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SINGLE-CUT PERFORMANCE OF FORAGE PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.] VARIETIES FOR GREEN FODDER YIELD AND ITS CONTRIBUTING TRAITS

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ABSTRACT

Pearl millet is the warm-season cereal crop with the highest drought tolerance, and it's mostly used as staple food grain, feed, and forage. The study aims to identify high green fodder yielding varieties of pearl millet for North Indian states. The Field experiments were carried out at Zira, Punjab and Thamber, Haryana, India, during summer 2024, to know the performance of 29 varieties of fodder pearl millet. Significant differences were observed among the varieties for all the characters over the locations. Mean performance revealed that variety FFV-7 (24.8) yielded high for green fodder yield over Nutrifed and wonderleaf. Significant and positive correlation of the traits *viz*., early vigour, number of tillers, leaf length and stem girth with green fodder yield revealed that direct selection of varieties for these traits contributed to the high green fodder yield. Seven varieties were found superior over all three checks for brix percentage, *i.e* FFV-2, FFV-9, FFV-11, FFV-13, FFV-17, FFV-28 and FFV-29. These high Brix varieties can be exploited for silage making. Leaf length and stem girth exhibited a highly significant positive correlation with green fodder yield, and both traits contributed for green fodder yield. So, eight varieties *viz*., FFV-14, FFV-20, FFV-22, FFV-26, FFV-27, FFV-10, FFV-11 and FFV-21, which were found superior over all three checks for these traits. These varieties can be exploited for the development of single-cross forage hybrids and the development of varieties for broadening the genetic base.

Key words : Pearl millet, Varieties, Clustering, Heterosis, Green fodder yield.

Introduction

Pearl millet (*Pennisetum glaucum*) is a highly nutritious cereal crop that plays a vital role in food and fodder security, particularly in arid and semi-arid regions of Africa and Asia. It's the warm-season cereal crop with the highest drought tolerance, and it's mostly used as staple food grain, feed, and forage. Pearl millet is an appropriate crop for different agro-climatic environments as it efficiently uses moisture in the soil and has greater heat tolerance than sorghum and maize (Shashibhushan *et al*., 2022; Kaushal *et al*., 2024). India, Africa, and parts of Asia are among the largest producers of pearl millet. India is the largest producer of pearl millet, having 68.3 lakh hectare area, 98.4 lakh tons of production with 1441 kg ha^{-1} yield during 2024-25 (DA&FW report 2024-25 3rd advance estimate, upag.gov.in). Its high-quality fodder makes it an essential crop for livestock production, supporting dairy and meat industries. Major demand drivers for pearl millet are an increasing demand for food security and awareness of pearl millet's nutritional value, the growing livestock industry and need for quality animal feed and government initiatives and policies supporting agriculture and livestock production. Forage yield is a complex trait influenced by various morphological and physiological factors (Supriya *et al*., 2024). According to the Indian Grassland and Fodder Research Institute (IGFRI, Technical Bulletin, 2022), India faces a significant deficit in both green and dry fodder. The projected demand is 1207 million tonnes of green fodder and 671 million tonnes of dry fodder, while the current supply falls short, leading to deficits of 66% and 25%, respectively.

The way forward is to promote high-yielding forage varieties and hybrids and enable "fodder-as-a-service" across regions. Pearl millet is a promising crop for green fodder supply, especially in the lean period during the summer months of May to July and in combination with other fodder crops during the summer and *kharif* season (Arya *et al*., 2009). The objective of the present investigation was to identify high green fodder-yielding varieties of pearl millet for North Indian states.

Materials and Methods

Material for the experiment includes twenty-five forage varieties with three commercial checks *viz*., Nutrifed, Raftar and Wonderleaf. Experiments were conducted at Zira, Punjab (latitude 30.96° N and longitude 74.98° E) and Thamber, Haryana 12.92° N latitude and 80.12° E longitude) during the summer season of 2024, to know the performance of fodder pearl millet varieties. The test varieties and checks were planted in a randomised block design with three replications at both locations. Each plot was planted with 4 rows and 4 m long, with 30 cm row to row spacing, middle 2 rows were considered for all observations. The crop was supplied with a recommended dose of fertiliser 100-50-40 kg N, P_2O_5 and K_2O ha^{-1}. Nitrogen was given in two splits, half as basal and the remaining half at 30days after sowing. After every cut, 30 kg N ha^{-1} was given as top dressing. The first cut was taken 50 days after sowing, regardless of the 50% flowering time. Observations recorded for 11 morphological traits: early vigour, days to 50% flowering, plant height (cm), number of tillers, number of leaves, leaf length (cm), leaf width (cm), stem girth (cm), leaf: stem ratio, brix percentage and green fodder yield (t ha^{-1}). Analysis of variance was calculated in MS excel, correlation was calculated by using NCSS 2025 software and standard heterosis was calculated using below formula.

$$\text{Standard heterosis (\%)} = \frac{\text{Variety mean} - \text{Check mean}}{\text{Check mean}} \times 100$$

Results and Discussion

Pooled mean performance and clustering of pearl millet fodder varieties during summer 2024

The mean performance of the varieties over the locations was presented in Table 1 and Fig. 1. A linear dendrogram visually represents hierarchical relationships between data points, indicating the degree of similarity or dissimilarity. The varieties were grouped into twelve clusters based on their similarity for various traits (Fig. 1). Among the clusters, cluster 6 grouped a large number of varieties; however, clusters 9, 10, 11 and 12 grouped one variety each. For early vigour, cluster 11 showed poor vigour (7). Whereas, cluster 6 exhibited a very good vigour score (9). Among the varieties, cluster 4 varieties flowered at par with check wonderleaf (47 days). However, cluster 11 variety flowered (59 days) later than the checks. The minimum and maximum plant height were recorded by cluster 3 (197 cm) and cluster 12 (222 cm), respectively. For the number of leaves, cluster 10 (10) showed a higher number of tillers, while cluster 11 (7) had with minimum number of tillers. Cluster 11 exhibited the highest number of leaves, whereas cluster 10 had with a lower number of leaves. Cluster 4 (69 cm) showed the shortest leaves while cluster 12 (89 cm) had with longest leaves. For leaf width, cluster 6 showed narrow leaves; however, clusters 1, 4, 11 and 12 showed broad leaves. Cluster 8 showed thin stem varieties, whereas clusters 10 and 12 with thick stem varieties. Minimum leaf: stem ratio exhibited by cluster 12 (0.46) and maximum by cluster 5 (0.64). The 1st cut green fodder yield ranged from 14.7 to 23.6 ton ha^{-1} between the clusters. The highest green fodder yield was recorded by cluster 3 (23.6 tons ha^{-1}) and the minimum green fodder yield was shown by cluster 8 (14.7 tons ha^{-1}). Analysis of variance was carried out for 11 morphological traits pooled over the locations. Coefficient of variation values revealed that high variability was observed for traits, Leaf: stem ratio and brix per cent. Similar results were dictated by Hassanat *et al*. (2007) and Bidinger *et al*. (2004) reported significantly high variability for the leaf-to-stem ratio. However, moderate variability was shown by early vigour, plant height, number of tillers, leaf length, stem girth and green fodder yield (Table 1) (Sai Kumar *et al*., 2020). While traits *viz*., days to 50% flowering, number of leaves and leaf width exhibited less variation Ishwarraddy *et al*. (2018).

Correlation analysis among the twelve clusters for different traits of pearl millet fodder varieties

Correlation among the twelve clusters for different morphological traits was presented in Table 2. Early vigour exhibited significant and positive correlation with the number of tillers, leaf length, stem girth and brix% % at the 0.05 level of significance. However, for green fodder yield showed a highly significant result at the 0.001 level of significance. For days to 50% flowering showed a significant and positive correlation with leaf length at the 0.01 level of significance. However, for other traits recorded as positive but non-significant, except for brix percentage. Plant height exhibited a positive correlation with all the traits except for brix percentage, but was significantly positive with the number of leaves and leaf length. At the 0.05 level of significance. Number of tillers

Table 1 : Pooled mean performance and clustering of pearl millet fodder varieties.

No of clusters	No. of varieties	Name of Cultivars	EVG	DF	PH	NOT	NOL	LL	LW	SG	L:S	BRX Ratio	GFY
1	**6**	**FFV-3**	8	53	203	8	12	81	4	1	1	4.2	21.8
		FFV-4	7	53	189	7	10	71	4	1	0	3.5	20.0
		FFV-18	8	53	214	7	12	84	5	1	0	4.4	22.4
		FFV-21	9	53	251	10	11	83	5	2	0	4.5	16.8
		FFV-23	7	53	209	9	12	81	5	1	1	3.4	18.9
		FFV-25	8	53	207	7	11	66	4	1	1	4.7	18.5
	Mean		**8**	**53**	**212**	**8**	**11**	**78**	**4**	**1**	**0**	**4.1**	**19.8**
2	**5**	**FFV-8**	7	52	211	8	12	81	4	1	1	3.8	18.5
		FFV-14	8	52	226	9	11	92	4	1	0	4.6	23.6
		FFV-24	7	52	189	9	12	74	4	1	1	3.5	15.1
		FFV-27	9	52	250	8	13	88	4	1	0	3.6	22.8
		FFV-29	8	52	212	7	11	75	4	1	1	5.2	22.2
	Mean		**8**	**52**	**218**	**8**	**12**	**82**	**4**	**1**	**0**	**4.2**	**20.4**
3	**4**	**FFV-7**	8	55	227	9	12	81	4	1	0	4.4	24.8
		FFV-9	8	55	202	8	11	81	4	1	1	5.8	18.5
		FFV-22	8	55	177	7	11	92	4	1	1	3.6	24.4
		Rafftar	9	55	184	11	12	85	4	1	1	3.9	26.5
	Mean		**8**	**55**	**197**	**9**	**11**	**85**	**4**	**1**	**1**	**4.4**	**23.6**
4	**4**	**FFV-2**	8	47	211	7	12	70	5	1	1	5.4	16.5
		FFV-11	8	47	214	8	12	74	5	1	0	5.2	24.4
		FFV-13	7	47	230	8	11	66	4	1	1	5.8	15.1
		Wonderleaf	7	47	179	9	11	68	4	1	1	4.6	13.2
	Mean		**8**	**47**	**208**	**8**	**12**	**69**	**4**	**1**	**1**	**5.3**	**17.3**
5	**3**	**FFV-17**	8	54	230	8	13	85	4	1	1	5.8	24.7
		FFV-20	8	54	182	9	11	90	4	1	1	4.3	16.0
		Nutrifed	8	54	221	8	13	86	5	1	0	4.7	16.8
	Mean		**8**	**54**	**211**	**8**	**12**	**87**	**4**	**1**	**1**	**4.9**	**19.2**
6	**2**	**FFV-16**	9	51	213	8	11	83	4	1	1	4.2	22.5
		FFV-28	9	51	223	8	13	83	4	1	1	5.3	20.8
	Mean		**9**	**51**	**218**	**8**	**12**	**83**	**4**	**1**	**1**	**4.7**	**21.7**
7	**2**	**FFV-15**	8	56	198	10	11	84	4	1	0	3.4	22.8
		FFV-19	8	56	237	8	13	81	4	1	1	3.9	24.4
	Mean		**8**	**56**	**217**	**9**	**12**	**83**	**4**	**1**	**1**	**3.6**	**23.6**
8	**2**	**FFV-1**	7	49	191	8	11	66	4	1	1	4.0	13.5
		FFV-5	8	49	210	8	12	72	4	1	1	4.2	15.8
	Mean		**7**	**49**	**200**	**8**	**11**	**69**	**4**	**1**	**1**	**4.1**	**14.7**
9	**1**	**FFV-6**	8	57	218	8	12	84	4	1	1	3.8	**18.4**

Table 1 continued...

Table 1 continued...

10	**1**	**FFV-10**	8	58	219	10	11	81	4	1	1	3.4	**22.7**
11	**1**	**FFV-12**	7	59	218	7	13	84	4	1	1	3.3	**18.6**
12	**1**	**FFV-26**	8	50	222	9	12	89	4	1	0	3.7	**23.1**
	Mean		7.66	52.69	211.48	8.25	11.68	79.93	4.17	1.23	0.55	4.31	160.45
	SE(m)		0.46	1.71	12.47	0.86	0.66	4.83	0.23	0.09	0.10	0.54	16.33
	CV		**10.04**	**5.63**	**10.21**	**18.01**	**9.72**	**10.47**	**9.38**	**12.66**	**31.36**	**21.59**	**17.62**
	CD		NS	4.84	35.25	NS	NS	13.66	0.64	0.26	NS	1.52	46.15

1st cut – EVG-Early vigour; DF – Days to 50% flowering; PH – Plant height (cm); NOT – Number of tillers; NOL – Number of leaves; LL (cm) – Leaf length (cm); LW (cm) – Leaf width (cm); SG (cm) – Stem girth (cm); L: S Ratio – Leaf: stem ratio; BRX – Brix percentage; GFY – Green fodder yield (tha^{-1}), FFV: Foragen Forage Varieties.

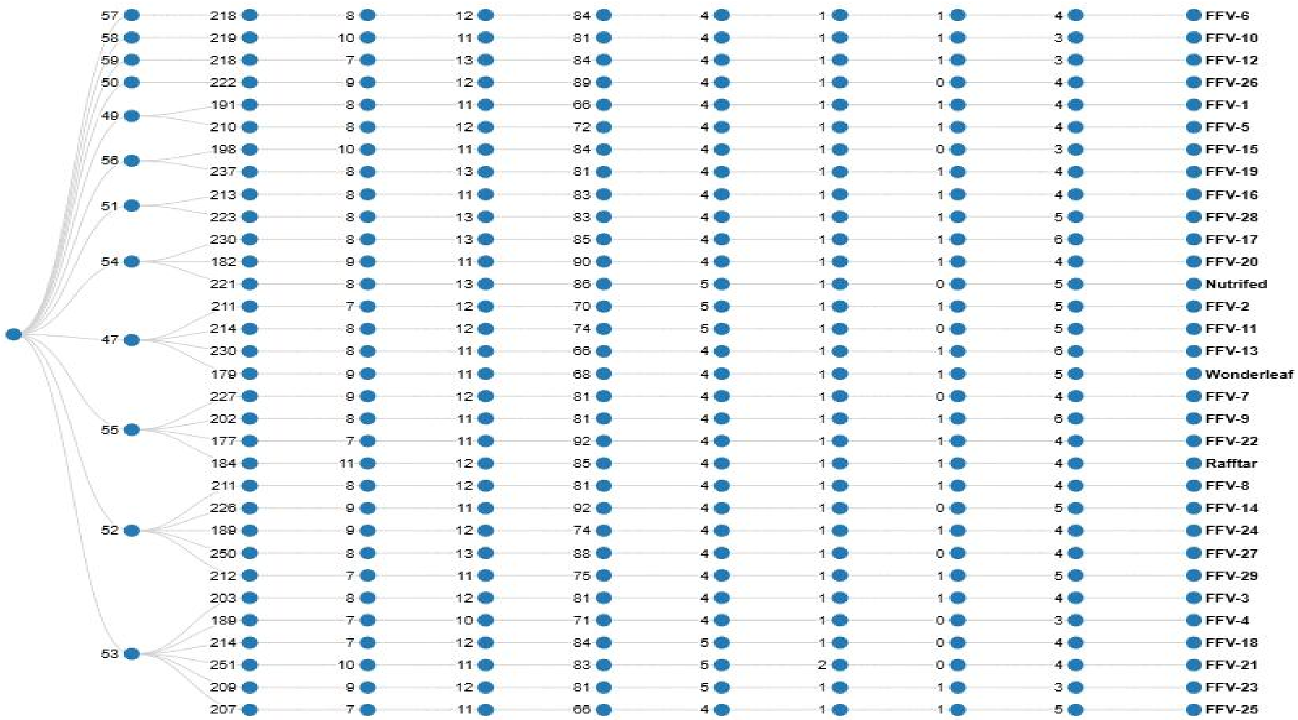

Fig. 1 : Linear dendrogram.

exhibited a positive correlation with all the traits and a significantly positive correlation with stem girth and green fodder yield at 0.001 and 0.01 levels of significance, respectively. For number of leaves exhibited a non-significant but positive correlation with all the traits. Leaf length exhibited a significantly positive correlation with stem girth and green fodder yield at the 0.01 and 0.05 level of significance. While other traits exhibited a positive, non-significant correlation. Positive correlation was shown by leaf width with all traits. Stem girth showed a positive correlation with other traits and a significant correlation with green fodder yield. Leaf: stem ratio showed a positive correlation with brix and green fodder yield. Brix exhibited a positive correlation with green fodder yield.

Traits like early vigour, number of tillers, leaf length and stem girth were significantly correlated with green fodder yield (Bhardwaj *et al.*, 2017). Direct selection of these traits based on mean performance can be done for selecting high green fodder-yielding varieties. Nevertheless, a slight compromise for medium-tall plant varieties with increased leaf length, stem girth and biomass yield is preferable. Whereas, plant height and days to 50% flowering were negatively correlated with brix percentage, Hundekar *et al*. (2016), Makanda *et al*. (2017) and Kavya *et al*. (2020) also concluded the same results. The substantial negative correlation between plant height and brix indicates that taller genotypes exhibit lower brix levels. Direct selection for medium plant height and late flowering with high brix can be considered useful.

Standard heterosis of pearl millet fodder varieties for green fodder yield tons ha^{-1} over checks

The per cent superiority of pearl millet fodder

Table 2 : Correlation among the 12 clusters for different traits of pearl millet forage varieties.

Traits	EVG	DF	PH	NOT	NOL	LL	LW	SG	L:S	BRX	GFY
EVG	1	0.25	0.53	0.586*	0.319	0.546*	0.135	0.544*	0.202	0.623*	0.827***
DF		1	0.518	0.44	0.423	0.682**	0.394	0.486	0.492	-0.137	0.19
PH			1	0.371	0.656*	0.653*	0.471	0.522	0.003	-0.004	0.374
NOT				1	0.008	0.466	0.236	0.803***	0.107	0.21	0.701**
NOL					1	0.523	0.508	0.247	0.463	0.278	0.051
LL						1	0.391	0.717**	0.316	0.074	0.561*
LW							1	0.447	0.171	0.184	0.24
SG								1	0.172	0.197	0.568*
L:S									1	0.512	0.011
BRX										1	0.442
GFY											1

EVG – Early vigour; 1st cut DF – Days to 50% flowering; 1st cut PH – Plant height (cm); 1st cut NOT – Number of tillers; NOL – Number of leaves; LL (cm) – Leaf length (cm); LW (cm) – Leaf width (cm); SG (cm) – Stem girth (cm); L: S Ratio – Leaf: stem ratio; 1st cut BRX – Brix percentage; 1st cut GFY – Green fodder yield (t ha^{-1})

*** Correlation is significant at 0.001 level (two tailed) ** Correlation is significant at 0.01 level (two tailed)

* Correlation is significant at 0.05 level (two tailed)

Table 3 : Standard heterosis of pearl millet varieties for green fodder yield tons ha^{-1} over checks.

Traits	Heterosis over checks	Standard heterosis %		Number of varieties better than checks
		Minimum	Maximum	
Early vigour	SH over Nutrifed	-15.2	10.9	13
	SH over Raftar	-25.0	-1.9	0
	SH over Wonderleaf	-9.3	18.6	25
Days to 50% flowering	SH over Nutrifed	-14.1	8.6	8
	SH over Raftar	-14.6	7.9	7
	SH over Wonderleaf	-1.4	24.6	26
Plant height	SH over Nutrifed	-19.9	13.7	9
	SH over Raftar	-4.0	36.4	27
	SH over Wonderleaf	-1.5	40.0	28
Leaf length	SH over Nutrifed	-23.1	7.0	5
	SH over Raftar	-22.1	8.4	5
	SH over Wonderleaf	-2.7	35.3	26
Leaf width	SH over Nutrifed	-21.0	6.5	3
	SH over Raftar	-12.8	17.6	14
	SH over Wonderleaf	-1.8	32.4	27
Stem girth	SH over Nutrifed	-33.3	9.5	4
	SH over Raftar	-30.0	15.0	6
	SH over Wonderleaf	-22.2	27.8	13
Brix percent	SH over Nutrifed	-31.0	22.5	7
	SH over Raftar	-15.5	50.0	17
	SH over Wonderleaf	-29.5	25.2	8
Green fodder yield	SH over Nutrifed	-19.9	47.8	22
	SH over Raftar	-49.3	-6.5	0
	SH over Wonderleaf	1.7	87.6	29

Table 4 : Standard heterosis of pearl millet fodder varieties for various morphological traits.

Varieties	EVG			DF			PH			LL			LW			SG			Brix%			GFY		
	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL	NF	RFT	WL
FFV-1	-15.2	-25.0	-9.3	-10.4	-11.0	2.8	-13.6	3.6	6.3	-23.1	-22.1	-2.7	-14.5	-5.6	6.3	-28.6	-25.0	-16.7	-15.5	3.4	-13.7	-19.9	-49.3	1.7
FFV-2	2.2	-9.6	9.3	-13.5	-14.0	-0.7	-4.5	14.5	17.5	-18.2	-17.2	3.4	-1.4	8.8	22.5	-33.3	-30.0	-22.2	14.1	39.7	16.5	-1.7	-37.8	24.7
FFV-3	-4.3	-15.4	2.3	-1.8	-2.4	12.7	-8.2	10.1	13.0	-5.4	-4.1	19.7	-18.1	-9.6	1.8	-19.0	-15.0	-5.6	-10.6	9.5	-8.6	30.1	-17.6	65.2
FFV-4	-8.7	-19.2	-2.3	-2.5	-3.0	12.0	-14.2	2.9	5.6	-17.2	-16.2	4.7	-21.0	-12.8	-1.8	-26.2	-22.5	-13.9	-26.8	-10.3	-25.2	19.2	-24.5	51.4
FFV-5	-2.2	-13.5	4.7	-9.2	-9.8	4.2	-5.0	13.9	16.9	-15.9	-14.8	6.4	-13.0	-4.0	8.1	-14.3	-10.0	0.0	-11.3	8.6	-9.4	-5.6	-40.3	19.8
FFV-6	-6.5	-17.3	0.0	4.9	4.3	20.4	-1.4	18.3	21.4	-2.4	-1.2	23.4	-8.0	1.6	14.4	-11.9	-7.5	2.8	-19.7	-1.7	-18.0	9.4	-30.7	38.9
FFV-7	4.3	-7.7	11.6	1.2	0.6	16.2	2.7	23.2	26.4	-4.9	-3.6	20.3	-15.9	-7.2	4.5	-14.3	-10.0	0.0	-7.7	12.9	-5.8	47.8	-6.5	87.6
FFV-8	-4.3	-15.4	2.3	-3.7	-4.3	10.6	-4.4	14.7	17.7	-5.9	-4.7	19.0	-13.8	-4.8	7.2	-14.3	-10.0	0.0	-19.7	-1.7	-18.0	10.1	-30.3	39.8
FFV-9	2.2	-9.6	9.3	0.6	0.0	15.5	-8.3	10.0	12.8	-5.0	-3.7	20.2	-7.2	2.4	15.3	-11.9	-7.5	2.8	22.5	50.0	25.2	9.9	-30.4	39.6
FFV-10	0.0	-11.5	7.0	6.7	6.1	22.5	-0.6	19.2	22.3	-5.4	-4.1	19.7	-10.1	-0.8	11.7	2.4	7.5	19.4	-28.2	-12.1	-26.6	35.1	-14.5	71.5
FFV-11	2.2	-9.6	9.3	-13.5	-14.0	-0.7	-3.2	16.1	19.1	-13.0	-11.9	10.0	0.7	11.2	25.2	4.8	10.0	22.2	9.2	33.6	11.5	45.4	-8.0	84.5
FFV-12	-4.3	-15.4	2.3	8.6	7.9	24.6	-1.1	18.7	21.7	-1.9	-0.6	24.1	-5.8	4.0	17.1	-16.7	-12.5	-2.8	-31.0	-15.5	-29.5	10.5	-30.1	40.3
FFV-13	-4.3	-15.4	2.3	-14.1	-14.6	-1.4	4.1	24.8	28.1	-23.1	-22.1	-2.7	-9.4	0.0	12.6	-23.8	-20.0	-11.1	22.5	50.0	25.2	-10.2	-43.1	14.0
FFV-14	-2.2	-13.5	4.7	-4.3	-4.9	9.9	2.6	23.0	26.2	6.9	8.3	35.2	-8.0	1.6	14.4	-16.7	-12.5	-2.8	-2.8	19.0	-0.7	40.8	-10.9	78.7
FFV-15	4.3	-7.7	11.6	3.7	3.0	19.0	-10.4	7.4	10.2	-1.7	-0.4	24.4	-7.2	2.4	15.3	-9.5	-5.0	5.6	-28.9	-12.9	-27.3	35.5	-14.2	72.0
FFV-16	8.7	-3.8	16.3	-6.7	-7.3	7.0	-3.3	15.9	19.0	-3.4	-2.2	22.2	-13.0	-4.0	8.1	-14.3	-10.0	0.0	-11.3	8.6	-9.4	33.9	-15.2	70.0
FFV-17	6.5	-5.8	14.0	0.0	-0.6	14.8	4.4	25.2	28.4	-1.1	0.2	25.1	-16.7	-8.0	3.6	-19.0	-15.0	-5.6	21.8	49.1	24.5	47.0	-6.9	86.7
FFV-18	0.0	-11.5	7.0	-2.5	-3.0	12.0	-2.9	16.5	19.5	-1.9	-0.6	24.1	-1.4	8.8	22.5	-7.1	-2.5	8.3	-7.0	13.8	-5.0	33.5	-15.5	69.5
FFV-19	2.2	-9.6	9.3	3.1	2.4	18.3	7.4	28.8	32.2	-5.4	-4.1	19.7	-10.9	-1.6	10.8	-23.8	-20.0	-11.1	-18.3	0.0	-16.5	45.2	-8.1	84.4
FFV-20	-4.3	-15.4	2.3	-0.6	-1.2	14.1	-17.4	-0.9	1.7	5.6	6.9	33.5	-8.0	1.6	14.4	-4.8	0.0	11.1	-8.5	12.1	-6.5	-4.5	-39.6	21.2
FFV-21	8.7	-3.8	16.3	-1.8	-2.4	12.7	13.7	36.4	40.0	-3.6	-2.4	21.9	0.7	11.2	25.2	9.5	15.0	27.8	-5.6	15.5	-3.6	-0.1	-36.7	26.9
FFV-22	0.0	-11.5	7.0	1.2	0.6	16.2	-19.9	-4.0	-1.5	7.0	8.4	35.3	-8.0	1.6	14.4	4.8	10.0	22.2	-23.9	-6.9	-22.3	45.4	-8.0	84.6
FFV-23	-4.3	-15.4	2.3	-3.1	-3.7	11.3	-5.4	13.4	16.4	-5.6	-4.4	19.3	6.5	17.6	32.4	-2.4	2.5	13.9	-28.2	-12.1	-26.6	12.8	-28.6	43.1
FFV-24	-13.0	-23.1	-7.0	-3.7	-4.3	10.6	-14.4	2.7	5.4	-13.1	-12.0	9.9	-15.2	-6.4	5.4	-7.1	-2.5	8.3	-25.4	-8.6	-23.7	-10.3	-43.2	13.9
FFV-25	-2.2	-13.5	4.7	-1.8	-2.4	12.7	-6.0	12.7	15.6	-22.6	-21.7	-2.2	-5.8	4.0	17.1	-23.8	-20.0	-11.1	0.0	22.4	2.2	10.3	-30.2	40.1
FFV-26	2.2	-9.6	9.3	-7.4	-7.9	6.3	0.8	20.8	24.0	4.2	5.5	31.8	-7.2	2.4	15.3	0.0	5.0	16.7	-22.5	-5.2	-20.9	37.3	-13.1	74.2
FFV-27	10.9	-1.9	18.6	-3.7	-4.3	10.6	13.4	36.1	39.6	2.6	3.9	29.8	-16.7	-8.0	3.6	-9.5	-5.0	5.6	-23.2	-6.0	-21.6	35.5	-14.2	72.0
FFV-28	6.5	-5.8	14.0	-5.5	-6.1	8.5	0.9	21.0	24.2	-3.0	-1.8	22.7	-19.6	-11.2	0.0	-16.7	-12.5	-2.8	11.3	36.2	13.7	24.1	-21.4	57.5
FFV-29	4.3	-7.7	11.6	-4.9	-5.5	9.2	-3.8	15.4	18.4	-12.8	-11.6	10.3	-4.3	5.6	18.9	-16.7	-12.5	-2.8	9.9	34.5	12.2	32.2	-16.3	67.8
NF	0.0	-11.5	7.0	0.0	-0.6	14.8	0.0	19.9	23.0	0.0	1.3	26.5	0.0	10.4	24.3	0.0	5.0	16.7	0.0	22.4	2.2	0.0	-36.7	26.9
RFT	13.0	0.0	20.9	0.6	0.0	15.5	-16.6	0.0	2.6	-1.3	0.0	24.9	-9.4	0.0	12.6	-4.8	0.0	11.1	-18.3	0.0	-16.5	58.0	0.0	100.6
WL	-6.5	-17.3	0.0	-12.9	-13.4	0.0	-18.7	-2.5	0.0	-20.9	-19.9	0.0	-19.6	-11.2	0.0	-14.3	-10.0	0.0	-2.1	19.8	0.0	-21.2	-50.1	0.0

EVG – Early vigour; 1st cut DF – Days to 50% flowering; 1st cut PH – Plant height (cm); LL (cm) – Leaf length (cm); LW (cm) – Leaf width (cm); SG (cm) – Stem girth (cm); 1st cut BRX – Brix percentage; 1st cut GFY – Green fodder yield (t ha^{-1}) **NF:** Nutrifeb; **RFT:** Raftar; **WL:** Wonderleaf

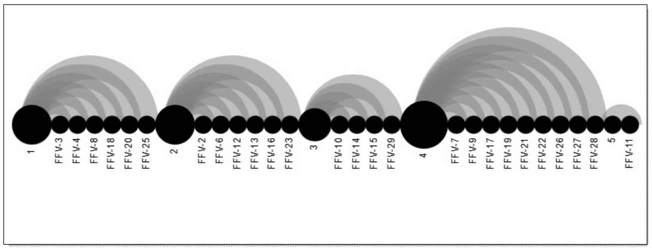

Fig. 2 : Number of varieties superior for number of traits over check Nutrifed.

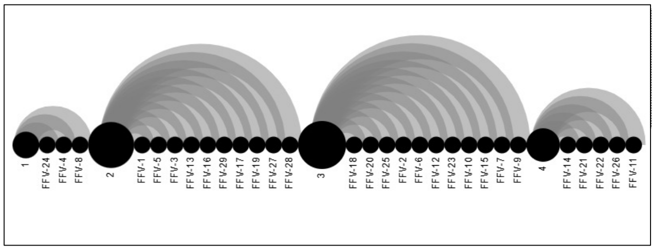

Fig. 3 : Number of varieties superior for number of traits over check Raftar.

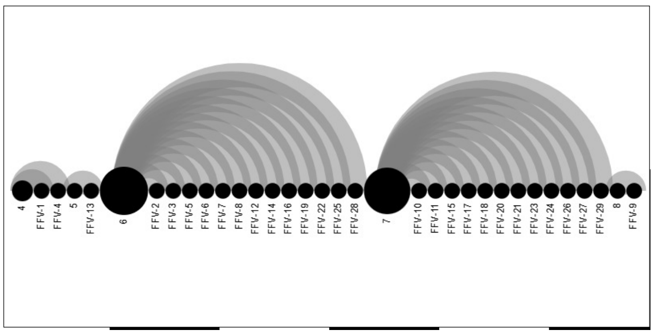

Fig. 4 : Number of varieties superior for number of traits over check Wonderleaf.

varieties for green fodder yield tons ha^{-1} over checks was presented in Table 3. Twenty twenty-eight varieties showed more than 10 per cent higher green fodder yield over Nutrifed and Wonderleaf, respectively. The percentage superiority ranged from 10.1 to 87.6 per cent over these two checks. Among the varieties, FFV-7 recorded the highest green fodder yield (24.8 t ha^{-1}), which was 47.8 per cent higher than the check Nutrifed (16.8). Whereas, FFV-17 (24.7 t ha^{-1}) exhibited higher green fodder yield than the check Wonderleaf (13.2 t ha^{-1}). None of the varieties was out-yielded over check Raftar (26.5 t ha^{-1}). For other traits, standard heterosis is presented in Tables 3 and 4.

The present investigation showed -49.3 to 87.6 % standard heterosis for green fodder yield over the commercial checks (Table 3). Aswini *et al.* (2021) recorded 10.9 to 64.9% standard heterosis for green fodder yield and Ladumor *et al.* (2018) recorded 6.6 to 97.6% standard heterosis for dry fodder yield (Karvar *et al.*, 2017). The found standard heterosis ranged from 21.7 to 62.94%. Govintharaj *et al.* (2021) recorded –51.5 to 10.5% standard heterosis for single-cross hybrids first-cut green fodder yield. Number of varieties superior for number of traits over checks presented in Figs. 2, 3 and 4 by arc diagram generated with software RAW Graphs version 2.0.

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