Society for Advancement of Wheat and Barley Research
ICAR-Indian Institute of Wheat & Barley Research
Karnal - 132 001, India

Wheat and Barley Research

10(2):102-107

Research Article

Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Development of high yielding bread wheat variety UAS 375 for timely sown, rainfed conditions of the Peninsular Zone of India

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Article history

Received: 14 May, 2018
Revised : 22 June, 2018
Accepted: 04 August, 2018

Citation

Naik VR, SA Desai, Suma Biradar, MY Kamatkar, SK Singh, T Sudha and PV Patil. 2018. Development of high yielding bread wheat variety UAS 375 for timely sown rainfed conditions of the Peninsular Zone of India. *Wheat and Barley Research* **10**(2):102-107. doi. org/ *10.25174/2249-4065/2018/81917*

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Abstract

The bread wheat variety UAS 375 was released by Central Sub-committee on Crop Standards, Notification and Release of variety, Ministry of Agriculture, Govt. of India vide. S.O. 1379(E) dated: 27.03.2018 for cultivation in the Peninsular Zone of the country comprising states of Maharashtra and Karnataka. UAS 375 has recorded average yield of 21.4q/ha with potential yield of 29.1q/ha. It has shown yield superiority of 14.4% over the best check variety NI 5439 (18.7q/ha) during three years of testing under timely sown, rainfed conditions. The variety UAS 375 has shown resistance to prevalent pathotypes of stem and leaf rusts in the target environments and has combination of *Lr13+1+ and Sr7b+2+* genes for diversified gene deployment against these rusts. It has better grain, product as well as nutritional quality parameters which makes it preferable variety for product developments. High yield potential of the variety UAS 375 under rainfed conditions coupled with disease resistance and quality traits makes it a suitable choice for the wheat growing farmers of the Peninsular India.

Keywords: Bread wheat, Peninsular Zone, rainfed crop, rust resistance.

Introduction

Wheat (*Triticum aestivum* L) is one of the most important cereal crop grown in India for ensured food security. It is next to rice with respect to the production of 99.70 million tones (DAC&FW, 2018) from an area of 29.72 Mha with productivity of 3354kg/ha during 2017-18. The recent climatic scenario posed a threat of reduction in food grains due to predicted increase in the frequency and severity of heat stress (Talukder *et al.*, 2014). The diverse production conditions of wheat divided the country in 5 mega-zones of which Peninsular zone comprised the states of Maharashtra and Karnataka occupying an area of approx 1.10 mha. It is unique zone as all three wheat species namely bread wheat, durum wheat and dicoccum wheat are grown in this zone with the dominance of bread wheat. In this zone, wheat crop usually exposed to more heat as compared to other zones. Although there is availability of the irrigation water to wheat crop in the Peninsular Zone, a sizeable area of wheat crop depends on rains and gets 1-2 irrigations only. The major challenge in this zone is to sustain the wheat production under warmer climatic conditions and water scarcity. Therefore, the wheat improvement programme for this zone has a basic objective of improvement in thermo-tolerance to make genotypes adapted to water scarce conditions. (Mishra *et al.*, 2014). Multilocational evaluation of the wheat genotype for yield stability under stress conditions is a classic approach towards identification of superior genotypes for such environments (Rane *et al.*, 2007). The research efforts in this zone have enabled to release wheat varieties NI 5439 and NIAW 1415 for these conditions which are released in 1973 and 2011, respectively. As these are very old cultivars and therefore, there is need to develop new cultivars suitable to present climatic conditions. Keeping in view these concerns, development of high yielding wheat cultivars for rainfed/limited irrigation conditions was taken under AICRP on Wheat & Barley at University

of Agricultural Sciences (UAS), Dharwad. The research efforts led to development of wheat variety UAS 375 which was released and notified by the Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural crops (CVRC) vide S.O. 1379(E) dated 27th March, 2018 for timely sown rainfed conditions of the Peninsular zone.

Materials and methods

The bread wheat variety UAS 375 was developed from the cross UAS320/GW322//LOK62 at UAS, Dharwad following pedigree method (Fig. 1). In its course of development, the segregating material was evaluated under both irrigated and rainfed conditions. This helped in identification of genotype having high yield levels and adaptability to water stress conditions. After getting uniformity, it was evaluated in yield trials conducted at Annigeri and Dharwad in 6 rowed plot of 6.0m length spaced at 20cm under rainfed condition alongwith check varieties NIAW 1415 and NI 5439, the released and commercialized varieties in the zone for timely sown rainfed conditions. Based on its performance, it was contributed to NIVT 5A-Rainfed trial under AICRP

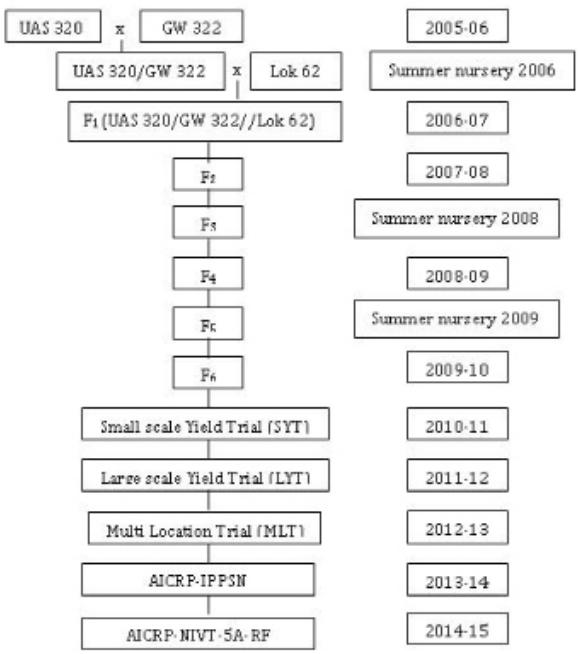

Fig.1: Scheme for development of wheat variety UAS 375

on Wheat & Barley during 2014-15 in which evaluation was done in 6 rowed plot of 6.0m length spaced at 20cm alongwith zonal check NI 5439 in an alpha lattice design. Afterward it was promoted to Advanced Varietal Trials of the Peninsular zone for multilocational evaluation in a randomized block design with 4 replications in 12 rowed plot of 6.0m length spaced at 20cm. The recommended package of practices was adopted to raise a satisfactory crop as per AICRP-W&B standards. During the course of the coordinated evaluation, data on yield, ancillary traits, disease resistance, quality attributes and agronomical manipulations were recorded. The entry was also characterized for different DUS traits as per the standard procedures (PPV&FRA, 2007) for varietal identification.

Result and discussion

Yield evaluation under coordinated trials: The performance of UAS 375 was assessed in the multilocational station trials during 2012-13 at Annigeri and Dharwad where it recorded average yield of 2521g per plot equivalent to 35.0q/ha which was 44.5% higher than the best check variety NI 5439 (Table 1). It was earlier in heading and maturity than the recent check variety NIAW 1415. The disease reactions were recorded under natural conditions at both the locations in which it showed non appearance of disease in UAS 375 as well as in check varieties.

Table 1: Performance of UAS 375 in multilocational station trial

Parameters	UAS-BW-10048 (UAS 375)	NIAW 1415 (C)	NI-5439 (C)	CD at 5%
Yield performance In Kg/ha				
Anigeri	1818	1522	1643	439
Dharwad	3224	1621	1847	418
Mean	2521	1572	1745	
% increase over		60.4	44.5	
Agronomic traits				
Days to heading	48	61	48	
Days to maturity	90	107	90	
Colour	White	Amber	Amber	
Texture	Hard	Semi hard	Semi hard	
1000-grains weight (g)	36.1	32.5	32.4	
Disease data under natural conditions				
Stem rust	0	0	0	
Leaf rust	0	0	0	
Leaf blight	12	0	1	

Based on yield performance and disease resistance, it was promoted for multilocational coordinated evaluation under AICRP on Wheat & Barley in trial NIVT 5A-RF during 2014-15. The results indicated that it has significant yield superiority over NI 5439 and thereafter promoted for evaluation in Advanced Varietal Trials under rainfed conditions in the Peninsular Zone during 2015-16 and 2016-17. Variety UAS 375 had an average yield of 21.4q/ ha and had shown 14.4% yield superiority over the best check variety NI 5439 (18.7q/ha) over three years of testing under coordinated trials (Table 2). It showed higher yield potential of 29.1q/ha compared to NI 5439 (25.7q/ha) and NIAW 1415 (24.4q/ha). It has shown superior performance across the zone by appearing 8 times out of 9 in 1st non-significant group as compared to the check variety NI 5439 (Anonymous, 2015, 2016, 2017a). UAS 375 also had earlier heading ad maturity alongwith comparatively taller plants with bolder seeds under rainfed conditions. The DUS characterization indicated semi-erect growth habit, dark green foliage, drooping flag leaf with strong sheath waxiness, medium dense waxy ears, appressed white awns, elliptical shape grains with medium crease and very short brush hair length (Table.2).

Table 2. Performance of wheat variety UAS 375 over check variety for grain yield, ancillary and DUS traits during 2014-15 to 2016-17

Trials	Locations	Trials	Variety	Check varieties		CD (0.05)
			UAS 375	NI 5439	NIAW 1415	
Yield performance						
NIVT-5A-RF	Annigeri, Dharwad	2	27.7	22	-	4.1
AVT I-RF-PZ	Bagalkot, Dharwad, Vijayapur	3	17.2	14.2	12.9	1.6
AVT II-RF-PZ	Jalgaon, Bagalkot, Vijayapur, Bailhongal	4	21.4	20.4	20.9	2.3
	Weighted mean		21.4	18.7	17.5	
% Increase over checks based on weighted mean			-	14.4	22.3	
Frequency in 1st NS group			9-Aug	9-Apr	7-Apr	
Yield potential (q/ha)			29.1	25.7	24.4	
Ancillary traits						
Days to heading			54	58	58	
Days to maturity			103	104	108	
Plant height (cm)			61	61	55	
1000-grain weight (g)			39	39	37	
DUS traits						
Growth habit			Semi erect	Erect	Semi erect	
Coleoptile (Anthocyanin pigmentation)			Absent	Present	Absent	
Foliage colour (Boot stage)			Dark green	Pale green	Green	
Flag leaf: Attitude			Drooping	Semi erect	Semi erect	
Flag leaf: Hairs on auricles			Absent	Present	Absent	
Flag leaf: Waxiness of sheath			Strong	Medium	Medium	
Ear Waxiness			Medium	Weak	Weak	
Ear Density			Medium	Dense	Lax	
Awn Attitude			Appressed	Medium	Spreading	
Grain Shape			Elliptical	Oblong	Oblong	
Grain Crease			Medium	Deep	Shallow	
Grain Brush hair length			Very short	Medium	Short	

The molecular profiling of UAS 375 and check varieties was done using STS/AS-PCR markers that indicated presence of *Rhtb, VP1B3A, Wxb1A, Vrn-1a, Ppd-D1 (228), PPO33 (290)* and *DuPw004b* genes in UAS 375 as shown in table.3.

Table 3: Profile of the gene distribution using STS/AS-PCR markers

Genotypes	Genes												
	Rhtb	*Vp1B3a*	*Wxb1A*	*DuPw004*		*Ppd-D1*		*PPO33*		*Lr10*	*Lr34*	*VrnA1a*	*Vrn-A1bR1*
				A	*B*	*228*	*414*	*290*	*481*				
UAS 375	+	+	+	-	+	+	-	+	-	-	-	+	-
NI 5439 (C)	-	+	+	-	+	-	+	+	-	+	+	+	+
NIAW 1415 (C)	+	+	+	+	-	+	-	+	+	-	+	-	+

+ denotes presence and – denotes absence of amplification

Evaluation in agronomical trials for variable nitrogen levels: UAS 375 was evaluated for agronomical manipulations during 2016-17 at different nitrogen levels (40kg, 60kg, 80kg per ha) at Dharwad, Pune and Washim. The results indicated (Table 4) that UAS 375 was highest yielding variety at all the nitrogen levels with mean yield of 17.3q/ha which is 4.2% higher than the best check NI 5439 (16.6q/ha). This higher yield of UAS 375 was attributed to high grain number per spike (24.0) coupled with bolder grains (37g TGW) as compared to the check varieties (Anonymous 2017b).

Table 4: Evaluation for agronomical manipulations at different nitrogen levels

Traits	Nitrogen levels	UAS 375	NI 5439 (C)	NIAW 1415(C)	Critical difference (5% level)
Yield (q/ha)	N1 (40kg/ha)	15.4	14.6	13.9	Nitrogen (A) =1.27, Variety (B) =1.09, B within A = NS, A within B = NS
	N2 (60kg/ha)	17.6	17.4	15.5	
	N3 (80kg/ha)	19	18	17.5	
	Mean	17.3	16.6	15.6	
Spike number /m2	Mean	204	252	233	Variety =8.63
Grains per spike	Mean	23.98	19.48	18.62	Variety =1.49
1000-Gr Wt. (g)	Mean	36.85	34.76	36.38	Variety =0.5

Disease resistance: Bread wheat cultivar UAS 375 was evaluated for resistance to diseases especially rust and leaf blight under natural as well as artificially created epiphytotic conditions under AICRP-W&B. During the period under evaluation, there was no rust development at any of the centre in the zone under natural condition. Under artificial epiphytotic conditions, stem (black) as well as leaf (brown) rusts were created that showed resistance in wheat variety UAS 375. The gene postulation indicated presence of *Lr 13+1+, Sr7b+2+* genes which are different to those in popular cultivars NI 5439 (*Lr 34+, Sr11+*) and NIAW 1415 (*Lr 26+1+, Sr31+2+*) which will be beneficial for diversified deployment of rust resistant genes (Table.5).

The seedling resistance test (SRT) was also done at IIWBR Regional centre, Flowerdale, Shimla and RWRRS, Mahabaleshwar against prevalent pathotypes which indicated resistance reaction in UAS 375 against most of

Table 5: Disease reaction and gene postulation

Disease	UAS 375	NI 5439 (C)	NIAW 1415 (C)
Rust Diseases	HS (ACI)	HS (ACI)	HS (ACI)
Brown (Leaf) Rust	40S (13.4)	80S (39.2)	20S (3.3)
Black (Stem) Rust	40S (8.7)	80S (29.3)	30MS (3.6)
Lr gene	*13+1+*	*34+*	*26+1+*
Sr gene	*7b+2+*	*11+*	*31+2+*
Other diseases	HS (Av)	HS (Av)	HS (Av)
Karnal Bunt	14.7 (8.1)	26.3 (15.5)	24.8 (12.5)
Leaf blight (dd)	89 (58)	99 (67)	89 (67)
Powdery mildew (0-9)	7 (5)	8(4)	8(5)

HS- Highest score, ACI- Av coefficient of infection, Av- Average score

the pathotypes as compared to check varieties (Table.6). The variety UAS 375 showed better resistance to Karnal bunt, leaf blight and powdery mildew as compared to check varieties as shown in table 5 (Anonymous, 2015b, 2016b, 2017c).

Table 6: Seedling Resistance test for prevalent rust pathotypes

Pathotypes	Shimla			Mahabaleshwar		
	UAS 375	NI5439 (C)	NIAW 1415 (C)	UAS 375	NI5439 (C)	NIAW 1415 (C)
Leaf rust						
2-Dec	R	S	R	S	S	R
5-Dec	R	MS	R	R	S	R
77-2	R	S	R	S	S	R
77-5	R	S	R	S	S	R
77-9	R	R	R	NG	S	R
104-2	R	R	R	S	S	R
Stem rust						
11	R	S	R	R	S	R
40-A	R	S	R	R	S	R
42	-	-	-	R	R	R
117-6	R	R	R	R	R	R
122	R	R	R	R	R	R

R- Resistant, S-susceptible, NG-not germinated

Quality traits: Wheat variety UAS 375 was evaluated for different grain, processing and nutritional quality parameters as per the AICRP on Wheat & Barley protocol. UAS 375 has shown better performance for various grain and product quality parameters, i.e., grain hardness index, HMW Glu 1 score, bread quality, extraction rate, biscuit diameter and spread factor (Table.7) which indicated its better suitability for industrial processing and product making traits. It possesses higher values for other quality traits like protein content (13.8%), hectoliter weight (80.3kg/hl), grain appearance score (6.3), chapatti quality (7.8) and bread loaf volume (588ml) that fall in category of better quality as per the grain quality standards (Anonymous, 2016c, 2017d).

Table 7: Quality attributes in UAS 375 and check varieties under coordinated testing

Quality parameters	UAS 375	NI 5439 (C)	NIAW 1415 (C)
Protein (%)	13.8	14.5	14.3
Grain appearance (max score 10)	6.3	6.4	6.4
Hectolitre weight (kg/hl)	80.3	79.8	80.7
Sedimentation value (ml)	47	54	52
Grain Hardness index	87	80	85
HMW *Glu-1 Score*	8	6	7
Chapatti quality (max score 10)	7.8	7.8	8.1
Bread loaf volume (ml)	588	588	583
Bread quality (max score 10)	7.4	7.4	7.3
Extraction rate (%)	73.5	71.3	73
Biscuit diameter (cm)	7.09	6.57	6.67
Biscuit Spread factor	5.86	5.23	5.79

Conclusion

The research efforts led to development of wheat variety UAS 375 which was released and notified by the Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural crops (CVRC) vide S.O. 1379(E) dated 27th March, 2018 for timely sown rainfed conditions of the Peninsular Zone. From the

above results, it has been indicated that the wheat variety UAS 375 has high yield levels under rainfed condition coupled with better disease resistance and quality traits. This variety may provide a good choice to the farmers of Maharashtra and Karnataka for harvesting higher wheat yields under low input and stressed production conditions.

Acknowledgement

The article is based on the variety release proposal of UAS 375 submitted to the CVRC and the authors acknowledge the support of cooperators in Peninsular Zone under the AICRP on Wheat & Barley.

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