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Variety Release

NIAW 4114 (Phule Shashwat): A New High Yielding Bread Wheat Variety for Late Sown Irrigated Conditions of Peninsular Zone in India

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Wheat is one of India's major staple crops and plays a vital role in the country's food security strategy, holding a prominent place in its agricultural landscape. It is cultivated across various agro-climatic regions, and over the years, its production has shown consistent growth. This progress has been driven by improved farming practices, technological advancements, and strong government support. Globally, India ranks second in wheat production, following China. In 2023, the country produced 110.6 million tonnes of wheat, with an average productivity of 35.20 q ha^{-1}.

The Peninsular Zone of India spans a vast area with diverse agro-climatic conditions, ranging from semi-arid to humid regions, and includes states such as Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu. In recent years, wheat cultivation under late-sown, irrigated conditions has expanded in this zone, largely due to the adoption of various cropping systems. Wheat sowing now extends to mid-December, and the area under delayed sowing is expected to grow further, owing to the improved adaptability of varieties to such conditions. With the short winter duration in this region, wheat varieties must be capable of avoiding high temperatures during the booting and flowering stages. As a result, there is a growing demand for early-maturing varieties that can tolerate high temperatures during anthesis and maturity. In this context, the development of climate-resilient crop varieties is critical to enhancing agricultural productivity and sustainability. This research article introduces NIAW 4114, a newly released bread wheat variety specifically developed for late-sown conditions. It marks a significant advancement in sustainable agriculture, offering both disease resistance and tolerance to terminal heat stress.

NIAW 4114, line was developed from 2012-13 to 2017-18. In 2012, a single cross was made between LO-62 and NIAW 1689 resulted F_1 was planted with parents to obtain F_2 during next year. Individual plant selection was made during segregating generations (F_2 to F_5). During 2018-19 and 2019-20, this entry was evaluated in station trials at Agricultural Research Station, MPKV; Niphad. Further it was evaluated in University Multilocation trial at four different locations of MPKV, Rahuri jurisdiction during 2020-21. It was tested in Indian Plant Pathology Screening Nursery for screening against stem and leaf rust during the same year. Figure 1 shows flow chart of details of development and evaluation of NIAW 4114. During 2021-22, it was evaluated in National Initial Varietal Trial- 3B (NIVT-3B-IR-LS) under the All India Coordinated Research Project at seven locations in simple lattice design with plot size (7.2 m^2) under late sown irrigated conditions against checks HD 2864 and

HD 2932. During 2022-23 and 2023-24, the entry was evaluated at 09 and 12 different locations, respectively, for yield and yield attributes in Advance Varietal Trials (AVTs) in randomized block design having four replications and plot sizes of 14.4 m^2 along with three checks *viz.,* HI HD 3090, RAJ 4083 and HI 16330.

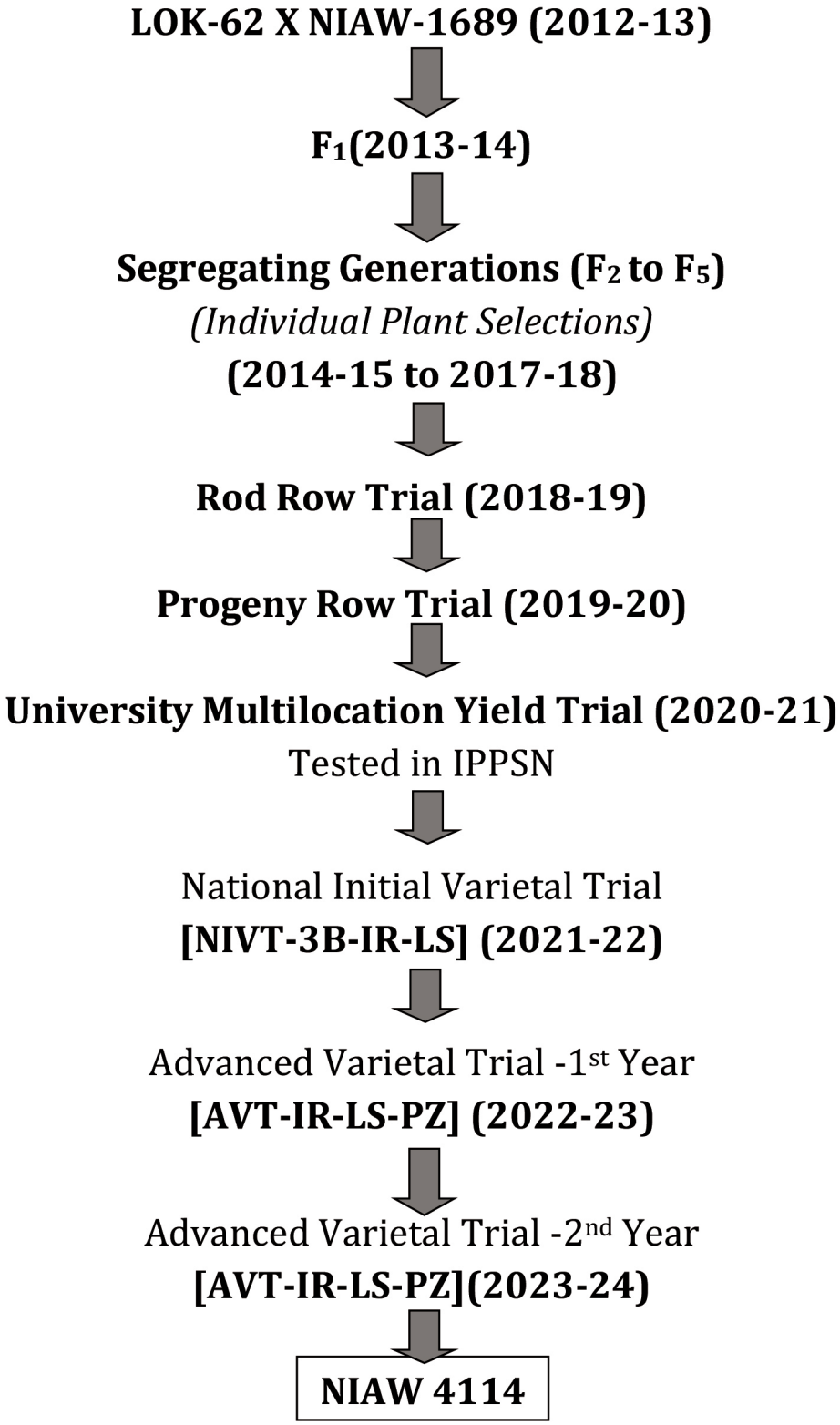


Fig 1: Flow chart showing details of the development of bread wheat variety NIAW 4114

All the treatments were screened for stem and leaf rust throughout the yield evaluation process under artificial conditions. Rust severity and response in the field were assessed using the 0–100 scale developed by Loegering (1959). For statistical analysis, rust reactions were converted into a Coefficient of Infection (COI), also following Loegering's methodology. Gene postulation for rust resistance genes was conducted through multipathotype testing at the seedling stage, using the 0–4 infection type scale described by Stakman *et al.* (1962). The Average Coefficient of Infection (ACI) for both stem and leaf rusts was calculated following the method of Saari and Wilcoxson (1974), by multiplying disease severity with the constant values assigned to each infection type: Resistant (R) = 0.2, Moderately Resistant (MR) = 0.4, Moderate (M) = 0.6, Moderately Susceptible (MS) = 0.8, and Susceptible (S) = 1.0. Seedling resistance tests for gene postulation were conducted using pathotype matching techniques against 21 races of stem rust and 23 races of leaf rust. Quality parameters such as grain appearance score, hectoliter weight, protein content, sedimentation value, grain hardness, chapati quality, bread loaf volume, bread quality, biscuit spread factor, wet and dry gluten content, gluten index, and micronutrient content (Fe and Zn), along with high molecular weight glutenin subunits, were evaluated using standard procedures and protocols. Characterization for Distinctness, Uniformity, and Stability (DUS) of the genotype was performed following the standard varietal identification procedures established for wheat (Gupta *et al.*, 2017).

The genotype NIAW 4114 was evaluated for yield in NIVT and AVT for 2021-22, 2022-23 and 2023-24 which resulted in superior and stable performance under late sown irrigated conditions of Peninsular Zone. The mean performance of NIAW 4114 in coordinated trials over the course of three years in comparisons to the check varieties is presented in Table 1. NIAW 4114 recorded highest yield potential of 70.2 q ha^{-1} (in NIVT 3B-IR-LS-PZ at Parbhani location) with an average yield of 47.9 q ha^{-1} under late sown irrigated conditions. NIAW 4114 was more likely to be appear in first non-significant group (13/28) than check varieties HD 2864 (1/7), HD 2932 (6/28), HD 3090 (11/21), Raj 4083 (4/21) and HI 1633 (5/21).

The average plant height of the variety is 86 cm, and it found resistant to lodging. The variety reaches physiological maturity in 87-113 days with an average of 98 days. Average thousand grain weight of the NIAW 4114 is 39 g as compare to the check varieties HD 2864 (39 g), HD 2932 (38 g), HD 3090 (38 g), Raj 4083 (40) and HI 1633 (41 g). In agronomy trial, NIAW 4114 was tested with checks under two sowing conditions i.e. late (26th November to 2nd December) and very late (17th December to 23rd December). NIAW 4114 recorded higher grain yield (48.94 q ha^{-1}) than the check varieties under late sown conditions. It also showed superior performance when sown very late with yield increment to the tune of 3.5 % to 16.8 % over the check varieties. This suggest that the new variety NIAW 4114 is suitable for sowing under very late sown irrigated conditions of wheat growing regions of Peninsular India.

NIAW 4114 showed resistance to leaf and stem rusts with ACI values of 3.4 and 7.4 respectively under artificial epiphytotic conditions (Table 3). Gene postulation analysis suggested the presence of a *#R+Lr24+* and *Sr24+R* gene combination conferring resistance to leaf and stem rust in NIAW 4114. It also demonstrated the resistance against Karnal bunt and Powdery mildew diseases.

The quality characteristics of NIAW 4114 were evaluated along with check varieties, it recorded better *chapati* quality score (8.1) as compared to the check varieties HD 2932 (7.7), HD 3090 (7.7), RAJ 4083 (8.0) and HI 1633 (8.0). Protein content of the variety NIAW 4114 was 12.7 % with Glu-1 score (10.4) indicating better protein quality. The other quality parameters of the variety are acceptable as per the prescribed standards (Table 4).

NIAW 4114 exhibits a semi-erect growth habit. On an average, it takes 53 days to head and reaches maturity in 98 days. The variety is characterized by pale green foliage and waxy features at the time of ear emergence. The ears are white in color, parallel-sided in shape, and medium in density, with short, light brown awns. The peduncle displays a bent posture and is of medium length. The glumes have an elevated shoulder, narrow shoulder width, and a straight, long beak. Grains are amber-colored, elliptical in shape, and have a hard texture, with an average test weight of 39 grams. A pictorial representation of the field view and selected morphological features of the variety is provided in Figures 2 and 3.

Table 1: Yield Performance of NIAW 4114 in AICRP Yield Trials (2021-22 to 2023-24)

Particulars	Year of testing	No. of trials	NIAW 4114	Check varieties					C.D.
				HD 2864	HD 2932	HD 3090	RAJ 4083	HI 1633	
Mean yield (q ha^{-1})	2021-22 (NIVT 5B)	07	50.0	46.2	36.8	--	--	--	3.0
	2022-23 (AVT I)	09	51.1	--	47.6	49.6	45.3	47.7	1.9
	2023-24 (AVT II)	12	42.7	--	39.5	42.9	37.8	40.9	1.4
	Mean		47.9	46.2	41.3	46.3	41.6	44.3	
	Weighted mean		47.2	46.2	41.4	45.8	41.0	43.8	
Frequency in 1st non significant group	2021-22 (NIVT 5B)		3/7	1/7	1/7	--	--	--	
	2022-23 (AVT I)		5/9	--	4/9	4/9	1/9	2/9	
	2023-24(AVT II)		5/12	--	1/12	7/12	3/12	3/12	
	Total		13/28	1/7	6/28	11/21	4/21	5/21	
Yield Potential			70.2	53.8	63.8	58.5	60.2	67.4	

Table 2: Adaptability of NIAW 4114 to Agronomic Variables

Experiment / Item	Sowing conditions	NIAW 4114	Check Varieties			
			HD 2932	HD 3090	RAJ 4083	HI 1633
Yield (q/ha)	Late	**48.94**	46.71	48.87	45.60	48.30
	Very Late	**38.71**	33.13	37.25	34.83	37.39
	Mean	**43.83**	39.92	43.06	40.22	42.85
% gain/loss in yield with very late sowing	Very Late	-20.9	-29.1	-23.8	-23.6	-22.6
% Increase / decrease over checks	Late	--	4.8	0.1	7.3	1.3
	Very Late	--	16.8	3.9	11.1	3.5
	Over mean	**--**	**9.8**	**1.8**	**9.0**	**2.3**

CD (P=0.05): A Date of sowing: 3.37 B Genotypes: 2.15, B within A: N. S., A within B: NS

Table 3: Evaluation of NIAW 4114 and checks under artificial epiphytotic conditions

Disease	Year	NIAW 4114		Check varieties									
				HD 2864		HD 2932		HD 3090		RAJ 4083		HI 1633	
		HS	ACI	HS	ACI	HS	ACI	HS	ACI	HS	ACI	HS	ACI
	2021-22	20MS	6.4	10S	2.1	60S	22.4	--	--	--	--	--	--
Leaf Rust	2022-23	10MR	1.7	--	--	40S	27.4	10MS	1.9	20MS	5.7	10MS	1.2
	2023-24	10S	2.0	--	--	40S	21.3	20MS	5.0	20MS	8.7	10MS	1.5
HS & Mean ACI		10S	3.4	10S	2.1	60S	23.7	20MS	3.5	20MS	7.2	10MS	1.4
	2021-22	40MR	3.7	10MR	1.2	20MR	3.2	--	--	--	--	--	--
Stem Rust	2022-23	20MS	6.8	--	--	30MS	17.5	20MS	4.9	20MS	5.3	10S	3.5
	2023-24	30S	11.8	--	--	80S	28.0	30MS	6.6	30S	11.8	30MS	6.2
HS & Mean ACI		30S	7.4	10MR	1.2	80S	16.2	30MS	5.8	30S	8.6	10S	4.9
Gene postulation													
Leaf Rust		#R+*Lr24*+		--		*Lr13*+		R+*Lr26*+		*Lr13*+		R+*Lr26*+	
Stem Rust		*Sr24*+R		--		*Sr11*+		*Sr31*+		*Sr11*+2		*Sr31*+2+	

HS = Highest score, ACI = Average coefficient of infection

Table 4: Performance of NIAW 4114 along with checks for quality traits

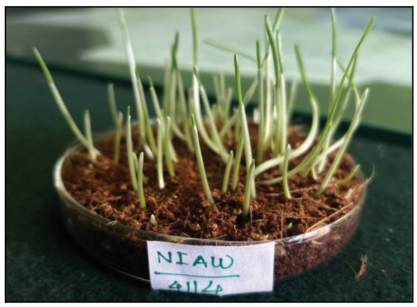
Quality traits	NIAW 4114	Check varieties			
		HD 2932	HD 3090	RAJ 4083	HI 1633
Nutritional quality					
Protein (%)	12.7	12.6	12.8	12.9	13.0
Fe (PPM)	39.9	36.4	39.5	41.9	40.9
Zn (PPM)	39.5	40.0	40.2	45.8	43.0
Phenol test (max 0)	2.2	2.2	6.8	4.0	5.2
Grain Characters					
Grain appearance (Max score 10)	6.4	5.7	6.5	6.8	6.7
Hectolitre weight (kg/hl)	80.1	78.2	78.9	80.3	80.7
Grain Hardness Index	81.5	79.0	81.5	79.5	84.0
Chapati quality characters					
Chapati quality (max score 10)	8.1	7.7	7.7	8.0	8.0
Sedimentation value (ml)	51.0	50.6	48.5	52.5	45.5
Dry gluten (%)	10.4	10.3	10.3	10.5	10.3
Wet gluten (%)	35.3	32.9	31.7	31.5	31.8
Gluten index (%)	69	75	68	70	59
Bread quality characters					
Bread loaf volume (ml)	553	573	622	588	565
Bread quality (max core 10)	6.7	6.9	8.0	7.9	7.1
Biscuit quality characters					
Biscuit spread factor	6.8	6.9	6.5	6.7	6.8

Field View

Growth habit

Spike with peduncle attitude

Fig 2: Phule Shashwat (NIAW 4114)



Coleoptiles

Field view (Physiological maturity)

Spikelet with awns

Shoulder and beak

Grains

Germ width, crease and brush hair

Fig 3: Some characteristic features of Phule Shashwat (NIAW 4114)

Phule Shashwat (NIAW 4114) was officially released and notified by the Central Sub-Committee on Crop Standards, Notification, and Release of Varieties in India, under notification number S.O. 2128 (E), dated 13th May 2025, as published in the official Gazette. The Agricultural Research Station, MPKV, Niphad**,** is designated as the maintainer and is responsible for the production of nucleus and breeder seeds of this variety.

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Author contributions

NM, SD, DG, BM, BG and YP conducted the experiment, recorded data & prepared the manuscript; RL, BM and SC conceptualized the research including plant material & finalized the manuscript; All authors read, edited, and approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

Ethical Approval

The article doesn't contain any study involving ethical approval.

Generative AI or AI/Assisted Technologies use in Manuscript Preparation

No

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