

# Analysis of musculoskeletal disorders of workers in grape cultivation

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■ **ABSTRACT** : 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, and western Uttar Pradesh, Rajasthan and Madhya Pradesh. Agricultural workers involve several strenuous activities like ploughing, spading, carrying, uprooting, planting, weeding, cutting, shafting, threshing, sweeping, etc. Musculoskeletal disorders were common among farmers. Farmers handle heavy workloads often in awkward posture and experiencing some work related problems. That majority of the workers (59.3%) in pooled sample belonged to old age and similar trend was also observed in three districts *i.e.* majority 50 per cent, 75.0 per cent and 66.6 per cent, respectively from Hisar, Sirsa, Fatehabad were in old aged. Cent per cent of the workers were male. Majority of the workers 44.4 per cent obtained education upto primary school 38.8 per cent upto senior secondary which was the good indication for grapes farming. The musculoskeletal problems and the pain perceived during MMH (Manual material handling) activity with different methods were determined by administering standardized Nordic Questionnaire. These discomforts may be due to prolonged standing work and also other agriculture operation which necessitated frequent bending. Use of improved agricultural tools for varied agricultural operations may mitigate this problem. Governmental efforts are also aimed to address these issues.

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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, 2011). Haryana is the sixth largest producers of grapes in the country with 5.7 million ton/hectare/ year. Grape cultivation is grown under a variety of soil and climatic conditions (Shikhamany, 2001). In Haryana, it is usually cultivated from January to June end. According to the International

Labor Organization (ILO), the agricultural sector is one of the most hazardous sectors to health worldwide. Agriculture work possesses several characteristics that are risky for health: exposure to the weather, close contact with animals and plants, extensive use of chemicals and biological products, difficult working postures and lengthy hours, and use of hazardous agricultural tools and machinery. Agricultural workers involve several strenuous activities like ploughing, spading, carrying, uprooting, planting, weeding, cutting, shafting, threshing, sweeping, etc. 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 labour 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. The frequencies of cuts, the pruning task were highly repetitive, and vineyard worker more autonomy than industrial workers and can modulate their rhythm of works and takes break they need. The use of pesticides and fertilizers in grape cultivation is a common everyday practice. It was found that pesticide crop sprayers were more likely to report work-related skin symptoms, asthma and other respiratory health problems among farm workers (Jeebhay *et al.*, 2007). Fathallah *et al.* (2006) conducted a study to evaluate the effectiveness of an intervention on the incidence of musculoskeletal symptoms among workers during two grape harvest seasons. There was five-fold reduction in workers post seasons musculoskeletal symptoms scores, without significant reductions in productivity. 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. So keeping in mind the working pattern and working conditions the present study was under taken to study analysis of Musculoskeletal Disorders of workers in grape cultivation.

## ■ RESEARCH METHODS

### Selection of area:

Three districts of Haryana state were selected purposively in consultation with Horticultural Department of Haryana state, where grape cultivation was being done and six Grape orchards from these districts were selected randomly for the field study. Two Grape orchards were selected randomly for field experiment from the six grape orchards.

### Selection of the sample :

All the workers working in six grape orchards were selected purposively from each orchard. The work profile of the workers was examined on the basis of type of work, time spent, rest period, body part involved, discomfort rating, pain symptoms, work load as per time and environmental condition in all the activities of grape cultivation *viz.*, land preparation, pruning, manuring, irrigation, plant protection, harvesting and handling and transportation. 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 were physically fit and willing to cooperate and engaged in grape cultivation activity were selected.

### Interview with the workers:

A well structured and pre-tested interview schedule was being prepared to collect information by direct interview. Interview schedule consisted details regarding socio-economic status, occupational status and musculoskeletal disorder and recovery pattern, information obtained through this method was more accurate and the interviewer can clear up the doubts pertaining to certain questions. In addition to it, observation as a tool of research can also be adopted for the study.

## ■ RESEARCH FINDINGS AND DISCUSSION

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

### Background profile of the workers of grape orchard:

#### Age :

Age is very important variable in any study as it affects the working capacity of an individual. Majority

of the respondents (59.3%) in pooled sample belonged to old age and similar trend was also observed in three district *i.e.* majority 50 per cent, 75 per cent and 66.6 per cent, respectively from Hisar, Sirsa and Fatehabad were in old age group. Out of the total sample surveyed 34 per cent of the respondents belonged to middle age group, 38.8 per cent, 25 per cent and 33.3 per cent from Hisar, Sirsa and Fatehabad, respectively were middle aged. About one third of the respondents (6.25%) from pooled data were in young age group.

#### *Education :*

There was lot of variation in the level of education of the respondents in three district *i.e.* Hisar, Sirsa and Fatehabad. In Hisar district 44.4 per cent obtained education upto primary school, 38.8 per cent upto senior secondary, 11.1 per cent of the respondents could read and write and only 5.5 per cent were graduate. In Sirsa district, half of the respondents were educated upto senior secondary level and 37.5 per cent upto primary level. Few respondents (12.5%) were diploma holder. In Fatehabad district half of the respondents had their education upto senior secondary school and rest half were educated upto primary level.

#### *Pattern of employment :*

Finding in Table 1 illustrate that pattern of employment of majority of the respondents (90.6%) in total sample was temporary. Cent per cent from Fatehabad, 88.8 per cent from Hisar and 87.5 per cent from Sirsa had temporary employment. Only 6.2 per cent respondents in pooled sample were having permanent employment, and employment of 12.5 per cent from Sirsa and 55 per cent from Hisar was permanent. Employment of only few respondents (3.1%) was on daily wages in total sample.

#### *Source of income :*

Further results in Table 1 revealed that 68.7 per cent respondents in total sample were doing agriculture and 87.5 per cent from Sirsa, 66.6 per cent from Hisar and 50.0 per cent from Fatehabad were involved in agriculture. Whereas 31.3 per cent respondents in total sample, half of the respondents from Fatehabad, one third from Hisar and 12.5 per cent from Sirsa were involved in private job.

#### *Annual income :*

The annual income of the respondents from grape orchards had been presented in Table 1. Half of the respondents of pooled sample from grape orchards (More than Rs. 1,40,000/annum) followed by 33.3 per cent having income ranging from (Rs. 70,000-1,40,000/ annum) and only few (16.6%) were (upto Rs. 70,000 per annum). In Hisar cent per cent had income more than Rs. 1,40,000 per annum, In Sirsa (50%) each were in middle *i.e.* Rs. 70,001-1,40,000 per annum and more than 1,40,000/annum. In Fatehabad (50%) each were in the medium income group.

#### **Working hours of workers in grape cultivation :**

Table 2 depicts the working hours in grape orchard. Finding in Table 2 illustrate that in pooled sample cent per cent of the workers were involved in grape cultivation from more than 9 years. Overall cent per cent of the respondents were taking rest in between the work, with the length of work period 4-8 hours per days. Results further indicated that majority of respondents (55%) in Hisar district were taking rest for 10 min-60 min and remaining 44.4 per cent were taking rest for 60 min-120 min, In Sirsa rest period of 10 min-60 min and 60-120min was taken by 37.5 per cent each, whereas, rest period of more than 120 min was taken by 25.0 per cent of workers. In Fatehabad majority (83.3%) were taking rest of 60min-120min and only 16.6 per cent were taking rest for of more than 120 min. Mines *et al.* (2001) reported that individuals working full day under stressful conditions were more prone to accidents and injuries thus occurred during work lead to other serious problem like crushing from farm equipment, acciendental slicing with hands labors tools and falling from ladders. Further, findings were in line with Mclean *et al.* (2001) who reported that person can actually work more productivity (and last much longer) with breaks between the works, and further showed that frequent breaks of 30 seconds to 10 minutes were beneficial. The benefits include increased performance and reduced fatigue to the eyes, lower back, neck and wrist, especially when breaks were taken at 20 minutes intervals rather than at 40 minutes interval. Similarly Pheasante (2010) reported that people need to get up and walk around as much as possible to reduce health hazards as well as poorly designed workstation were increasing the length needed for rest breaks. Moore *et al.* (1991) showed that cumulated duration of exposure over the entire day was high, *i.e.* approximately 8 to 10 h per day over a 4-month period. Trimming the vines

was performed after October and takes a team of 4-6 employees working 3 month, 8 hours a day.

### Mean score of Intensity of musculoskeletal pain in workers of grapes orchards as per body map :

Intensity of musculoskeletal pain of workers in

grape cultivation as per body map has been recorded after performing the grapes cultivation activities on a five point scale as per human body map as indicating very severe pain, severe pain, moderate pain, mild pain and very mild pain been presented in Table 3.

Table 1: Background profile of the workers of grape orchard				(n=32)
Variables	Hisar (n=18)	Sirsa (n=8)	Fatehabad (n=6)	Total
<b>Age</b>				
Below 18 years (adolscents)	2(11.1)	-	-	2(6.25)
19-25 years (young)	7(38.8)	2(25.0)	2(33.3)	11(34.3)
Above 26 years (late young)	9(50.0)	6(75.0)	4(66.6)	19(59.3)
<b>Gender</b>				
Male	18(100.0)	8(100.0)	6(100.0)	32(100.0)
<b>Education</b>				
Read write	2(11.1)	-	-	2(6.2)
Primary	8(44.4)	3(37.5)	3(50.0)	14(43.7)
Sen Secondary	7(38.8)	4(50.0)	3(50.0)	14(43.7)
College	1(5.5)	-	-	1(3.1)
Diploma	-	1(12.5)	-	1(3.1)
<b>Pattern of employment</b>				
Permanant	1(5.5)	1(12.5)	-	2(6.2)
Temporary	16(88.8)	7(87.5)	6(100.0)	29(90.6)
Daily labour	1(5.5)	-	-	1(3.1)
<b>Source of income</b>				
Agriculture	12(66.6)	7(87.5)	3(50.0)	22(68.7)
Private Job	6(33.3)	1(12.5)	3(50.0)	10(31.2)
<b>Family type</b>				
Joint	10(55.5)	6(75.0)	5(83.3)	21(65.6)
Nuclear	8(44.4)	2(25.0)	1(16.6)	11(34.3)
Widowed	1(5.5)	-	-	1(3.1)
<b>Income</b>				
(Upto Rs. 70,000) annum	-	-	1(50.0)	1(16.6)
(Rs. 70,001-140,000) per annum	-	1(50.0)	1(50.0)	2(33.3)
(More than Rs. 140,000) per annum	2(100)	1(50.0)	-	3(50.0)

Figures in parenthesis indicate percentage

Table 2 : Working hours of workers in grape cultivation				(n=32)
	Hisar (n=18)	Sirsa (n=8)	Fatehabad (n=6)	Total
<b>Years of grape farming</b>				
More than 9 years	18(100.0)	8(100.0)	6(100.0)	32(100.0)
<b>Rest in between the work</b>				
Yes	18(100.0)	8(100.0)	6(100.0)	32(100.0))
<b>Length of work period/day</b>				
4hrs to 8hrs	18(100)	8(100)	6(100)	32(100)
<b>Frequency of rest period</b>				
10min – 60min	10(55.5)	3(37.5)	-	13(40.6)
60min-120min	8(44.4)	3(37.5)	5(83.3)	16(50.0)
More tha120 minutes	-	2(25.0)	1(16.6)	3(9.3)

Figures in parenthesis indicate percentage

**Land preparation:**

In land preparation activity intensity of musculoskeletal discomfort was highest in upper back and lower back with mean score 35.2 (rank II)

**Pruning:**

For pruning maximum intensity of musculoskeletal discomfort in wrist and neck with mean score 34.4 (rank IV)

**Manuring:**

During manuring majority of the workers were suffering from lower back, wrist, hand with mean score 33.7 (rank VI)

**Irrigation:**

Most of the workers were facing intensity of pain in upper arm, buttock, wrist with mean score 4.2 (rank V)

**Plant protection:**

For plant protection, maximum intensity of musculoskeletal discomfort in lower back, lower arm, ankle/feet with mean score 34.4 (rank IV)

**Harvesting:**

In harvesting, maximum workers were suffering from intensity of musculoskeletal in hand, thigh, neck with mean score 35.7 (rank I)

**Handling and transportation:**

In handling and transportation intensity of musculoskeletal discomfort was highest in shoulder, lower back, wrist with mean score 34.6 (rank III). The intensity of musculoskeletal discomfort was highest in buttocks, wrist/hand and neck followed by ankle/feet, shoulder, elbow upper, arm, and muscles lower arm and eye. Least

discomfort was in ankle/feet, calf muscle. Risk factors for upper – extremity musculoskeletal disorder include biomechanical factors (force, repetition, posture and psycho-social factor (job stress) as stated by Morse *et al.* (2007). Aweto *et al.* (2015) reported that the low back pain was the most common area of discomfort, followed by the shoulder and then the neck. Similarly Youakim (2006) reported that tasks such as pruning and harvesting cause repeated stressing of hands and wrists, therefore MSDs were very common during the pruning and harvesting seasons.

**Visual Analogue Discomfort (VAD) of workers in various activities of grape cultivation :**

Table 4 reflects the visual analogue discomfort scale in different activities of grape production system. On the basis of observation, land preparation pruning and harvesting activity got VAD score of 8.0 hence, these were found to be very vigorous activity. However, handling and transportation got VAD score of 5.0 hence, depicting them moderate activity. Data further showed that manuring, irrigation and plant protection had VAD score of 3.0 indicating them as mild activities.

Land preparation, pruning and harvesting activities were the considered as the vigorous activities by the workers in grape cultivation hence were risky as per VAD score. Work safe BC (2009) reported that half of the claims of injuries in the agriculture industry were related to ornamental nurseries, greenhouses, and farm labour supply or services.

**Nordic analysis of prevalence of musculoskeletal problems in workers in grape cultivation :**

Nordic analysis of prevalence of musculoskeletal problems during 12 month of workers in grape cultivation has been presented in Table 5.

Table 3 : Mean score of intensity of musculoskeletal pain in workers of grapes orchards as per body map												(n=15)	
Activities	Neck	Shoulder	Upper back	Upper arm	Lower back	Lower arm	Buttock	Wrist	Hand	Thigh	Feet	Total	Rank
Land preparation	3.2	3.2	3.6	3.2	3.6	3	2.8	3.6	3.5	2.8	2.7	35.2	II
Pruning	3.5	3.1	3.2	3.2	3.4	3.2	2.7	3.6	3.3	2.6	2.6	34.4	IV
Manuring	2.8	3.1	3.1	3.0	3.3	3.0	2.7	3.3	3.4	2.8	3.2	33.7	VI
Irrigation	3.2	2.9	3.2	3.3	3.0	2.7	3.3	3.4	2.8	3.2	3.2	34.2	V
Plant protection	2.9	2.6	2.6	2.8	3.2	3.2	2.9	2.6	2.6	2.6	3.2	34.4	IV
Harvesting	3.5	3.1	3.2	3.2	3.4	3.2	2.7	2.9	3.8	3.6	3.1	35.7	I
Handling and transportation	3.2	3.6	3	2.8	3.6	3.1	2.8	3.4	2.7	3.3	3.1	34.6	III

**Land preparation:**

In land preparation activity, prevalence of musculoskeletal problems was highest in neck, wrist, lower back, one or both ankle/feet with mean score 12.2 (rank III)

**Pruning:**

For pruning, maximum prevalence of musculoskeletal problems in elbows, one or both ankle feet with mean score 12.7 rank (II)

**Manuring:**

During manuring majority of the workers were suffering from shoulder, elbows, wrist with mean score (11.4) rank IV

**Irrigation:**

Most of the workers were facing prevalence of musculoskeletal problems in shoulder, elbows with mean score 11.1 rank V

**Plant protection:**

For plant protection, maximum prevalence of musculoskeletal problems in neck, elbows, lower back, one or both ankle/feet with mean score 12.7 rank II.

**Harvesting:**

In Harvesting, maximum workers were suffering

from prevalence of musculoskeletal problems in elbows, one or both ankle /feet with mean score 12.7 (rank II)

**Handling and transportation:**

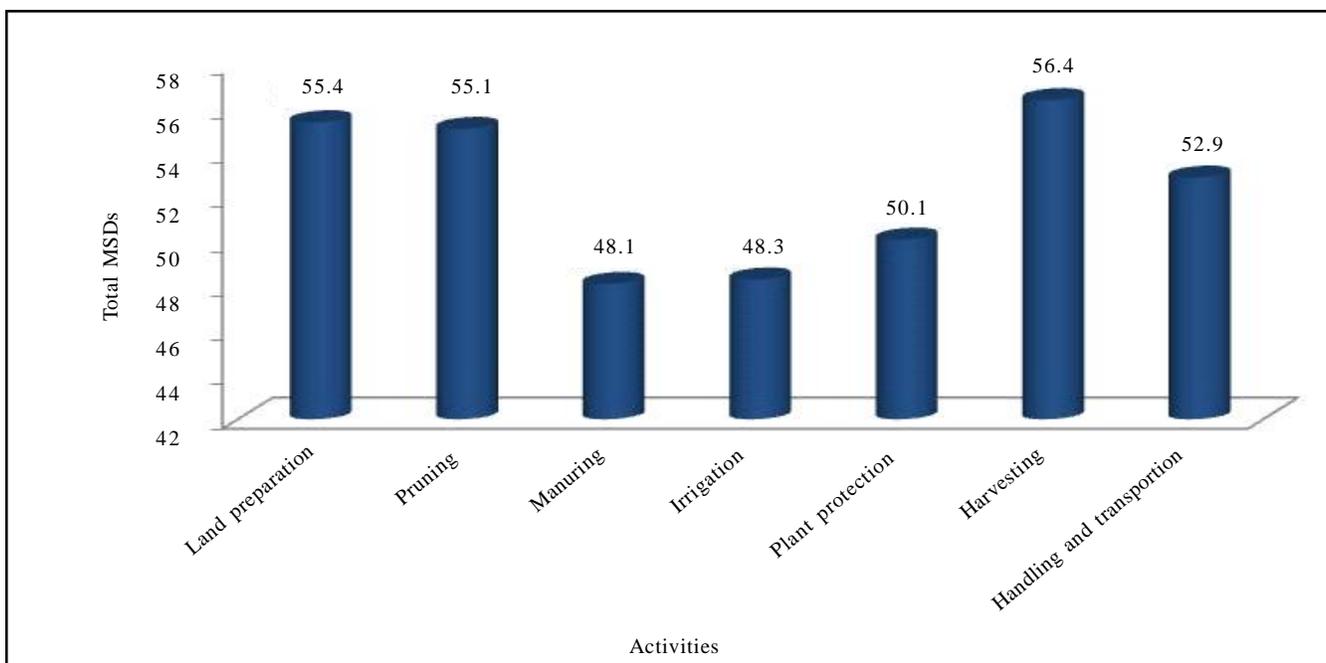
In handling and transportation prevalence of MSDs problem was higher in elbows and upper back with mean score 13.3 (rank I). Meyers *et al.* (2000) reported that main risk factor for upper back and neck MSDs in farming was severe neck flexion or extension. Many farming tasks produce severe neck flexion that was oftentimes held for long durations such as: harvesting of plants on the ground, weeding fields, and pruning plants. Neck extension occurs the farm workers do tasks above their heads in tasks such as fruit harvesting and wine grape pruning. Long durations of the neck being twisted during driving of tractors in the field. Similarly Larson and Hannihen (1995) unfolded that excessive musculoskeletal stress at work, specially with static load, as it plays a major role in low back pain, neck and shoulder disorders. Electromyography recording during working conditions has been used to quantify muscular stresses, allowing better designing of work environment to reduce low back pain and neck shoulder tensions. Wrists and neck, shoulder, lower arms and upper back was the frequently used body part in grapes cultivation activities. Pain felt in the other body parts were 'buttocks due to adoption of poor posture for prolonged period.

Activity	Visual analogue discomfort (VAD) score	Action	Ranking
Land preparation	8.0	Vigorous activity	1
Pruning	8.0	Vigorous activity	1
Manuring	3.0	Mild activity	3
Irrigation	3.0	Mild activity	3
Plant protection	3.0	Mild activity	3
Harvesting	8.0	Vigorous activity	1
Handling and transportation	5.0	Moderate activity	2

Activities	Mean score							Total	Rank
	Neck	Shoulder	Elbows	Wrist	Upper back	Lower back	One or both/ankle/feet		
Land preparation	1.8	2	1.4	1.9	1.4	1.8	1.9	12.2	III
Pruning	2	2	1.8	2	1.5	1.5	1.9	12.7	II
Manuring	2	1.8	1.8	1.8	1.5	1.5	1	11.4	IV
Irrigation	2	1.8	1.8	1.5	1.5	1.5	1	11.1	V
Plant protection	1.9	1.7	1.9	2	1.3	1.9	1.8	12.7	II
Harvesting	2	2	1.8	2	1.5	1.5	1.9	12.7	II
Handling and transportation	2	2	1.8	2	1.8	1.7	2	13.3	I

**Table 6 : Musculoskeletal discomforts of workers in grape cultivation**

Activities	Musculoskeletal discomforts			Total	Rank
	Human body map score	VAD scale score	Nordic scale score		
Land preparation	35.2	8.0	12.2	55.4	II
Pruning	34.4	8.0	12.7	55.1	III
Manuring	33.7	3.0	11.4	48.1	VII
Irrigation	34.2	3.0	11.1	48.3	VI
Plant protection	34.4	3.0	12.7	50.1	V
Harvesting	35.7	8.0	12.7	56.4	I
Handling and transportation	34.6	5.0	13.3	52.9	IV

**Fig. 1 : Musculoskeletal discomforts of workers in grape cultivation**

Similarly, Hildebrandt (1995) reported that 75 per cent of farm workers reported experiencing musculoskeletal symptoms during the previous 12 months.

#### **Musculoskeletal discomforts of workers in grape cultivation :**

The overall musculoskeletal discomfort was assessed on the basis of Human body map, VAD scale, Nordic scale presented in Table 6. The musculoskeletal discomfort was maximum for harvesting with total score (56.4), followed by land preparation (55.4). The total score of other activities was pruning (55.1), handling and transportation (52.9), and plant protection (50.1). The least of total musculoskeletal discomfort was for manuring (48.1) and irrigation (48.3) (Fig. 1).

Hence, musculoskeletal discomfort in the grape

cultivation was highest for harvesting activity had highest MSD. Takala (2008) reported that most musculoskeletal disorders were cumulative disorders resulting from repeated exposures high or low intensity loads over a long period of time.

#### **Conclusion :**

- Maximum respondents were in age group of above 26 years and cent per cent of the respondents were male. They all were educated upto primary and senior secondary levels and had temporary pattern of employment.

- A huge majority of respondents were doing grape farming from more than 9 years. Cent per cent of the respondents were taking rest in between the work with length of work period 4-8 hours per days. Majority of

the respondents were taking rest period of 60-120 min. They were getting income (wages) weekly and working on contract basis and mode of fixing of wages of half of the respondents was based on time of work and that of other half of the respondents was on quantum of work.

– Overall maximum Musculoskeletal discomforts of workers in grape cultivation was in harvesting activity.

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