AJHS
Asian Journal of Home Science
Volume **12** | Issue 1 | June, 2017 | 226-234

DOI: 10.15740/HAS/AJHS/12.1/226-234
e ISSN-0976-8351 ■ Visit us: *www.researchjournal.co.in*

Research Paper

A postural load' occupational risk in grape cultivation

■ SAVITA KUMARI **AND** MANJU MEHTA

Received: 06.04.2017; **Revised:** 28.04.2017; **Accepted:** 15.05.2017

■ **ABSTRACT :** The aim of this study was to find out a postural load occupational risk in grape cultivation. The research designs comprised on field study conducted on 15 respondents were engaged on grapes cultivation activities. Physical fitness was determined by calculating the physiological parameters *i.e.* blood pressure, body temperature, pulse rate and (VO_2 max). Occupational risk was assessed through Biomechanical stress *viz.*, Grip strength, Flexi curve and RULA score. The results indicated that mean height and weight of workers involved grape activities was 159.9 cm and 64.2 kg, respectively. BMI was observed as 21.8 kg/m^2, fat percentage was worked out to 29.9 per cent, and hence LBM was 44.1 kg with variation of ±19.3kg. VO_2 max was found to be 31.8 ml/kg x min exhibiting that the subjects were having good health. Conclusively on the basis of biomechanical stress in the grape cultivation occupational risk was highest in land preparation (46.3) followed by pruning activity (41.8) and least was in plant protection activity (21.5).

■ **KEY WORDS:** A postural load, Occupational risk, Grape cultivation, Physical fitness

■ **HOW TO CITE THIS PAPER :** Kumari, Savita and Mehta, Manju (2017). A postural load' occupational risk in grape cultivation. *Asian J. Home Sci.*, **12** (1) : 226-234, **DOI: 10.15740/HAS/AJHS/12.1/226-234.**

See end of the paper for authors' affiliations

SAVITA KUMARI
Department of Family Resource Management, College of Home Science, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA
Email : jrozydhiman@gmail.com

Grape (*Vitis vinifera* L.) is an important fruit crop in India. Grapes are the third most widely cultivated fruit after citrus and banana. Major grape-growing states are Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and the north- western region covering Punjab, Haryana, Delhi, western, Uttar Pradesh, Rajasthan and Madhya Pradesh (Singh, 2010). In Haryana grapes are cultivated in an area of 111.00 (000 ha) with a total production of 1235.00 (Tons) and productivity of 11.10 (tons/ha) in 2010-11 (National Horticultural Board, Government of India). Haryana is the sixth largest producers of grapes in the country with 5.7 million ton/hectare/ year. In Haryana, it is usually cultivated from January to June end. Near about 75 per cent of grape produce is used for table purpose, 15- 20 per cent is dried for raisin production and 5 per cent is used for manufacturing of juice and wine (Guarav and Salunkhe *et al.*, 2011). Musculoskeletal disorders were common among farmers. Farmers handle heavy workloads often in awkward posture and experiencing some work related problems. They experience high rates of low back, shoulder, hand, knee and upper extremity disorders (Donald, 2006). Grape cultivation is one of the agricultural activities. Grape cultivation involves various activities like land preparation, irrigation, manuring, pruning, harvesting, transportation etc. Grape production is very labor intensive operation *i.e.* Grape vineyard workers faces high stress on the hands during pruning of the grapevines under highly repetitive conditions (8 to 10 week period of intense and fast-paced work) and

also the cumulated duration of exposure over the entire day was high, *i.e.* approximately 8 to 10 hours per day over a 4-month period. In vine pruning and harvesting, the operators are open to a great deal of strain likely to trigger or accelerate the Work related musculoskeletal disorder generating mechanisms including, repetitive movements combined with external forces acting on the finger, hand wrist system and static work in the upper arm shoulder system**.** Pruning of wine grape vines have also been found to have awkward postures of the shoulders. Hand pruning of vines requires the frequent squeezing of the hand to engage a clipper, or the frequent use of a knife. Hazards from the knife are obvious, as there is no solid surface against which to place the vine, shoot or stalk and frequent cuts to the fingers, hands, arms, legs and feet are likely to result. Work related disorder is an area of concern worldwide, with the rapid growth of industries in the present decade. It is distributed in developed countries as well as developing countries, with incidence of high levels especially in the industrially developing countries like India. WRMSD were mostly cumulative resulting from repeated exposure to loads at work over a certain period of time. Employees working in manufacturing and transport, plant and machine, operators and assemblers, construction and mining are those who experience more WRMSD's. A good working posture is one, which can sustain minimum of static muscular effort and in which it is possible to perform the given task more effectively and with least muscular discomfort. The term posture is defined as orientation of body segments in the space. This orientation is possible only because of the related muscular effort. The basic frame work of human body is the skeleton on which muscles are attached. By controlling the muscles we therefore manipulate our body segments resulting changes in posture. The main purpose is to assess the work posture and see that during work, center of gravity of whole body remains as close as possible to that of normal standing erect position. Strength is the indicator of strength of grip muscles. Reduced grip strength during activity is the indicator of fatigue of that activity. RULA stands for Rapid upper limb assessment method. Body posture including movement of arms, wrist, neck, trunk and legs by scoring method including three scoring table to evaluate the level of exposure of risk factors. Conclusively, Grape cultivation, vertical farming in which workers were adopting repetitive, strenuous, awkward posture with over stretching and bending posture to accomplish the task. High level of MSDs was prevalent in workers.

■ RESEARCH METHODS

A sample of 15 respondents was selected purposively from the randomly selected 2 grape orchards out of the six grape orchards selected in phase I respondents who are physically fit and willing to co-operate and engaged in grape cultivation activity were selected. Physical fitness of the workers involved in grapes cultivation activity was ascertained by measuring the parameters *i.e.* body height, body weight, body mass index (BMI), body composition, (VO_2max). The height was measured using a stadiometer. A stadiometer is a piece of medical equipment used for measuring height. The stadiometer has a measuring range. Body weight: An accurate portable weighing machine was used for the study to take the weight of the orchards workers. The subject was asked to stand straight on the balance and the weight was recorded in kg with an accuracy of 0.1kg.

Body mass index :

The condition of the workers was assessed by specifying the different degrees of the underweight expressed as the body mass index (BMI), the weight and height measures was used to calculate the BMI of respondents. Weight in (kg)/ Height in (m^2) (Garrow, 1981) the Body mass index was calculated using the standard formula. Accordingly, the health status was defined as follows: i) BMI 20–24.9 (normal); ii) BMI 25–29.9 (overweight); and iii) BMI $\geq$ 30 (obesity). Estimation of body composition was determined from skin fold thickness at four sites *i.e.*, biceps, tricep, subscapular and supreilliac with the help of skin fold caliper by using the methods proposed by Durnin and Rahman (1967). The lean body mass was assessed with the help of the following formula.

LBM (Kg) = Body weight – Fat weight

$$\text{Fat weight } Z \frac{\text{Body weight x \% fat}}{100}$$

% fat = (4.95 /D - 4.5) x 100

where D is body density.

Body density= 1.1599 - (0.0717 x log of sum of four skin folds)

Maximum aerobic capacity (VO_2 max) was on the basis of physical fitness is the term which denotes an

individual ability to accomplish a given task in a given period of time aerobically with maximum utilization of oxygen possible. It is also known as maximum aerobic capacity and abbreviated as VO_2 max. The maximum aerobic capacity is considered as the best measures for the individual cardio respiratory fitness or capability of doing work Varghese *et al*. (1994). The formula was based on the relationship between age and body weight as they have great influence on VO_2 max.

(VO_2 max) = VO_2 (1/min) = 0.023 × body weight (kg) – 0.034 × age (year) + 1.652

(VO_2 max) (Ml/kg × min) = VO_2 max (1/min/ Body weight (kg) × 10000

Blood pressure and pulse rate was standardized through sphygmomanometer and stethoscope and digital blood pressure, body temperature was measured by using clinical thermometer, Body temperature for three minutes- not above 99 per cent, blood pressure-120/80± 10, and Heart rate-70-90 b-min^{-}.

Pulse pressure = Systolic pressure- Diastolic pressure

Average mean pressure = Diastolic pressure + 1/ 3rd of pulse pressure

Occupational risk was assessed through biomechanical stress. Biomechanical stress includes grip fatigue, spinal deviation and RULA score. Grip strength is the indicator of strength of grip muscles. Reduced grip strength during activity is the indicator of fatigue of that activity. Hence, decreased grip strength while the performance of the activity is interpreted as grip fatigue of the muscles. Grip fatigue is the stress experienced by the grip muscles during or after an activity. It was measured using grip dynamometer. Grip strength of workers was measured before the start of the activity separately for right and left hand and also after the completion of the activity. The grip fatigue was calculated using the following formula:

Grip fatigue (%) = Sr-Sw × 100/Sr

where,

Sr = Strength of muscles at rest

Sw= Strength of muscles at work

Reduced muscular strength during activity is an indicator of muscular stress because of the activity. Flexi curve- It was used to measure the angle of deviation (degree) between the normal spine curve and maximum deviated posture. The flexi curve was mounted to the contour of the spine and immediately drawn on a plain paper to measure the angle of deviation. The angle of bent of the back during the performance of the activity was measured and compared with the normal bent of the back and the angle of the deviation was determined by subtracting the normal angle of bent from the angle of bent during the bending posture.

Required angle = x

Measured angle = y

Required angle (x) = 360-Ly

In addition to flexi curve, the postural deviation was measured using following scales.

RULA :

RULA stands for Rapid upper limb assessment method given by Atamney and Corlett (1993). It is a survey method developed for ergonomics investigations of workplaces where work related upper limb disorders are reported. It uses the diagram of body posture including movement of arms, wrist, neck, trunk and legs by scoring method including three scoring table to evaluate the level of exposure of risk factors. A coding system is used to generate an action list which indicates the level of interventions required to reduce the risk of injury due to physical loading on the operator. On the basis of observation of workers in different activities of grape cultivation the RULA observation sheet was filled and then grape cultivation activities were numbered to suggest corrective actions and necessary changes.

■ RESEARCH FINDINGS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Physical characteristics of workers involved in grape cultivation :

Mean height and weight of grape workers involved in grape was 159.9 cm and 64.2 kg, respectively. Body mass index (BMI) was observed as 21.8 kg/m^2. Fat percentage was worked out to be 29.9 per cent. Hence, LBM (Lean body mass) was 44.1 kg with variation of ±19.3kg. Aerobic capacity (VO_2 max) was found to be 31.8 ml/kg x min exhibiting that the subjects were having good health (Table 1).

Health status of workers involved in grape cultivation :

In order to avoid any experimental error and to

maintain the uniformity in data, only those workers were selected for the experimental study that had high average to good health status. It was clear from the Table 2 that the mean body temperature was 98.6±0.33, blood pressure was systolic (mm/Hg)125.6±10.3, diastolic(mm/Hg) 80.3±4.8, pulse rate was 86.8±9.3bpm and pulse pressure was 45.7±4.2 mm/Hg. All the variables were in the normal range.

Grip fatigue before and after performing the activities in grapes cultivation :

Biomechanical stress was assessed by measuring the grip strength of the subjects before and after performing various activities in grape orchard and per cent change was noted down, and presented in Table 3.

Land preparation:

Average grip strength before and after the land preparation for left hand was 36.0 kg and 25.2 kg, respectively. This resulted in the grip fatigue was 30%. For the left hand grip strength was 31.8 kg and 22.3 kg, respectively, before and after the activity, respectively resulting in fatigue of 29.8 per cent.

Pruning:

The average grip strength of the right hand before and after activity was 29.7kg and 20.5 kg, respectively, which resulted in grip fatigue was 30.9 per cent similarly for left hand before and after the pruning average grip strength was 25.1kg and 17.3 kg, respectively. The grip fatigue of the left hand was 31.0 per cent.

Manuring:

The average grip strength of the right hand before and after the activity was 26.3 kg and 23.0 kg, respectively, which resulted in grip fatigue was 20 per cent. The average grip strength of the left hand before and after performing the manuring was 22.1 kg and 17.6 kg, respectively. The grip fatigue of left hand was 20.3 per cent.

Irrigation:

Before and after performing the irrigation, the average grip strength of the right hand was 20.5 kg and 16.4kg, respectively. This resulted in grip fatigue was 20 per cent. Similarly for left hand it was 18.2 kg and 14.6 kg, respectively. The grip fatigue of the left hand was 19.7 per cent.

Plant protection:

Before and after performing the plant protection activity, the average grip strength of the right hand was 23.7 kg and 19.9 kg, respectively. This resulted in grip fatigue was 15.7 per cent. Similarly for left hand it was 21.5 and 20.0, respectively. The grip fatigue of the left hand was 6.7 per cent.

Harvesting:

In harvesting activity the average grip strength before and after the activity for right hand was 34.7 kg

Table 1 : Personal profile and health status of the selected respondents (n=15)

Physical characteristics		Mean ± SD
Height (cm)		159.9± 8.8
Weight (kg)		64.2±4.7
BMI (kg/m^2)		21.8±1.1
Body composition	Fat percentage (%)	29.9±5.9
	Lean body mass(kg)	44.1±19.3
VO_2 max (ml/kg x min)		31.8±6.3

Table 2 : Health status of workers involved in grape cultivation (n=15)

Variables of health status	Observed values	Recommended value	Category
Body temperature (^{0}F)	98.68±0.33	98.4degree F	Normal
Blood pressure :			
Systolic (mm/Hg)	125.69±10.36	120mm/Hg	Normal
Diastolic (mm/Hg)	80.38±4.89	80mm/Hg	
Pulse rate (bpm)	86.8±9.36	70-80bpm	Normal
Pulse pressure (mm/Hg)	45.7±4.2	30-50mm/Hg	Normal

Table 3 : Grip fatigue of worker before and after performing the activities in grapes cultivation (n=15)

Activity	Grip strength before activity (kg)	Grip strength After activity (kg)	Grip fatigue (%)
Land preparation			
Right hand	36.0±10.6	25.2±9.98	30
Left hand	31.8±10.8	22.3± 11.3	29.8
Pruning			
Right hand	29.7±11.3	20.5±11.3	30.9
Left hand	25.1±10.3	17.3±10.3	31.0
Manuring			
Right hand	26.3±11.04	21.0±11.3	20.1
Left hand	22.1±10.5	17.6±8.69	20.3
Irrigation			
Right hand	20.5±12.2	16.4±11.5	20
Left hand	18.2±9.73	14.6±8.92	19.7
Plant protection			
Right hand	23.7±12.2	19.96±11.5	15.7
Left hand	21.50±9.73	20.05±8.92	6.7
Harvesting			
Right hand	34.7±10.3	29.5±10.5	14.9
Left hand	31.1±11.0	26.4±10.9	15.1
Handling and transportation			
Right hand	37.7±12.2	32.5±11.5	13.7
Left hand	34.1±9.73	29.4±8.92	14.9

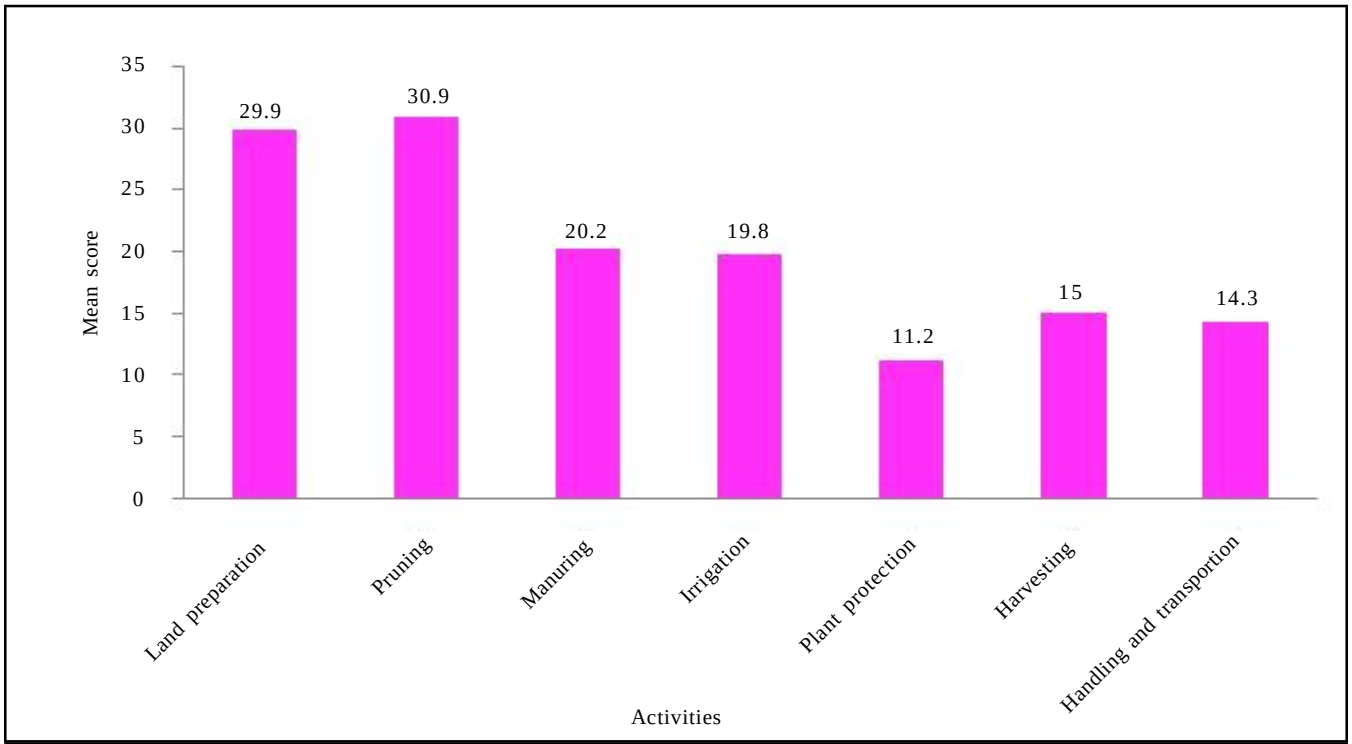

Fig. 1 : Grip fatigue of worker before and after performing the activities in grapes cultivation

and 29.5 kg, respectively. This resulted in grip fatigue of 14.9 per cent. The average grip strength of the left hand was 31.1kg and 26.4kg respectively and grip fatigue of the left hand was 15.1 per cent.

Handling and transportation:

In handling and transportation activity the average grip strength before and after the activity for right hand 37.7 kg and 32.5, respectively. This resulted in grip fatigue of 13.7 per cent. The average grip strength of the left hand 34.1 kg and 29.4 kg, respectively and grip fatigue of the left hand was 14.9 per cent. Mainly daily functions and sporting events require high levels of the flexor musculature of the forearms and hands. During gripping activities the muscles of the flexor mechanism in the hand and forearm create grip strength while the extensors of the forearm stabilize the wrist. Handheld grip strength dynamometry was used to measures the muscular force generated by flexor mechanism of the hand and forearm. Grip strength was moderately correlated with over all body strength**.** Grip strength gives the measures of fatigue. As the strength decreases, the fatigue increases Smith *et al.* (2006). Fry *et al.* (2006) also found correlation between grip strength and performance. Performance of highly repetitive task was associated with force dependent decline in grip strength and increased fiberogenic related problem this change was attenuated least short term, by anti -inflammatory treatment. Data reflect that pruning was an activity of cutting extra leaves and weeds to make the space between plants. It was highly prolonged activity in stooping posture and frequent lifting and hand intensive task.

The grip fatigue was maximum in pruning activity for both the hands.

Spinal angle deviation in different activities in grapes cultivation :

The finding in Table 4 and Fig. 2 highlights the angle of back (spinal cord) of workers in normal position and during work. The normal angle of workers was found to be 181.9 ± 2.8^0. The maximum forwarded deviation in angle was observed in land preparation 17.1 followed by manuring and irrigation, plant protection 7.9 each, pruning 7.1 and least deviation was in harvesting and handling and transportation 5.1. This resulted in maximum per cent deviation in spinal angle in land preparation 9.4 per cent followed by manuring and irrigation, plant protection 4.3 per cent each pruning 3.9 per cent and least deviation was for harvesting, handling and transportation (2.8%).

The maximum deviation in the spinal angle was in land preparation followed by manuring, irrigation, plant protection and pruning and least was for harvesting and handling and transportation. Mayer (2010) reported that repetitive washing tasks with lifting and carrying of beds and moving materials in awkward posture were found to be big problems. The spinal deviation in bed washing was highest and was at 21^0 of flexion, which were causing the back injuries with prolonged working. Problem in neck, shoulder and low back were found higher because workers were doing full day job in stooping posture with forward bending of neck, shoulder and back. Similarly Grandejean (1998) reported that constrained body posture and deviation from neutral posture were the most frequent of static muscular effort. Borah (2009) conducted a study on women labour engaged in cashew nut industry. The angle of deviation of spinal curve was above the normal range while performing the activity which was the high risk factor for musculoskeletal disorders. Similarly Meyers *et al.* (2000) reported that pruning, weeding and labeling were particularly stressful due to prolonged extreme flexion of the trunk ($>60^0$).

Rapid upper limb assessment (RULA) scores of workers in grape cultivation :

Table 5 depicts the rapid upper limb assessment (RULA) of posture used during land preparation,

Table 4: Spinal angle deviation in different activities in grapes cultivation **(n=15)**

Activity	Normal (degree)	Working (degree)	Deviation in angle	Per cent deviation %
Land preparation	181.9±2.8	199±1.6	17.1	9.4
Pruning		189±0.7	7.1	3.9
Manuring		174±1.8	7.9	4.3
Irrigation		174±1.8	7.9	4.3
Plant protection		174±1.8	7.9	4.3
Harvesting		187±1.4	5.1	2.8
Handling and transportation		187±1.4	5.1	2.8

harvesting, manuring pruning, irrigation, plant protection and handling and transportation activity of grapes cultivation.

Land preparation:

The mean value of wrist and arm score was 3.0 and muscles used forces was 2, thus giving the total score of 5. The mean score for neck, trunk and leg, worked out to be 6 with muscle force of 1, and total score (score B) of 6. Thus leading to a mean final score of 7. This total scores of 7 generates an action category investigate and change immediately, in the land preparation activity

Pruning:

The mean value of wrist and arm was 8 and muscles used forces was 1, thus giving the total score of 8. The mean score for neck, trunk and leg was worked out to be 9 with muscle force of 1, and total score (score B) of 7. This score of 7 indicates action category investigate and change in posture immediately in pruning.

Harvesting:

The mean value of wrist and arm score was 8 and muscles used force was 1, thus giving the total score of 8. The mean score for neck, trunk and leg was worked out 7 with muscle force of 0, and total score (score B) of 7. This scores generate action level which implies that the investigate and immediately change in the posture used for harvesting.

Manuring:

The mean value of wrist and arm score was 4 and

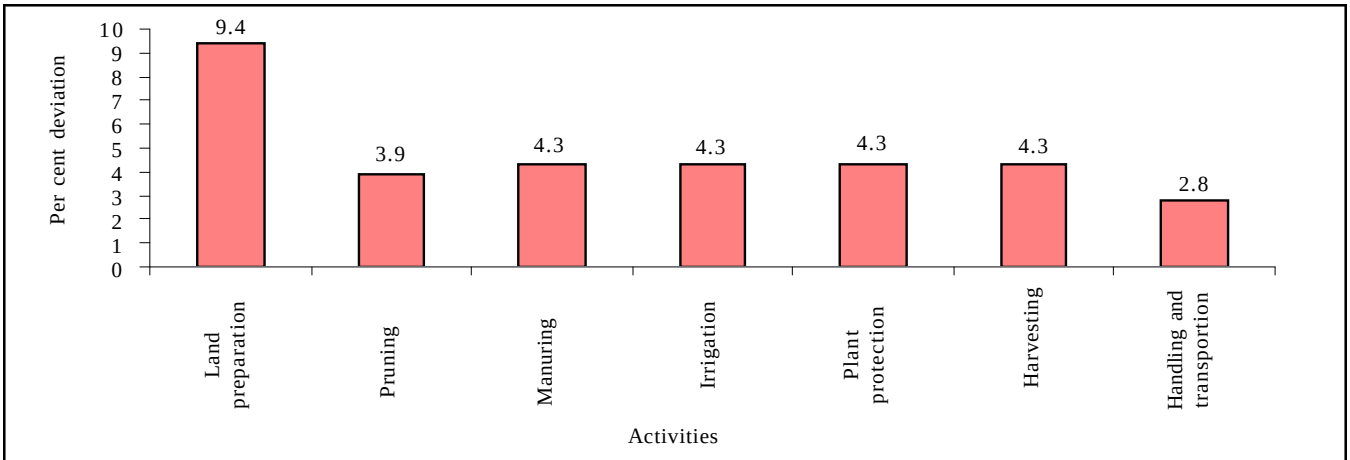

Fig. 2 : Spinal angle deviation in different activities in grapes cultivation

Table 5 : Rapid upper limb assessment (RULA) score of workers in grape cultivation (n=15)

Posture	Posture score A (upper arm+ Lower arm+wrist+wrist twist)	Muscle used force	Score A	Posture score B (Neck, Trunk and leg score)	Muscle used force	Score B	Final score	Action category	Description	Rank
Land preparation	2+2+3+1=3	1+1	5	3+4+1=5	1+0	6	7	7	Investigate and change immediately	I
Pruning	5+3+3+2=7	1+0	8	5+4+1=8	1+0	9	+7	7	Investigate and change immediately	I
Manuring	3+3+2+1=4	0+0	4	3+4+1=5	0+0	5	5	5	Investigate further and change soon	III
Irrigation	2+3+4+1=5	1+0	6	3+3+1=4	1+0	5	6	6	Investigate further and change soon	II
Plant protection	2+3+3+2=4	1+0	5	3+4+1=5	0+0	5	6	6	Investigate further and change soon	II
Harvesting	5+3+4+1=7	1+0	8	4+5+1=7	0+0	7	7	7	Investigate and change immediately	I
Handling and transportation	4+3+4+1=6	1+0	7	3+3+1=4	0+0	4	6	6	Investigate further and change soon	II

Table 6 : Occupational risk of workers in grape cultivation terms of biomechanical stress

Activity	Grip fatigue	RULA	Spinal deviation	Total	Rank
Land preparation	29.9	7	9.4	46.3	I
Pruning	30.9	7	3.9	41.8	II
Manuring	20.2	5	4.3	29.5	IV
Irrigation	19.8	6	4.3	30.1	III
Plant protection	11.2	6	4.3	21.5	VII
Harvesting	15	7	4.3	26.3	V
Handling and transportation	14.3	6	3.8	23.1	VI

muscle used force was 0, thus giving the total score of 4. The mean score for neck, trunk and leg was worked out 5 with muscle force of 0, total score (score B) of 5. This score of 5 implies that investigate further the posture used in manuring and change it soon.

Irrigation:

The mean value of wrist and arm score was 5 and muscle used force was 1, thus giving the total score of 6. The mean score for neck, trunk and leg was worked out with muscle force of 1 resulting in total score (score B) of 6. This score of 6 indicate that further investigate the posture used in irrigation and change it soon.

Plant protection:

The mean value of wrist and arm score was 4 and muscle used was 1, thus giving the total core of 5. The mean score for neck, trunk and leg was worked out with muscle force of 0 and total score (score B) of 6. This score generates action investigate further the posture used and change it soon.

Handling and transportation:

The mean value of wrist and arm score was 6 and muscle used 1, thus giving the total score of 7. The mean score neck, trunk and leg with muscle force of 0 was total score (score B) of 6. This score generate action investigate further the posture used and change soon.

As per the RULA of activities in grape orchard posture used in land preparation, pruning and harvesting required investigation and should be changed immediately. The rapid upper limb assessment (RULA) a posture targeting method was used for estimating the risk of the work related upper limb disorder. A RULA assessment gives a quick and systematic assessment of postural risk at a work (Metamney and Nigel, 1993). Louhevaara and Suuranakki (1992) also reported that working postures cause static load on the musculoskeletal system. Static work results in low efficiency of work. The reduction of the static load caused by poor work posture was one of the main measures for correcting the situation where there was constant increased prevalence of back disorder and musculoskeletal complaints. Similarly Mayer (2005) reported that high risk factors in pruning in vineyard were prolonged trunk flexion (upto 90 degree of trunk flexion, 50 degree flexion of lumber), awkward posture of both wrist, primarily flexion and ulnar deviation and continuous stress by handling/gripping sheers. Similarly Chapman *et al*. (2004) also reported that fresh market vegetable farmer produce vegetables that are sold at markets and roadside stands are exposed to high stress on the low back during lifting of containers filled with vegetables.

Occupational risk of workers in grape cultivation terms of biomechanical stress :

The occupational risk un grape cultivation in terms of biomechanical stress was assessed on the basis of grip fatigue, RULA, posture load score presented in Table 6. The occupational risk in terms of biomechanical stress was highest in land preparation followed by pruning. Further Table 6 revealed that rank scored by other activities in descending order was irrigation,manuring, handling transportation and harvesting and least was plant protection.

Conclusion :

– The grip fatigue was maximum in pruning activity for both the hands. The maximum deviation in the spinal angle was in land preparation followed by manuring, irrigation, plant protection and pruning and least grip fatigue was for harvesting and handling and transportation.

– As per the RULA posture used in land

preparation, pruning and harvesting required investigation and should be changed immediately.

– OWAS analysis depicted that posture used in pruning and harvesting was highly risky and corrective measures in posture were required immediately. The posture load factor was highest in pruning.

Authors' affiliations:
MANJU MEHTA, Department of Family Resource Management, College of Home Science, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA

■ REFERENCES

Borah, S. (2009). Ergonomics evaluation of the rural women while performing wheat harvesting activity. *J. Human Ecol.*, **18**(4): 309-311.

Chapman, L.J., Newenhouse, A.C., Meyer, R.H., Taveira, A.D., Karsh, B.T., Ehlers, J.J. and Palermo, T. (2004). Evaluation of an intervention to reduce musculoskeletal hazards among fresh market vegetable growers. *Appl. Ergonomics*, **35**(1): 57-66.

Donald, C. (2006). Understanding the links between agriculture and health, occupational Health Hazards of agriculture. *Vision: for Food Agriculture and the Environment*, **13** : 8-16.

Durnin, J. and Rahman, M. (1967). The assessment of the amount of fat in the human body from measurements of skin fold thickness. *British J. Nutr.*, **21**: 681-688.

Fry, A.C., Ciroslan, D., Fry, M.D., Leroux, C.D. and Schilling, B.K. (2006). Anthropometric and performance Variables Discriminating Elite American Junior men weightlifters. *J. Strength & Conditioning Res.*, **20** : 861-219.

Garrow, J.S. and Webster, J. (1983). Quetelet;'s index as measures of fatness. *Internat. J. Obese*, **9**:147-153.

Grandejean, E.(1998). *Ergonomics of the home*. Taylor and francis Ltd., LONDON, UNITED KINGDOM.

Guarav, M.A. and Salunkhe, S. R. (2011). A study of problem and prospects of women employees in grape farm. *Indian Stream Res. J.*, **1** : 2230-7850.

Louhevaara and Suuranakki (1992). A rapid appraisal of occupational work load modified scale of perceived exertion. *Ergonomics*, **37**(3): 485-491.

Mayer, A. (2005). Environmental/occupational safety and health. National canter for farm worker health. *Migrant Health Issues Monograph Series*, **2** : 3-7.

Mayer, J. (2010). International Agricultural Migration and Public Health: Examining Migrant Farm Worker Health and the Public Health Implications of Agricultural Temporary Migration. Public Health Agency of Canada.

Mc Atamney, L. and Corlett, E. N. (1993). RULA: A survey method for the investigation of work related upper limb disorder. *Appl. Ergonomics*, **24** : 91-99.

Metamney and Nigel (1993). Agricultural work related injury and ill–health and the economic cost. *Environ. Sci. & Pollut.*, **6** (3) : 175-182

Meyers, J. M., Miles, J. A., Faucett, J., Janowitz, I., Tejeda, D. G., Duraj, V., Kabashima, J., Smith, R. and Weber, E. (2000). High risk tasks for musculoskeletal disorders in agricultural field work. *Proceedings of the IEA 2000/HFES Congress.*

Murali, D., Kulkarni, M.S. and Pardesi, R.S. (2004). Postural deviation of body of farm women while performing selected farm activities using traditional method and improved tools. Proceedings of HWWE, Mumbai, pp.43. (Abstract)

Shahnavaz, H. (1987). Workplace injuries in the developing countries. *Ergonomics*, **30** : 397 - 404.

Shikdar, A.A. and Sawaqed, N.M. (2003). Worker productivity, occupational health and safety problems in selected industries. *Computers & Industrial Engg.*, **45**(4) : 563 – 572.

Singh, A. (2010). *Recent initiative in horticulture*, Westville Publishing House, Ist Ed., pp. 2-4.

Smith, A.B., Shimomur, Y., Iwanag, K. and Katsuura, T. (2006). The influence of different lower seat height on the muscular stress during squatting for a ground level job. *J. Human Ergol.*, **36** : 25-33.

Varghese, M.A., Saha, P.N. and Atrey, N. (1994). A rapid appraisal of occupational work load from a modified scale of perceived exertion. *Ergonomics*, **37**: 485-491.

Wakula, J., Beckmann, T., Hett, M. and Landau, K. (2000). Ergonomics analysis of grapevine pruning and wine harvesting to define work and hand tools design requirements. *Occupational Ergonomics*, **2** : 151-161.

■ WEBLIOGRAPHY

National Horticultural Board, Government of India (2011). *Agriexchange.apeda.gov.in.*