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Research Article

A new high yielding, charcoal rot and yellow mosaic virus disease resistant soybean variety AMS-1001 (PDKV Yellow Gold)

S. S. Nichal*, P. V. Patil, G. D. Chandankar, M. S. Dandge, Y. V. Ingle, S. S. Munje and H. H. Dikey.

Regional Research Center, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Amravati- 444 601, Maharashtra, India.
***E-Mail:** nichal_satish@rediffmail.com

Abstract
Soybean variety AMS-1001 is an induced mutant of JS-93-05. In multilocation trials AMS-1001 has recorded yield increase over state check MAUS-71 by 24.17% and national check JS-335 by 20.58%. In state multilocation trials AMS-1001 has recorded 36.01%, 30.58% and 33.82% increase yield over JS-335, JS-97-52 and MAUS-71, respectively. AMS-1001 has also given 23.90% higher seed yield over check variety JS-335, in adaptive trials on farmer's field. This culture has shown highly resistant reaction to charcoal-rot and YMV diseases. It has medium maturity duration, determinate growth habit, purple flower, glabrous pods/stem with pointed ovate dark green leaves. AMS-1001 differentiated from other soybean varieties using molecular markers and primer Glysatt-180 was found specific to the sample AMS-1001 and can be used for its identification. Considering its yield superiority and resistance diseases the SVRC has released this culture as AMS-1001 (PDKV Yellow Gold) for Maharashtra state. The national identity of this variety is IC 626343.

Key words
Soybean, AMS-1001, charcoal rot and yellow mosaic virus

INTRODUCTION

Soybean (*Glycine max* L. Merril) is the world most important seed legume, which contributes to 25% of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding. Soybean meal is a valuable ingredient in formulated feeds for poultry and fish (Agarwal *et al.,* 2013). It is therefore no surprise that global soybean demand is increasing rapidly. India stands fifth in soybean production. Soybean has emerged as one of the major oilseed crop and revolutionized rural economy and lifted the socio economic status of soybean growing farmers in India. With unparallel growth, the area and production of soybean in India reached 10.96 million ha and 13.46 million tons respectively (Anonymous, 2019).

However, productivity is not more than half of the world average; hence, there is a tremendous scope to increase soybean production by enhancing productivity. Improved varieties, in any crops are essential for achieving higher productivity. Lack in diversification of varieties is a major constraint of productivity. About more than 115 varieties have been released in India but most of the varieties have narrow genetic base and hence restricted to grow on small area. Soybean culture AMS-1001 has ability to produce sustainable optimum yield facing newly emerged problems of Root Rot/Charcoal Rot and yellow mosaic virus disease in the Vidarbha region. The mutant AMS 1001 is high yielding than the parent variety JS 93-05 and recorded 10.90% and 38.29% increase in station trial and AICRIP trial, respectively. AMS-1001 is resistant to charcoal-rot and YMV diseases.

Root rot/ Charcoal Rot caused by *Macrophomina phaseolina/ Sclerotium rolfsii* are the severe menace in soybean cultivation particularly in Maharashtra state. A yield reduction is caused from post emergence death of seedlings, weakening of plants, root rot, collar rot as well as premature death of infected plants. Being seed and soil borne polyphagus pathogen, it is difficult to manage in field (Chavan and Gupta, 2005).

Yellow mosaic virus (YMV) is a serious and widespread disease of soybean in India and nearly all the major varieties grown in the central India are susceptible to YMV (Bhattacharyya *et al.,* 1999). The magnitude of yield loss due to YMV in soybean has been reported to be as high as 80 per cent (Nene, 1972). YMV is transmitted by white fly (*Bemisia tabaci*); therefore, control of this disease is indirectly related to the control of its vector. Its chemical or cultural control has not been found to be economical and environmental friendly.

Therefore, the most effective way to prevent the occurrence of these diseases are to develop genetically resistant cultivars. Hence, AMS-1001 (PDKV Yellow Gold) has been developed and released as high yielding new variety with resistance to charcoal rot and yellow mosaic virus diseases.

MATERIALS AND METHODS

Considering the previous studied regarding LD50 and effective doses of gamma rays in soybean crop improvement (Van-Harten, 1998; Karthika and Lakshmi, 2006; Pavadai, 2006), irradiation of seed material of soybean variety JS-9305 was done with three treatments *viz.,* 150 Gy, 250 Gy & 300 Gy at Bhabha Atomic Research Centre, Trombay, Mumbai in the year 2006. The treated seed material was sown during *kharif* 2006 at Research Farm of Regional Research Center (Dr. PDKV), Amravati to raise the M_1 population. The seed of each M_1 plant was harvested separately. In *kharif* 2007 the M_1 seeds were sown and M_2 population was raised. Intensive selection was done in M_2 population for desirable mutants. Among these mutants one unique mutant (Plant No.100) with 86 mm long secondary root length with series of nodules was observed which was named as AMS-100. Subsequent from 2007 to 2010 generations (two generations in a year) were completed (from M_3 to M_8) and a stable line was developed which was named as AMS-1001 and was tested for yield performance in 10 meter row length. The soybean culture AMS 1001 was tested in Preliminary and Advanced Yield Trials along with the check varieties from 2012 to 2017. Based on superiority in University Multilocation Varietal Trials (MVT) it was promoted in State Multilocation Varietal Trial for testing over different locations of Maharashtra state during *kharif* 2013 and 2014 and also nominated for evaluation under AICRP trials during *Kharif* 2013. The culture AMS-1001 was pre-released during the year 2016 by Research Review and Finding Committee of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The adoptive trials (on farm trial) were conducted on famer's field during *kharif* 2017. The culture AMS-1001 was also screened for major diseases and inset-pests. The resistance of this culture to root rot/ charcoal rot was tested in natural as well as sick plot condition.

Considering its superior yield performance and resistance to charcoal rot and yellow mosaic virus disease State Variety Release Committee approved and released it as a Soybean variety AMS-1001 (PDKV Yellow Gold) in 2018.

Table1. Overall seed yield performance of soybean AMS-1001 in different trials.

Sr. No.	Name of Trial	No. of trails / locations	AMS-1001	Checks				
				JS -335	MAUS -71	JS 93-05	JS 97-52	JS 95-60
1	Station Trial (2011)	1	2563	-	-	2311	-	-
	Per cent yield increase			-	-	**10.90**	-	-
2	MVT (2012 to 2017)	30	2173	1802	1750	-	-	-
	Per cent yield increase			**20.58**	**24.17**	-	-	-
3	SMVT (2013 & 2014)	22	1998	1469	1530	-	1493	-
	Per cent yield increase			**36.01**	**33.82**	-	**30.58**	-
4	IVT (AICRP) (2013)	4	1784	1580	-	1290	-	1216
	Per cent yield increase			**12.91**	**-**	**38.29**	**-**	**46.71**
5	Adoptive Trials (On farmers field) (2017)	20	1749	1412	-	-	-	-
	Per cent yield increase			**23.90**	-	-	-	-

Source: Annual Research Review Committee Report of Soybean Breeding 2012-13 to 2017-18

RESULTS AND DISCUSSION

The culture AMS-1001 is the mutant of soybean variety JS 93-05. AMS-1001 has determinate growth habit and mature in 95 to 100 days. In station trial conducted during *kharif* 2011, the culture AMS-1001 has given the 2563 kg/ ha seed yield, which was 10.90 per cent higher seed yield than national check JS 93-05 (**Table 1**).

Based on the yield performance in station trial the culture AMS-1001 was promoted to Multilocation Varietal Trial (MVT) and evaluated for six years from *kharif* 2012 to *kharif* 2017, over 30 locations. Based on average seed yield over six years the culture AMS-1001 (2173 kg/ha) has recorded 24.17% and 20.58% increase in seed yield over state check MAUS-71 (1750 kg/ha) and over national

Table 2. Seed yield performance of soybean AMS-1001 in Multilocation Varietal Trials (MVT)

Year of testing	No. of Locations/ trails	AMS-1001	Checks	
			JS-335 (NC)	MAUS-71 (LC)
2012	6	2619	2365	2222
2013	5	2490	2150	2063
2014	5	1586	1324	1482
2015	4	1903	937	1076
2016	5	2683	2529	2346
2017	5	1615	1221	1064
	30	**2173**	**1802**	**1750**
Overall % increase over checks			**20.58**	**24.17**

Source: Annual Research Review Committee Report of Soybean Breeding 2012-13 to 2017-18

check JS-335 (1802 kg/ha), respectively (**Table 2**). Further culture AMS-1001 was promoted to State Multilocation Trial (SMVT) and evaluated for two seasons (*kharif*-2013 & *kharif*-2014) over 22 locations, spread over the jurisdiction of four agricultural universities of Maharashtra State. In these trials, the soybean culture AMS-1001 has registered higher seed yield potential of 1989 kg/ha and shown an increase in seed yield over national checks JS-335 (1469 kg/ha) by 36.01 % and another national check JS 97-52 (1453kg/ha) by 30.58%. It has also shown an increase in seed yield over state check MAUS-71 (1530 kg/ha) by 33.82 % (**Table 3**).

The genotype AMS-1001 was also tested at national level in All India Coordinated Research Project's (AICRP) Initial Varietal Trial (IVT) during kharif-2013 and recorded an average seed yield of 1784 kg/ha which was 46.71%, 38.29% and 12.91% higher than the yield performance at national checks JS 95-60 (1216 kg/ha), JS 93-05 (1290 kg/ha) and JS-335 (1580 kg/ha) respectively (**Table 4**)

Table 3. Seed yield performance of soybean AMS-1001 in State Multilocation Varietal Trials (SMVT)

Years	No. of Locations	AMS-1001	Checks		
			JS-335 (NC)	JS 97-52 (NC)	MAUS-71 (LC)
2013	11	2235	1954	1872	1972
2014	11	1762	985	1189	1015
	22	**1998**	**1469**	**1530**	**1493**
Overall % increase			**36.01**	**30.58**	**33.82**

Source: Annual Research Review Committee Report of Soybean Breeding 2013-14 to 2014-15

Table 4. Yield performance of Soybean AMS-1001 in All India Coordinated Trial: Initial Varietal Trial (IVT)

Year	Locations	Seed yield (kg/ha)				C. D. (kg/ ha.)	C.V. (%)
		AMS-1001	JS 95-60	JS 93-05	JS-335		
2013	Amravati	2593	2025	1531	1827	271.60	10.90
	Jalna	1481	543	1160	1284	271.60	14.69
	Nagpur	1012	1136	914	1210	345.68	16.75
	Parbhani	2049	1160	1556	2000	370.37	13.20
	Mean (4)	**1784**	**1216**	**1290**	**1580**		
% increase/ decrease over			**46.71**	**38.29**	**12.91**		

Source: AICRP Annual Report on Soybean 2013-14

(Anonymous, 2013). Further in adoptive trials conducted on farmer fields (on-farm trials) of Amravati, Akola, Washim, Buldhana, Yavatmal, Nagpur and Chandrapur districts of Maharashtra, the culture AMS-1001 has given 23.90 per cent higher seed yield than check variety JS 335 (**Table 1**). The soybean culture AMS-1001 also screened for root rot/ charcoal rot and Yellow mosaic virus disease over the seven year from 2011 to 2017. AMS-1001 shows

highly resistant reaction to both the diseases under natural field condition, whereas, it also shows absolute resistance to root rot/ charcoal rot in sick plot (Table 5 & 6). Thus, AMS-1001 (PDKV Yellow Gold) is high yielding new variety with resistance to charcoal rot and yellow mosaic virus diseases. Similarly, during recent years, Sumathi *et al,* 2017 has developed high yielding downy mildew disease resistant pearl millet composite CO 10 and Pandiyan *et al,* 2018 has developed a new high yielding MYMV disease resistant blackgram variety VBN 8.

Table 5. Reactions to Root rot /Charcoal rot and Yellow Mosaic Virus diseases of AMS-1001 in station trials at Amravati location under natural field condition.

Sr. No.	Disease	Year	Checks			
			AMS-1001	TAMS-38	JS-335	MAUS-71
1	Root Rot/ Charcoal rot	2011	AR (0.00)	HS (100.00)	MR (30.40)	AR (0.00)
		2012	AR (0.00)	HS (100.00)	MS (36.10)	-
		2013	AR (0.00)	HS (98.40)	S (60.40)	AR (0.00)
		2014	AR (0.00)	HS (80.60)	S (70.10)	AR (0.00)
		2015	AR (0.00)	HS (100.00)	S (60.50)	MR (17.40)
		2016	HR (5.60)	HS (100.00)	MR (14.50)	MR (22.14)
		2017	HR (8.40)	HS (100.00)	MS (40.50)	HR (10.10)
		Average rating	**HR(2.00)**	**HS(97.00)**	**MS(44.64)**	**AR(8.27)**
2	Yellow Mosaic Virus	2011	AR* (0.00)	AR (0.00)	MR (22.60)	MR(16.32) (JS 9305)
		2012	AR* (0.00)	AR (0.00)	MR (12.20)	-
		2013	AR (0.00)	AR (0.00)	AR (0.00)	S (77.90) (JS 9305)
		2014	AR (0.00)	MR (12.50)	HR (8.15)	HS(78.10) (JS 9305)
		2015	AR (0.00)	AR (0.00)	S (58.00)	HS (89.0) (JS 9305)
		2016	HR (2.10)	AR (0.00)	HR (3.60)	MR(18.20) (JS 9305)
		2017	HR (3.16)	AR (0.00)	MR (18.20)	HR(10.20) (JS 9305)
		Average rating	**HR(1.05)**	**HR(2.50)**	**MR(17.59)**	**MS(54.68)**

*Data not considered as infection index below susceptible level in check
Source: Annual Research Review Committee Report of Plant Pathology 2011-12 to 2017-18

Scale of Ratings:
AR-O % 4) MS-34 to 55 %
HR-1 to11 % 5) S- 56 to 77 %
MR-12 to 33 % 6) HS-78 to 100 %

Table 6. Reaction to Root rot diseases of AMS-1001 in station trials under sick plot condition at Amravati location.

Genotype	Year & Reaction to Root rot						
	2011	2012	2013	2014	2015	2016	2017
AMS-1001	AR (0.00)	AR (0.00)	AR (0.00)	AR (0.00)	AR (0.00)	AR (0.00)	HR (10.50)
TAMS 38 ©	HS (100.00)	HS (100.00)	HS (100.00)	HS (100.00)	HS (100.00)	HS (100.00)	HS (100.00)
JS 335 ©	MS (35.50)	MS (34.50)	S (76.20)	HS (80.0)	S (74.0)	HS (90.00)	MS (52.50)

Source: Annual Research Review Committee Report of Plant Pathology 2011-12 to 2017-18

Scale of Ratings:
AR-O % 4) MS-34 to 55 %
HR-1 to11 % 5) S- 56 to 77 %
MR-12 to 33 % 6) HS-78 to 100 %

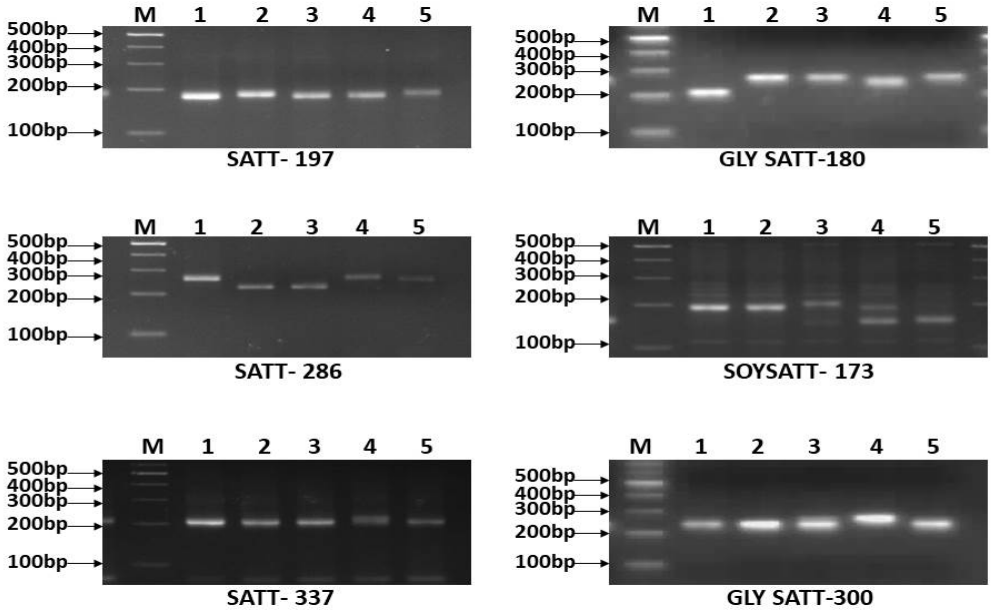

Fig.1. DNA Finger printing of soybean variety AMS-1001 (PDKV Yellow Gold)

(Lane 1, 2 and 3 are samples AMS-1001, JS-93-05 and JS-335, respectively. Lane 4 and 5 are control samples. M is the 100 base pair (M/S BR Biochem Life Sciences) molecular weight size standard).

Table 7. Descriptor of soybean Variety AMS 1001 (PDKV Yellow Gold)

1	**General**		
1.1	Name of variety		AMS-1001 (PDKV Yellow Gold)
1.2	Pedigree		Mutant of JS 93-05
1.3	Year of Development		2004
1.4	Year of Release		2018
1.5	Origin (Name of Institute)		Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
2	**Plant type**		
2.1	Growth type	:	Determinant
2.2	Growth habit	:	Semi-erect
3	**Flower characteristics**		
3.1	Colour of Flower	:	Purple
4	**Pod characteristics**		
4.1	Pod Pubescence	:	Absent
5	**Seed characteristics**		
5.1	Seed size	:	Medium size
5.2	Seed shape	:	Spherical
5.3	Seed Coat colour	:	Light yellow
5.4	Hilum colour	:	Grey
6	**Stem Characteristics**	:	
6.1	Anthocynin Pigmentation	:	Present
6.2	Pubescence on stem	:	Absent
7	**Leaf Characteristics**	:	
7.1	Leaf Size	:	Medium
7.2	Leaf Shape	:	Pointed Ovate
7.3	Leaf Colour	:	Dark green leaves
7.4	Leaf surface	:	Rough
8	**Other Characteristics**		
8.1	Maturity range (days)	:	95-100
8.2	Maturity group	:	Medium
8.3	Test weight (gm)	:	10.48

The key morphological characters to distinguish this culture from other varieties during seed production are medium maturity, determinant growth habit, purple flower, glabrous pods /stem with pointed ovate dark green leaves (**Table 7**).

The soybean culture AMS-1001 is differentiated from parental variety JS 93-05 and also from popularly grown soybean variety JS-335 and other two control samples using molecular marker technology. out of 18 primer used nine primers namely Glysatt-588, Glysatt-184, Glysatt-453, Glysatt-180, Glysatt-300, Glysatt-449, Satt-286, Satt-005 and Glysatt-173 were found to be polymorphic in the sample and controls and were useful for differentiating the sample. However, primer Glysatt-180 was specific to the sample AMS-1001 and can be used for identification (**Fig. 1**).

Considering the superiority over the check varieties the culture AMS-1001 was released as AMS-1001 (PDKV Yellow Gold) by the 50th State Seed Sub Committee (SVRC) meeting during 2018. It is recommended for *kharif* planting in Vidarbha region of Maharashtra. The national identity of the variety is IC 626343.

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REFERENCES

Anonymous, 2013. Annual Report 2013-14 of All India Coordinated Research Project on Soybean, Indian Institute of Soybean Research, Indore.

Anonymous, 2019. Annual Report 2018-19 of All India Coordinated Research Project on Soybean, Indian Institute of Soybean Research, Indore.

Agarwal, D.K., Billore, S.D., Sharma, A.N., Dupare, B.U. and Srivastava, S.K. 2013. Soybean: Introduction, Improvement and Utilization in India - Problems and Prospects. *Agric Res,* **2(4)**:293-300. [Cross Ref]

Bhattacharyya, P.K., Ram, H.H. and Kole, P.C. 1999. Inheritance of resistance to yellow mosaic virus in inter-specific crosses of soybean. *Euphytica,* **108**: 157-159. [Cross Ref]

Chavan, S. and Gupta, G.K. 2005. Symptoms, identification and management of soybean diseases. Technical bulletin by Directorate of Soybean Research, Indore, India.

Karthika, R. and Lakshmi B.S. 2006. Effect of gamma rays and EMS on two varieties of soybean. *Asian Journal of Plant Sciences*, **5 (4)**: 721-724. [Cross Ref]

Nene, Y.L. 1972. A survey of the viral diseases of pulse crops in India. *Indian J. Res. Bull*.**4**: 191.

Pandiyan, M., Geetha, S., Gnanamalar, R. P., Packiaraj, D., Mahalingam, A., Sassikumar, D., Dinakaran, D., Soundararajan, R. P., Vijayaraghavan, C., Rajarathinam, P. and Satya V.K. 2018. A new high yielding MYMV disease resistant blackgram variety VBN 8. *Electronic Journal of Plant Breeding*, **9(4)**: 1272-1279. [Cross Ref]

Pavadai, P. 2006. Studies on induced mutagenesis in soybean (*Glycine max* (L.) Merr.). Ph.D. Thesis, Annamalai University, Annamalainagar, Tamil Nadu.

Sumathi, P., Veerabadhiran, P., Ravikesavan, R., Karthikeyan, G., Meyyazhagan, N., Poonguzhali, R., Ananda kumar, C.R., Ganesamurthy, K. and Revathi, S. 2017. A high yielding downy mildew disease resistant pearl millet composite CO 10. *Electronic Journal of Plant Breeding*, **8(1)**: 111-116. [Cross Ref]

Van-Harten, A.M. 1998. Mutation Breeding: Theory and Practical Application. Cambridge University Press. Cambridge, UK.