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Effect of Foliar Application of Organics and Fertilizers on Growth Yield and Economics of Cluster Bean (*Cyamopsis tetragonoloba* L. Taub.)

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ABSTRACT: For optimal plant growth, nutrients must be present in appropriate and balanced amounts. Natural reserved plant nutrients in soil are mainly unavailable to plants. The rate of release of nutrients is insufficient to compensate for the depletion of nutrients required for crop. During the reproductive stage, root activity decreases, and more nutrients are required at the same time. Foliar spraying with nutrient solution is an alternate source of nutrients. A field experiment was carried out to study the effect of foliar applied organics and fertilizers on growth and yield of cluster bean (*Cyamopsis tetragonoloba* L. Taub.) during *kharif*, 2019 at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The experiment was laid out in randomized block design with thirteen treatments and three replications. The treatments viz., T_1- control, T_2- water spray, T_3- urea @ 2%, T_4- DAP @ 2%, T_5- NPK @ 1%, T_6- Panchagavya @ 3%, T_7- Panchagavya @ 5%, T_8- cow urine @ 5%, T_9- cow urine @ 10%, T_{10}- Jeevamrut @10%, T_{11}- Jeevamrut @15%, T_{12}- cow dung extract @ 5% and T_{13}- cow dung extract @ 10% in the form of two foliar sprays were applied at 40 and 55 DAS. Foliar spray of organics and fertilizers had significant influence on growth parameters, yield attributes and yield of cluster bean as compared to control and water spray. Foliar spray of *Panchagavya* @ 3% significantly improved the plant height at harvest, dry matter accumulation at 90 DAS and at harvest in comparison to control and water spray. Significantly higher number of pods plant^{-1}, number of seeds pod^{-1}, seed yield, straw yield and biological yield were also observed with foliar spray of *Panchagavya* @ 3% and it was at par with foliar sprays of NPK @ 1%, *Panchagavya* @ 5%, *Jeevamrut* @10% and *Jeevamrut* @15%. Economic study of data affirmed that net returns was highly influenced by foliar application of Panchagavya @ 3% and accrued 29563/ha with B:C ratio of 2.38.

Keywords: Cluster bean, *Jeevamrut*, *Panchagavya*, plant height, dry matter, seed yield and economics.

INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.Taub.) commonly known as guar, is a coarse, drought tolerant legume, mainly grown in *kharif* season in arid and semi-arid regions of the country. This crop is a rich source of nourishment and is considered as protective supplementary food as it contains large quantities of minerals, vitamins and essential amino acids. Galactomannan gum, a natural polysaccharide water-soluble polymer discovered in endosperm (Reddy *et al.*, 2011), is the main product used in various industries (Amin *et al.*, 2007). For export, cluster bean cultivars with a high gum content (>32%) are preferable (Bhatt *et al.*, 2015). Cluster bean gum is in high demand in the international market because to its numerous applications in the textile, paper, explosives, and mining sectors, as well as pharmaceuticals, cosmetics, and food products. Cluster bean improves soil fertility by fixing a significant amount of nitrogen from the atmosphere (Singh and Usha, 2003). It can fix 37-196 kg of atmospheric nitrogen/ha/year in soil. It is occasionally employed in the reclamation of saline and alkaline soils (Mahata *et al.*, 2009). Fertilizers and organic manures are essential for increasing cluster bean yield. Nitrogen is the most critical nutrient for plant growth and development among the several plant nutrients. Nitrogen, as one of the most significant components of plant nutrition, is essential for the synthesis of chlorophyll and amino acids (Masclaux-

Daubresse *et al.,* 2006). Inadequate nitrogen can severely limit yield and degrade the quality of crops, particularly the protein content.

In India, cluster bean is grown over an area about 3.46 million ha with an average production of 1.31 million tonnes Average grain yield of 378 kg/ha (Anonymous 2020). Total coverage under cluster bean in Rajasthan 2.84 million ha with a production 1.28 million tonnes and the productivity 452 kg/ha (Anonymous 2019). Nutrient application via foliar spray at critical periods of crop growth is critical for their utilisation and improved crop performance (Anandhakrishnaveni *et al.,* 2004).

Foliar application is credited with the benefits of rapid and efficient nutrient consumption, elimination of losses due to leaching and fixation, and regulation of nutrient uptake by plants (Manonmani and Srimati, 2009). In order to improve crop productivity and quality, there is an urgent need to limit the usage of chemical fertilisers in agriculture. One option is the use of organic nutrients or growth regulators, which may promote plant growth through a variety of mechanisms. *Panchagavya a*nd *Jeevamrut* are organic preparations made by cow products namely dung, urine, milk, curd and ghee. The *Panchagavya* is a potential organic product to play great role for promoting growth and providing immunity in plant system. Foliar spray of p*anchagavya* @ 3 % increases number of pods plant^{-1}, pod length, number of seeds pod^{-1} and seed yields (Panchal *et al*., 2017; Gunasekar *et al*., 2018). *Jeevamrut* is liquid organic manure that is high in organic carbon, nitrogen, phosphorus, potassium, and a variety of other micronutrients that crops require. Gore and Sreenivasa (2011) reported that application of beejamruth + *jivamrut*h + *Panchagavya* improve the yield of crops. Antifungal qualities and a strong source of plant nutrients are both found in cow urine. It has a nitrogen content of 1.0 per cent, traces of phosphorus, and 1.0 per cent potassium. Cow urine is a natural disinfectant as well as a bug repellent. Cow manure improves the texture of the soil and helps it to maintain moisture. Manure can also improve the texture of the soil and help it to maintain moisture. Therefore, keeping these points in view present study was planned to study the effect of foliar application of organics and fertilizers on growth and yield of cluster bean.

MATERIAL AND METHODS

The experiment was conducted at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *kharif* season 2019. It is situated at 28°10′N latitude, 73°35′E longitude and 235 meters above mean sea level in Agro-climatic zone Ic (Hyper arid partially irrigated western plain) of Rajasthan.

The soil of experimental field was loamy sand in texture and slightly alkaline in reaction (pH 8.3), poor in organic carbon (0.07 per cent), very low in available nitrogen (89.25 kg ha^{-1}) and low in phosphorus (19.5 kg ha^{-1}) and medium in available potassium (190.35 kg ha^{-1}).

The experiment comprised thirteen treatments viz., T_1- control, T_2- water spray, T_3- urea @ 2%, T_4- DAP @ 2%, T_5- NPK @ 1%, T_6- *Panchagavya* @ 3%, T_7- *Panchagavya* @ 5%, T_8- cow urine @ 5%, T_9- cow urine @ 10%, T_{10}- *Jeevamrut* @10%, T_{11}- *Jeevamrut* @15%, T_{12}- cow dung extract @ 5% and T_{13}-cow dung extract @ 10%. The experiment was laid out in randomized block design with three replications.

Sowing of cluster bean was done on 24th July 2019 with 30 × 10 cm crop geometry. Two irrigations were given as per the demand of crop using sprinkler irrigation method. Nitrogen was supplied through urea @ 20 kg ha^{-1} and phosphorus was supplied @ 32 kg ha^{-1} through SSP at the time of sowing as basal application.

The *Panchagavya* was prepared by mixing of cow dung (5 kg) and ghee (1 kg) in a wide mouth plastic container for 72 hours. After that remaining ingredients viz. cow urine (3 litres), cow milk (2 litres), curd (2 kg), jaggary (1 kg) and banana (1 dozen) were added and the container was kept for 15 days for fermentation. The contents were stirred daily clockwise and anticlockwise during morning and evening. The prepared *Panchagavya* was filtered with cloth and used for foliar spray @ 3% and 5 % in the allotted plots. Fresh cow urine from indigenous cows was collected and used for spray @ 5% and 10%. *Jeevamrut* was prepared by using fresh cow dung (10 kg), cow urine (5 litres), jaggery (2 kg), gram flour (2 kg), garden/live soil (1 kg) and water (200 litres). 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 ingradients properly with wooden stick. After that crushed jaggery, gram flour, live soil were added into drum and mixed 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% and 15 % in the allotted plots. Cow dung extract was prepared with Cow dung. Cow dung was taken into an earthen pot and water added into until it's become completely saturated. Muslin cloth was spread on a bucket and saturated cow dung paste was pour on it. Now muslin cloth was hanged at a height and bucket was kept under it for 4 to 5 hours so that the extract was collected into bucket. Now the extract was ready to use. A solution containing 2% urea was prepared and sprayed. Solution of desired concentration of DAP (2%) was prepared and sprayed. Water soluble NPK (19:19:19) was used to prepare 1% solution and sprayed.

Five plants were selected randomly from each plot and tagged. Height of tagged plant was measured at harvest from base of the plant to top of the main shoot and averaged to express as plant height (cm) at harvest.

Plant sample were randomly taken from each plot at 45, 90 DAS and at harvest for estimation of dry matter accumulation.

Five randomly chosen plants had their pods counted, and the average number of pods per plant was calculated and recorded as the mean number of pods per plant. Ten pods from each plot were threshed at random during threshing and the total number of seeds counted. The number of seeds per pod was calculated by averaging the results. At the time of threshing, five pods were randomly selected from each plot and the length was measured from the base to the top of the pod, and then averaged to give the pod length (cm) at harvest. A small seed sample was randomly collected from the produce of each plot for recording test weight, and 1000 seeds were counted and weighed. The weight of seeds gathered from each plot after harvesting and threshing was recorded and then converted to kg/ha. By subtracting seed yield (kg/ha) from biological yield (kg/ha), straw yield (kg/ha) was estimated. Harvested bundles of each net plot (4.0 m × 1.8 m) were weighed after sun drying for biological yield and converted to kg/ha.

RESULT AND DISCUSSION

A. Growth attributes

Foliar sprays of organics and fertilizers were significantly improved the plant height and dry matter accumulation of cluster bean (Table 1). Application of *panchagavya* @ 3% recorded maximum plant height (123.4 cm) at harvest which was significantly higher by 29.4, 24.1, 21.7, 18.7, 21.9, 18.2, 17.2 and 15.8 per cent over control and foliar spray of water, urea @ 2%, DAP @ 2%, cow urine @ 5%, cow urine @ 10%, cow dung extract @ 5% and cow dung extract @ 10%, respectively.

Dry matter accumulation was found to improve at all the growth stages under study except at 45 DAS (Table 1). It was observed that foliar spray of *panchagavya* @ 3% has resulted in significantly higher dry matter accumulation at 90 DAS and at harvest. Foliar spray of *panchagavya* @ 3% remained at par with NPK @ 1%, p*anchagavya* @ 5%, *jeevamrut* @10% and *jeevamrut* @15% as compared to control, water spray, urea @ 2%, DAP @ 2%, cow urine @ 5%, cow urine @ 10%, cow dung extract @ 5% and cow dung extract @ 10%. Foliar spray of *panchagavya* @ 3% increases dry matter accumulation to the tune of 73.5 and 57.6 and 43.9 and 36.4 per cent of as compared to control and water spray at 90 DAS and at harvest, respectively.

Foliar sprays enhanced the availability of nutrients at the site of photosynthesis leading to improved growth of cluster bean plants. Organics as *panchagavya* and *jeevamrut*, possessed good amount of nutrients enriched with beneficial microorganism and growth promoting substances along with other enzymes (Gore and Sreenivasa, 2011). Similar results were also reported by Yadav *et al*. (2017); Gunasekar *et al*. (2018).

Table 1: Effect of foliar application of organics and fertilizers on growth attributes of cluster bean.

Treatments	Plant height (cm) at harvest	Dry matter accumulation (g plant^{-1})		
		45 DAS	90 DAS	At harvest
Control	95.3	4.76	9.21	19.17
Water spray	99.4	4.84	10.14	20.22
Urea @ 2%	101.4	5.20	12.84	23.25
DAP @ 2%	103.9	5.30	13.33	24.99
NPK @ 1%	116.3	5.61	14.35	26.16
Panchagavya @ 3%	123.4	5.65	15.98	27.58
Panchagavya @ 5%	127.4	5.80	16.41	28.97
Cow urine @ 5%	101.3	5.26	11.89	22.16
Cow urine @ 10%	104.4	5.35	12.19	22.89
Jeevamrut @10%	117.1	5.52	14.92	25.70
Jeevamrut @15%	120.3	5.66	14.95	26.78
Cow dung extract @ 5%	105.3	5.42	12.37	23.13
Cow dung extract @ 10%	106.5	5.51	12.90	23.58
S.Em.±	5.7	0.41	0.87	0.98
C.D. (P=0.05)	16.8	NS	2.54	2.85

B. Yield attributes

Pods plant^{-1} and number of seeds pod^{-1} significantly differed with foliar spray of organics and fertilizers (Table 2). Significantly higher number of pods plant^{-1} were recorded with the foliar spray of *panchagavya* @ 3% over rest of the treatments except *panchagavya* @ 5%, *jeevamrut* @10% and *jeevamrut* @15%. The number of seeds pod^{-1} were significantly increased with foliar spray of *panchagavya* @ 3% in comparison to control, water spray, urea @ 2%, DAP @ 2%, cow urine @ 5%, cow urine @ 10% and cow dung extract @ 5% and found to be statistically non-significant with NPK @ 1%, p*anchagavya* @ 5%, *jeevamrut* @10% and *jeevamrut* @15% and cow dung extract @ 10%. Foliar spray of *panchagavya* @ 3% significantly increased the number of pods plant^{-1} and number of seeds pod^{-1} by 51.67 and 11.82 per cent over control, respectively. The larger number of pods plant^{-1} and seeds pod^{-1} could be due to the maximal nutritional

enrichment, as well as good vegetative development and photosynthate translocation. Organic treatments may have provided the crop with micro and macro nutrients as well as growth-promoting chemicals, resulting in an increase in the number of pods plant^{-1} and seeds pod^{-1}. Higher number of pods plant^{-1} in green gram with foliar spray of *panchagavya* @ 3% was also reported by Somasundaram *et al.* (2003).

Table 2: Effect of foliar application of organics and fertilizers on yield attributes of cluster bean.

Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	Pod length (cm)	Test weight (g)
Control	31.60	7.27	4.63	32.5
Water spray	32.80	7.33	4.68	32.8
Urea @ 2%	38.33	7.40	4.75	33.0
DAP @ 2%	40.73	7.47	4.78	33.7
NPK @ 1%	42.00	7.73	5.01	33.9
Panchagavya @ 3%	47.93	8.13	5.03	33.9
Panchagavya @ 5%	50.87	8.20	5.11	34.0
Cow urine @ 5%	33.80	7.37	4.70	32.4
Cow urine @ 10%	35.40	7.43	4.71	32.5
Jeevamrut @10%	44.07	8.00	4.81	33.5
Jeevamrut @15%	45.87	8.07	4.94	33.8
Cow dung extract @ 5%	39.07	7.38	4.82	32.8
Cow dung extract @ 10%	40.87	7.58	4.88	33.0
S.Em.±	1.80	0.21	0.20	0.5
C.D. (P=0.05)	5.26	0.61	NS	NS

C. Yield

Seed and straw yield of cluster bean increased with foliar spray of organics and fertilizers (Table 3). Significantly higher seed yield (1216 kg ha^{-1}) was obtained with foliar spray of *panchagavya* @ 3% as compared to control, water spray, urea @ 2%, DAP @ 2%, cow urine @ 5%, cow urine @ 10%, cow dung extract @ 5% and cow dung extract @ 10% and at par with NPK @ 1%, *panchagavya* @ 5%, *jeevamrut* @10% and *jeevamrut* @15%. Significantly higher seed yield recorded with the application of *panchagavya* @ 3% and *panchagavya* @ 5%, *jeevamrut*h @ 10% and *jeevamrut*h @ 15% and NPK @ 1% was due to the cumulative effect of growth and yield attributes, like plant height, dry matter accumulation, number of pods plant^{-1} and number of seeds pod^{-1} and slight improvement in test weight which were the important yield attributes having significant positive correlation with seed yield. Crop yield is the result of a complex interaction of physiological and biochemical processes that alter the anatomy and morphology of growing plants. According to Natarajan (2002), foliar spraying panchgavya at a concentration of 3% was beneficial in the majority of crops. The present trend of increase in seed yield with application of organics and fertilizers were also observed by Kumar *et al.*, (2011); Patel *et al.*, (2013); Shariff *et al.* (2017).

Significantly higher straw yield (2712 kg ha^{-1}) was also recorded with foliar spray of *panchagavya* @ 3% with an increase of 41.76 over control. It was on account of its direct and positive influence on plant height and dry matter production. These findings were in accordance with Patel *et al*. (2013) I cowpea and Panchal *et al.*, (2017) in chick pea.

The improvement in yield attributes and yields with *panchagavya* and *jeevamrut* treatment could be attributed to the fact that cow excrement in *panchagavya* acts as a medium for the growth of beneficial bacteria, and cow urine offers nitrogen, which is necessary for crop growth (De Britto and Girija, 2006). These findings are in line with those of Patil *et al.* (2012).

D. Economics

Net return and B:C ratio have a stronger impact on the practical utility and adoption of the technology. Significantly higher net return (₹ 29563/ha) and B:C ratio (2.38) were recorded with the application of *Panchagavya* @ 3% (Table 3) in comparison to control and water spray and remained at par with *panchagavya* @ 5%, and NPK @ 1%. The increased net returns and B:C ratio could be explained on the basis of increased seed and straw yield under these treatments. These findings are in line with those reported by Singhal *et al*. (2015); Panchal *et al*. (2017); Zinzala *et al*., (2018).

Table 3: Effect of foliar application of organics and fertilizers on yield and economics of cluster bean.

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Control	824	1913	17218	1.98
Water spray	868	2135	17872	1.93
Urea @ 2%	1025	2235	23346	2.20
DAP @ 2%	1072	2417	25332	2.29
NPK @ 1%	1150	2578	28296	2.42
Panchagavya @ 3%	1216	2712	29563	2.38
Panchagavya @ 5%	1277	2744	30273	2.33
Cow urine @ 5%	925	2205	19439	1.98
Cow urine @ 10%	982	2439	21635	2.05
Jeevamrut @10%	1123	2543	24007	2.03
Jeevamrut @15%	1163	2585	23515	1.93
Cow dung extract @ 5%	950	2135	20546	2.06
Cow dung extract @ 10%	990	2322	22592	2.17
S.Em.±	49	151	1815	0.09
C.D. (P=0.05)	142	442	5299	0.25

CONCLUSION

Foliar application of *panchagavya* @ 3% found to be equally effective to NPK @ 1% in improving growth parameters, yield attributes yield and economics of cluster bean and hence it can be used as an alternate source of nutrients in standing crop of cluster bean in place of chemical fertilizers.

FUTURE SCOPE

The result of the study will provide the basis for future research to find out the suitable and sustained source of nutrients in standing crop for organic growers in the time of fertilizer crisis.

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Conflict of Interest. None.

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