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ORIGINAL ARTICLE

Lac production on *Cajanus cajan*- an option for doubling farmers income

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ABSTRACT

The present study was conducted to evaluate the economics of lac production on ten local genotypes of C. cajan. The field study in Randomized Block Design (RBD) with ten genotypes in three replications was carried out at research field of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India from April 2019 to June 2020. The selling price of lac (Rs 280/kg) was calculated from Barghat lac mandi in Seoni district in June 2020, while that of C. cajan (Rs 50/kg) was collected from Jabalpur mandi. The price of fuel wood (Rs 3/kg) was collected from the villages in Jabalpur district. There were three produce from the same plant i.e. seed, lac and fuel wood. The highest mean gross return of Rs 195.89 per plant i.e. Rs 71.69 of seed, Rs 116.06 worth lac and Rs 8.14 worth fuel wood was from C. cajan genotype Lakhnadon-2. It was closely followed by genotype Korsar-2 (Rs 159.85/plant) and C. cajan variety TJT-501 (Rs 157.38/plant). Mean gross return was lowest in genotype Amarkantak-4 (Rs 72.52) and Amarkantak-1 (Rs 94.95). The cost of cultivation from nursery to harvest and scrapping of lac was Rs. 55 per C. cajan plant. The net return per plant varied from Rs. 140.89 in Lakhnadon-2 to Rs. 17.52 in Amarkantak-4. The results reveal that doubling farmers income is possible by producing lac on C. cajan.

Key words: Pigeonpea, sustainable, model, yield, economics

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INTRODUCTION

In rural India, fuel wood, pulses and cash are the three important things always in shortage. Villages with the above three are comparatively better developed and people are healthy [1]. In villages there is a need of cash crop [2] for regular flow of income to sustain their household expenditure [3]. Similarly, protein deficiency in India is wide spread [4]. Better yield of pulses crop is an easy way to improve dietary protein [5] and economy of the household [6].

Government of India and Madhya Pradesh is focusing on doubling of farmers' income. The present mean annual household income of small and marginal farmers in India is Rs 77,112. These farmers seldom fail to invest more in agriculture to raise their farm output and adopt recent technologies. Pigeonpea [*Cajanus cajan* (L.) Millsp.] – an annual host plant of lac insect, is widely cultivated in all the 11 agro-climatic zones of MP.

Thus promotion of lac production on *C. cajan* was thought to be a viable low input option to help pigeonpea farmers to increase their income. Unfortunately, in the present days dwarf and short duration *C. cajan* are cultivated, *w*hereas for lac production tall and long duration varieties are preferred. Evaluation of local tall and long duration local genotypes of *C. cajan* available with farmers for lac production was needed. In order to convince traditional *C. cajan* farmers to adopt lac production on the same crop economical data is required.

MATERIAL AND METHODS

A field trial was conducted to study the performance of lac insect (*Kerria lacca* Kerr.) on ten genotypes of *C. cajan,* in JNKVV, Jabalpur, MP from May 2019 to June 2020. The topography of the experimental field was fairly uniform and all physical facilities were adequately available. Nine tall and long duration genotypes of *C. cajan* (Table-1) as well as a released variety TJT-501 was replicated thrice in a RBD format. Agro-climatically Jabalpur lies in the Kymore plateau and Satpura hill zone. The weather is typically sub humid, featured by hot dry summer and cool dry winter.

Nursery raising of *C. cajan*

Nursery of ten genotypes of *C. cajan* was raised in perforated polythene bag (18 x 16 cm) filled with substrate (*Kapu* + FYM). Kapu is river bed basin soil. Seeds treated with *Trichoderma viridae, Rhizobium* and PSB sown in polythene bags were kept in shade for its germination. The seedlings were sprayed with contact insecticides to prevent foliage feeding insects. The growing tips of the seedlings were nipped at 8-12 days interval till its transplantation, to train the seedlings into a bush form.

Substrate

Polypropylene bag (PPB) each weighing 125 g of size 93 cm x 61 cm was filled were with 65 kg of homogeneously mixed substrate consisting of 45 kg river bed basin soil (*Kapu*) and 20 kg well rotten Farmyard manure, (Patent application no 201921005340 A dated 01.03.2019). The substrate was filled into the PPB with help of a *tasala* followed by constantly shaking the bag to ensure proper compactness. Substrate filled PPB were kept on the designated spot in the layout of the experiment, such that it is not disturbed in future. PPB filled with 65 kg substrate attained a dimension of 46 cm height and 125 cm circumference. Availability of Nitrogen, Phosphorous and Potash in 65 kg of substrate was 136.15 g, 45 g and 304 g respectively.

Transplantation

The trial conducted in plot size of 56 feet x 54 feet accommodated 90 *C. cajan* plants with spacing of 6 feet between plant to plant and row to row. The inter space between replications were 10 feet.

Transplantation of *C. cajan* seedlings

C. cajan seedlings on attaining a height varying from 1.5 feet to 2 feet were transported to the main field and transplanted in the PPB. *C. cajan* seedlings was carefully removed from poly bags without disturbing its root system, and transplanted in the substrate filled PPB in the evening hours of 05th July 2019. The transplanted seedlings were pressed from all sides to remove air pockets followed by watering.

Application pesticides

Insecticides were sprayed on *C. cajan* plants to protect lac insects from its predator and foliage feeders. First spray of Cartap hydrochloride 50%SP @ 1g/litre was at 30 days after BLI, while the second spray of Cartap hydrochloride+ Dithane M-45 75%WP was at 60 days after BLI. The transplanted *C. cajan* was again nipped at 10-12 days interval between 12th July 2019 the last week of September 2019.

Irrigation

C. cajan plant in PPB was irrigated intervals from November to February at 15 days interval and at 10 days interval from March 2020 to June 2020. Approximately 10 litres of water was at given per plant during each irrigation.

Brood lac inoculation (BLI)

Rangeeni brood lac was purchased from M/s Adarsh Lac Samiti, Jamankhari village, Tehsil Barghat, District Seoni, M.P. on 11.11.2019. Predator free good quality brood lac was sorted before its inoculation on *C. cajan*. Brood lac stick weighing 15 g was tied at the base of each *C. cajan* in the PPB on with the help of a twine. *Phunki* was carefully removed from *C. cajan* plants 21 days after BLI without damaging the lac insect settlement on the plants. *Phunki* removal pertains to the removal of left over brood lac twigs.

Harvest

Harvest of pigeon pea

Mature pods of *C. cajan* was done by hand picking. There were two hand pickings i.e. January 2020 and April 2020. The harvested pods were shade dried and threshed for seeds.

Lac crop

C. cajan with lac was harvested on 12.06.2020 by cutting the plant from the base and shade dried for four days. All the branches with lac encrustation was separately kept measured and tagged. Lac was scrapped from the branches after keeping a clean polythene sheet beneath them. Lac was scrapped after harvesting of *C. cajan* plant between 24th June to 25th June 2020. The lac thus obtained was dried and weighing was done at 28th June 2020.

Fuel wood

After scrapping of raw lac from the shade dried *C. cajan* plant, the left over is used a fuel wood. The fuel wood per plant was weighed and recorded.

RESULTS AND DISCUSSION

Mean seed yield per plant

Mean weight (g) of seeds per plant during 1st picking

During the 1st picking the mean seed yield plant varied from 322.50 g (Amarkantak-1) to 771.50 g (Lakhnadon-2). The later was significantly highest. Genotypes Korsar-3 and Korsar-2 being late podding there was no picking of pods during 1st picking. The mean seed yield per plant among Amarkantak-1, Amarkantak-4, Gadarwara and Amarkantak-3 as well as TJT-501, Saraswahi and Amarkantak-2 were at par. There was a significant difference in the mean seed yield per plant in Lakhnadon-2, TJT-501, Amarkantak-2 and Saraswahi over Amarkantak-3, Gadarwara, Amarkantak-4 and Amarkantak-1 (Table 2).

Mean weight (g) of seeds per plant during 2nd picking

During the second picking the mean seed yield per plant was lowest (272.83 g) in Gadarwara while it was highest (956 g) in Korsar-2. The mean of seed yield per plant in Korsar-2 and Korsar-3 were significantly higher than that of rest of the genotypes. Gadarwara, Amarkantak-1, Amarkantak-4, Amarkantak-3 and Amarkantak-2 were at par with each other (Table 2). It was significantly highest in Korsar-2 followed by that of Korsar-3 and Lakhnadon-2. Both Korsar-2 and Korsar-3 significantly differed with rest of the treatments. It may be noted that these two genotypes had only one picking.

Mean of total seed yield per plant (1st and 2nd picking)

The mean of total seed yield per plant (i.e. total of 1st and 2nd picking) varied from 597.67 g (Amarkantak-1) to 1433.83 g (Lakhnadon-2). The latter was significantly highest over all the genotypes. It was followed by TJT-501 (1137.38 g), which was at par with Saraswahi (1023.83 g). Rest of the genotypes were at par with each other in terms of mean of total seed yield per plant.

The mean seed yield per plant of *C. cajan* genotypes evaluated were exceptionally higher as it varied from 597.67 g to 1433.83 g. This was because of the Jawahar model technology for doubling of income of resource constrained marginal farmers developed in JNKVV Jabalpur (Patent application no. 201921044327 A). The mean seed yield per plant of TJT-501 under traditional cultivation practice is 50 to 75 g, but the same variety in the above model with lac insects on it gave 1137 g in two pickings.

It was also recorded from 1058.33 g to 1442.50 g mean seed per plant of TJT-501 with lac insect under the technology [7] [8]. Under the same technology a mean seed yield per plant of TJT-501 from 1066.67 g to 1254.83 g was reported [9]. However other workers [10] reported per plant yield 269.33 g with lac insect. These workers may have grown *C. cajan* plant at closer spacing with no or few nipping operations. In the present study as mentioned earlier, the plants were transplanted in substrate filled PPB with a spacing of 6 feet apart with nipping at 10-12 days interval during the vegetative growth stage of *C. cajan.*

Mean lac yield per plant

The mean lac yield per plant was highest in Lakhnadon-2 (414.50 g) followed by Korsar-2 (349.33 g), TJT-501 (340 g), Amarkantak-2 (245.83 g), Korsar-3 (245.17 g), Amarkantak-3 (240 g), Amarkantak-1 (221.83 g), Saraswahi (209.33 g), Gadarwara (205.67 g) and Amarkantak-4 (131.83 g). There was significant difference the mean lac yield per plant in all genotypes over Amarkantak-4. The mean lac yield among Gadarwara, Saraswahi and Amarkantak-1, 2, 3 and Korsar-3 were at par.

Thus raw lac and grain yield of *C. cajan* can be successively harvested from the same plant. However the productivity of lac also depends on the variety [11] reported 350g of lac from *C. cajan*. Per plant yield of lac from *C. cajan* earlier reported were 3.74 g to 29.45 g [12], 332.33 g to 446 g [7]. Mean lac yield from trees like *B. monosperma* was 0.58 kg to 2.10 kg [13], 2.03 kg to 4.01 kg [14] *and Z. mauritiana* 3.83 to 5.08 kg [15]. In view of this, lac production from annual shrub *C. cajan* is quite encouraging. There was a positive correlation between mean number of lac insect, secondary branches per plant and the lac yield per *C. cajan* plant.

Fuel wood

Mean total (shoot + root) weight of fuel wood/plant (g):

The mean dry weight of total fuel (shoot + root) varied from a minimum 836.17 g (Amarkantak-4) to maximum 4746.67 g (Korsar-2). There was a significant difference in the mean total fuel weight in genotypes Korsar-2, Korsar-3, Lakhnadon-2, Amarkantak-2, Amarkantak-3 and Saraswahi over Amarkantak-4. The mean weight of total fuel per plant in genotypes Korsar-2 was significantly highest over all the genotypes. Among TJT-501, Saraswahi, Amarkantak-2 and Amarkantak-3 it was at par with each other. Similar, Gadarwara, Amarkantak-1 and Amarkantak-4 were also at par. There was a significance difference among Lakhnadon-2 and Korsar-3 and also between Korsar-3 and Korsar-2.

In Jawahar model technology of lac produce on *C. cajan*, the farmer gets three productions from the same plant grown in 65 kg substrate with the same input and effort. The first produce was the seed, the yield of which was exceptionally higher [7] [9] the second was raw lac after the harvest of the plant. Lac is again a

cash crop [16] [17]. After scrapping of the lac from the harvest *C. cajan* plant and the third produce is fuel wood, which is again of economic importance to small and marginal farmers.

Dry stems are important household fuel woods in many countries [18]. On an average dry fuel wood yield from *C. cajan* is 10-12 ton/ha [19] to 6 ton/ha [20]

The economics of lac production on all the ten genotypes of *C. cajan*

There was three produce from the same plant *i.e*. seed, lac and fuel wood when lac is produced on *C. cajan*. The selling price of lac (Rs 280/kg) was calculated from Barghat lac mandi in Seoni district in June 2020. The selling price of pigeonpea (Rs 50/kg) from Jabalpur mandi and of fuel wood (Rs 3/ kg) from the village in Jabalpur district. The highest mean gross return of Rs 195.89 per plant i.e. Rs 71.69 of seed, Rs 116.06 worth lac and Rs 8.14 worth fuel wood was from Lakhnadon-2. It was closely followed by Korsar-2 (Rs 159.85/plant) and TJT-501 (Rs 157.38/plant). The mean gross return per plant was lowest in genotype Amarkantak-4 (Rs 72.52) and Amarkantak-1 (Rs 94.95).

The mean expenditure per plant for raising of it in nursery to harvest and scrapping of lac was Rs. 55. Thus, the net return per plant varied from Rs. 140.89 in Lakhnadon-2 to Rs. 17.52 in Amarkantak-4.

Table: 1 Details of the treatments

Genotypes	Source
T_1 TJT-501	JNKVV , Jabalpur district
T_2 Lakhnadon-2	Farmer , Lakhnadon, Seoni district
T_3 Korsar-3	Farmer , Korsar, Singrauli district
T_4 Saraswahi	Farmer , Saraswahi, Jabalpur district
T_5 Gadarwara	Farmer , Gadarwara, Narsinghpur district
T_6 Amarkantak-1	Farmer , Amarkantak, Anuppur district
T_7 Amarkantak-2	Farmer , Amarkantak, Anuppur district
T_8 Amarkantak-3	Farmer , Amarkantak, Anuppur district
T_9 Korsar-2	Farmer , Korsar, Singrauli district
T_{10} Amarkantak-4	Farmer , Amarkantak, Anuppur district

Table 2: - Mean seed yield, lac and fuel wood per *C. cajan* plant

Mean seed yield/plant (g)					Lac yield/plant (g)	Mean weight of fuel wood/plant (g)	
Treatments		Picking					
No.	Genotypes	1st	2nd	Total		Shoot (g)	Total (g)
T_1	TJT-501	615.17	522.67	1137.83	340.00	1422.50	1762.83
T_2	Lakhnadon-2	771.50	662.33	1433.83	414.50	2343.33	2713.33
T_3	Korsar-3	-	870.50	870.50	245.17	3354.00	3784.00
T_4	Saraswahi	563.00	460.83	1023.83	209.33	1599.17	1872.50
T_5	Gadarwara	388.33	272.83	661.17	205.67	1387.33	1674.00
T_6	Amarkantak-1	322.50	275.17	597.67	221.83	676.83	983.50
T_7	Amarkantak-2	558.33	400.17	958.50	245.83	1768.33	2075.00
T_8	Amarkantak-3	414.83	335.50	750.33	240.00	1655.00	1888.33
T_9	Korsar-2	-	956.00	956.00	349.33	4326.67	4746.67
T_{10}	Amarkantak-4	386.50	275.50	662.00	131.83	659.50	836.17
SE(M)		38.13	48.61	71.67	7.21	302.22	303.50
CD at 5%		115.67	144.43	212.93	21.43	897.95	913.62

Table 3: Economics of lac production on *C. cajan* genotypes

Selling price of produce/plant (Rs)												
Treatments		Seed @ Rs 50/kg*			Lac @ Rs 280/kg**			Fuel wood @ Rs 3/kg***			Total	
No.	Genotypes	Yield/ plant (g)	Rs/ plant	Rs/acre	Yield/plant (g)	Rs/ plant	Rs/acre	Yield/ plant (g)	Rs/ plant	Rs/acre	Rs/plant	Rs/acre
T_1	TJT-501	1137.83	56.89	68838.92	340.00	95.20	115192.00	1762.83	5.29	6399.09	157.38	190430.00
T_2	Lakhnadon-2	1433.83	71.69	86746.92	414.50	116.06	140432.60	2713.33	8.14	9849.40	195.89	237028.92
T_3	Korsar-3	870.50	43.53	52665.25	245.17	68.65	83062.47	3784.00	11.35	13735.92	123.52	149463.64
T_4	Saraswahi	1023.83	51.19	61941.92	209.33	58.61	70922.13	1872.50	5.62	6797.18	115.42	139661.23
T_5	Gadarwara	661.17	33.06	40000.58	205.67	57.59	69679.87	1674.00	5.02	6076.62	95.67	115757.07
T_6	Amarkantak-1	597.67	29.88	36158.83	221.83	62.11	75157.13	983.50	2.95	3570.11	94.95	114886.07
T_7	Amarkantak-2	958.50	47.93	57989.25	245.83	68.83	83288.33	2075.00	6.23	7532.25	122.98	148809.83
T_8	Amarkantak-3	750.33	37.52	45395.17	240.00	67.20	81312.00	1888.33	5.67	6854.65	110.38	133561.82
T_9	Korsar-2	956.00	47.80	57838.00	349.33	97.81	118354.13	4746.67	14.24	17230.40	159.85	193422.53
T_{10}	Amarkantak-4	662.00	33.10	40051.00	131.83	36.91	44665.13	836.17	2.51	3035.29	72.52	87751.42
One ha. (Area) = 43560 feet² Spacing 6x6 1210 plant/acre or 2990 plant/ha												

* Selling price of pigeonpea Jabalpur mandi in June 2020

**Selling price of lac in Barghat lac mandi in June 2020

*** Selling price of fuel wood collected from village

Table 4: Meteorological data of the crop growth period

		Temperature (⁰C)		Rainfall (mm)		Wind speed (km/hr)	
SMW		**Range**	**Avg.**	**Range**	**Avg.**	**Range**	**Avg.**
27	Transplanting		29.9		178.8		5.9
28-38	Vegetative growth	28.5-34.9	30.68	24.2-302.1	114.93	0.7-6.9	3.04
39-47	Reproductive growth	28.2-30.3	29.22	0-77.6	10.57	0.6-2	1.26
52-04	1st Picking	20.3-24.1	22.46	0-17.9	6.82	2.5-3	2.76
45-23	Irrigation	20.3-42.4	30.71	0-37.5	5.08	1.2-5.8	3.11
46	Brood Lac Inoculation		28.7		0		1.4
11-12	Adult male emergence	29.9-31.6	30.75	0.5-36.4	18.45	2.4-2.9	2.65
09-15	Reproductive growth	28.5-38.9	32.77	0-36.4	5.77	2.4-3.1	2.84
16-20	2nd picking	37.9-40.1	39.04	0-2.3	0.46	3.2-4.6	3.92
24	Harvesting		40.9		37.5		5.4

Transplanting: - 5th July 2019; BLI: - 15th November 2019; Harvesting: - 12th June 2020; Adult male emergence: - 2nd and 3rd week of March; BLI 132 days after transplanting; Adult male emergence 115-125 days after BLI and 247-257 days after transplanting; Harvesting 212 days after BLI and 344 days after transplanting

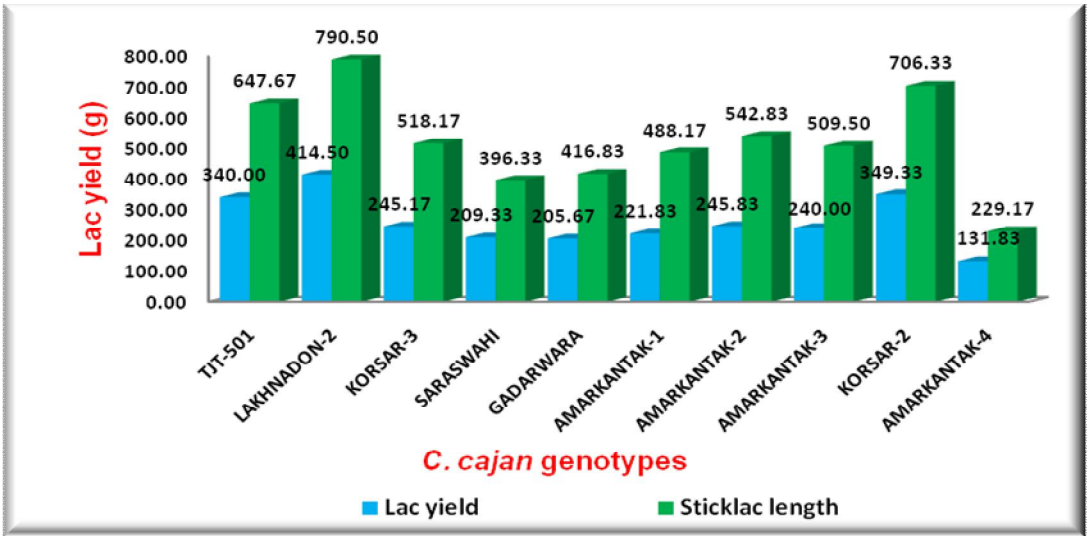

Fig.1 Mean length of stick lac and lac yield of *C. cajan*

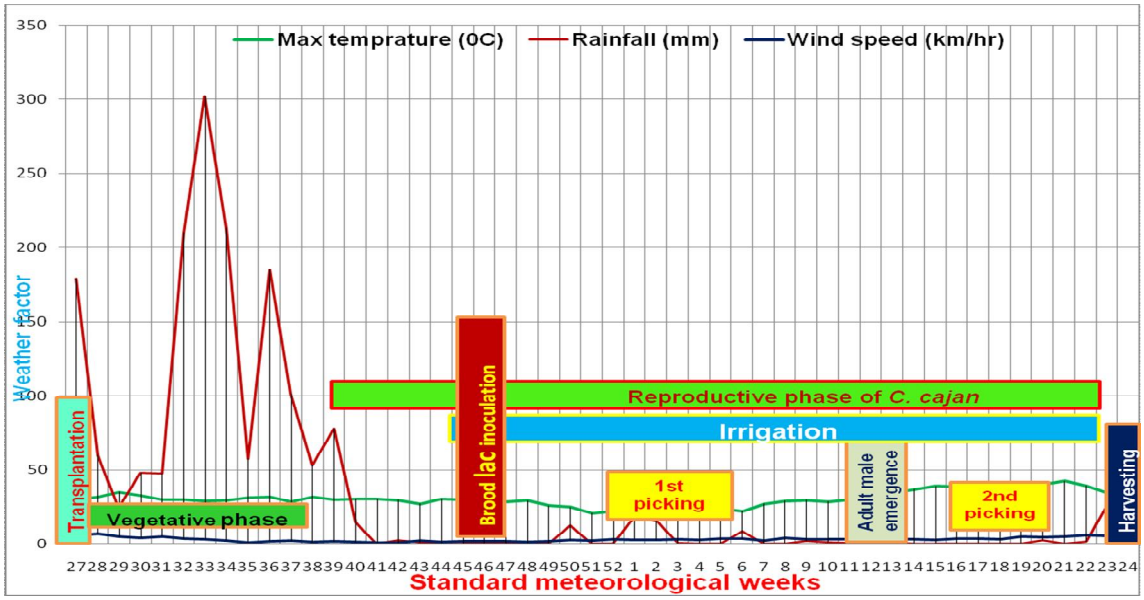

Fig.2 Meteorological data of the crop growth period

CONCLUSION

C. cajan as an annual host plant of *K. lacca* offers a good opportunity to produce *lac* on it without compromising the yield of the host crop.

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COMPETING INTERESTS

The authors have declared that no competing interest exists.

REFERENCES

1. Abebe, T. and Mulu, D. (2017). The Role of Women in the Management and Utilization of Home Garden: The Case of Dale District, in Southern Ethiopia. Asian Journal of Plant Science and Research, **7**(4):41-54
2. Klasen, S., Priebe, J. and Rudolf, R. (2010). Cash Crop Choice and Income Dynamics in Rural Areas: Evidence for Post-Crisis Indonesia. Courant Research Centre PEG, Courant Research Centre: Poverty, Equity and Growth - Discussion Papers. 44. 10.1111/agec.12015.
3. Majumder, A., Kumar, M., Nishad, D., Das, H., and Kumar, A. (2017). Composite index for cash crop production. RASHI, 2 (1): 98-100
4. Rao, N.D., Jihoon, M., Ruth, D., Ghosh-Jerath, S., Hugo, V. and Jess, F. (2018). Healthy, affordable and climate-friendly diets in India. Global Environmental Change, 49: 154-165.
5. Tenorio, A.T., Konstantina, E.K., Suarez-Garcia, E., Corjan van den, B. and Atze Jan van der, G. (2018). Understanding differences in protein fractionation from conventional crops, and herbaceous and aquatic biomass - Consequences for industrial use, Trends in Food Science & Technology, 71: 235-245, ISSN 0924-2244.
6. Srivastavaa, S.K., Sivaramaneb, N. and Mathura, V.C. (2010). Diagnosis of Pulses Performance of India. Agricultural Economics Research Review, 23: 137-148
7. Vajpayee, S., Patidar, R., Kakade, S., Thomas, M., Tripathi, N. and Bhowmick, A.K. (2019). Effect of population density of *Kerria lacca* Kerr. on Rangeeni lac production. International Journal of Chemical Studies, 7(6): 2014-2018
8. Vajpayee, S., Patidar, R., Kakade, S., Thomas, M., Tripathi, N., Bhowmick, A.K., Gontia, A.S., Kulhare, P.S. and Sharma, H.L. (2019). Effect of Population density of *Kerria lacca Kerr*. on its growth and survival. International Journal of Current Microbiology and Applied Sciences, 8(12): 912-924 ISSN: 319-7706.
9. Patidar, R. (2019). Study on the performance of *Kerria lacca* (Kerr.) on *Cajanus cajan* (L.) Millsp. grown on substrate treated with soil microbes Jabalpur, Madhya Pradesh. M.Sc. (Ag) thesis submitted, JNKVV, Jabalpur.
10. Jamadar, M.I., Sajjan, A.S. and Kumar, S. (2014). Economic analysis of seed production in transplanted pigeonpea [*Cajanus cajan* (L.) Millsp.]. International Journal of Commerce and Business Management, 7(1): 63-66.
11. Sharma, S., Swami, H., Lekha, Bhan, C. and Bairwa. H.L. (2018). Life cycle of lac insect on different hosts. Indian J. Appl. Ent., 32(1): 19–23.
12. Kalahal, C., Swami, H. and Lekha. (2017). Productivity-linked parameters of the Rangeeni strain Lac Insect, *Kerria lacca* (Kerr) on Pigeonpea, *Cajanus cajan* Linn. at Rajasthan Journal of Entomology and Zoology Studies, 5(3): 1745-1751
13. Sharma, H., Ghugal, S.G., Gurjar, R., Thomas, M. and Rajawat, B.S. (2015). Performance of Kerria lacca (kerr) in response to foliar application of nutrients on *Butea monosperma*. An International Quarterly Journal of Environmental Sciences, 8: 355-359
14. Ghugal, S.G., Thomas, M. and Pachori, R. (2015). Performance of *Katki* Lac on Nutrient Managed of *Butea monosperma* (Lam.) Taub. Trends in Biosciences, 8(24): 6873- 6877. Print : ISSN 0974-8431
15. Namdev, B.K., Thomas, M., Kurmi, A., Thakur, A.S. and Upadhyaya, A. (2015). Impact of nutrient management of *Zizyphus mauritiana* (lamb.) on the yield of *Kusmi* lac. An International Quarterly Journal of life science. 10(3): 1219-1222.
16. Thomas, M., Khare, V.R., Shukla, P.K., Srivastava, R. and Dave, R. (2011). Impact of promotion of lac cultivation on rural livelihoods and forest conservation in Madhya Pradesh. International Conference on NWFP for Sustained Livelihood Bhopal- India: 30.
17. Shah, T.H., Thomas, M. and Bhandari, R. (2014). Impact of nutrient management in *Z. mauritiana* (Lamb.) on the survivability of lac insect and the yield of *Aghani* crop of *Kusmi* lac. Journal of Entomology and Zoology Studies, 2(5):160-163.
18. Yude, C., Kaiwei, H., Fuji, L. and Yuanjie. (1993). The potential and utilization prospect of 3 kinds of wood fodder resources in Yunnan. Forestry Research, 6(3): 346-350.
19. Mathews, C. and Saxena, K.B. (2005). Prospects for pigeonpea cultivation in drought-prone areas of South Africa. In: In Proceedings of the First International Edible Legume Conference in conjunction with the IVth World Cowpea Congress, 17–21 April 2005, Durban, South Africa.

20. Zhenghong, L. and Fuji, L. (1997). Development prospect on pigeonpea resources for fodder and food. Pages 127–130 in Papers collection of deliberating conference - Industry and Market Development of Special Animals and Plants in Yunnan. Kunming, China: Scientific and Technological Publishing House of Yunnan.