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Efficacy of Botanicals on Seed Quality Enhancement in Cowpea [*Vigna unguiculata* (L.) Walp.] on Yield and Yield Attributes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted at the Regional Agricultural Research Station, Pattambi of Kerala Agricultural University with the objective to understand the effect of seed treatment using different organic leaf extracts on the growth and yield of cowpea. The experimental design was used for the layout of the design in Randomized Block Design, with three replications and nine treatments. The experiment was conducted with 9 treatments viz., the 5% leaf extracts of Calotropis (T1), Pappaya (T2), Pongamia (T3), Castor (T4), Moringa (T5), Vitex (T6), Neem (T7), Tulsi (T8), Control with distilled water (T9). Different field observations revealed that the seed hardening significantly influenced the seed yield and yield contributing characters of cowpea. The highest yield was recorded due to seed hardening treatment with Pongamia 5% leaf extract (T3) for 4 hrs followed by Calotropis 5% leaf extract (T1) for 4 hrs. All the seed hardening treatments had

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significant effects on yield contributing characters like plant height at maturity, number of branches(primary and secondary) per plant, number of clusters per plant, number of seeds per pod, pod length, pod girth, pod weight, 100 seed weight, seed yield per plot(kg/ha) and dry matter production at harvest. The nodule count at flowering and total chlorophyll content at maturity were also found to be significantly different among the treatments. The seeds hardened with Pongamia leaf extract (5%) (T3) for 4 hrs recorded higher field emergence with maximum grain yield (716 Kg/ha), plant height at maturity (145.07 cm), number of primary branches per plant (3.60), seed yield per plant (g) (13.69 g), and seed yield (716 kg/ha) followed by Calotropis leaf extract (5%) (T1) for 4 hrs with a seed yield of 694 kg/ha.

Keywords: Seed hardening; botanicals; leaf extract; cowpea.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L.), a native of Africa, is known as poor man's meat. Cowpea is mainly grown in tropical and sub-tropical regions in the world for vegetable and seed purposes and to a lesser extent as a fodder crop. It is a most versatile pulse crop because of its smothering nature, drought tolerant characteristics, soil restoring properties, and multi-purpose uses. As a pulse crop, cowpea fits well into most of the cropping systems. Cowpea being a legume is an important source of food, income, and livestock feed and forms a major component of tropical farming systems because of its ability to improve the fertility status of marginal lands through nitrogen fixation (Timko and Singh, 2008).

Grain cowpea is generally taken up as a rainfed summer crop. A rainfed crop in rice fallow condition will have low productivity due to soil moisture deficit. The problem of moisture stress can be alleviated by seed hardening techniques. Seed hardening is the physiological preconditioning of the seed by hydration to withstand drought under rainfed conditions. It is a pre-sowing seed enhancement technique with a significant positive effect on seed and seedling quality characteristics under laboratory and field conditions. Seed hardening of cowpeas enables accelerated rapid germination. This is highly useful for the farmers, as the hardened seeds have enhanced germination and dry matter production.

Seed hardening with different leaf extracts is cost-effective, non-toxic, and eco-friendly in nature and is found to be quite useful and successful in many crops. The positive effects of hardening the seeds with different leaf extracts include enhanced germination percent, length of root and shoot and dry matter production of seedlings. Seed hardening with leaf extracts has been reported to have a positive impact on seed storability and seedling vigor.

Due to the significant advantages in terms of plant growth, productivity, and seed quality qualities, the usage of botanicals has recently become quite important, particularly among researchers. The neem tree, *Azadirachtin indica*, a source of several insecticidal alkaloids is a sub-tropical tree native to the arid areas of Asia and Africa (Saha *et al.,* 2006) the main pesticidal component in neem is Azadirachtin. The products which can be made from neem are cheaper and safe for beneficial organisms. Nowadays usage of neem leaf extract in agriculture has increased due to its beneficial effects some other botanicals like Calotropis, Papaya, Pongamia, Castor, Moringa, Vitex, and Tulsi are also used for seed treatment. They have a synergistic effect on the early stage of the crop they protect the crop in the early stage from pest and diseases and leads to uniform growth and enhance the yield of the crop.

Suratuzzaman et al. [1] reported that botanicals possess antifungal properties against seed-borne fungi [2,3]. Botanicals are effective for the reduction of the population of Fusarium associated with seed [4]. Prakash et al. [5] reported that seed pelleting with pungam leaf powder at the rate of 150 g / kg recorded higher germination percent, root and shoot length, dry matter production and yield parameters in black gram.

Seed priming with moringa leaf extract with 5 percent increased the germination percent, shoot, root length and fresh weight of shoot and root in cowpeas [6]. Available literature indicates that plant extracts and plant essential oils possess effective antimicrobial principles against food and grain storage fungi [7].

2. MATERIALS AND METHODS

2.1 Preparation of Botanical Leaf Extracts for Seed Treatment

Stock solutions are prepared by using different leaves like calatropis, papaya, pongamia, castor, moringa, vitex, neem, and tulsi. The stock solution of botanical extracts was prepared by grinding the 50 g of leaves with adding 200 ml water. By this, a 1:4 stock solution of all the botanicals was prepared. From the stock solution again 5% solution is prepared and used for seed treatment. The various botanicals used for seed hardening treatments are Calotropis (T1), Pappaya (T2), Pongamia (T3), Castor (T4), Moringa (T5), Vitex (T6), Neem (T7), Tulsi (T8), Control with distilled water(T9). Seeds of 150 g were soaked in 5 % solution for 4 hours after that kept for shade drying for 3 days and then sown in the respective plots. The seeds were manually sown on October 27, 2022, in rows with 2 seeds at a time, at a depth of 3–4 cm.

2.2 Cultural Operations

Since it was taken as a rabi crop, less irrigation was required. Following the sowing, a brief irrigation was administered, followed by a ten-day break. Earthing up is done after one month after sowing. Weeding and necessary plant protection measures were being taken up to protect the crop from pests and diseases whenever required. Harvesting was done after the seeds attained physical maturity. The harvesting of the crops was done after 80-85 days after sowing.

2.3 Observations

Five plants were randomly selected from each plot. The following observations were recorded on the different growth parameters like plant height, no. of branches, Total dry matter, Leaf Area Index (LAI), chlorophyll content, nodule count at the flowering stage, and yield parameters like no. of clusters per plant, no. of pods per cluster, no. of pods per plant, no. of seeds per pod, seed yield per plant, seed yield per plot, 100 seed weight, pod weight, pod girth, pod length. The method recommended by Panse and Sukhatme (1961) for statistical analysis is used to study all the characters in the experiment of RBD (Randomized Block Design).

3. RESULTS AND DISCUSSION

In this study results of the experiment on the effect of seed treatment with botanical extracts on plant growth and yield of cowpea (*Vigna unguiculata* L.) obtained during the course of investigation revealed the importance of botanicals in seed hardening. The botanical seed treatments were found significant for different morphological and physiological parameters of cowpea. The analysis of variance and mean value for growth and seed yield parameters was presented in Table 1 and 2. The results revealed that the differences among 9 treatments were significant for growth and yield attributing characters, viz. plant height, number of branches, seed yield, total chlorophyll content, nodule count at flowering, harvest index.

3.1 Growth Parameters

The data pertaining to the plant height given in Table 1 indicated that there was a significant difference in plant height at 60 DAS (Fig. 1). Maximum plant height (145.07cm) was observed in treatment T3, followed by T5 (140.833 cm) and T2 (138.533 cm). Whereas, the least plant height (117.700) was observed in T4. There was a significant difference in plant height at 60 days after sowing. There was a significant difference between treatments in relation to the number of branches per plant. A higher number of primary branches (6.8) were recorded in T1 followed by T3 (6.6) and T6 (6.2). While the lowest number of primary branches (4.0) was observed in the control. Seed treatment with various botanical extracts revealed a significant difference in the total dry matter of plant at harvest (Fig. 3). Maximum total dry matter (56.95 g) was observed in T3, while the least total dry matter (51.95 g) was recorded in T8. Whereas at 30 DAS highest (3.89 g) is recorded in T1 and the lowest (2.98 g) was observed in control, whereas at 60 DAS highest (25.2 g) is recorded in T1 and the lowest (18.2 g) was observed in T6.

Seed treatment with various botanical extracts revealed significant differences in pod length and pod girth regarding pod length highest (**17.18)** is recorded in T1 followed by T3, T2, and the lowest (15.24) was observed in T8. Regarding pod girth highest (2.2) is observed in T7 and the lowest (1.95) is observed in control. The observed data is presented in Table.1 and (Figs. 3&4). It is evident from Table 1 that results indicated significant differences between various treatments. Among the treatments, T1 was recorded as the highest (10.629) in relation to pod weight.

Table 1. Effect of seed treatment with botanical extracts on yield and yield parameters

Treatments		Plant height (cm)	No. of Primary branches per plant	No. of Secondary branches per plant	Pod length (cm)	Pod girth (cm)	Pod weight (g)	No. of clusters / plant	No. of pods / cluster	No. of pods /plant	No. of seeds/ pod	100 Seed weight (g)	Seed yield / plant (g)	Seed yield (kg/ha)
T1	Calotropis leaf extract @ 5%	123.40	3.07	6.80	**17.18**	2.12	**10.63**	7.27	1.50	10.07	**16.37**	10.47	11.91	694.40
T2	Papaya leaf extract @ 5%	138.53	2.87	4.40	16.48	2.11	9.78	5.73	1.28	**11.93**	13.55	11.97	12.41	651.00
T3	Pongamia leaf extract @ 5%	**145.07**	**3.60**	**6.67**	16.51	2.16	9.59	6.53	1.33	10.13	13.74	11.11	**13.69**	**716.10**
T4	Castor leaf extract @ 5%	117.70	3.33	4.20	16.42	2.10	9.48	**3.87**	1.33	8.87	16.33	10.68	12.98	542.50
T5	Moringa leaf extract @ 5%	140.83	3.47	4.67	15.70	2.06	8.67	5.53	1.62	7.20	13.30	10.47	12.96	585.90
T6	Vitex leaf extract @ 5%	134.57	2.33	6.20	15.82	2.10	9.11	**8.73**	1.35	10.17	13.41	10.66	13.20	434.00
T7	Neem leaf extract @ 5%	129.57	3.00	4.13	16.27	**2.20**	9.67	4.60	1.36	6.73	12.33	**12.88**	13.31	585.90
T8	Tulasi leaf extract @ 5%	134.93	2.07	5.27	15.25	2.09	8.85	4.37	**1.11**	7.60	13.67	10.29	11.67	477.40
T9	Control	135.73	2.27	4.07	15.62	1.96	8.33	4.23	**2.00**	8.13	11.89	10.95	9.38	564.20
S.EM.		5.13	0.43	0.54	0.34	0.04	0.40	0.91	0.33	1.19	0.95	0.40	0.89	34.99
CD at 5%		15.38	1.29	1.61	1.01	0.12	1.19	2.73	1.00	3.57	2.85	1.20	2.68	104.93

Table 2. Effect of seed treatment with botanical extracts on chlorophyll at 30 and 60 DAS, nodule count at flowering stage, and leaf area index at 30 and 60 DAS

Treatments		Chlorophyll content at 30DAS			Chlorophyll content at 60 DAS			Leaf area index at 30 DAS	Leaf area index at 60 DAS	Nodule count at flowering stage	Dry matter production at 30 DAS	Dry matter production at 60 DAS	Dry matter production at Harvest
		Chl 'a'	Chl 'b'	Total chl	Chl 'a'	Chl 'b'	Total chl						
T1	Calotropis leaf extract @ 5%	**1.84**	0.45	**2.39**	1.38	0.47	1.84	**3.78**	4.08	15.00	**3.892**	**25.21**	54.33
T2	Papaya leaf extract @ 5%	1.66	0.40	1.85	1.31	0.46	1.77	3.56	3.78	12.89	3.116	23.21	46.25
T3	Pongamia leaf extract @ 5%	1.57	0.34	1.86	1.31	0.43	1.74	3.23	3.29	**17.78**	3.670	22.45	**56.95**
T4	Castor leaf extract @ 5%	1.68	0.39	2.05	1.06	0.36	1.42	3.35	3.89	9.89	3.440	19.25	52.17
T5	Moringa leaf extract @ 5%	1.71	0.39	1.95	1.02	0.33	1.35	3.29	**4.21**	12.89	2.324	25.14	52.23
T6	Vitex leaf extract @ 5%	1.57	0.39	2.05	1.21	0.39	1.60	3.14	3.76	11.56	3.49	**18.21**	55.52
T7	Neem leaf extract @ 5%	1.72	**0.89**	2.08	**1.18**	**0.70**	**1.88**	3.60	4.10	13.44	3.08	19.12	**51.95**
T8	Tulasi leaf extract @ 5%	1.70	0.44	2.18	1.39	0.45	1.84	**2.99**	3.85	**8.89**	3.27	18.48	52.10
T9	Control	1.60	0.46	2.12	1.33	0.48	1.81	3.30	**3.52**	10.44	**2.98**	18.43	45.61
S.EM.		0.12	0.16	0.14	0.09	0.11	0.16	0.24	0.29	0.91	0.34	2.43	1.40
CD at 5%		0.41	0.49	0.43	0.30	0.33	0.49	0.73	0.85	2.73	1.02	7.28	4.21

Seed treatment with various botanical extracts revealed a significant difference in Seed index (100 seed weight). Maximum seed index (12.883) was observed in T7 and minimum seed index (10.293) was observed in T8. The observed data is presented in Table.1 and (Fig. 5). It is evident from Table 1 that there was a significant difference between the treatments in relation to the number of clusters/plant (Fig. 5). maximum number of clusters per plant (8.733) was observed in T6 and minimum (3.867) was observed in T4. The data in Table 1 indicates that a maximum number of pods per cluster (2.0) was recorded in control and the minimum number of pods per cluster (1.11) was recorded in T8. (Fig. 5). The data on the number of pods per plant, presented in Table 1 indicated that among all the treatments, T2 recorded a higher number of pods per plant (11.933). Whereas, the minimum number of pods per plant was found in T7 (6.733). (Fig. 5). It is evident from Table 1 that the result indicated significant differences between various treatments. Among the treatments, T1 recorded a higher number of seeds per pod (16.370), which was followed by T4 (16.333). Whereas, the minimum number of seeds per pods (11.889) was found in the control (T9). The data on yield per plant, presented in Table 1 (Fig. 4) indicated that among all the treatments, T3 recorded a higher yield per plant (13.69 g), Whereas, minimum yields per plant (9.379 g) was found in T9 (control). The data with respect to yield per plot, given in Table 1 has shown among all the treatments, T3 recorded as higher yield per plot (0.334 kg), followed by T1 (0.324 kg). Whereas, minimum yield per plot (0.221 kg) was found in T1.

3.2 Physiological Parameters

The major physiological parameters like chlorophyll content, nodule count, and leaf area index were taken into consideration. The study revealed from observed data presented in Table 2 that there is no significant difference between treatments. The maximum chlorophyll content is observed in T1 (2.385) and the minimum is observed in T2 (1.851) at 30 DAS. Whereas at 60 DAS, a maximum (1.882) is observed in T7 and a minimum (1.346) is observed in T5. In leaf area index, the observed data presented in Table 2 showed that there is no significant difference between treatments. Maximum leaf area index (3.784) is observed in T1 and minimum (2.997) leaf area index was observed in T8 at 30 DAS. Whereas at 60 DAS, the maximum leaf area index (4.208) is observed in T7, and the minimum leaf area index (3.523) is observed in control. The nodule count taken during the flowering stage revealed from observed data presented in Table 2 significant difference was observed between treatments. The nodule count was highest (17.778**)** in T3 and lowest (8.889**)** was observed in T8.

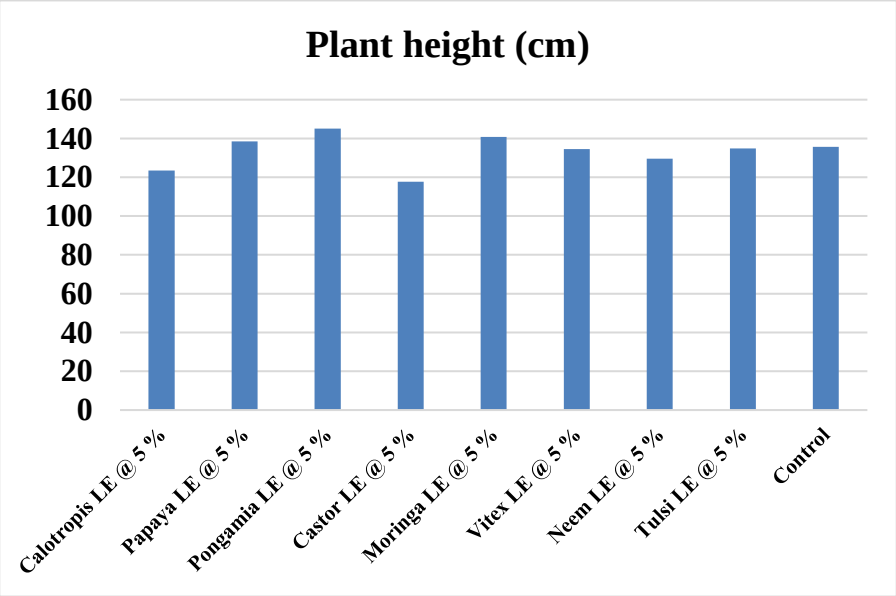

Fig. 1. Effect of seed treatment with botanical extracts on plant height

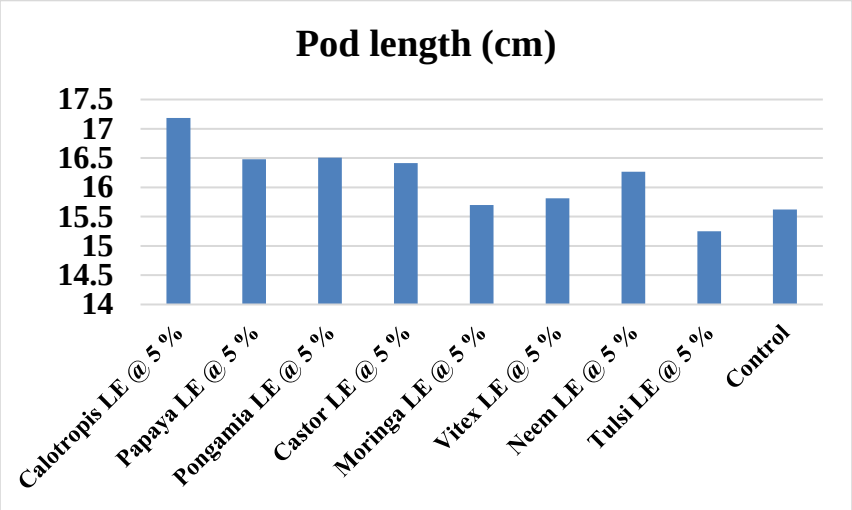

Fig. 2. Effect of seed treatment with botanical extracts on pod length

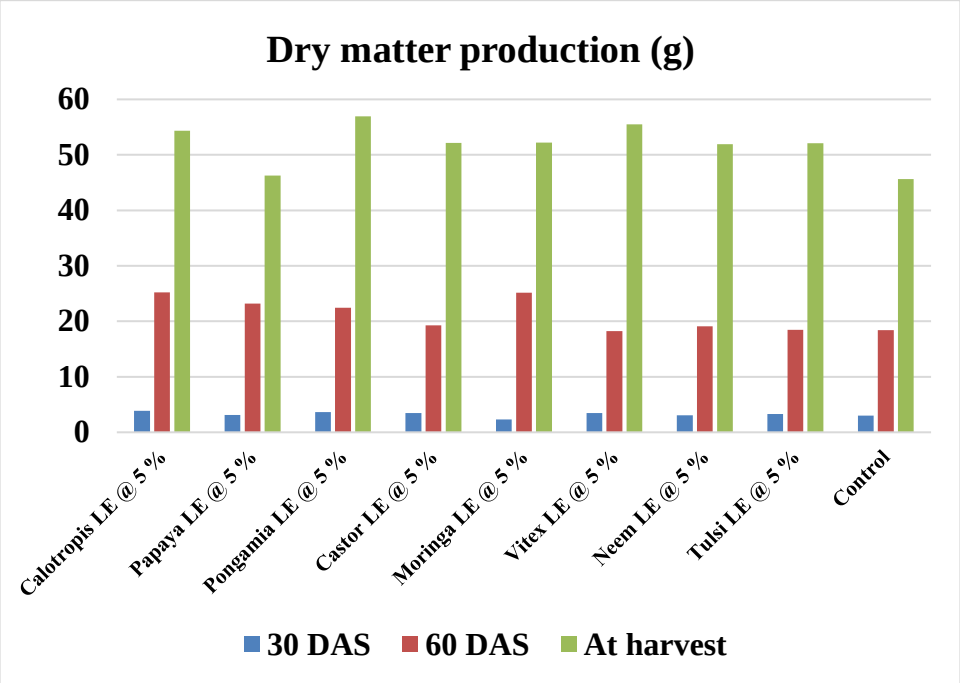

Fig. 3 Effect of seed treatment with botanical extracts on Dry matter production at 30, 60 DAS and at harvest

The data for plant height, number of branches per plant, dry matter production at harvest, nodule count at flowering stage, pod length, pod girth and pod weight has shown significant differences due to seed treatment with various botanicals. Gunasekar et al. [8] found an increase in plant height, number of branches per plant, and pod length when black gram seeds are treated with Pongamia leaf extract. Abdul Wajid et al. [9]. also found in their experiment that plant height and number of branches per plant has been increased when field pea seeds were treated with pongamia leaf extract. The reallocation of GA_3 to the aerial parts can cause an increase in plant height. The easy and early availability of biomolecules by the seed treatment can provide the developing seedlings with an increase in plant height. The presence of growth-promoting chemicals like GA_3 is found in the Pongamia leaf extracts, which in turn helps in the growth and development of cowpea in the seedling stage.

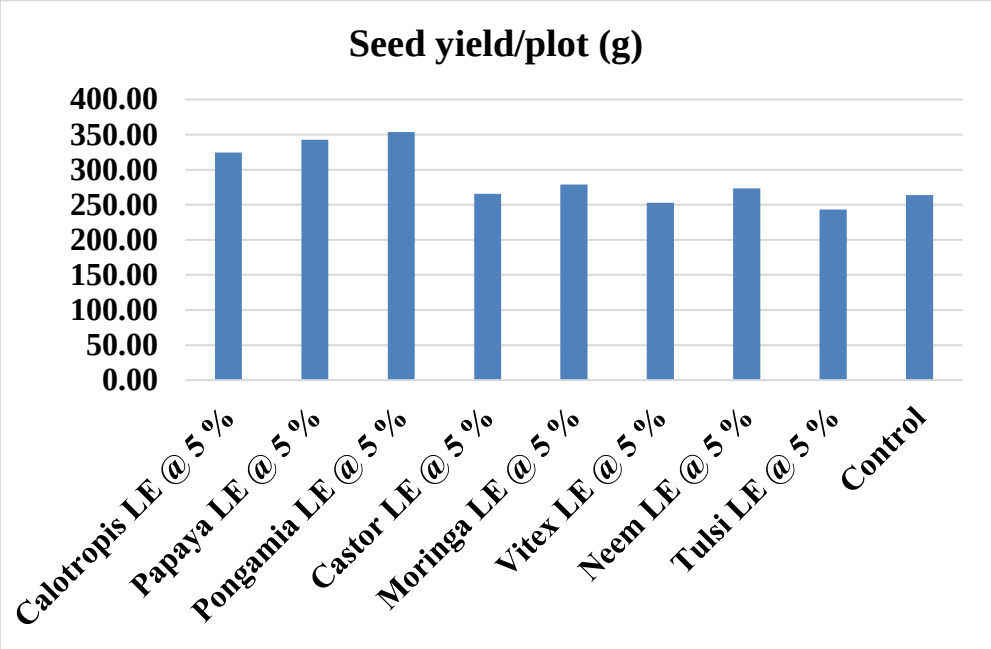

Fig. 4. Effect of seed treatment with botanical leaf extracts on seed yield per plot

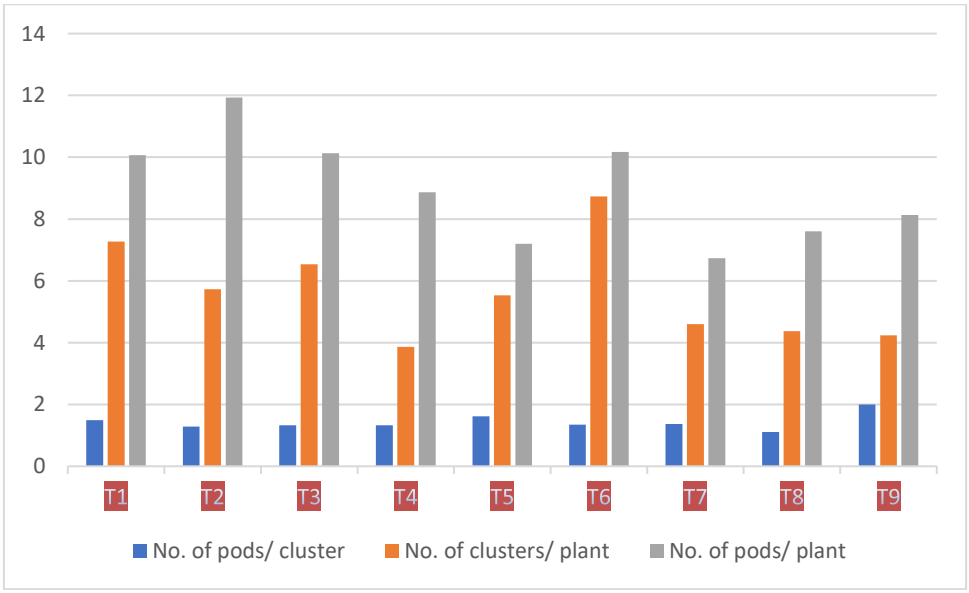

Fig. 5. Effect of seed treatment with botanical extracts on number of clusters / plant, number of pods / cluster and number of pods / plant

The data concerning the number of seeds per pod and seed index (100 seed weight) has shown significant differences due to seed treatment with various botanical extracts like calotropis, papaya, pongamia, castor, moringa, vitex, neem, and tulsi. Gunasekar et al. [8] found that the seed index (100 seed weight) increased when the black gram seeds were treated with neem leaf extract compared to the control. The increase in 100 seed weight might be due to the absorption of more nutrients by seeds treated with neem leaf extract @ 5 % which induces the biosynthesis of proteins, nucleic acids, and hydrolytic enzymes, increasing the photosynthetic process with an increased ability to absorb more nutrients through more robust and efficient roots.

According to Fugare et al. [10], the Pongamia leaf powder contains bioactive compounds which

may be the cause for the increased yield parameters. Gibberellin is produced when gibberellin synthesis is triggered by those bioactive compounds present in pongamia leaf powder leads to improving the germination percentage, growth, and development of crops more quickly. The increase in seed yield of Pongamia leaf powder pelleted seeds might be due to an increase in the activity of dehydrogenase, amylase, and peroxidase enzymes, which may be due to the presence of growth regulators like GA3 which activates the enzymes. According to Rathinavel and Dharmalingam, [11] enhancement in dry matter production is due to increased utilization of lipids and enzyme activity due to the presence of bioactive compounds like auxins and GA3 in Pongamia leaf extract.

4. CONCLUSION

Different botanicals were found effective in cowpea seed hardening which increases the seed yield. Pongamia leaf extract is found to be the best eight botanicals used. The presence of flavonoids, glycosides, steroids, tannins, etc in pongamia leaf extract makes it a superior one for seed hardening. The combination of various compounds improves the effectiveness of a plant extract in seed hardening.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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