Int.J.Curr.Microbiol.App.Sci (2017) *6*(12): 3665-3669

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 12 (2017) pp. 3665-3669**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.612.423

Energetic and Economics of Different Tillage Methods and Conservation Farming in Finger Millet

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Keywords

Tillage, Energetic, Economics, Conservation farming, Finger millet.

Article Info

Accepted:
28 October 2017
Available Online:
10 December 2017

A B S T R A C T

Investigation was conducted during *kharif* season of 2016 at Instructional cum Research Farm, S.G. College of Agriculture and research station, Jagdalpur (C.G.). The soil of experimental field was sandy clay loam in texture and available N was low and, P and K were medium. The experiment was laid out in split plot design with two factors namely tillage practices and different conservation farming with three replications. The treatment consisted of three tillage practices *viz.* T_1- Conventional tillage, T_2 - Minimum tillage and T_3 - Summer ploughing and five conservation farming *viz.* C_1-Opening conservation, C_2-Intercropping with redgram, C_3- Mulching, C_4- Herbicide application, C_5- Combination of all treatments (C_1+C_2+C_3+C_4). Two crops were taken as a taste crop *viz.* finger millet *cv* "GPU 28" and redgram *cv* "Rajeevlochan". The result revealed that tillage methods produce summer plouging recorded significantly highest gross income, net return, B: C ratio, energy output, energy use efficiency and energy productivity during experimentation. In case of conservation farming, combination of all treatments recorded significantly higher gross income and herbicide application recorded significantly higher net return and B: C ratio among all conservation farming. Energy use efficiency, energy output input ratio, energy intensiveness and energy production were recorded significantly higher in treatment herbicide application and mulching.

Introduction

Finger millet (*Eleusine coracana* (L.) Gaertn) is a major food crop of the semi-arid tropics of Asia and Africa and has been an indispensable component of dryland farming systems (Kerr, 2014). Dida *et al.,* (2008) reported that the crop was domesticated in the highlands of Ethiopia and Uganda 5000 years ago, but reached India 3000 years ago. Today, the crop is ranked fourth globally in importance among the millets, after sorghum, pearl millet, and foxtail millet (Gupta *et al.,* 2012). In India, finger millet is primarily grown in the states of Karnataka, Andhra Pradesh, Odisha, and Tamil Nadu (Dass *et al.,* 2013). Millets are important food for sustaining tribal population in Bastar region of Chhattisgarh. The important small cereals among tribes of Bastar region after rice, kodo millet (*Paspalum scrobiculatum* L.) and finger millet [*Eleusine coracana* (L.) Gaertn.] (Verma and Mishra, 2010). The role of tillage in conserving soil moisture and its subsequent beneficial effect on crop productivity has long been recognized Adequate tillage operations controlled weeds and resulted in higher crop productivity, but caused more soil loss and were more capital intensive (Dogra *et al.*, 2002). The use of conservation tillage can play an important role in reducing soil erosion and improving soil quality (Uri *et al.*, 1999) and can be an attractive to conventional tillage for farmers because of its potential to minimum labour and fuel consumption and to lower total production cost (Uri, 2000).

Materials and Methods

Location of the experiment

The field experiment was carried out during *kharif* session of 2016 at Instructional cum Research Farm, S.G. College of Agriculture and research station, Jagdalpur (C.G.). Bastar (Chhattisgarh) is situated in between 19^0 05'36.55" North latitude and $81^0$57'34.69" East longitude with altitude ranging from 550-760m above mean sea level. The experiment in *Kharif* season was framed in split plot design with three replications. The main plot treatment consisted of three tillage practices *viz.* conventional tillage (T_1), Minimum tillage (T_2) and Summer ploughing (T_3) and five Conservation farming *viz.* opening conservation furrow (C_1), Intercropping of finger millet + Red gram (C_2), Mulching with crop residues (C_3), Weedicide application (Pre emergence): Isoproturon @ 0.5 kg *a.i.* ha^{-1} (C_4) and $C_1+C_2+C_3+C_4$ (C_5). Net returns were obtained by deducting cost of cultivation from gross returns. The benefit: cost ratio of each treatment was calculated by dividing net returns by cost of cultivation of respective treatments. Energy inputs were calculated and estimated in Mega Joule (MJ) ha^{-1} with reference to the standard values prescribed by Mittal *et al.*, (1985). These inputs were taken to each treatment of crops. Energy values, which were taken for energy estimation. The standard energy coefficient for seed and straw of crops was multiplied with their respective yields and summed up to obtain the total energy output. The energy input for crops was calculated by adding the respective values of input under these crops. An energy study was done by following formula:

Energy output (10^{-3} x MJ ha^{-1}) = Total biological yield (Seed + straw) x Equivalent energy MJ kg^{-1}

$$\text{Energy use efficiency (kg MJ-1)} = \frac{\text{Total produce (kg)}}{\text{Energy input (MJ x 10-3)}}$$

$$\text{Energy output input ratio} = \frac{\text{Energy output (MJ ha-1)}}{\text{Energy input (MJ ha-1)}}$$

$$\text{Energy output input ratio} = \frac{\text{Output grain + Byproduct (Kg ha-1)}}{\text{Energy input (MJ ha-1)}}$$

Results and Discussion

Economics

Gross income (Rs ha^{-1}), Net return (Rs ha^{-1}) and B: C ratio

The response of various treatments under finger millet on economics parameter *i.e.* gross income, net return and benefit cost ratio are presented in Table 1. The data shows that tillage and conservation farming were recorded significantly effect. Treatment T_3 (Summer plouging) recorded significantly higher net return and B: C ratio which was on par with treatment T_2 (Minimum tillage). Whereas, in case of conservation farming, treatment C_5 ($C_1+C_2+C_3+C_4$) recorded significantly higher gross income and treatment C_4 (Herbicide application) recorded significantly higher Net return and B: C ratio among all the treatment, but it was at par with C_5 ($C_1+C_2+C_3+C_4$) and C_4 (Herbicide application) in net return. Bali *et al.*, (2006) observed that the application of herbicides proved most profitable with net returns and benefit: cost ratio. Redgram yield was recorded numerically higher in treatment T3 (Summer ploughing) in different methods, whereas, in case of conservation farming system, treatment T5 ($C_1+C_2+C_3+C_4$) recorded significantly higher redgram yield among all the treatments. System productivity recorded significant higher in treatment T_3 (Summer ploughing) followed by treatment T2 (Minimum tillage) and in conservation farming system, treatment T_5 ($C_1+C_2+C_3+C_4$) recorded significantly highest system productivity during the experimentation.

Energetics

Energy output, energy use efficiency, energy output input ratio, energy intensiveness and energy productivity have calculated and presented in Table 2. Energy output, energy use efficiency, energy productivity recorded significantly highest in treatment T_3 (Summer ploging) but energy output, treatment T_2 was at par with T_3. In conservation farming, energy output recorded significantly highest in treatment C_5 among all the treatments.

Energy use efficiency, energy output input ratio, energy intensiveness and energy production were recorded significantly higher in treatment C_4 and C_3 and it was at par with C_5 in energy intensiveness. Borin *et al.*, (1997) noted that the energy use efficiency value increased as the number of soil tillage reduced. In order to compare the tillage methods, the fuel consumption per area was used as a measure for calculating the effectiveness of each method (Yalcin and Cakir, 2006).

Table.1 Economics, Redgram yield and system productivity of finger millet as influenced by different tillage and conservation farming

Treatment	Gross income (Rs ha^{-1})	Net Income (Rs ha^{-1})	B:C Ratio	Redgram yield (q ha^{-1})	System productivity (q ha^{-1})
		Tillage Methods			
T1	56655	35950	1.76	1.43	25.54
T2	47087	39634	2.11	1.62	27.70
T3	61927	42386	2.19	2.18	29.06
SEm±	782	783	0.04	-	0.47
CD at 0.05	3154	3155	0.16	-	1.90
		Conservation farming			
C1	54292	33414	1.60	-	22.91
C2	49555	32318	1.88	4.33	26.91
C3	59757	41000	2.19	-	25.39
C4	62994	45187	2.55	-	27.56
C5	68831	44697	1.86	4.37	34.40
SEm±	1444	1445	0.07	-	0.72
CD at 0.05	4241	4241	0.22	-	2.12

T1: Conventional tillage, T2: Minimum tillage, T3: Summer ploughing, C1: Open conservation, C2: Intercropping (finger millet + redgram), C3: Mulching, C4: Herbicide application, C5: C1+C2+C3+C4

Table.2 Energy variables as influenced by different tillage and conservation farming

Treatment	Energy output (MJ ha^{-1})	Energy use efficiency (qMJ^{-1}x 10^{-3})	Energy output input ratio	Energy productivity (g MJ ha^{-1})	Energy intensiveness (MJ Re^{-1})
			Tillage Methods		
T1	35436	64.50	2.38	161.84	6.09
T2	38345	80.01	3.40	231.06	6.29
T3	39523	99.23	3.89	264.35	6.80
SEm±	653	1.29	0.04	3.26	0.11
CD at 5%	2632	5.21	0.24	13.14	0.42
			Conservation farming		
C1	50520	87.23	4.73	322.02	8.77
C2	49780	68.18	4.71	320.42	8.33
C3	55979	74.83	4.12	280.23	10.63
C4	60769	96.67	5.83	396.48	11.18
C5	66213	79.32	4.76	323.98	9.06
SEm±	1094	2.66	0.10	6.08	0.20
CD at 5%	3211	7.80	0.31	17.84	0.59

T1: Conventional tillage, T2: Minimum tillage, T3: Summer ploughing, C1: Open conservation, C2: Intercropping (finger millet + redgram), C3: Mulching, C4: Herbicide application, C5: C1+C2+C3+C4

On the basis of one year experimentation on finger millet crop at Bastar Plateu Zone of Chhattisgarh, summer plouging recorded significantly highest gross income, Net return and B: C ratio. Energy output, energy use efficiency, energy productivity recorded significantly highest in summer plouging. In Conservation farming, combination of all treatment recorded significantly higher gross income and herbicide application recorded significantly higher Net return and B: C ratio among all the treatment.

Energy use efficiency, energy output input ratio, energy intensiveness and energy production were recorded significantly higher in treatment herbicide application and mulching.

Acknowledgement

The authors are thankful to Project Coordinator, All India Coordinated Research Project on Small Millets (AICRPSM), Bangalore, Karnataka and Dean SG College of Agriculture and Research Station, Jagdalpur, Chhattisgarh for providing grants and physical support for conducting the experiment.

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How to cite this article:

Ashwani Kumar Thakur and Sudha Sidar. 2017. Energetic and Economics of Different Tillage Methods and Conservation Farming in Finger Millet. *Int.J.Curr.Microbiol.App.Sci.* 6(12): 3665-3669.
doi: https://doi.org/10.20546/ijcmas.2017.612.423