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Physiological Workload and Postural Discomfort Among the Farm Women During Vegetable Transplanting

Pragya Ojha[1]* and Shyam Singh[2]

ABSTRACT

Manual transplanting of vegetable saplings are labour intensive and time consuming operation. During the manual transplanting of saplings of vegetables, farm workers are highly affected by excessive physiological workload and postural discomfort which are the major cause of human drudgery. Pace of work, time spent in various activities, static body position and physiological and mental strain etc. are also the important factors which affect the work capacity of the farm workers. The study was undertaken to assess the physiological workload and postural discomfort among farm workers during conventional method and mechanized method of vegetable sapling transplanting. Physiological parameters i.e. HR, energy expenditure, TCCW and PCW etc. were measured during transplanting operations. The center of gravity method was used to assess the postural discomfort among farm workers. Total 30 farm women were selected for the study. The results revealed that working heart rate (HR work) of the subjects when the vegetable seedling transplanting was performed with conventional method ranged from 122.25 to 154.65 beats/min with a mean value of 135.65 ± 9.54 beats/min. OCR was found to be 1.06 ± 0.38 and 0.54 ± 0.43 l/min, respectively for manual and mechanized method of vegetable transplanting.

Keywords: Discomfort, Physiological, Postural, Transplanting, Vegetable, Workload

INTRODUCTION

The health benefits of vegetables are well recognized by nutritional and medical communities. Vegetables occupy an important place in Indian diets as they increase their nutritive value and palatability (Kaur, 2016). In worldwide, India ranks second in producing the vegetables. Vegetable production is labour intensive and can generate 3 - 10 times the employment and income per hectare of land compared to that of cereals. Vegetables also create a number of job opportunities in complementary businesses that arises such as marketing, processing and transportation. The demand for horticultural products is projected to grow significantly in the coming decades, due to an increase in the awareness of their nutritional importance and the resultant increase in their consumption. This offers an opportunity to absorb an ever-increasing unemployed labour force. Agriculture ranks among the most hazardous industries. Farmers are at very high risk for fatal and non-fatal injuries; and farming is one of the few industries in which family members (who often share the work and live on the premises) are also at risk for fatal and non-fatal injuries (NIOSH, 2013).

The farm workers perform these multiple tasks in a traditional manner due to limited knowledge and skill, which consumes most of their time and energy. There is no doubt that some of the traditional implements have low risk but at the same time they also have high level of

[1]Subject Matter Specialist, [2]Senior Scientist cum Head, Krishi Vigyan Kendra Banda, Banda University of Agriculture & Technology, Banda, Uttar Pradesh
*Corresponding author email id: ojha.pragya063@gmail.com

occupational health hazards. The risk factors includes awkward body postures, repetitive movements and long working hours which ultimately leads to occupational health hazards like drudgery, musculoskeletal disorders, postural discomfort and body pain etc.

A large number of studies have revealed that different component of vegetable production produces postural discomforts in body of farm workers. This is why the productivity of crop and working efficiency of farm workers both are declined. Keeping the above mentioned fact in mind, this study was planned to assess the physiological workload and postural discomfort among the farm workers during vegetable transplanting.

METHODOLOGY

The ergonomical evaluation of vegetable seedling transplanting was conducted with female agricultural workers at Krishi Vigyan Kendra, Banda in the month of October 2018. Thirty female subjects in the age group of 20- 55 years were selected because they usually attain their highest strength level between 20-45 years (Mc Ardle *et al.*, 2001). The vegetable seedling transplanting operation was done for 7:00 A.M.12:30 P.M. and 2:00 P.M. to 5:30 P.M. for the comparison of drudgery in mechanized and conventional method. Farm women performed the vegetable seedling transplantation activity with manual transplanting in squatting posture and with Hand operaterated vegetable transplanter in standing posture. Farm women performed the continuous transplanting operations for 50 minutes and taking 10 minutes break. For the assessment of physical and physiological parameters of female workers heart rate, blood pressure, VO2 max, body mass index (BMI), age, weight, energy expenditure, total cardiac cost of work (TCCW) and physiological cost of work (PCW) were taken into consideration. Before going to field HR rest, blood pressure, and oxygen consumption rate of the subjects were measured. After 50 minutes of continuous operation HR work, VO2, energy expenditure, total cardiac cost of work, physiological cost of work, rate of perceived exertion and overall discomfort rating were measured. Segmental method of Center of gravity was used to assess the deviation of center of gravity of body from normal body posture.

The subjects were calibrated with the Harvard step stool test to determine their physical fitness index by using following formula:

Physical fitness index = Duration of stepping × 100 / Sum of 1^{st}, 2^{nd} and 3^{rd} minute recovery heart rate

The physical fitness of the respondents was calculated and interpreted by using physical fitness index (PFI) score given by Verghese *et al.* (1994) and the respondents were ranked from poor to excellent. The resting heart rate (HR rest), oxygen consumption rate at rest (VO2 rest) and the blood pressure were measured at rest and 15 minute prior to any experiment. The blood pressure of the samples was measured by digital blood pressure monitor and the heart rate was measured by Polar heart rate monitor and recorded as HR=beat/min.

The oxygen consumption rate was calculated by following formula:

VO2= 0.023 × Body weight (kg) - 0.034 × Age (years) + 1.65

The body mass index of subjects was calculated by dividing square of height (m^2) to weight (kg).

Following formula was used to calculate the total cardiac cost of work (TCCW) and physiological cost of work (PCW).

Total cardiac cost of work = cardiac cost of work + cardiac cost of recovery.

TCCW = CCW + CCR; where

CCW = AHR × Duration of activity; where

AHR = Avg. working HR- Average resting HR

CCR = (Avg. recovery HR- Average resting HR) × Duration.

Physiological cost of work = Duration of work/TCCW

Energy Expenditure was calculated using the formula:

EE (Kj/min) = 0.159 × HR (beats/min) –8.72

The whole body center of gravity (CG) of the workers were determined by segmental method in normal erect posture, which was taken as reference posture and

in other postures adopted by farm workers during traditional and mechanized method of transplanting. The location of CG was compared by the following equations:

Percentage of location of CG = Length of CG from ground/Total length of the body x 100

Two-sample t-test assuming unequal variances was performed among the female farm workers to find out whether there is any significant difference in ergonomical parameters of workers for the chosen level of significance (P<0.0001). Statistical analysis was performed using the statistical package IBM SPSS statistics (Version =20).

RESULTS AND DISCUSSION

Heart rate: The working heart rate (HR work) of the subjects when the vegetable seedling transplanting was performed with conventional method ranged from 122.25 to 154.65 beats/min with a mean value of 135.65 ± 9.54 beats/min. The corresponding values with hand operated vegetable transplanter were 103.78 to 126.45 and 118.32 ± 7.67 beats/ min, respectively. The mean work pulse (HR) with manual transplanting was observed to be 63.99 ± 6.21 beats/min but reduced to 39.7 ± 10.9 beats/min with mechanized method; a reduction of HR by 11.68 per cent. Work pulse of 40 beats/ min is the allowable limit for sustained working (Kroemer *et al.,* 1997).

Oxygen consumption rate (OCR): OCR was found to be 1.06 ± 0.38 and 0.54 ± 0.43 l/min, respectively for manual and mechanized method of vegetable transplanting. T-test showed a significant decrease (17.54%) in OCR with mechanized method (P<0.0001). An OCR of 0.63 l/min and HR of 105 beats/ min for women were considered acceptable for sustained work of 8 hours with intermittent rests (Mohanty *et al.,* 2008).

Energy expenditure rate (EER): EER with manual transplanting was observed to be 18.43 ± 2.02 kJ/ min whereas with hand row vegetable transplanter it decreased to 9.40 ± 0.95 kJ/min (14.25%). The total cardiac cost of work (TCCW) was found to be 1956.3 and 765.4 in case of manual and mechanical method respectively. With vegetable tranplanter, the TCCW reduced by 47.46 per cent. The corresponding physiological cost of work (PCW) was 218.54 and 22.17 in manual and mechanical transplanting, respectively.

Table 1: Comparative ergonomic evaluation of manual vegetable transplanting with hand operated vegetable transplanter

Physiological parameters	Manual Transplanting			Transplanting with vegetable transplanter			% Decrease	t cal
	Range	Mean	SD	Range	Mean	SD		
HR work (beats/min)	122.25-154.65	135.65	9.54	103.78-126.45	118.32	7.67	21.97	0.975
Work pulse (beats/min)	54.32-75.21	63.99	6.21	39.8 –50.8	39.7	10.9	11.68	1.219
VO2 work (l/min)	0.54-1.75	1.06	0.38	0.49-1.17	0.54	0.43	17.54	0.623
EER (kJ/min)	14.36-21.35	18.43	2.02	9.54-13.54	9.40	0.95	14.25	0.060
TCCW	-	1956.3	61.23	-	765.4	63.66	47.46	0.461
PCW	-	218.54	25.17	-	117.98	22.17	4.32	1.653

Table 2: Percent deviation of center of gravity in various working posture during manual and mechanical vegetable transplanting

Different body postures adopted by respondents	Manual method		Mechanical method		t value
	CG of women	Percent deviation from normal	CG of women	Percent deviation from normal	
Normal Standing Posture	59.2±3.92		59.2±3.92		
Transplanting					
Standing	49.87±10.69	9.89	55.49±7.13	3.26	4.87**
Bending	35.64±6.87	22.90	52.69±5.41	17.75	7.95**
Squatting	38.22±1.23	35.43	-	-	-

During the operation of manual transplanting, female farm workers adopt standing and bending postures for longer duration of time and perform the activity in repetitive motion. In standing body posture during manual method of transplanting the deviation of CG of female farm workers it was shifted to 9.89 per cent (49.87±10.69) whereas in mechanical method it was assessed as 3.26 per cent (55.49±7.13). During the bending position the location of CG of female farm workers during manual transplanting was 22.90 (35.64±6.87) and in mechanical method it was found 17.75 (52.69±5.41) respectively. Agrawal *et al.* (2004) studied the effect of linkage of ergonomic performance of agricultural workers. In posture extremes, muscles may not be able to produce the forces requires by the task, may place extreme stress on tendons and may put pressure on nerve tissue and blood vessels (Jumah and Nyame, 2004).

CONCLUSION

From this investigation it has been concluded that in manual method of uprooting and transplanting, agricultural workers adopt traditional sitting, bending and squatting body postures with folded legs. This is directly associated to high postural stress and work performance of the farmers. As body joint angles and the location of center of gravity had lesser degree of deviation from the reference position during vegetable transplanting operations, a lesser degree of postural stress was imposed in reference postures. Hence, the agricultural workers involved in vegetable seedling transplanting operation may be suggested to work with improved and mechanized method to lessen work related postural stress.

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