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Economics of Lac Production on Annual Host *Cajanus cajan* under Different Plant Density and Soil Moisture Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Inclusive of cash crop in crop production system a small and marginal farmer is an important state to shift them from sustainable farming to an economical farming. Lac is a cash crop while *Cajanus cajan* is a popular pulse crop in India. The present attempt was to evaluate economics of lac and grain production on *C. cajan* indifferent plant densities and soil moisture conditions. The two year data revealed that the highest net returnRs. 125.21 per plant, Rs. 149749.08 per hectare, in (S_2W_3) medium plant density (S_2) and higher level of irrigation (W_3), also highest input-output ratio (2.95) and B:C ratio (1.95).

Keywords: Cajanus cajan; lac; plant density; soil moisture; net return.

1. INTRODUCTION

Agriculture is an economic activity [1] It is a food productive activity [2] and one of the most important human ventures. Food production is the process of transforming soler energy to biochemical energy through photosynthesis (Murchie et al., 2008).[3] Food production, processing and distribution is an economic activity which is a growth engine in rural sectorof many countries in the world [1]. But against this, in many countries agriculture is still practice household substance and not an economic activities [4]. The national mean monthly household income of farmers in India is around Rs 6426 andRs 6210 in MP [5]. In India small and marginal farmer constitute 81 percent of the total farmer [5]. Majority of the producers are in the bracket of low socio-economy. The data compel all agriculture research and policies to focus on small and marginal farmers. The small and marginal farmers make up the bulk of the Indian agricultural economy by contributing 51 percent of total agricultural output and 70 percent of high value crops with 46 percent of operational land holdings [6]. In India total area of pulses is 28.78 million hectares (Anon, 2022). Among pulses pigeonpea is most popular and widely consumed in the country [7] It has an area of 4.72million hectares and production o f4.32 million tonnes annually (Anon, 2022). Against the domestic consume around 44-45 lakh tonnes in India, the country have imported 8.9 lakh tonnes during the 2022-23 [8] Pigeonpea is generally grown in kharif across in India rainfed situation [7] Majority of pigeonpea grower are small and marginal land holders in india [9].

Pigeonpea is a good annual host plant of lac insect [10] Lac insect (Kerria lacca. Kerr.) produces natural resign [11] of commercially important [12]. It is a cash crop [13] In recent year an effort is made to shift the production from the common host trees *Butea monosperma, Ziziphus mauritiana* and *Schleichera oleosa* to pigeonpea (*Cajanus cajan*). In context to the production of *C cajan* plant density and management of soil moisture level to overcome the biotic stress on it by the lac insects very crucial. The present field experiment which is a part of Ph.D thesis was an attempt to explore the above objective.

2. MATERIALS AND METHODS

The present research work is a part of Ph.D field work is a carried out in Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India between June 2020 to May 2022. Research was in Jawahar Model. The model is a low input intensive and diversified field crop production system [5]

2.1 Treatment Details

The field experiment was laid out in Split Plot Design with nine treatments replicated thrice. Three plants of *C. cajan* were put on each treatment in each replication. Local long duration *C. cajan* plant were grown at three plant to plant spacing viz; S_1 (6 feet), S_2 (9 feet) and S_3 (12 feet) while the row to row spacing was maintained at 10 feet. The three levels of drip irrigation per plant were viz; W_1- 2 litres/h, W_2- 4 litres/h and W_3- 8 litres/h once in seven days interval for 2 hours.

2.2 Substrate

Crops are grown in polypropylene bag (PPBs) on size 93x61 cm. The weight of substrate for each *C. cajan* plant in PPB was 45 kg i.e., 30 kg of soil + 15 kg of FYM. The soil and FYM in the above ratio were filled in the PPB in alternate layers. The substrate was treated with consortium of biofertilizers. The consortium consisted of Rhizobium, PSB, *Trichoderma viridae* and Mycorrhiza.

2.3 Irrigation Scheduled

The irrigation scheduled was initiated after the cessation of rainfall i.e. from October. The total mean rainfall from DAT to the initiation of irrigation was 672.05 mm. The mean temperature of the both year varied from 16.33 to 31.03^{0}C.

2.4 Nursery Raising

C. cajan raised in nursery by sowing seed treated with biofertilizers cultures and *Trichoderma viridea* on in polythene bag on size 18x16 cm filled with the light soil and FYM in the ratio of 1:1. The substrate filled polyethene bags were punctured with a sharp nail in eight to ten different places to drain out irrigation water. The seedling from nursery were transplanted in the PPBs in main field at decided spacing.

2.5 Nipping

The growing tips of the seedling were nipped at 15 days interval from 15 DAT to 60 DAT. The plants were protected from insect pests by spraying of insecticides on *C. cajan* pants at 30 days after transplanting of seedling, 30 and 60 days after BLI. At 30 and 60 days of BLI an insecticide spray (Cartap hydrochloride) was spray to protect lac insects from its predators and parasitoids.

2.6 Brood Lac Inoculation

Rangeeni brood lac after shorting for quality was inoculate on the *C. cajan* on 30.10.2020 (1st year) and 24.10.2021 (2nd year). Brood lac weighing 15g per plant was tied on the main stem about one foot above the ground. The brood lac after 21 days of the brood lac inoculation (BLI) was removed from the plant. This process is referred as *Phunki* removal.

2.7 Harvesting of *C. cajan* and Lac Crop

On the maturity of 80 per cent pods of *C. cajan*, they were handpicked separately per plant. *C. cajan* with lac crop was harvested on 25.05.2021 and 28.05.2022. The harvested plants were shade dried and the lac was scrapped from the plant after keeping a clean and thick sheet of tarpaulin. All the Quantitative observation of lac and pigeonpea was recorded.

2.8 Statistically Analysis

The experimental data was analyzedstatistically by following Fischer's method of analysis of variance, as per procedure suggested by Gomez and Gomez (1984). F–test was significant at P = 0.05 and the results have been compared among treatments based on critical difference.

2.9 Economics Analysis

2.9.1 Cost of cultivation

The share of major cost on the cultivation of lac production on *C. cajan* was human labor, substrate (Soil, FYM, PSB, Trichoderma, Rhizobium), poly propylene bag (PPB), *phunki*, nursery raising, pesticide, electricity, water and seed.

2.10 Profitability Concept

2.10.1 Gross income

The gross returns are worked out based on the prevailing market rate of row lac, pigeonpea seed and fuelwood. The benefit cost ratio was worked out for different treatments by dividing the net returns by the corresponding cost of cultivation of the treatments

Gross Income = Physical Production × Price/kg

2.10.2 Net income

Net Income = Gross Income – Total cost

2.11 Input-Output Ratio

Input-Output Ratio = Gross income/Total Cost

2.12 Benefit-Cost Ratio

Benefit-Cost Ratio = Net Income/Total cost

3. RESULTS AND DISCUSSION

Lac is a substance secreted by insects [*Kerria lacca* (Kerr)], which have long been farmed for economic purposes. India is the origin of lac cultivation, which is a significant economic driver for the local population. Even though different parts of India have reported a variety of lac hosts, the crop is not grown for profit. The pigeonpea crop might be used to promote lac growing in different areas, and extra money from lac resin could make up for yield losses [14].

Experimental results (two years pooled data) of lac production on *C. cajan* under different plant spacings, levels of irrigation and their interactions.

3.1 Seed, Lac and Fuelwood Yield under Different Plant Spacings, Levels of Irrigation and their Interactions

Plant spacings and levels of irrigation differed significantly with regard to lac yield, seed yield and fuelwood yield per plant (Table 1).

3.1.1 Main plot (Spacings)

Wider spacing (S_3) recorded significantly maximum lac yield (196.09g) than lesser plant spacing (S_1) but at par with S_2 (193.69g). The seed yield also significantly maximum in S_3(1500.78g) than S_1 but at par with S_2(1466.89g). Fuelwood per plant was significant highest (4850.02g) in wider spacing (S_3) than S_2 and S_1 spacings, respectively.

3.1.2 Sub plot effect (Levels of irrigation)

Higher level of irrigation (W_3)recorded significantly maximum lac yield (202.94g) seed yield (1567.46g) and fuelwood (4802.20g) plant^{-1} than W_2 and W_1irrigation levels, respectively. The mean additional quantity of water per plant was 134 litres (W_1), 268 litres (W_2) and 528 litres(W_3).

Table 1. Quantitative analysis of seed, lac and fuelwoodyield under different plant spacings, levels of irrigation and their interactions

	Mean yield (g) per plant								
Treatments	**Lac**			**Seed**			**Fuelwood**		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
Main plot (Spacings)									
S_1	157.64	152.95	155.30	1168.04	1071.37	1119.70	3860.33	4109.04	3984.69
S_2	201.38	186.00	193.69	1551.33	1382.44	1466.89	4775.81	4058.00	4416.91
S_3	198.89	193.29	196.09	1564.63	1436.93	1500.78	4801.78	4900.26	4851.02
SEm (±)	6.30	12.25	6.28	76.77	26.69	28.19	75.84	123.46	56.63
CD (5%)	24.72	48.08	24.67	301.45	104.79	110.70	297.79	484.75	222.37
Sub plot (Irrigation levels)									
W_1	168.51	152.84	160.67	1161.37	991.48	1076.43	3983.59	3666.81	3825.20
W_2	187.38	175.54	181.46	1473.48	1413.48	1443.48	4565.78	4684.63	4625.20
W_3	202.02	203.86	202.94	1649.15	1485.78	1567.46	4888.56	4715.85	4802.20
SEm (±)	6.47	7.71	5.98	66.41	28.49	36.55	216.15	227.36	148.83
CD (5%)	19.93	23.77	18.42	204.62	87.80	112.61	666.03	700.57	458.59
Interaction (Spacings × Levels of irrigation)									
S_1W_1	139.21	148.22	143.72	1063.78	986.78	1025.28	3753.56	3713.44	3733.50
S_1W_2	152.82	144.90	148.86	1203.44	1123.55	1163.50	3553.89	4116.78	3835.33
S_1W_3	180.88	165.74	173.31	1236.89	1103.78	1170.34	4273.55	4496.89	4385.22
S_2W_1	197.84	145.31	171.57	1193.56	967.11	1080.34	4040.44	3263.56	3652.00
S_2W_2	179.47	190.16	184.82	1620.11	1513.55	1566.83	5203.33	4506.89	4855.11
S_2W_3	226.82	222.53	224.67	1840.33	1666.67	1753.50	5083.67	4403.55	4743.61
S_3W_1	168.47	164.98	166.72	1226.78	1020.56	1123.67	4156.78	4023.44	4090.11
S_3W_2	229.85	191.56	210.71	1596.89	1603.33	1600.11	4940.11	5430.22	5185.17
S_3W_3	198.35	223.32	210.83	1870.22	1686.89	1778.56	5308.45	5247.11	5277.78
SEm(±)	11.20	13.36	10.36	115.02	49.35	63.30	374.39	393.80	257.78
CD (5%)	34.53	41.17	31.91	354.41	152.07	195.04	1153.60	1213.43	794.30

3.1.3 Interaction effect (Spacings x Levels of irrigation)

In the interaction of plant spacings and levels of irrigation was highest significantly mean lac yield (g) per plant in S_2W_3(224.67g). Next better interaction on lac yield was S_3W_3 (210.83g) that was at par with S_3W_2 (210.71g) andS_2W_2 (184.82g). The mean seed yield per plant in the interactions varied from 1025.28g (S_1W_1) to 1778.56g (S_3W_3). The mean seed yield in S_3W_3 (1778.56g) were significantly higher than all the interactions. Next better interaction was S_2W_3 (1753.50g).) at par with S_2W_3 (1753.50g), S_3W_2 (1600.11g) and S_2W_2 (1566.83g**).** The mean fuelwood yield in the interaction of plant spacings and levels of irrigation was varied from 3733.50 (S_3W_1) to 5277.78 (S_3W_3) per plant. In S_3W_3 (5277.78g) was significantly higher mean fuelwood yield than S_2W_1 (3652.00) but at par with S_2W_3 (4743.61g), S_2W_2 (4855.11g) and S_2W_3 (5185.17g). The mean fuelwood yield of S_2W_1 (3652.00g) at par with S_1W_1 (3733.50g), S_2W_2 (3835.33g), S_1W_3 (4090.11g) and S_2W_3 (4385.22).

Similarly, Patidar et al. (2021) reported that the total *C. cajan* seed yield per plant in 3 hand pickings varied from 1066.66g to 1254.83g in different treatment combination of soil microbes in a substrate. Lac yield from the plant varied from a mean of 327.47g to 386.07g per *C. cajan* plant.

3.2 The Economics of Lac Production on *C. cajan* under Different Plant Spacings, Levels of Irrigation and their Interactions (Pooled)

There was three produces from the same plant i.e. seed, lac and fuel wood. The calculation of economy output was done on the selling price of these three produces on the month of June 2020-21 and 2021-22 from respective mandis. The average selling price of lac (Rs 300/kg) was calculated from Barghat lac mandi in June 2020-21 and 2021-22 from while that of *C. cajan* also (Rs 61.5/kg) from Jabalpur mandi and fuelwood (Rs 3/kg) from the villages in Jabalpur district (Table 2). Recently Patil et al [15] conducted an experiment on lac production on pigonpea and reported that after harvest of *C. cajan* seeds and lac as cash crops, the left-over wood of *C. cajan* was evaluated for fuelwood (as an energy stove) for the small and marginal farm households. The mean dry weight of total fuelwood (including shoot+root) varied from 1196.67 to 1393.67 g plant^{-1} in pooled data. The estimated mean weight of total fuelwood (root+shoot) of *C. cajan* varied from 1447.98 to 1686.34 kg ha^{-1} in pooled mean of both the years. The value of total (shoot+root) dry fuelwood per plant varied from Rs. 7,239.85 to Rs. 8,431.70 in pooled mean of both the years. This total fuelwood can fulfill daily household requirement of fuelwood upto 3 years (891 to 1037 days) @ 4.06 kg day^{-1} household^{-1}

3.2.1 Gross return

3.2.1.1 Main plot (Spacings)

The spacing S_3 had the highest mean total economy of Rs 165.66 per plant i.e., Rs 92.28 of seed, Rs 58.83 worth lac and Rs 14.55 worth fuel wood. It was closely followed by S_2 (Rs 161.56/plant) and lowest in S_1 (Rs 127.39/plant). The mean total gross economy per hectare was highest Rs. 228535.20 in close spacing S_1, followed by S_2 (Rs 193222.09/ha) and lowest in S_3 (Rs 148600.16/ha).

3.2.1.2 Sub plot (Levels of irrigation)

The highest mean total economy per plant on W_3 (Rs. 171.67) i.e., Rs. 96.38 of seed, Rs. 60.88 worth lac and Rs. 14.41 worth fuel wood. The next was W_2 (Rs. 157.08/plant) and lowest in W_1 (Rs. 125.86/plant). The mean total gross economy per hectare was highest Rs. 222486.43 in W_3, followed by W_2 (Rs 203574.90/ha) and lowest gross economy in W_1 (Rs 163111.15/ha).

3.2.1.3 Interactions (Spacings x Levels of irrigation)

In interactions the mean total economy per plant were varied from Rs. 117.35 (S_1W_1) to Rs. 189.46 (S_2W_3). The highest mean total economy per plantin interaction S_2W_3 was Rs. 189.46, it was closely followed by Rs. 188.45 (S_3W_3) and Rs. 177.17 (S_3W_2). The mean total economy per hectare in interactions were varied from Rs. 117839.90 per ha at S_3W_1 to Rs. 245963.97 per hectare at S_1W_3. The highest mean total economy per hectarein interaction S_1W_3 was Rs. 245963.97, next were Rs. 229109.56(S_1W_2) and Rs. 226596.10(S_2W_3). Lowest total economy per hectare was in wider plant spacing and low level of irrigation interactions S_3W_1 (Table 3).

Table 2. Cost of cultivation in lac production on *C. cajan* under different plant spacings, levels of irrigation and their interactions (Pooled)

Treatments	Cost of cultivation (CC)/ha (Rs)								Total cost per plant
	Nursery raising	Poly propylene bag (PPB)	Substrate (Soil, FYM, PSB, Trichoderma, Rhizobium) and Seed	*Phunki*	Pesticide	Labor	Irrigation	Total cost	
Main plot (Spacings)									
S_1	3588.00	26910.00	27286.74	5382.00	1435.20	47844.00	1297.66	113743.60	63.40
S_2	2392.00	17940.00	18191.16	3588.00	956.80	32296.00	865.11	76229.07	63.74
S_3	1794.00	13455.00	13643.37	2691.00	717.60	24522.00	648.83	57471.80	64.07
Sub plot (Levels of irrigation)									
W_1	2592.00	19440.00	19712.16	3888.00	1036.74	34896.00	401.77	81966.66	63.25
W_2	2592.00	19440.00	19712.16	3888.00	1036.74	34896.00	803.53	82368.43	63.56
W_3	2592.00	19440.00	19712.16	3888.00	1036.74	34896.00	1607.06	83171.96	64.18
Interaction (Spacings × Levels of irrigation)									
S_1W_1	3588.00	26910.00	27286.74	5382.00	1435.20	47844.00	556.15	113002.09	62.99
S_1W_2	3588.00	26910.00	27286.74	5382.00	1435.20	47844.00	1112.30	113558.23	63.30
S_1W_3	3588.00	26910.00	27286.74	5382.00	1435.20	47844.00	2224.59	114670.53	63.92
S_2W_1	2392.00	17940.00	18191.16	3588.00	956.80	32296.00	370.77	75734.72	63.32
S_2W_2	2392.00	17940.00	18191.16	3588.00	956.80	32296.00	741.53	76105.49	63.63
S_2W_3	2392.00	17940.00	18191.16	3588.00	956.80	32296.00	1483.06	76847.02	64.25
S_3W_1	1794.00	13455.00	13643.37	2691.00	717.60	24522.00	278.07	57101.04	63.66
S_3W_2	1794.00	13455.00	13643.37	2691.00	717.60	24522.00	556.15	57379.12	63.97
S_3W_3	1794.00	13455.00	13643.37	2691.00	717.60	24522.00	1112.30	57935.26	64.59

Table 3. Yield and economics of lac production on *C. cajan* under different plant spacings, levels of irrigation and their interactions (Pooled)

Treatments	Plants per ha	Gross return (GR) /plant /ha (Rs)													
		Seed				Lac				Fuel wood				Total	
		Yield per plant(kg)	Yield per ha (kg)	Rs per plant	Rs per ha	Yield per plant (kg)	Yield per ha (kg)	Rs per plant	Rs per ha	Yield per plant(kg)	Yield per ha (kg)	Rs per plant	Rs per ha	Rs per plant	Rs/ha
Main plot (Spacings)															
S_1	1794	1.12	2008.28	68.85	123508.93	0.16	278.60	46.59	83580.67	3.98	7148.53	11.95	21445.60	127.39	228535.20
S_2	1196	1.47	1754.14	90.20	107879.45	0.19	231.65	58.11	69494.78	4.42	5282.62	13.25	15847.87	161.56	193222.09
S_3	897	1.50	1346.00	92.28	82779.14	0.20	175.89	58.83	52766.92	4.85	4351.36	14.55	13054.09	165.66	148600.16
Sub plot (Levels of irrigation)															
W_1	1296	1.08	1394.64	66.18	85770.27	0.16	208.23	48.20	62468.50	3.83	4957.46	11.48	14872.38	125.86	163111.15

Gross return (GR) /plant /ha (Rs)															
Treatments	**Plants per ha**	**Seed**				**Lac**				**Fuel wood**				**Total**	
		Yield per plant(kg)	**Yield per ha (kg)**	**Rs per plant**	**Rs per ha**	**Yield per plant (kg)**	**Yield per ha (kg)**	**Rs per plant**	**Rs per ha**	**Yield per plant(kg)**	**Yield per ha (kg)**	**Rs per plant**	**Rs per ha**	**Rs per plant**	**Rs/ha**
W_2	1296	1.44	1870.56	88.76	115039.17	0.18	235.18	54.44	70552.94	4.63	5994.26	13.88	17982.78	157.08	203574.90
W_3	1296	1.57	2031.12	96.38	124913.70	0.20	263.01	60.88	78901.78	4.80	6223.65	14.41	18670.95	171.67	222486.43
Interaction (Spacings × Levels of irrigation)															
S_1W_1	1794	1.03	1838.85	63.04	113089.28	0.14	257.83	43.12	77350.10	3.73	6697.90	11.20	20093.70	117.35	210533.08
S_1W_2	1794	1.16	2087.01	71.54	128351.36	0.15	267.05	44.66	80116.45	3.84	6880.58	11.51	20641.75	127.71	229109.56
S_1W_3	1794	1.17	2098.98	71.96	129087.27	0.17	310.92	51.99	93275.44	4.39	7867.08	13.16	23601.25	137.10	245963.97
S_2W_1	1196	1.08	1291.68	66.42	79438.32	0.17	205.20	51.47	61559.32	3.65	4367.79	10.96	13103.38	128.85	154101.01
S_2W_2	1196	1.57	1873.74	96.35	115234.85	0.18	221.04	55.45	66313.42	4.86	5806.71	14.57	17420.13	166.36	198968.40
S_2W_3	1196	1.75	2096.98	107.83	128964.43	0.22	268.71	67.40	80611.60	4.74	5673.36	14.23	17020.07	189.46	226596.10
S_3W_1	897	1.12	1007.63	69.08	61969.06	0.17	149.55	50.02	44864.35	4.09	3668.83	12.27	11006.49	131.37	117839.90
S_3W_2	897	1.60	1435.20	98.40	88264.80	0.21	189.01	63.21	56702.06	5.19	4651.10	15.56	13953.29	177.17	158920.15
S_3W_3	897	1.78	1595.16	109.37	98102.46	0.21	189.11	63.25	56734.35	5.28	4734.17	15.83	14202.51	188.45	169039.32

Table 4. Net return by lac production on *C. cajan* under different plant spacings, levels of irrigation and their interactions (Pooled)

Treatments	Net profit /plant/ha (Rs)							
	Gross return (GR)		Cost of production (CP)		Net profit		Input-output ratio	B:C
	Rs per plant	Rs/ha	Rs per plant	Rs/ha	Rs per plant	Rs/ha		
Main plot (Spacings)								
S_1	127.39	228535.20	63.40	113743.60	63.99	114791.60	1:2.01	1:1.01
S_2	161.56	193222.09	63.74	76229.07	97.82	116993.03	1:2.53	1:1.53
S_3	165.66	148600.16	64.07	57471.80	101.59	91128.36	1:2.59	1:1.59
Sub plot (Levels of irrigation)								
W_1	125.86	163111.15	63.25	81966.66	62.61	81144.48	1:1.99	1:0.99
W_2	157.08	203574.90	63.56	82368.43	93.52	121206.47	1:2.47	1:1.47
W_3	171.67	222486.43	64.18	83171.96	107.50	139314.47	1:2.68	1:1.67
Interaction (Spacings × Levels of irrigation)								
S_1W_1	117.35	210533.08	62.99	113002.09	54.37	97530.99	1:1.86	1:0.86
S_1W_2	127.71	229109.56	63.30	113558.23	64.41	115551.33	1:2.02	1:1.02
S_1W_3	137.10	245963.97	63.92	114670.53	73.18	131293.44	1:2.14	1:1.14
S_2W_1	128.85	154101.01	63.32	75734.72	65.52	78366.29	1:2.03	1:1.03
S_2W_2	166.36	198968.40	63.63	76105.49	102.73	122862.91	1:2.61	1:1.61
S_2W_3	189.46	226596.10	64.25	76847.02	125.21	149749.08	1:2.95	1:1.95
S_3W_1	131.37	117839.90	63.66	57101.04	67.71	60738.86	1:2.06	1:1.06
S_3W_2	177.17	158920.15	63.97	57379.12	113.20	101541.04	1:2.77	1:1.77
S_3W_3	188.45	169039.32	64.59	57935.26	123.86	111104.06	1:2.92	1:1.92

3.2.2 Net return

3.2.2.1 Main plot (Spacings)

The net return (Rs/plant) was varied from Rs. 63.99(S_1), 97.82(S_2) to 101.59(S_3). The latter (S_3) was highest net return per plant Rs. 101.59, high input-output ratio (2.59) and B:C ratio (1.59) but net return per hectare was lowest (Rs. 91128.36). In case of per hectare the net return of lac production on *C. cajan* under different plant spacings were highest in S_2 (Rs. 116993.03) closely followed by S_1 (Rs.114791.60). The lowest input-output ratio (2.01) and B:C ratio (1.01) in S_1.

3.2.2.2 Sub plot (Levels of irrigation)

The net return of lac production on *C. cajan* under different levels of irrigation was higher in W_3 (Rs. 107.50 plant^{-1}), (Rs. 139314.47 ha^{-1}), high input-output ratio (2.68) and B:C ratio (1.67). Next was W_2 (Rs. 93.52plant $^{-1}$), (Rs. 121206.47 ha^{-1}), input-output ratio (2.47) and B:C ratio (1.47). Lowest net return in W_1 (Rs. 62.61 plant $^{-1}$), (Rs. 81144.48 ha^{-1}), input-output (1.99) and B:C ratio (0.99).

3.2.2.3 Interactions (Spacings x Levels of irrigation)

In interactions net return per plant were varied from Rs. 54.37(S_1W_1) to Rs. 125.21(S_2W_3). The highest mean net return per plantin interaction S_2W_3 was Rs. 125.21, it was closely followed by Rs. 123.86(S_3W_3) and Rs. 113.20 (S_3W_2). The net return per hectare in interactions were varied from Rs. 60738.86 ha-^{1} at S_3W_1 to Rs. 149749.08 ha^{-1} at S_2W_3. The highest net return per hectarein interaction S_2W_3 was Rs. 149749.08, next were Rs. 131293.44(S_1W_3) and Rs. 122862.91(S_2W_2). Lowest total economy per hectare was in wider plant spacing and low level of irrigation interactions S_3W_1 (Table 4).

In interactions the highest input-output ratio (2.95) and B:C ratio (1.95) in S_2W_3, it was closely followed by S_3W_3 (input-output ratio 2.92 and B:C ratio 1.92). Next best interactions input-output ratio was S_3W_2 (2.77), S_2W_2 (2.61), S_1W_3 (2.14), S_3W_1 (2.06), S_2W_1 (2.03) and S_1W_2 (2.02). In S_1W_1 was lowest input-output ratio (1.86). Similarly, next best interactions B:C ratio was S_3W_2 (1.77), S_2W_2 (1.61), S_1W_3 (1.14), S_3W_1 (1.06), S_2W_1 (1.03) and S_1W_2 (1.02). In S_1W_1 was lowest B:C ratio (0.86). According to a recent study conducted by Swami et al. (2023) on lac production on pigeonpea the benefit cost ratio was 1.95 and 2.09 in lac inoculated experiment and it was higher than the sole seed crop (control) of pigeon pea (1.84 and 1.35) in season 2019-20 and 2020-21, respectively. All the studied parameters revealed that pigeon pea was found to be an economically efficient host for lac production [16].

4. CONCLUSION

The present study was conducted to evaluate economics of lac and grain production on *C. cajan* in different plant densities and soil moisture conditions. The findings of the present investigation confirm that plant density and soil moisture conditions have their impact on pigeonpea plants. These parameters also impacted the grain as well as lac yield. The two year data revealed that the highest net return Rs. 125.21 per plant, Rs. 149749.08 per hectare, in (S_2W_3) medium plant density (S_2) and higher level of irrigation (W_3), also highest input-output ratio (2.95) and B:C ratio (1.95).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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