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Growth, yield and economics of Clusterbean (*Cyamopsis tetragonoloba* L. Taub.) cultivars as influenced by various methods of Jeevamrut application

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Abstract

A research was conducted during *kharif*-2023 at loamy sand of College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (Raj.). The treatments consisting of four cultivars [RGC-1066 (V₁), RGC-1033 (V₂), HG-2-20 (V₃) and RGr-12-1(V₄)] in main plots and five treatments of Jeevamrut application [control (B₀), soil application 500 lit ha⁻¹ at 30 DAS (B₁), foliar spray (10%) at 30 DAS (B₂), soil application 500 lit ha⁻¹ + foliar spray (10%) at 30 DAS (B₃) and soil application 500 lit ha⁻¹ + foliar spray (10%) at 30 and 60 DAS (B₄)] in sub-plots, thus 20 treatment combinations were laid out in split blot design with three replication. The results revealed that among clusterbean cultivars, RGC-1066 recorded significantly maximum height at 60 DAS (106.43 cm) and at harvest (163.60 cm), whereas HG-2-20 cultivar was proved significantly superior in dry matter accumulation (DMA) at 60 DAS (319.27 g plant⁻¹) and at harvest (907.95 g plant⁻¹), C.G.R., R.G.R., LAI (2.98), yield attributes viz. clusters plant⁻¹, pods cluster⁻¹ and total number of pod plant⁻¹, seed (2175 kg ha⁻¹), haulm (5434 kg ha⁻¹) and biological (7610 kg ha⁻¹) yield, gross return (140282 ₹ ha⁻¹), net return (101886 ₹ ha⁻¹) and B-C ratio (3.65) over rest of the cultivars. The trail data further revealed that B₄ treatment of Jeevamrut application significantly increased the growth parameters like plant height and DMA 60 DAS and at harvest, C.G.R., R.G.R., LAI (2.69), yield attributes viz. number of cluster plant⁻¹ (10.66), pod cluster⁻¹ (5.20), pod plant⁻¹ (53.32), test weight (32.27 g), seed (2316 kg ha⁻¹), haulm (5373 kg ha⁻¹), biological (7688 kg ha⁻¹) yield and harvest index (30.06), gross return (147281 ₹ ha⁻¹), net return (107783 ₹ ha⁻¹) and B-C ratio (3.73) over rest of the treatments.

Keywords: Jeevamrut, cultivars, yield, foliar, nodules

Introduction

Clusterbean (*Cyamopsis tetragonoloba* L. Taub.), popularly known by its vernacular name guar is an important drought-tolerant leguminous crop belonging to the family Fabaceae. It is believed to have originated in Africa and later spread to the Indian subcontinent, where it has become one of the major arid and semi-arid zone crops. India is the largest producer, consumer and exporter of clusterbean in the world, contributing more than 80 per cent of global production. In Rajasthan, clusterbean is being grown in 2.39 million hectares area with 1.02 million tones production and 449 kg ha⁻¹ average productivity (Anonymous 2024-25) ^[1]. In Rajasthan, Bikaner is the leading district both in terms of area (20.7%) and production (21.9%), however, the average productivity is low (384 kg ha⁻¹). Conventionally grown foods have immense adverse health effect due to presence of higher pesticides residues, high nitrate content, heavy metals, antibiotic residues and genetically modified organisms. The overuse of chemical inputs in agriculture has led to soil and environment pollution. Jeevamrut is liquid organic manure which is an excellent source of organic carbon, nitrogen, phosphorous, potassium and lot of other micro nutrients required by crops. Jeevamrut promotes immense biological activity in soil and makes nutrient available to the crop. It is described as one of the four wheels of Zero Budget Natural Farming (Palekar, 2005) ^[9]. There was three times increase in available phosphate and two times increase in potash content of soil and the improvement in soil pH and E.C were reported to be close to neutral after organic cultivation (Ali *et al.*, 2011) ^[2].

Materials and Methods

A field experiment was conducted during *kharif*-2023 at Agronomy farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The treatments consisting of four cultivars [RGC-1066 (V₁), RGC-1033 (V₂), HG-2-20 (V₃) and RGr-12-1 (V₄)] in main plots and five treatments of Jeevamrut application [control (Bn₀), soil application 500 lit ha⁻¹ at 30 DAS (Bn₁), foliar spray (10%) at 30 DAS (Bn₂), soil application 500 lit ha⁻¹ + foliar spray (10%) at 30 DAS (Bn₃) and soil application 500 lit ha⁻¹ + foliar spray (10%) at 30 and 60 DAS (Bn₄)] in sub-plots, thus 20 treatment combinations were laid out in split blot design with three replication. It was prepared by using fresh cow dung (10 kg), cow urine (5 liters), jaggery (2 kg), gram flour (2 kg), garden/live soil (1 kg) and water (200 liter). To prepare the stock/mother solution of Jeevamrut, water, cow dung and cow urine were added in a wide mouth plastic drum and mixed all these content properly with wooden stick. After that add crushed jaggery, gram flour, live soil into drum and mix all these content properly. Cover it with lid and pack tightly. The contents were stirred daily clockwise and anticlockwise during morning and evening for 13 days. After 13 days, mixture is ready to use. The prepared Jeevamrut was filtered with cloth and used for foliar spray @ 10% in the allotted plots.

Results and Discussion

1. Growth Parameters

1.1 Effect of cultivars: A critical examination of data from table 1 showed that none of the cultivar significantly influenced the plant height at 30 DAS whereas at 60 DAS and at harvest it was found significant. Maximum height was observed in RGC-1066 cultivar at both growths stages *i.e.* 60 DAS (106.43 cm) and at harvest (163.60 cm) and it was statistically superior over RGC-1033, HG-2-20 and RGr-12-1 by 36.01, 62.3 and 29.3 per cent respectively. This may be due to the inherent genetic character of cultivar as RGC -1066 is a single stem cultivar and rest of all are branched ones, therefore energy and store food diverted to the branches whereas in RGC-1066 cultivar, all aforesaid things boost the plant height. Similar findings were given by Sharma *et al.* (2019) [10]. Further data (Table 1) indicated that none of the cultivar significantly affects the DMA at 30 DAS. However, at 60 DAS (319.27 g plant⁻¹) and at harvest (907.95 g plant⁻¹) highest DMA was produced by HG-2-20 cultivar and this might be due to HG-2-20 had higher yield attributing characters (Table

3) therefore plant got more sink sites for accumulation of food which directly add in DMA. Another reason is that, HG-2-20 had maximum LAI which became responsible for a higher rate of photosynthesis and end product is carbohydrate production which reflects as higher DMA. HG-2-20 showed (Table 2) significant higher C.G.R. and R.G.R. at 30-60 DAS (8.46 g m⁻²day⁻¹ and 22.98 g g⁻¹day⁻¹) and 60 DAS-at harvest (12.80 g m⁻²day⁻¹ and 9.87 g g⁻¹day⁻¹), respectively. This is the reason of higher growth rate of a particular cultivar as compared to the rest of all and as C.G.R. and R.G.R. were also computed over DMA at 30, 60 DAS and at harvest. These findings are correlated with the findings of Ammaladinne *et al.* (2022) [3]. Growth character like LAI as shown in table 2 was observed higher (2.98) by HG-2-20 cultivar which was significant superior over RGC-1066, RGC-1033 and RGr-12-1 cultivars by 33.0, 21.6 and 22.1 per cent respectively. The reason is this cultivar has profuse branching character which bears more number of leaves plant⁻¹ and results in higher leaf area and LAI.

1.2 Effect of Jeevamrut

Experiment findings from table 1 depicted that none of the treatment significantly affects plant height and DMA at 30 DAS whereas treatment Bn₄ performed better in plant height and DMA at both growth stages *i.e.* 60 DAS (86.76 cm and 343.69 g plant⁻¹) and at harvest (131.87 cm and 956.56 g plant⁻¹), respectively. This might be due to combined application of Jeevamrut as soil and foliar, increased availability of nutrients at initial stage of growth, through organic manure mineralization. Jeevamrut also contains nutrient elements, plant growth promoting substances and microbial biomass that help in improving plant growth and metabolic activities (Devakumar *et al.*, 2008) [6]. Higher DMA was also directly proportional to the higher growth and yield attributing characters at all stages of growth. Further data from table 2 indicated that treatment Bn₄ gained highest C.G.R. and R.G.R. at both stages *i.e.* 30-60 DAS (9.25 g m⁻²day⁻¹ and 23.81 g g⁻¹day⁻¹) and 60 DAS-at harvest (13.32 g m⁻²day⁻¹ and 9.64 g g⁻¹day⁻¹), respectively. The reason behind this, Bn₄ treatment significantly increased LAI and chlorophyll content which increased availability of essential nutrients at both soil and foliage which helps plant to do more photosynthesis and cause rapid growth over rest of the treatments which results in higher DMA and rapid growth of crop. These findings are correlated with the findings of Sharma *et al.* (2019) [10] and Ammaladinne *et al.* (2022) [3].

Table 1: Effect of different methods of Jeevamrut application on plant height and dry matter accumulation (DMA) of clusterbean cultivars

Treatment	Plant height (cm)			DMA (g plant ⁻¹)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Clusterbean cultivars						
RGC- 1066	30.82	106.43	163.60	67.24	265.30	692.47
RGC - 1033	31.78	77.94	117.65	65.74	275.75	779.63
HG-2-20	31.88	65.59	97.73	65.36	319.27	907.95
RGr-12-1	31.89	82.30	124.68	66.42	282.50	797.74
S.Em.±	0.40	2.16	4.36	1.64	6.99	19.10
CD at 5%	NS	7.48	15.07	NS	24.180	66.099
Methods of Jeevamrut application						
Control	31.67	77.71	117.27	65.04	235.71	644.82
Soil application @ 500 liter ha ⁻¹	31.55	82.46	124.94	66.00	259.97	732.15
Foliar spray (10%) at 30 DAS	31.61	83.65	126.85	65.76	277.75	773.26
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	31.68	84.76	128.64	67.92	311.40	865.46
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	31.47	86.76	131.87	66.24	343.69	956.56
S.Em.±	0.67	1.43	3.15	1.39	2.11	8.28
CD at 5%	NS	4.11	9.07	NS	6.079	23.842

A perusal of data from table 2 highlighted that Bn₄ treatment found significantly superior in LAI (2.69) at 90 DAS over Bn₀, Bn₁, Bn₂ and Bn₃ by 14.0, 10.7, 5.5 and 2.8 per cent respectively. This due to higher microbial activity of Jeevamrut in soil which helps in rapid mineralization of organic manure

and resulted higher solubilisation and mobilization of macro plant nutrient [N,P,K]. Along with soil application, foliar application of Jeevamrut also contains essential plant nutrient such as nitrogen, which helps plant to produce more number of leaves and turns into higher LAI.

Table 2: Effect of different methods of Jeevamrut application on crop growth rate (C.G.R.), relative growth rate (R.G.R.) and LAI of clusterbean cultivars

Treatment	C.G.R (g m ² day ⁻¹)			R.G.R (g g ⁻¹ day ⁻¹)		LAI (90 DAS)
	(0-30 DAS)	(30-60 DAS)	(60 DAS-harvest)	(30-60 DAS)	(60 DAS-harvest)	
Clusterbean cultivars						
RGC- 1066	2.24	6.60	9.29	19.70	9.05	2.24
RGC - 1033	2.19	7.00	10.95	20.54	9.81	2.45
HG-2-20	2.18	8.46	12.80	22.98	9.87	2.98
RGr-12-1	2.21	7.20	11.20	20.83	9.79	2.44
S.Em.±	0.05	0.20	0.27	0.32	0.04	0.06
CD at 5%	NS	0.708	0.920	1.11	0.15	0.22
Methods of Jeevamrut application						
Control	2.17	5.69	8.89	18.51	9.45	2.36
Soil application @ 500 liter ha ⁻¹	2.20	6.47	10.26	19.80	9.75	2.43
Foliar spray (10%) at 30 DAS	2.19	7.07	10.77	20.82	9.65	2.55
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	2.26	8.12	12.04	22.14	9.64	2.62
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	2.21	9.25	13.32	23.81	9.64	2.69
S.Em.±	0.05	0.09	0.15	0.33	0.08	0.02
CD at 5%	NS	0.255	0.435	0.95	NS	0.05

2. Yield Parameters

2.1 Effect of cultivars: An analysis of data (Table 3 and Fig. 1) indicated that variation in clusterbean cultivars for yield attributes found significant. Cultivar HG-2-20 recorded highest clusters plant⁻¹, pods cluster⁻¹ and total number of pod plant⁻¹ as compared to rest of all cultivars. This is may be due to genetic superiority of cultivar to bear more number of cluster and pod meanwhile HG-2-20 cultivar also characterized by a branched cultivar which helps to contain more of number of cluster, pod and total number of pod plant⁻¹ than over other cultivars whereas pod length, seed pod⁻¹ and test weight were found maximum with RGr-12-1 cultivar which is due to its genetic superiority over other cultivars. Similar findings were recorded by Bishnoi *et al.* (2021) [4]. Further data presented in table 5 pointed that HG-2-20 cultivar had maximum seed (2175 kg ha⁻¹), haulm (5434 kg ha⁻¹) and biological (7610 kg ha⁻¹) yield. As yield is direct multiplication of yield attributing characters. Another reason was that all the agronomic practices and recommended dose of nutrients were same for all the cultivars so after managing all the things same, the difference in yield of cultivars was significant, which is a clear indication of genetic difference in cultivars. Haulm yield is directly proportional to DMA and maximum dry weight at harvest (Table 1) was achieved maximum with HG-2-20 cultivar and biological yield depends on seed and haulm yield and HG-2-20 cultivar was significant superior in this aspect over rest cultivars. A close examination of data in table 5 exposed that maximum harvest index was observed in RGr-12-1 (29.58) which was at par with HG-2-20 and RGC-1033 this is because harvest index also calculated over seed and haulm yield. These findings are in close agreement with the findings of Sharma *et al.* (2019) [10].

2.2 Effect of Jeevamrut: It is apparent front at table 3 that all the yield attributes of clusterbean viz., number of clusters plant⁻¹ (10.66), pods cluster⁻¹ (5.20), number of pods plant⁻¹ (53.32), test weight (32.27 g) with soil application 500 lit ha⁻¹ + foliar spray (10%) at 30 and 60 DAS of Jeevamrut treatment. Application of Jeevamrut as soil and foliar might fulfill the nutritional demand of plant during vegetative and flowering

stage leading better photosynthetic efficiency with better partitioning of photosynthates from leaf to sink areas. Meanwhile availability of nutrient especially at flower primodial initiation stage resulted in improvement of sink size which reflected as significantly increased in yield attributes. Further data from table 5 showed that treatment Bn₄ achieved maximum seed (2316 kg ha⁻¹), haulm (5373 kg ha⁻¹), biological (7688 kg ha⁻¹) yield and harvest index (30.06). Since seed yield is a cumulative effect of yield attributes thus significant improvement in yield attributes like cluster plant⁻¹, pod cluster⁻¹, test weight and pod length due to above treatment led to increased seed yield. Similar result was also observed Safiullah *et al.* (2018) [11] in maize, Bhadu *et al.* (2021) [5] in wheat. Haulm yield also increased significantly and it might be due to its direct and positive influence on plant height and DMA as discussed in preceding paragraphs. Whenever liquid manures are applied at regular intervals (1-2 times), they act as a stimulating agent in the plant system and in turn, increased the production of growth regulators in cell system. Palakar (2005) and Devakumar *et al.* (2008) [6] reported the beneficial effects of Jiwamrita which was attributed to huge quantity of microbial load and growth hormones. Biological yield and harvest index (Table 5) have direct correlation with seed and haulm yield.

2.3 Interaction effect of cultivars and Jeevamrut

An appraisal of data (Table 4 and 6) showed that combined effect of cultivar and Jeevamrut significantly increased pods plant⁻¹ and seed yield. Result revealed that maximum number of pods plant⁻¹ (69.71) and seed yield (2664 kg ha⁻¹) were recorded in V₃Bn₄ treatment combination. It was due to ability of HG-2-20 to produce more number of pods plant⁻¹ which accompanied with wholesome supply essential plant nutrients at flowering and seed setting stage by Jeevamrut application thus ultimately increased number of effective pods plant⁻¹. Seed yield is directly for depend upon yield attributing characters and HG-2-20 cultivar had higher yield attributing character which was supported by Bn₄ treatment which has significant effect on seed yield, thus combine both increased the seed yield.

Table 3: Effect of different methods of Jeevamrut application on clusters plant⁻¹, pods cluster⁻¹, number of pods plant⁻¹, seeds pod⁻¹, test weight and pod length of clusterbean cultivars

Treatment	Clusters plant ⁻¹	Pods cluster ⁻¹	Number of pods plant ⁻¹	Seeds pod ⁻¹	Test weight (g)	Pod length (cm)
Clusterbean cultivars						
RGC- 1066	7.88	4.79	35.87	6.22	30.35	5.72
RGC - 1033	8.01	5.13	39.18	7.05	30.79	6.55
HG-2-20	11.45	4.91	54.56	7.00	31.15	6.50
RGr-12-1	10.02	4.56	44.04	7.12	31.61	6.62
S.Em.±	0.17	0.09	1.53	0.17	0.18	0.17
CD at 5%	0.59	0.31	5.31	0.58	0.62	0.58
Methods of Jeevamrut application						
Control	7.64	4.48	32.15	6.63	29.78	6.13
Soil application @ 500 liter ha ⁻¹	8.90	4.90	41.48	6.84	30.87	6.34
Foliar spray (10%) at 30 DAS	9.42	4.63	41.65	6.90	30.94	6.40
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	10.10	5.01	48.46	6.92	31.02	6.42
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	10.66	5.20	53.32	6.94	32.27	6.44
S.Em.±	0.16	0.04	0.73	0.09	0.45	0.09
CD at 5%	0.45	0.12	2.11	NS	1.30	NS

Table 4: Interaction effect of Clusterbean cultivars and Jeevamrut on pods plant⁻¹

Methods of Jeevamrut application	Clusterbean cultivars			
	RGC- 1066	RGC - 1033	HG-2-20	RGr-12-1
Control	28.81	31.64	36.37	31.78
Soil application @ 500 liter ha ⁻¹	35.08	39.34	49.99	41.51
Foliar spray (10%) at 30 DAS	33.70	39.06	55.18	38.67
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	40.05	41.71	61.55	50.55
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	41.69	44.17	69.71	57.70
	S.Em.±	1.46	S.Em.±	1.91
	*CD at 5%	4.21	**CD at 5%	5.49

Table 5: Effect of different methods of Jeevamrut application on seed, haulm, biological and harvest index of clusterbean cultivars

Treatment	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)	H.I (%)
Clusterbean cultivars				
RGC- 1066	1473	4202	5675	25.72
RGC - 1033	1957	4617	6574	29.56
HG-2-20	2175	5434	7610	28.46
RGr-12-1	1927	4535	6462	29.58
S.Em.±	49	176	222	0.33
CD at 5%	170	610	770	1.15
Methods of Jeevamrut application				
Control	1282	3939	5221	24.41
Soil application @ 500 liter ha ⁻¹	1902	4727	6629	28.61
Foliar spray (10%) at 30 DAS	1813	4472	6286	28.81
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	2102	4975	7077	29.76
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	2316	5373	7688	30.06
S.Em.±	20	79	91	0.25
CD at 5%	57	226	261	0.72

Table 6: Interaction effect of Clusterbean cultivars and Jeevamrut on seed yield (kg ha⁻¹)

Methods of Jeevamrut application	Clusterbean cultivars			
	RGC- 1066	RGC - 1033	HG-2-20	RGr-12-1
Control	978	1297	1546	1308
Soil application @ 500 liter ha ⁻¹	1476	2045	2158	1930
Foliar spray (10%) at 30 DAS	1422	1928	2059	1844
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	1669	2153	2449	2136
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	1821	2362	2664	2416
	S.Em.±	39.3	S.Em.±	57.8
	*CD at 5%	113.1	**CD at 5%	166.5

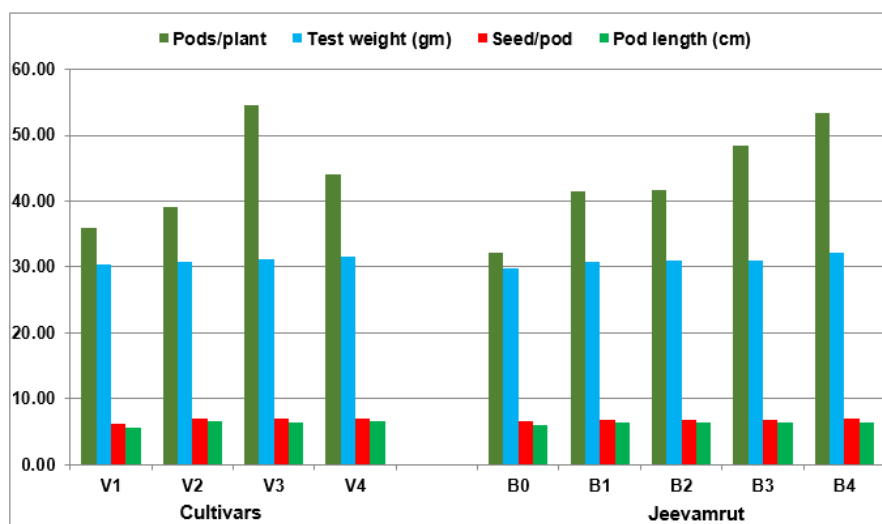


Fig 1: Effect of different methods of Jeevamrut application on yield attributes of clusterbean cultivars

3. Economic analysis

3.1 Effect of cultivars

Data illustrated in table 7 indicated that cultivars were found highly effective to produce variation in economic aspects of clusterbean. Further analysis of data (Table 7 and Fig. 2) revealed that HG-2-20 cultivar proved remunerative in all

economic aspects. Highest gross return (140282 ₹ ha⁻¹), net return (101886 ₹ ha⁻¹) and B-C ratio (3.65) were recorded in HG-2-20 cultivar followed by RGC-1033, RGr-12-1 and RGC-1066, respectively. This superiority of HG-2-20 cultivar was due to highest seed and haulm yield with same common cost of cultivation in

Table 7: Effect of different methods of Jeevamrut application on gross return, net return and B-C ratio by clusterbean cultivars

Treatment	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B-C ratio
Clusterbean cultivars			
RGC- 1066	97620	59225	2.54
RGC - 1033	124850	86455	3.25
HG-2-20	140282	101886	3.65
RGr-12-1	122879	84484	3.19
S.Em.±	3386	3386	0.09
CD at 5%	11717	11717	0.30
Methods of Jeevamrut application			
Control	86360	48700	2.29
Soil application @ 500 liter ha ⁻¹	122555	84565	3.23
Foliar spray (10%) at 30 DAS	116661	78412	3.05
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 DAS	134181	95602	3.48
Soil application @ 500 liter ha ⁻¹ + Foliar spray (10%) at 30 and 60 DAS	147281	107783	3.73
S.Em.±	1279	1279	0.03
CD at 5%	3684	3684	0.10

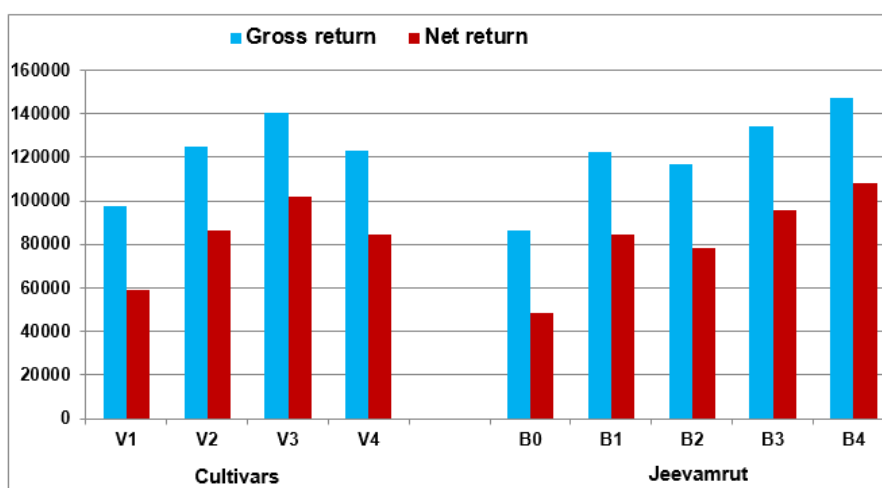


Fig 2: Effect of different methods of Jeevamrut application on economics of clusterbean cultivars

comparison for other cultivars. Response of HG-2-20 was found superior under organic and irrigated condition and its reflection came in yield, but in same situation, rest of all cultivars can't beat the HG-2-20. Gross and net return depends upon yield of crop and market price of crop whereas all the cultivars have same market price. The results of the present investigation corroborate the findings of Bishnoi *et al.* (2021) ^[4] and Lal *et al.* (2023) ^[8].

3.2 Effect of Jeevamrut

Results from table 7 showed that maximum gross return (147281 ₹ ha⁻¹), net return (107783 ₹ ha⁻¹) and B-C ratio (3.73) of clusterbean were recorded with the combined application of soil (500 lit ha⁻¹) and foliar (10%) at twice *i.e.* 30 and 60 DAS as Bn₄ treatment as compared to other methods of Jeevamrut application. This is because Jeevamrut is one of the cheapest and efficient organic formulations to other organic formulation, for high crop yield and profitability, besides improving the nutrient status of the soil. Similar results were found by Divya and Mahapatra (2015) ^[7] in rice and Bhadu *et al.* (2021) ^[5] in wheat.

Conclusion

Thus, on the basis of one year experimentation, it can be concluded that cultivation of HG-2-20 cultivar along with the soil application 500 liter ha⁻¹+ foliar spray (10%) at 30 and 60 DAS of Jeevamrut is a remunerative approach in maximizing the crop productivity under organic cultivation system.

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