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Comparative evaluation of ergonomics while operation of different types of harrows in eggplant Crop

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Abstract: Two type of self-propelled power weeders used in the eggplant crop were evaluated with three subjects of different age group who were allowed to work at different day timings at different forward speeds and different depth of operations. The duration of work was kept of 120 minutes. The weeders were evaluated by recording the body temperature, blood pressure, pulse rate, heart rate, and body posture and finally based on average heart rate, the energy expenditure of the subject was considered as a criterion. During the ergonomic evaluation, 4 HP self propelled power weeder and 8.38 HP self propelled power weeder it was found that the body temperature of the operator rises in accordance to the rise in forward speed, duration of time, nature of work done and time of work. The highest rise in temperature was observed in the evening whereas nominal increase was in the morning time. Similar phenomenon was observed in blood pressure, heart rate and pulse rate. The change in the body posture was calculated in the net bending angle that was observed most when the speed of weeding operation was 4.8km/h in 8.38 HP self-propelled power weeder, which was 6.28˚. The 4.00 HP self-propelled power weeder showed a variation of 9.226 to 17.108kJ/min when the forward speed was increased from 1.2km/h to 2.4 km/h and 8.38HP self-propelled power weeder ranged from 6.614 kJ/min to 19.475kJ/min. It was observed in the operators that after the continuous work of 120 minutes the energy expenditure had a great hike from the normal condition. It is estimated that burning of one litre of oxygen results in energy consumption of 29.9 kJ.

Keywords: weeding operation, self-propelled, body temperature, blood pressure, pulse rate, heart rate, body posture

INTRODUCTION

In accordance to attain suitable intercultural agriculture implement, it becomes a necessity to know the impact of power weeders on Indian farmers as the productivity per unit area of a land holding depends on proper weeding operations. Weeding is the most drudgery involved agriculture operation and neglecting proper weeding practices can affect the crop yield from 30% to 60%. Power weeders are becoming most popular these days, hence the walking type power weeders of different capacity were tested ergonomically with different parameters such as speed of travel, time of operation, field capacity, weeding efficiency etc. Eggplant is one of the most common annually grown crop. The following weeds are very common in eggplant:

Some of the common grass weeds in Eggplant Fields like Kunjampul -Chloris barbata**,** Arugampul (Hariali grass)- Cynodon dactylon**,** Mathangipul- Dactyloctenium aegyptium**,** Arisipul- Digitaria sanguinalis**,** Ingipul- Panicum repens. Apart from grass weeds Nutgrass (Korai) also called as Cyprus rotundus invade eggplant. Some dicot weeds for instance Kuppaimeni(Acalypha indica), Kuppaikerai (Amaranthus viridis), Aduthinna palai (Aristolochia bracteata) Oomathai (Datura fastuosa) Nai thulasi (Ocimum canum) Congress weed(Parthenium hysterophorus Saranai Trianthema portulocastrum Nerungi Tribulus terrestris Verrukayapoondu Tridax procumbens

As per the studies conducted, every year in India approx 4.2 billion rupees are spend for controlling weeds in production of major crops. According to Singh & Sahay (2001) at least 400 million tones of major food grains are lost every year due to weeds alone. It was reported by Datta (1981) that 11.8 % of total yield of crops get reduced due to weeds. It was noted by Gite(1993) that in case the ergonomic aspects are considered and improved, the performance of machine enhances significantly. Grandjean, (1982) and Gite and Singh, (1997) prescribed during the studies that in the age group of 25 to 35 years, the strength or power is expected to be maximum.

Keeping these things in focus the present work was an approach to study two different types of self propelled power weeders which was adopted in eggplant crop The ergonomic study was done to assess the impact of self propelled power weeders on human body of three different age groups on basis of their gender viz. male and females of different age groups, respectively

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Objective: The present study was an approach to evaluate the ergonomic effect of power weeder of 4HP and 8.38 HP self propelled power weeder in eggplant crop.

In order to improve the design and for commercialization through small-scale manufacturers a wheel hoe weeder should consider ergonomic evaluation. It required 60-110 man-h/ha for weeding in black heavy soil and 25 man-h/ha in light soil was developed by Singh (1992). Kumar et al., (2000) evaluated hand weeder operation on ergonomic basis using simulated actuary motion. Subjects with distinct anthropometric characteristics were evaluated ergonomically on the simulator with loading of 20 to 120 N increased in steps of 20 N. The subjects' responses were also studied while operating the weeders in the field. The results indicated that the push-pull actuation of manual weeders contributed the maximum continuous load application of 60 N with least fatigue. The simulation studies on actuary motion were able to assess the man-machine interaction accurately.

MATERIALS & METHODS

Two wheel walking type single axle power weeder (4HP):

A four hp two wheel walking type single axle power weeder is available in AAI, Allahabad that is commonly manufactured in India and commonly used by Indian farmers. The transmission of power from the engine takes place through the drive wheels and in the rotavator "V" belts, chain and sprocket and gear trains do the same. Because of the two wheels, an operator generally has to walk behind the power weeder to guide the direction of travel for various operations. There are hand clutches to engage or disengage power to the wheels and rotavator unit. The Rota-tilling operation is performed on unplowed field using L-type rotary tines. The rotary tiller consists of 18 tynes in opposite direction alternately. These tynes when rotating enable cutting and mulching the soil.

Two wheel walking type single axle power weeder (8.38HP):-

An 8.83 hp two wheel walking type single axle power weeder is available in AAI, Allahabad that is commonly manufactured in India and commonly used by Indian farmers. The power from the engine is transmitted to the drive wheels and the rotavator through "V" belts, chain and sprocket and gear trains. Because of the two wheels, an operator generally has to walk behind the power weeder to guide the direction of travel for various operations. There are hand clutches to engage or disengage power to the wheels and rotavator unit. For depth control, a gauge wheel is provided at the rear to maintain the operating depth. The Rota-tilling operation is performed on unplowed field using L-type rotary tines. The rotary tiller consists of 24 tynes in opposite direction alternately. These tynes when rotating enable cutting and mulching the soil.

Table: 1.2 SPECIFICATION OF SELF- PROPELLED POWER OPERATED WEEDER

PARAMETERS	Self propelled (4.00 HP)	Self propelled (8.83 HP)
Manufacturer	Trident Dynamics Ltd.	Trident Dynamic Ltd.
Type	Self-propelled	Self - propelled
Engine	High speed diesel oil	High speed diesel oil
Fuel used	Single cylinder ,4-stroke, air cooled ,vertical diesel engine	Single cylinder ,4-stroke, air cooled ,vertical diesel engine
Power requirement	4.00 hp	8.38 hp
Overall dimensions, cm **Length** **Width** **Height**	185.0X59.0 X110.0 185.0 59.0 110.0	240.0X175.0X110.0 240.0 175.0 110.0
Weight ,kg	220 kg	285 kg
Working width ,cm	56.00	56.00
Transmission box	Chain and sprocket	Chain and sprocket
Length of blade,cm	50.80	18
Distance between blades,cm	10	12
Number of blade	18	24
Type of blade	J- type	L-type
Number of operator needed	1	1
Capacity	0.8-1 ha/day	1-1.2 ha/day

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TESTS FOR WEEDERS

(i) General test:

1. Checking of specifications.
2. Checking of materials.

(ii) Field tests

1. Short –run test :
   - i) Effective width of weeding
   - ii) Field efficiency
   - iii) Power requirement
   - iv) Weeding efficiency
2. Long- run test

I. Ergonomic Test:

Equipment and instrument used:

a. Anthropometry
b. Heart rate monitor
c. Flexi curve
d. Sphygmomanometer
e. Thermometer

Method of measuring different variables

a. Measurement of heart rate
b. Measurement of blood pressure
c. Measurement of body temperature
d. Measurement of Postural Configuration

Subject Calibration on Treadmill

In the ergonomics laboratory of the department, the subjects were calibrated. The average room temperature and relative humidity were 22.0˚C and 65 to 70.00 per cent respectively. The calibration curve obtained was used to determine the workload on the subjects during field experiments.

A computerized treadmill was used for calibration and details of it are described. It has four in-built programs. For subjects calibration 'Quick Start' program was used. Initial trials on the treadmill showed that 4 per cent inclination and speed up to 6 km/h was sufficient to get a desired level of heart rate for all subjects. Therefore, 4 percent inclination was kept constant throughout the calibration and workload was varied by changing the speed of treadmill.

Table: 1.3 AVERAGE OF THE BASIC BODY DIMENSION OF WEEDER OPERATORS (N= 4)

S. No.	Particulars	Subject		
		Subject $_1$	Subject $_2$	Subject $_3$
1.	Age (years)	36	23	35
2.	Weight (kg)	80	60	56
3.	Stature (cm)	188	169	175
4.	Eye height (cm)	173	157	174
5.	Shoulder height (cm)	137.2	122	125.5
6.	Elbow height (cm)	108.31	96	105
7.	Hip height (cm)	58.42	57	59
8.	Sitting height (cm)	153	145	147
9.	Sitting eye height (cm)	177	135	136
10.	Sitting shoulder height (cm)	118	117	114
11.	Sitting elbow height (cm)	84	83	78
12.	Knee height (cm)	83	50	53
13.	Popliteal height (cm)	109	93	103
14.	Shoulder breadth (cm)	19.05	13.92	12
15.	Shoulder –elbow length (cm)	53.34	47.72	43
16.	Elbow fingertip length (cm)	48.26	45.72	47
17.	Head length	24.13	20.32	22
18.	Head breadth (cm)	15.24	19.05	17
19.	Hand length	20.32	17.78	20.5
20.	Hand breadth (cm)	17.78	13.97	15

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21.	**Foot length (cm)**	25.4	25.4	20.32
22.	**Foot breadth (cm)**	14.224	11.43	13.97
23.	**Elbow span (cm)**	63.5	45.72	46
24.	**Grip reading (cm)**	10.16	8.89	8

RESULTS & DISCUSSION

Performance evaluation of self propelled power weeder

In village of Kukhudi, block-kundiyara, tehsil- Karchna and district –Allahabad, the self propelled power weeders were tested in field with the test plot size of 10*10 m^2. The average soil moisture content (MCsoil) was 36.16 %, 52.296% and 53.624 % for 21st, 40th and 75th DAS, respectively. During the operation, at different forward speed of operation the weeding efficiency was calculated. The machine was run at four forward speeds of 1.2 km/h, 2.4 km/h, 3.6 km/h, and 4.8 km/h. The weeding was done at four different depths of 35mm, 50mm, 65mm and 80 mm. At the four different speeds and at specified depth, weeding operation through the machine was allowed. Three replications were done to eliminate the errors.

Case 1: 4.00 HP self propelled power weeder

When 4.00 HP self propelled power weeder was operated at the different speed and different depth, On the 21st DAS the weeding efficiency increased from 84.635% to 86.734% at different speed, but it was observed that when the speed of operation was 3.6km/h and the depth of operation was 65mm the weeding efficiency was most that is 86.734 %. It was seen that there was significant increase in the weeding efficiency when the speed was increased. From this observation it was clear about the 4.00 HP self propelled power weeder that if the forward speed ranged between 3.6km/h and 4.8km/hr and the depth was between 65mm to 80mm the weeding efficiency was high in comparison to the low forward speed yet the plant damage was most at this speed. This was mainly because the weeder is easy to operate and move in the field but absence of ground wheel makes it tough to hold for long time.

Case 2: 8.38 HP self propelled power weeder

When 8.38 HP self propelled power weeder was operated at the different speed and different depth, On the 21st DAS the weeding efficiency increased from 84.270% to 86.644% at different speed, but it was observed that when the speed of operation was 2.4km/h and the depth of operation was 50mm the weeding efficiency was most that is 86.644% .It was seen that there was significant increase in the weeding efficiency when the speed was decreased. The plant damage was nil. Although, the 8.38 HP self propelled power weeder was adjustable and easy to operate. As it is well known that plant damage mainly, depend on the skill of operator and the adaptability of the machine to the operator. This machine was found very compatible with the operator during operation. At the 5th day, after weeding was done in the field the plant damage was significantly lowest among all the weeders.

The comparison of ergonomic effect of different types of self propelled power weeders in eggplant on different subjects.

The two types of self propelled power weeders used in the eggplant crop were evaluated with three subjects of different age group. These subjects were allowed to work at different day timings (T_1 = 6:30am to 8:30 am, T_2 = 9:00 am to 11:00 am, T_3= 11:30 am to 1:30 pm and T_4 = 2:00pm to 4:00 pm) at different forward speeds and different depth of operations. The duration of work was kept of 120 minutes. The weeders were evaluated by recording the body temperature, blood pressure, pulse rate, heart rate, and body posture and finally on the basis average heart rate, the energy expenditure of the subject was considered as a criterion. The following was obtained as comparative evaluation of self propelled power weeders on ergonomic basis:

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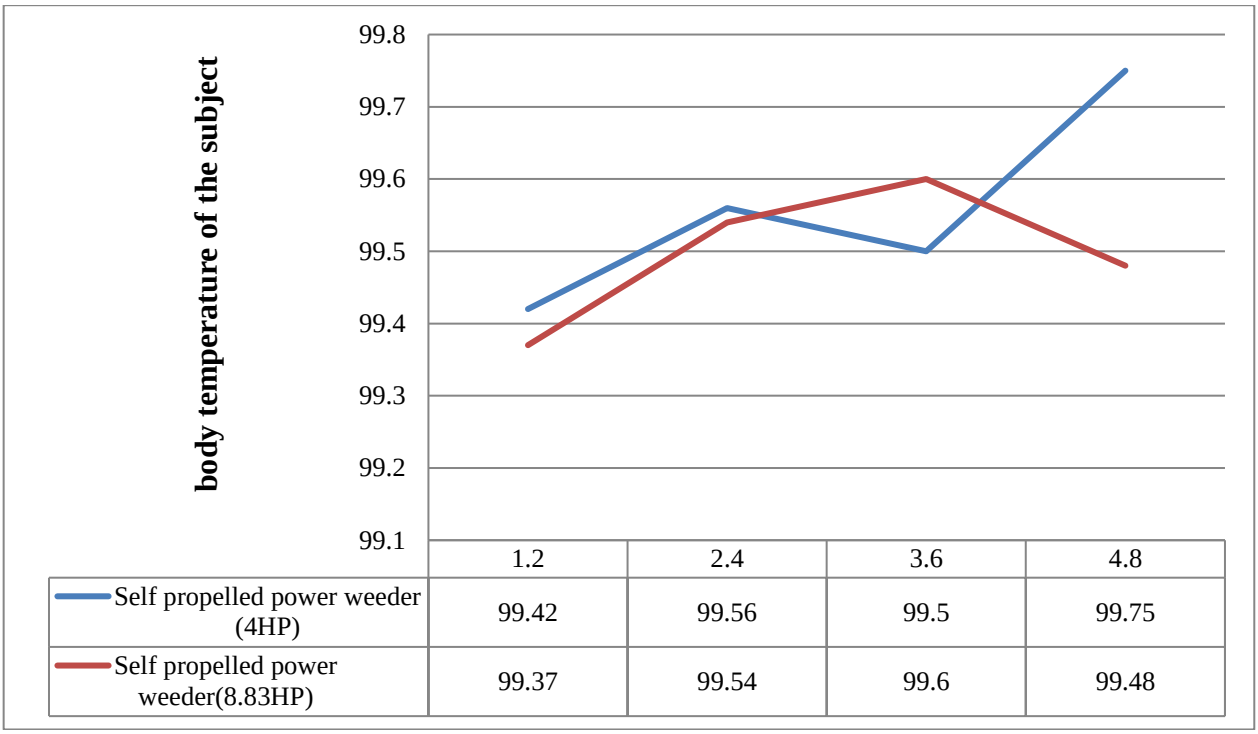
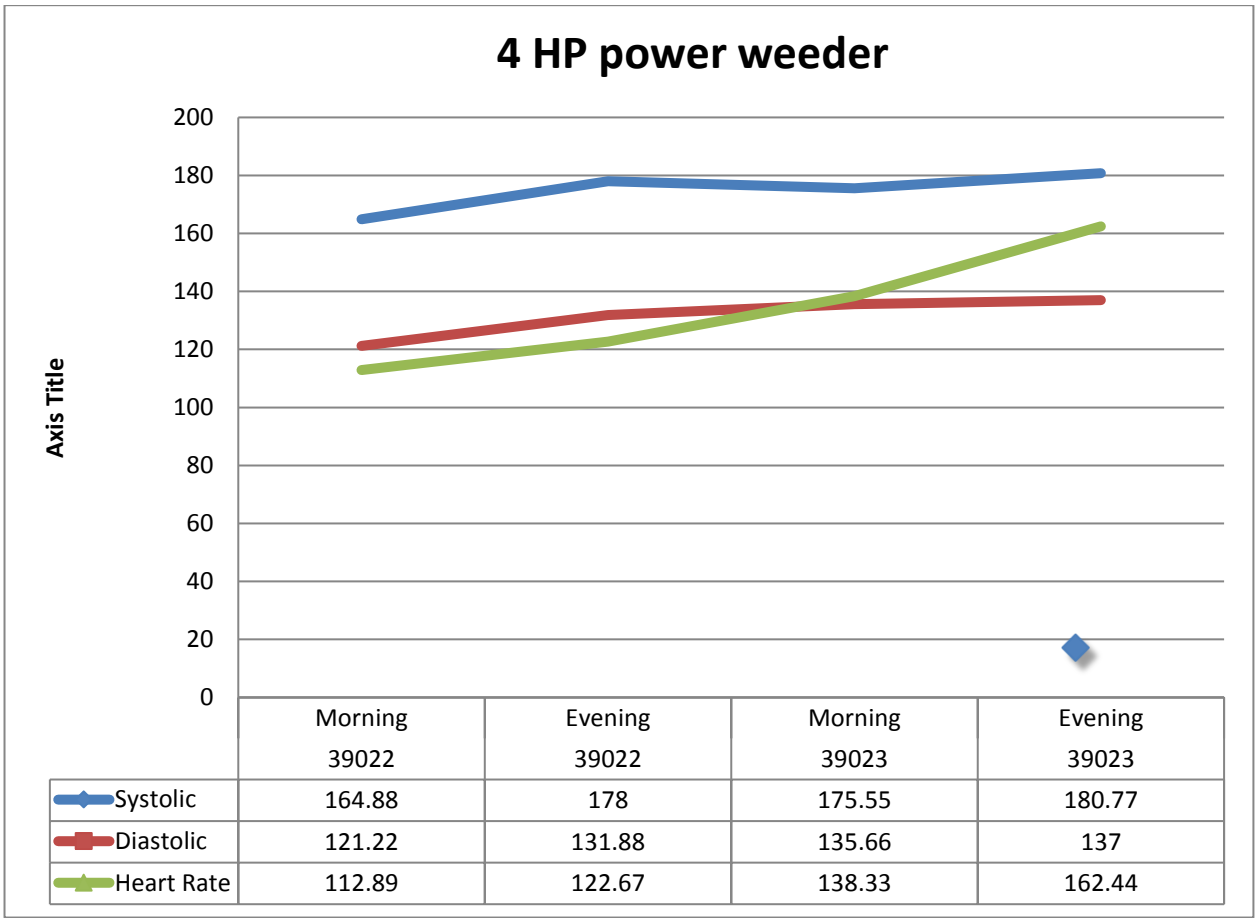


	1.2	2.4	3.6	4.8
Self propelled power weeder (4HP)	99.42	99.56	99.5	99.75
Self propelled power weeder(8.83HP)	99.37	99.54	99.6	99.48

Figure: 1.1 Effect of different forward speed on the body temperature of the subject while operating the weeders with respect to time of work and duration of work .



	Morning 39022	Evening 39022	Morning 39023	Evening 39023
Systolic	164.88	178	175.55	180.77
Diastolic	121.22	131.88	135.66	137
Heart Rate	112.89	122.67	138.33	162.44

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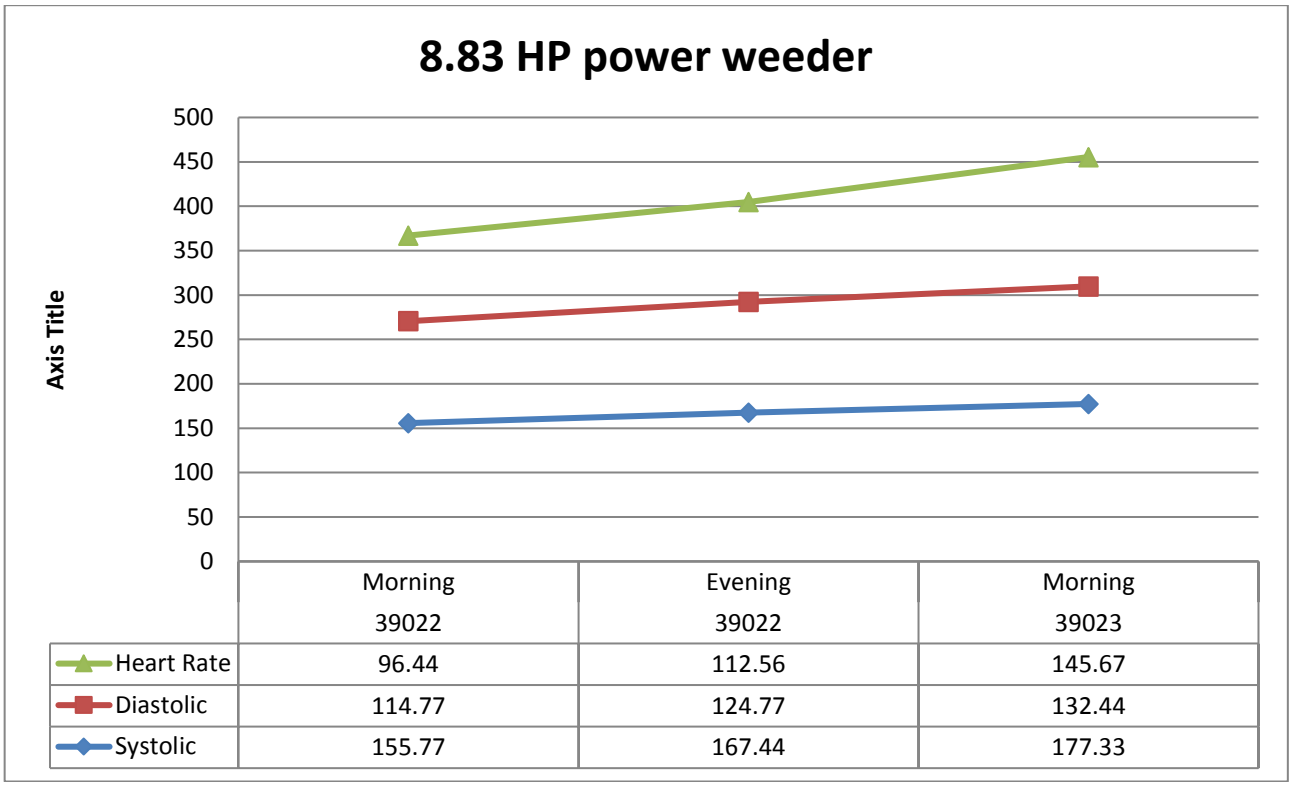
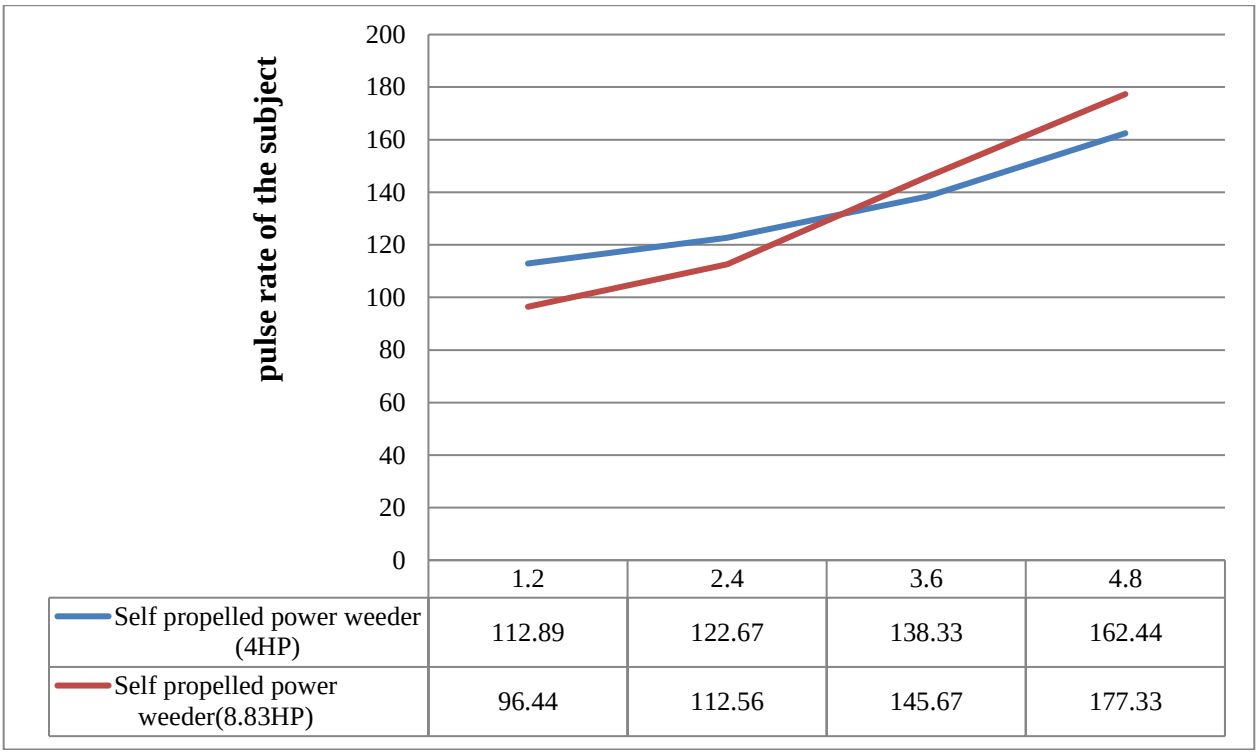


	Morning 39022	Evening 39022	Morning 39023
Heart Rate	96.44	112.56	145.67
Diastolic	114.77	124.77	132.44
Systolic	155.77	167.44	177.33

Figure: 1.2(a) (b) Effect of different forward speed on the blood pressure and heart rate of the subject while operating the weeders with respect to time of work and duration of work.



	1.2	2.4	3.6	4.8
Self propelled power weeder (4HP)	112.89	122.67	138.33	162.44
Self propelled power weeder(8.83HP)	96.44	112.56	145.67	177.33

Figure: 1.3 Effect of different forward speed on the pulse rate of the subject while operating the weeders with respect to time of work and duration of work.

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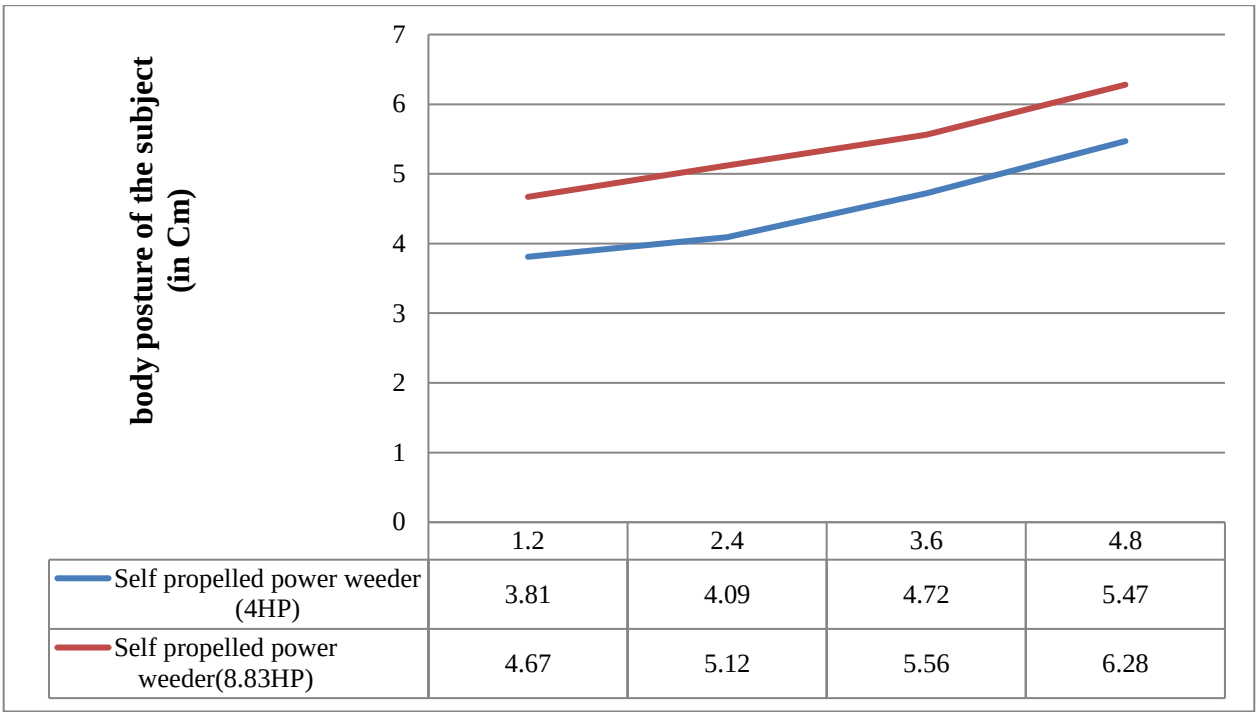
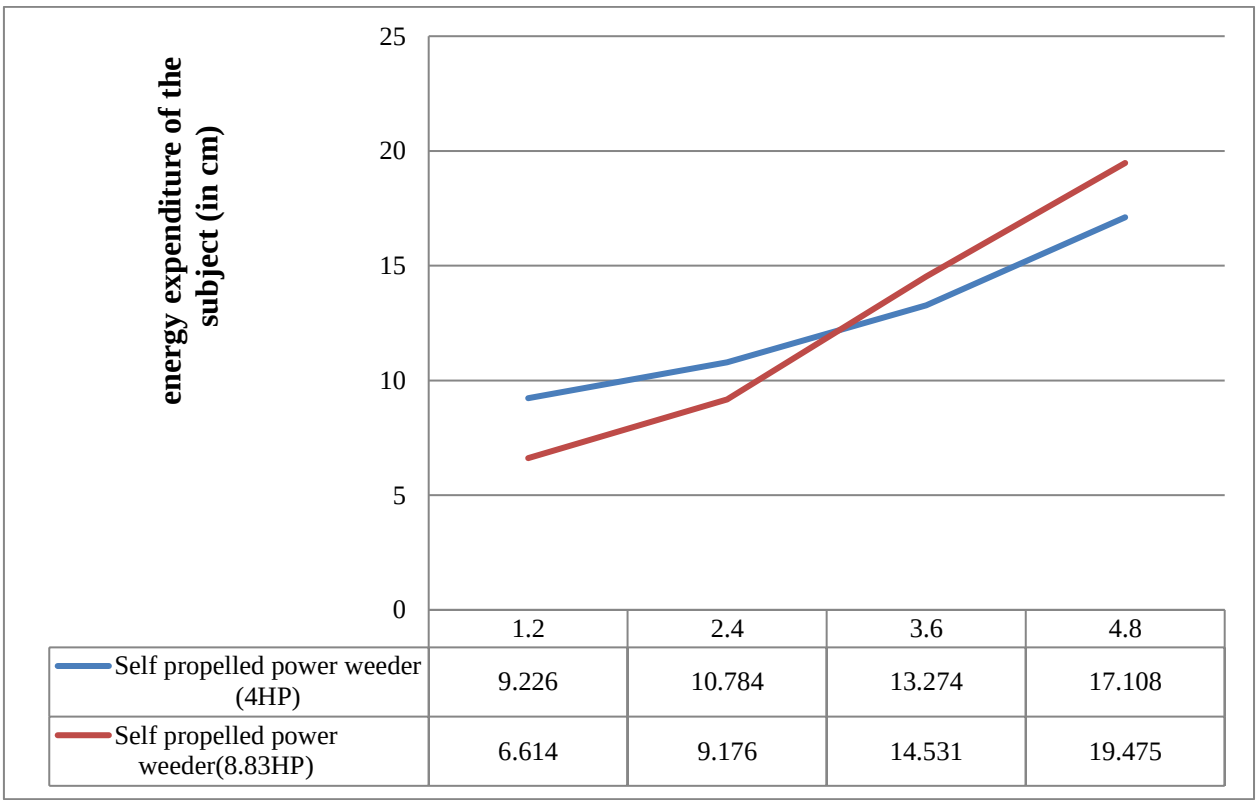


	1.2	2.4	3.6	4.8
Self propelled power weeder (4HP)	3.81	4.09	4.72	5.47
Self propelled power weeder(8.83HP)	4.67	5.12	5.56	6.28

Figure: 1.4 Effect of different forward speed on the body posture of the subject while operating the weeders with respect to time of work and duration of work .



	1.2	2.4	3.6	4.8
Self propelled power weeder (4HP)	9.226	10.784	13.274	17.108
Self propelled power weeder(8.83HP)	6.614	9.176	14.531	19.475

Figure: 1.5 Effect of different forward speed on the energy expenditure of the subject while operating the weeders with respect to time of work and duration of work .

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CONCLUSION

During the ergonomic evaluation, 4 HP self propelled power weeder and 8.38 HP self propelled power weeder it was found that the body temperature of the operator rises in accordance to the rise in forward speed , duration of time , nature of work done and time of work . The highest rise in temperature was observed in the evening during the time period of 1:00 pm and 4:00 pm whereas nominal increase was in the morning time between 7:30 am to 9:30 am. Similar phenomenon was observed in blood pressure, heart rate and pulse rate. The change in the body posture was calculated in the net bending angle that was observed most when the speed of weeding operation was 4.8km/h in 8.38 HP self propelled power weeder which was 6.28˚. It was concluded that rigorous work for a long duration of time depicts a rise in energy expenditure and the energy expenditure also depend on the timing of the work. Energy expenditure was significantly low in the morning timings but at the evening the energy expenditure increased. The forward speed was when increased then also the rise was observed. So, as a conclusion it can be said that energy expenditure of the subject depends on the duration of time, nature of work and the forward speed given to the weeder.

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