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ERGONOMIC INTERVENTIONS IN GARLIC CULTIVATION PRACTICES THROUGH USE OF GARLIC PLANTER

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Abstract: Garlic is popularly used as a spice or a condiment throughout India and has enormous processing potential in domestic and export markets. It is a low input crop and result in high benefit: cost ratio. Many farmers are taking garlic cultivation as a promising field but still uses labor intensive traditional methods of garlic sowing. Farm mechanisation keep workers safe, comfortable, reduce their workload and drudgery, enhance their productivity as well as crop production. The present study was planned for mechanized intervention of garlic sowing through use of manual garlic planter and to assess and compare the rate of drudgery involved with the traditional sowing method. Ergonomic cost was calculated by measuring heart rate, energy expenditure, and total cardiac cost of work. When both methods were compared ergonomically, it was observed that ergonomic cost during garlic sowing was almost the same. Muscular stress during the performance of the activity was measured by recording the incidences of discomfort and pain perceived by the subjects. The subjects perceived moderate discomfort and exertion in using the garlic planter while they rated traditional sowing as heavy activity when compared with former. The farmers used the garlic planter for the first time and gave a very positive feedback for its performance.
Keywords: Garlic planter, Sowing, Performance Evaluation, Ergonomics, Drudgery.

Introduction

Garlic (*Allium sativum*) is cultivated in most countries both in the tropic and temperate zones. Garlic belongs to the onion family and is an important bulb crop grown and used as a spice or a condiment throughout India. It is also popular for remedy or medicine for various ailments and physiological disorders. Besides, it has insecticidal, fungicidal and bactericidal properties too. Its regular use is known to lower the cholesterol and blood pressure in human body. It is a low input crop and result in high benefit: cost ratio. The garlic crop is sown in October/November and harvested from April to June. It is also an important foreign exchange gaining crop for India. Garlic has enormous processing potential in domestic and export markets. India exports fresh and chilled garlic, dried garlic, dehydrated garlic flakes, dehydrated garlic powder, and garlic oil to various countries. Value addition through processing of the bulbs in the form of dehydrated flakes, dehydrated powder, paste etc is instrumental in

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substantially expanding the export basket of garlic and its derivative products. The emergence of processing industries at a faster rate has necessitated the demand for more raw materials in future. Many farmers are therefore taking garlic cultivation as a promising field. The area under garlic therefore has been gradually increased in last decades due to its profitability in the form as cash crop. The other reason for its increased cultivation is its long shelf life and increase in number of good hybrids having large cloves with easy peeling efficiency.

Garlic is grown commercially in over a dozen of states of India. The major garlic producing states in India are Madhya Pradesh, Gujarat, Uttar Pradesh and Rajasthan which produce about 80% of country's total output (Kushwaha et al 2020). Garlic cannot withstand too hot or too cold weather; Short days are very favorable for the formation of bulbs. It can be grown well at an elevation of 1000-1500 m above the sea level. Himachal Pradesh is the leading garlic producing state in Northern India. According to the report of NHRDF (2010), Himachal Pradesh was ranked second among the garlic producing states with production of 12.42 t/ha. The state produces sizeable quantity of garlic in different regions. Per unit yield of garlic is high but, due to limited area, total production is less. Most of the farmers in Himachal Pradesh are small and marginal farmers. So, this crop is very suitable for them as it require less labour. The sowing of garlic is labour intensive as its planting requires 56 to 62 man-days/ha (Garg and Dixit, 2000).

The state of Himachal Pradesh has a hilly terrain that constitutes bench terraces and small field areas. Majority of the farmers are still using labor intensive old farm tools/equipment and traditional methods of garlic sowing i.e. manual placement of seed with traditional tools, which consumes maximum time. The sowing of garlic by traditional method is highly labor intensive. Man power requirement is very high for the garlic planting in traditional methods. It requires about 60-70 persons to sow one hectare in one day because row and plant spacing in garlic is very narrow, that is, 15 cm and 7.5 cm, respectively (Maheswari and Varma, 2007). Long hours of exhaustive work using traditional tools/equipment leads to backaches, pain in shoulders and other health problems of the farmers leading to low productivity and a high risk of stress related to diseases. During the sowing season the scarcity of labour results in delayed sowing which reduces yield. This necessitates adoption of farm mechanisation that will keep workers safe, comfortable, will reduce the workload and drudgery of farmers and will enhance their productivity and will increase the cultivation of this cash crop. Directorate of Onion & Garlic Research (ICAR), Pune in its booklet on Vision-2050 has stressed for development and evaluation of machines and tools for garlic cultivation for small and medium level farmers in

view of emerging labour problem. By promoting appropriate machinery, the work and work environment can be improved, physiological workload can be reduced and efficiency/work output can be improved significantly. So, keeping this in view, the present study was planned for mechanized intervention of garlic sowing through use of manual garlic planter and to assess and compare the rate of drudgery involved with the traditional sowing method. In addition to this, the acceptability, feasibility and ease of operation of planter from users' point of view was also assessed.

Methodology

The ergonomical evaluation of Falcon make garlic planter was conducted at farmers' fields who were involved in garlic farming on a commercial scale for years. An equal number of farmers were selected for conventional method of garlic sowing for working out the economics and drudgery rate.

The farmers were trained in operation of the planter before start of the actual experiment. The resting heart rate (HR rest), oxygen consumption rate at rest (VO_2 rest) and the blood pressure of the subjects were measured at rest and 15 minute prior to conducting the experiment. The blood pressure and heart rate of the subjects were measured by digital blood pressure monitor and polar heart rate monitor respectively. The oxygen consumption of subjects on their measured heart rate was estimated based on equation given by Singh et al (2008).

The body mass index of subjects was calculated by dividing square of height (m^2) to weight (kg). During and after continuous garlic sowing operation, working heart rate (HR work) and recovery heart rate were measured. Based on these values, oxygen consumption rate at work (VO_2 work), energy expenditure, total cardiac cost and physiological cost of work were worked out ((Singh et al.2007). Based on the energy expenditure values, the categorization of the work was done as per classification by Nag et al. (1980).

Overall discomfort rating for the activity was measured by VAD scale- a 10-point scale based on adoption of technique developed by Corlett and Bishop (1976). The category scale constructed by Borg (1980) was used to assess the rate of perceived exertion of workers after garlic sowing activity.

Results and discussion

Falcon make garlic planter was evaluated at farmers' field. The specification of the planter is given in Table__. The planter has length of 95cm, width of 30cm and height 110cm. It has a vertical disc with 12 spoons on the plate for seeding mechanism. The spoons are fixed on the circular ring & the ring is mounted on the vertical plate in the planting hopper by means of nuts

and bolts. The power from the wheel to the planting mechanism is provided by means of chain & sprocket. The machine is quite simple in design and weighs 14kg and has 3 kg capacity seed box.

Sowing of garlic means the placement of cloves in soil at proper depth, with proper moisture and soil temperature. Well-grown compact bulbs of uniform shape and size (Length-35.6, Width-26.8, Thickness-20.7mm) of variety GHC-1 were selected. The cloves were planted at distance of 7.6 cm at 3.0 cm soil depth. The variety of the garlic used in the region have large sized cloves which did not fit well in the spoons of the planter. Therefore, the spoons of the garlic planter were modified so that the large sized cloves fit appropriately. The spoons that were of size 2.8 x 2 x 1.2 cm previously were modified to size of 4 x 2.4 x 1.3 cm. Two persons are required for operating the machine in push and pull mode.

For conventional sowing, the *desi* variety of garlic (Length-27.4, Width-18.3, Thickness-15.5mm) was used with seed rate of 430 kg/ha. The desi cloves were sown at a distance of around 7.0 cm with average depth of 3.1cm. The average germination percentage after 10 days of sowing was 71.6% in comparison to about 89.8% in manual planting. After 20 days of sowing the germination percentage for planter was 93.8% and 98.6% in manual planting respectively.

Before starting the experiment on ergonomic interventions in garlic sowing, the subjects were made aware of the purpose and objectives of the study. They were also familiarised with the planter to remove their apprehensions regarding the machine. Age, height, weight and heart rate of each subject during rest were recorded. Mean height and weight of subjects were 175.34 and 187.16 cm and 52.4 and 60.33kg respectively for garlic planter and conventional sowing method respectively. The farmers had normal blood pressure. Heart rate is one of the most accurate means of the energy expenditure while performing any activity. Generally heart rate is used as an ergonomic measure to evaluate the physiological or functional demand of work on the individual (Hasalkar et al., 2004). From the physiological point of view, the job demand or work load refers to the demands placed on the cardio-respiratory system and is determined by the energy cost and cardiac cost of work (Chauhan, 1999). Heart rate of the subjects at rest was calculated as 77.4 and 81.66 with calculated oxygen consumption rate of 0.20 and 0.25 before conducting experiments by garlic planter and by conventional method.

When both methods were compared ergonomically, it was observed that maximum heart rate during sowing was almost the same thereby a consistent value was obtained for heart rate (average), energy expenditure (average and maximum) and oxygen consumption rate (work).

During the period of recovery too, values at par viz. 93.88 and 93.60 and 0.39 and 0.38 were calculated for subjects sowing garlic by garlic planter and traditional technique. Total cardiac cost of work for garlic planter was 611.07 and for traditional sowing was 526.86.

Muscular stress during the performance of the activity was measured by recording the incidences of discomfort and pain perceived by the subjects. The subjects were asked for their opinion about the operation of the sowing. The subjects perceived moderate discomfort and exertion in using the garlic planter while they rated traditional sowing as heavy activity when compared with former. Traditional sowing required making of furrows and manual seed placing followed by levelling off the field as additional work. Majority of the farmers do sowing operations using conventional tools like khurpi (grub hoe), spade etc. thereby adopting bending and squatting body postures due to which their physiological workload increases and efficiency decreases. Based on the energy expenditure values (maximum) the categorization of the sowing work was 'moderate' for both techniques as per classification by Nag et al. The farmers used the garlic planter for the first time and gave a very positive feedback for its performance.

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Table 1: Specification of the garlic planter

Overall Dimensions, cm Length Width Height	 95 30 110
No. of rows	1
Capacity of the seed box, kg	3.0
Type of seeding mechanism	Vertical disc with spoons
No. of spoons on the plate	12
Spoons dimensions (cm)	2.8 x 2 x 1.2 (previous) 4 x 2.4 x 1.3 (modified)
Type of power transmission	Through chain and sprocket from wheel
Type of furrow openers	Shovel type, width-25mm
Machine weight, kg	14
Machine Cost, Rs	6500

Table 2: Performance of garlic planter

Particulars	**Garlic planter**	**Conventional sowing**
Variety	GHC-1	Desi
Seed rate, kg/ha	400	430
Size of seed, mm Length Width Thickness	 35.6 26.8 20.7	 27.4 18.3 15.5
Depth of planting, cm	3.0	3.1
Plant spacing, cm	7.6	7.0
Germination, % After 10 days After 20 days	 71.6 93.8	 89.8 98.6
Missing, %	8.4	-
Number of plant/m^2	70.6	78.5

Table 3: Physiological parameters of subjects before garlic sowing activity

	Garlic planter		**Conventional garlic sowing**	
Parameters	**Range**	**Mean**	**Range**	**Mean**
Age (years)	32-53	43	31-46	38
Height (cm)	160-183.9	175.34	168.2-188.5	187.16
Weight(kg)	45-56	52.4	54-66	60.33
BMI (kg/m^2)	14.37-21.48	17.17	16.07-18.09	16.78
HR_{rest} (beats/min)	72.84	77.4	72-89	81.66
Blood pressure(mmHg)	109/64-130/94	124/85	127/78-137/84	131/84
OCR_{rest} (l/min)	0.14-0.27	0.20	0.14-0.33	0.25
EE_{rest} (kj/min)	2.73-4.63	3.58	2.73-5.43	4.26

Table 4: Mean physiological parameters of subjects during and after garlic sowing activity

Parameters	**Garlic planter**	**Conventional garlic sowing**
HR_{avg} (beats/min)	123.22	122.42
HR_{max} (beats/min)	134.67	134.33
EE_{avg} (kj/min)	10.87	10.74
EE_{max} (kj/min)	12.70	12.64
OCR_{work} (l/min)	0.85	0.85
$HR_{recovery}$ (beats/min)	93.88	93.60
$OCR_{recovery}$ (l/min)	0.39	0.38
TCCW	611.07	526.86
PCW	0.021	0.016
Work categorization (EE_{max})	Moderate	Moderate
Overall discomfort rating	5 (moderate discomfort)	7 (heavy discomfort)
Perceived rate of exertion	3 (moderately heavy)	2 (heavy)