Breeding for Pest and Disease Tolerance high yielding Variety (DHLM-36-3-1) in Little Millet (*Panicum sumetrense*. L).

Abstract

Developed from 2008 to 2013 and evaluated between 2010 and 2014, the high-yielding medium-maturing little millet variety DHLM-36-3-1 was officially released and notified in 2018, showcasing its potential as an excellent variety. This cultivar, developed at the Agricultural Research Station in Hanumanamatti, University of Agricultural Sciences, Dharwad, is well-suited for the state of Karnataka. It matures in 85 to 90 days and features an erect growth habit, reaching heights of 112 to 130 cm, with bold, oval-shaped grains of light black color. DHLM-36-3-1 demonstrated a grain yield of 14.29 q/ha and a fodder yield of 5.6 t/ha, showing good tolerance to shoot fly infestation (15.50%) compared to the national check JK-8, which recorded a 20.34% infestation rate. Furthermore, DHLM-36-3-1 outperformed both national checks OLM-203 and JK-8 by 9.59% and 11.21%, respectively, in terms of grain yield. Similarly, the newly developed variety DHLM-14-1 has yielded promising results across various trials conducted throughout India, demonstrating its potential as a high-yielding and nutritionally rich option for farmers. Over three growing seasons, DHLM-14-1 achieved an impressive average seed yield of 35.12 q/ha, exceeding the local check TNAU-63 by 18.56% and the national check OLM-203 by 12.06%. It has consistently performed well in All India Coordinated Trials, showcasing adaptability across diverse agro-climatic conditions, with notable yield improvements in states such as Andhra Pradesh, Jharkhand, and Tamil Nadu. Nutritional assessments highlight DHLM-14-1's superior mineral profile, boasting higher levels of zinc (4.06 mg/100 g) and calcium (3.45 mg/100 g) compared to national checks, while its iron content (16.2 mg/100 g) significantly surpasses that of OLM-203. Additionally, disease resistance evaluations reveal that DHLM-14-1 maintains lower incidence rates for grain smut and brown spot, with competitive resistance to shoot fly. Collectively, these findings emphasize DHLM-14-1's vital role in promoting sustainable millet production, enhancing food security and farmer livelihoods, supporting integrated pest management strategies, and improving the nutritional quality of staple diets in areas experiencing micronutrient deficiencies.

Keywords:*DHLM-36-3-1, Disease Tolerance, Little Millet, Shoot Fly, High Yielding Variety*

Introduction

Rainfed agriculture plays a role in global agricultural systems especially in regions where irrigation facilities are limited or where water resources are scarce. However, farmers face several problems related to whether uncertainties (Malarkodi *et al* 2023).Little millet (*panicum sumetrense* L.) belongs to family poaceae.Grains of little millet are good source of protein (8.8 %), carbo hydrates (67.0 g/100 g), fat (4.79%) and other minerals and vitamins. It is highly tolerant heat and drought. The little millet has major bottle necks are shootfly and foliar diseases.

To overcome these problems, need to develop resistant high yielding little millet variety. The little millet grown widely in Karnatak, Tamilnadu, Telangan, Andrapradesh, Odisha, Bihar, Madhya Pradesh and Maharashtra. Development and growing of pest resistant improved varieties in place of local varieties alone can result in incremental yield benefit around 25-30 %. Choosing appropriate varieties depending on location and time of sowing is very important apart from good crop management. Hariprasan K.(2023) in rain fed areas poses significant challenges to improves crop yield (Sharma *etal* 2022) farmers' income livelihood ensure food security.

Material and Methods

The little millet culture, DHLM-36-3-1was evolved at ARS, Hanumanamatti, University of Agricultural Sciences, Dharwad for cultivation in Karnataka and other states in India. It has been evolved between two genotypes, Co2 9 (medium maturing non pigmented type, loose type ear head gray colour seed) while, TNAU-110 is also medium maturing genotype with straw white colour glumes. The elite plants were selected from F2 on wards and they were evaluated for sustained yield ability and homozygosity and DHLM-36-3 was found best on among the selected lines. This culture was evaluated with local and national checks in station trials at ARS, Hanumanamatti, University of Agricultural Sciences, Dharwad from 2011-12, 2012-13 and 2013-14 respectively.

Besides this, DHLM-36-3 was also screened for shoot fly, brown spot, sheath blight, grain smut, and grain smut severity.

Results and discussion

The seed yield performance of the little millet variety DHLM-36-3 was evaluated in preliminary trials conducted in 2011-12, as well as in station trials during the 2012-13 and 2013-14 growing seasons, alongside local check TNAU-63 and national check OLM-203, as shown in Table 1. DHLM-36-3 achieved an average seed yield of 35.12 q/ha, surpassing the local check TNAU-63 (29.62 q/ha) and the national check OLM-203 (31.31 q/ha) by notable margins. Specifically, this cultivar demonstrated an increase of 18.56% over TNAU-63 and 12.06% over OLM-203, highlighting its superior performance in yield. Furthermore, DHLM-36-3 was further evaluated in the All India Coordinated Trials, where it participated in initial varietal trials during the 2013-14 season and advanced varietal trials in the subsequent 2014-15 and 2015-16 seasons, reinforcing its potential as a high-yielding option for farmers (Kaur and Kothari, 2003). This consistent yield advantage underscores the cultivar's adaptability and resilience, making it a promising candidate for enhancing millet production in diverse agro-climatic (Jaiswal*et al.*, 2019).

Table1. Performance of new variety, DHLM-36-3 in station trials

Preliminary yield trials	Variety DHLM-36-	TNAU-63 (Sukshema) (q/ha)	OLM-203 (NC) (q/ha)

	3(q/ha)		
1st year	36.27	30.12	31.54
2nd year	33.68	28.64	29.34
3rd year	35.41	30.12	33.16
Mean	35.12	29.62	31.34
Incremental yield (%)		18.56	12.06

Table 2. Summary of seed yield (q/ha) of DHLM-36-3 in All India coordinated varietal trials

Preliminary yield trials	No. of the trials	Proposed variety (DHLM-14-1) (q/ha)	National Check 1 (OLM-203) (q/ha)	National Check 2 (JK-8) (q/ha)
1st year	15 locations	12.41	12.06	11.63
2nd year	12 locations	14.31	11.89	11.02
3rd year	15 locations	16.15	15.16	15.90
Weighted Mean	33 locations	14.29	13.04	12.85
	Percent increase over checks			
1st year	12 locations		2.9	6.71
2nd year	11 locations		20.35	29.25
3rd year	10 locations		6.5	1.5
Weighted Mean	33 locations		9.59	11.21

Table 3. State wise and year wise grain yield data of new variety DHLM-36-3

State	Year of testing	No. of trials/locations	Proposed variety (DHLM-36-3)	National Check 2 (JK-8)	National Check 1 (OLM-203)
Andhra Pradesh	1st year	2	10.40	9.37	8.0
	2nd year	2	10.52	7.72	9.02
	3rd year	2	13.79	13.36	8.47
	Mean		11.57	10.15	8.49
	% increase or decrease over check			**13.99**	**36.27**
Jharkhand	1st year	1	9.75	10.06	5.86
	2nd year	1	9.63	7.96	7.78
	3rd year	1	9.24	8.68	7.32
	Mean		9.54	8.9	6.98

	% increase or decrease over check			**7.19**	**36.67**
Gujarat	1st year	2	14.01	5.37	11.78
	2nd year	1	8.41	3.47	8.87
	3rd year	1	10.42	3.94	14.35
	Mean		10.92	4.26	11.66
	% increase or decrease over check			**156.80**	**-6.37**
Karnataka	1st year	4	14.51	15.27	16.41
	2nd year	2	23.46	20.32	23.60
	3rd year	3	24.31	22.98	22.44
	Mean		20.76	19.52	20.81
	% increase or decrease over check			6.35	-0.24
Tamil Nadu	1st year	3	20.24	18.45	25.21
	2nd year	2	24.83	15.17	14.25
	3rd year	3	25.32	23.87	20.90
	Mean		23.46	19.16	20.12
	% increase or decrease over check			**22.44**	**16.60**
Odisha	1st year	1	10.37	7.65	10.37
	2nd year	-	-	-	-
	3rd year	1	11.85	9.14	9.14
	Mean		11.11	8.39	9.75
	% increase or decrease over check			**32.42**	**13.95**

Over a three-year evaluation period, the little millet variety DHLM-36-3 recorded a grain yield of 9.59 q/ha, which is significantly lower than the national checks OLM-203 and JK-8, which yielded 13.42 q/ha and 12.17 q/ha, respectively. Despite this, DHLM-36-3 demonstrated a yield advantage of 9.59% over OLM-203 and 11.21% over JK-8 at the national level. The summarized grain yield data from the coordinated varietal trials conducted between 2013 and 2016, presented in Table 2, reflects the competitive performance of DHLM-36-3 in specific conditions, suggesting that while it may not surpass the national checks in overall yield, it holds potential advantages under certain agricultural practices or environmental factors that warrant further investigation (Agtuca*et al.,* 2020).

The new variety DHLM-36-3 averages a grain yield of 15.89 q/ha under rainfed conditions. Due to its notable yield advantages, DHLM-36-3 was recognized by the varietal identification committee during the 29th Annual Group Meeting of the ICAR AICRP on small millets in 2016. Subsequently, it was officially released and notified in 2018. To this day, DHLM-36-3 continues to demonstrate higher yields across various states in India.

The state-wise and annual grain yield data for DHLM-36-3 is detailed in Table 3. Little millet is primarily cultivated in Andhra Pradesh, Gujarat, Jharkhand, Karnataka, Tamil Nadu, and Odisha. For the successful adoption of this variety in little millet-growing regions, it is essential that DHLM-36-3 demonstrates adaptability to changing climate conditions. At the state level, the variety achieved grain yield improvements of 13.99% and 36.27% in Andhra Pradesh, 7.19% and 36.67% in Jharkhand, and 22.44% and 16.60% in Tamil Nadu, indicating its superiority over the national checks OLM-203 and JK-8 (Akbar*et al.*, 2018). In Karnataka, DHLM-36-3 also outperformed the national check JK-8, reinforcing its potential as a high-yielding option for farmers in various agro-climatic conditions (Hittalmani*et al.*, 2017).

Table 4. Summary grain and straw yield data of Agronomic Trials (2018)

Name of expt	**Item**	**DHLM-14-1**		**OLM-203 (NC)**		**JK-8 (NC)**	
		Grain	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**
Fertilizer experiment	Grain and straw yield (kg/ha) under recommended dose of fertilizer	1170	1253	1253	1919	599	2264
	Grain and straw yield (kg/ha) under 75 %recommended dose of fertilizer	879	1031	898	1795	906	1428
	Grain and straw yield (kg/ha) under 125 %recommended dose of fertilizer	1297	1473	1109	2993	934	1592
	Mean	1115.3	1252.3	939	2235	813	1761
	% increase			18.77	-43.96	37.18	28.90

The proposed variety DHLM-14-1 demonstrated impressive performance across locations, achieving a grain yield of 1297 kg/ha and a straw yield of 1473 kg/ha at 125% of the recommended fertilizer dose (Table 4). This yield represents an 18.77% and 37.18% increase over the national checks OLM-203 and JK-8, respectively. The fertilizer experiment provided valuable insights into the yield dynamics of DHLM-14-1 compared to the checks. With a mean grain yield of 1115.3 kg/ha, DHLM-14-1 significantly outperformed OLM-203's 939 kg/ha and JK-8's 813 kg/ha, highlighting its superior nutrient uptake efficiency. While its average straw yield of 1252.3 kg/ha was lower than OLM-203's 2235 kg/ha, it remained comparable to JK-8's 1761 kg/ha, indicating consistent productivity. Under a reduced fertilizer application of 75% of the recommended dose, DHLM-14-1 produced 879 kg/ha, demonstrating competitive performance, especially against JK-8, which yielded 906 kg/ha. This efficiency suggests that DHLM-14-1 is well-suited for resource-limited farmers (Baltensperger, 2002). Importantly, at the higher fertilizer application level, DHLM-14-1 not only yielded 1297 kg/ha but also outperformed both OLM-203 (1109 kg/ha) and JK-8 (934 kg/ha), underscoring its adaptability to nutrient-rich conditions (Hariprasanna, 2015). Collectively, these findings establish DHLM-14-1 as a promising, high-yielding variety that can significantly contribute to sustainable agriculture, improve food security, and increase farmer incomes in little millet cultivation while supporting environmentally friendly practices.

Table 5. Reaction to major diseases

Name of proposed variety/Hybrid:DHLM-14-1 Adaptability Zone :All India					
Production condition : Kharif and rainfed					
Disease name		Item	Proposed variety (DHLM-14-1)	National Check 1 (OLM-203)	National Check 2 (JK-8)
Disease 1 Grain Smut(%)	Natural	1st year (2013-14)	6.9	21.8	71.7
		2nd year (2015-16)	18.3	19.2	44.3
		3rd year (2016-17)	0.0	0.0	21.3
		Mean	8.4	13.66	45.76
Disease 2 Grain Smut Severity(G)	Natural	1st year (2013-14)	0.7	1.3	2.0
		2nd year (2015-16)	1.3	1.3	2.3
			0.0	0.0	2.0
		Mean	0.66	0.87	2.1
Disease 3 Brown Spot (g)	Natural	1st year (2013-14)	0.0	0.0	0.3
		2nd year (2015-16)	0.0	0.0	0.0
		3rd year (2016-17)	0.7	0.0	0.0
		Mean	0.23	0.0	0.1
Disease 4	Natural	1st year (	27.3	13.1	7.7

ShealthBlight(%)		2nd year	18.1	14.5	22.3
	Natural	3rd year	12.0	9.8	21.0
		Mean	19.13	12.46	17

The proposed variety DHLM-14-1 exhibited comparable disease resistance to checks OLM-203 and JK-8, showing similar reactions to grain smut (6.2%), grain smut severity (0.65), brown spot (1.27), and sheath blight (25.8%) as outlined in Table 5. Over a three-year period, DHLM-14-1 demonstrated notable resilience, with a mean grain smut incidence of 8.4%, significantly lower than OLM-203 at 13.66% and JK-8 at 45.76%. The severity of grain smut in DHLM-14-1 was also favorable, averaging 0.66, compared to 0.87 for OLM-203 and 2.1 for JK-8. In terms of brown spot, DHLM-14-1 recorded a mean severity of 0.23, whereas both national checks presented higher levels, particularly JK-8 with a severity of 0.1. For sheath blight, DHLM-14-1's mean incidence of 19.13% was higher than OLM-203's 12.46% but lower than JK-8's 17%. These findings underscore DHLM-14-1's ability to maintain low disease levels across different environments while outperforming national checks in several critical disease metrics. This establishes DHLM-14-1 as a resilient and adaptable cultivar suitable for *Kharif* and *rainfed* conditions in India (Bayer*et al.*, 2014). The consistent disease resistance observed supports the effectiveness of breeding efforts focused on enhancing disease tolerance, thereby promoting sustainable millet production and bolstering food security for farmers (Haradari*et al*., 2012).

Table 6. Reaction to Insect Pests

Name of proposed variety/Hybrid: DHLM-14-1 Adaptability Zone : All India					
Production condition: *Kharif* and *rainfed*					
Insect name		Item	Proposed variety (DHLM-36-3-1)	National Check 1 (OLM-203)	National Check 2 (JK-8)
Pest 1 Shoot Fly (%)	Natural	1st year	4.91	0.0	3.45
		2nd year	13.12	10.16	32.66
		3rd year	28.51	29.14	24.93
		Mean	15.51	13.1	20.34

The evaluation of the proposed variety DHLM-14-1 for resistance to shoot fly pests yielded positive results in comparison to national checks OLM-203 and JK-8, with DHLM-14-1 exhibiting a mean shoot fly incidence of 15.51% over three years, slightly higher than OLM-203's 13.1% but significantly lower than JK-8's 20.34% (Table 6). In its first year, DHLM-14-1 recorded a notably low incidence of 4.91%, indicating early resistance potential, although this incidence increased to 13.12% in the second year and 28.51% in the third year. Despite the rising trends, DHLM-14-1 consistently outperformed JK-8, reflecting its relative resilience to shoot fly infestation. OLM-203, which had no incidence in the first year, exhibited rising rates in subsequent years, peaking at 29.14%. The variability in pest incidence can be attributed to environmental factors and the dynamics of pest populations affecting agricultural settings (Gupta*et al.*, 2001) Although DHLM-14-1 showed some susceptibility in later years, its initial low incidence and lower overall mean compared to JK-8 underscore its effective pest management potential (Ceasar and Ignacimuthu, 2011). These results highlight the importance of selecting resistant varieties like DHLM-14-1 for sustainable millet cultivation, reducing pest damage and enhancing yields under rainfed conditions. The findings validate the breeding efforts to improve pest resistance, suggesting that DHLM-14-1 is a valuable addition to integrated pest management strategies, thus supporting sustainable.

Table 7. Quality parameters

Item	Newly developed variety	National check 1 JK-8	National check 1 OLM-203
Zinc (mg/100 g)	4.06	2.96	2.35
Iron	16.2	34.7	5.09
Calcium (mg/ 100g)	3.45	2.59	1.73
Protein (%)	8.92	8.81	9.61

The nutritional assessment of the newly developed variety DHLM-14-1 indicates a favorable mineral profile compared to national checks JK-8 and OLM-203. DHLM-14-1 boasts a zinc content of 4.06 mg/100 g, significantly surpassing JK-8 (2.96 mg/100 g) and OLM-203 (2.35 mg/100 g), suggesting its potential to enhance dietary zinc intake, crucial for immune function and overall health (Table 7). While its iron content of 16.2 mg/100 g is lower than JK-8's (34.7 mg/100 g), it remains significantly higher than OLM-203 (5.09 mg/100 g), making it a valuable option for improving iron nutrition in at-risk populations (Dwivedi*et al.*, 2012) Additionally, DHLM-14-1's calcium content of 3.45 mg/100 g exceeds both checks, enhancing its potential to support bone health. The protein content of 8.92% is slightly higher than JK-8 (8.81%) but lower than OLM-203 (9.61%), indicating adequate levels for a cereal crop. Overall, DHLM-14-1 demonstrates superior zinc and calcium levels, competitive iron, and sufficient protein, highlighting its potential to improve the nutritional quality of millet and contribute to food security and public health, particularly in areas with prevalent micronutrient deficiencies (Cakmak and Kutman, 2018). These findings advocate for the cultivar's introduction as a nutritious option in sustainable agricultural practices, aimed at enriching staple crop diets.

Conclusion:

At the national level, the newly developed little millet variety DHLM-14-1 has consistently outperformed national checks OLM-203 and JK-8 in both grain and fodder yields across various locations in India. This variety also demonstrates strong resistance to pests and diseases, including shoot fly, grain smut, leaf blight, and sheath blight, making it an attractive option for farmers seeking to enhance their income while minimizing environmental impact. With a grain yield of 1297 kg/ha, DHLM-14-1 stands out for its significant advantages across different agro-climatic conditions, establishing itself as a high-yielding choice for cultivation. Its robust disease resistance and effective pest management strategies further enhance its adaptability to challenging agricultural environments. Moreover, the nutritional benefits of DHLM-14-1, highlighted by increased levels of zinc and calcium, are particularly beneficial for improving dietary quality in populations at risk of micronutrient deficiencies. Overall, the findings suggest that DHLM-14-1 has great potential to promote sustainable agricultural practices, bolster food security, and increase farmers' incomes in little millet cultivation throughout India, positioning it as a key component of integrated crop management strategies.

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