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ENERGY BALANCE COMPONENTS INFLUENCED BY DIFFERENT PLANT POPULATION AND NUTRIENT LEVELS UNDER ZAI CULTIVATION

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Abstract

The field experiment was conducted at College of Agriculture Farm, Bijapur during *kharif* season 2013-14, to study the performance of pigeonpea [*Cajanus cajan* (L.) Millsp.] under different plant population and nutrient levels in Zai method of cultivation under dry land situation. The different plant populations and nutrient levels were practiced under zai method of *in situ* moisture conservation method were compared with recommended practice. The result shows that 22 seeds per Zai + 125% RDF with plant population 91674 plants ha^{-1} produced significantly higher seed yield (2188 kg ha^{-1}), stalk yield (6529 kg ha^{-1}) and harvest index (25.10) compared to recommended practice (flatbed 90 cm x 20 cm with RDF) (55556 plant population ha^{-1}) (1626 kg ha^{-1}), (5500 kg ha^{-1}) and (22.81), respectively. The recommended practice (flatbed 90 cm × 20 cm with RDF) (55556 plant population ha^{-1}) (17.72MJ/ha) was recorded significantly higher energy ratio compared to zai method of cultivation. The significantly lower energy ratio was recorded in 10 seeds per zai + 150% RDF (41670 plants ha^{-1}) (7.83 MJ/ha).

Key words : Energy ratio, *in situ,* pigeonpea, harvest index.

Introduction

Energy in agriculture assumes greater important in terms of crop production and agro processing for value adding. The relation between agriculture and energy is very close. Agriculture itself is an energy user and energy supplier in the form of bio-energy. At present, productivity and profitability of agriculture depends on energy consumption. Energy use in agriculture has developed in response to increasing population, limited supply of arable land and desire for an increasing standard of living. In all societies, these factors have encouraged an increase in energy inputs to maximize the yields, minimize labour-intensive practices or both. Energy in one form or another is a crucial input to agricultural production. Continuously rising prices, increasing proportion of commercial energy in the total energy input to agriculture and the growing scarcity of commercial energy sources, such as fossil fuels, have necessitated the more efficient use of these sources for different crops. Agriculture uses large quantities of locally available non-commercial energies, such as seed, manure and animate energy and commercial energies directly and indirectly in the form of diesel, electricity, fertilizer, plant protection, chemicals, irrigation water, machinery, etc. Efficient use of these energies helps to achieve increased production and productivity and contribute to economy, profitability and competitiveness of agriculture sustainability to rural living. The aim of this study was to determine the amount of input-output energy used in pigeonpea production under Zai cultivation, determines the efficiency of energy consumption and makes an economic analysis of pigeonpea production under Zai cultivation.

In Zai method of cultivation circular pits of 15-20 cm diameter are opened at an interval of 2 × 1 meter. Sowing or dibbling of seeds is done along the circumference of the pits. The Zais are filled with FYM or vermicompost or Green leaf manures along with fertilizers. The seeds are sown such that recommended plant population per unit area is maintained. The pits ensure better interception and storage of rain water as well as runoff water thus supplying water to the crop for a longer period. Zai method of cultivation is also advantages in areas where availability of animal power is very meager. All operations were carried by man labours or man power without using the bullock powers and also higher input were used in this zai method of *in situ* moisture conservation method. With

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this background a study was undertaken to evaluate the energy balance components influenced by different plant population and nutrient levels under zai cultivation

Materials and Methods

A field experiment was conducted at college of Agricultural farm, Bijapur during *kharif* 2013-14 in *vertisols* under rainfed conditions. The soil of the experimental field was medium deep black (100-135 cm). The treatments included four levels of plant population (22, 18, 14 and 10 seeds per Zai pit) and three levels of fertilizer application (25: 50 : 0, 31.5: 62.5 :0 and 37.5 : 75 : 0 kg N : P_2O_5 : K_2O ha^{-1} respectively) under Zai method of cultivation, which was compared with farmers' practice. Thirteen treatments were tested in randomized complete block design with three replications in a plot size 12 × 9.6 m^2. Circular pits having diameter 60 cm and depth about 15cm were dug in straight lines 2 m apart. The intra row distance was kept at 1.2m. Seeds were dibbled along the periphery of the pit on the 2^{nd} forth night of May. FYM (6 t/ha) and *Glyricidia* (5 t/ha) were applied in all the pits. The amount of energy input from different energy sources such as human, animal, seed, fertilizers, farm yard manure, pesticides were recorded at different stages of their application. The total energy was calculated from the total material input energy with their required operational energy. The amount of output energy was calculated from the yield.

Energy balance = Output Energy – Input Energy

Energy ratio = output energy ÷ input energy

Results and Discussion

Among the treatments 22 seeds + 125% RDF (91674 plants ha^{-1}) (2188 kg/ha) recorded significantly higher seed yield compared to the recommended practice (flat bed 90 cm × 20 cm with RDF) (55556 plants ha^{-1}) (1626 kg/ha). 22 seeds + 125% RDF (91674 plants ha^{-1}) (2188 kg/ha) being on par with 22 seeds per zai + 150% RDF (91674 plants ha^{-1}) (2094 kg/ha), 22 seeds per zai + 100% RDF (91674 plants ha^{-1}) (2072 kg/ha) and 18 seeds per zai + 125% RDF (75006 plants ha^{-1}) (2025 kg/ha). The tune of 34.40, 28.62, 27.27 and 24.38 per cent, respectively (table 3). 22 seeds + 125% RDF (91674 plants ha^{-1}) also recorded significantly higher stalk yield ha^{-1} (6529 kg ha^{-1}) and harvest index (25.10 per cent) compared to recommended practice (5500 kg ha^{-1}) and (22.81), respectively. The superiority of treatments under Zai method over recommended practice may be attributed to better soil moisture conservation at different stages of pigeonpea, optimum plant population and adequate nutrient management compared to recommended practice

Table 1 : Seed yield, stalk yield and harvest index of pigeonpea as influenced by planting geometry and fertility levels under Zai cultivation.

Tr. No.	Treatments	Seed yield (kg ha^{-1})	Stalk yield (kg/ha)	Harvest index (%)
T_1	22 seeds per zai +100% RDF (91674 plants ha^{-1})	2072	6251	24.90
T_2	22 seeds per zai +125% RDF (91674 plants ha^{-1})	2188	6529	25.10
T_3	22 seeds per zai +150% RDF (91674 plants ha^{-1})	2094	6451	24.50
T_4	18 seeds per zai +100% RDF (75006 plants ha^{-1})	1970	6142	24.27
T_5	18 seeds per zai +125% RDF (75006 plants ha^{-1})	2025	6178	24.68
T_6	18 seeds per zai +150% RDF (75006 plants ha^{-1})	1985	6027	24.78
T_7	14 seeds per zai +100% RDF (58338 plants ha^{-1})	1754	5401	24.53
T_8	14 seeds per zai +125% RDF (58338 plants ha^{-1})	1846	5620	24.73
T_9	14 seeds per zai +150% RDF (58338 plants ha^{-1})	1812	5466	24.90
T_{10}	10 Seeds per zai + 100% RDF(41670 plants ha^{-1})	1730	5436	24.15
T_{11}	10 Seeds per zai +125% RDF(41670 plants ha^{-1})	1778	5447	24.58
T_{12}	10 Seeds per zai +150% RDF (41670 plants ha^{-1})	1760	5406	24.55
T_{13}	Recommended practice (flatbed 90 cm x 20 cm with RDF) (55556 plants ha^{-1})	1626	5500	22.81
S.Em.±		56.66	157.92	0.31
C.D.at 5%		165.37	460.95	0.91

Table 2 : Energy balance components of pigeonpea as influenced by planting geometry and fertility levels under Zai method of cultivation.

Tr. no.	Treatments	Input energy (MJ/ha)	Output energy (MJ/ha)	Energy ratio (MJ/ha)	Net energy output (MJ/ha)
T_1	22 seeds per zai +100% RDF (91674 plants ha^{-1})	15120	146000	9.66	130880
T_2	22 seeds per zai +125% RDF (91674 plants ha^{-1})	15645	152845	9.77	137200
T_3	22 seeds per zai +150% RDF (91674 plants ha^{-1})	16170	150037	9.28	133867
T_4	18 seeds per zai +100% RDF (75006 plants ha^{-1})	15089	142522	9.45	127433
T_5	18 seeds per zai +125% RDF (75006 plants ha^{-1})	15614	143964	9.22	128349
T_6	18 seeds per zai +150% RDF (75006 plants ha^{-1})	16139	140593	8.71	124454
T_7	14 seeds per zai +100% RDF (58338 plants ha^{-1})	15058	125622	8.34	110564
T_8	14 seeds per zai +125% RDF (58338 plants ha^{-1})	15583	131024	8.41	115441
T_9	14 seeds per zai +150% RDF (58338 plants ha^{-1})	16108	127681	7.93	111573
T_{10}	10 Seeds per zai + 100% RDF(41670 plants ha^{-1})	15027	125942	8.38	110915
T_{11}	10 Seeds per zai +125% RDF(41670 plants ha^{-1})	15552	126825	8.15	111273
T_{12}	10 Seeds per zai +150% RDF (41670 plants ha^{-1})	16077	125812	7.83	109735
T_{13}	Recommended practice (flatbed 90 cm x 20 cm with RDF) (55556 plants ha^{-1})	7089	125630	17.72	118540
S.Em.±			3650	0.25	3650
C.D.at 5%			10655	0.72	10655

Table 3 : Input energy used.

S. no.	Particulars	Labour used	Energy (MJ)	Total energy (MJ)
1.	Man			
	a) For Zai formation	8×8	1.96	125.44
	b) For sowing	10×8	1.96	156.80
	c) Cycle weeding	2×8	1.96	31.36
	d) For FYM application	6×8	1.96	94.08
	e) For fertilizer application	2×8	1.96	31.36
	f) Glyricidia application	2×8	1.96	31.36
	g) For harvesting	6×8	1.96	94.08
	h) Total for Zai cultivation			564.48
	i) Total for flat bed			439.04
2	Women			
	a) Threshing			
	b) Weeding	8×8	1.57	100.48
	Total	5×8	1.57	62.80
3	Fertilizer	Quantity used		
	a) Nitrogen (100%)	25.0	60.60 per kg	1515.0
	(125%)	31.25	60.60 per kg	1893.75
	(150%)	37.5	60.60 per kg	2272.5
	b) Phosphorus (100%)	50.0	11.70 per kg	585.00
	(125%)	62.5	11.70 per kg	731.25
	(150%)	75.0	11.70 per kg	877.50
4	Pigeonpea seeds	For 1 kg	14.35	14.35
	Pigeonpea straw		18.60	18.60

resulting in higher number of pods per plant, pod weight per plant and seed yield per plant (table 1). These results are in conformity with the findings of Nivedeta and Narasareddy (1990) and Srinivas and Srinivas Raju (1997).

The significantly higher output energy was noticed in Zai method of *in situ* moisture conservation practice in general and specifically in 22 seeds per Zai +125% (152845 MJ) compared to recommended practice (125630 MJ) (table 2). This might be due to higher seed yield ha^{-1} (2188 kg/ha) and higher stalk yield ha^{-1} (6529 kg/ha) (table 2).

The recommended practice (flat bed 90 cm x 20 cm with RDF) (55556 plants ha^{-1}) (17.72MJ/ha) recorded significantly higher energy ratio compared to zai method cultivation practice. The significantly lower energy ratio was recorded in 10 seeds per zai + 150% RDF (41670 plants ha^{-1}) (7.83 MJ/ha), which was on par with 14 seeds per zai + 125% RDF (58338 plants ha^{-1}) (8.41MJ/ha), 10 seeds per zai + 100% RDF (41670 plants ha^{-1}) (8.38MJ/ha), 14 seeds per zai + 100% RDF (58338 plants ha^{-1}) (8.34MJ/ha),10 Seeds per zai + 125% RDF (41670 plants ha^{-1}) (8.15MJ/ha) and 14 seeds per zai + 150% RDF (58338 plants ha^{-1}) (7.93MJ/ha). The energy ratio was higher in recommended practice to zai treatments this may be due to the higher energy needed for the formation of the zai's, on the contrary of lower input energy to the recommended practice.

Further, higher input energy was observed in zai method of *in situ* moisture conservation practice compared to recommended practice. The lower input energy was recorded in the flat bed (7089.107MJ). The significantly higher energy balance was noticed in Zai method of land configuration. The treatment receiving 22 seeds per zai + 125% RDF (91674 plants ha^{-1}) recorded significantly higher energy balance (137200 MJ) compared to rest of the treatments. This may be due to higher grain yield and stalk yield of the crop which resulted in the higher energy. Seed energy had the highest impact among the other inputs in pigeonpea production. This indicates that by increase in the energy obtained from seed input, the amount of output level improves more (Manju Suman *et al*., 2006; Payman Salami and Hojat Ahmadi, 2010).

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