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## Research Note

### VL *Mandua* 380: A medium maturing, high yielding and blast tolerant finger millet cultivar for rainfed organic agro-ecology of hills

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#### Abstract

The medium duration blast tolerant finger millet variety VL *Mandua* 380 was developed at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora from the cross between GEC-440 (blast resistant core collection germplasm line) and VL 149 ((blast resistant cultivars adapted to hills) followed by a pedigree method of selection in the segregating generations. Under rainfed organic conditions, it has recorded an average grain yield of 1,877 kg/ha, which is 34.1 and 46.9 per cent higher yield over the check varieties VL *Mandua* 324 (1,400 kg/ha) and PRM-1 (1278 kg/ha), respectively in SVT trial conducted over 3 years from 2014-16. It is a medium duration variety with a duration of 113-118 days. The grains are nutritious with a higher concentration of calcium (322.5 mg/100 g) and zinc (4.3 mg/100 g) in comparison to the check variety VL *Mandua* 324 (294.0 mg /100 g and 2.8 mg/100 g, respectively). It exhibited resistant reaction to leaf blast and moderate reaction to finger and neck blast in the multilocation trials conducted over nine locations. Based on its superior performance for grain yield, grain quality and blast tolerance VL *Mandua* 380 was released by State Varietal Release Committee, Uttarakhand on 5<sup>th</sup>, February 2018. Subsequently, it was notified by the Central Sub-Committee on Crops Standards, Notification and Release of Varieties for Agricultural Crops vide notification number S.O.1498 (E) dated April 1, 2019. The specific area of adaptation of this variety is the rainfed organic condition of Uttarakhand hills.

**Keywords:** Finger millet, VL *Mandua* 380, medium maturity, high calcium content, blast tolerance

Rainfed agriculture accounts for approximately 86 million hectares in India and small millets are reported to occupy around 90% of India's rainfed acreage (Rao *et al.*, 2015). Small millet is resilient to climatic uncertainties and best suitable for rainfed cultivation due to their shorter growth period, C<sub>4</sub> means of photosynthesis, and ability to yield even in marginal environments and low input agriculture (Himasree *et al.*, 2017). It is known as nutricereal because of the high concentration of fibre and calcium in its grains (Keerthana *et al.*, 2019) and consumed in a variety of ways. More importantly, it is recommended

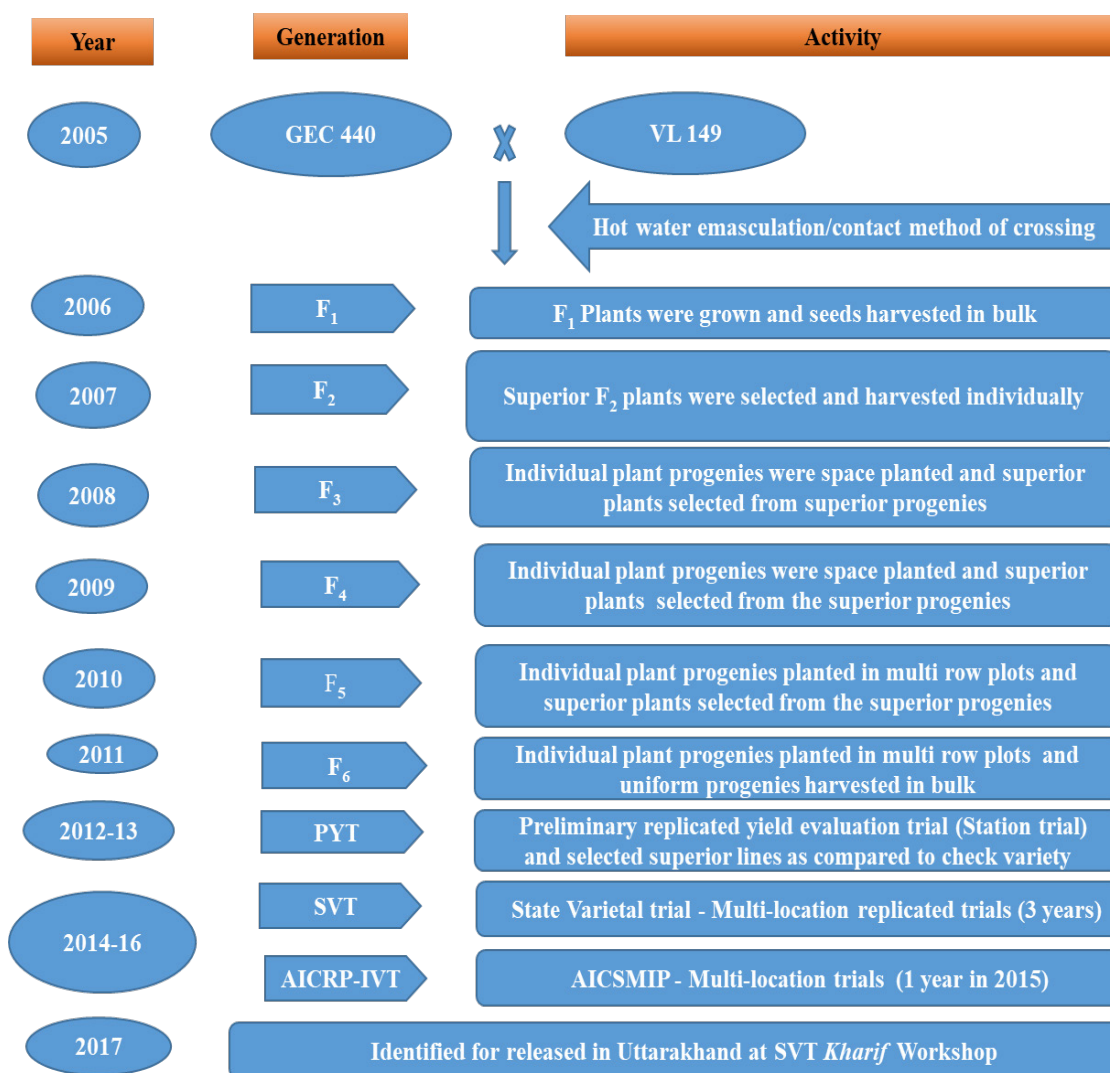
for diabetic patients because of its low glycemic index (Sood *et al.*, 2017). These crops have a broad range of seasonal adaptations ranging from sea level (in parts of Andhra Pradesh and Tamil Nadu) to around 2400 metres above mean sea level in the hills of Uttarakhand, India (Joshi *et al.*, 2021).

In Uttarakhand hills, finger millet is a traditional crop grown from millennia and specifically suited to the fragile mountain ecosystem and rainfed and organic agro-ecology of the region (Gururani *et al.*, 2021). It plays an

important role in ensuring the food and nutritional security of the hill farmers, as well as meeting the fodder needs of their livestock. However, farmers generally cultivate traditional cultivars, which are blast susceptible and low yielding with loose panicles which has rendered poor productivity levels of the crop in the region. The finger millet is generally grown without chemical fertilizer and by default it is organic. In this region, early to medium maturing genotypes (110-120 days) are preferred by the farmers as the crop occupies rainfed areas where the growth period is mostly limited due to less availability of water for the crop. Further, hills are the hot spots for all three types of blasts (leaf, neck and finger) of finger millet (Kumar *et al.*, 2021). Therefore, an early to medium maturing finger millet cultivar, which can be responsive to organic fertilizer with high to moderate resistance to blast within a locally adapted genetic background is required to cater for the need of the area.

Thus with the objective to develop a medium maturing, blast resistant brown seeded finger millet variety specifically suited to rainfed and organic agro-ecology of hills, the variety VL *Mandua* 380 was developed to provide a new option to farmers growing traditional landraces and old variety of finger millet in the hills.

In order to develop a high yielding blast tolerant and nutritionally rich finger millet variety, the inter-varietal hybridization was carried out between GEC 440 (blast resistant core collection germplasm line) and VL 149 ((blast resistant cultivars adapted to hills) and followed by the pedigree method of selection (**Fig. 1**). Uniform lines were bulked in F<sub>6</sub> generation during 2011 and tested in station trial during 2012-13 along with the check varieties (VL*Mandua* 324, VR 708 and GPU 45). Among the different stabilised lines evaluated in station trials and the culture VL *Mandua*380 was observed to be superior



**Fig. 1. Development of high yielding blast tolerant variety (VL*Mandua* 380) for Uttarakhand Hills**

to the checks. It was further evaluated in multilocal state varietal trials of Uttarakhand during the rainy season of 2014, 2015 and 2016 in five locations following a randomized complete block design with three replicates under organic conditions. The recommended sowing time of June was followed and the row to row distance of 22.5 cm and row length of 3 m with a plot of 5 rows were followed uniformly in all the locations. The crop was raised under organic conditions by recommended dose of FYM@15t/ha. The strain was also nominated to the All India Coordinated Small Millets (AICRP-SM) Trial-2015 and was evaluated in multi-location All India Coordinated Small Millets Early and Medium Duration Trials conducted in inorganic conditions during 2015-2016. Disease screening was done in the natural field conditions of nine hot spot locations in AICRP-SM IVT trials.

The overall mean performance of finger millet pre-release culture VL 380 in SVT trials is presented in **Table 1**. A total of 15 multi-location trials (MLTs) were conducted in Uttarakhand hills to evaluate the performance of the pre-release culture in comparison to the checks. It recorded an average grain yield of 1,877 kg/ha, which was 34.1 per cent superior to the check variety VL *Mandua* 324 (1,400 kg/ha) and 46.9 per cent superior than PRM -1 (1,278 kg/ha). Based on the mean grain yield performance of AICRP-SM IVT trials (**Table 2**) conducted at 10 locations

under inorganic conditions VL380 (2,867 kg/ha) exhibited a grain yield advantage of 28.1 per cent over VR 708 (2,238 kg/ha) and 4.2 per cent over VL *Mandua*352 (2,751 kg/ha). Similarly, superior performance of the VL 380 was also observed at farmer's field trials conducted by the state department of agriculture, Uttarakhand. The recorded mean grain yield was 1,575 kg/ha, which was 19.2 per cent higher than the farmer's variety under organic conditions.

Among the various diseases, blast plays a detrimental role in the production and productivity of finger millet in hills (Sood *et al.*, 2019). In the coordinated trials, conducted across nine diverse hot spot locations of blast, the per cent damage due to leaf blast in VL *Mandua* 380 was very low (disease score 1.8) and it fell in the resistant (R) reaction category with the check VR708 (2.5, moderately resistant) and VL *Mandua* 352 (2.0, resistant) (**Table 3**). The per cent damage due to finger blast in VL *Mandua* 380 was low (11.5%) and was grouped in the same disease scale category of 11-20 per cent (moderately resistant reaction) as both the brown seeded check varieties (**Table 3**). Likewise, the per cent damage due to neck blast in VL *Mandua* 380 (11.9%) was low and fell in the same disease scale category of 11-20 per cent (moderately resistant reaction) with the brown seeded national checks (**Table 3**).

**Table 1. Performance of VL *Mandua* 380 in comparison to check varieties in state varietal trials conducted during 2014 to 2016**

Name and year of the trials	Number of locations	Name of locations	Grain yield (kg/ha)					% increase over VL <i>Mandua</i> 324	% increase over PRM 1
			VL <i>Mandua</i> 380	VL <i>Mandua</i> 324	PRM 1	C.D. at 5%	CV (%)		
SVT-2014	5	Hawalbagh	2028	1733	1309	4.48	14.96		
		Ranichauri	2070	1672	2125	1.53	4.55		
		Thal	1235	1057	889	1.21	7.71		
		Majhera	1811	1481	1481	6.11	19.86		
		Chinyalisaur	630	557	604	1.30	11.86		
		Mean	1555	1300	1282	-	-	19.6	21.3
		SVT-2015	5	Hawalbagh	3376	2939	2652	5.05	10.19
SVT-2016	5	Ranichauri	986	495	1139	0.07	0.47		
		Thal	2509	1165	731	1.90	8.82		
		Majhera	988	905	996	2.23	17.18		
		Chinyalisaur	630	555	622	1.22	11.34		
		Mean	1698	1212	1228	-	-	40.1	38.3
		Hawalbagh	2800	2242	1946	5.73	14.15		
		Ranichauri	692	888	889	0.50	3.36		
Pooled mean of SVT	5	Thal	2094	1481	1111	1.81	6.60		
		Majhera	3042	1975	1333	5.84	16.45		
		Chinyalisaur	3269	1859	1345	9.71	26.31		
		Mean	2380	1689	1325	-	-	40.9	79.6
		Pooled mean of SVT	1877	1400	1278			34.07	46.89

**Table 2. Performance of VL *Mandua* 380 in comparison to national check varieties in Uttarakhand and All India IVT coordinated trial during 2015**

Locations	Grain yield (kg/ha)				
	VL <i>Mandua</i> 380	VR 708	VL 352	% increase over VR 708	% increase over VL <i>Mandua</i> 352
Almora	3832	3516	4020	8.99	-4.68
Gaja	1024	1017	1442	0.69	-28.99
Ranichauri	958	961	1361	-0.31	-29.61
Uttarakhand mean	1938	1849	2274	4.81	-14.78
Mean	2867	2238	2751	28.11	4.22

**Table 3. Reaction of VL *Mandua* 380 to blast (range and mean score in % of 9 locations) as recorded in IVT coordinated trial during 2015**

Genotype	Year	Number of locations	Leaf blast (grade)	Neck blast (% damage)	Finger blast (% damage)
VL <i>Mandua</i> 380	2015	9	1.8	11.9	11.5
VR 708 (Susceptible check)	2015	9	2.5	16.0	16.6
VL <i>Mandua</i> 352 (Resistant check)	2015	9	2.0	9.4	5.8

In terms of grain quality (Table 4), VL *Mandua* 380 has higher calcium (322 mg/100 g) and iron content (4.3 mg/100 g) in comparison to the brown seeded check VL *Mandua* 324 (294 mg/100 g and 2.8 mg/100 g, respectively). In addition, the protein (6.6%) and zinc (2.6 mg/100 g) content in VL *Mandua* 380 were at par with the check variety VL *Mandua* 324 (6.6% and 2.4 mg/100 g).

Frontline demonstrations were conducted during *kharif* 2019-20 and 2020-21 crop seasons. During *kharif* 2019-20, VL *Mandua* 380 recorded a grain yield of 2,061 which

was 31.8 per cent higher than 1,563 kg/ha of the local farmer's variety. These demonstrations were conducted in the Pauri and Nainital districts of Uttarakhand with 78 farmers. During 2020-21 also VL *Mandua* 380 yielded a grain yield of 2,135 which was 26.4 per cent higher than 1,689 kg/ha of the local farmer's variety. These demonstrations were conducted in the Almora district of Uttarakhand with 60 farmers (Table 5). Farmers' response to this variety has been positive and they are very enthusiastic for this variety which led to a high farmer to farmer exchange of seeds of the variety.

**Table 4. Grain quality characteristics of VL *Mandua* 380**

Quality parameters	VL <i>Mandua</i> 380	VL 324 (C)
Calcium (mg/100g)	322.5	294.0
Zinc (mg/100g)	2.6	2.4
Iron (mg/100g)	4.3	2.8
Protein (%)	6.66	6.60

**Table 5. Performance of VL *Mandua*378 in front line demonstrations**

Year	Area (ha)	Demonstration yield (kg/ha)	Farmers field yield (kg/ha)	% increase over farmers field yield	Cost of production (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		BC ratio	
					DP	FP	DP	FP	DP	FP	DP	FP
2019	3	2,061	1,563	31.8	21164	18896	44743	31454	23578	11577	1.2	0.61
2020	3.6	2,135	1,689	26.4	21567	19234	43267	29873	24560	12445	1.2	0.65

DP-Demonstration plots; FP- Farmers plots



**Fig. 2.** Field view and seed photograph of the variety VL *Mandua* 380

**Table 6.** Descriptors of VL *Mandua* 380

S. No.	Characters	Proposed variety (VL Mandua 378)		Check variety 1 (VL 324)		Check variety 2 (PRM 2)	
		Range	Mean	Range	Mean	Range	Mean
1	Days to 50% flowering	74-81	78	73-79	75	71-84	78
2	Days to maturity	113-118	116	107-117	113	108-122	115
3	Plant height (cm)	70.6-94.6	81.0	80.0-91.5	85.0	78.1-99.9	88.0
4	Panicle length (cm)	7.3-9.8	8.4	6.2-7.7	7.0	7.7-8.8	8.1
6	Ear shape	Semi compact					
7	Grain shape						
8	Grain colour	Light copper					

The year wise economics of finger millet production under frontline demonstrations were estimated and results have been presented in Table 6. Finger millet variety VL *Mandua* 380 recorded a higher Benefit: Cost (B:C) ratio of 1.13 in demonstration plots than of 0.57 in farmers' plot and 1.12 in demonstration plot than of 0.60 in farmers' plot, respectively during 2019-20 and 2020-21.

The variety VL *Mandua*380 is characterised by non-pigmented nodes and panicles (Fig. 2). The growth habit was erect. The leaves are characterised with blade pubescence and panicles with thumb fingers. The ear shape is semi compact in nature. The fingers were measured 7.6 to 10 cm in length. This variety having bold grains with light copper colour (Fig. 2) and 1000 seed weight was recorded 2.83 g. The detailed descriptor for VL *Mandua* 380 is presented in Table 6.

In view of the consistent superior performance of VL *Mandua* 380 as compared to the checks for grain yield,

and preferable grain quality traits and blast tolerance, it was released by the State Seed Sub Committee, Uttarakhand during 2018 for rainfed organic agroecology of Uttarakhand hills. Later on, it was notified by the Central Sub-Committee on Crops Standards, Notification and Release of Varieties for Agricultural Crops vide notification number S.O.1498 (E) dated April 1, 2019. This would fulfil the long felt needs of the farmers of hilly areas of not only Uttarakhand but also the entire North Western Himalayan region, where finger millet is predominantly grown under rainfed organic conditions. Besides, VL *Mandua* 380 will also add to finger millet varietal diversity for organic farming in the country as a whole and in the hills of Uttarakhand state in particular.

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