Efficacy of Bioactivity of Ethnopharmacological Weed Extract on Seed Yield and Quality of Cowpea (*Vigna unguiculata* L.)

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ABSTRACT

Over the last couple of years, the production of cow pea has declined dramatically due to lack of quality seeds, poor germination, uneven plant stands, insect pest problems, and improper storage techniques. To ensure sustainable good crop growth and productivity, it is imperative to develop a judicious and comprehensive package of crop-specific seed management technologies, involving seed germination, vigour enhancing treatments, and seed protection treatments. A new approach to improve seed performance is to value-add plant-based extracts i.e., ethnopharmacological weed extracts at low doses, which are natural and multi-compound products. A study was carried out to explore the impact of ethnopharmacological weed extract on growth, yield and seed quality parameters of cowpea. Cowpea seeds primed with various ethnopharmacological weed extracts (*Alternanthera sessilis, Cassia tora, Croton bonplondianum, Euphorbia hirta and Xanthium strumarium*) with different concentrations for 8 hours. Ethnopharmacological weed extract of *Alternanthera sessilis* @ 0.5 % for 8 hours found superior in promoting higher plant height (28.27 cm), number of branches (15.53), pod length (19.84 cm) that resulted in higher seed yield per hectare (13.89 q) compared to control (23.73 cm, 10.80, 14.09 cm and 10.28 q) and higher seed quality attributes viz., seed germination (97.35 %), seedling vigour index □(3532) and □ (6409), TDH activity (2.05), seed protein content (269.10 µg/g) and lesser electrical conductivity (218.78 µS/cm/g) and total soluble sugar content (68.24 µg/ml) compare to control (90.50 %, 2856 and 5533, 1.59 and 207.70 µg/g and 264.23 µS/cm/g and 108.14 µg/ml). The results indicated that seeds treated *Alternnathera sessilis* @ 0.5 % could be employed to enhance seed yield and quality of cowpea.

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Key words: Ethnopharmacological weed, Seed priming, Seed germination, Seedling vigour

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L.), also known as black-eyed peas or southern pea, is a versatile legume cultivated worldwide for its nutritional value and adaptability. The cowpea is one of the most important crops in global agriculture, contributing a healthy amount of protein and income to several communities. In spite of its importance, low productivity levels limit its potential contribution to food security and economic growth. Seed priming is a well-established technique in agriculture to improve seed performance and crop productivity. Seed priming is a seed enhancement technique that involves the controlled hydration and dehydration of seeds before sowing. This pre-sowing treatment aims to activate the metabolic processes within the seed without actual germination, preparing it for optimal growth conditions. The importance of seed priming lies in its ability to confer several advantages to seeds, leading to improved germination rates, enhanced seedling vigor, and ultimately, increased crop productivity.

In recent years, the use of bioactive chemicals such as growth promoters, antioxidants, and nutrients has gained prominence in seed priming to improve crop performance. Notably, plant-based extracts have emerged as a natural and multi-compound solution for seed treatment, offering a range of benefits, including antifungal, antimicrobial, and antioxidant

properties (Godlewska *et al.*, 2021). These extracts, when applied at low doses, hold significant promise in enhancing the seed quality attributes of various crops. Integrating traditional knowledge, this study focuses on the application of ethnopharmacological weed extracts known for their bioactive compounds. in seed priming, aiming to enhance seed yield and quality. This study aims to explore the effects of ethnopharmacological weed extracts on the growth, yield, and seed quality parameters of cowpea, offering innovative and sustainable solutions to enhance cowpea production and productivity.

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2. MATERIALS AND METHODS

The experiment was carried out at Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore, Karnataka, India during 2022 - 2023.

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2.1 Preparation of ethnopharmacological weed extract

Ethnopharmacological weeds viz., *Alternanthera sessilis* (L.) R.Br. ex DC, *Cassia tora* L., *Croton bonplandium* Baill, *Euphorbia hirta* L. and *Xanthium strumarium* were selected for the experiment. Leaves of the collected plants were dried for 15 days. The leaves were powdered with the help of blender. One-gram plant powdered was then extracted in 10 ml solvent (Acetone). The overnight extracts were filtered with a Whatman's no.1 filter paper and then extracted liquid was subjected to rotary evaporation in order to remove the solvents. After evaporation 10 ml of DMSO (di methyl sulphoxide) were added in the extracts separately. The extracted material is stored in refrigerator for further investigation. (Pal *et al.*, 2013). Preparation of ethnopharmacological weed extract depicted in Figure 1.

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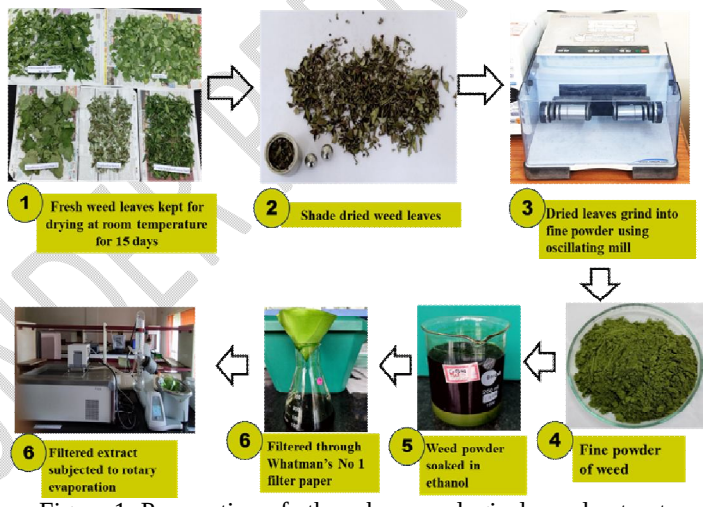

Figure 1. Preparation of ethnopharmacological weed extract

2.2 Seed priming

Seeds were primed with different weed extracts *viz*., *Alternanthera sessilis* (L.) R.Br. ex DC, *Cassia tora* L., *Croton bonplandium* Baill., *Euphorbia hirta* L. and *Xanthium strumarium* L. for 8 hours and seeds were shade dried before sowing and then sown on plots. Treatment details are: T1: Control; T2: *Alternanthera sessilis* (L.) R.Br. ex DC - 0.5%, T3: *Alternanthera sessilis* (L.) R.Br. ex DC – 3 %, T4: *Cassia tora* L.- 2%, T5: *Cassia tora* L.- 3%, T6: *Croton bonplandium* Baill. - 1%, T7: *Croton bonplandium* Baill. - 3%, T8:

Euphorbia hirta L.- 2%, T9: *Euphorbia hirta* L.- 3%, T10: *Xanthium strumarium* L.- 2%, T11: *Xanthium strumarium* L.- 3%

2.3 Experimental design and crop cultivation

Eleven treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. Primed seeds were planted in designated plots under uniform soil conditions, irrigation, and other agronomic practices.

2.4 Growth parameters measurement

2.4.1 Field emergence (%)

The seeds were sown in well prepared soil at 2.50 to 3.00 cm deep and covered with soil. Field emergence count was taken on 8th day after sowing and the emergence percentage was calculated based on number of seedlings emerged three centimeters above the soil surface.

2.4.2 Plant height at harvest

Plant height was measured from base of the plant to the tip of the plant at harvest. In each plot, ten plants were selected and mean height was calculated and expressed in centimeter (cm).

2.4.3 Number of branches at harvest

Number of branches were counted in each tagged plants and averaged to get branches per plant.

2.4.4 Days to 50 per cent flowering

Number of days taken from sowing to the day on which 50 per cent of the plants flowered in each genotype was counted and the mean was expressed in days.

2.4.5 Days to maturity

Number of days taken for maturity was recorded in each plant and the mean values were expressed in days.

2.4.6 Number of pods/plants

The number of pods were recorded from ten randomly selected plants and the mean value expressed as number of pods per plants.

2.4.7 Number of seeds/pods

Average number of seeds in ten randomly selected pods in each randomly selected plant was counted which was again averaged to get number of seeds per pod.

2.4.8 Pod length (cm)

Length of ten dry pods from each of the selected plant was recorded and average value for five pods was expressed in cm.

2.4.9 Seed weight/plant(g)

The seed weight was recorded from ten randomly selected plants and the mean value expressed as seed weight per plant in grams.

2.4.10 Seed yield/ha (q)

Yield obtained from each plot was converted into kg per hectare

2.5 Seed quality parameters measurement

2.5.1 Seed germination (%)

The germination test was conducted as per ISTA guidelines (Anon., 2021) in the laboratory by using between paper method. One hundred seeds were randomly selected from each treatment in four replications and placed equidistantly on the paper towel, they were further rolled and kept in a germination chamber with a temperature of 25 ± 1°C and RH of 90 % was set. The first count and the final count of the germinated seedlings were taken on the 5th and 8th day respectively and the percentage of germination was expressed based on the number of normal seedlings present.

$$\text{Seed germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Number of seeds kept for germination}} \times 100$$

2.5.2 Seedling vigour index (SVI-□ and SVI-□)

The seedling vigour index was calculated as per the formula given by Abdul-Baki and Anderson, 1973.

SVI-□ = Germination (%) × Mean seedling length (cm)

SVI-□ = Germination (%) × Mean seedling dry weight (mg)

2.5.3 Electrical conductivity (µS/cm/g)

Twenty-five seeds were selected randomly from three replications of each treatment in a beaker. The selected seeds were soaked in 125 ml of distilled water for 24 hours at 25 ±1°C. The electrical conductivity (EC) of seed leachate was measured from the steeped water of soaked seeds in a digital conductivity meter (Model: Systronic conductivity meter 306). The actual EC of seed leachate was calculated by subtracting the EC of distilled water from the obtained values and expressed in µS/cm/g (Anon., 2021).

$$\text{Electrical conductivity (µS/cm/g)} = \frac{\text{Conductivity reading(µS/cm) - Background reading}}{\text{Weight of the replicate (g)}}$$

2.5.4 Total dehydrogenase (TDH) activity (A480)

Ten seeds were randomly selected from seeds incubated for EC test from each treatment in three replications. The seed coat was carefully removed and made sure embryonic axis is soaked in a test tube containing 0.5 percent tetrazolium chloride solution and incubated at 25 ± 1°C in the dark for 4 hours. Further, seeds were washed thoroughly in distilled water, and the red colour formazan from stained embryos was eluted by soaking in 5 ml of 2- methoxy ethanol for 24 hours in an airtight container. The extract was decanted and

colour intensity is measured using a spectrophotometer at 480 nm. The dehydrogenase activity is expressed in terms of optical density at A480 (Perl *et al.*, 1978).

2.5.5 Total soluble sugars (µg/ml of seed leachate)

The total soluble sugar content of seed samples was estimated by the phenol sulphuric acid method according to Dubois *et al.*, 1951. The required quantity (0.1 ml) of seed leachate was diluted to 1 ml with distilled water. 1 ml of 5 percent phenol and 5 ml of 96 percent H_2SO_4 were added. Sulphuric acid was added in such a way that it hits the reactant's surface directly. The mixture was allowed to cool for 45 minutes at room temperature. After cooling to room temperature, the absorbance was read at 490 nm against the reagent blank. A standard curve was constructed with glucose as a standard with a concentration of 10 to 100 µg. The standard curve was used to estimate the total soluble sugars of the sample and the results are expressed in µg/ml of seed leachate.

2.5.6 Total soluble protein (µg /g)

The total soluble protein was estimated as per the method prescribed by Lowry *et al.*, 1951. The procedure followed is as follows.

a. Sample extraction

One hundred mg of oven dried sample was extracted in 10 ml of 0.1 M sodium phosphate buffer, pH 7 for one hour on a magnetic stirrer at room temperature. The extract was centrifuged at 10000 rpm for 15 minutes. The supernatant was used for the estimation of total soluble seed protein.

b. Estimation of protein

The required quantity (0.1 ml) of supernatant was diluted to 1 ml with distilled water. Five ml of solution C was added and mixed thoroughly. After 10 minutes, 0.5 ml of FCR was added and mixed immediately. The mixture was incubated for 30 minutes under dark, and then the absorbance of the solution was recorded at 660nm against a reagent blank.

A standard graph was constructed with BSA as a standard with the concentrations of 20 to 120 mg. The standard curve was used to estimate the protein content of the sample and expressed in µg /g.

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3. RESULTS AND DISCUSSION

3.1 Growth attributes

3.1.1 Field emergence

Data obtained for field emergence showed statistically significant (p=0.05) results by reporting that *Xanthium strumarium* L.@ 3% was the best while *Cassia tora* L. @ 3% was least effective (Table 1). In addition, the overall trend for plant height is as follows: T11 (92.88 %) > T2 (91.75 %) > T10 (90.90 %) > T3 (89.85 %) > T7 (87.69 %) > T9 (86.90 %) > T8 (85.31 %) >T6 (84.92 %) > control (80.45 %). As far as overall performance of field emergence is concerned, *Xanthium strumarium* L. @ 3% primed seeds significantly improved field performance. The improvement in field emergence by ethnopharmacological weed extracts could be ascribed to the activation of cells resulting in the enhancement of

mitochondrial activity leading to the formation of more high energy compounds and vital biomolecules that are made available during the early phase of germination as reported by Dharmalingam *et al.* (1988). Similar results obtained by Renugadevi *et al.* (2001) in cowpea and black gram seeds invigorated with prosopis leaf extract, improved the emergence and establishment.

3.1.2 Plant height at harvest

The results obtained for plant height showed statistically significant (p=0.05) results (Table 1). *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2) recorded highest plant height (28.27 cm) followed by *Xanthium strumarium* L.-3% (T11) (27.40 cm) and lowest plant height (23.73 cm) was recorded in control (T1) (Table 1). In addition, the overall trend for plant height is as follows: T2 (28.27 cm) > T11 (27.40 cm) > T7 (26.80 cm) > T10 (26.67 cm) > T3 (25.40 cm) > T9 (24.93 cm) > T8 (24.70 cm) > T6 (24.03 cm) > T4 (23.85 cm) > T5 (23.78 cm) > T1 (23.73 cm). It is clear from the results that seed priming with ethnopharmacological weed extract significantly increase plant height compared to control. Increased plant height may be due to the translocation of GA_3 to the aerial part of plants, which perhaps to an extent that is enough to increase hypocotyl size and the consequent increase in first nodal height hence sufficient to positively affect plant height are indicated by Gunasekar *et al.* (2017). This increase in plant height may also due to the early availability of high energy compounds and vital biomolecules to the growing seedlings (Renugadevi and Vijayageetha, 2006). Similar findings were also reported by Prakash *et al.* (2021) in blackgram.

3.1.3 Number of branches per plant at harvest

Statistically (p= 0.05) significant results were found for the number of branches per plant (Table 1). In this study, it was found that seeds primed with *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5% (T2) shown maximum number of branches per plant (15.53) which was statistically on par with by *Xanthium strumarium* L.-3% (T11) (15.36) and lower number of branches (10.17) observed in *Cassia tora* L. -3% (T5) (Table 1). In addition, the overall trend for number of branches per plant is as follows: T2 (15.53) > T11 (15.36) > T10 (14.43) > T3 (13.98) > T9 (13.17) > T8 (12.73) > T7 (12.37) > T6 (12.20) > T4 (11.13) > T1 (10.17) > T5 (10.80). The results clearly indicate that seed priming with ethnopharmacological weed extract significantly increases number of branches per plant. Increase in number of branches per plant in ethnopharmacological weed extract treated seeds might be due the presence of growth regulating substances like GA_3 which causes increase in enzyme activity which leads to more availability of energy biomolecules for plant growth and development thereby increasing light trapping area for photosynthesis which induces more photo assimilation and vegetative growth in these plants compared to control (Gunasekar *et al.*, 2017).

3.1.4 Days to 50 % flowering

It is revealed from observed data presented in Table 2 that there was no significant (p =0.05) difference between treatments in relation to days to 50% flowering (Fig.4). It was ranged from T7 (48 days) to T10 (54 days) (Table 1).

3.1.5 Days to maturity

Statistically (p= 0.05) significant results were obtained for days to maturity (Table 1). The seeds primed with *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2) and *Xanthium*

strumarium L. @ 3 % (T11) taken 72 days to maturity, while control (T1) taken 79 days to maturity (Table 1). Additionally, days to maturity follows the following pattern: T11, T2 (72 days) < (72 days) < T10 (73 days) < T3 (74 days) < T9, T7 (77 days) < T4, T5, T6, T8, (78 days) < T1 (79 days). The results showed that seed priming with ethnopharmacological weed extract decreased the days to maturity, which indicates that the priming treatment was effective in helping the plant to mature early. The treated plants taken less days to maturity might be due the uptake and utilization of nutrients by these plants during early seedling stage promoted by bioactive compounds present in these leaf extracts. So, improved nutrient availability can accelerate plant growth and development, leading to earlier maturity.

Table 1. Effect of ethnopharmacological weed extract on plant growth attribuites of cowpea

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Treatment Details	Field Emergence (%)	Plant height (cm) At harvest	Number of branches per plant at harvest	Days to 50% Flowering	Days to Maturity
T_1	80.45	23.73	10.80	51.00	79
T_2	91.75	28.27	15.53	49.33	72
T_3	89.85	25.40	13.98	50.00	74
T_4	82.14	23.85	11.13	49.67	78
T_5	81.69	23.78	10.17	53.00	78
T_6	84.92	24.03	12.20	53.67	78
T_7	87.69	26.80	12.37	47.67	77
T_8	85.31	24.70	12.73	50.33	78
T_9	86.90	24.93	13.17	51.33	77
T_{10}	90.90	26.67	14.43	54.00	73
T_{11}	92.88	27.40	15.36	49.67	72
S.Em ±	**2.77**	**0.99**	**0.78**	**2.04**	**1.35**
CD(P=0.05)	**8.16**	**2.93**	**2.30**	**NS**	**3.97**
CV (%)	**5.52**	**6.77**	**10.49**	**6.95**	**3.07**

Treatment details: T_1: Control; T_2: *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5%; T_3: *Alternanthera sessilis* (L.) R.Br. ex DC- 3%; T_4: *Cassia tora* L.-2%; T_5: *Cassia tora* L. -3%; T_6: *Croton bonplandium* Baill. -1%; T_7: *Croton bonplandium* Baill. -3%; T_8: *Euphorbia hirta* L.-2%; T_9: *Euphorbia hirta* L.-3%; T_{10}: *Xanthium strumarium* L.-2%; T_{11}: *Xanthium strumarium* L.-3%

3.2 Yield attributes

3.2.1 Number of pods per plant

Data recorded for number of pods per plant showed statistically significant results (p=0.05) (Figure 2). The results for number of pods per plant demonstrated that the highest number of pods per plant was observed in seeds primed with *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2 - 19.47) and lowest number of pods per plant was observed in control (T1 - 10.40) (Table 1). However, number of pods per plant follows the following trend: T2 (19.47) > T11 (17.20) > T10 (16.13) > T8 (15.00) > T3 (14.87) > T4 (14.00) > T6 (13.67) > T7 (13.47) > T5 (13.27) > T9 (12.13) > T1 (10.40). The results indicate that seed priming with ethnopharmacological weed extract is an effective strategy to increase number of pods per plant in cowpea.

3.2.2 Pod length

The results obtained for pod length showed statistically significant (p= 0.05) results (Figure 2). However, the data for pod length illustrated that highest pod length of 19.84 cm observed in *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2) and the untreated seeds recorded lowest pod length of 14.09 cm. Additionally, pod length follows the following pattern: T2 (19.84 cm) > T11 (19.51 cm) > T10 (19.34 cm) > T3 (19.20 cm) > T9 (19.19 cm) > T8 (19.03 cm) > T7 (18.82 cm) > T6 (18.59 cm) > T4 (17.89 cm) > T5 (17.42 cm) > T1 (14.09 cm). The data showed that seed priming with ethnopharmacological weed extract increased the pod length, which indicates that the priming treatment has positive effect on pod length of cowpea.

3.2.3 Number of seeds per pod

The data obtained for number of seeds per pod showed statistically significant (p= 0.05) results (Figure 2). The obtained results suggested that maximum number of seeds per pod (17.53) was observed in seeds primed with *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2) and control recorded minimum number of seeds per pod (10.62). Additionally, number of seeds per pod follows the following pattern: T2 (17.53) > T11 (17.20) > T3 (16.80) > T10 (16.28) > T9 (15.87) > T7 (15.73) > T4 (15.67) > T6 (15.53) > T8 (14.00) > T5 (13.87) > T1 (10.62). The data indicated that priming of seeds with an ethnopharmacological weed extract resulted in an increased seed count per pod, suggesting a beneficial impact of the priming treatment on the number of seeds per plant of cowpea.

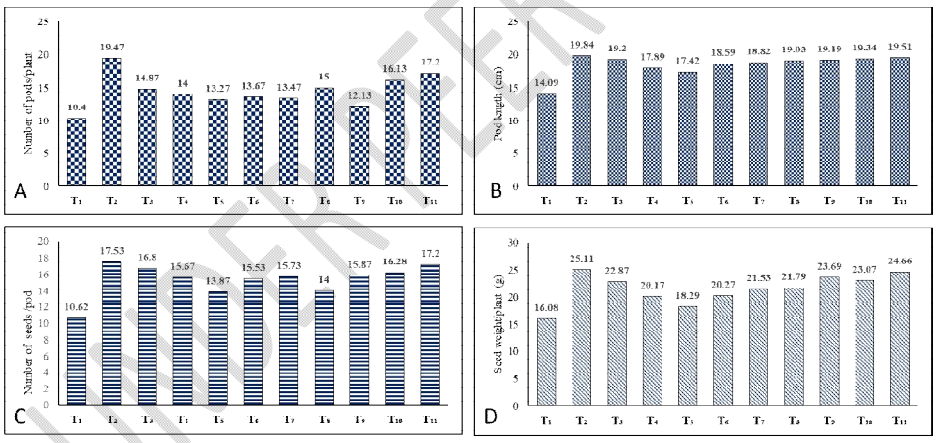

Figure 2. Effect of ethnopharmacological weed extract on yield attributes of cowpea A) Number of pods per plant B) Pod length C) Number of seeds per pod D) Seed weight per plant.

Treatment details: T_1: Control; T_2: *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5%; T_3: *Alternanthera sessilis* (L.) R.Br. ex DC- 3%; T_4: *Cassia tora* L.-2%; T_5: *Cassia tora* L. -3%; T_6: *Croton bonplandium* Baill. -1%; T_7: *Croton bonplandium* Baill. -3%; T_8: *Euphorbia hirta* L.-2%; T_9: *Euphorbia hirta* L.-3%; T_{10}: *Xanthium strumarium* L.-2%; T_{11}: *Xanthium strumarium* L.-3%

3.2.4 Seed weight per plant

The data recorded for seed weight per plant showed statistically significant (p= 0.05) results (Figure 2). The data revealed that highest seed weight per plant (25.11 g) was recorded in seeds primed with *Alternanthera sessilis* (L.) R.Br. ex DC @ 0.5% (T2) and control recorded lowest seed weight per plant (T1-16.08 g). Additionally, seed weight per plant follows the following pattern: T2 (25.11 g) > T11 (24.66 g) > T9 (23.69 g) > T10 (23.07 g) > T3 (22.87 g) > T8 (21.79 g) > T7 (21.53 g) > T6 (20.27 g) > T4 (20.17 g) > T5 (18. 29 g) > T1 (16.08 g). The findings revealed that seed priming using an ethnopharmacological weed extract led to a significant increase in seed weight per plant, suggesting a favourable influence of the priming treatment on the yield of cowpea plants.

3.2.5 Seed yield per hectare

The data recorded for seed yield per hectare showed statistically significant (p= 0.05) results (Figure 3). Maximum seed yield per hectare (13.89 q) noticed in *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5% (T2) and minimum seed yield depicted in untreated seeds (T1-10.28 q). Further, the overall trend for seed yield per hectare was recorded as: T2 (13.89 q) > T11 (13.65 q) > T9 (13.19 q) > T3 (12.7 q) > T10 (12,68 q) > T8 (12.17 q) > T7 (12.03 q) > T6 (11.45 q) > T4 (11.12 q) > T5 (10.35 q) > T1 (10.28 q). The results indicate that the utilization of seed priming with an ethnopharmacological weed extract resulted in a notable augmentation in seed yield per hectare. This implies a beneficial impact of the priming on the cowpea plant yield. Susheela (1996) reported that the increase in number of seeds may be due to increased pollen production resulted in enhanced fertilization (which might be due to improved mobilization of nutrient and moisture supply) that leads to increased number of filled seeds and the seed yield (Lee and Kim, 2000). Improved seed yield by leaf extract priming treatment is the result of improved number of pods per plant and increased number of seeds per pod as evident from the present study. Similar findings reported by Prakash *et al.* (2021) in blackgram, Gunasekar *et al.* (2017) in blackgram.

3.3 Seed quality parameters

3.3.1 Seed germination (g)

The data recorded for seed yield per hectare showed statistically significant (p= 0.05) results (Figure 3). Highest germination per cent (97.35 %) was recorded in *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5 % (T2) whereas, lowest seed germination was noticed in T1 (90.50 %). Additionally, germination percent of seeds follows the following pattern: T2 (97.35 %) > T11 (96.5 %) > T3 (95.17 %) > T10 (94.83 %) > T9 (94.67 %) > T8 (92.33 %) > T7 (92 %) > T6 (91.67 %) > T4 (91.5 %) > T5 (91.0 %) > T1 (90.5 %). The results elucidate that seed priming with ethnopharmacological weed extract markedly enhanced the germination percentage of seeds in comparison to untreated seeds.

3.3.2 Seedling vigour index (SVI-□ and SVI-□)

The data recorded for seedling vigour index (SVI-□ and SVI-□) showed statistically significant (p= 0.05) results (Figure 3). Highest seedling vigour index-□ (3532) was recorded in T2 whereas, untreated seeds (T1) recorded lowest seedling vigour index-□ (2856). Additionally, seedling vigour index-□ follows the following pattern: T2 (3532) > T11 (3490) > T10 (3342) > T13 (3333) > T9 (3280) > T8 (3192) > T7 (3032) > T4 (3006) > T6 (2985) > T5 (2883) > T1 (2856). Highest seedling vigour index-□ (6409) was recorded in T2 whereas, untreated seeds (T1) recorded lowest seedling vigour index-□□ (5533). Additionally,

seedling vigour index-□□ follows the following pattern: T2 (6409) > T11 (6315) > T9 (6166) > T3 (6107) > T10 (6050) > T8 (5887) > T6 (5786) > T4 (5779) > T7 (5716) > T5 (5589) > T1 (5533). The findings revealed that seed priming with ethnopharmacological weed extract impacted the seedling vigor index when compared to the control.

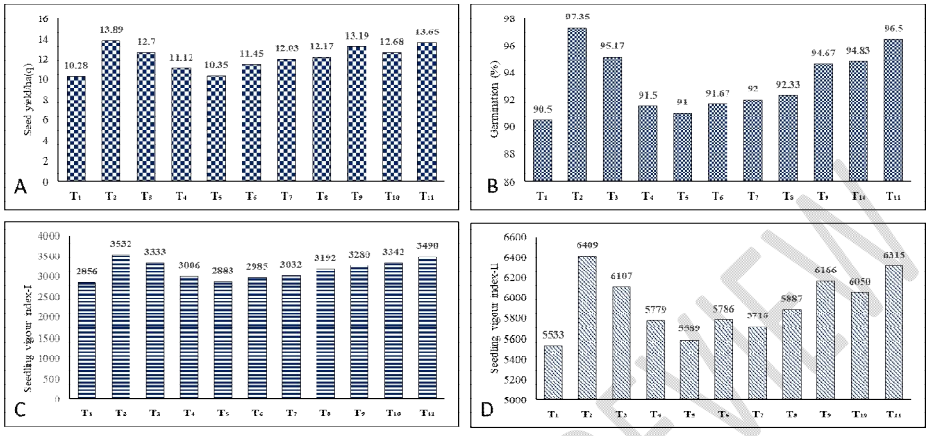

Figure 3. Effect of ethnopharmacological weed extract on yield and seed quality attributes of cowpea A) Seed yield per hectare B) Germination C) Seedling vigour Index-I D) Seedling vigour Index-II.

Treatment details: T_1: Control; T_2: *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5%; T_3: *Alternanthera sessilis* (L.) R.Br. ex DC- 3%; T_4: *Cassia tora* L.-2%; T_5: *Cassia tora* L. -3%; T_6: *Croton bonplandium* Baill. -1%; T_7: *Croton bonplandium* Baill. -3%; T_8: *Euphorbia hirta* L.-2%; T_9: *Euphorbia hirta* L.-3%; T_{10}: *Xanthium strumarium* L.-2%; T_{11}: *Xanthium strumarium* L.-3%

3.3.3 Electrical conductivity of seed leachate ($\mu Scm^{-1}g^{-1}$)

The data recorded for electrical conductivity of seed leachate showed statistically significant (p= 0.05) results (Figure 4). It was recorded lowest in *Alternanthera sessilis* (L.) R.Br. ex DC - 0.5 % (T2) (218.8 µScm-1g-1) and untreated seeds (T1) recorded higher EC i.e., (264.2 µScm-1g-1). Additionally, electrical conductivity of seed leachates follows the following pattern: T2 (218.78 µScm-1g-1) > T11 (222.9 µScm-1g-1) > T9 (232.56 µScm-1g-1) > T3 (233.19 µScm-1g-1) > T10 (241.37 µScm-1g-1) > T7 (242.33 µScm-1g-1) > T8 (246.14 µScm-1g-1) > T6 (255.73 µScm-1g-1) > T4 (256.62 µScm-1g-1) > T5 (260.1 µScm-1g-1) > T1 (264.23 µScm-1g-1). Seed priming with ethnopharmacological weed extract significantly reduces seed leachate compared to untreated seeds, suggesting its potential as a sustainable and effective treatment for enhancing seed quality.

3.3.4 Total dehydrogenase activity (A480 nm)

The data recorded for total dehydrogenase activity of seeds showed statistically significant (p= 0.05) results (Figure 4). *Alternanthera sessilis* (L.) R.Br. ex DC - 0.5 % (T2) recorded higher TDH (2.05) and lower TDH was observed in control (1.59). Additionally, the total dehydrogenase activity follows the following pattern: T2 (2.05) > T3 (1.99) > T9 (1.99) >

T11 (1.99) > T10 (1.97) > T8 (1.83) > T7 (1.87) > T6 (1.77) > T4 (1.74) > T5 (1.68) > T1 (1.59). Investigation reveals that seeds primed with ethnopharmacological weed extract exhibit significantly elevated total dehydrogenase activity in comparison to the control, indicating a notable increase in TDH activity within primed seeds.

3.3.5 Total soluble sugar content (µg/ml of seed leachate)

The data recorded for total soluble sugar content showed statistically significant (p= 0.05) results (Figure 4). *Alternanthera sessilis* (L.) R.Br. ex DC - 0.5 % (T2) recorded lower soluble sugar content from seed leachate (68.24 µg/ml) whereas, control recorded higher soluble sugar content from seed leachate (108.14 µg/ml). Additionally, soluble sugar from seed leachates follows the following pattern: T2 (68.24 µg/ml) > T11 (72.25 µg/ml) > T9 (82.21 µg/ml) > T3 (83.28 µg/ml) > T10 (83.54 µg/ml) > T8 (85.84 µg/ml) > T7 (86.38 µg/ml) > T6 (88.63 µg/ml) > T4 (89.26 µg/ml) > T5 (96.05 µg/ml) > T1 (108.14 µg/ml). Seed priming with ethnopharmacological weed extract significantly reduced total soluble sugars from seed leachate compared to untreated seeds.

3.3.6 Total soluble protein content (µg/g)

The data recorded for total soluble seed protein showed statistically significant (p= 0.05) results (Figure 4). Higher seed protein content (269.10 µg/g) was observed in *Alternanthera sessilis* (L.) R.Br. ex DC - 0.5 % (T2) and lower protein content seen in untreated seeds T1 (207.70 µg/g).Additionally, protein content of seeds follows the following pattern: T2 (269.10 µg/g) > T11 (266.59 µg/g) > T3 (253.90 µg/g) > T9 (251.58 µg/g) > T10 (250.32 µg/g) > T8 (241.23 µg/g) > T7 (236.65 µg/g) > T6 (229.65 µg/g) > T4 (221.89 µg/g) > T5 (209.99 µg/g) > T1 (207.70 µg/g). Analysis demonstrates that seeds subjected to priming with ethnopharmacological weed extract display a marked augmentation in protein content relative to the control group, underscoring the influence of ethnopharmacological weed extract priming on seed protein content. The ethnopharmacological weed extracts shown promising results on seed quality parameters of cowpea. Seeds treated with *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5% (T2) has shown promising increase in seed quality parameters viz., seed germination, seedling vigour index-□, seedling vigour index-□, electrical conductivity, total dehydrogenase activity, protein content and soluble sugar content. This might be due to these weed extract contains compounds which will enhance nutrient uptake by the plants. Improved nutrient availability can lead to better seed development and higher seed quality parameters. The leaf extracts content antioxidant properties can protect plant tissue from oxidative stress. This protection can extend to the developing seeds, preserving their quality. *Alternanthera* has shown higher seed quality attributes at 0.5 % and cassia at 2 % compared to seeds treated at 3 %. So, increasing concentrations has reduced the seed quality parameters. Similar finding reported by Vinothini *et al*. (2020) in rice seeds treated with *Chenapodium* extract. But *Xanthium* and *Euphorbia* have shown increase in seed attributes with increasing concentrations. Seeds primed at 3 % have shown increase in seed quality attributes had been noticed by Girase *et al.* (2019) in okra seeds treated with Albizia and Prosposis leaf extract at 3 %. Some weed extracts like cassia, croton have observed for less increase in the seed attributes compared to other weed extracts that may because of presence of alkaloids and condensed tannins. Khan *et al*. (2023) noticed that extracts which are rich in alkaloids and condensed tannins are highly phytotoxic on seedling growth of radish.

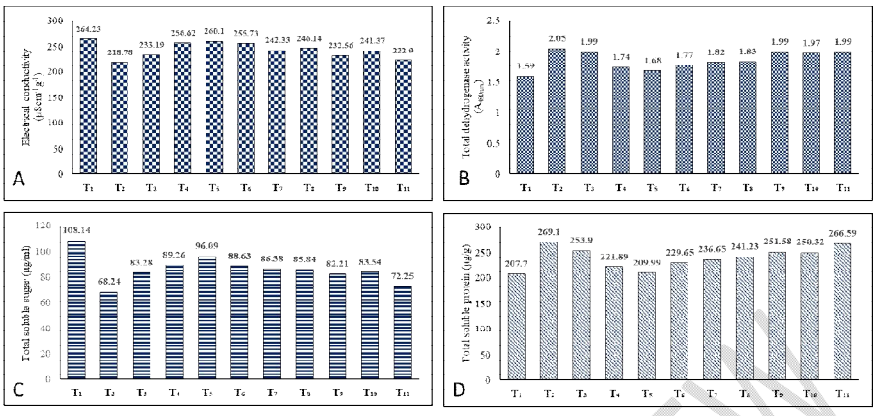

Figure 4. Effect of ethnopharmacological weed extract on yield and seed quality attibutes of cowpea A) Seed yield per hectare B) Germination C) Seedling vigour Index-I D) Seedling vigour Index-II.

Treatment details: T_1: Control; T_2: *Alternanthera sessilis* (L.) R.Br. ex DC- 0.5%; T_3: *Alternanthera sessilis* (L.) R.Br. ex DC- 3%; T_4: *Cassia tora* L.-2%; T_5: *Cassia tora* L. -3%; T_6: *Croton bonplandium* Baill. -1%; T_7: *Croton bonplandium* Baill. -3%; T_8: *Euphorbia hirta* L.-2%; T_9: *Euphorbia hirta* L.-3%; T_{10}: *Xanthium strumarium* L.-2%; T_{11}: *Xanthium strumarium* L.-3%

4. CONCLUSION

The utilization of ethnopharmacological weed extract treatment is a promising avenue in modern agriculture. These innovative approaches have demonstrated their potential to significantly enhance crop growth, increase yields, and improve seed quality parameters. Among those seeds treated with *Alternanthera sessilis* @ 0.5 % has shown promising effects in improving crop yield and seed quality parameters followed by *Xanthium strumarium* @ 3 %. Ethnopharmacological weed extract treatments represent a bridge between tradition and innovation, paving the way towards a more sustainable and resilient agricultural future.

ETHICAL APPROVAL

This article does not contain any studies with human participants or animals performed by any of the authors.

This research work is ethically sound as it does not contain any studies with human participants or animals.

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