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Health Effect of Extended Work Schedule and Environment on Workers Health in Polyhouses

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***Abstract* — Increasing attention is being drawn to the application of practical actions in rural and agricultural settings to help reduce work-related accidents and illness, improve living conditions and increase productivity. Many effective and feasible ergonomic modifications in improving living and working conditions have been introduced in many countries. The International Labour Office (ILO) and the International Ergonomics Association (IEA) have collaborated over the years in the collection of typical practical improvements reflecting basic ergonomic principles achieved in agricultural and rural settings, particularly in developing countries. Polyhouses are essentially microcosms aimed at providing physical environments suitable for the survival and growth of plants. Often this is to extend the season in which a particular crop, such as lettuce, tomato or flowers, is available; sometimes, as in botanic gardens, it is to allow growth of plants which would not survive otherwise. This all is possible due to extreme environmental condition but this environment is not suitable for the workers who work 6-8 hours daily inside. Further according to research this situation leads to occupational health hazards in workers like high blood pressure, asthma, skin disease, heart rate and other cardiovascular problems. As the demand of polyhouses is increasing day by day so for workers better living and institutional benefit, rest work period was calculated on the basis on working time and workers health .**

***Keywords* — Polyhouse, Rest Period, Environmental Parameters.**

I. INTRODUCTION

Greenhouses are used to grow 'protected crops', and the main 'protected crops' grown In area. Temperature, light intensity, humidity and atmospheric carbon di-oxide levels can be manipulated in order to encourage growth. In temperate northern latitudes, such as that of Great Britain, this almost always includes the means (often artificial) with which to raise temperature and, in winter, light intensity and/or duration. The primary environmental parameter traditionally controlled temperature, usually providing heat to overcome extreme cold conditions. High temperature (up to 40^{0}C) and humidity (70-80%) exhibits a significant influence on the rate of photosynthesis. Generally, the higher the temperature and humidity, assuming CO_2 and light are abundant, the faster the photosynthesis takes place. But polyhouse cannot be considered a very suitable place for work operators especially in hot season. Workers are forced to work in unfavourable conditions and exposed to harmful effects. Working in unsuitable environment, combined with stress to the body from heavy physical activity can be very dangerous to man's health. Increasing attention is being drawn to the application of practical actions in rural and agricultural settings to help reduce work-related accidents and illness, improve living conditions and increase productivity. Many effective and feasible ergonomic modifications in improving living and working conditions have been introduced in many countries. The International Labour Office (ILO) and the International Ergonomics Association (IEA) have collaborated over the years in the collection of typical practical improvements reflecting basic ergonomic principles achieved in agricultural and rural settings, particularly in developing countries. A group of ergonomics experts from both developed and developing countries convened by the ILO and the IEA compiled and reviewed examples of practical improvements and produced this manual (Machida, S. 2010). The know-how embodied in these examples, based on locally achieved ergonomic applications, will be extremely useful in increasing productivity and in reducing injuries and illness The regulation of working time is one of the oldest concerns of labour legislation. Already in the early 19th century it was recognized that working excessive hours posed a danger to workers' health and to their families. The very first ILO Convention, adopted in 1919, limited hours of work and provided for adequate rest periods for workers. Today, ILO standards on working time provide the framework for regulated hours of work, daily and weekly rest periods, and annual holidays. These instruments ensure high productivity while safeguarding workers' physical and mental health. Standards on part-time work have become increasingly important instruments for addressing such issues as job creation and promoting equality between men and women. The working hours of persons employed in any public or private industrial undertaking or in any branch thereof, other than an undertaking in which only members of the same family are employed, shall not exceed eight in the day and forty-eight in the week. The research was offered as a contribution towards evaluating the risks from long period of exposure at unfavourable environmental conditions and occupational hazards into polyhouses that are bereft of artificial heating.

II. METHODOLOGY

Stage : I To study the environmental condition of different polyhouses:

Under the research work four types of polyhouses were studied namely Hi-tech polyhouse, naturally ventilated polyhouse (NVPH), walk-in-tunnel (WIT) and anti insect net shade house (AINSH). The polyhouses specially walk in tunnel and NVPH had extreme environmental condition because they were totally air tight without any provision of ventilation. Environmental parameters of polyhouses were compared to conventional farming to find out the difference of climate.

For stage I, season wise climatic data (temperature, humidity and level of CO_2) of different polyhouses was recorded. Environmental parameters were taken during working period. Experiments were conducted in four different polyhouses and comparison was done for two different seasons of the years i.e. summer and winter. In stage II, month wise climatic data of all months excluding June and July was taken. Three replications were taken for each experiment. Experiments were conducted in four different polyhouses and also in conventional farming.

Table 1. Environmental parameters

Parameters	Name of instrument/formula
Temperature	Thermometer
Humidity	Hygrometer
Carbon dioxide	Air quality monitor

Stage: II To study the nature and extent of involvement of workers in different polyhouses

In present study, 86 polyhouse workers from 3 respective districts (Ambala-48, Hisar-14 and Karnal-24) who were engaged in polyhouse farming were randomly selected and interviewed. Workers were examined on the basis of involvement pattern in polyhouse farming, satisfaction regarding workplace and organizational facilities and problems faced by workers at workplace.

Stage: III Risk assessment among workers engaged in polyhouses and to provide rest allowances on the basis of ILO recommendations to reduce the workers occupational hazards

For the ergonomic study, 15 women workers of polyhouses of Karnal district were selected on the basis of good health status. Occupational health hazards were studied in terms of physical activity and physiological parameters.

Table 2. Physiological parameters

Parameters	Name of instrument/formula
Heart rate	Polar heart rate monitor
Oxygen consumption rate	Oxylog (oxygen consumption, 1/min.) = 0.0155x HR- 1.2248 (Singh and Gite, 2007)
Energy expenditure	0.159x HR (bpm)-8.72 (Varghese *et al.* 1994)
Lung function	Spirometer

After that, rest allowance period was developed on the basis of recommendation by ILO. For the workers of different polyhouses rest allowance was calculated on the basis of workers physiological response and temperature of polyhouses. Following equation was used:

CALCULATION OF REST ALLOWENCES

$$RA = \left(\frac{\text{Energy expindature in K,cal/Min}}{\text{Allowable Energy expindature in K.Cal/min}} - 1 \right) X\ 100$$

Where
RA = Rest allowence in % of working time
EE = Energy Expindature in K.Cal/min to be measur on job
AEE = allowable energy expindature in K.cal /min taken as 4 K.cal/Min

III. Results and Discussion

Exiting condition of polyhouses : Polyhouse farming is an area where Government initiatives have been far more forthcoming though not as complimentary for human resource development but technical support to the farmers adopting polyhouse farming. Govt. of Haryana is providing subsidy on different parameters involved in polyhouse farming like; structure, crop, mulching and irrigation. Findings explain that maximum subsidy provision was for Hi-Tech polyhouses i.e. Rs. 1,405/sqm. In case of NVPH and WIT polyhouses the subsidy was based on height of structure like in NVPH subsidy of Rs. 700/sqm at the height of 5mt. and Rs. 935/sqm at height of 6.5mt is provided. In WIT polyhouses subsidy varied from Rs. 450-600/sqm based on height of 2.5mt-3.5mt. Subsidy on AINSH polyhouses was Rs. 600/sqm. Khanna, (2013) stated that a polyhouse involves an investment of about Rs. 35 to 45 lakh, out of which Govt. of Gujarat subsidize it by 65 percent for common farmers and by 75 percent for tribal, schedule castes and schedule tribal. In Punjab State, central Govt. gives 50 percent subsidy to setup polyhouses and in Himachal Pradesh farmers get 75 percent subsidy (Anonymous, 2012) In Haryana state 1,956 farmers were found to be engaged in polyhouse farming. Haryana Kisan Ayog has constituted Working Group on "Development of Protected Cultivation in Haryana" and a diploma course on Maintenance and Repair of Protected Structure/Greenhouses, Micro irrigation, Systems and Related Aspect at each Industrial Training Institute. The steps taken by Government of Haryana to promote protected cultivation seems to be the first of its kind in the country. (Paroda, 2013). The area under polyhouse farming is increasing day by day but we have no any study on harm of extreme environmental condition on workers who spend 8 hours daily inside polyhouses

Study of extreme environment in different polyhouses: Findings explain that temperature was found higher in WIT polyhouses, especially in the month of May i.e. above 500C. Temperature was observed more than 25 percent higher in WIT polyhouses and more than 18 percent in NVPH in comparison to conventional farming throughout the year. Calpas (2003) noticed that without ventilation and cooling system the temperature within the polyhouse can increase to more than 450C. On the similar pattern result was found by Gusman et al. (2008) that average temperature differences between inside and outside was 100C and 180C in winter and summer season, respectively. The concentration of humidity was also

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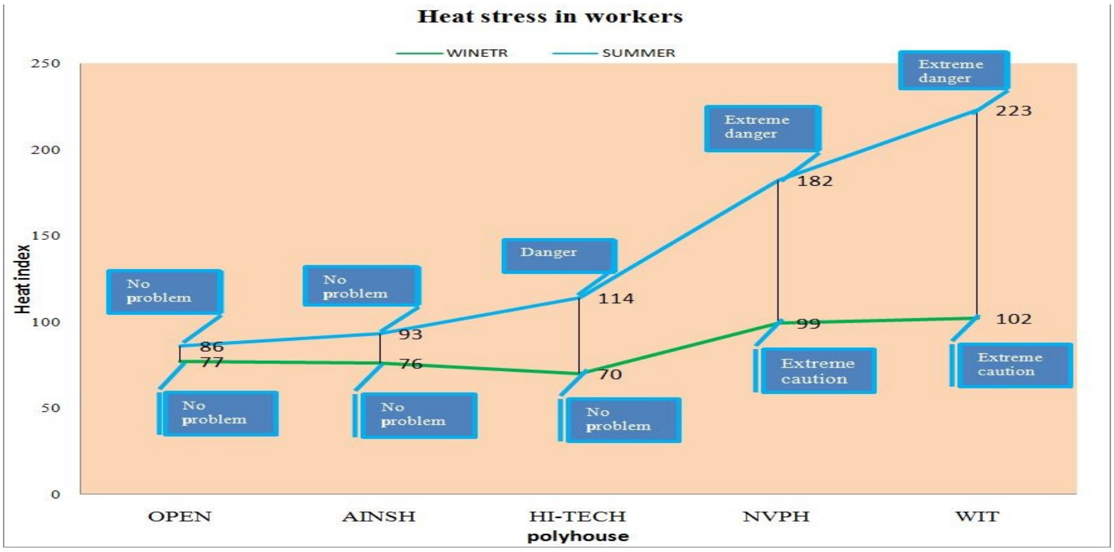
higher in WIT and NVPH polyhouses, about 40 percent higher humidity in comparison to conventional farming in all month with maximum in months of January, February,



November and December. The level of humidity was found above 90 percent at the time of 11:00pm to 5:00am in both the seasons i.e. summer and winter. According to Morgan and Leonard (2008) humidity inside polyhouses and outside was almost similar in summer but it was 7.5 percent higher than outside environment during winter season. Concentration of CO2 was found significantly higher in WIT and NVPH polyhouses. In WIT polyhouse, CO2 concentration was more than 50 percent higher in comparison to conventional farming and as well as from other polyhouses also. The maximum increase in CO_2 concentration was observed at night time (11:00-5:00) i.e. up to 2500ppm in winter and up to 1600ppm in summer season, because polyhouses were air tight, trap CO_2 released by plant during the night and make it available increases the CO_2 level in polyhouses. According to Singh et al. (2007) the optimum CO_2 level in polyhouses should be 5-10 times higher than conventional farming i.e. 1500-3000ppm. Similar result was reported by Upadhyaya (2009) that high level of temperature (up to 40^0C) and humidity (70-80%) exhibits a significant influence on the rate of photosynthesis, generally the higher temperature and humidity, assuming CO_2 and the faster photosynthesis takes place by warming the air immediately around the crops. That's why polyhouses effectively extend the growing season and allow the cultivation of crop from lower latitude. NVPH and WIT polyhouses climate was at extreme danger with heat score of 182^0F and 223^0F, which depicts that if workers will continuous do work in this environment can have heat stroke during the day time. Mulching and soil respiration also On similar pattern, results were observed by Gusman et al. (2008) that in thermal stress condition (above 25^0C) the amount of energy given off by perspiration increases markedly reaching 60 percent at 30^0C, 70 percent at 35^0C and rises over 80 percent above the temperature of 40^0C. Water given off in the form of perspiration and breathing rises with the increase of temperature. The amount of water given off by perspiration increases and is above 300gm/h when the air temperature is above 40^0C. Undoubtly the water loss produces an alteration of body water equilibrium with a consequent loss of minerals, leading workers to severe health risks.

To study the nature and extent of involvement of workers in different polyhouses: Workers (62.79%) were involved in polyhouse type of farming from last 2-3 years and found to be working for 5-8 hrs (73.25%) daily. The work schedule was 9:00-17:30 hrs form Monday to Saturday. Callejon-ferre *et al*. (2009) conducted a study on 110 polyhouses and found that most common work schedule of workers was from 8:00 to 15:00 in 49.10 percent of cases. Though, most of them admitted that they also work until the evening. In 86.4 percent of polyhouses, the work week was from Monday to Saturday, while remaining 13.6 percent worked for 7 days a week. A large number of the respondents (83.73%) were getting monthly income between Rs. 6000-7000 (65.12%). More than fifty percent respondents' (53.48%) income was based on time, which they spend on work place, followed by quantity of production (19.70%) in polyhouse farming.

Table 3. Annually number of days spend by workers inside polyhouses

Activities	*No. of days*	*Percentage of days spend on activity*	*Rank*
Bed washing	242	66.30	III
Bed making	245	67.12	II
Field preparation	28	7.67	VI
Sowing	20	5.47	VII
Tying	280	76.71	I
Pruning	235	64.38	IV
Irrigation and fertilizer	28	7.67	VI
Harvesting	192	52.60	V

Physical health hazards in workers: Regarding physiological parameters in working condition, heart rate of WIT polyhouse workers (103.5 b.min-1) was found to be significantly higher in comparison to workers of NVPH (96.16 b.min-1), Hi-tech (92.16 b.min-1), AINSH (92.9 b.min-1) and conventional farming (87.6 b.min-1). While the blood pressure of the workers from WIT (62/98mmHg) and NVPH (61/94mmHg) polyhouses was found significantly lower in comparison to workers of Hi-tech (79/113mmHg), AINSH (72/111mmHg) and conventional farming (83/125mmHg).

Effect of extreme environment on workers health: The effect of environmental parameters (temperature, humidity and CO2) on physiological parameters (heart rate, blood pressure and lung function capacity) of the workers was probed out. Data reflect that in summer season, humidity:CO2 was significantly (F=16.0) increasing the heart rate of workers in Hi-tech polyhouse i.e. from 71 b.min-1 to 76 b.min-1. Results further divulge that in NVPH in summer season increasing level of temp. CO_2, $temp_2$ and (humidity:CO_2) were significantly (F= 52.57, 8.11, 13.83 and8.22) increasing the heart rate of workers i.e. from 104.05 b.min-1 to 117.05 b.min-1, from 117.05 b.min-1 to 112.55 b.min-1, from 113.55 to 122.55 b.min-1 and from 110.05 b.min-1 to125.05 b.min-1, respectively. In winter season temp., humidity, CO_2, Temp.: humidity, temp.: CO_2 and CO_2^2 were significantly associated with heart rate of NVPH workers. Carrying out prolonged physical activity in a hot, humid environment increases the risks of heat exhaustion and heat stroke (Kjellstrom, 2009). Kelley et al. (2007) conducted a study on 21 subjects of polyhouse farming. Workers were tested by spirometry immediately before and after a 4-hr work period. These workers had statistically significant decrements in flow rates ranging from 3.3 percent (mean FVC) to 11.9 percent (mean FEF25–75). There was suggestive evidence for a dose–response association between environmental exposures to carbon dioxide (CO_2) and hydrogen sulfide (H2S). There was also some evidence for an additive relationship between smoking and work environment exposure on decline in lung function.

Rest allowances on the basis of ILO recommendations to reduce the workers occupational hazards: The workers of polyhouses were doing long hours job (8.30hrs) in extreme environment. The workers were getting one long rest break as a lunch break for 1 hour in summer and 30 minutes in winter. There was no provision of intermediate break during work. Workers were allowed only for taking 4-5 minutes interval for drinking water after 11/2 hours. To calculate the rest allowance for worker of different polyhouses ILO calculation for rest allowance was used. On the basis of temperature of polyhouse and workload in workers of that polyhouse, rest interval was calculated. Month wise rest intervals in different polyhouse are shown in figure as below. According to calculation high rest interval is needed in WIT polyhouse followed by NVPH in all months.

IV. Summary

Farming in polyhouses was done in overall 10 months in a year except months of June and July due to extreme weather. Data further depict that bed washing, bed making and tying activities were done continuously for 10 months. Workers were involved in tying activity throughout the year. In beginning of two months, field was prepared by tying rope to wire, which was above 9-10 feet from ground level. After sowing plants were tied to wire to grow them vertical. Bed washing and bed making were also conducted for maximum days of year, because nursery in Hi-tech polyhouse was prepared for sale purpose and per day near 70-80 bed were prepared. Pruning, irrigation and fertilizing were conducted for 9 months. In harvesting activity, workers were involved for almost 7 months. Only field preparation and sowing were done for two months (Augusts and September). In polyhouse farming, workers were spending most of their days (280 days) on tying activity followed by bed making (245 days) and bed washing (242 days). According to Callejon - ferre et al. (2009) psycho-social inputs including social status (=6.50), communication (=3.00), cooperation (=8.30) and identification (=6.00) with long working time of 9 hours daily had negative effect on workers well-being. As the workers of polyhouses were found to be engaged for 5-8 hours daily in polyhouse farming under high concentration of humidity and temperature which cause problems of vomiting and headache.

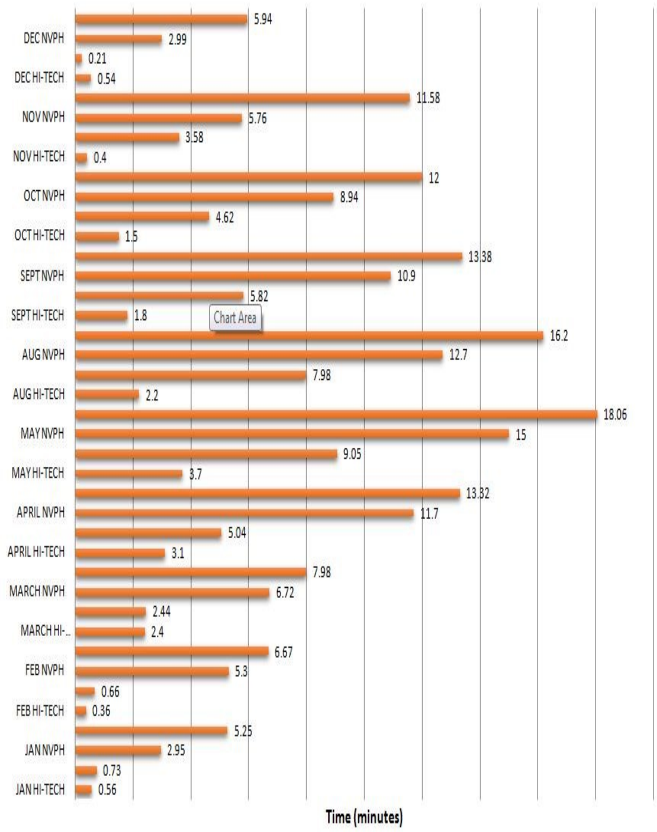


Fig. 2. Month wise rest allowances for different polyhouse working.

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