

Original Research Article

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Energy Analysis of Berseem (*Trifolium alexandrinum* L.) Crop under Different Weed Management Practices in Chhattisgarh

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ABSTRACT

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Energy utilization pattern is the vital characteristic for successful crop production. In the present paper energy analysis of berseem (*Trifolium alexandrinum* L.) under different weed management practices has been studied at the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur (C.G.). Significantly the highest total dry fodder yield (6.51 and 6.01 t/ha) was registered with the application of oxyfluorfen 0.25 kg/ha as PE over rest of the treatments during the year 2018-19 and 2019-20. It was also found that the PE application of oxyfluorfen 0.25 kg/ha could be a very effective in terms of energy output (mean 112680 MJ) and energy efficiency (8.46 MJ/ha/day) and energy productivity (0.47 kg/MJ) among the different weed management practices.

Introduction

Energy conservation and effective utilization of available resources is of major concern for every economic activity. Energy utilization pattern is a key development indicator in any sector in the current scenario. The worldwide energy crisis caused by fuel shortage and high prices of petroleum has adversely affected the world economy. In order to mitigate the hardship, it is necessary to conserve utilize non renewable energy sources wherever possible, failing which; make efficient use of available conventional energy sources.

In the field of agriculture, energy utilization can be seen in all the farm practices including the use of farm equipment, application of

irrigation and pesticides, transportation and food processing. Obviously, this entails the farmer to increase power availability to increase the productivity in the farm. Power is mainly required for tillage, irrigation, harvesting and threshing etc. Increase in the productivity requires additional mechanical and as well as electrical power. Thus, energy input is one of the key factors for successful crop production. The production of crops with high yield targets can be accomplished with higher energy inputs to the system.

Energy requirements for crop production system have been witnessing a dramatic diversification in agriculture (Dhaliwal and Kler, 1995). Agricultural intensification requires more energy and energy input pattern

for crop production depends on economic, technological and social constraints. Commercial and noncommercial energy are available for agricultural operations. Commercial energy inputs arrive on farm in many different forms, e.g. fuel, irrigation water, chemical fertilizer, machinery and pesticides (Khan and Hussain, 2007). Among field crops, legumes require less energy input than cereals and oilseeds.

Berseem is India's most dominant winter season forage crop with a productivity of 60-110 t/ha grown under 1.9 m ha area (Anonymous, 2012). Although, it is not a crop of Chhattisgarh but is gaining popularity among the farmers because it offers high quality, protein-rich green forage (15-25%), minerals (11-19%) and carotene (Sharma and Murdia, 1974). However, Berseem suffers from strong crop weed competition at initial 30-40 DAS, or at the time up to 1st cutting and resulted in low quality fodder. At later cuttings, the weeds are smothered by heavy branching and faster growth of berseem. Fodder yield and seed yield losses have been estimated to be 23-30% and 50%, respectively due to weeds (Joshi and Bhilare, 2006; Alfred, 2012).

Materials and Methods

The experiment was conducted at the IGKV, Raipur (C.G.) during *rabi* 2018-19 and 2019-20 to analyse the energy requirements and output of berseem (*Trifolium alexandrinum* L.) crop under different weed management practices in Chhattisgarh. The experiment was carried out in randomized block design with six treatments replicated thrice. The treatments involved pendimethalin (PE) 1000 g/ha (T₁), pendimethalin (EPoE) at 10 DAS 1000 g/ha (T₂), oxyfluorfen (PE) 250 g/ha (T₃), imazethapyr (PoE) 40 g/ha, just after 1st cutting (T₄), imazethapyr (PoE) 40 g/ha just after last cutting (T₅) and imazethapyr (PoE) g/ha, just after 1st and last cutting (T₆). In case

of dry forage yield, highest and lowest value was obtained under the PE application of oxyfluorfen 250 g/ha (T₃) and imazethapyr (PoE) 40 g/ha, just after last cutting (T₅), respectively.

Energy values for various input and outputs used in the experimentation are given in Table 1 (Singh and Mittal, 1992). The total energy input for a given crop was calculated by adding the energy requirement for human labour, diesel, herbicides, seed and fertilizers used, in that sequence.

The output: input ratio was worked out by dividing the total energy generated from main product and by-product by the total energy used for raising the crop in an unit area. The energy input and output were computed as Mega Joule (MJ) by using different formulae. The energy efficiency (EE) was worked out as per Dazhong and Pimental (1984).

$$EE = \frac{\text{Energy output (MJ/ha)}}{\text{Energy input (MJ/ha)}}$$

Energy output efficiency (MJ/ha/day) and energy productivity were calculated by:

$$\text{Energy output efficiency} = \frac{\text{Energy output (MJ/ha)}}{\text{Duration of the system (days)}}$$

$$\text{Energy productivity} = \frac{\text{Yield (kg/ha)}}{\text{Energy input (MJ/ha)}}$$

Results and Discussion

Energy input in Berseem production

Energy inputs for berseem as required in different weed management practices under the study was ranged between 13416.47 to 13692.95 MJ/ha. Irrigation accounted for a major share of energy input (45.9 to 46.9%), followed by field preparation (16.1-16.4%), seed sowing (15.0–15.3%), fertilizer (14.0-

14.3%) and harvesting (6.5–6.7%). The energy input through herbicides (0.38–2.4%) was minimum. The highest energy input was recorded in both the treatment of pendimethalin 1000 g/ha PE and EPoE (T₁

and T₂). The lowest energy input was required for the treatment of both imazethapyr 40 g/ha just after 1st cutting (T₄) and just after last cutting (T₅).

Table.1 Equivalents for various sources of energy

Particulars Inputs (MJ)	Units	Equivalent energy MJ
Human labour	Man-hour	1.96 Mittal <i>et al</i> , 1985
Diesel (3.5 lit/hours)	Litre	56.31 Mittal <i>et al</i> , 1985
Cultivator	hr ⁻¹	220.00 Mittal <i>et al</i> , 1985
Seeder	ha ⁻¹	338.83
Berseem (legume)	kg	14.7 Mittal <i>et al</i> , 1985
Chemical fertilizer		
N	Kg	60.60 Mittal <i>et al</i> , 1985
P₂O₅	Kg	11.10 Mittal <i>et al</i> , 1985
K₂O	Kg	6.70 Mittal <i>et al</i> , 1985
Irrigation Each 7.5 cm Irrigation requires 10 hr/ha and Irrigation pump is of 15 hp		
(i) Man	Man-hour	1.96
(ii) Electricity	KWh	11.93/hours
(iii) Submersible pump	HP	68.4/hp
Herbicide	kg a.i	288

Table.2 Calculation of input energy for berseem crop under different weed management practices in Chhattisgarh

Particulars	Unit required	Total energy MJ
Field preparation tractor	per ha	
2 Ploughing + 1 planking	5 hours	1100.00
Diesel consumption	3.5 lit/ha	985.25
Driver	5 hours	98.00
	Sub total	2177.25
Seed and sowing		
Berseem (legume)	25 kg	367.50
Seed drill	3 hours	1016.49
Diesel consumption	3.5 lit/ha	591.15
Driver	3 hours	8.55
	Sub total	2032.2
Fertilizer		
Nitrogen 20 kg/ha	60.60/kg	1212
P₂O₅ 50 kg/ha	11.10	555
K₂O 20 kg/ha	6.7	134
	Sub total	1901.00
Irrigation		
Labour	2 per irrigation	98.00
Electricity	11.93/hours	119.30

Submer sible pump (15hp)	68.4/hp (10 hours/irrigation)	1026.00
	Sub total	1243.3
(Total 5 irrigation)		6216.5
Forage cutting		
Cutting (total 3 cuts)	15 labours per cut	882.00
	Sub total	882.00
	Grand total	13208.95
Treatment Herbicide application	2 Labours per application	39.20
1. Pendimethalin PE	1 kg/ha	327.20
2. Pendimethalin (EPoE)	1 kg/ha	327.20
3. Oxyfluorfen PE	0.25 kg/ha	111.20
4. Imazethapyr (just after 1 st cut)	0.04 kg/ha	50.72
5. Imazethapyr (just after last cut)	0.04 kg/ha	50.72
6. Imazethapyr (just after 1 st cut and last cut)	0.04 kg/ha	101.44

Table.3 Energy input requirement for energy output and dry forage yield production of berseem crop under different weed management practices in Chhattisgarh

Treatment	Total dry forage yield, t/ha		Energy, MJ/ha			
	2018-19	2019-20	Input		Output	
			Treatment	Total	2018-19	2019-20
Pendimethalin 1 kg/ha (PE)	6.1	5.67	327	135361	109800	102060
Pendimethalin 1 kg/ha (EPoE) at (10 DAS)	6.03	5.44	327	135361	108540	97920
Oxyfluorfen 0.25 kg/ha (PE)	6.51	6.01	111	133201	117180	108180
Imazethapyr at 0.04 kg/ha after 1st cutting	5.25	4.52	51	13260	94500	81360
Imazethapyr at 0.04 kg/ha after last cut	3.58	4.43	51	13260	64440	79740
Imazethapyr at 0.04 kg/ha after 1st cutting fb Imazethapyr at 0.04 kg/ha after last cut	5.46	5.16	1011	13310	98280	92880

Table.4 Energy efficiency, energy output efficiency and energy productivity by berseem crop under different weed management practices in Chhattisgarh

Treatment	Energy efficiency MJ/ha/day		Energy output efficiency MJ/ha/day		Energy productivity kg/MJ	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Pendimethalin 1 kg/ha (PE)	8.11	7.54	954.78	887.48	0.45	0.42
Pendimethalin 1 kg/ha (EPoE) at (10 DAS)	8.02	7.23	943.83	851.48	0.45	0.40
Oxyfluorfen 0.25 kg/ha (PE)	8.80	8.12	1018.96	940.70	0.49	0.45
Imazethapyr at 0.04 kg/ha after 1st cutting	7.13	6.14	821.74	707.48	0.40	0.34
Imazethapyr at 0.04 kg/ha after last cut	4.86	6.01	560.35	693.39	0.27	0.33
Imazethapyr at 0.04 kg/ha after 1st cutting fb Imazethapyr at 0.04 kg/ha after last cut	7.38	6.98	854.61	807.65	0.41	0.39

Productivity of berseem crop under different weed management practices

In case of dry forage yield, highest (mean 6.26 t/ha) and lowest (mean 4.01 t/ha) value was obtained under the PE application of oxyfluorfen 250 g/ha and imazethapyr (PoE) 40 g/ha just after last cutting (T₅), respectively during both the year. This is due to pre emergence application of herbicides providing weed free condition offered a favorable environment to crops from weeds for light nutrients and moisture. Which results in increased crop growth and thus increase in green forage yield hence, increased dry forage yield.

Energy output of berseem crop under different weed management practices

Total energy output was computed from forage dry yield of different weed management practices and it ranged from 64440 to 117180 MJ/ha as per two years production (Table 2). The mean of 2 years revealed that the highest total energy output was obtained from application of oxyfluorfen (PE) 250 g/ha followed by the application of pendimethalin (PE) 1000 g/ha. The lowest energy output was obtained from imazethapyr (PoE) 40 g/ha, just after last cutting.

Energy-output efficiency and energy productivity

It was observed that PE application of oxyfluorfen 250 g/ha resulted in the highest energy output efficiency (1019 & 941 MJ/ha/day), for both the year. However, imazethapyr (PoE) 40 g/ha, just after last cutting, was less efficient in energy output efficiency (560 & 693 MJ/ha/day), as compared to other weed management practices. Maximum energy productivity was obtained in oxyfluorfen 250 g/ha might be due to its higher total dry forage yield (6.51 and 6.01 t/ha).

Based on this study, it can be concluded that the oxyfluorfen 250 g/ha (T₃) which may be competent to produce more forage yield, profit per unit cost of cultivation and energy productivity under different weed management practices in Chhattisgarh.

Based on the experiments conducted as detailed above, it is observed that PE application of oxyfluorfen 250 g/ha produced the highest energy output efficiency (1019 & 941 MJ/ha/day), for both the year. However, application of imazethapyr (PoE) 40 g/ha, just after last cutting was found to be less efficient in energy output efficiency (560 & 693 MJ/ha/day) as compared to other weed management practices. It was further noticed that the maximum energy productivity obtained for oxyfluorfen 250 g/ha might be due to its higher total dry forage yield (6.51 and 6.01 t/ha). On the basis of this study, it is concluded that the oxyfluorfen 250 g/ha may be a competent weed control option to produce more forage yield and energy productivity under different weed management practices in Chhattisgarh.

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