Ergonomic Risks in Polyhouse Farming

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ABSTRACT

Polyhouses are structures utilized as microclimate environment to make the plants grow well in unfavorable climate. In polyhouse, farming is done in vertical form rather than horizontal form, so the workers had to stretch their body in tying, pruning, harvesting. Polyhouses are essentially microcosms aimed at providing physical environment suitable for the survival and growth of plants with high degree of temperature, humidity and carbon dioxide. Working at unsuitable temperature combined with stress to the body from heavy physical activity, and exposure to chemicals can be very dangerous to man's health. So present study was conducted to find out effect of unsuitable working environment and posture on workers health. In study it was found that in walk-in-tunnel (WIT) and natural ventilated polyhouses (NVPH) the temperature was 69.54% and 52.29% higher and the humidity was 96.37% and 85.19 % higher in comparison to open farming in the months of January and May. No significant different was found in temperature, humidity, dust, solar radiation and CO_2 level between open and anti insect net shade house (AINH). In Hi-tech polyhouse, the environment was totally controlled by computer and was not found to much strenuous. The CO_2 level in WIT was found to be 359.82% and 332.95 % higher in comparison to open farming. According to mental workload scale the working condition in WIT and NVPH was found 'risky' the score of 51.17% and 47.6%. The posture analysis of 8 activities was done by REBA score sheet and bed washing and tying work were at high risk level with score 12 and 11 and required necessary action. In case of occupational health hazards both biological and psychological aspects were found more risky with mean value 3.22 and 2.86. Health status of workers was checked by doctor, and it was found that in polyhouse farming workers were more prone to problems of allergy and asthma.

Key words: Polyhouse, unfavorable climate, walk-in-tunnel and psychological aspect

INTRODUCTION

Polyhouses are essentially microcosms aimed at providing physical environments suitable for the survival and growth of plants. High temperature (up to 40°C) and humidity (70-80%) exhibits a significant influence on the rate of photosynthesis, generally, the higher temperature and humidity, assuming CO_2 and light are abundant, and the faster photosynthesis takes place (Grimes and Williams, 1990). By warming the air immediately around crops, polyhouses effectively extend the growing season and allow the cultivation of crops from lower latitudes. (Patel and Rajput, 2010). But polyhouse cannot be considered a very suitable place for work operators especially in hot season. Operators are forced to work in unfavorable conditions and exposed to harmful effects. Working at unsuitable environment combined with stress to the body from heavy physical activity, and exposure to chemicals, can be very dangerous to man's health. Vegetables need very high levels of temperature with a peak of 30°C and 80% of relative humidity but these levels cannot be considered favorable to operators who work in this environment. According to Jose (2009) Workers participate different operations of polyhosue farming like; seeding, potting, transplanting or transporting plants and materials throughout the polyhouse. Polyhouse farming is done in vertical form and in all these activities workers have to move frequently, working in a bent over position for any prolonged period of time, or from excessive bending and have to stretch their body to perform the task. Such maneuvers require rotation of the lower spine and may place undo strain on the supporting musculature and supportive ligamentous structures. Excessive head, back and knee bending may predispose to other lower extremity musculoskeletal disorders. Nearly one-quarter of injuries result from overexertion, usually when moving or lifting objects such as equipment, supplies, or debris. All of these injuries are costly, both in human terms and in terms of time lost from work and work disruption. Workplace accidents can have a tremendous impact on injured workers, their co-workers, and their families, in terms of pain and suffering, disability, stress, and loss or change of employment. (Abou-Hadid et. al., 1994). There are also indirect costs, which may include damage to property, the cost of finding and training temporary employees, and service interruption that could lead to loss of customers. So the study was conducted to find out the extreme environment condition in polyhouses and their effect on workers health as well as posture and mental workload on workers due to working different polyhouse and in different activities.

METHODOLOGY

The study was conducted in two phases.

Phase-I: Study of environmental parameters in polyhouses

Phase-II: Effect of polyhouse farming on workers

Stage-I: Physiological response of workers in different polyhouses

Stage-II: Posture assessment of workers in different working condition

Phase-I: The present study was conducted in polyhouses at indo-Israel project on vegetables, at Karnal district. Four different types of polyhouses viz., Hi-tech, Naturally ventilated polyhouse, Walk-in-tunnel and Anti-insect net house were taken. Month wise climatic data / environmental parameters (temperature, humidity, and CO_2) were analyzed during working hours. Comparison of environmental parameters was done between open farming (control) and polyhouses to find out the extreme environmental condition.

Phase-II:

Stage-I: Physiological response of workers in different polyhouses

Effect on environmental parameters on workers' health was studied in terms of physiological parameters i.e. heart rate, blood pressure and lung function capacity. Physiological parameters of workers were studied during working condition in different polyhouses.

Stage-II: Posture assessment of workers in different working condition

The posture of workers was studied in 8 different activities; bed washing, bed making, field preparation, sowing, tying, pruning, irrigation and fertilizing and harvesting which were carried out in polyhouse farming.

The posture was accessed by REBA score analysis.

REBA stands for rapid entire body assessment, designed to provide a quick and easy observation postural analysis tool for whole body activities. In REBA, position of individual body segments was observed in different polyhouse activities.

Mental workload: On account of the different causes of the negative effects of mental workload individual checklists have been drawn up for the assessment of stress, mental satiation. Each checklist contains features of activities, working conditions, performance and behavior. The data are evaluated quantitatively in relation to the number of ticked off answers per feature (expressed as percentage).

Table 1: Action category of mental workload checklist

NO RISK	INCREASED RISK	HIGH RISK
Need for action regarding some features	Redesign recommended	Redesign urgently required
0-33%	34-66%	67-100%

Analysis of data: To find out the increasing and decreasing level of environmental parameters in different polyhouses in comparison to conventional farming were assessed by following equation:

$$\frac{\textbf{Level of environmental parameter in conventional framing - Level of environmental parameter in polyhouse}}{\textbf{Level of environmental parameter in polyhouse}} \times 100$$

**Environmental parameter (temperature, humidity, CO_2, dust)*

ANOVA test was used to find out the difference of climatic data (temperature, humidity, and CO_2) between polyhouses and open farming (control). Response surface methodology (quadratic model) was used to find out the effect of environmental parameters (temperature, humidity and CO_2) on workers' physiological responses (Heart rate, Blood pressure and Lung function capacity). By RSM software analysis on the basis of three environmental values and three physiological responses the calculation was done on 8 parameters that were assuming by software itself to analyze the data. The values are as follow:

A (temperature)- Value of temperature
B (humidity) - Value of humidity

C (carbon-dioxide)- Value of carbon-dioxide
AC (temp.-CO_2)- Ratio of temperature and carbon-dioxide
BC (Humidity-CO_2)- Ratio of humidity and carbon-dioxide
A^2 (temp.^{2})- Assuming double value of temperature
B^2 (Humidity^2)- Assuming double value of humidity
C^2 (CO_2^2)- Assuming double value of carbon-dioxide

RESULTS AND DISCUSSION

In Karnal, at indo-Israel project, study was conducted on 16 different polyhouses viz; 1-Hi-tech, 2- NVPH, 10-WIT and 3-AINH. The total area under polyhouses was 11048 m2 and installed with total cost of RS. 78,24,732. Hi-tech polyhouse was used to be for nursery production other side NVPH, WIT and AINH polyhouses for crop production/farming like; capsicum, cucumber, tomato, brinjal and chilli. A total 50 people were found to be engaged in polyhouse organization including 10 experts and 40 labors. Environmental parameters were accessed during working hours in different polyhouses and posture was accessed during different during work.

Data in Table 2 represent the temperature of different polyhouses in different months. Results explore that the temperature in open and Hi-tech polyhouse was found similar in all months with increasing level of 3.86 (Jan.), 5.11% (Feb.), 1.42% (March), 3.26% (April), 2.77% (May), 3.13% (Aug.), 4.50% (Sept.), 5.67% (Oct), 1.66% (Nov.) and 2.83%(Dec.). The temperature of AINH was observed significantly higher to open temperature in Jan (22.3%), April (15.54%) and Aug.(12.29%) with critical difference 9.7, 8.7 and 10.1, except these months, the temperature viewed similar in all months in AINH and Open. Alongside in NVPH and WIT the temperature was significantly higher in all months from open temperature. In months of January, Feb., March, Nov. and Dec., the temperature of NVPH (26.^{0}C, 31.0^{0}C, 33.4^{0}C, 37.4^{0}C and 28.0^{0}C) and WIT (29.5^{0}C, 33.6^{0}C, 35.1^{0}C, 41.5^{0}C and 31.5^{0}C) was found to be similar with increasing level of 22.56%-26.29% (April), 16.6%-25.20% (Aug.), 18.70%-24.83% (Sept.) and 19.59%-25.64% (Oct.). Regarding temperature of May, in WIT 53.9°C was significantly higher in comparison to open, AINH, WIT and NVPH.

Table 2: Comparison of temperature in different polyhouses in different months

Month	Open	AINH	Increased (%)	Hi-tech	Increased (%)	NVPH	Increased (%)	WIT	Increased (%)	CD
January	17.4 [a]	18.1	3.86 [a]	22.4	22.32 [b]	26.5	34.33 [c]	29.5	41.01 [c]	9.7
February	24.1 [a]	25.4	5.11 [a]	26.6	9.39 [a]	31	22.25 [c]	33.6	28.27 [c]	10.8
March	27.6 [a]	28	1.42 [a]	31.6	12.65 [a]	33.4	17.36 [b]	35.1	21.36 [b]	11.4
April	32.6 [a]	33.7	3.26 [a]	38.6	15.54 [b]	42.1	22.56 [bc]	44.2	26.24 [c]	8.7
May	38.6 [a]	39.7	2.77 [a]	43.7	11.67 [ab]	47.8	19.24 [b]	53.9	28.38 [c]	9.2
August	37.1 [a]	38.3	3.13 [a]	42.3	12.29 [b]	44.5	16.62 [bc]	49.6	25.20 [c]	10.1
September	33.9 [a]	35.5	4.50 [a]	38.6	12.17 [a]	41.7	18.70 [ab]	45.1	24.83 [b]	7.8
October	31.6 [a]	33.5	5.67 [a]	36.3	12.94 [a]	39.3	19.59 [ab]	42.5	25.64 [b]	6.8
November	29.5 [a]	30	1.66 [a]	33.4	11.67 [b]	37.4	21.12 [c]	41.5	28.91 [c]	8.4
December	24.0 [a]	24.7	2.83 [a]	26	7.69 [a]	28	14.28 [b]	31.7	24.29 [b]	9.1

Table 3: Comparison of humidity in different polyhouses in different months

Month	Open	HI-TECH	Increased (%)	AINH	Increased (%)	NVPH	Increased (%)	WIT	Increased (%)	CD
January	50.8 [a]	55.2	7.97 [a]	70.1	27.53 [a]	81.4	37.59 [b]	90.4	43.80 [b]	18.3
February	47.8 [a]	48.7	1.84 [a]	64.9	26.34 [b]	78.9	39.41 [bc]	88.1	45.74 [c]	17.2
March	44.2 [a]	46.3	4.53 [a]	65.2	32.20 [b]	75.1	41.14 [b]	82	46.09 [b]	16.1
April	44.5 [a]	45.8	2.83 [a]	62.6	28.91 [b]	72.1	38.28 [bc]	78.4	43.23 [c]	12.7
May	33.1 [a]	35.6	7.02 [a]	44.9	26.28 [b]	61.3	46.00 [c]	65	49.07 [c]	17.4
August	40.8 [a]	42.6	4.22 [a]	55.5	26.48 [b]	67.1	39.19 [c]	70.2	41.88 [c]	13.4
September	39.2 [a]	41.4	5.31 [a]	59	33.55 [b]	69.1	43.27 [bc]	73	46.30 [c]	12.2
October	42.8 [a]	44.8	4.46 [a]	58.1	26.33 [b]	71.4	40.05 [c]	78.3	45.33 [c]	13.7
November	45.7 [a]	48.7	6.16 [a]	62.9	27.34 [b]	76.3	40.10 [c]	82.6	44.67 [c]	11.4
December	55.9 [a]	60.8	8.05 [a]	72.5	22.89 [b]	82.7	32.40 [b]	92.1	39.30 [c]	12.4

Results in Table 3 reflect the humidity level in different polyhouse in different months. Finding in table examined that the level of humidity in open and hi-tech was significantly similar in all months with increasing level 7.97% in Jan., 1.84% in Feb., 4.53% in March, 2.83% in April, 7.02 in May, 4.22% in Aug., 5.31 in Sept., 4.46% in Oct., 6.16 in Nov. and 8.05 in Dec, respectively. Concerning AINH , the level of humidity was significantly higher to open level of humidity with critical difference 18.3, 17.2, 16.1, 12.7, 17.4, 13.4, 12.2, 13.7, 11.4 and 12.4 in months of Jan., Feb., march, April, may, Aug. Sept. Oct., Nov., and Dec., respectively. Results in table elucidate that the humidity in NVPH and WIT was significantly higher to open, AINH and Hi-tech with increasing level of 37.59%-43.80% in Jan., 39.41%-42.23%, in April, 46.0%-49.07% in May, 39.1% and 41.8% in Oct., 40.10%-44.67% in Nov. and 32.40%-39.30% in Dec.

Table 4: Comparison of CO_2 in different polyhouses in different months

Month	OPEN	HI-TECH	Increased (%)	AINH	Increased (%)	NVPH	Increased (%)	WIT	Increased (%)	CD
January	327.1 [a]	488.2	32.99 [b]	879.9	62.82 [c]	1072.1	69.48 [cd]	1504.1	78.25 [d]	10.7
February	313.4 [a]	451.2	30.54 [b]	628.8	50.15 [c]	962.6	67.44 [d]	1166.5	73.13 [d]	17.1
March	325.8 [a]	414.5	21.39 [b]	606.4	46.27 [c]	831.8	60.83 [cd]	955.9	65.91 [d]	15.4
April	315.8 [a]	358.5	11.91 [a]	536.2	41.10 [b]	762.7	58.59 [bc]	833.5	62.11 [c]	18.1
May	379.5 [a]	397.3	4.48 [a]	571.8	33.63 [b]	717	47.07 [c]	739.3	48.66 [c]	14.8
August	359.7 [a]	394.1	8.72 [a]	588.7	38.89 [b]	673.4	46.58 [b]	708.4	49.22 [b]	20.2
September	347.4 [a]	441.2	21.26 [b]	626	44.50 [c]	687.8	49.49 [c]	704.3	50.67 [c]	16.6
October	316.5 [a]	418.5	24.37 [b]	686.3	53.88 [c]	812.3	61.03 [c]	840.7	62.35 [c]	21.6
November	352.6 [a]	442.9	20.38 [a]	802.9	56.08 [b]	907.5	61.14 [b]	1047.8	66.34 [b]	24.2
December	366.3 [a]	453.7	19.26 [a]	892.5	58.95 [b]	1118.1	67.23 [b]	1585.9	76.90 [b]	25.4

Data in Table 4 represent the level of CO_2 in different polyhouse in comparison to open CO_2 level. Findings in table disclose that the level of CO_2 in Hi-tech was found to be similar to open CO level in months of April (11.91%), May (4.48%), Aug. (8.72%), Nov. (20.38%) and Dec^{22}(19.26%) except of moths Jan.(32.98%), Feb. (30.54%), March (21.39%), Sept. (21.26%) and Oct. (24.37%). The level of CO_2 in AINH, NVPH and WIT was found to be significantly increased to open level. The level of CO_2 in WIT was observed increasing in all months with level 78.25% (Jan.), 73.13 (Feb.), 65.91% (March), 62.11% (April), 48.66% (May), 49.22% (Aug.), 50.67% (Sept.), 62.35% (Oct.), 66.34% (Nov.) and 76.90% (Dec.), respectively.

Table 5 shows the association between different environmental parameters (temperature, humidity and CO_2) and heart rate of different polyhouse workers. Regarding hi-tech polyhouse, in summer high concentration of humidity-CO_2 was significantly increasing heart rate of workers, in winter assuming double value of humidity was significantly increasing heart rate of workers. Other side in AINH polyhouse humidity and increasing ratio of humidity: CO_2 were significantly affecting heart rate of workers. NVPH workers heart rate was found to be significantly affected by temperature, humidity, CO_2, humidity:CO_2 and temperature^2 in summer and by temperature, CO_2, AC, A^2 in winter, respectively. As table reflect that high concentration of temp., humidity, CO_2, AB, B^2 and C^2 were significantly affecting heart rate of WIT polyhouse workers.

Table 5: Association between environmental parameters and heart rate of different polyhouses workers (n=15)

Environmental parameters	Hi-tech		AINH		NVPH		WIT	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
A (temperature)	ns	ns	ns	ns	52.57**	106.48**	18.86**	28.1*8
B(humidity)	ns	ns	ns	6.30*	28.08**	ns	117.90**	58.92**
C(carbon-dioxide)	ns	ns	87.50**	ns	8.11*	575.24**	24.3**	28.3**
AB(temp.-humidity)	ns	ns	ns	ns	ns	ns	42.5**	36.8**
AC(temp.-CO_2)	ns	ns	ns	ns	ns	7.62*	ns	16.7*
BC(Humidity-CO_2)	16.00**	ns	ns	7.78*	13.83**	ns	ns	7.28*
A^2 (temp.^{2})	ns	ns	ns	ns	8.22*	5.89*	ns	8.92*
B^2(Humidity^2)	ns	5.36*	ns	ns	ns	ns	10.29*	21.73**
C^2(CO_2^2)	ns	ns	ns	ns	ns	ns	8.85*	0.91
R^2	0.91	0.83	0.93	0.70	0.92	0.99	0.95	0.91

Table 6: Association between environmental parameters and blood pressure of different polyhouses workers (n=15)

Environmental parameters	Hi-tech		AINH		NVPH		WIT	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
A (temperature)	ns	ns	ns	ns	-101.21**	-7.08*	ns	-12.68**
B(humidity)	ns	ns	ns	-16.68**	ns	ns	-9.31*	ns
C(carbon-dioxide)	ns	-5.33*	ns	-24.91**	9.70*	-81.30**	-501.39**	-53.73**
AB(temp.-humidity)	ns	ns	ns	12.6*	ns	7.83	-18.49**	-32.7*
AC(temp.-CO_2)	ns	ns	ns	ns	-13.89**	-5.29*	-4.61*	-8.93*
BC(Humidity-CO_2)	ns	ns	5.21*	ns	ns	ns	ns	-3.21
A^2 (temp.^{2})	ns	ns	-21.16**	ns	-12.08**	-4.24*	-28.03**	-18.3*
B^2(Humidity^2)	ns	ns	ns	ns	-63.90***	ns	ns	ns
C^2(CO_2^2)	ns	ns	ns	ns	ns	-43.61**	-124.34**	-10.73*
R^2	0.86	0.49	0.80	0.86	0.97	0.93	0.98	0.67

Data in Table 6 represent the effect of environmental parameters on blood pressure of different polyhouse workers. Regarding Hi-tech polyhouse, only high concentration of CO_2 was significantly decreasing the blood pressure of workers. In AINH polyhouse high concentration of BC (humidity: CO_2) B^2 (humidity^2) in winter and high value of B (humidity), C (carbon-dioxide), AB (temperature: humidity) in summer were significantly decreasing the blood pressure of workers. Alongside high concentration of A, C. AC, A^2, B^2 was significantly affecting blood pressure of workers in both seasons; summer and winter in NVPH and WIT polyhouse.

Table 7: Association between environmental parameters and lung function capacity of different polyhouses workers (n=15)

Environmental parameters	Hi-tech		AINH		NVPH		WIT	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
A (temperature)	ns	ns	ns	ns	-27.07**	-6.21*	ns	-18.71**
B(humidity)	ns	ns	3.64*	ns	ns	ns	ns	ns
C(carbon-dioxide)	ns	ns	ns	ns	ns	-40.98**	-110.91**	-15.91*
AB(temp.-humidity)	ns	ns	ns	ns	ns	ns	-23.75**	-74.45**
AC(temp.-CO_2)	ns	ns	ns	9.33*	ns	ns	ns	ns
BC(Humidity-CO_2)	ns	ns	9.13*	12.3**	-7.28*	-3.36*	ns	ns
A^2 (temp.^{2})	ns	ns	ns	ns	ns	ns	-10.58*	ns
B^2(Humidity^2)	ns	ns	ns	ns	-6.81*	-7.83*	ns	-5.57*
C^2(CO_2^2)	ns	ns	ns	ns	ns	Ns	-30.78**	ns
R^2	0.90	0.96	0.65	0.78	0.84	0.88	0.96	0.79

Results in Table 7 represent the association between environmental parameters and lung function capacity of different polyhouse workers. Regarding Hi-tech polyhouse no significant effect of temperature, humidity and CO_2 was found on workers lung function capacity. In AINH polyhouse high concentration of B (humidity), BC (humidity: carbon-dioxide) was significantly affecting the lung function of workers in summer season. Regarding winter AC and BC value were significantly decreasing the lung function capacity. In NVPH and WIT polyhouses, high concentration of temperature, humidity and carbon-dioxide and their ratios were significantly (R^2= 0.96, 0.79) negatively associated to lung function capacity of workers in both seasons; summer and winter.

Table 8: REBA posture analysis of different polyhouse activities (n=15)

Activity	Activity score						REBA score	Risk level	REBA action category
	Trunk	Neck	Leg	Upper arms	Lower arms	Wrist			
Bed washing	5	3	3	2	1	3	**12**	Very high	Necessary now
Bed making	2	2	2	2	1	2	3	Low	May be necessary
Field preparation	3	2	2	2	1	2	5	Medium	Necessary
Sowing	5	3	3	1	2	2	9	High	Necessary soon
Tying	3	3	3	5	2	3	**11**	Very high	Necessary now
Pruning	2	3	2	4	2	3	7	Medium	Necessary
Irrigation and fertilizing	2	2	1	2	1	2	3	Low	May be necessary
Harvesting	2	2	2	4	2	2	5	Medium	Necessary

Observation in Table 8 shows posture analysis of different activities by REBA scale. Results unveiled that maximum score (12 and11) was found in bed washing and tying with very high risk level and necessary action in redesigning. In bed washing and tying activities score were 533213 and 233523 for the body parts of trunk, neck, legs, upper arm, lower arm and wrist. Sowing activity in polyhouse farming got activity score 533122 and REBA action score 9 which reflect high risk level and action should be taken as soon as possible. Three polyhouse activities; pruning, field preparation and harvesting were observed at medium risk level with REBA score 7, 5 and 5 and activity score 232423, 322212, 222422, respectively. Low postural problem was found in bed making and irrigation and harvesting with REBA score 3 and activity score 222212, 221212, respectively.

Table 9: Mental workload in polyhouse workers (n=15)

Mental workload						
Polyhouse	Stress	Metal fatigue	Monotony	Mental satiation	Overall	Action
Hi-tech (4)	50	68.3	66.7	38.3	55.8	INCREASE RISK
NVPH (4)	33.3	31.6	33.3	26.6	31.2	NO RISK
WIT (4)	48.3	46.6	41.6	30.0	53.5	INCREASE RISK
AINH (3)	28.3	26.6	23.3	15.0	23.3	NO RISK
Overall	39.9	43.2	41.2	27.4	40.9	INCREASE RISK
Action	NO RISK	INCREASE RISK	INCREASE RISK	INCREASE RISK		

Findings in Table 9 elucidate that level of mental workload in different polyhouse workers. High level of workload was observed in Hi-tech (55.8%) followed by WIT (53.5%) and NVPH (31.2%). Regarding stress, mental fatigue, monotony, mental satiation. The high level of problem was found to be in Hi-tech polyhouse workers with action category of increased risk and recommendation of redesign of workplace.

Table 10: Occupational heath diseases in workers (n=15)

Diseases	Frequency	Percentage
Allergy	4	26.7
Asthma	2	13.3
Low BP	6	40.0
Skin burning	3	20.0

On the basis of doctor checkup it was found that low blood pressure (40.0%) was the main problem in polyhouse workers followed by allergy (26.7%) and skin burning (20.0%) due to extreme environmental condition.

CONCLUSION

In study high level of temperature, humidity and CO_2, were observed higher in different polyhouses in comparison to open farming. The level of increasing of temperature, humidity and CO_2 was found to be higher in WIT and NVPH polyhouses in comparison to open farming. In line similar results was found by Morgan and Leonard (2000) that an average, air temperature difference between inside and outside the polyhouse was about 2–8°C. The air temperature inside the polyhouse was higher than outside the polyhouse. On the contrary, the relative humidity inside the polyhouse humidity was almost same during the summer but it was about 7.5 % lower than the outside environment during winter season. But among the net houses no significant variations in temperature were found. (Singh *et al.*, 2007). Regarding effect of environmental parameters on workers health, the increasing level of temperature, humidity and CO2 was significantly increasing the level of heart rate and decreasing the BP and lung function capacity of workers of WIT and NVPH workers. The workers, especially from WIT and NVPH polyhouses were found to be suffering from asthma problem with low expiratory and inhale capacity in forced vital capacity (1.54 l/s), slow vital capacity (1.59 l/s) and maximum ventilation volume (40.93 l/m). Study demonstrated significant reductions of FEV_1, FEF 5O, and FEF 2 5 when compared to predicted values. A large number of greenhouse workers had an FEF 2, smaller than 70 % of predicted. Data on lung function thus suggest that employment in greenhouses may contribute to the development of chronic ventilatory impairment although the role of smoking cannot be quantitated. (Zuskin et al., 1988). The mental workload was observed higher (51.17%) in Hi-tech polyhouse. In polyhouse workers the main mental problem was monotony (48.33%) and 73.3 percent workers were in category of increasing risk with mental workload level 33-66% demands redesigning of job and environment. The posture in bed washing and tying activities were found to be at higher risk with action category of redesign workplace as soon as possible. Gangopadhyay (2005) conducted a detailed posture analysis study on 50 male and 50 female workers of polyhouse on the base of Ovako Working Posture Analysis System (OWAS). It was observed that those workers worked continuously in awkward postures during certain activities. Consequently they suffered from discomfort in different parts of their body. Even though they were very young, they were likely to suffer from serious musculoskeletal disorders in the future.

RELEVANCE

Polyhouse farming is increasing day by day with increase in population and its demand of agriculture products. In India, 0.23% of total cultivated area is under polyhouse farming. In polyhouses, higher production is based on extreme environment parameters which are directly predispose hazardous problems for human health. But there is not any work has been conducted on problems of polyhouse workers.

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