	53	70
rubber	0.600	1	3	2	4	63	92	53	70
latex on cotton, back of hand cotton only	0.750	1	4	3	4	60	90	47	66
leather	0.900	0	4	4	3	42	82	48	57
cotton/leather	1.220	0	4	5	4	42	81	42	55
cotton/leather	1.200	0	4	5	3	33	76	43	51
latex on cotton, back of hand cotton only	2.000	0	5	3. 5	2	28	73	40	47
latex on cotton	1.020	0	4	3	1	33	73	32	46
pvc on cotton	1.400	0	4	3	0	26	62	7	32

CONCLUSIONS

Glove material affects hand comfort, and also overall body comfort. Thus, selection of glove material is important for optimal thermal comfort of the wearer. The observed reductions in manual dexterity were found to be substantial. This can create a safety risk when workers have to handle poisonous substances, as often happens in glass culture workers. The presented results can assist in glove selection for optimal comfort and dexterity once the needed protection level is determined.

REFERENCES

1 ISO/DIS 10551. 1993, Ergonomics of the thermal environment-assessment of the influence of the thermal environment using subjective judgement scales. *Geneva, International Organization for Standardization.*

2 Havenith G. and Vrijkotte T.G.M. 1993, Effectiveness of personal protective equipment for skin protection while working with pesticides in greenhouses. Part III: Comfort and Ergonomics. *Report TNO-IZF, 1993-C-40.*