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Standardization of Pre-Sowing Treatments with Panchagavya, Beejamrutha, Jeevamrutha, and Neem Oil for Growth, Yield, and Yield Attributing Traits of Cowpea (*Vigna unguiculata* L.)

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Abstract: Cowpea (*Vigna unguiculata* L.), a crucial legume for both nutrition and soil enrichment, stands to gain from effective organic treatments. This study investigated the impact of Panchagavya, Beejamruth, and Jeevamruth on *Cowpea* variety Pusa Phalguni, conducted during the Rabi season of 2021 at Sam Higginbottom University, Prayagraj. Seeds were treated with these organic formulations, and key growth and yield parameters, including field emergence, plant height, flowering and maturity times, number of branches, pods per plant, pod length, seeds per pod, seed index, seed yield, biological yield, and harvest index were meticulously assessed. Panchagavya at 7% and Beejamrutha 5% emerged as the most effective treatment, significantly outperforming other treatments and the control in enhancing plant growth and yield. This research underscores Panchagavya and Beejamrutha as a transformative organic solution, offering a compelling advantage for boosting *Cowpea* productivity and supporting sustainable agricultural practices.

Keywords: Cowpea, Panchagavya, Beejamrutha, Jeevamrutha, Neem oil, Seed priming

INTRODUCTION

Cowpea (*Vigna unguiculata*), also known as black-eyed pea or southern pea, is an annual plant within the pea family Fabaceae, cultivated for its edible legumes. Thought to be native to West Africa, cowpea are now widely grown in warm regions around the world. In addition to serving as a protein-rich food crop, cowpea are extensively grown as hay and as a green manure or cover crop. Typically, cowpea are climbing or trailing vines bearing compound leaves with three leaflets. The flowers, which can be white, purple, or pale yellow, usually grow in pairs or threes at the ends of long stalks. The pods are long and cylindrical, reaching 20–30 cm (8–12 inches) in length, depending on the cultivar. These plants are heat-adapted and drought-tolerant and play a crucial role in nitrogen fixation, ultimately contributing to soil fertility [1; 7].

In India, cowpea is a vital source of protein, vitamins, and minerals, particularly in addressing malnutrition in rural areas. Cowpea seeds are a nutritious component of the human diet and serve as cheap livestock feed. Both green and dried seeds are suitable for canning and boiling. In India, cowpea is a minor pulse cultivated mainly in arid and semi-arid regions, grown in pockets of Punjab, Haryana, Delhi, and West Uttar Pradesh, as well as in Rajasthan, Karnataka, Kerala, Tamil Nadu, Maharashtra, and Gujarat. Cowpea has a nutritive value of 22-24% protein, 55-66% carbohydrates, 0.005% iron, 0.08-0.11% calcium, and essential amino acids such as lysine, leucine, and phenylalanine [1; 7].

Globally, cowpea is grown on an estimated 14.5 million hectares annually, with a total production of 6.2 million metric tons. Over the last three decades, global cowpea production has grown at an average rate of 5%, with 3.5% annual growth in area and 1.5% growth in yield. Area expansion accounts for 70% of this total growth. Approximately 84% of the world's cowpea production area and 83.4% of its overall production come from Africa, with over 80% of African production occurring in West Africa. According to FAOSTAT (2016), cowpea was grown on an estimated 12.3 million hectares in Africa in 2014, with the bulk of production occurring on 10.6 million hectares in West Africa, particularly in Nigeria, Niger, Burkina Faso, Mali, and Senegal. Despite Ethiopia being a center of diversity for cowpea, previous studies on cowpea production and productivity in Africa and other regions often overlook Ethiopia [2; 7].

In contemporary agriculture, the enhancement of plant growth and resilience through natural methods has gained significant attention. Panchagavya, a traditional preparation known for its rich content of essential nutrients and growth hormones such as Indole Acetic Acid (IAA) and Gibberellic Acid (GA), has shown considerable potential in promoting plant health and immunity due to its unique composition and fermentative microorganisms [1; 8]. Beejamrutha, consisting of cow dung, cow urine, legume flour, and jaggery, is effectively used to protect seeds and seedlings from soil-borne and seed-borne diseases by supporting beneficial microbial activity [8; 9]. Jeevamrutha, another widely used preparation, enhances soil fertility and plant growth through its contribution of vital nutrients and improved soil conditions [1; 9]. Neem oil, extracted from the neem tree (*Azadirachta indica*), contains biologically active compounds such as azadirachtin, which are effective in pest control and plant protection [2; 7]. This research aims to standardize the application of these treatments and evaluate their effects on the growth, yield, and yield-attributing traits of cowpea (*Vigna unguiculata L.*) variety Pusa Phalguni, thereby providing valuable insights into their practical benefits and applications in sustainable agriculture.

MATERIAL AND METHODS

The field experiment was conducted during the Rabi season of 2021 at the Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. Seeds of Cowpea variety Pusa Phalguni were subjected to pre-sowing treatments with various doses of Panchagavya, Jeevamruth, and Beejamruth liquid formulations. Panchagavya was prepared following the standard procedure outlined by Natarajan [6]. After preparation, the Panchagavya was filtered through a clean cloth, and 3 liters of the filtrate was diluted in 100 liters of water for application. Beejamruth was prepared according to the standard procedure given by Palekar [8].

Panchagavya was prepared according to traditional methods involving the fermentation of five primary ingredients: cow dung, cow urine, milk, curd, and ghee. The preparation was conducted under controlled conditions to ensure consistency in the formulation. The physico-chemical properties of Panchagavya were analyzed to confirm the presence of essential nutrients, micronutrients, and growth hormones such as Indole Acetic Acid (IAA) and Gibberellic Acid (GA). The formulation's effectiveness is attributed to its low pH and the presence of fermentative microorganisms like yeast and lactobacillus, which thrive due to the addition of milk products and jaggery or sugarcane juice as growth substrates [1; 8].

Beejamrutha was utilized as a pre-sowing treatment for seeds, seedlings, and other planting materials. This formulation, composed of cow dung, cow urine, legume flour, and jaggery, was applied to protect against soil-borne and seed-borne diseases. The beneficial effects of Beejamrutha stem from its rich content of macro and micronutrients, vitamins, essential amino acids, and growth-promoting substances including IAA and GA. The presence of beneficial microorganisms in Beejamrutha enhances its efficacy in safeguarding young plants from fungal and microbial infections [8; 9; 14].

Jeevamrutha was prepared as a liquid organic fertilizer using a mixture of cow dung, cow urine, jaggery, and water, often supplemented with plant-based materials. This preparation was applied to improve soil fertility by increasing natural carbon, nitrogen, potassium, phosphorus, and other micronutrients. Jeevamrutha enhances soil pH, aeration, and microbial activity, thereby supporting plant growth. Its application promotes a higher microbial count in the soil and benefits from the activity of earthworms, which mobilize minerals from deeper soil layers to the surface [1; 9].

Neem oil was extracted from the seeds of the neem tree (*Azadirachta indica*) using standard extraction techniques. This oil contains over 100 biologically active compounds, including triterpenes such as azadirachtin, which is responsible for approximately 90% of its pest-control effects. Other active compounds include meliantriol, nimbin, nimbidin, nimbinin, nimbolides, and fatty acids like oleic, stearic, and palmitic acids. The extraction process focused on maximizing the azadirachtin content, which can be enhanced by artificial infection with arbuscular mycorrhiza [2; 7].

The experimental observations included field emergence, plant height, days to 50% flowering, days to maturity, number of primary branches, number of pods per plant, pod length, number of seeds per pod, seed index, seed yield per plant, biological yield, and harvest index. These parameters were systematically recorded. The data were analyzed by analysis of variance using SPSS-16 statistical software.

RESULTS AND DISCUSSION

Growth parameters

The study revealed significant variations in growth parameters among the different treatments. Seeds treated with Beejamruth at 1% (T_4) exhibited the highest field emergence of 83.00% at 10 days after sowing (DAS). This was statistically comparable to T_7, which recorded 81.00% field emergence, while the control group showed the lowest field emergence of 60.00%. Additionally, Beejamruth (1%) treatment (T_4) resulted in significantly higher plant height, measuring 89.95 cm at 90 DAS. T_8, with a height of 87.90 cm, was statistically comparable to T_4. The control recorded the lowest plant height of 63.41 cm. The increase in plant height suggests that the treatment improved nitrogen utilization during cell division and elongation, consistent with the findings of Maheswari *et al.* [4].

Days to 50% flowering were found minimum in treatment T_7 (41 DAS) followed by T_9 (42 DAS) among all the treatments while days to 50% flowering also found minimum in control, i.e. 36 DAS. Highest days to 50% flowering were reported in treatment T_3 (61 DAS) followed by treatment T_6 (57 DAS). Seeds treated with Panchagavya at 7% (T_3) also exhibited a higher number of days to maturity, averaging 84 DAS, compared to T_6, which matured in 82 DAS. The control reached maturity in 71 DAS. These results suggest that Panchagavya and Beejamrutha physico-chemical components, such as IAA and GA3, enhance plant height and facilitate early pod setting, as observed by Devakumar *et al.* [10] and Sreenivasa *et al*. [11].

Yield parameters

Among the treatments, Panchagavya at 7% (T_3) resulted in the highest number of primary branches (7), while T_6 also showing the same number of branches [7]. The control had the lowest number of primary branches (4). This increase can be attributed to the availability of macronutrients, micronutrients, and growth-promoting substances in Panchagavya, which enhances plant growth, as noted by Choudhary *et al.* [1].

The number of pods per plant was significantly higher in T_3 (13 pods), with T_6 (12 pods) also showing comparable results [10]. The control had the lowest number of pods (8). This increased pod production may be linked to the enhanced leaf area and photosynthetic activity promoted by Panchagavya, which improves carbohydrate production and allocation, in line with findings from Sutar *et al.* [7]. The pod length was also significantly greater in T_3 (31 cm), with T_6 (30 cm) being statistically similar. The control had the shortest pod length (11 cm), a difference attributed to the presence of gibberellic acid in Panchagavya and Beejamrutha which promotes cell elongation [2] and [11].

Seeds per pod were significantly higher in T_3 (13 seeds), with T_6 (13 seeds) showing similar results. The control had the lowest number of seeds per pod (8). This increase is likely due to the hormonal substances in Panchagavya, particularly cytokinin, which enhances nutrient mobilization in reproductive parts [12].

The seed index was significantly higher in T_3 (84 g) as compared to other treatments, with T_6 being statistically comparable (84 g). The control had the lowest seed index

Table 1. Analysis of Variance on Seedling Quality Parameters of Cowpea (*Vigna unguiculata* L.)

Characters	Mean sum of squares		
	Replication (d.f =2)	Treatments (d.f=12)	Error (d.f=24)
Field emergence (%) at 10DAS	5.41	120.77*	4.99
Plant height at 90 DAS	16.90	208.98*	5.66
Days to 50% Flowering	13.32	141.09*	5.91
Days to Maturity	1.80	31.65*	1.77
Number of primary branches	0.32	1.82*	0.11
Number of Pods per plant	1.50	5.50*	0.53
Pod length	10.83	97.57*	4.12
Numbers of seeds per pod	1.05	5.87*	1.19
Seed index	1.42	15.69*	1.58
Biological yield per plant	63951.42	112250.71*	21403.48
Seed yield per plant	0.89	28.98*	1.04
Harvest Index	9.86	57.95*	3.30

*indicates significance at 5% level of significance.

Table 2. Mean Performance of morphological traits of Cowpea seed treated with Panchagavya, Beejamruth, Jeevamruth and Neem oil

Treatments	Field emergence (10 DAS)	Plant height (cm) (90DAS)	Days to 50% Flowering	Days to Maturity	Number of Primary Branches	Number of Pods per plant	Pod length (cm)	Number of Seeds per pod	Seed index (g)	Biological yield (g)	Seed yield per plant (g)	Harvest index (%)
T_0	60.00	63.41	36	71	4	8	11	8	76	2700	11	20
T_1	70.00	65.09	43	77	5	9	16	9	78	3349	13	24
T_2	66.33	69.78	44	77	5	11	23	12	81	3291	16	28
T_3	69.67	75.44	61	84	7	13	31	13	84	3423	21	34
T_4	83.00	89.95	54	77	5	12	30	11	79	3401	16	30
T_5	70.67	79.92	48	75	6	12	18	11	80	3372	18	26
T_6	72.00	82.48	57	82	7	12	30	13	84	3441	21	31
T_7	81.00	78.45	41	79	6	11	20	10	81	3373	20	26
T_8	77.00	87.86	46	77	6	11	20	12	80	3362	17	29
T_9	76.67	68.35	42	81	5	10	20	13	81	3428	16	29
T_{10}	72.33	70.39	47	80	5	10	22	11	79	3350	16	19
T_{11}	68.33	71.83	51	79	5	11	19	10	78	3417	14	29
T_{12}	78.33	70.54	49	76	5	10	22	11	80	3375	13	29
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEm±	1.29	1.37	1.40	0.77	0.19	0.42	1.17	0.63	0.73	84.47	0.59	1.05
CD(P=0.05)	3.77	4.01	4.10	2.24	0.55	1.22	3.42	1.84	2.12	246.54	1.72	3.06

T_0 – Control, T_1 - Panchagavya 3 %, T_2 - Panchagavya 5 %, T_3 - Panchagavya 7%, T_4 - Beejamruth 1%, T_5 - Beejamruth 3%, T_6 - Beejamruth 5%, T_7 – Jeevamruth 1%, T_8 – Jeevamruth 3%, T_9 – Jeevamruth 5%, T_{10} - Neem oil 3%, T_{11} - Neem oil 5%, T_{12} - Neem oil 7%.

(76 g). The higher seed weight can be attributed to increased nitrogen uptake and macro element availability, which enhances photosynthesis and carbohydrate synthesis, consistent with Bharadwaj *et al.* [5] and Shivani and Rai [14].

The seed yield per plant was highest in T_3 (21 g), while T_6 also showing same results (21 g). The control had the lowest seed yield per plant (11 g). Higher seed yield in Panchagavya-treated plants can be linked to the beneficial microorganisms present in the organic liquid manures, which enhance soil fertility and plant growth [6].

Biological yield was significantly higher in T_6 (3441 g) followed by T_3 (3423 g) , while the control yielded the least (2700 g). The increase in biological yield can be attributed to the favorable macro and micronutrient profile and beneficial microorganisms in Panchagavya, which enhance root development and nutrient uptake, as supported by Thirumeninathan *et al.* [12] and Samatha and Rai [13].

The harvest index was highest in T_3 (32.85%) and statistically comparable to T_6 (30.25%). The control had the lowest harvest index (20%). This increase in harvest index is indicative of improved crop production efficiency due to Panchagavya treatment, which enhances plant growth and yield [13, 14].

Panchagavya plays a crucial role in enhancing crop growth and yield as an organic manure. Its application improves soil fertility, promotes crop health, and increases yield without the use of synthetic fertilizers or pesticides. Panchagavya's benefits include enhanced soil quality, better crop health, and reduced production costs, ultimately leading to increased profit margins [9; 13 and 14].

CONCLUSION

The application of Panchagavya at 7% T_3 and Beejamrutha at 5% (T_8) significantly enhanced the growth, yield, and yield attributes of *Cowpea* (*Vigna unguiculata* L.) variety Pusa Phalguni. This treatment led to improvements in field emergence, plant height, flowering and maturity times, branch number, pod count, pod length, seed count, seed index, seed yield, biological yield, and harvest index. Panchagavya's nutrient-rich composition and beneficial microorganisms contributed to superior plant performance and reduced the need for synthetic inputs.

These results advocate for the adoption of Panchagavya in sustainable agriculture to enhance crop productivity and soil health while supporting organic farming practices.

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