Short communication

Energy evaluations of several weed control techniques that undermine Cotton (*Gossypium hirsutum* L.) planted in high density

ABSTRACT

The current study was carried out at the Dr. PanjabraoDeshmukh Krishi Vidyapeeth. Akola, Cotton Research Center in Maharashtra, India, for the kharif season to assess the effectiveness of various weed management strategies in high density planting system (HDPS) cotton and also to assess the energy studies of different weed control methods used with HDPS cottonfor two consecutive years (2015–16 and 2016–17). The results showed that among the other treatments, application of Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha fbhoeing at 30 DAS and one hand weeding at 45 DAS significantly improved the energy output (84627 and 123742Mj ha^{-1}), energy balance (73492 and 120656Mj ha^{-1}), energy balance per unit input(6.6 and 10.8Mj ha^{-1}) and energy output per unit input ratio(7.60 and 11. With weedy check (control), however, lower values were seen. As a result, cotton production with various weed control techniques under high density planting technique significantly improved energy output, energy balance per unit input, and energy output per unit input ratio realized that, efficient enough in terms of energy consumption as appropriate energy management (avoid excess energy input consumption) favors to maximize energy output, energy balance with higher cotton production in rainfed areas under high density planting system.

INTRODUCTION

India's cotton industry, which is possibly the largest component of organized industries in the nation, depends on cotton as a major commercial crop. a high density planting strategy (HDP) that promotes quicker canopy closure and less soil water evaporation. One solution under rainfed to stop the current trend of stagnant Bt output is to adopt high density planting (accommodating more plants per unit area), together with improved genotype with good fertilizer, early weed and insect management.Cotton around 550 lint kg ha^{-1} in India and 325 kg ha^{-1} in Vidarbha region of Maharashtra. weed are a major deterrent in increasing the cotton yield as seedling are comparatively small and grow slowly for the first 20-30 days and consequently do not compete well with most weeds in the early stage of crop growth resulting in yield loss of 50-85 %, depending upon the nature and intensity of weeds (Venugopalan et al. 2009).

The energy picture of agricultural production was altered with the introduction of modern inputs. In India, agriculture not only feeds everyone but also employs 70% of the population, contributes 40% of the country's GDP, and uses 10% of the commercial energy source. In addition to being extended in agricultural operations, energy is a crucial component of national development processes. At various phases, crop cultivation needs the application of both live and inanimate kinds of energy. Direct and indirect energy requirements for farms can be distinguished. Indirect energy included energy contained in seed, chemical fertilizer, herbicides, pesticides, fungicides, farm yard manure, and machinery. This category could also be divided into renewable and non-renewable energy. Direct energy included human labor, diesel electricity, and water for irrigation. Human labor, irrigation water, seeds, and non-chemical fertilizers are examples of renewable energy, while fossil fuels, pesticides, herbicides, chemical fertilizers, and machinery are examples of non-renewable energy (Mohammadi et al. 2008).Utilizing this energy effectively enables crop production systems to boost yield, productivity, and profitability. This study's objective is to quantify the total amount of input-output energy consumed by HDPS cotton when it is subjected to various weed management techniques.

MATERIALS AND METHODS

A field experiment was conducted over two consecutive years (2015-16 and 2016-17) at cotton research unit, Dr. P.D.K.V. Akola (Maharashtra), located at between 220 42’ N latitude and 770 ^{o}2’ E longitude with an altitude of 307.41 m above mean sea level.The total amount of rain that fell throughout the investigation was 560 mm (in 2015–16) and 647 mm (in 2016–17), while the mean maximum and lowest temperatures were 33.70 C and 13.00 C, respectively. The soil at the experimental site had a clayey texture, a pH of 8.0, was somewhat alkaline, had low levels of available potassium (328 kg ha^{-1}), available phosphorus (17.0 kg ha^{-1}), and available nitrogen (204 kg ha^{-1}). Using a broad bed and furrow technique and RDF 60:30:30 NPK kg ha^{-1}, cotton seed variety 'AKH081' was sown at a spacing of 60 x 10 cm (1, 66,666 plants/ha). Flubendamide 480 SC @ 40 ml/acre and Spinosad 50 ml/acre were employed to suppress the bollworm complex.Cotton planted in wide bed furrows helped conserve moisture.

Three randomized block designs were used to test the therapy with various weed management techniques. The medication used included Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha fbhoeing at 30 DAS and one hand weeding at 45 DAS, Quizalofop ethyl 5 EC @ 0.075 kg a.i./ ha POE 20-25 DAS (2-4 leaf weed stage) fbhoeing at 45 DAS, Pyrithiobac sodium 10 EC @ 0.075 kgPyrithiobac sodium 10 ECPOE @ 0.062 kg a.i./ha POE (tank mix) (2-4 leaf weed stage), Quizalofop ethyl 5 EC@ 0.060kg a.i./ha, Weed free check (2 Weeding & 2 Hoeing), weedy check as control, hoeing at 20-25 DAS fbGlyphosate 71G @ 1.50 kg a.i./ha as directed spray at 45 DAS, hoeing at 20-25 DAS fbGlyphosate 71G @ 0.5 kg a.i./ha as directed spray at 45 DAS. Pendimethalin was administered as pre-emergence in accordance with the treatment regimen. The herbicides were sprayed using a hand-operated knapsack sprayer equipped with a flat fan type nozzle, adopting a spray volume of 700 and 500 litter’s ha^{-1} for pre-emergence and post-emergence, respectively.

The system's energy input, output, energy balance per unit of input, and energy input output ratio (Mj ha^{-1}) were calculated. According to Devasenapathy et al. (2009), the energy input was calculated using the item-wise energy values for each treatment and expressed as Mj ha^{-1}. By multiplying yields (Biological yield) by their respective energy values, the energy output from seed cotton yield and stalk cotton yield of cotton crop was calculated and expressed as Mj ha^{-1}. The energy balance was calculated as Mj ha^{-1} by subtracting the energy input from the energy output for each treatment. The energy balance per input unit (Mj ha^{-1}) was determined as follows:

Energy balance/unit input= Energy balance /Energy input. The energy output per unit input ratio(Mj ha^{-1}) was estimated by dividing energy output values with input values.

RESULTS AND DISCUSSION

As a result of various weed control techniques, data on energy output, energy input, and energy balance are shown in table 1 of the document.

First and second years' average energy outputs were 41114 and 67257 MJ ha-1, respectively. The various weed management techniques had a big impact on cotton's ability to produce energy. When compared to the other treatments for both years, the weed-free plot (T7) produced much more energy. The application of pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha fb hoeing at 30 DAS and one hand weeding at 45 DAS (T1) and hoeing at 15-20 DAS fbglyphosate 71 G @ 1.50 kg a.i./ha as directed spray at 45 DAS (T10), however, was shown to be equivalent in achieving a weed-free plot.

The application of Pendimethalin 38.7 CS PE at 1.25 kg a.i./ha in a fbtank mix of POE Quizalofop ethyl 10 EC@ 0.060 kg a.i./ha + Pyrithiobac sodium 10 EC POE at 0.062 kg a.i./ha (T6) was shown to have the maximum energy input (11212 MJ ha^{-1}). In 2015–16 and 2016–17, the average energy balance was 49616 MJ ha^{-1} and 89968 MJ ha^{-1}, respectively. In comparison to other treatments, the weed-free check recorded a much greater energy balance, and it was on par with pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha fb hoeing at 30 DAS and one Hand Weeding at 45 DAS throughout the course of both years. The application of fbglyphosate 71 G @ 1.50 kg a.i./ha as directed spray at 35–40 DAS for both years was the second-best treatment.

Energy output per unit input ratio was 8.14 and 8.83 MJ ha^{-1}, respectively, whereas the mean energy balance per unit input recorded for the first and second years was 4.49 and 5.49 MJ ha^{-1}.

Due to diverse weed management techniques used in HDPS cotton over both seasons, energy balance per unit input of cotton showed notable variances. The application of Weed

Free Check considerably increased the energy balance per unit input in cotton when compared to the other treatments and Weedy Check, and it was on par with pendimethalin 38.7 CS @ 1.25 kg a.i./ ha fb hoeing at 30 DAS and one hand hoeing. It was equivalent to weeding at 45 DAS and hoeing at 15-20 DAS to apply fbglyphosate 71 G @ 1.50 kg a.i./ha as directed spray at 45 DAS. The energy production per unit input ratio of cotton showed a similar pattern over the course of the two study years. Under weedy check (T8) treatment, cotton had the lowest energy output, energy intake, and energy balance for both years.

Energy studies showed that applying two hand weeding and two hoeing, followed by applying pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha fb hoeing at 30 DAS and one hand weeding at 45 DAS, all increased cotton's energy output, balance, balance per unit input, and output per unit input ratio. This might be caused by a rise in total biological yield, which is directly correlated with energy output. These results are consistent with those of (Erdale et al., 2007), who found that the efficient use of agricultural technology and the utilization of support input can minimize environmental issues and, as a result, encourage sustainable agricultural intensification.

CONCLUSION

The outcome showed that adequate energy management, which avoids excessive energy input consumption in favor of maximizing energy output, favors energy balance with higher cotton production in rainfed areas with high density planting systems under various weed control techniques.

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Table1: Energy output (MJ ha^{-1}), Energy input (MJ ha^{-1}), Energy balance (MJ ha^{-1}), Energy balance per unit input (MJ ha^{-1}) and Energy output per unit input ratio in HDPS cotton as influenced by different treatments during 2015-16 and 2016-17

Treatments		**Energy analysis of HDPS Cotton**									
		2015-16					**2016-17**				
		Energy output	Energy input	Energy balance	Energy balance per unit input	Energy output per unit input ratio	Energy output	Energy input	Energy balance	Energy balance per unit input	Energy output per unit input ratio
T_1	Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha *fb* hoeing at 30 DAS and one Hand Weeding at 45 DAS.	80816	11174	69643	6.2	7.23	120221	11174	115993	10.4	10.76
T_2	Quizalofop ethyl 10 EC@ 0.075kg a.i. /ha POE (2-4 leaf weed stage) *fb*hoeing at 45 DAS	64612	11079	53533	4.8	5.83	95123	11079	84786	7.7	8.59
T_3	Pyrithiobacsodium 10 EC @ 0.075 kg a.i./ ha POE(2-4 leaf weed stage) *fb*hoeing at 45 DAS	57444	11079	46364	4.2	5.18	97461	11079	87263	7.9	8.80
T_4	Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ha *fb*Quizalofop-ethyl 10 EC@ 0.075 kg a.i./ha POE (2-4 leaf weed stage)	47818	11079	36739	3.3	4.32	94243	11079	84482	7.6	8.51
T_5	Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha *fb*Pyrithiobacsodium 10 EC @ 0.075 kg a.i./ ha POE (2-4 leaf weed stage).	51936	11212	40724	3.6	4.63	100022	11212	91851	8.2	8.92
T_6	Pendimethalin 38.7 CS PE @ 1.25 kg a.i./ ha *fb*Quizalofop ethyl 10 EC@ 0.060 kg a.i. /ha + Pyrithiobacsodium 10 EC POE @ 0.062 kg a.i./ ha POE (tank mix) (2-4 leaf weed stage).	55609	11212	44397	4.0	4.96	103745	11212	96999	8.7	9.25
T_7	Weed free check (2 Weeding *fb*2 Hoeing)	84627	11135	73492	6.6	7.60	123742	11135	120656	10.8	11.11
T_8	Weedy check	13003	10478	2103	0.2	1.19	34977	10478	24499	2.8	3.21
T_9	*In- situ* mulching of Greengram in cotton.	72900	10900	62000	6.0	6.96	99388	10900	88488	8.5	9.49
T_{10}	Hoeing at 15-20 DAS *fb*Glyphosate 71 G @ 1.50 kg a.i./ha as directed spray at 35-40 DAS	77900	11079	66820	6.0	7.03	106956	11079	97415	8.8	9.65
SE (m)±		2934	--	3616	0.33	0.38	4664	--	6279	0.56	0.61
CD (P= 0.05)		8717	--	10743	0.97	1.16	13857	--	18655	1.68	1.81
GM		41114	11054	49616	4.49	5.49	67257	11054	89968	8.14	8.83

Where, SE= Standard error, CD= Critical difference, GM= General mean