PN-AAN-815

ISN32297

INDIAN MULTILINES

PREFACE

Norman E. Borlaug
CIMMYT

KSML 3

Khem Singh Gill, G.S. Nanda, Gurdev Singh and S.S. Ahujla
Punjab Agricultural University

BITHOOR

M.P. Singh, L.S. Gupta and H.G. Singh
C.S. Azad University of Agriculture and Technology

MLKS-11

M.V. Rao, S.M.A. Naqvi, J.K. Luthra
Indian Agricultural Research Institute

PREFACE

Wheat and other autogamous crop species are notoriously more vulnerable to epidemics of airborne pathogens, e.g. the rusts, than are allogamous crop species such as maize. Other factors being equal, the greater the degree of genetic purity of the crop species, the greater the vulnerability. Mixed populations of wild grasses, including wheats and other species, or land races of cultivated wheat made up of a mixture of many types often with different degrees of resistance or susceptibility, had a measure of built-in protection from ruinous epidemics largely due to their heterogeneity.

The early decades of this century saw a shift away from land races as the result of the introduction and use of the pure-line method of varietal improvement. The pure-line method of plant breeding involved selecting the best plants from wild or land race populations which subsequently were used to develop pure-line varieties from segregating populations derived from crosses. Varietal purity and/or uniformity became a fashionable dogma following the advent of the pure-line method of breeding.

Thirty years ago, I became concerned over the periodic change in rust resistance in commercial varieties, which often resulted in epidemics and severe crop losses before such varieties could be replaced. It is clear that there is no serious difficulty for a good aggressive wheat breeding-pathology program to develop an improved variety which could, at any point in time, provide protection against the physiologic races of the rust pathogen that prevail in the area where the variety is to be grown. The problem is how long the variety will remain resistant. In many different countries of the world where rust-resistant pure-line varieties have been produced and grown, the resistance has become ineffective because of the appearance of new virulence genes in the pathogen, resulting from either mutations or para-sexual and sexual recombinations. All too often, epidemics resulting in serious crop losses have occurred before varieties that have lost their resistance can be replaced by varieties possessing a different spectrum of resistance which will protect them against both the virulence of the former races and against the virulence of the new races.

One approach to help stabilize disease resistance is a backcross program in which the best commercial variety is used as the recurrent parent to develop a series of isolines that are phenotypically similar in type of plant, spike, grain, height, maturity, yield, and milling and baking quality, but that differ genotypically from each other in genetic make up for rust resistance. A "multiline variety" would then be a mechanical mixture of the best isolines (e.g. 6 to 12) chosen from the standpoint of providing the best protection against the prevalent races of the rust pathogen, and which has the best grain yield and suitability for farmers and millers.

During the period of 1952 to 1960, a large number of Yaqui 50 isolines were developed in Mexico by scientists in the cooperative Mexican Government-Rockefeller Foundation Office of Special Studies. These were used to produce a series of Yaqui-type experimental multiline varieties that were tested at three locations over a three-year period (1957-60). These multilines were found to be very similar to, or slightly better than, the recurrent parent Yaqui 50 in grain yield, agronomic type, and milling and baking quality, and yet were definitely superior to Yaqui 50 in certain disease-resistance characteristics. Fortunately or unfortunately, depending upon the point of view, a series of events took place which diverted the attention of our limited staff in the development of multilines until the early 1970s.

The first event was the development of high-yielding semidwarf lines derived from intercrossing tall Mexican varieties with the semidwarf variety Norin 10 x Brevor. The first derivatives released as commercial varieties, Penjamo 62 and Pitic 62, had a potential grain yield of more than twice that of Yaqui 50 and the Yaqui multiline, making both obsolete.

The second event was the urgency to correct certain serious defects in the early semidwarf varieties and lines, especially low grain test weight, low flour yield, poor baking properties, and susceptibility to several diseases. The third factor was the involvement of our limited scientific staff in transferring the high-yielding semidwarf wheats to the then critically food-deficit countries, India and Pakistan, and a few years later to other Asian and African countries.

Over the last 15 years, semidwarf varieties have spread across 35 million hectares in the developing world and many millions more in the developed countries. To date, with the exception of Pitic 62, Sonora 64, Siete Cerros, and Zaragoza 75, all of the important high-yielding semidwarf varieties developed in the cooperative INIA-CIMMYT program over the past 20 years have maintained their resistance to stem rust. However, the situation with respect to leaf rust is very different. There has been a parade of short-lived semidwarf varieties which have fallen prey like dominos to *Puccinia recondita*. These include Sonora 63 and 64, Lerma Rojo 64, Super X 65, Siete Cerros 66, Noroeste 66, INIA 66, CIANO 67, Yecora 70, Potam 70, Saric 70, Vicam 71, Tanori 71, Cajeme 71, Jupateco 73, Anahuac 75, Cocoraque 75, Zaragoza 75, and Nacozari 76. When released, all these cultivars were resistant to the leaf rust pathogen *P. recondita*, but their resistance succumbed with the appearance of new virulent races within 2 to 4 years after each reached large-scale commercial production. Only Penjamo 62, Tobari 66, Torim 73, Pavon 76, and Tezopaco 76 have maintained their resistance.

Fortunately, during the years when the Mexican INIA-CIMMYT wheat program was unable to continue to work on the development of multiline varieties, two other groups launched breeding programs and carried them to successful conclusion. Since 1968, Drs. Frey, Browning, and Simons at Iowa State University have produced and released a series of 14 multiline varieties of oats in two maturity classes. These multiline varieties were developed to provide protection against the crown rust pathogen, *Puccinia coronata avenae*. They are currently grown on more than a million acres in the north central region of the USA. They have provided protection against epidemics of the crown rust pathogen to the commercial oat crop of the region over the past twelve years. Moreover, experimental plantings of these multiline varieties have been made in east Texas near the Gulf Coast, and have shown that they can provide good protection from rust losses where moisture and temperature favor heavy infection and epidemics. These scientists, in collaboration with Dr. Isaac Wahl, also have studied "natural multilines" of wild oat species and other small grains in Israel and found that such mixtures provide a high degree of protection from rust damage in such populations.

In the 1970s, Drs. Khem Singh Gill, G.S. Nanda, Gurdev Singh and S.A. Ahujla of the Punjab Agricultural University in Ludhiana, India; Drs. M.P. Singh, L.S. Gupta, H.G. Singh of C.S. Azad Univeristy of Agriculture and Technology, Kanpur, India; and Drs. M.V. Rao, S.M.A. Naqvi, and J.K. Luthra of the Indian Agricultural Research Institute, New Delhi, India have developed the multiline varieties KSML3, Bithoor, and MLKS-11, respectively. These multilines are based on the popular variety Kalyansona, which played a major role in revolutionizing wheat production in India over the past 12 years.

This publication summarizes the work of these Indian colleagues to develop Kalyansona multilines. I hope their efforts will serve as stimulating examples to other wheat scientists around the world.

Norman E. Borlaug

KSML 3 WHEAT MULTILINE VARIETY FOR PUNJAB, INDIA.

Khem Singh Gill, G.S. Nanda, Gurdev Singh and S.S. Aujla
Department of Plant Breeding
Punjab Agricultural University
Ludhiana, India.

The concept of the multilines as an approach to the long-term control of diseases in self pollinated crops was first presented by Jensen (1952) in oats and by Borlaug and Gibler (1953) in wheat. The multiline approach is concerned with the management of resistance genes which condition vertical resistance.

The first multiline variety in wheat, Miramar 63, was developed and released in Colombia to control stripe rust. Multiline varieties of oats were later developed and are successfully cultivated in Iowa where they provide good control of crown rust of oats (Browning and Frey, 1969).

The variety Kalyansona, derived from the Mexican cross II-8156, was grown on an extensive scale in India during the late sixties and early seventies. It was resistant to stripe and leaf rust at the time of release in 1966-67, but later became susceptible to new races of leaf and stripe rust. Bearing in mind that this variety could still provide high yield if it were resistant, an effort to develop multiline components based on the Kalyansona phenotype was made at the Punjab Agricultural University and at CIMMYT during the early seventies, and lines were isolated under artificial rust epidemics at P.A.U. with resistance to prevalent races of the rust. Six components were selected for inclusion in a mechanical mixture which was named KSML3. Three of the components were derived from lines developed at CIMMYT. The components are:

C1 Kal x Tob-Cno/Kal
C2 Son64-K1. Rend x Kal
C3 Cno-Bb x Cdl (7C/LR64-Inia x Inia-Bb)
C4 Bb-Kal^2
C5 PV18-Cno x Kal-Bb
C6 Cno-Bb x Cdl (7C/LR64-Inia x Inia-Bb)

KSML3 has given an outstanding yield performance and has shown excellent resistance to both stripe and leaf rust (Table 1). It was tested on farmers' fields in Punjab State during 1977-78 where its average yield in 39 trials was 4587 kg/ha compared to 4203, 4205, 3494 and 3930 kg/ha for Kalyansona, WG357, Sonalika, and WG377, respectively. The margin of superiority of KSML3 over the check varieties was 9.14, 9.13, 31.28 and 16.72 percent, respectively. It may be noted from Table 1 that KSML3 has an excellent level of both stripe and leaf rust resistance. These two rusts are the only major wheat diseases of Punjab State.

The agronomic characters of KSML3, its components, and Kalyansona are given in Table 2. It should be noted that variation is relatively small for the characters which are important for uniformity in the field. In fact, variation exists only for the number of tillers per meter of row. It may be noted also that the number of tillers for all components is greater than that of the recurrent parent Kalyansona. In addition, the seed size of the component lines is larger than that of the recurrent parent. The higher value for these characteristics in KSML3 may be partly responsible for its yield increase over Kalyansona. One must also, of course, consider that the yield of the original may have been reduced in certain trials as a result of rust infection.

On the basis of yield performance and disease resistance, the Variety Approval Committee of Punjab State has recommended KSML3 for cultivation under high fertility conditions in all parts of the state. It has also been identified by the All-India Wheat Research Workers' Workshop in 1978 as a superior genotype for the entire Northwestern Plains Zone of India, comprising the states of Punjab, Haryana, Delhi, parts of Rajasthan and Uttar Pradesh.

TABLE 1. Yield (t/ha) performance and rust reaction of KSML 3 compared to Kalyansona in Punjab.

			LSD	Stripe rust		Leaf rust	
Year	KSML 3	Kalyansona	.05	KSML 3	Kalyansona	KSML 3	Kalyansona
1974-75	4.58	4.28	195	0-TR	40S	0	40S
1975-76	4.66	4.22	120	0-5S	40S	0-TS	60S
1976-77	4.40	4.00	312	0	40S	0-10S	80S
1977-78	4.82	3.80	179	0	40S	0	60S
Mean	4.62	4.01	121	–	–	–	–

TABLE 2. Agronomic characters of KSML 3, its components and Kalyansona

	Components							Kalyan-
Character	C1	C2	C3	C4	C5	C6	KSML 3	sona
Days to 50 per cent heading	110	109	109	108	109	110	109	111
Plant height (cm)	98	98	99	100	99	98	99	100
Number of spikelets/spike	19	21	19	21	21	21	21	19
Number of tillers/meter	115	125	120	124	123	130	128	115
Ear length (cm)	12.5	12.8	13.2	12.9	13.0	12.8	12.9	12.4
Grain color	*A	A	A	A	A	A	A	A
1000 kernel weight (grams)	41	40	41	40	41	41	40	34

* Amber

REFERENCES

Borlaug, N.E., Gibler, J.W. 1953. The use of flexible composite wheat varieties to control the constantly changing stem rust pathogen. Abstracts of the Annual Meetings of the American Society of Agronomy, Dallas, Texas, 1953, pp. 81.

Browning, J.A. and Frey, K.J. 1969. Multiline cultivars as means of disease control. Ann. Rev. Phytopathology. 7: 355-382.

Jensen, N.F. 1952. Intra-varietal diversification in oat breeding. Agron. J. 44: 30-34.

ACKNOWLEDGEMENT

The authors are highly grateful to Dr. S. Rajaram, wheat breeder, CIMMYT for editing and arranging to publish the article through CIMMYT.

BITHOOR-A WHEAT MULTILINE VARIETY FOR UTTAR PRADESH, INDIA.

M.P. Singh, L.S. Gupta and H.G. Singh
C.S. Azad University of Agriculture and Technology, Kanpur, India.

The wheat cultivar Kalyansona (popularly known as Siete Cerros in Mexico and as Mexipak in Pakistan and various Middle Eastern countries) was derived from the CIMMYT cross II-8156. At one time, it occupied the number one position in regard to acreage in India and exhibited a very stable yield. Indeed, this cultivar was one of the principal factors responsible for the breakthrough in wheat production in many countries of the developing world.

At the time of its introduction, Kalyansona was resistant to the prevalent races of rusts, but as it became more popular and occupied the entire Gangetic Plain, new races of leaf and stripe rust arose which rendered it susceptible.

CIMMYT, as the original creator of this genotype, had realized the increasing popularity of the various released varieties of this cross throughout the Indian subcontinent, Middle East, and North Africa, and the consequent danger of large scale rust epidemics involving vast areas of the globe. To stabilize production and to reduce the possibility of an epidemic, CIMMYT in the early seventies began a large-scale crossing program involving Kalyansona (Siete Cerros) in order to produce components for multiline varieties based on this genotype. Breeding methods for developing Siete Cerros components at CIMMYT have been described by Rajaram and Dubin (1977). By 1973-74, a large number of components were available in Ciudad Obregon when the senior author (M.P. Singh) joined the CIMMYT wheat program, as a visiting scientist. Many components of Siete Cerros were selected in the Yaqui Valley, Ciudad Obregon and reselected at Kanpur, India in succeeding years. The collections were thoroughly checked for resistance to leaf rust and a number of components were isolated.

"Bithoor" is the mechanical mixture of nine of these Kalyansona components, viz:

1. Bb-7C x Cno"S"
2. (7C/LR64-Inia x Inia-Bb) Tob-8156
3. Vcm-Cno"S" x Kal-Bb
4. Tzpp x PI-7C
5. Bb-Cno x Jar/Cno-7C x CC-Tob
6. LR64 x Tzpp-Ane/Bb-7C
7. Y50-Kal^3
8. Bb-Cno x Jar/Cno-7C x CC-Tob
9. CC-Inia/Tob-Cno x Bb-7C

Bithoor, originally designated as KML-7406, was tested in the All-India Coordinated Multiline-Trials for 3 years. Its yield performance and agronomic and disease data, compared to Kalyansona, are given in Tables 1 and 2. Based on its overall superiority for yield and leaf rust resistance, the U.P. State Variety Release Committee on May 29, 1978, released it for cultivation in Uttar Pradesh.

Uttar Pradesh State lies in the Gangetic Plain and is considered a rust hazard area. With the release of the Bithoor multiline variety in this area it should be possible to begin studies of the fundamentals of multiline-pathogen relationships as well as to serve to promote the development and release of other multilineal varieties. For the first time, a wheat multiline variety and its interaction with a rust pathogen on an epidemic level will be observed on a large acreage.

TABLE 1. Yield performance and leaf rust reaction of the multiline variety Bithoor compared to Kalyansona for the years 1974-75, 1975-76 and 1976-77 (yield in t/ha).

Variety and year	Yield (t/ha)							Leaf rust reaction	
	Uttar Pradesh Pantnagar	Kanpur	Punjab	Gurdaspur	NEPZ*	NWPZ**	National	NEPZ	NWPZ
1974-75									
Bithoor	4.46	4.32	3.61	3.48	4.32	4.14	3.88	5S	10S
Kalyansona	3.95	3.64	2.82	3.29	3.64	3.39	3.34	50S	90S
L.S.D.	7.5	10.0	4.2	5.8	9.9	2.9	2.4		
1975-76									
Bithoor	3.99	5.22	3.73	3.39	4.12	4.24	3.89	0	10S
Kalyansona	3.57	4.57	2.99	2.09	3.65	3.87	3.63	80S	80S
L.S.D.	4.3	7.0	2.7	3.9	4.6	1.7	1.5		
1976-77									
Bithoor	4.78	7.64	3.37	3.48	4.06	4.06	4.06	0	0
Kalyansona	3.52	6.55	3.10	2.69	3.61	3.61	3.61	70S	70S
L.S.D.	4.7	8.6	3.7	2.8	1.9	1.9	1.9		

* North East Plain Zone

** North West Plain Zone

TABLE 2. Agronomic and quality characteristics of Bithoor and Kalyansona.

Variety	Year	Height (cm)	Maturity	Grain color	1000 grain weight (gm)	Protein percent	Pelshenke value
Bithoor	1974-75	98 100	Mid-late	Amber	34-46	12.19	104
	1975-76	91-113	Mid-late	Amber	36-45	12.48	100
Kalyansona	1974-75	99-101	Mid-late	Amber	21-38	10.42	99
	1975-76	92-113	Mid-late	Amber	30-39	12.26	90

REFERENCE

Rajaram S. and H.J. Dubin, 1977. Avoiding genetic vulnerability in semi-dwarf wheats. Annals of the New York Academy of Sciences. 287: 243-254.

MLKS-11–A WHEAT MULTILINE VARIETY FOR THE NORTHERN AND NORTHWESTERN PLAINS OF INDIA

M.V. Rao, S.M.A. Naqvi, J.K. Luthra
Indian Agricultural Research Institute, New Delhi, India

In the present context of the 'wheat revolution' in India, one of the pressing needs besides further increasing the yielding ability of genotypes, is to stabilize the production potential of our existing high-yielding commercial wheats through control of major diseases. Rusts which can spread wide and fast can greatly upset our production plans. New physiologic races of stripe, leaf and stem rusts capable of attacking our commercial varieties have arisen and some of these are already widely prevalent. Kalyansona—once the most popular and widely grown variety—at the time of its release had a good level of resistance to rusts. Today, it has become susceptible to all three rusts. So is the case with other popular varieties like Sonalika. A number of varieties released recently have also become susceptible to one or the other of the rusts even before they actually covered large acreages. In fact, experience over the past years has shown that in India, the life of a variety with regard to resistance to rusts is only about 3 to 5 years. Therefore, the immediate need in our national wheat improvement program is to stabilize production by adding disease resistance quickly to the best of our present day commercial varieties.

The situation described above was realized by scientists at the IARI, Delhi as early as 1967 and a backcross program to improve the resistance of commercial wheats was initiated. The best available recurrent parents at that time were chosen, viz. Kalyansona and Sonalika. A large group of donor parents resistant to rusts was selected from different national and international nurseries. The ultimate aim of this program was to produce multiline wheat varieties having genes for resistance from different sources. We felt that such multiline cultivars offered the most practical solution to reduce losses from rusts and stabilize production (Rao *et al* 1973).

A limited backcross program was followed and three backcross doses were given with the recurrent parent. Selection for rust resistance was done under artificial conditions of rust infection at Delhi. Selected plants were screened for protein and pelshenke values. These were also screened further for rust resistance at the summer nursery sites at Lahaul in the Himalayas and Wellington in the southern hills under natural conditions. Selections under diverse agro-climatic conditions at Delhi, Lahaul, and Wellington also helped in locating photoinsensitive plants simultaneously. Lines from BC_1, BC_2 and BC_3 generations which reached homozygosity for different phenotypic characters were tested in regular yield trials at Delhi, and at certain other centers in the country.

This work resulted in the development of a large number of high-yielding and rust resistant backcross lines in each of the recurrent parents that closely resembled the recurrent parent involved, for most of the characters. Out of the Kalyansona backcross lines, eight components were selected for inclusion in a mechanical mixture which was called as MLKS-11. The other lines are being maintained as reserve stock. The eight individual components are:

Backcross Line	Pedigree
IWP 19	(Fr x McM/Kt-Y)(Coronation-Fr) x Fr2, II-11084-12t-1b-3t-1b x Kal2
IWP 72	II-50-72 x Lee, II-54-76 x Kal2
IWP 87	/(Nor 10-B x Y 53)Y50/Kt54B, II-7056-2r-5M-6r-4M x Kal3
IWP 124	Kalyansona cross
IWP 127	Frocor x Kal2
IWP 129	HS 19 x Kal2
IWP 139	/(Nor 10-B x Y53)Y50/Kt 548, II-7056-2r-5m-6r-4m x Kal4
IWP 143	NP 875/S-Mt x M-Ren2, P4270-3b-1b-1t-3b-1t x Kal4

MLKS-11 was tested in the All-India Coordinated Multiline Trials in the Northern and Northwestern Plains Zone from 1974-75 to 1977-78. Its yield performance, rust reactions and quality characters are given in Table 1. In these trials MLKS-11 has given stable and good yield performance and has significantly outyielded the recurrent parent Kalyansona in all the years. On the basis of the average of 32 trials in 4 years it gave 13 percent more yield than Kalyansona and was at par in yield to the best control variety Arjun (4.3 t/ha). It has shown much higher resistance to both leaf and stripe rusts than Kalyansona. For protein percent, MLKS-11 is also superior to Kalyansona.

TABLE 1. Yield performance (t/ha), rust reactions and quality characters of the multiline variety MLKS-11 compared to recurrent parent Kalyansona for the years 1974-75 to 1977-78 in Multiline Trials.

	Average yield			Increase in yield as o/o of the check	Leaf rust		Stripe rust		Protein o/o		Pelshenke Value	
Year	MLKS-11	Kalyansona	LSD	Kalyansona	MLKS-11	K.Sona	MLKS-11	K.Sona	MLKS-11	K.Sona	MLKS-11	K.Sona
1974-75	4.15	3.39	2.9	22.4	–	–	–	–	–	–	–	–
1975-76	4.17	3.87	1.7	7.7	0-40S	100S	0-15S	40S	11.94	10.42	98	99
1976-77	3.90	3.61	1.9	8.0	tS	100S	tS	0	–	–	–	–
1977-78	3.78	3.29	2.1	14.8	0-25S	100S	0-40S	60S	11.86	10.59	97	97
Mean	4.00	3.54	–	13.0								

Agronomic characters of individual components of MLKS-11 and Kalyansona are given in Table 2. It may be noted that there is very little variation for different agronomic characters among the components. This has given this variety a uniform look in the field.

TABLE 2. Summary of agronomic characters of individual components of MLKS-11.

Line	Plant Height (cm)	Days to flower	1000-grain weight (gm)	No. of grains/ spike	No. of tillers/ plant	Glume color	Grain color
IWP 19	91.1	94.3	37.1	61.1	12.4	Brown	Amber
IWP 72	87.4	95.3	33.9	55.6	12.7	Brown	Amber
IWP 87	90.3	94.3	30.8	67.1	12.6	Brown	Amber
IWP 124	87.9	97.0	33.9	64.1	11.0	Brown	Amber
IWP 127	89.9	96.0	32.9	69.7	14.9	Brown	Amber
IWP 129	88.8	95.0	31.7	57.0	13.5	Brown	Amber
IWP 139	85.7	94.7	30.0	58.1	14.1	Brown	Amber
IWP 143	85.5	96.0	35.3	75.6	13.2	Brown	Amber
Mean	88.3	95.1	33.2	63.5	13.0		
Kalyansona	92.0	95.3	29.1	59.2	15.6	Brown	Amber

The average number of grains per spike and 1000-grain weight of the individual components are better than that of the Kalyansona and hence may be partly responsible for higher yield of MLKS-11. Better resistance to leaf and stripe rusts has evidently contributed to the increase in yield of MLKS-11.

Table 3 gives the seedling reaction to Indian races of leaf rust and probable Lr genes carried by components of MLKS-11. It may be seen from Table 3 that all the individual components are genetically diverse from each other. Therefore, it is expected that MLKS-11 will have a long and useful life under field conditions and will help in stabilizing production.

TABLE 3. Seedling reaction to leaf rust races and probable Lr genes carried by components of MLKS-11.

Line	Probable Lr genes in the components	Seedling reaction to leaf rust races												
		10	11	12	17	20	63	77	104	106	107	108	162	162A
IWP 19	Lr2b/Lr2c, Lr3(ka) and one additional gene	R	R	S	R	R	R	S	S	R	R	R	R	R
IWP 72	Lr1/Lr3(ka), Lr10, Lr15/16/17/20	R	R	R	R	R	R	R	R	R	R	R	R	R
IWP 87	Adult plant resgene	S	R	R	S	R	R	S	S	R	R	R	R	R
IWP 124	Lr3(ka), Lr10	R	R	S	R	R	R	R	S	R	R	R	R	R
IWP 127	Lr3(do), Lr16, one gene conferring resistance to 162A	R	R	S	R	R	R	S	R	R	R	R	S	R
IWP 129	Lr2a, Lr3(do), Lr10, one gene conferring resistance to 162A	R	R	R	R	R	R	S	R	R	R	R	R	R
IWP 139	Lr3(do), Lr17, one gene conferring resistance to race 162A	R	R	R	R	R	R	S	R	R	R	R	S	R
IWP 143	Lr2b/2c/2d, Lr3(do), one new gene	R	R	S	R	R	R	S	S	R	R	R	S	R
Kalyansona	Lr12/13/14/18	S	R	S	S	S	R	S	S	R	R	S	S	S

Considering its superior yield performance and disease resistance, MLKS-11 was identified by the All-India Wheat Research Workers' Workshop in 1978 for the entire Northern and Northwestern Plains Zone of India, comprised of Punjab, Haryana, Jammu, Western Uttar Pradesh, Delhi and Rajasthan states (excluding Kota and Udaipur Divisions). At present, the variety is undergoing extensive testing in the Adaptive and Minikit Trial Program of the Goverment of India under farmers' field conditions. The seed of all the individual component of MLKS-11 is being multiplied separately by the National Seeds Corporation (NSC) of India on a large scale for distribution to farmers after making mechanical mixture MLKS-11. The breeders are closely associated with NSC in seed production program of this variety.

REFERENCE

Rao M.V., S.M.A. Naqvi and J.K. Luthra (1973). Current status in developing multilines of some of the dwarf commercial wheats. Proc. 12th All-India Wheat Workers' Workshop, New Delhi.