REVIEW ARTICLE

Response of cluster bean (*Cyamopsis tetragonoloba* L. Taub.) to organics and fertilizers in hyper arid region: A review

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Cluster bean (*Cyamopsis tetragonoloba* L.Taub.), also known as guar, is a coarse, drought-tolerant legume that is primarily grown during the kharif season in arid and semi-arid regions of the country. Important minerals such as calcium, phosphorus and iron are generally lacking in cereals but abundant in this legume. The natural polysaccharide water-soluble polymer found in endosperm, known as galactomannan gum, is the primary product used in many industries. Cluster bean cultivars with a high gum content (>32%) are more suitable for export. Panchagavya and Jeevamrut are affordable, eco-friendly organic concoctions crafted from cow by-products such as dung, urine, milk, curd and ghee. Panchagavya is an effective plant growth stimulant and organic product that can help promote growth and provide immunity in the plant system. Panchagavya contains growth regulatory substances such as Indole-3-Acetic Acid (IAA) and Gibberellic Acid (GA), which are required for crop growth. Jeevamrut stimulates significant biological activity in the soil, making nutrients available to crops. Cow urine has anti-fungal properties and is a good source of plant nutrients. Cow manure is high in minerals, specifically nitrogen, phosphorus and potassium. When mixed with soil, it promotes the growth of beneficial microorganisms.

Key Words: *Panchagavya; Cluster bean; Jeevamrut; Cow urine; Cow dung extract; Urea*

INTRODUCTION

Cluster bean improves soil fertility by fixing a significant amount of atmospheric nitrogen. It can fix approximately 37-196 kg of atmospheric nitrogen per hectare per year in soil. It is sometimes used to reclaim saline and alkaline soils [1-5]. Fertilizers and organic manures play an important role in increasing cluster bean yield [6]. Nitrogen stands as the paramount nutrient crucial for the growth and development of plants. Nitrogen, as a key component of plant nutrition, is essential for the synthesis of chlorophyll and amino acids [7]. Insufficient nitrogen can significantly reduce yield and degrade produce quality, particularly protein content.

Because arid soils are both hungry and thirsty, foliar nutrient application is critical for increasing crop production and productivity. As a result, it may be necessary to conduct research to identify appropriate nutrient sources for foliar application in order to increase crop quantity and quality. Due to environmental concerns, there is an urgent need to reduce the use of chemical fertilizers in agriculture and chemical-free alternatives are being sought to improve crop productivity and quality. One option is to use organic nutrients or growth regulators, which can promote plant growth *via* a variety of mechanisms such as organic nutrient supply or plant hormone production. Panchagavya and Jeevamrut are cost-effective, environmentally friendly organic formulations crafted from cow-derived substances like dung, urine, milk, curd and ghee. Panchagavya is an effective plant growth stimulant and organic product that can help promote growth and provide immunity in the plant system. Farmers in South India are using Panchagavya for sustainable agriculture [8]. It is used to activate the soil, protect plants from disease and improve the nutritional value of fruits and vegetables. Panchagavya contains growth regulatory substances such as IAA and GA, which are required for crop growth [4]. It is used for foliar spraying, soil application with irrigation water and seed treatment. Panchagavya is an organic product endorsed for enhancing crops in organic farming [9]. Jeevamrut is a liquid organic manure that contains a high concentration of organic carbon, nitrogen, phosphorous, potassium and other micronutrients (Ca, S and Fe) that crops require. Jeevamrut has demonstrated greater effectiveness compared to other manures and can be utilized in combination with them.

Jeevamrut stimulates significant biological activity in the soil, making nutrients available to crops. Cow urine has anti-fungal properties and is a good source of plant nutrients. It's been used in crop production for ages. Cow urine contains approximately 1.0% nitrogen, traces of phosphorus and 1.0% potassium. Annually, approximately 2400 to 2500 liters of urine are produced per animal. If this urine was not conserved, the nitrogen, which is primarily in the form of urea, would be rapidly lost as ammonia. It is also used as a natural disinfectant and pest repellent and it is the primary ingredient in Panchagavya (an organic crop booster prepared and sprayed by Indian farmers) [10]. Cow manure is high in minerals, specifically nitrogen, phosphorus and potassium. When mixed with soil, it promotes the growth of beneficial microorganisms. Manure can also improve the texture of the soil and help it retain moisture.

LITERATURE REVIEW

Effect of organics and fertilizers on cluster bean

Growth parameters: When wheat (*Triticum aestivum* L.) was sprayed with urea 4% during tillering, stem elongation and boot stage, the plant height and spike length increased significantly [11]. A pot experiment revealed that applying 3% Panchagavya spray 10 days after sowing resulted in significantly increased lateral roots, number of nodules, fresh and dry mass of the plants and total leaf area [12]. While working at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, the application of RD F+beejamruth+jivamrut+Panchagavya resulted in significantly higher plant growth and root length of tomato (*Lycopersicon esculentum*) compared to other treatments [13]. A pot experiment on black gram (*Vigna mungo*) found that applying 3% Panchagavya at the 15th, 25th, 35th and 45th days of the interval period resulted in a significant improvement in plant height (42.6 cm) and number of branches plant^{-1} (10) when compared to Nitrogen, Phosphorus and Potassium (NPK) and control. The foliar application of Panchagavya also significantly improved the chlorophyll content (Chlorophyll a, b and total 2.2, 0.9, 6 and 3.2 mg g^{-1}, respectively) and N content of root nodules (5.50 g) when compared to NPK and control [14]. Applying Panchagavya (3%) 15 days after flowering resulted in increased chickpea plant height (37.01 cm), number of branches per plant (5.22) and root nodules (20.50) [15]. At 75 Days After Sowing (DAS), spraying chickpea with 2% urea and Diammonium Phosphate (DAP) resulted in the highest Soil-Plant Analysis Development (SPAD) chlorophyll meter readings of 69.6 and 67.5, respectively [16]. A field experiment on summer cowpea at was carried out Agronomy Instructional

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Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of foliar application of 3 % Panchagavya on growth parameters of cowpea. The application of Panchagavya at 3% resulted in significant maximum dry matter accumulation of 38.73 g, 66.67 g and 92.00 g at 30 days after sowing, 60 days after sowing and harvest, respectively [17]. While working on black gram (*Vigna mungo*), we observed significantly higher growth and yield in pots treated with 50% vermicompost [18]. A field experiment on brinjal (*Solanum melongena*) was carried out to show that vermi wash spray enhanced the growth parameters like plant height and number of leaves [19]. On the basis of an experiment on cluster bean (*Cyamopsis tetragonoloba* L. Taub.) observed best performance in terms of dry matter production and seed quality parameters at 2 % cow urine [20]. While working on *Dolichus lablab* showed that application of different concentrations of vermi wash and Panchagavya (5:2 %, 10:3% and 15:4%) significantly increased the Chlorophyll-a (0.81 mg g^{-1}) and Chlorophyll-b (0.75 mg g^{-1}) [21]. Chickpea reached its highest plant height (54.9 cm) at C. P. College of Agriculture, Sardar Krushinagar Dantiwada Agricultural University, with 4% Panchagavya spray during the branching and flowering stages when compared to other treatments [22]. A field experiment was conducted in Udaipur (Rajasthan) and the tallest plant (54.48 cm), dry matter accumulation (17.90 g $plant^{-1}$) and haulm yield (2804 kg ha^{-1}) were significantly higher with panchagvya 3% than with cow urine and control. The effect remained consistent with vermiwash 10% [23]. The application of jivamrut at 1000 L ha^{-1} and Panchagavya at 7.5% resulted in significantly higher plant height, branch count, leaf area and leaf area index [24]. A field experiment conducted at Navsari Agricultural University found that foliar application of 3% Panchagavya+2% banana pseudostem sap during the branching and flowering stages resulted in a significantly higher plant height at harvest (46.60 cm) [25].

Yield attributes and yield: According to the findings of a field study carried out at Tamil Nadu Agricultural University in Coimbatore, applying Biogas Slurry (BGS) with panchagavya increased maize and sunflower yield [26]. Spraying 4% urea solution foliarly at tillering, stem elongation and boot stage resulted in a 32% increase in grain yield, $spike^{-1}$ number of grains, seed index, biological yield and grain yield [11]. To investigate the impact of Panchagavya on the growth characteristics of the sesame crop, a field experiment was carried out. Two Panchagavya sprays at 30 days after sowing and flowering stage produced a noticeably higher yield than no Panchagavya spray [27]. When beejamruth+jivamruth+Panchagavya were applied, the yield was noticeably higher than when Recommended Dose of Fertilizer (RDF) was used alone [13]. When compared to other treatments, foliar spraying with 2% urea and DAP at 75 DAS produced the highest pods $plant^{-1}$ (45.3), seed index (16.9), seed yield (2437 kg ha^{-1}) and (2389 kg ha^{-1}) [16]. When 2% DAP, 2% urea and 2% Potassium Chloride (KCL) were sprayed on the leaves of cowpea plants (*Vigna unguiculata* L.) during branching and flowering, a noticeably increased seed yield was observed [28]. The highest number of branches (6.0), number of pod $plant^{-1}$ (12.33), number of seeds $plant^{-1}$ (11.33), pod length (11.89 cm), number of root nodules $plant^{-1}$ (18.33), seed index (8.30 g) and seed yield $plant^{-1}$ (8.33 g) were recorded following the application of 3% Panchagavya spray at 20 and 40 days after sowing. Under this treatment, the highest stover yield (2373 kg ha^{-1}) and seed yield (1509 kg ha^{-1}) were also noted [17]. Working with baby corn revealed that the highest fresh baby corn yield (7439 and 7476 kg ha^{-1} in 2008 and 2009, respectively) was recorded with four sprays of 3% Panchagavya at 15, 25, 35 and 45 Days After Showing (DAS) in conjunction with 100% RDF [29]. According to a field experiment on organic farming, the application of panchagavya and cow urine increased grain yield to a maximum, while plots without these treatments showed the lowest grain yield [30]. Based on a field experiment, it was determined that applying 100% RDF as fertigation and vermi wash foliar spray 1:4 at 15 and 30 days after seed sowing resulted in significantly higher values of root diameter (10.41 cm), length (23.79 cm), weight (85.21 g), yield plot-1 (17.04 kg), yield ha^{-1} (56.80-ton ha^{-1}) and marketable yield (49.25-ton ha^{-1}) of radish [31]. The number of pods $plant^{-1}$, number of seeds pod-1, number of seeds $plant^{-1}$, biomass and grain yield of common beans were all considerably increased by foliar spraying NPK [32]. A study conducted at a certified organic farm by Navsari Agricultural University's ASPEE College of Horticulture and Forestry and backed by Biological Consortium (BC), Vermicompost (VC) and Compost tea (CC) plus percent cow urine produced significantly higher grain (952.30 kg ha^{-1}) and stover (1870.55 kg ha^{-1}) yields of chickpeas, which were comparable to other treatments [33]. It was reported that a 2% urea foliar spray had a significant impact on black gram seed yield based on a field experiment [34]. According to a field study carried out at the Agricultural Research Station in Chintamani, Karnataka, foliar application of 2% urea produced the highest yield of groundnuts (*Arachis hypogaea*) [35]. Applying urea (2%) and DAP (2%) topically at 25 and 45 days after seeding resulted in noticeably improved cluster bean yield attributes and yield [36]. Increased nodule weight (15.67), fresh nodule weight (157.57 mg), dry nodule weight (52.67 mg), seed yield (2054 kg ha^{-1}) and stover yield (2483 kg ha^{-1}) of chickpea with 4% Panchagavya sprayed at branching and flowering stage [22]. According to the results of a field experiment, applying foliar spray of Panchagavya (3%) at flower initiation and 15 DAF led to significantly higher numbers of pods $plant^{-1}$ (21.27), pod length (10.25 cm), number of seeds pod-1 (12.10), seed yield $plant^{-1}$ (12.89 g $plant^{-1}$) and seed yield (1263.68 kg ha^{-1}) with concurrently higher seed index (5.86 g) [37]. Applying Panchagvya at 3% was found to be on par with vermi wash at 10% when working with chickpeas. It also produced noticeably higher pods $plant^{-1}$ (49.54) and seed yield (1888 kg ha^{-1}) when compared to cow urine and control [23]. The treatments supplemented with 3% Panchagavya spray had the highest number of pods $plant^{-1}$, pod length, number of seeds pod-1, seed yield $plant^{-1}$ and seed yield plot-1, all of which were significantly higher [38]. Based on a field experiment conducted during the Rabi season, it was found that, when compared to the control, the application of 50%, 75% and 100% cow urine spray resulted in 2.69 %, 18.01 % and 27.21% higher grain yield and 40.08 %, 42.55 % and 43.67 % higher harvest index [39]. In treatments supplemented with jivamrut at 1000 L ha^{-1} and Panchagavya at 7.5%, significantly higher numbers of pods plant-1, length of pods, pod weight, number of seeds pod-1, seed weight $plant^{-1}$, seed index and grain yield of cowpea (*Vigna unguiculata*) were observed [24]. During the branching and flowering stages, applying 2% Panchagavya+3% banana pseudostem sap resulted in notably higher pod yield (2101 kg ha^{-1}) and haulm yield (2742 kg ha^{-1}) [25]. Based on a field experiment carried out at the Indian Council of Agricultural Research-Indian Institute of Soil Science Research Farm in Bhopal, it was determined that the application of organic manures, either alone or in conjunction with Panchagavya and/or biodynamic methods, improved soybean yields [40]. A 9.10 ton ha^{-1} dry grain yield increase was achieved by foliar applying 4 ml/l liquid NPK fertilizer to corn plants along with 300 kg urea ha^{-1} and 50 kg SP-36 ha^{-1} [41].

RESULTS AND DISCUSSION

Nutrient content, uptake and quality

The results of a field study on annual moringa revealed that the treatments of poultry manure, neem cake and panchagavya improved the contents of secondary and micronutrients (Ca, S and Fe) and macronutrients (NPK) in the leaves and pods of the plant [42]. Increased crop uptake of nitrogen when 4% urea solution is sprayed foliarly during the tillering, stem elongation and boot stages [11]. With two sprays of Panchagavya at the flowering stage and one spray at 30 days after sowing over no spray of Panchagavya, available soil N, P, K and microbial counts were also significantly higher [27]. With the application of RDF+beejamruth+jivamrut+Panchagavya, tomato (*Lycopersicon esculentum*) plants exhibited significantly highest concentrations of N, P and K [13]. Grain weight, spike-1 number of seeds, plant height and protein content were significantly impacted by foliar urea application at four stages (tillering, jointing, anthesis and grain filling) at 22.5, 45, 67.5 and 90 kg ha^{-1} (12.5, 25, 37.5 and 50% of total urea application) [43]. Greater than other treatments in terms of protein, nitrogen, phosphorus and potassium content in seed and straw as well as total uptake of these elements with foliar spraying of 2% DAP, 2% urea and 2% KCL at branching and flowering [28]. Blackgram's growth characteristics, chlorophyll content, soluble protein content and nitrate reductase activity were all enhanced by a 2% urea foliar spray [34]. Comparing foliar application of cow urine spray (10% and 3%), Panchagavya spray (3%) and total sugar (23.10% and 22.56%) with other treatments, the results showed higher protein content (9.27% and 9.21%), reducing sugar (3.34% and 3.50%), non-reducing sugar (19.76% and 1.21%) and total carbohydrates (73.26% and 76.36%) [44]. The maximum levels of nitrogen, phosphorus, potassium, sulfur, zinc and iron in seed and straw, as well as their uptake and protein content in seed, were found to be significantly higher when Panchagavya 4 percent was applied compared to control, Panchagavya 2 percent, Panchagavya 6 percent, Panchagavya 8 percent, Panchagavya 10 percent and indigenous Panchagavya 2 percent [45]. The nutrient uptake and oil quality of groundnuts were enhanced by foliar application of Farmyard Manure (FYM)+recommended NPK+5 kg Borax+10 kg ha^{-1} $ZnSO_4$ and foliar spraying of 2% urea at 30 and 60 days post-sowing [35]. When compared to other treatment combinations and the control,

foliar spraying green gram with Panchagavya (3%) at flower initiation and 15 days after flowering resulted in a significantly higher protein content (23.79%) [37]. The application of Panchagavya (6% foliar spray+Jivamrut) resulted in the highest uptake of N, P and K by the kernel and haulm of kharif groundnut (*Arachis hypogaea* L.) during the six-year experimentation period (2011-2016) [46]. Application of organic manures, either separately or in conjunction with Panchagavya and/or biodynamic application, enhances the removal of nutrients from soybean crops [40]. In comparison to control and water spray, foliar application of 1% NPK, 3% Panchagavya, 5% Panchagavya, 10% Jeevamrut and 15% Jeevamrut greatly increased the nitrogen content in seed and straw and the phosphorus and potassium content in cluster bean seeds [47].

CONCLUSION

It was found that for improving the growth parameters, yield attributes, yields, quality parameters and economics of cluster beans, foliar application of Panchagavya at 3% was just as effective as NPK at 1%. Panchagavya can boost growth and immunity within the plant system. Among the compounds in panchgavya that control growth is indole acetic acid, gibbrellins, cytokinins, essential plant nutrients and beneficial microorganisms like actinomycetes, yeast and lactic acid bacteria. It also includes biofertilizers and compounds that protect plants, like phosphobacterium, azospirillum and acetobactor. It contributes significantly to the resistance that crops develop against pests and diseases, increasing overall yield.

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