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MORPHO-BIOCHEMICAL RESPONSES AND FODDER YIELD ASSESSMENT OF COWPEA (*VIGNA UNGUICULATA* L. WALP) GENOTYPES UNDER WATERLOGGING STRESS

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SUMMARY

The livestock sector plays a critical role in poverty alleviation and food security through provision of nutritional products and farm inputs. While cowpea (*Vigna unguiculata* L. Walp) serves as a valuable nutritional resource for both human consumption and livestock feed, its sensitivity to waterlogging presents challenges for sustainable production. Though drought-tolerant, waterlogging induces metabolic, physiological, and morphological alterations in legumes. This investigation evaluated ten cowpea genotypes under controlled and waterlogged conditions. Analysis of biochemical parameters revealed superior antioxidant defense mechanisms and photosynthetic pigment maintenance in genotypes EC240630, IC372130, and PFC-50. Waterlogging significantly affected all measured yield attributes except plant height, with green fodder yield reductions ranging from 23-75% with a mean reduction of 57%. Results demonstrate that waterlogging stress significantly compromises fodder cowpea growth and productivity, with implications for livestock nutrition systems dependent on this protein-rich fodder crop.

Key words: Biochemical, Evaluation, Fodder cowpea, Fodder yield, Waterlogging

Livestock sector contributes about 40% of the value of agricultural output and supports the livelihood ensuring food security of almost 1.3 billion people (FAO, 2022). Fodder cowpea is one major crop which can be used as food and feed for livestock. Cowpea grows quickly and is a main food source during lean periods, thus known as hungry- season crop (Gómez, 2004). The crop has high feeding value and is superior to other pulse crops like soybean because of its low fibre content and minimal wastage in feeding. The crop can support a 6-7 kg milk yield/ cow/ day without any concentrate supplement (NDDB, 2014). Globally, cowpea occupies an area of 15 million hectares both for grains and fodder (FAO, 2020). Cowpea grows well in all seasons, if proper irrigation is there. It is one of the most drought-tolerant crops (Ravelombola *et al.*, 2020), but highly susceptible to waterlogging (Olorunwa *et al.*, 2022a).

Waterlogging is an extreme abiotic stress affecting crops, and its severity has been worsened by increased frequency of high-intensity rains due to climactic changes. Waterlogging stress is the second most detrimental stress after drought in terms of crop yield reduction and economic losses, which impacts around 16% of cultivated area globally (Ploschuk *et al.*, 2018; Zhang *et al.*, 2023). According to FAO (2018), flood caused nearly 20 percent of the loss in crops and livestock between 2005 and 2015, in developing countries. In India, waterlogging has affected nearly 33.9 million hectares of crop land over the past seven years (2015–2022) (Anonymous, 2023). Odisha, West Bengal, Bihar and Uttar Pradesh have maximum waterlogged soil in India (Sarkar *et al.*, 2019). The IPCC report (2021) suggested that the annual daily precipitation events could intensify by 14% by 2050 and by 35% by the end of the 21st century. Thus, waterlogging is a significant threat to global crop production, with yield reductions ranging from 5% to 80% (Bansal *et al.*, 2022).

Effect of waterlogging on fodder cowpea is still unknown. In the present study, the effect of waterlogging on the yield of ten fodder cowpea genotypes was studied. The objective of the experiment was to find out the impact of waterlogging on fodder cowpea genotypes.

MATERIALS AND METHODS

Ten genotypes of fodder cowpea were selected from a previous screening experiment (unpublished data). In the experiment, waterlogging was given to hundred genotypes till their death. Waterlogging was given at 25 days after sowing (DAS). The genotypes which exhibited waterlogging tolerance showed better performance under stress were utilized for this study. The germplasm included accessions from NBPGR, New Delhi and trials.

S. No.	Treatments	Accession No.	Source
1.	T_1	EC240630	NBPGR, Philippines
2.	T_2	SNAR-12-11	NBPGR, Unknown
3.	T_3	IC398992	NBPGR, Andra Pradesh
4.	T_4	EC98668	NBPGR, Unknown
5.	T_5	IC372130	NBPGR, Unknown
6.	T_6	EC244217	NBPGR, Phillipines
7.	T_7	IC20678	NBPGR, MP
8.	T_8	EC99566	NBPGR, Nigeria
9.	T_9	IC97787	NBPGR, Kerala
10.	T_{10}	PFC-50	PAU, Ludhiana

The experiment was conducted during December 2023 – February 2024. There were ten genotypes raised under two conditions as control and waterlogging. In the control condition, the genotypes were grown in pots with proper drainage. For waterlogging condition, the genotypes were subjected to waterlogging at 25 days after sowing (DAS). Water level was maintained 2 centimeter above the soil surface. Waterlogging condition was maintained for 15 days and then drained. Different biochemical, biometrical and morphological traits were observed on them. Chlorophyll a, Chlorophyll b, Total chlorophyll, Peroxidase activity, Lipid peroxidation and Membrane Stability Index were recorded. Biometric traits such as number of primary branches, number of leaves, plant height, green fodder yield, total dry matter, leaf area and leaf area index (LAI) were observed in both experimental conditions. The experiment was conducted in completely randomized design with three replications.

Estimation of photosynthetic pigments were estimated following the protocol of Lichtenthaler and Wellburn (1983).

Peroxidase activity was determined using the method of Summer and Gjessing, (1943). The enzyme activity was analyzed using ortho-dianisidine as hydrogen donor and hydrogen peroxide as electron acceptor. The rate of formation of yellow orange coloured dianisidine dehydrogenation product was measure of peroxidase activity and measured spectrophotometrically at 430 nm.

The level of lipid peroxidation in the leaf tissue was measured in terms of malondialdehyde (MDA) content determined by the thiobarbituric acid (TBA) reaction (Heath and Packer, 1968).

Membrane stability index (MSI) was estimated as per Sairam *et al.* (1997). Plant material (0.1 g) was taken in 10 cm^3 of double distilled water in two sets. One set was subjected to 40 °C for 30 min and its conductivity was recorded using a conductivity meter (C_1). Second set was kept in a boiling water bath (100 °C) for 10 min and its conductivity was also recorded (C_2).

Membrane stability index (MSI) = $[1 - (C_1/C_2)] \times 100$.

Yield parameters like number of primary branches per plant, number of leaves per plant, leaf area, LAI, green fodder yield per plant, dry matter yield per plant and plant height per plant were measured destructively during 50% flowering stage.

RESULTS AND DISCUSSION

The data obtained from the experiment was evaluated using ANOVA with the software GRAPES (Gopinath *et al.*, 2020). ANOVA for treatments under waterlogging is given (Table 2).

Biochemical responses

The analysis recorded significant variation in all the biochemical traits except membrane stability index (MSI) and chlorophyll a among the treatments under control condition (Table 2). All other traits including chlorophyll b, total chlorophyll, peroxidase activity and lipid peroxidation showed significant variation in the control condition. These variations might be due to their genetic and environmental conditions.

Under waterlogging conditions, all the genotypes exhibited significant variation in chlorophyll content, peroxidase activity and lipid peroxidation, except for no variation in MSI (Fig 2). Olorunwa *et al.* (2022) also recorded notable reduction in the

TABLE 2

Biochemical parameters of fodder cowpea under waterlogging [C: Control; W: Waterlogging]

Accessions	Chlorophyll a		Chlorophyll b		Total Chlorophyll		Peroxidase activity		Lipid Peroxidation		Membrane Stability Index	
	C	W	C	W	C	W	C	W	C	W	C	W
EC240630	0.76 ± 0.05	0.73 ± 0.01^{ab}	1.30 ± 0.01^{a}	1.02 ± 0.10^{a}	2.06 ± 0.07^{a}	1.76 ± 0.08^{a}	0.07 ± 0.02^{f}	7.17 ± 0.43^{a}	6.96 ± 0.24^{a}	7.82 ± 0.41^{bcde}	87.88 ± 2.62	78.17 ± 3.43
SNAR-12-11	0.71 ± 0.06	0.55 ± 0.08^{c}	1.28 ± 0.02^{ab}	0.83 ± 0.18^{a}	1.81 ± 0.19^{b}	1.74 ± 0.18^{a}	0.10 ± 0.03^{f}	5.26 ± 2.38^{b}	5.60 ± 0.52^{bc}	8.73 ± 0.66^{abc}	79.35 ± 6.83	71.25 ± 4.27
IC398992	0.70 ± 0.03	0.64 ± 0.06^{bc}	1.26 ± 0.09^{ab}	0.83 ± 0.10^{a}	1.86 ± 0.18^{ab}	1.30 ± 0.31^{bc}	0.94 ± 0.06^{a}	3.13 ± 0.08^{c}	4.80 ± 0.88^{cd}	9.60 ± 1.10^{a}	84.93 ± 5.41	67.87 ± 10.44
EC98668	0.75 ± 0.05	0.71 ± 0.04^{ab}	1.12 ± 0.05^{abc}	0.55 ± 0.09^{b}	1.84 ± 0.08^{ab}	1.34 ± 0.18^{b}	0.09 ± 0.01^{f}	3.72 ± 0.30^{c}	4.32 ± 0.42^{d}	8.92 ± 0.43^{ab}	86.06 ± 3.57	69.32 ± 11.88
IC372130	0.70 ± 0.05	0.69 ± 0.06^{ab}	1.27 ± 0.05^{ab}	0.98 ± 0.11^{a}	1.94 ± 0.04^{ab}	1.04 ± 0.13^{bcde}	0.10 ± 0.01^{f}	6.85 ± 0.24^{a}	5.86 ± 0.40^{abc}	6.89 ± 0.14^{e}	83.20 ± 5.89	76.80 ± 2.00
EC244217	0.75 ± 0.05	0.69 ± 0.05^{ab}	1.32 ± 0.01^{a}	0.48 ± 0.05^{b}	1.99 ± 0.18^{ab}	0.93 ± 0.23^{cde}	0.56 ± 0.02^{c}	4.09 ± 0.43^{bc}	5.06 ± 0.78^{cd}	7.47 ± 0.80^{de}	78.49 ± 19.02	62.68 ± 11.24
IC20678	0.75 ± 0.04	0.58 ± 0.06^{c}	0.87 ± 0.22^{c}	0.26 ± 0.07^{c}	1.32 ± 0.09^{c}	0.72 ± 0.10^{e}	0.04 ± 0.01^{f}	4.42 ± 0.51^{bc}	5.15 ± 1.06^{cd}	7.07 ± 1.56^{de}	84.54 ± 6.06	70.86 ± 13.50
EC99566	0.71 ± 0.12	0.64 ± 0.09^{bc}	1.31 ± 0.02^{a}	0.84 ± 0.19^{a}	1.97 ± 0.10^{ab}	1.12 ± 0.43^{bcd}	0.27 ± 0.07^{e}	3.60 ± 0.13^{c}	5.84 ± 0.98^{abc}	8.16 ± 0.33^{bcd}	86.06 ± 3.57	70.25 ± 3.23
IC97787	0.71 ± 0.01	0.63 ± 0.08^{bc}	1.19 ± 0.12^{ab}	0.44 ± 0.07^{bc}	1.91 ± 0.14^{ab}	1.00 ± 0.22^{bcde}	0.41 ± 0.03^{d}	5.33 ± 0.32^{b}	6.76 ± 0.39^{ab}	8.23 ± 0.19^{bcd}	77.24 ± 18.56	69.73 ± 12.45
PFC-50	0.78 ± 0.00	0.76 ± 0.01^{a}	1.04 ± 0.39^{bc}	0.93 ± 0.07^{a}	1.14 ± 0.23^{c}	0.87 ± 0.10^{de}	0.77 ± 0.09^{b}	7.00 ± 0.15^{a}	5.90 ± 0.83^{abc}	7.55 ± 0.23^{cde}	84.93 ± 5.41	81.37 ± 2.23
F stat	0.85^{NS}	3.58**	2.86*	15.97**	13.87**	7.49**	162.34**	10.39**	4.15**	4.20**	0.43^{NS}	1.18^{NS}
p value	0.58	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.36
CD	-	0.1	0.26	0.19	0.24	0.38	0.08	1.38	1.2	1.24	-	-
MSE	0.00	0.00	0.02	0.01	0.02	0.05	0.00	0.66	0.50	0.53	91.54	76.33
SE(m)	0.03	0.03	0.09	0.07	0.08	0.13	0.03	0.47	0.41	0.42	5.52	5.04
SE(d)	0.04	0.05	0.12	0.09	0.12	0.18	0.04	0.66	0.58	0.59	7.81	7.13
CV(%)	7.37	8.94	12.55	15.84	7.94	18.83	13.17	16.06	12.54	9.02	11.49	12.16

Cell values are mean±SD; Treatments with the same letter grouping are not significantly different.

photosynthetic pigments during waterlogging in cowpea. This will affect photosynthesis adversely. Shao *et al.* (2013) suggested that the loss of photosynthetic pigments might be due to the limitations of stomata.

Kyu *et al.* (2021) observed short term waterlogging do not have effect on chlorophyll content, but long-term waterlogging negatively affected chlorophyll in the mungbean.

All the genotypes recorded decreased MSI compared to control, which is a common expression under stress. The membrane stability index analyses the extent of damage of cell membrane and gives an overview on the ability of the membrane to survive in the stress condition (Sakya *et al.*, 2018). It reflects the integrity and functionality of cellular membranes, which can be used to assess the tolerance of crop varieties on stress conditions. Even though there were not much variation in the MSI of genotypes, highest mean values were observed in IVTC-6, followed by EC240630 and IC372130. Bansal *et al.* (2019) also found similar findings in black gram where susceptible genotypes showed reduction in MSI compared to tolerant genotypes.

The PCA biplot (Fig. 2) was used to distinguish the genotypes based on their biochemical responses under waterlogging condition. PC1 primarily separates treatments based on oxidative stress and antioxidant defense mechanisms, while PC2 accounts for variations in chlorophyll content. From this, it is evident that treatments such as EC240630, IC372130 and PFC-50 exhibited characteristics of stress tolerance, whereas others showed higher oxidative stress, which is indicated by high lipid peroxidation. Index plot based on PC1 is given here (Fig. 3).

Yield attributing traits

Yield attributing traits such as number of primary branches, number of leaves, leaf area, leaf area index (LAI), green fodder yield, total dry matter and plant height were noted in each plant under both control and waterlogging condition. ANOVA was carried out on the data.

In control condition, all traits exhibited significant variation. The variation might be genotypical. Vamsi *et al.* (2022) analysed 79 fodder cowpea genotypes and recorded wide variation for the traits including number of primary branches, number of leaves, green fodder yield, etc. The study revealed the characters like number of primary

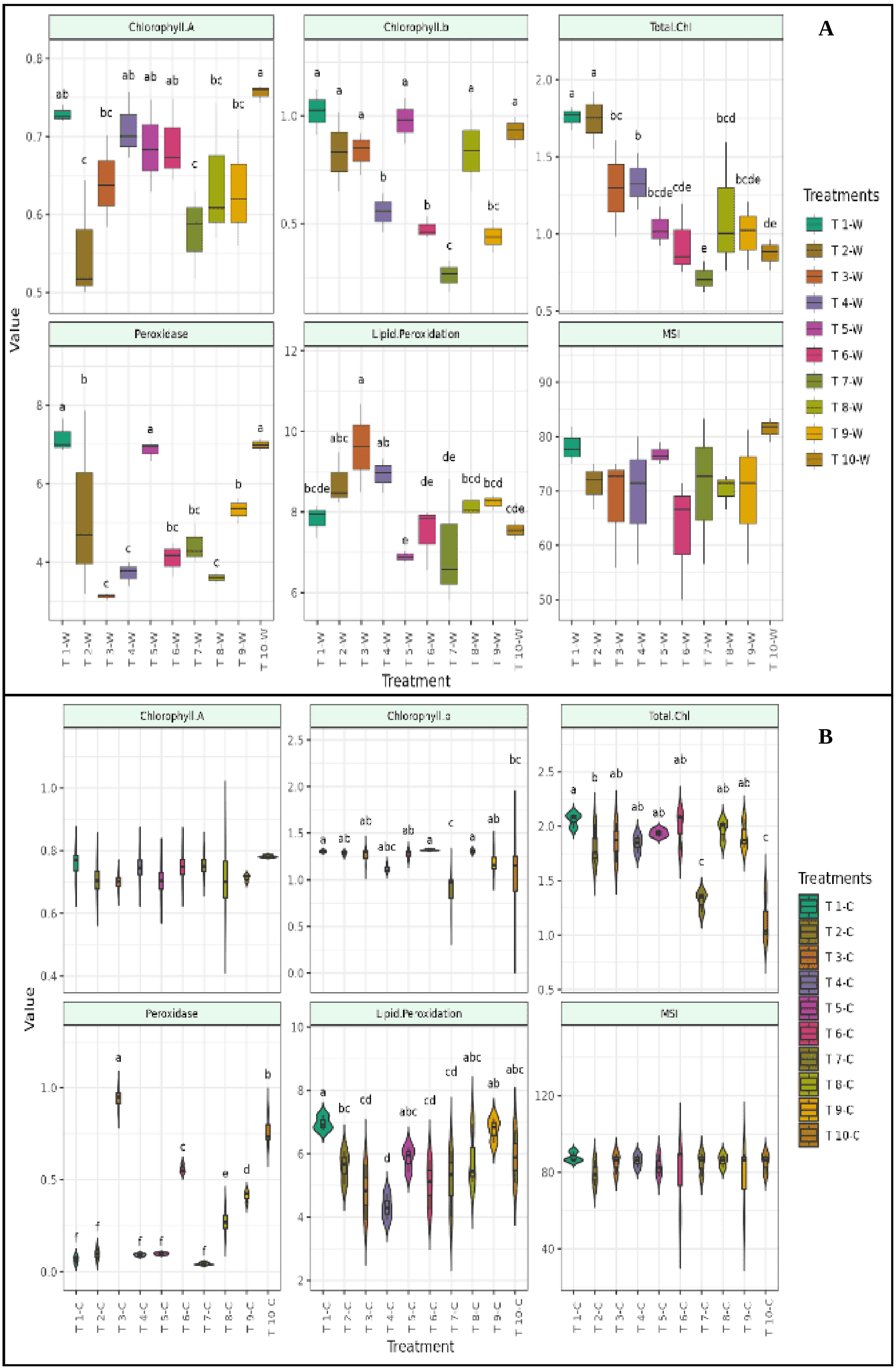

Fig. 1. Graphical representation of biochemical data (Chlorophyll a, Chlorophyll b, Total Chlorophyll, Peroxidase activity, Lipid peroxidation and Membrane Stability Index) under control (A) and waterlogging condition (B).

TABLE 3
Comparisons of yield attributing traits of fodder cowpea under control and waterlogging conditions [C: Control; W: Waterlogging]

Accessions	No. of primary branches		Leaves		Plant height (cm)		Green fodder yield (g)		Total dry matter (g)		Leaf area (cm^2)		LAI	
	C	W	C	W	C	W	C	W	C	W	C	W	C	W
EC240630	3.00 ± 0.00^{cd}	2.00 ± 1.00^{b}	43.00 ± 7.55^{cde}	40.67 ± 7.51^{a}	72.43 ± 16.45^{de}	65.33 ± 10.49	86.67 ± 11.55^{d}	66.67 ± 5.77^{a}	7.83 ± 1.19^{de}	8.51 ± 0.35^{a}	59.86 ± 5.68^{cde}	31.00 ± 6.24^{bc}	0.13 ± 0.01^{cde}	0.07 ± 0.01^{bc}
SNAR-12-11	2.67 ± 0.58^{d}	1.00 ± 0.00^{bc}	52.00 ± 4.00^{bcd}	26.00 ± 4.58^{de}	130.17 ± 14.78^{c}	57.10 ± 8.07	110.00 ± 10.00^{c}	36.67 ± 5.77^{b}	12.03 ± 1.56^{b}	3.13 ± 0.80^{bc}	54.10 ± 4.83^{de}	34.63 ± 1.56^{abc}	0.12 ± 0.01^{de}	0.08 ± 0.00^{abc}
IC398992	6.00 ± 2.65^{a}	1.33 ± 0.58^{bc}	68.00 ± 6.24^{a}	31.00 ± 1.73^{bcd}	200.00 ± 10.00^{a}	56.07 ± 17.68	158.33 ± 23.63^{a}	38.33 ± 10.41^{b}	16.42 ± 1.27^{a}	4.07 ± 2.20^{bc}	63.20 ± 4.49^{cd}	33.90 ± 1.93^{abc}	0.14 ± 0.01^{cd}	0.08 ± 0.00^{abc}
EC98668	4.67 ± 0.58^{ab}	0.67 ± 0.58^{c}	56.00 ± 3.61^{abc}	27.00 ± 3.00^{cde}	163.67 ± 21.08^{b}	57.07 ± 10.93	136.67 ± 15.28^{ab}	33.33 ± 5.77^{b}	15.04 ± 1.07^{a}	2.39 ± 1.27^{c}	99.67 ± 12.01^{a}	28.28 ± 2.94^{c}	0.22 ± 0.03^{a}	0.06 ± 0.01^{c}
IC372130	4.33 ± 0.58^{bc}	3.33 ± 0.58^{a}	63.33 ± 11.24^{ab}	36.00 ± 7.94^{ab}	65.43 ± 9.70^{e}	53.80 ± 8.46	116.67 ± 5.77^{bc}	46.67 ± 15.28^{b}	16.50 ± 0.75^{a}	5.32 ± 2.78^{b}	52.50 ± 4.50^{e}	40.39 ± 5.71^{a}	0.12 ± 0.01^{e}	0.09 ± 0.01^{a}
EC244217	3.00 ± 0.00^{cd}	1.67 ± 0.58^{bc}	48.00 ± 7.94^{cd}	17.67 ± 5.77^{f}	187.00 ± 19.67^{ab}	65.00 ± 7.00	96.67 ± 5.77^{cd}	36.67 ± 5.77^{b}	9.67 ± 1.62^{cd}	3.75 ± 1.10^{bc}	80.25 ± 7.55^{b}	32.80 ± 2.43^{bc}	0.18 ± 0.02^{b}	0.07 ± 0.01^{bc}
IC20678	2.67 ± 0.58^{d}	0.67 ± 0.58^{c}	68.00 ± 6.24^{a}	29.00 ± 1.73^{bcde}	95.33 ± 7.09^{d}	49.47 ± 3.11	101.00 ± 10.15^{cd}	43.33 ± 5.77^{b}	9.24 ± 0.60^{cd}	3.72 ± 0.11^{bc}	62.85 ± 4.81^{cde}	34.67 ± 5.28^{abc}	0.14 ± 0.01^{cde}	0.08 ± 0.01^{abc}
EC99566	2.33 ± 0.58^{d}	0.67 ± 0.58^{c}	34.33 ± 12.58^{e}	22.00 ± 4.58^{ef}	72.33 ± 22.01^{de}	64.00 ± 15.87	60.00 ± 10.00^{e}	36.67 ± 5.77^{b}	6.17 ± 0.54^{e}	3.37 ± 0.85^{bc}	65.63 ± 4.07^{c}	36.84 ± 3.86^{ab}	0.15 ± 0.01^{c}	0.08 ± 0.01^{ab}
IC97787	3.00 ± 0.00^{cd}	1.67 ± 0.58^{bc}	42.00 ± 7.94^{de}	30.67 ± 2.08^{bcd}	73.67 ± 4.73^{de}	47.00 ± 4.00	86.67 ± 20.82^{d}	33.33 ± 5.77^{b}	8.75 ± 1.36^{d}	3.33 ± 0.49^{bc}	83.67 ± 5.05^{b}	27.86 ± 2.69^{c}	0.19 ± 0.01^{b}	0.06 ± 0.01^{c}
IVTC-6	3.33 ± 0.58^{bcd}	1.67 ± 0.58^{bc}	30.00 ± 3.00^{e}	34.67 ± 4.51^{abc}	73.90 ± 25.50^{de}	66.33 ± 18.90	80.00 ± 10.00^{de}	40.00 ± 10.00^{b}	10.83 ± 0.64^{bc}	4.28 ± 1.24^{bc}	64.03 ± 5.65^{cd}	33.60 ± 4.35^{abc}	0.14 ± 0.01^{cd}	0.07 ± 0.01^{abc}
F stat	4.38**	5.49**	9.29**	5.86**	30.44**	1.04^{NS}	13.47**	4.34**	31.41**	4.67**	16.61**	2.63*	16.61**	2.63*
p value	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03
CD	1.62	1.03	13.01	8.24	28.1	-	23.03	13.99	1.92	2.33	10.7	6.84	0.02	0.02
MSE	0.90	0.37	58.37	23.43	272.18	136.28	182.80	67.50	1.27	1.87	39.43	16.12	0.00	0.00
SE(m)	0.55	0.35	4.41	2.79	9.52	6.74	7.81	4.74	0.65	0.79	3.63	2.32	0.01	0.01
SE(d)	0.77	0.49	6.24	3.95	13.47	9.53	11.04	6.71	0.92	1.12	5.13	3.28	0.01	0.01
CV (%)	27.11	41.29	15.14	16.43	14.55	20.09	13.09	19.96	1 0.02	32.62	9.16	12.02	9.16	12.02

Note: Cell values are mean±SD; Treatments with the same letter grouping are not significantly different.

branches, number of leaves, leaf area index and plant height have positive relationship with green fodder yield.

In the stress condition, all the traits except plant height exhibited significant variation. Significant reduction in the mean values of the observed traits were recorded (Table 2). Similar findings were reported by Olorunwa *et al.* (2022[b]) in cowpea. The experiment found out that plant height, leaf area, fresh and dry weight of cowpea genotypes were reduced significantly under waterlogging compared to the control treatments.

Majority of the plants under waterlogging showed reduced vegetative growth when waterlogging was induced at 25 DAS. Under waterlogging treatment, the number of primary branches of cowpea genotypes ranged from 0.67 (T_4-EC98668, T_7- IC20678, T_8-EC99566) to 3.33 (IC372130) whereas at control treatment, number of primary branches varied from 2.33 to 6.00 (Table 3).

Similarly, significant reduction was observed in all the traits including green fodder yield and dry matter yield. Umaharan *et al.* (1997) conducted an experiment on the waterlogging of cowpea. Waterlogging was given in different cycles to cowpea and observed nearly 40% reduction in the leaf area after waterlogging cycles. Basavaraj *et al.* (2024) also reported decreased plant height, number of leaves, leaf area and biomass accumulation in cowpea when waterlogging was induced. Similarly, mung bean and pigeon pea also showed stunned plants during waterlogging (Kumar *et al.*, 2013; Basavaraj *et al.*, 2023). Significant reduction in fresh weight and dry matter of soybean under waterlogging was also recorded (Sathi *et al.*, 2022).

The comparison of data on biometric characters of the treatments grown under control and waterlogging conditions are given below. In the comparison (Fig 4), it is shown that the reduction in the yield traits during waterlogging was very prominent in all the genotypes. There were 23% yield reduction for green fodder yield for EC240630, whereas IC398992 recorded 75.78% yield reduction. Similarly for dry matter yield, EC98668 recorded 84% reduction during waterlogging. But surprisingly, EC240630 recorded more dry matter yield under waterlogging stress. Analysis of biochemical traits indicated that the genotypes EC240630, IC372130 and PFC-50 have stress tolerance.

In the visual observation (Fig 5), EC240630 exhibited massive adventitious root growth under waterlogging conditions. Basavaraj *et al.* (2023)

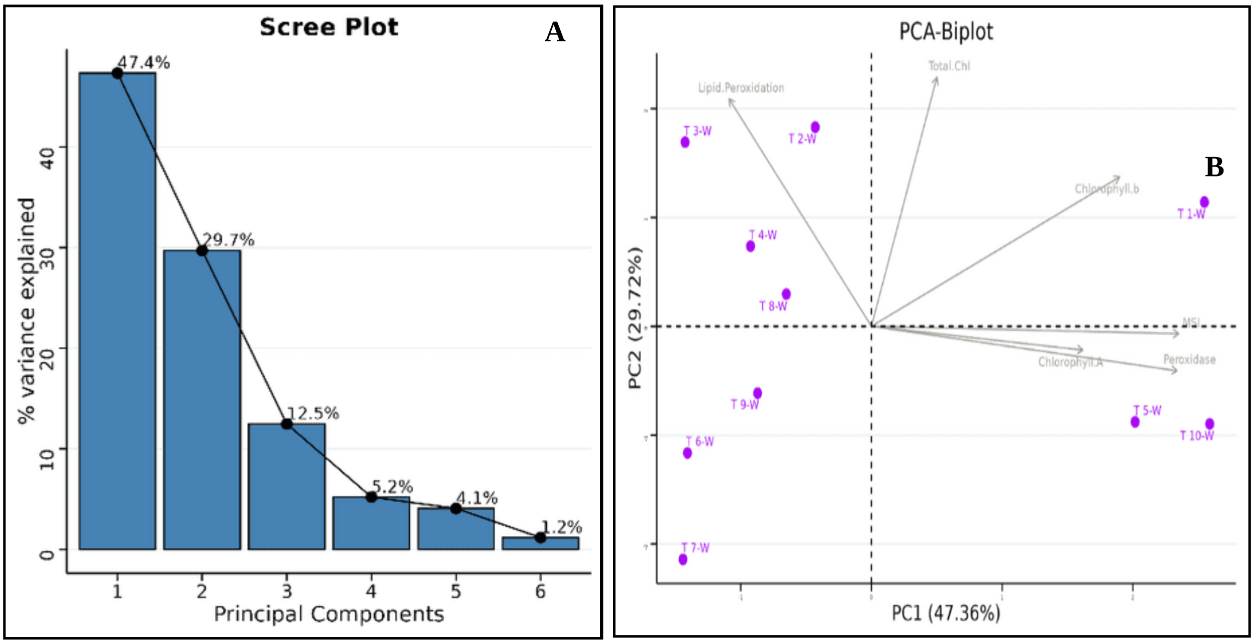

Fig. 2. Scree plot (A) and PCA Biplot (B) on biochemical traits of ten genotypes under waterlogging condition.

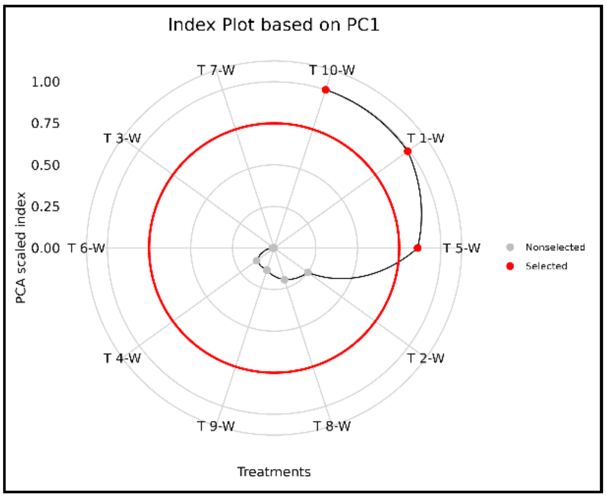

Fig. 3. Index plot based on PC1.

reported that development of adventitious roots is one of the potential traits conferring waterlogging tolerance in cowpea. Leaves of IC398992 genotype were big in control, which became small in waterlogged condition. Leaves of EC98668 genotype were wilted after waterlogging. The genotype IC372130 started flowering even during the induction of stress condition. EC244217 genotype showed little bit yellowing on the leaves. Genotypes SNAR-12-11, IC20678, EC99566 and IC97787 also became stunned after waterlogging stress. Genotype PFC-50 was an early flowering, early maturing, erect genotype. The plants exhibited same traits with waterlogging also. It flowered on same time with control and initiation of pod was also there. The genotypes which slowed down their growth phase, took more time to flower after the stress conditions were withdrawn.

CONCLUSION

Waterlogging is one the most affecting environmental stress, which adversely affect the food security and environment. Fodder cowpea is an important feed for livestock, which is sensitive to waterlogging. The study was conducted to find out the effect of waterlogging stress on cowpea genotypes. Waterlogging stress was given at 25 DAS. By comparing the ten genotypes under waterlogging and control conditions, it was evident that waterlogging has very negative impact on the growth and yield of fodder cowpea. Biochemical and yield parameters were studied. A reduction of 23% - 75% green fodder yield was recorded in this study on ten genotypes, where the average yield reduction was 57%. Tolerant genotypes will maintain their photosynthetic pigment content and other antioxidant enzyme contents to survive in the stress. Emergence of adventitious roots also favour the stress tolerance. Comparatively yield reduction was lesser in the tolerant genotypes. There might be variation due to the stage and duration of stress induction. Among the ten genotypes studied here, EC240630 genotype performed better under waterlogging with a greater number of adventitious roots, higher antioxidant activities and better yield performance. Detailed study on the biochemical pathways on the tolerant genotypes will give more

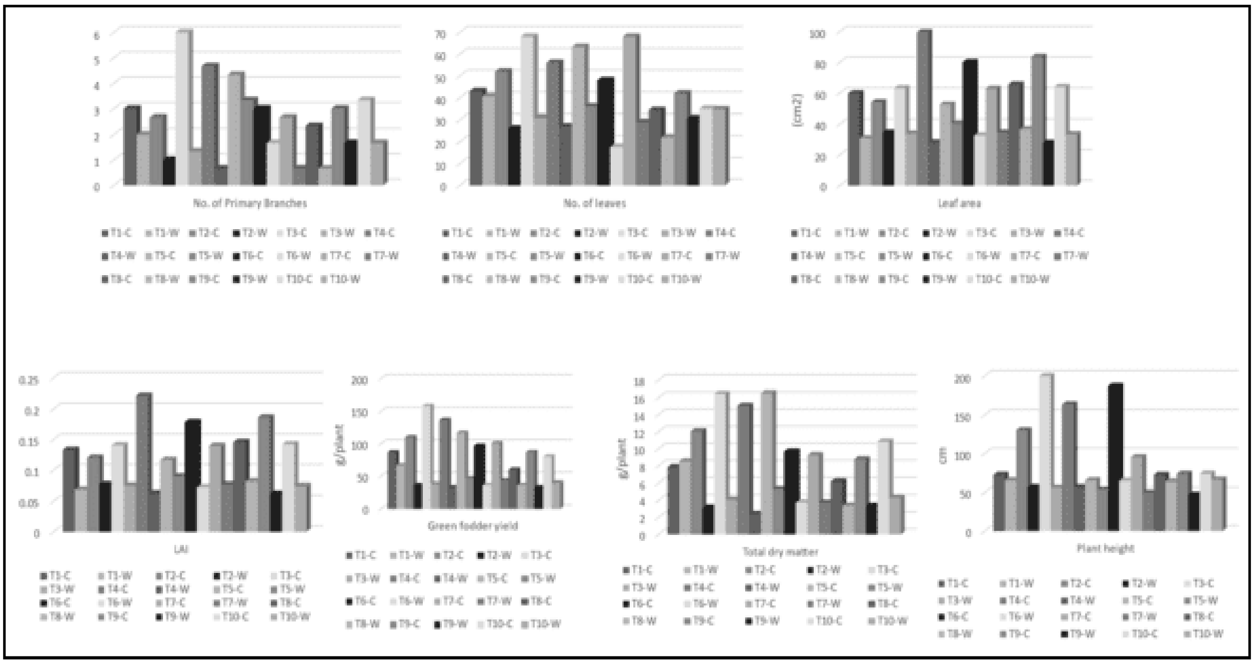

Fig. 4. Graphical representation on the comparison of data on number of primary branches, number of leaves, leaf area, leaf area index and green fodder yield, total dry matter and plant height per plant of ten genotypes grown under control and waterlogging condition.

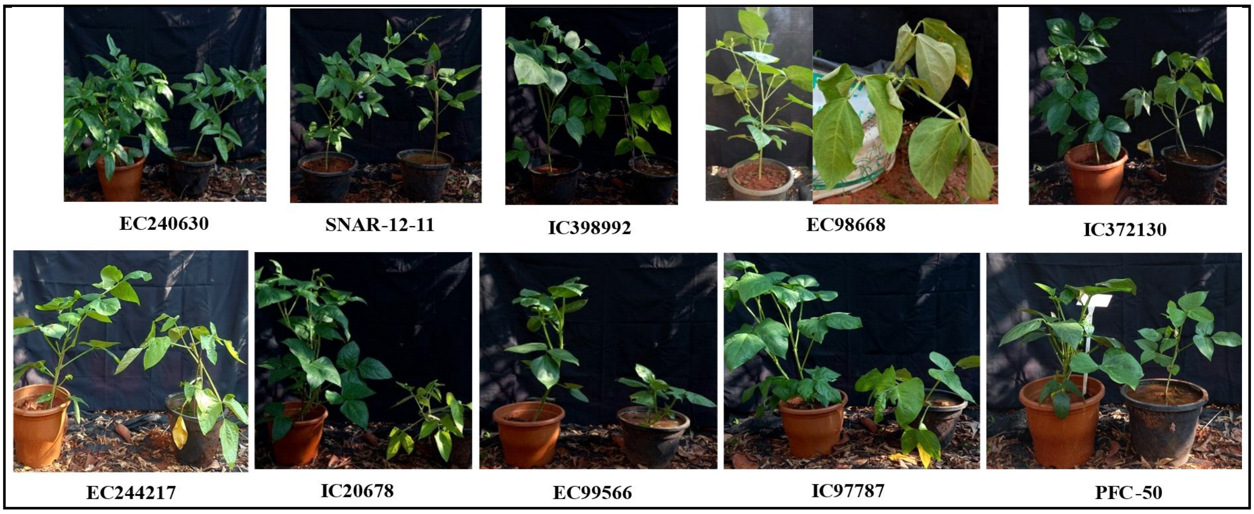

Fig 5. Genotypes after 15 days of waterlogging (25 DAS - 40 DAS) [control at left and waterlogged at right respectively].

insights about stress tolerance and they can be utilized in the future breeding programmes.

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