Flood Tolerance of Hybrid Napier(*Pennisetum purpureum* x *Pennisetum glaucum*) Cultivars

ABSTRACT

A pot culture study was conducted from February to May 2020 at the Agronomy Farm, Department of Agronomy, College of Agriculture, Vellanikkara, Kerala to study the effects of short-term flooding on the growth, physiology, and yield of four high-yielding cultivars of hybrid napier(*Pennisetum purpureum* x *Pennisetum glaucum*) cultivated in Kerala. The experiment followed a 4 x 2 factorial Completely Randomized Design with three replications. The treatments comprised two factors: varieties and flooding treatments. The four hybrid napiervarieties used in the study were CO-3 (V_1), CO-5 (V_2), IGFRI -3 (V_3), and Suguna (V_4).The flooding treatments included no flooding (F_0) as a control and short-term floodingstress treatment (F_1)at three different growth stages: 30 days after planting (DAP), 60 DAPand just after the first harvest (75 DAP). Flooding stress was imposed for seven days by inundating water in the pots up to 3-4 cm above the soil level. Floodingat all three stages resulted in a significant reduction in plant height, tiller number, leaf number and above-ground biomassfor all varieties. Asevere reduction in growth and yield parameters was observedwhen flooding stress was imposed immediately after the first harvest.Among the varieties, CO-5 had the tallest plants,followed by Suguna, CO-3, and IGFRI-3. When exposed to flooding stress, variety CO-5 was also found to be significantly superior in terms of above-ground biomass production, followed by CO-3.Superoxide dismutase (SOD) activity increased in all varieties due to flooding stress, with a pronounced increase observed in Suguna. Variety CO-5, which exhibitedgreater plant height and above-ground biomass production, was found to be more tolerant to flooding stress, while variety IGFRI-3, with a dwarf plant stature and the lowest biomass yield, was identified as sensitive to short-term flooding stress.

Keywords : Chlorophyll content; Growth parameters;Green fodder yield; Physiology;

Superoxide dismutase enzyme

1. INTRODUCTION

Hybrid napier(*Pennisetum purpureum* x *Pennisetum glaucum*)is the most popular fodder grass among dairy farmers due to its high yield potential[1]. Several elite cultivars are currently under cultivation. While the adaptation of hybrid napier to rainfed conditions is well recognized, very little is known about its response to flooding stress. Abiotic stress and its effects on plants are topics that are receiving increasing attention due to the potential impacts of climate change, flooding in agricultural lands and the overall need to maintain or increase agricultural productivity.

In Kerala, hybrid napier is cultivated even in lowlands where periodic flooding during the rainy season often poses a threat to crop loss and reduced production. Due to climate change, flooding events are expected to increase in occurrence and severity in some parts of the tropics in the near future. Flooding leads to an immediate reduction in the exchange of gases between the plant and its environment and mechanisms of tolerance to flooding are based on many adaptive features and strategies that improve gas exchange and maintain energy production [2]. The extent to which tropical fodder grasses may be flood-tolerant and the mechanisms involved in the flood tolerance of these plants have not been extensively studied. Gaining insights into the flood resilience in hybrid napier cultivars can aid in identifying suitable cultivars for regions susceptible to frequent flooding. Therefore, the objective of the present study was to evaluate the effect of short-term flooding during different growth stages on the growth, physiology, and yield of a few high-yielding cultivars of hybrid napier cultivated in Kerala.

2. MATERIALS AND METHODS

A pot culture study was conducted from February to May 2020 at the AgronomyFarm, Department of Agronomy, College of Agriculture,Vellanikkara,Kerala Agricultural University, Thrissur, India. The location is situated at 10^0 31’ N and 76^0 13’ E longitude, at an altitude of 40.3 m above mean sea level.

The experiment was laid out in a 4 x 2 factorial Completely Randomized Design with three replications. The treatments included two factors: varieties and flooding treatments. Four high-yielding varieties of hybrid napierwere used for the study which included CO-3 (V_1), CO-5 (V_2), IGFRI -3 (V_3), and Suguna (V_4). The flooding treatments were no flooding (F_0) as control and short-term flooding stress treatment(F_1). The flooding treatments were applied at three growth stages:30 days after planting (DAP), 60 DAPand just after first harvest (75 DAP).Flooding stress was imposed for a period of 7 days by inundating water in the pot up to 3-4 cm above the soil level. Control pots were kept at field capacity.

Three-noded stem cuttings of selected high-yielding hybrid napier varieties were collected from the germplasm collection maintained at the Agronomy Farm and used for planting. Each pot was filled with 12 kg of sandy loam soil with a pH of 4.75 and electrical conductivity of 0.78 dSm^{-1}. The soil had available nitrogen, phosphorus, and potassium content of 176, 75, and 153 kg ha^{-1}, respectively. Farmyard manure was applied at a rate of 0.5 kg/ pot,and a basal fertilizer dose of 50:50:50 $kgha^{-1}$ $N:P_2O_5:K_2O$was uniformly applied to all pots two weeks after the establishment of hybrid napier setts following the Package of Practices recommendations [3].Harvesting was done 75 DAP in all treatments.

Plant height, the number of tillers and leaves per plant and aboveground biomass were recorded at the end of flooding stress treatment (after 7 days of flooding stress) at each growth stage.Plant height was measured from the base of the plant to the tip of the longest leaf and was expressed in centimetres (cm). The above-ground biomass in each pot was recorded andexpressed in g/pot.

Physiological parameters such as total chlorophyll content[4]; soluble protein content [5] and superoxide dismutase (SOD) activity [6] in leaves, were recorded immediately after flooding stress at 60 DAP.

The data generated were subjected to Analysis of Variance (ANOVA) using the statistical package KAU GRAPES (General Rshiny-based Analysis Platform Empowered by Statistics) developed by Kerala Agricultural University [7]. Mean values were compared using the least significant difference test.

3. RESULTS AND DISCUSSION

3.1. Morphological response of high-yielding hybrid napier varieties to flooding at different growth stages

The data presented in Table 1 provides information on growth parameters, including plant height, the number of tillers per plant, and the number of leaves per plant, and above-ground biomass for various hybrid Napier grass varieties under the influence of flooding stress at 30 DAP. Significant variations were observed in growth parameters due to flooding stress among the varieties under investigation.

Flooding stress at 30 DAPled to a reduced plant height of 66.81 cm compared to height under no stress (85.53 cm). This was 22 per cent lower than the non-stressed plants. This can be attributed to the reduction in leaf elongation rate caused by stress-induced changes in physiology, resulting in a decreased photosynthetic rate [8]. Similar stunted growth habit due to a reduction in the internodal length under flooding stress was also reported in maize [9]. However, the flooding treatment had no significant impact on the number of tillers and leaves. Additionally, flooding at 30 DAP resulted in decreased above-ground biomass of 428.56 g, compared to the control, which had a biomass of 565.5 g.

The varietal differences were significant concerning plant height, the number of tillers and leaves per clump, and above-ground biomass production. Among the varieties, CO-5 had the tallest plants (92.63 cm), followed by Suguna (77.00 cm), CO-3 (76.44 cm), and IGFRI-3 (58.63 cm), indicating genetic diversity in their responses during the early growth stage. In terms of tiller count, IGFRI-3 had the highest (12.25), closely followed by Suguna (10.88), while CO-3 and CO-5 had 7.25 and 6 tillers per clump, respectively. IGFRI-3 also produced more leaves per clump (94.63), and CO-5 (89.75) being the next best variety. Vigorous leaf growth during the early stages of crop growth in IGFRI-3 makes it a promising variety, CO-5 exhibited the highest initial biomass (592.88 g), trailed by Suguna (526.63 g), CO-3 (524.25 g), and IGFRI-3 (344.38 g). The observed differences in plant height suggest varying responses of these hybrid napier varieties to flooding stress during the early growth stage. CO-5 displayed greater tolerance or adaptability to flooding, as evidenced by its taller stature compared to the other varieties during the early growth stage. In contrast, IGFRI-3 exhibited lower height, indicating potential sensitivity to flood-induced stress.

The interaction between variety and flooding stress was also significant with respect to plant height and no. of leaves per clump when flooding was imposed at 30 DAS. Under no flooding stress, variety CO-5 recorded significantly higher plant height (99.5 cm) followed by Suguna (88.25 cm), CO-3 (85.88) and IGFRI-3 (68.5 cm). Even after flood stress, variety CO-5 maintained a significantly higher plant height (85.75 cm). The shortest plants were observed in the variety IGFRI-3 (48.75 cm) when exposed to flooding stress. However, in terms of leaf count, the highest count (102.00) was registered for variety IGFRI-3, followed by CO-5 (87.25) under no flooding stress conditions. Under flood stress, variety CO-5 produced a higher leaf count (92.25), which was on par with Suguna (90.5). Variety CO-5 consistently registered the highest value both under flood stress and control, probably due to the inherent genetic nature. The adverse effects of flooding on plant growth and yield mostly depend on a plant's species or genotype [10]**.** Taller plants have an advantage over shorter plants under waterlogging conditions, as the chances of complete submergence are reduced, and plant height could serve as a simple trait in screening waterlogging-tolerant grasses [11].

The data on growth parameters, including plant height, number of tillers per plant, number of leaves per plant and above ground biomass production of hybrid napier varieties as influenced by flooding stress at 60 DAP are presented in Table2.

At 60 DAS, flooding had a more pronounced impact, resulting in significant reductions in plant height (105.6 cm) and tiller count (8) compared to the control (195.94 cm and 10.5, respectively). The plant height was reduced by 46 per cent under flood stress. However, the reduction in the number of leaves was relatively minor (101.5 compared to 129.88 in the control). Flooding at 60 DAS resulted significant reduction in above-ground biomass, amounting to 58 per cent under flood stress (714.69 g) compared to the control (1713.06 g).

Among the varieties, CO-5 maintained its growth advantage with the tallest plants (190.80 cm), followed by Suguna (136.89 cm), CO-3 (145.12 cm), and IGFRI-3 (130.28 cm). However, IGFRI-3 had the highest tiller count (12.25), while CO-5 and Suguna showed slight increases in tillers. IGFRI-3 also maintained the highest leaf count (133.88), followed by CO-5 with 111 leaves per clump. These findings suggest that IGFRI-3 is particularly vigorous in tiller production, especially in the early stages, making it a potential candidate for situations where rapid growth and tillering are desirable. CO-5 maintained the highest biomass (1916.38 g), followed by CO-3 (1050.13 g), Suguna (996.00 g), and IGFRI-3 (893.00 g).

The interaction of variety and flooding stress at 60 DAS was significant with respect to plant height, the number of tillers and leaves per clump, and green fodder yield. In general, stressed plants resulted in shorter plants irrespective of varieties compared to plants under control conditions. Among the treatments, CO-5 under no stress resulted in taller plants (243.59), but the plant height reduced to 138.02 cm, resulting in a reduction of 43.38 per cent compared to the control. IGFRI-3 produced the shortest plants (82.48 cm) when flood stress was imposed at 60 DAS. However, IGFRI-3 produced the highest number of tillers and leaves (14.5; 143.25) under no stress, but produced only 10 tillers per clump and 124.5 leaves per clump under flood stress at 60 DAS, leading to a 31.03 per cent and 13. 08 per cent reduction in tiller count and leaf count respectively compared to the control. The highest green fodder yield was also recorded by CO-5 (2552.25 g), followed by IGFRI-3 (1442.25 g) and CO-3 (1432.25 g) under non-flooded conditions. However, flood stress resulted in lower above-ground biomass, irrespective of varieties, with a biomass reduction to the tune of 50, 76, 53, and 60 per cent observed for CO-5, IGFRI-3, CO-3, and Suguna, respectively.

At 75 DAP, the grass was subjected to flooding after harvesting of the clumps and the flooding had the most significant impact, resulting in a substantial reduction of 55.35 and 60.17 per cent, respectively, in plant height (30.14 cm) and tiller count (3.31) compared to the control (67.39 cm and 8.31) (Table3). A similar reduction in tiller number was also reported in *Brachiariabrizantha* accessions due to a delay in the development of tiller buds into tillers in response to flooding stress [12]. Flooding stress at 75 DAP significantly affected the number of leaves per clump. Plants under no flooding stress produced a significantly higher number of leaves per clump (87.25) as compared to plants under flooding stress (25.5). This was due to the production of a greater number of tillers in non-flooded plants and the decay of growth primordia, which resulted in poor tillering under flood stress. Reduction in leaf production was 71 per cent in plants subjected to flood stress at 75 DAP. Plants without stress recorded significantly higher above-ground biomass (321.06 g), and the average green fodder yield was reduced to 131.94 g when flood stress was imposed. The reduction was to the tune of 58.91 per cent compared to the control.

There was a significant difference between varieties with respect to the growth parameters of plants imposed to flood stress at 75 DAP. Among the varieties, CO-5 remained the tallest (54.35 cm), followed by Suguna (47.49 cm), CO-3 (49.46 cm), and IGFRI-3 (43.75 cm). Variety Suguna produced a higher number of tillers (6.5) and was on par with IGFRI-3 (6). A higher number of leaves per clump was produced by CO-3 (58.88), followed by Suguna, CO-3, CO-5 and IGFRI-3, which recorded statistically similar values. CO-5 consistently displayed higher biomass (276.63 g), particularly in the later stages of growth, followed by CO-3 (255.38 g), Suguna (235.50 g), and IGFRI-3 (138.50 g).

These measurements highlight the changes in biomass as the plants matured and faced flooding stress. CO-5 invariably outperformed the other varieties in terms of growth under various conditions, making it a promising choice for regions prone to flooding.

Interaction between varieties and flooding stress at 75 DAP also significantly influenced plant height, the number of tillers and leaves per clump, and above-ground biomass. Compared to no-stress conditions, flood stress resulted in lower plant height in all varieties of hybrid Napier grass. Variety CO-5 had the tallest plants under no-stress conditions (72.83 cm), and the average plant height was reduced by 50.74 per cent under flood stress (35.88 cm). Flood stress also led to lower tiller and leaf production in all varieties of hybrid Napier grass compared to the control. Since the rate of leaf production depends on the number of tillers produced, the trend in leaf production was similar to that of tiller production. Variety IGFRI-3 produced a higher tiller count (10.5) and leaf number (95.5) under no-stress conditions. However, the variety failed to produce the same result under flood stress and resulted in the lowest tiller count (1.5) and leaf count (6.25) when stress was imposed at 75 DAP. Genetic factors, physiological factors, and their interaction with environmental factors play a major role in tiller production in grasses [13]. Variety CO-3 was on par with Suguna with respect to tiller number after flooding stress (3.25 and 3.75, respectively). A significant difference in above-ground biomass was observed among the varieties under flood stress and non-stress conditions. The highest above-ground biomass was recorded for CO-5 (387 g) under control conditions and was significantly superior to others, followed by CO-3 (356.25 g). IGFRI-3 recorded a lower green fodder yield of 213.5 g and the above-ground biomass was reduced by 57 per cent under flood stress at 75 DAP compared to the control. This overall reduction in aboveground biomass production might be attributed to reduced tiller and leaf production due to flood stress and reduced carbon assimilation caused by stomatal closure due to hypoxic conditions [12]; [14].

Table1. Effect of flooding stress at 30 DAPon growthparameters of hybrid napier varieties

Treatment	**Plant height (cm)**	**No. of. tillers / clump**	**No. of. leaves / clump**	**Above-ground biomass (g/pot)**
Varieties (V)				
V$_1$ - Co 3	76.44^{b}	7.25^{c}	85.00^{c}	524.25^{a}
V$_2$ - Co 5	92.63^{a}	6.00^{d}	89.75^{b}	592.88^{a}
V$_3$ - IGFRI- 3	58.63^{c}	12.25^{a}	94.63^{a}	344.38^{b}
V$_4$– Suguna	77.00^{b}	10.88^{b}	88.00^{b}	526.63^{a}
SE (m)	1.029	0.308	0.942	29.118
CD (0.05)	3.003	0.900	2.749	84.990
Flooding (F)				
F$_0$– Control	85.53^{a}	8.69	89.31	565.50^{a}
F$_1$ - Flooding	66.81^{b}	9.50	89.38	428.56^{b}
SE (m)	0.727	0.218	0.666	20.590
CD (0.05)	2.123	NS	NS	60.097
Interaction (V x F)				
V$_1$ F$_0$	85.88^{b}	6.75	82.50^{e}	583.75
V$_2$F$_0$	99.50^{a}	6.00	87.25^{cd}	686.75
V$_3$F$_0$	68.50^{c}	11.50	102.00^{a}	395.25
V$_4$ F$_0$	88.25^{b}	10.50	85.50^{de}	596.25
V$_1$F$_1$	67.00^{c}	7.75	87.50^{cd}	464.75
V$_2$F$_1$	85.75^{b}	6.00	92.25^{b}	499.00
V$_3$F$_1$	48.75^{d}	13.00	87.25^{cd}	293.50
V$_4$F$_1$	65.75^{c}	11.25	90.50^{bc}	457.00

SE (m)	1.455	0.436	1.332	41.179
CD (0.05)	4.246	NS	3.887	NS

[*]*Treatments with same letters are not significantly different; NS- not significant; DAP- days after planting*

Table2. Effect of flooding stress at 60 DAPon growth and yield parameters of hybrid napier varieties

Treatment	**Plant height (cm)**	**No. of. tillers / Clump**	**No. of. leaves / clump**	**Above-ground biomass (g/pot)**
Varieties (V)				
V_1 - Co 3	145.12^{b}	8.00^{c}	109.25^{b}	1050.13^{b}
V_2 - Co 5	190.80^{a}	6.88^{d}	111.00^{b}	1916.38^{a}
V_3 - IGFRI- 3	130.28^{d}	12.25^{a}	133.88^{a}	893.00^{d}
V_4– Suguna	136.89^{c}	9.88^{b}	108.63^{b}	996.00^{c}
SE (m)	2.129	0.250	1.035	3.434
CD (0.05)	6.213	0.730	3.020	10.023
Flooding (F)				
F_0– Control	195.94^{a}	10.50^{a}	129.88^{a}	1713.06^{a}
F_1 - Flooding	105.60^{b}	8.00^{b}	101.50^{b}	714.69^{b}
SE (m)	1.505	0.177	0.732	2.428
CD (0.05)	4.393	0.516	2.135	7.087
Interaction (V x F)				
$V_1 F_0$	186.61^{b}	8.75^{d}	124.75^{b}	1432.25^{bc}
V_2F_0	243.59^{a}	7.25^{ef}	126.25^{b}	2552.25^{a}
V_3F_0	178.08^{bc}	14.50^{a}	143.25^{a}	1442.25^{b}
$V_4 F_0$	175.50^{c}	11.50^{b}	125.25^{b}	1425.50^{c}
V_1F_1	103.63^{e}	7.25^{ef}	93.75^{c}	668.00^{e}

V_2F_1	138.02^{d}	6.50^{f}	95.75^{c}	1280.50^{d}
V_3F_1	82.48^{f}	10.00^{c}	124.50^{b}	343.75^{g}
V_4F_1	98.28^{e}	8.25d^{e}	92.00^{c}	566.50^{f}
SE (m)	3.010	0.354	1.463	4.856
CD (0.05)	8.786	1.032	4.270	14.174

[*] *Treatments with same letters are not significantly different; NS- not significant; DAP- days after planting*

Table3. Effect of flooding stress at just after first harvest (75 DAP) on growth and yield parameters of hybrid napier varieties

Treatment	**Plant height (cm)**	**No. of. tillers / clump**	**No. of. leaves / clump**	**Above-ground biomass (g/pot)**
Varieties (V)				
V_1 - Co 3	49.46^{b}	5.25^{c}	58.88^{a}	255.38^{b}
V_2 - Co 5	54.35^{a}	5.50^{bc}	57.63^{a}	276.63^{a}
V_3 - IGFRI- 3	43.75^{c}	6.00^{ab}	50.88^{b}	138.50^{d}
V_4– Suguna	47.49^{b}	6.50^{a}	58.13^{a}	235.50^{c}
SE (m)	0.718	0.210	0.777	1.627
CD (0.05)	2.096	0.614	2.269	4.750
Flooding (S)				
F_0– Control	67.39^{a}	8.31^{a}	87.25^{a}	321.06^{a}
F_1 - Flooding	30.14^{b}	3.31^{b}	25.50^{b}	131.94^{b}
SE (m)	0.508	0.149	0.550	1.151
CD (0.05)	1.482	0.434	1.604	3.359
Interaction (V x F)				
V_1F_0	64.50^{c}	7.25^{c}	84.00^{b}	356.25^{b}
V_2F_0	72.83^{a}	6.25^{d}	83.75^{b}	387.00^{a}
V_3F_0	64.75^{bc}	10.5^{a}	95.50^{a}	213.50^{d}
V_4F_0	67.48^{b}	9.25^{b}	85.75^{b}	327.50^{c}

V_1F_1	34.43^{d}	3.25^{f}	33.75^{c}	154.50^{f}
V_2F_1	35.88^{d}	4.75^{e}	31.50^{cd}	166.25^{e}
V_3F_1	22.75^{f}	1.50^{g}	6.25^{e}	63.50^{h}
V_4F_1	27.50^{e}	3.75^{f}	30.50^{d}	143.50^{g}
SE (m)	1.016	0.298	1.099	2.301
CD (0.05)	2.964	0.869	3.208	6.718

**Treatments with same letters are not significantly different; NS- not significant; DAP- days after planting*

3.2. Physiological response of high yielding hybrid napier varieties to flooding stress at 60 DAP

Compared to control conditions, the plants exposed to flooding stress at 60 DAP showed lower total chlorophyll content (Table4). The average decrease in total chlorophyll content was approximately 30 % of the control. The average value is 2.25 in control compared to 1.59 in flooding stress-imposed plants. This is attributed to the increase in chlorophyll degradation due to the induction of oxidative stress resultingfrom flooding stress [15]. Flooding stress imposed at 60 days of growth also led to a significant reduction in soluble protein content from 22.42 to 20.11 mg g^{-1}. The reduction in soluble protein content due to flooding stress imposed was reported in rice [16]. This is attributed to the protein degradation as a consequence of the formation of Reactive Oxygen Species (ROS) such as superoxide, hydrogen peroxide, singlet oxygen and hydroxyl radicals, etc. under hypoxic conditionsresultingfrom flooding [15].However, the flooding stress imposed at 60 DAP led to a significant increase in superoxide dismutase (SOD) activity to the tune of 43.22 Units mg^{-1} protein over 30.32 Units mg^{-1} protein in non-stressed control. The percentage increase was 43 % as compared to control. Similar increase in SOD activity due to flooding stress was reported in maize [17]. Plant tissues generate antioxidant enzymes like superoxide dismutase (SOD) to protect the cells from the detrimental effects of flooding stress. Increased SOD activity is associated with high tolerance capacity to abiotic stress in plants [18].

A significant difference in total chlorophyll content was observed among varieties. IGFRI-3, CO-3 and Suguna showed higher and comparable values of 2.16, 2.08 and 1.92 mg g^{-1}, respectively. CO-5 registered a lower value of 1.51 mg g^{-1}. Hybrid napier varieties also differed with respect to soluble protein content. Varieties CO-3 and IGFRI-3 registered higher and comparable values. Though the varietal difference was significant with respect to SOD activity, three varieties Suguna, IGFRI-3 and CO-5 registered higher and comparable values.

The interaction of variety and flooding stress at 60 DAP was significant with respect to SOD activity (Fig.1). However, the interaction effect was not significant with respect to total chlorophyll and soluble protein content. Significantly higher SOD activity of 52. 9 Units mg^{-1} protein was observed for variety Suguna after flooding stress at 60 DAP. When flooding stress was imposed, Suguna recordeda higher percentage increment in SOD activity of 84.35 % compared to the non-stressed control condition. Lower percentage increment in SOD activity (16%) under flooding stress compared to control condition was recorded in IGFRI-3. Tolerant genotypes registered significantly higher SOD activity along with higher percent increment as compared to susceptible genotypes [18].

Table 4. Effect of flooding stress at 60 DAPon physiological parameters of hybrid napier varieties

Treatment	**Total chlorophyll (mg g^{-1})**	**Soluble protein (mg g^{-1})**	**SOD activity (Units mg^{-1} protein)**
Varieties (V)			
V_1 - Co 3	2.08^{a}	23.38^{a}	31.57^{b}
V_2 - Co 5	1.51^{b}	20.57^{bc}	36.95^{ab}
V_3 - IGFRI- 3	2.16^{a}	22.33^{ab}	37.76^{ab}
V_4– Suguna	1.92^{a}	18.77^{c}	40.79^{a}
SE (m)	0.142	0.896	2.098
CD (0.05)	0.425	2.685	6.291
Flooding (F)			
F_0–Control	2.25^{a}	20.76	30.32^{b}

F_1 - Flooding	1.59^b	21.77	43.22^a
SE (m)	0.100	0.633	1.484
CD (0.05)	0.300	NS	4.449

*Treatments with same letters are not significantly different; NS- not significant; DAP- days after planting

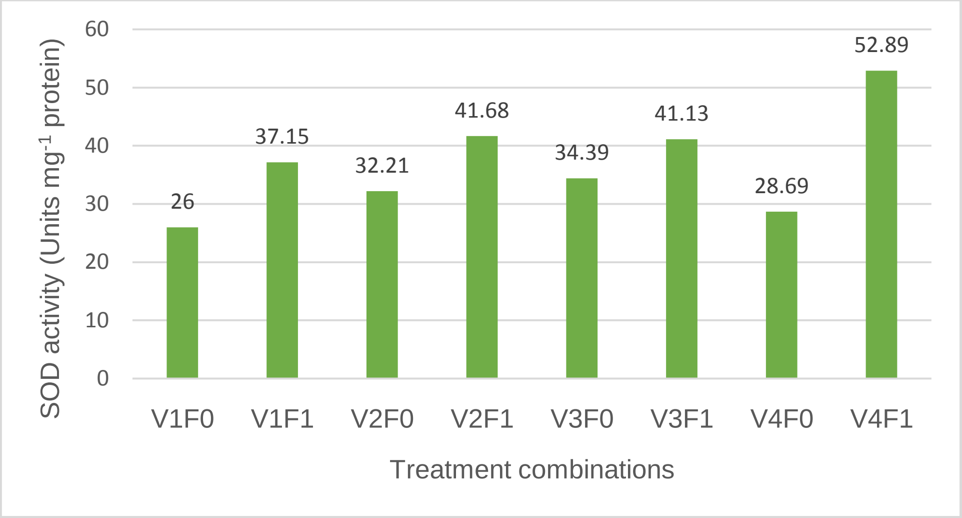

Fig.1. Effect of flooding stress at 60 DAP on superoxide dismutase (SOD) activity (Units mg^{-1} protein) in hybrid napier varieties

4. CONCLUSION

In hybrid napier, short-term flooding stress immediately after the first harvest resulted in significant reduction in growth parameters and fodder yield. Consequently, it was determined that flooding stressjust after harvest (75 DAP) was more severe compared to flooding stress at 30 DAP and 60 DAP in hybrid napier.

Variations were also observed among the different varieties concerning growth, yield, and physiological changes in response to flooding stress. Among the four varieties subjected to flooding stress, CO-5 displayed superiority in overall aboveground biomass production and plant height, whereas IGFRI-3 exhibited the lowest biomass production and plant height. When comparing the above-ground biomass production and plant height of plants after the imposition of flooding stress, it became evident that varieties capable of growing taller under flooding stressalso produced significantly higher above-ground biomass.These findings provide valuable insights into the growth performance of these varieties under flooding conditions, which have implications for their suitability to areas prone to short-term waterlogging.Hence, CO-5,due to its taller stature and higher biomass production, demonstrated greater tolerance to short-term flooding stress at all growth stages of hybrid napier,whereas IGFRI-3, with a shorter plant stature and lower biomass yield, was found to be susceptible to short-term flooding stress.

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