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JP Aditya

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

PK Agrawal

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

Anuradha Bhartiya

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

Rajashekara H

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

Manoj Parihar

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

L Kant

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

JK Arya

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

Devendra Lal

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

Corresponding Author:

JP Aditya

Crop Improvement Division,
ICAR-Vivekananda Parvatiya
Krishi Anusandhan Sansthan,
Almora, Uttarakhand, India

A red rice high yielding variety 'VL Dhan 69' for cultivation in Northern hills

JP Aditya, PK Agrawal, Anuradha Bhartiya, Rajashekara H, Manoj Parihar, L Kant, JK Arya and Devendra Lal

Abstract

VL Dhan 69 is a red rice variety suitable for cultivation under irrigated transplanted condition of medium elevated hills of Uttarakhand, Sikkim and Union territory of Jammu and Kashmir. This was released by the Central Sub-Committee on Crop Standards Notification and Release of Variety for Agricultural Crops and notified by the Central Seed Committee vide notification number S.O.8(E) dated the 24th December, 2021. This variety was developed by crossing between VL 10689 and UPRI2005-15 at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS) Almora, Uttarakhand. It has unique decorticated grain colour (reddish brown) which may fetch higher price in the market compare to normal rice. This variety has semi-erect, semi-dwarf and non-lodging plant type, green basal leaf sheath colour, erect to semi erect flag leaf, semi-erect, semi-straight and well exerted panicle, awnless grains and straw apiculus colour. VL Dhan 69 was found promising, stable and shown significant yield superiority over the checks. It recorded grain yield 4,255 kg/ha in medium hill on an average of three years of testing as compare to national check, Vivek Dhan 62 (3,010 kg/ha); regional check, VL Dhan 65 (3,599 kg/ha) & Local check (2,769 kg/ha) with yield advantage of 41.37, 18.22 and 53.65 per cent, respectively. It has very good quality characteristics viz., hulling 79.9%, milling 69.1%, head rice recovery 55.4%, intermediate ASV (5.0) and amylose content 26.78%, gel consistency (23mm), grain chalkiness is very occasionally present. It has short bold grain with kernel length (5.35mm), kernel breadth (2.62mm) and L/B ratio (2.04). This variety showed moderate resistance against leaf blast, neck blast, brown spot and sheath rot. Wide spread and cultivation of this variety would help in yield stabilization of hill farmers and fulfill the urgent requirement of varietal diversification in Northern Hill Zone (NHZ).

Keywords: Red rice, VL Dhan 69, irrigated transplanted hill rice, medium elevation hill, high yielding variety

Introduction

Rice is the principal food grain crop of the Northern Hill ecosystem followed by maize which occupies 3.94 million hectares area and share 8.62 per cent of the total rice area & 7.27 per cent production at national level. The total rice production of Northern Hill region is around 9.04 million tones with average productivity of 2,293 kg/ha, which is much below the national average of 2,717 kg/ha (DES 2022, GOI).

Red rice production and consumption is getting popular because of its health benefit, high costs & export prospect and now-a-days, it is favored by more customers regardless of its cost. The consumer's inclination toward red rice varieties has been enhanced to the great extent because of its feature like nutrient dense, special texture, flavor & taste. Considering that today people are searching for foods that could help to improve and maintain health and now specialty rices would also be considered in some way as functional food (Wickert *et al.*, 2014)^[7]. In the financial perspective, farmers' total income also gets increase with the adoption of modern high yielding rice varieties (Kader *et al.*, 2020). Development of rice cultivars with a high yielding ability is one of the most fundamental approaches for dealing with the expected increase in demand (IRRI, 1993)^[3].

Red rice is a variety of rice with red bran layer rather than the more common pale brown. It is usually eaten unpolished or partially polished and has a nutty flavor. The colour is confined to the bran layer, a tinge of red remains even after a high degree of milling. It has more bran than white and brown rice. The inner portion of red and white rice is alike i.e., white. The zinc and iron content of red rice is higher than that of white rice. It is also a richer source of magnesium and calcium than white rice. It is a good source of protein, fibre content, antioxidants, vitamins and minerals. Red rice helps in controlling diabetes.

The low glycemic index of red rice slowly digested and energy releases slowly therefore good for diabetic patients. Red rice can also prevent Asthma. It helps in controlling the pulmonary functions. It is simply because of the rich magnesium content, its regular consumption can improve oxygen circulation in the body and prevent from asthma. Red rice improves consumption of oxygen packed with the goodness of iron. Daily consumption of red rice can help in absorption of oxygen and circulate it to every tissue and cell of the body. An improved level of oxygen in the body can elevate mood and make feel energetic. Red rice helps in digestion in the sense that it is a great source of fibre and can help in several digestive functions. It is loaded with the goodness of soluble and insoluble fibers, red rice can easily drain out toxins from body and ease the bowel movement, therefore, it works as a natural laxative. Red rice keeps heart diseases away. The presence of whole grains in red rice can easily reduce the level of bad cholesterol in the body. The bran of red rice can help in reducing the cholesterol level and prevent heart diseases. Red rice contains high antioxidant levels which inhibits the formation or reduces the concentrations of reactive cell-damaging free radicals, thus protecting the body tissue from oxidative damage (Kang *et al.*, 2011) [5].

Red rice is pigmented rice belongs to the specialty rice varieties contains pigments in the aleurone layer composed of a mixture of anthocyanins (Kang *et al.* 2011) [5]. Anthocyanins lead to attractive coloration in different rice plant parts including rice caryopsis. Brown, red, purple and black colors of the rice caryopsis are due to the varying composition and concentration of pigments. The concentration of anthocyanins and proanthocyanidins are responsible for the color differentiation. The higher concentration of the total anthocyanin content (TAC) in the rice bran is responsible for the black and purple color of the rice whereas higher amount of total proanthocyanidin (TPC) leads to red appearance bran in the red rice. The pigmentation increases as the rice caryopsis develops and changes are observed at different developmental stages. The appearance of red colour in the grain of red rice is visible at fully maturity or ripened stage whereas in black rice the colour is visible from the milking or dough stage (Mackon *et al.*, 2021) [6]. Red pericarp is a genetic trait related to gene Rd on chromosome 1 with dominant effect (Wickert *et al.*, 2014) [7].

Like white rice, red rice has a wide range of varieties. They are glutinous and non-glutinous, fragrant and non-fragrant, late and early maturing, short and long-grained. However, the majority of red rices are coarse-grained (Ahuja, *et al.*, 2007) [1]. Local red rice cultivars are tall, low yielding, prone to lodging, therefore, considering these points in mind, efforts have been made towards the development of high yielding, semi dwarf, early & medium maturity rice varieties for irrigated hill ecosystem and consequently VL *Dhan* 69 has been developed at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, Uttarakhand. This variety is medium maturity duration rice variety suitable for cultivation under irrigated hill ecosystem of Uttarakhand, Sikkim and J&K. This has been released and notified by the Central Sub-Committee on Crop Standards Notification and Release of Variety for Agricultural Crops, New Delhi vide notification number S.O.8 (E) dated the 24th December, 2021. The wide spread cultivation of this variety would help in yield stabilization of hill farmers and fulfill the urgent requirement

of varietal diversification in Northern Hill Zone (NHZ).

Materials and Methods

VL *Dhan* 69 has been developed from the cross “VL 10689/UPRI2005-15” at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan Almora, Uttarakhand. The crosses between these parents were made in 2008 and 16 F₁ seeds were grown in 2009. The F₂ seed was grown in 21 rows in 2010 and ears from the best individual plants were selected on the basis of high yielding ability, desirable plant type, disease resistance traits etc. and harvested separately. Each F₃ ears were grown in 2 rows in 2011. Ear to row method were followed for generation advancement up to F₆ generation. Eight progenies of this cross were evaluated in observational nursery in 2014 and the best progeny rows first namely VR 3103-1 found significantly superior to the best check were bulked for further evaluation in station trial. It was named as VL 32130 in station trial and tested for two years during 2015 and 2016 for yield and disease resistance.

Its performance was excellent in two years station trial over the best check and based on this it was nominated as entry in All India Coordinated Rice Improvement Programme (AICRIP) Trial in 2017 in Hill Zone (Zone I) where it was evaluated under multilocation irrigated transplanted medium duration hill trials for three years (2017-2019) at different AICRIP hill centres for grain yield and other important traits. The detailed flow chat of pedigree, breeding programme and evaluation of VL *Dhan* 69 are shown in the Figure1. The experiment was conducted in randomized complete block design (RCBD) in three replication and observations were recorded in each replication for grain yield, days to 50% flowering, days to maturity, plant height (cm) and number of panicles per meter square. In the AICRIP trials viz., Initial Varietal Trials (IVT), Advanced Varietal Trials (AVT1 & AVT2) test entry VL 32130 was found superior over the checks in three years for grain yield. The reaction against major diseases and insect pests were also studied in this entry along with resistant and susceptible checks in various hot spot centers for three years (2017-2019). The different grain quality parameters were also analyzed for two years (2018 and 2019) at ICAR- Indian Institute of Rice Research, Hyderabad. Agronomical performance of this entry was tested at four different centers in 2020. This entry was identified for release by the Variety Identification Committee (VIC) in the rice workshop meeting and subsequently released and notified by the Central Sub-Committee on Crop Standards Notification and Release of Variety for Agricultural Crops vide notification number S.O.8 (E) dated the 24th December, 2021.

Results and Discussion

VL *Dhan* 69 is a medium maturity duration rice variety suitable for irrigated transplanted conditions of medium elevated hills and valleys of Uttarakhand, Sikkim and Union territory of Jammu and Kashmir. Over three years (2017-2019) of multilocation testing under AICRIP, it has provided grain yield 4,255 kg/ha as compare to national check, *Vivek Dhan* 62 (3,010 kg/ha); regional check, VL *Dhan* 65 (3,599 kg/ha) & Local check (2,769 kg/ha) with yield advantage of 41.37, 18.22 and 53.65 per cent, respectively. It has also recorded yield advantage of 8.65%, 5.32% & 6.47% over qualifying varieties (Table1).

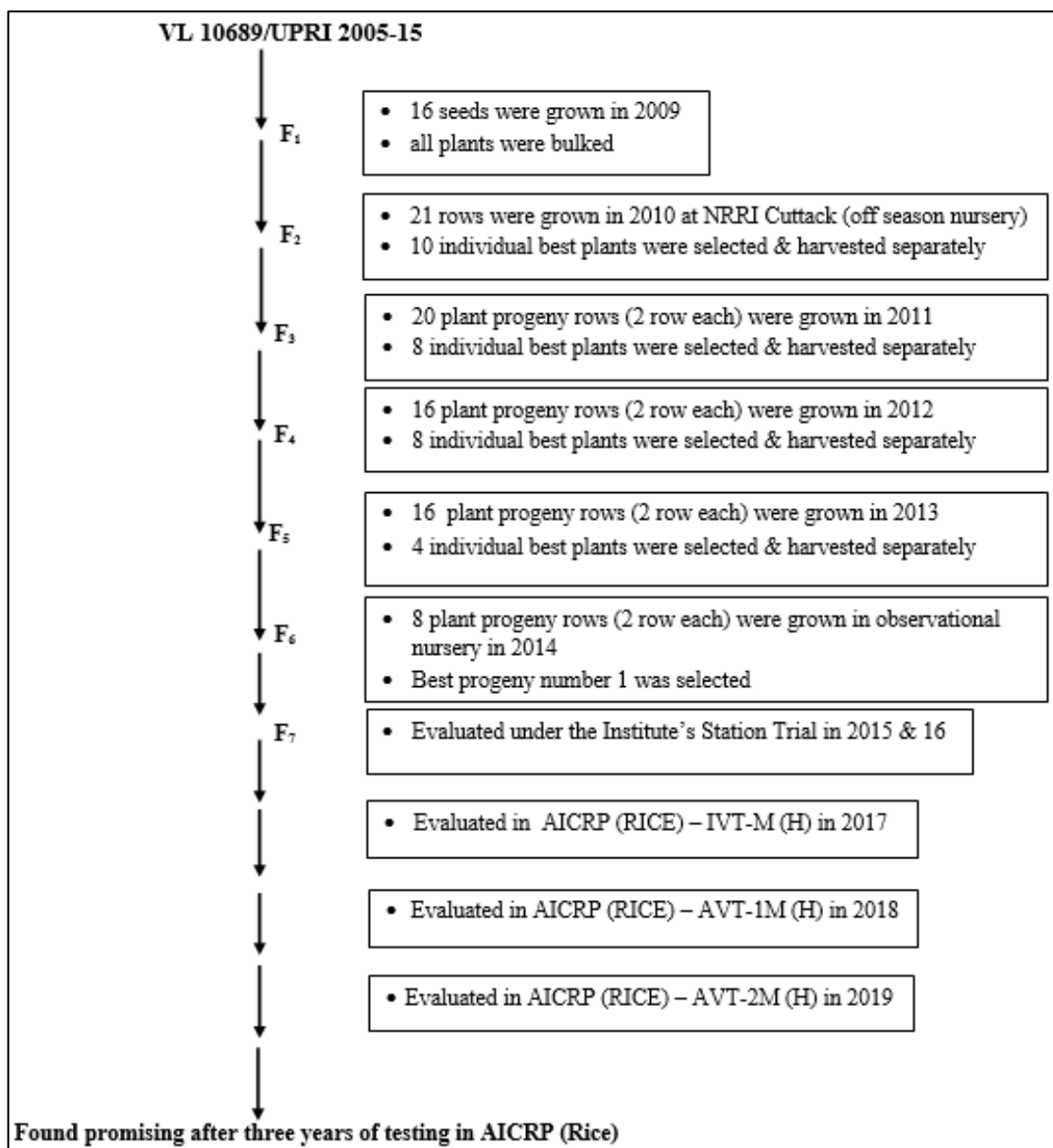


Fig 1: Flow Chart of pedigree of VL Dhan 69 (VL 32130)

Table 1: Summary of yield (kg/ha) data of Coordinated Variety Trials in Northern Medium Hills (UT, Sikkim, J&K)

	Year of testing	Released variety VL Dhan 69	Check Var.1 Vivek Dhan 62 (NC)	Check Var.2 VL Dhan 65 (RC)	Check Var.3 (LC)	Qual. Var.1 IET 26579	Qual. Var.2 IET 26597	Qual. Var.3 IET 26588	C.D.
Mean yield(kg/ha)	I Year (2017)	6234	3594	4766	4180	4531	4297	5648	1033
	II Year (2018)	4266	2979	3607	1942	4398	5080	4617	491-680
	III Year (2019)	3587	2835	3204	2850	3389	3260	3031	250
Weighted Mean		4255	3010	3599	2769	3916	4040	3996	
Percentage increase or decrease over the checks & Qualifying varieties	I Year (2017)		(+) 73.46	(+) 30.80	(+) 49.14	(+) 37.59	(+) 45.08	(+) 10.38	
	II Year (2018)		(+) 43.20	(+) 18.27	(+) 119.67	(-) 3.00	(-) 16.02	(-) 7.6	
	III Year (2019)		(+) 26.53	(+) 11.95	(+) 25.86	(+) 5.84	(+) 10.03	(+) 18.34	
Mean percentage increase			(+) 41.37	(+) 18.22	(+) 53.65	(+) 8.65	(+) 5.32	(+) 6.47	
Frequency in the top group (pooled for 3 years)		3/6	0/6	0/6	0/6	1/6	1/6	2/6	

Performance of VL Dhan 69 in agronomic trial: This variety was found responsive at both lower and normal (recommended) fertility level. Overall it has recorded significantly higher grain yield (3.81 t/ha) over the national

check *Vivek Dhan 62* (3.27 t/ha) and regional check *VL Dhan 65* (3.74 t/ha) but lower than the local check. The data regarding performance of the variety in agronomic trial is presented in Table 2.

Table 2: Adaptability to changes in agronomic conditions

Experiment	Year of testing	No. of trials	Item	Released variety VL Dhan 69	Check Var.1 Vivek Dhan 62(NC)	Check Var.2 VL Dhan 65 (RC)	Check Var.3 (LC)
Fertilizer Experiment response to NPK	2020	4	F1: 50 % RDF	3.56	3.06	3.51	3.77
			F2: 100 % RDF	4.06	3.47	3.96	4.62
			Mean	3.81	3.27	3.74	4.20

Performance of VL Dhan 69 for disease and pest reaction

This variety was evaluated for major diseases, insect pests under natural & artificial condition and it has shown moderately resistant reaction against leaf blast, neck blast,

brown spot, sheath rot, brown plant hopper, white backed plant hopper stem borer and grass hopper. The score for these diseases and insect pest over the year and in different locations are mentioned in Table 3-4.

Table 3: Reaction to major diseases

Parameter	Year of testing	No. of Location	Released variety VL Dhan 69	Check Var.1 Vivek Dhan 62 (NC)	Check Var.2 VL Dhan 65 (RC)	Qual. Var.1 IET 26579	Qual. Var.2 IET 26597	Qual. Var.3 IET 26588
Leaf Blast (SI)	I Year (2017)	8	5.8	6.1	5.1	6.0	5.8	5.8
	II Year (2018)	10	5.6	4.8	6.0	5.0	4.8	5.1
	III Year (2019)	9	5.8	5.8	5.8	5.1	5.9	5.8
	Mean		5.7	5.6	5.6	5.4	5.5	5.6
Neck Blast (SI)	I Year (2017)	9	5.5	5.0	5.0	5.0	6.0	4.5
	II Year (2018)	9	5.4	5.8	4.6	4.2	5.8	3.8
	III Year (2019)	4	4.5	5.0	5.5	4.0	5.7	4.0
	Mean		5.1	5.3	5.0	4.4	5.8	4.1
Brown Spot (SI)	I Year (2017)	5	5.4	4.4	5.6	6.0	5.4	6.0
	II Year (2018)	5	6.4	4.8	6.4	6.4	6.6	5.2
	III Year (2019)	6	5.2	5.8	6.2	6.2	5.5	6.0
	Mean		5.7	5.0	6.1	6.2	5.8	5.7
Sheath Rot (SI)	I Year (2017)	2	7.0	7.0	9.0	5.0	5.0	7.0
	II Year (2018)	2	6.0	7.0	7.0	8.0	8.0	7.0
	III Year (2019)	2	4.0	4.0	7.0	4.0	6.0	5.0
	Mean		5.7	6.0	7.7	5.7	6.3	6.3

Table 4: Reaction to major insect pests

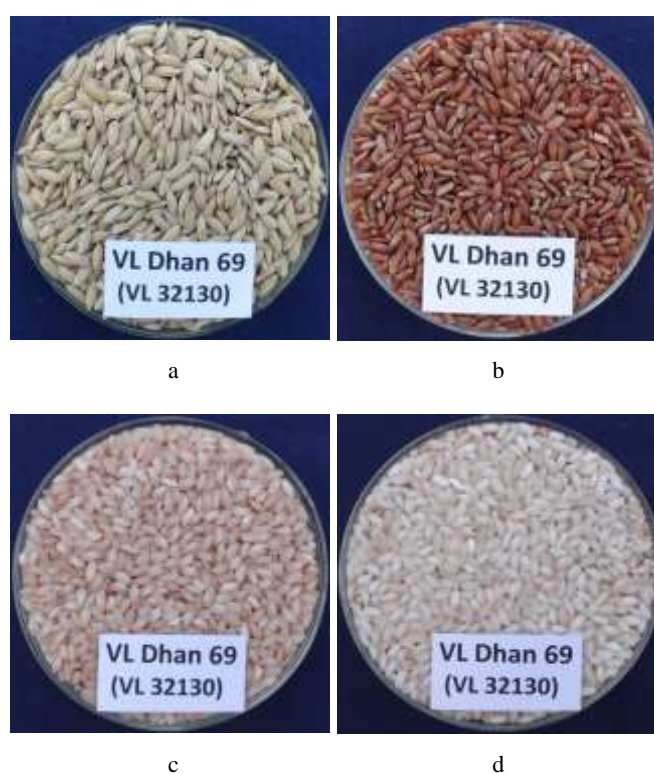
Parameter	Year of testing	No. of Location	Released variety VL Dhan 69	Check Var.1 Vivek Dhan 62 (NC)	Check Var.2 VL Dhan 65 (RC)	Qual. Var.1 IET 26579	Qual. Var.2 IET 26597	Qual. Var.3 IET 26588
BPH (GR, DS)	I Year (2017)	4	6.6	8.5	8.2	6.2	7.4	6.3
	II Year (2018)	4	7.9	7.2	7.6	6.4	5.7	5.0
	III Year (2019)	2	7.2	6.9	7.2	6.1	6.9	7.0
	Mean		7.2	7.5	7.6	6.2	6.7	6.1
WBPH (GR, DS)	I Year (2017)	2	7.5	9.0	8.8	7.4	7.1	8.7
	II Year (2018)	2	6.7	7.3	6.9	7.6	8.7	7.6
	III Year (2019)	1	7.0	9.0	6.5	7.0	9.0	9.0
	Mean		7.0	8.4	7.4	7.3	8.2	8.4
Stem Borer White Ear (% WE)	I Year (2017)	2	4.7	8.8	5.0	9.6	8.1	5.1
	II Year (2018)	1	9.1	11.7	11.5	23.7	28.6	10.1
	III Year (2019)	2	14.9	8.1	16.3	13.7	13.0	9.5
	Mean		9.6	9.5	10.9	15.6	16.6	8.3
Grass Hopper (% DL)	I Year (2017)	1	12.6	13.4	13.0	12.5	11.5	12.3
	II Year (2018)	1	9.0	10.5	10.3	10.4	8.5	13.5
	III Year (2019)	1	10.1	9.3	9.7	12.9	10.5	11.2
	Mean		10.6	11.1	11.0	11.9	10.2	12.3

Morphological Description: VL Dhan 69 has unique reddish brown decorticated grain colour (figure 2) which may fetch higher price in the market compare to normal rice. It has short bold grain with plant height 95-105 cm. It has more number of panicles/m² (282) in comparison to Vivek Dhan 62 (234),

VL Dhan 65 (254) and local check (238). It possesses non-lodging, semi-erect and semi-dwarf plant type; semi-erect and well exerted panicle, awnless grain, green basal leaf sheath colour with no pubescence on leaf blade surface (Table 6).

Table 5: Data on Quality Characteristics of the proposed variety

Grain quality characteristics	Year	Released variety VL Dhan 69	Check Var.1 Vivek Dhan 62 (NC)	Check Var.2 VL Dhan 65 (RC)	Check Var.3 (LC)	Qual. Var.1 IET 26579	Qual. Var.2 IET 26597	Qual. Var.3 IET 26588
Hulling (%)	2018	79.1	82.0	79.6	82.1	81.5	80.2	75.3
	2019	80.6	79.3	79.5	80.1	81.4	79.7	77.3
	Mean	79.9	80.7	79.6	81.1	81.5	80.0	76.3
Milling (%)	2018	68.6	73.6	71.2	68.0	71.2	68.0	66.2
	2019	69.5	70.6	70.2	70.7	74.0	69.2	68.5
	Mean	69.1	72.1	70.7	69.4	72.6	68.6	67.4
Head Rice Recovery (%)	2018	62.1	68.3	60.6	37.4	60.6	46.6	49.0
	2019	48.6	56.8	51.6	54.3	69.6	46.3	61.8
	Mean	55.4	62.6	56.1	45.9	65.1	46.5	55.4
Kernel length(mm)	2018	5.37	5.19	6.23	6.88	6.38	6.07	6.43
	2019	5.33	5.20	6.20	6.32	6.80	6.32	6.69
	Mean	5.35	5.20	6.22	6.60	6.59	6.20	6.56
Kernel breadth (mm)	2018	2.57	2.56	2.1	1.93	1.95	2.48	1.83
	2019	2.66	2.65	2.21	2.58	1.98	2.5	1.9
	Mean	2.62	2.61	2.16	2.26	1.97	2.49	1.87
L/B ratio	2018	2.08	2.02	2.96	3.56	3.27	2.44	3.51
	2019	2.00	1.96	2.80	2.44	3.43	2.52	3.52
	Mean	2.04	1.99	2.88	3.00	3.35	2.48	3.52
Grain type	2018	SB	SB	LB	LS	LS	LB	LS
	2019	SB	SB	LB	LB	LS	LB	LS
	Mean	SB	SB	LB	LB	LS	LB	LS
Grain Chalkiness	2018	VOC	VOC	VOC	VOC	VOC	VOC	VOC
	2019	VOC	OC	VOC	VOC	VOC	VOC	VOC
	Mean	VOC	VOC	VOC	VOC	VOC	VOC	VOC
Alkali Spreading Value	2018	4	4	4	4	4	7	4
	2019	5	5	5	5	5	4	4
	Mean	5	5	5	5	5	6	4
Amylose content (%)	2018	26.72	24.31	23.78	24.11	26.62	21.76	21.38
	2019	26.84	24.46	24.22	26.98	26.37	21.32	22.08
	Mean	26.78	24.39	24.00	25.55	26.50	21.54	21.73
Gel Consistency (mm)	2018	23	22	22	55	27	87	25
	2019	23	24	22	22	24	95	25
	Mean	23	23	22	39	26	91	25

**Fig 2:** Grain sample of VL Dhan 69(VL 32130) (a) with hull/husk (b) after hulling (c) after milling (d) after intense milling

Grain quality: This variety has very good and acceptable grain quality viz., hulling 79.9%; milling 69.1%; Head Rice Recovery 55.4%; kernel length 5.35mm; kernel breadth 2.62

mm; L/B ratio 2.04mm short bold grain. It also exhibited intermediate alkali spread value (5.0), gel consistency (23 mm) and amylose (26.78%) content (Table 5).

Table 6: DUS characteristics of VL *Dhan 69* (VL 32130)

S. No.	Characters and code	Expression and score
1.	Basal Leaf: Sheath colour	Green (1)
2.	Leaf: Pubescence of blade surface	Absent (1)
3.	Leaf: Auricles	Present (9)
4.	Leaf: Anthocyanin colouration of auricles	Colourless (1)
5.	Leaf: Shape of ligule	Split (3)
6.	Leaf: Colour of ligule	White (1)
7.	Flag leaf: Attitude of blade(early observation)	Erect (1)
8.	Fag Leaf: Attitude of blade (late observation)	Semi-erect (3)
9.	Time of heading (50 % of plant with panicles)	Medium (5)
10.	Lemma: Anthocyanin colouration of apex	Absent (1)
11.	Spikelet: Colour of stigma	White (1)
12.	Stem: Length(excluding panicle; excluding floating rice)	Short (3)
13.	Stem: Anthocyanin colouration of nodes	Absent (1)
14.	Panicle: Length of main axis	Medium (5)
15.	Panicle: Curvature of main axis	Semi-straight (3)
16.	Spikelet: Density of pubescence of lemma	Absent (1)
17.	Spikelet: Colour of tip of lemma	White (1)
18.	Panicle: Awns	Absent (1)
19.	Panicle: Colour of awns(late observation)	Not Applicable
20.	Panicle: Distribution of awns	Not Applicable
21.	Panicle: Attitude of branches	Semi erect (5)
22.	Panicle: Exsertion	Well exerted (7)
23.	Sterile lemma: Colour	Straw (1)
24.	Decorticated grain: Length	Short (1)
25.	Decorticated grain: Width	Broad (7)
26.	Decorticated grain: Shape (in lateral view)	Short bold (4)
27.	Decorticated grain: Colour	Light Red (5)
28.	Endosperm: Content of amylose	High (7)
29.	Decorticated grain: Aroma	Absent (1)

Note: These DUS characteristics are of one season and one location at Hawalbagh, Almora.

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