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I. Articles

A unique wheat variety-Raj 3077

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Summary

A new wheat variety, Raj 3077 was developed from three genetically diverse cultivars (*Triticum aestivum* L.) in three way cross (HD 2267 / Raj 1482// Raj 1802). This variety exhibited a higher level of productivity both under optimum and sub optimum environments. It also possesses superior grain quality along with other desirable quality parameters and fairly high degree of resistance to rusts. Genetically it is blessed with *Lr23+*, *Lr10+* and *Yr2+* for rust resistance and *Rht1* gene for reducing height. It is a robust and reliable wheat variety that offers good degree of tolerance to saline/alkaline conditions. This variety was recommended for normal sowing (1987), late sowing (1988) for North Western Plains Zone and saline/alkaline condition (1992) for whole of the country by Wheat Varietal Release Committee (AICWIP). It is envisaged that this variety will open up new vistas of boosting wheat production and alleviate the socio-economic status of the subsistent Indian farmers.

Introduction

Wheat, the world's most extensively grown crop, is the second most important source of staple food in India. The increasing annual population growth rate of more than 2.1% along with rising nutritional standards on the one hand and stagnating productivity on other, have become a major concern to the fragile food security system of the country. Therefore, sustained research efforts are needed to keep on upward trend in wheat, well above the population growth. The upsurge in production and productivity could be achieved by the wide spread adoption of semi dwarf, lodging and disease resistant, photoinensitive and fertilizer responsive varieties amenable to improved agronomic practices.

Recently, a new wheat variety, Raj 3077 has been developed in India which has a genetic potential for excellent performance under different situations in the major wheat growing mega environments of North Western Plains Zone of India. This paper describes the development, performance, resistance and quality aspects of this marvelous wheat variety.

Materials and methods

Three genetically diverse cultivars of bread wheat (*Triticum aestivum* L.), namely, HD 2267, Raj 1482 and Raj 1802 were selected for hybridization. Three way cross (HD 2267 / Raj 1482 // Raj 1802) was attempted among these selected parents. The pedigree method was used for handling different generations under artificial epiphytotic condition of rusts at Agricultural Research Station, Durgapura, Jaipur, Rajasthan, India.

Based on yield tests, reaction to important diseases and other attributes of agronomic and grain quality value, the most promising homozygous lines including strain Raj 3077 were entered into different varietal yield evaluation trials for three years at different locations of North Western Plains Zone (NWPZ) of India under the All India Coordinated Wheat Improvement Project (AICWIP). Natural field under saline / alkaline conditions (pH above 7.0 and not beyond 3-4 Ece) was also used for this test. In first year (Initial varietal trial) the trial was conducted in double lattice design and onwards (Advance varietal trial) randomized block design was used for varietal testing programmes at all locations across the zone. The mean averaged over locations for different traits has been given only for Raj 3077 and check varieties for interpretation of the results in this paper, although a number of other varieties were also tested in the coordinated trials.

To obtain the maximum yield of wheat it is obligatory to find out the optimum sowing time, combination of nutrients and irrigation levels in relation to the variety. Hence, agronomic experiments were conducted to assess the adaptability of the newly developed Raj 3077 variety.

To assess the adaptability in different dates of sowing, the coordinated trials were planted under irrigated conditions at 44th (early), 46th (normal) and 50th (late) meteorological week, respectively. For the assessment of its adaptability under different levels of fertilization, the coordinated trials were conducted by using 4 levels of N, P₂O₅ and K₂O fertilizer as shown in Table 3, while under saline/alkaline production condition 7 levels of N and Zn fertilizers were used as shown in Table 4. Further, to assess the response to irrigation, coordinated trials were conducted by supplying three irrigation levels, i.e. once (at crown root initiation - CRI), twice (at CRI + flowering) and six times of irrigations at crucial stages of crop (CRI, late tillering, late jointing, flowering, milk and dough stage). All these experiments were laid out in split plot design with four replications. The sowing was done in row 23 cm apart in early and normal sowing and 18 cm apart in late sowing by drilled method. Generally six irrigations were applied to raise the crop.

The resistance of Raj 3077 to rusts was tested with the help of AICWIP at several locations in the country. The standard inoculation and post inoculation procedures and practices (Joshi et al. 1982; Nagarajan and Nayar 1986) were followed to generate comparable information. Host pathogen interactions were scored into various grades following Stakman et al. (1962) for black rust, Johnston (1963) for brown rust and Johnson et al. (1972) for yellow rust.

Quality laboratory under coordinated programme assists in screening varieties for different quality parameters required at the time of release a variety. The evaluation of different quality characteristics of the variety was made as suggested by Hanslas (1986).

Results and discussion

The expanded pedigree of wheat cultivar Raj 3077 is HD2177/3/CNO67/BB//HD2160/4//RAJ1482/5/BB/3/LR64/SN64//NAPO (Jain 1994). The main characteristics of Raj 3077 are dorsal leaf surface waxy and ventral surface non-waxy, profuse tillering, long erect ears that turn dusty white at maturity and possesses medium bold amber and lustrous grains. The results obtained are explained below:

Timely sown - irrigated condition

The analysis of varietal yield evaluation trials (1985 / 87) over 22 locations, revealed that variety Raj 3077 significantly out-yielded all check varieties in all the three years except in the first year, where it yielded as good as checks WH 283 and Raj 1972 (Table 1).

When Raj 3077 was sown at normal time, it gave significantly higher yield (6.79 t / ha) than both the check varieties (Table 2). However, it showed significant reduction in yield under early and late sown conditions. As to the response to fertilizer level Raj 3077 significantly

Table 1. Grain yield (t/ha) and rust reactions of Raj 3077 and check varieties in varietal yield evaluation trials in NWPZ of India

Variety	Zonal yield (t/ha)			Rust reaction*					
	First year	Second year	Third year	Black	ACI	Brown	ACI	Yellow	ACI
Timely sown - irrigated condition									
Raj 3077	3.73	4.74	4.27	50MR	8.0	40S	13.7	60S	21.0
Kalyansona	3.42	4.27	3.82	80S	60.0	90S	60.0	80S	40.0
WH 283	3.52	4.28	3.96	60S	50.0	20MS	8.7	80S	-
Raj 1972	3.68	4.08	4.09	10MR	3.0	30S	14.6	40S	8.6
C.D. 5%	0.27	0.23	0.19						
Late sown - irrigated condition									
Raj 3077	3.68	3.49	3.16	50MR	8.0	40S	13.7	60S	21.0
Sonalika	3.35	3.14	2.98	60S	45.0	100S	70.0	80S	-
Raj 2184	3.20	3.07	2.68	10MR	-	40S	16.7	30S	-
C.D. 5%	0.33	0.18	0.20						
Soil salinity / Alkalinity conditions (Timely sown - irrigated)									
Raj 3077	2.35	2.49	2.15	10MR	-	100S	43.0	0	-
Kharchia 65	1.99	2.25	1.55	40S	-	60S	45.0	20S	-
KRL 1-4	-	2.62	2.30	40S	-	100S	30.0	10S	-
WH 157	-	2.50	2.11	40S	-	45S	22.5	100S	-
C.D 5%	0.16	0.20	0.18						

*Maximum reaction and average coefficient of infection (ACI).

Table 2. Effect of date of sowing, fertilizer and irrigation level on grain yield (t/ha) of Raj 3077 and check varieties suitable to normal sown condition

Variety	Time of sowing			Fertilizer (NPK) kg/ha				Levels of irrigation		
	Early	Normal	Late	F ₀ 0:0:0	F ₁ 40:20 :14	F ₂ 80:40 :28	F ₃ 120: 60:40	Once	Twice	Adequate (six times)
Raj 3077	5.87	6.79	4.48	2.09	3.28	3.78	4.54	2.70	3.63	3.93
WH 283	5.62	6.04	4.40	2.15	3.17	3.94	4.28	2.17	3.32	3.78
Raj 1972	5.52	6.08	4.52	2.22	3.43	4.07	4.37	2.41	3.39	3.72

out-yielded (4.54 t / ha) at higher level of fertilization and was as good as check varieties under lower fertility levels (Table 2). However, this variety showed a significant reduction of yield at lower fertility levels. The varieties × irrigations experiments exhibited that Raj 3077 out-yielded the checks WH 283 and Raj 1972 at all the levels of irrigation and gave the highest yield under adequate irrigations (Table 2). In all these agronomic experiments a significant interaction between variety × treatment in respect of yield was observed.

It was concluded that among timely sown varieties Raj 3077 showed excellent performance. It yielded maximum at fertilizer level 120 : 60 : 40 (N, P₂O₅, K₂O kg/ha) and at six post sowing irrigation levels. This variety was consequently recommended by AICWIP in 1987 for normal sowing.

Late sown - irrigated condition.

The sowing span of wheat in the NWPZ of India is from early November to late December. More than 40 per cent of the total area under wheat is generally sown late due to the harvesting of long duration paddy and other crops like sugarcane, cotton and vegetables, i.e. potato, carrot and cauliflower. In low lying areas also sowing of wheat is often delayed till late December or early January. The average reduction in yield of normal sown variety under late sowing is about 0.5 t / ha for every fortnight's delay in sowing after November 15 (Khan and Chatterjee 1981), therefore, the development of separate set of varieties for late sown condition is considered peremptory.

The most commonly grown wheat variety Sonalika developed for such late sown situation became a low yielder in recent years due to susceptibility to brown and yellow rusts under field condition. Therefore, the need of another early maturing wheat variety coupled with high yield and rust resistance was considered imperative for wheat breeders to meet the challenges of environmental constraints.

The results of varietal yield evaluation trials over 17 locations (1986 / 88), exhibited superiority of Raj 3077 in yield over checks Sonalika and Raj 2184 during all the three years except in third year where it yielded as good as check Sonalika (Table 1). Further, Raj 3077 significantly out-yielded check Raj 2184 under late sown condition, whereas it yielded as good

Table 3. Effect of date of sowing on grain yield (t/ha) of Raj 3077 and check varieties suitable to late sown condition

Variety	Time of sowing		
	Early	Normal	Late
Raj 3077	6.14	6.01	5.76
Raj 2184	4.62	4.76	4.96
Sonalika	4.65	5.35	5.24

as check Sonalika (Table 3). It also tended to be more stable over different dates of sowing in comparison to check varieties, even though no significant differences were observed.

The results clearly established that Raj 3077 is a robust and reliable wheat variety which also offers persistent good response under late sown condition. It was, therefore, further recommended by AICWIP for late sown situation in 1988.

Saline / alkaline (irrigated - timely sown) conditions

Salinity and alkalinity are the important adverse soil conditions widely prevalent in 7 million ha areas in wheat growing states of India. However, the farmers generally use only those wheat varieties which are recommended for normal sowing, harvesting very low yields per ha. The successful wheat cultivation in such degraded land is possible with a suitable variety possessing adequate level of salt stress resistance (Giriraj et al. 1980 ; Kumar et al. 1986) with other desirable traits.

Kharchia 65 was the most popular red grain variety in vogue in salt affected soils of India before these studies were undertaken. However, it was susceptible to all the three rusts and was also associated with many other undesirable attributes. This variety, because of its red grains, did not fetch better price to the farmers in Indian wheat market. Therefore, an urgent need to replace Kharchia 65 variety by a new promising white seeded variety tailored for salt affected soils of mega environments of India was felt.

Table 4. Effect of fertilizer level on grain yield (t/ha) of Raj 3077 and check varieties under saline / alkaline conditions

Variety	Fertilizer (N : Zn) kg/ha						
	F ₀ (0:0)	F ₁ (40:30)	F ₂ (40:60)	F ₃ (80:30)	F ₄ (80:60)	F ₅ (120:30)	F ₆ (120:60)
Raj 3077	1.08	1.69	1.79	1.89	1.87	2.00	1.93
KRL 1-4	1.11	1.32	1.40	1.45	1.74	1.74	1.80
WH 157	1.45	1.35	1.45	1.69	1.50	1.55	1.60
Kharchia 65	1.59	1.74	1.67	1.29	1.32	1.21	1.21

The results of varietal yield evaluation trials over 27 locations showed that variety Raj 3077 gave out-standing yield performance over the check variety Kharchia 65. It also yielded as good as check KRL 1-4 and WH 157 during all the three years (Table 1).

The results of agronomic experiments exhibited that salinity reflected in poor yield and reduced the utilization efficiency of increased fertilizer to a great extent. From economic consideration, application of F2 level of fertilization was more beneficial in comparison to other levels to harvest good yield of Raj 3077 (Table 4).

It is noteworthy that Raj 3077 has been showing persistent good response in saline / alkaline conditions and also possesses white grain with better productivity as well as resistance to rusts. In recognition of these qualities this marvelous variety was again recommended for saline / alkaline production conditions by AICWIP in 1992 for the whole country.

The results of plant pathological screening nursery (1985 /92) revealed that Raj 3077 variety has fairly high degree of resistance to rusts as compared to check varieties under different situations in the major wheat growing mega environments of NWPZ of India (Table 1). The research carried out on this aspect shows that Raj 3077 variety combining more than one gene (*Lr23+*, *Lr10+* and *Yr2+*) for resistance maintains long lasting resistance (Nayar et al. 1994).

Table 5. Agronomic and qualitative attributes of Raj 3077 and check varieties in varietal yield evaluation trials in NWPZ of India

Variety	Agronomic characters			Qualitative attributes			
	Days to heading	Height (cm)	1000 grain weight(g)	Protein (%)	Pel-shenke value (min)	Chapati making score (1-10)	Bread making score (1-10)
Timely sown - irrigated condition							
Raj 3077	55-90	76-100	42-46	13.96	93	7.8	8.0
Kalyansona	61-101	82-102	28-40	12.29	96	7.2	6.8
WH 283	55-88	78-102	33-48	12.65	96	7.4	7.8
Raj 1972	55-93	77-96	40-52	11.95	112	7.4	6.4
Late sown -irrigated condition							
Raj 3077	59-76	78-96	32-37	13.90	95	9.0	7.8
Sonalika	51-70	73-98	40-41	13.85	91	5.8	5.0
Raj 2184	61-75	71-85	33-35	12.94	98	7.6	7.0
Soil salinity / Alkalinity conditions (Timely sown - irrigated)							
Raj 3077	69.90	113-134	22-43	14.15	95	8.2	8.0
Kharchia 65	71-91	119-137	22-40	11.68	96	7.0	6.4
KRL 1-4	73-85	115-132	21-43	12.92	100	7.8	7.6
WH 157	68-90	118-139	26-48	13.57	105	7.6	7.2

Quality characters of the grains are decisive for the success of variety. Assessment of quality characteristics of Raj 3077 showed the mean protein values range from 13.90-14.15%, pelshenke value (main) 95-96 (utility group - medium strong) and good to excellent chapati score (7.8 - 9.0 / 10) and bread score (7.8 - 8.0 / 10) in different sowing environments (Table 5) of NWPZ.

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Close linkage of the *Agropyron elongatum* gene *Sr26* for stem rust resistance to the centromere of wheat chromosome 6A

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Summary

The *Agropyron elongatum* gene *Sr26* for stem rust resistance on chromosome 6A of bread wheat variety Kite was mapped by using ditelo-6AL (beta arm). There was no pairing in F₁ between chromosome 6A of Kite carrying the *Agropyron* segment and telo-6AL of Chinese Spring. Analysis of test cross progeny for cytological constitution and rust resistance failed to recover any crossover between *Sr26* and the 6A centromere.

Introduction

Knott (1961) transferred the gene *Sr26* for stem rust resistance from *Agropyron elongatum* chromosome 6Ag to common wheat chromosome 6A by means of X-ray induced translocation. This resistance gene has been incorporated into the Australian wheat cultivars Eagle, Kite and Jabiru which are widely cultivated (Luig 1978). McIntosh (1978) lists *Sr26* as being located on chromosome arm 6A (beta). However, intra-chromosomal mapping of *Sr26* on 6A has not been reported and the present study was undertaken to determine this.

Materials and methods

The Australian wheat variety Kite was crossed to Kalyansona mono-6A and Chinese Spring ditelo-6AL. In the cross to mono-6A, monosomic and disomic F₁'s were identified cytologically and selfed. F₂ progenies were scored for resistance to stem rust. The monotelodisomic F₁ between ditelo-6AL and Kite was studied cytologically and test crossed to Kalyansona (susceptible variety). The test cross progeny was analyzed for both cytological constitution and resistance to stem rust.

Results and discussion

Monosomic analysis

In the cross between Kalyansona mono-6A and Kite, out of 4 F₁ plants, 3 were monosomics and 1 disomic. The F₂ progeny of disomic F₁ consisted of 36 resistant and 33 susceptible plants.

The F₂ of monosomic F₁ had 35 resistant plants and only 2 susceptible plants which appeared to be nullisomics with narrow leaves and thin culm. These results clearly indicated that *Sr26* gene of Kite was located on chromosome 6A.

Test cross analysis

The test cross results are summarized in Table 1. As a result of pairing failure between the entire 6A of Kite and telo-6AL of Chinese Spring in the F₁, a large number of monosomics were scored in the test cross progeny and these were all susceptible to stem rust. The resistant plants had the entire 6A of F₁ with the formation of 21 normal bivalents. The test cross plants with a telocentric (20ⁿ + t1ⁿ) were susceptible. Hence, all the 123 test cross plants analyzed were non-crossovers. It can thus be concluded that the *Sr26* gene shows complete linkage with the 6A centromere.

Table 1. Segregation of chromosome complements and resistance to stem rust in the test cross (CS ditelo-6AL × Kite) × Kalyansona

2n	Stem rust	
	Resistant	Susceptible
42	48	-
41	-	50
41+t	-	25
Total	48	75

It was interesting to note that though there was no 6A-6AL pairing in the Kite × ditelo-6AL F₁ (20ⁿ+1ⁿ+tⁿ), normal pairing with the formation of a heteromorphic rod bivalent (20ⁿ+t1ⁿ) was observed in the monotelodisomic susceptible test cross plants. The *Agropyron* segment did not permit any 6A-6AL pairing in the F₁. This indicates that most of the long arm of Kite 6A consists of the *Agropyron* segment. Knott (1961) also observed that when the Thatcher translocation line was backcrossed to Thatcher, the F₁ plants had 21ⁿ but there was always at least one open bivalent. Prabhakara Rao (1977) transferred the *Sr26* gene to *durum* wheat but observed that plants heterozygous for the *Agropyron* resistance gene always had 14 bivalents with at least one open rod bivalent. Such a large structural alteration of 6A was too drastic for *durum* background with the result there was no male transmission of the *Agropyron* resistance gene from heterozygotes. Hence, homozygous resistant line could not be recovered in the *durum* background.

The present study indicates that the wheat-*Agropyron* translocation break-point on 6AL is located very close to the centromere with the *Agropyron* segment replacing most of the long arm of 6A. The *Sr26* locus may be located anywhere along the length of the *Agropyron* segment. There is no way of determining its exact location since pairing does not take place between this translocated segment and the corresponding portion of wheat 6AL.

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Genetic analysis of some drought and yield related characters in Pakistani spring wheat varieties

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Summary

A Line \times Tester analysis involving three wheat varieties viz., Pak. 81, LU26S, K-1595 (males) and six lines, having high and low abscisic acids viz., HABA 7, HABA 9, HABA 20, LABA 7, LABA 9 and LABA 20 (females) were used for the study of some morpho-physiological characters. LABA 20 showed the highest negative GCA effects for specific flag leaf area and epidermal cell size. Positive GCA estimates for tillers per plant, grains per spike and grain yield per plant were obtained in LABA 9 and Pak. 81. Hybrid HABA 20 \times LU26S showed highest negative SCA effects for specific flag leaf area and epidermal cell size. While HABA 9 \times LU26S hybrid showed highest negative SCA effects for stomatal size. SCA effects for tillers per plant, grains per spike and grain yield per plant were positive in 50% of the hybrids. Results of the study in total suggested the usefulness of Pak. 81 and HABA 7 for further selection in the subsequent generations to synthesize drought tolerant genotypes with appreciable yield potential. This is because maximum mean values for the yield related traits and minimum for epidermal cell size were observed in Pak. 81. Furthermore all the crosses indicating maximum values for yield characters and minimum for specific flag leaf area and stomatal size, involved Pak. 81 as a tester. Pak. 81 was also best general combiner for yield traits and specific flag leaf area. HABA 7 showed desirable negative GCA effects for stress related traits and positive for yield traits. Cross HABA 7 \times Pak. 81 showed the suitable SCA effects for all the characters except for epidermal cell size.

Introduction

Drought resistance, one of the utmost important objectives in wheat breeding, is difficult to evaluate. The best criterion is the yield of grain when the varieties are grown in critical drought situations. Ability to retain green colour of leaves and a well turgid condition relates to drought resistance. Turgidity of the leaves is conditioned by the proper regulation of opening and closing of stomata and their size. A high endogenous level of ABA (Abscisic acid) can cause the closure of stomata and in this way reduce the rate of transpiration thus preventing moisture loss and moisture stress to plant. Shimshi and Ephrat (1975) reported that wheat cultivars with wider stomatal apertures were more productive without greater

water use. A substantial role of ABA in the control of plant water relations was suggested by the discovery that some mutants, which lack the ability to synthesize ABA, wilt easily because they do not close their stomata to reduce water loss (Tal and Imber 1970). External application of ABA to wilted plants restores their turgor. ABA also enhances the growth rate thus enabling the plant to complete its life cycle before a serious moisture deficit develops (Drought escape). Thus parental lines with varying amounts of ABA were included in this study.

To evolve high yielding, drought resistant varieties better understanding of various morpho-physiological characters like flag leaf area and weight, epidermal cell size, stomatal size, tillers per plant, grains per spike and grain yield per plant will need special attention. Equally significant would be the proper choice of parents. They should not only manifest the requisite traits but should also be capable of producing hybrids with superior performance when crossed with other parents. Combining ability analysis provides useful information in this respect. Significant value of general and specific combining ability effects (GCA and SCA) for flag leaf area (Prabhu and Sharma 1987), tillers per plant (Sarkar et al. 1987; Zubair et al. 1987; Yadav and Singh 1988), grains per spike and grain yield per plant (Sarkar et al. 1987; Malik et al. 1988; Yadav and Singh 1988) have been reported. The diallel analysis approach (Griffing 1956) is not practicable unless the number of parents involved is limited. A diallel analysis using a limited number of parents gives poor estimates of genetic parameters because of large sampling error with an additional disadvantage that potentially superior parents may be left untested. Line \times tester analysis (Kempthorne 1957) is used in this paper in order to evaluate nine parents for GCA and SCA.

Materials and methods

Three wheat varieties, Pak. 81 a commercial cultivar, LU26S a drought tolerant variety and K-1595 an elite line, which were used as testers, were crossed with three high and three low abscisic acid lines viz., High ABA 7, High ABA 9, High ABA 20, Low ABA 7, Low ABA 9, Low ABA 20, which were used as female parents (These high and low abscisic acid lines, which will be referred to as HABA and LABA, respectively, were acquired from Cambridge as such for drought tolerance studies). The F₁ seeds of the eighteen (3 \times 6) crosses along with their parents were planted in a triplicated randomized complete block design during 1991-92. Each replication was consisted of the nine parents and eighteen F₁ crosses with a five meter single row for each entry. Row to row and plant to plant spacings were kept 30 and 15 cm, respectively. Fertilizer was applied at the rate of 75 lbs nitrogen + 75 lbs phosphorous per acre. Data for specific flag leaf area (Flag leaf area /flag leaf weight), epidermal cell size (μm^2), stomatal size (μm^2), tillers per plant, grains per spike and grain yield per plant (g) were recorded from ten randomly selected and guarded plants from each entry. The data recorded were subjected to analysis of variance according to Steel and Torrie (1980) to determine significant differences among genotypes. Combining ability studies were made using line \times tester analysis as described by Kempthorne (1957).

Results and discussion

The perusal of the results presented in Table 1, show that the female parents (called lines here) accounted significant differences for specific flag leaf area, tillers per plant and grain yield per plant. Male parents (called testers here) showed significant differences for stomatal size and grains per spike. Interaction of line \times testers was significant in case of grains per spike only. Male and female parents provided broad range of expression for various traits (Table 2). Specific flag leaf area was highest in HABA 9 and minimum in LU26S. Maximum epidermal cell size was recorded in LU26S and minimum in HABA 20. Stomatal size was largest in HABA 20 and smallest in LABA 7. Pak. 81 produced maximum number of tillers per plant, grains per spike and grain yield per plant while minimum values for these traits were recorded in HABA 7, LU26S and LABA 7, respectively.

Mean performances of the eighteen crosses are presented in Table 2, which revealed presence of hybrid vigour for most of the characters studied. The hybrids manifested varied performances to their better parents for most of the traits evaluated. In case of specific flag leaf area, majority of hybrids, particularly those of involving HABA 20 and LABA 9 indicated increased vigour over their parents. Maximum flag leaf area was observed in LABA 9 \times LU26S while minimum value was found in LABA 7 \times Pak. 81. The average of the hybrids presented 7.8% increase over the average of parents. Most of the hybrids showed decrease in epidermal cell size. Maximum value was observed in LABA 9 \times Pak. 81 and minimum in HABA 20 \times K-1595. On the average 6.8% decrease was observed in hybrids compared to the

Table 1. Analysis of variance for the traits studied

SOV	df	Sp. flag leaf area	Epidermal cell size	Stomatal size	Tillers per plant	Grains per spike	Grain yield per plant
Replications	2	0.0135**	7775617.50**	97700.11 ^{NS}	8.92*	45.28 ^{NS}	3363.69*
Genotypes	26	0.0015 ^{NS}	21308608.13 ^{NS}	267802.00*	2.73 ^{NS}	75.40**	679.48*
Parents	8	0.0014 ^{NS}	2709871.25 ^{NS}	349684.66*	1.27 ^{NS}	145.42**	862.29*
P vs C	1	0.0039 ^{NS}	24902978.30 ^{NS}	22050.00 ^{NS}	6.38**	47.04 ^{NS}	1454.39 ^{NS}
Crosses	17	0.0014 ^{NS}	20437756.61 ^{NS}	243726.23 ^{NS}	3.21 ^{NS}	44.11*	547.87 ^{NS}
Lines	5	0.0092**	26651856.68 ^{NS}	163157.82 ^{NS}	4.84*	9.65 ^{NS}	926.75*
Testers	2	0.0011 ^{NS}	6220714.50 ^{NS}	713828.66*	2.88 ^{NS}	95.86*	202.80 ^{NS}
L \times T	10	0.0017 ^{NS}	20174114.91 ^{NS}	189989.95 ^{NS}	2.46 ^{NS}	51.04*	427.45 ^{NS}
Error	52	0.0016	18747458.28	150907.20	1.94	23.48	379.81

^{NS}= $P \geq 0.05$

*= $P \leq 0.05$

**= $P \leq 0.01$

Table 2. Mean values of the parents and crosses for the traits studied.

Parents/crosses	Sp. flag leaf area (cm ² /mg)	Epidermal cell size (μ m ²)	Stomatal size (μ m ²)	Tillers per plant	Grains per spike	Grain yield per plant (g)
Males						
Pak. 81	0.176	9880.0	2042.0	11.4	76.3	27.8
K-1595	0.180	10693.0	2057.0	9.5	58.7	21.4
LU26S	0.134	11704.0	1774.0	10.5	54.3	23.6
Mean	0.163	10759.0	1957.7	10.5	63.1	24.3
\pm S.D.	0.025	913.8	159.2	0.97	11.65	3.29
Females						
HABA 7	0.165	11418.0	2035.0	9.3	66.3	18.0
HABA 9	0.208	9953.0	2200.0	10.6	60.3	20.6
HABA 20	0.176	4297.0	2697.0	10.3	67.2	19.0
LABA 7	0.156	7756.0	1542.0	9.9	70.0	17.3
LABA 9	0.188	5134.0	2268.0	10.4	67.0	20.2
LABA 20	0.204	6473.0	2437.0	10.2	72.8	17.5
Mean	0.183	7505.2	2196.5	10.1	67.3	18.7
\pm S.D.	0.021	2769.3	391.9	0.45	14.20	1.39
Crosses						
HABA 7 \times Pak. 81	0.166	7629.0	1767.0	9.6	75.9	26.9
HABA 7 \times K-1595	0.203	6733.0	1864.0	9.3	64.0	24.5
HABA 7 \times LU26S	0.187	7407.0	2444.0	8.3	66.1	21.0
HABA 9 \times Pak. 81	0.196	4720.0	2289.0	8.9	73.3	21.2
HABA 9 \times K-1595	0.173	3803.0	2493.0	8.9	62.5	19.9
HABA 9 \times LU26S	0.193	8900.0	2134.0	9.0	64.3	20.1
HABA 20 \times Pak. 81	0.211	9244.0	2281.0	11.2	70.3	21.3
HABA 20 \times K-1595	0.220	9306.0	2162.0	11.3	66.0	22.1
HABA 20 \times LU26S	0.171	9577.0	2216.0	9.1	66.0	20.3
LABA 7 \times Pak. 81	0.119	5895.0	2216.0	8.6	67.0	22.6
LABA 7 \times K-1595	0.178	8465.0	2016.0	9.1	74.6	24.0
LABA 7 \times LU26S	0.171	11355.0	2338.0	9.9	66.7	23.9
LABA 9 \times Pak. 81	0.183	12095.0	1922.0	12.1	66.6	29.3
LABA 9 \times K-1595	0.197	6127.0	1837.0	10.5	70.0	23.4
LABA 9 \times LU26S	0.244	7657.0	2252.0	10.1	30.5	21.8
LABA 20 \times Pak. 81	0.175	4526.0	1877.0	9.8	71.4	17.1
LABA 20 \times K-1595	0.169	4046.0	2106.0	9.3	67.7	20.4
LABA 20 \times LU26S	0.160	6776.0	2880.0	9.1	64.5	21.5
Mean	0.184	7458.9	2171.9	9.67	66.0	22.3
\pm S.D.	0.027	2391.8	275.7	1.03	9.62	2.79

parents. Stomatal size was less variable in hybrids. However, increase in vigour was observed in some cases. Maximum value was observed in LABA 20 × LU26S which also exceeded its better parent LABA 20 by 18.2%. Minimum stomatal size was observed in HABA 7 × Pak. 81.

Tillers per plant were more variable in hybrids than in parents and most of the hybrids showed reduced tillers compared to their parents, particularly the hybrids involving HABA 9, LABA 7 and LABA 20. Maximum tiller number was observed in LABA 9 × Pak. 81 while minimum number was obtained in HABA 7 × LU26S which was also less than its lowest parent HABA 7. Maximum number of grains per spike was observed in HABA 7 × Pak. 81 hybrid while minimum was exhibited by LABA 7 × LU26S. In case of grain yield per plant most of the hybrids showed increase over their parents. Some hybrids like LABA 9 × Pak. 81, HABA 7 × K-1595, HABA 20 × K-1595, LABA 7 × LU26S and LABA 9 × K-1595 exceeded their better parents. On average basis 8.7% increase was observed in hybrids over the parents.

Combining ability studies

(a) General combining ability (GCA)

General combining ability is the mean performance of a parent in a series of crosses. GCA estimates for all the characters are given in Table 3 to identify potential parents for subsequent breeding. Flag leaf is the most important among all leaves. In case of specific flag leaf area, negative GCA effects are desirable. Therefore, selection of wheat genotypes having greater leaf weight and smaller leaf area are preferred since they may enable the limited photosynthetic activities to be continued under moisture stress. LABA 20 and Pak. 81 showed the highest negative GCA effects for this character as female and male parent, respectively. Mccree and Davis (1974) concluded that cell enlargement was adversely affected by moisture stress. Negative GCA effects are desirable for epidermal cell size. LABA 20 among the female parents and K-1595 among males were the best general combiners which seemed to be promising to decrease the epidermal cell size.

Plants with smaller size of stomata can better tolerate the moisture deficiency as they efficiently and economically regulate the supply of water. Spence et al. (1986) concluded that the geometry of resulting mechanical properties of small stomata gave the capability of opening or maintaining open pores with lower guard cell pressure, relative to the turgor of the surrounding epidermal cells. Through this mechanism, evaporation rate through stomata is much reduced as there will be greater resistance in the path-way of water during evapo-transpiration through stomata. As a result photosynthetic efficiency of a plant may be increased or maintained, thus ultimately increasing the final grain product. So negative GCA effects are given importance for stomatal size. For this point of view K-1595 among males and HABA 7 among females showing highest negative GCA effects were found to be useful. Productive tillers per plant is a major yield component. Therefore parents such as LABA 9, HABA 20 and Pak. 81 seemed to be good combiners for increasing tillering ability. Similarly grains per spike is also an important yield contributing factor. The useful parents depicting positive GCA effects for this trait included Pak. 81, LABA 7, LABA 9 and HABA 7. The suitable parent showing high GCA effects for grain yield were HABA 7, LABA 7 and LABA 9.

b) Specific combining ability (SCA)

Specific combining ability effects for the eighteen crosses are presented in Table 4. For specific flag leaf area five crosses showed negative SCA effects of which HABA 20 × LU26S exhibited the maximum value. For epidermal cell size ten crosses showed negative SCA effects. If smaller cell size is required then the crosses HABA 20 × LU26S, LABA 7 × Pak. 81, LABA 9 × K-1595, LABA 9 × LU26S and HABA 9 × K-1595 may be useful. In case of stomatal size, seven out of eighteen crosses showed negative SCA effects. For this trait crosses HABA 9 × LU26S, LABA 20 × Pak. 81 with negative SCA effects are suitable. SCA effects for tillers per plant were lower. However, 50% crosses showed positive SCA effects. Useful crosses were LABA 7 × LU26S, LABA 9 × Pak. 81 and HABA 20 × K-1595. In case of grains per spike, nine crosses showed positive SCA effects. The potential crosses with high SCA effects were LABA 7 × K-1595, LABA 9 × Pak. 81 and HABA 7 × Pak. 81. As regards the grain yield per plant, 50% crosses showed positive SCA effects. The prominent crosses were LABA 9 × Pak. 81, LABA 20 × LU26S, HABA 7 × Pak. 81 and HABA 9 × LU26S.

The main goal of plant breeder is to search out better yielding lines through hybridization programme. But when he breeds for drought resistance, his main emphases would be on the selection of those segregants which possesses maximum drought resistance combined with high yield potential. Stress related characters are needed to be incorporated in the existing

Table 3. General combining ability for the traits studied.

Parents	Sp. flag leaf area	Epidermal cell size	Stomatal size	Tillers per plant	Grains per spike	Grain yield per plant
Testers						
Pak. 81	-0.00077	-119.60	-152.78	0.36	2.296	0.08
K-1595	0.00250	-515.80	-172.45	0.08	-0.748	0.01
LU26S	-0.00020	635.40	325.23	-0.44	-1.848	-3.09
S.E.	0.0566	6123.31	549.376	1.970	6.853	27.56
Lines						
HABA 7	-0.00200	-225.82	-127.00	-0.60	0.522	8.23
HABA 9	0.00050	-1663.26	153.10	-0.76	-1.468	-7.10
HABA 20	0.01300	1982.29	67.34	0.86	-0.778	-5.12
LABA 7	-0.00830	1100.74	-80.44	-0.47	1.220	5.33
LABA 9	0.02020	1155.20	147.89	1.24	0.842	12.26
LABA 20	-0.01900	-2349.15	134.89	-0.30	-0.340	-13.59
S.E.	0.0387	4329.83	388.468	1.393	4.846	19.49

Table 4. Specific combining ability for the traits studied.

Crosses	Sp. flag leaf area	Epidermal cell size	Stomatal size	Tillers per plant	Grains per spike	Grain yield per plant
HABA 7 × Pak. 81	-0.018	503.02	-104.89	0.20	4.73	9.72
HABA 7 × K-1595	0.016	306.10	-88.88	0.17	-3.98	2.31
HABA 7 × LU26S	0.003	-506.62	193.79	-0.37	-0.75	-12.04
HABA 9 × Pak. 81	0.009	-968.52	136.66	-0.38	4.02	-3.26
HABA 9 × K-1595	0.132	-1488.63	260.00	-0.09	-3.46	-5.47
HABA 9 × LU26S	0.006	2457.15	-396.66	0.47	-0.56	8.73
HABA 20 × Pak. 81	0.011	-89.73	24.80	0.30	-0.33	-1.69
HABA 20 × K-1595	0.017	3601.79	15.10	0.75	-0.75	3.69
HABA 20 × LU26S	-0.038	-3512.06	-229.90	-1.05	0.42	-2.00
LABA 7 × Pak. 81	-0.007	-2556.85	58.12	-0.97	-5.00	-7.79
LABA 7 × K-1595	-0.004	408.70	16.88	-0.18	5.91	1.86
LABA 7 × LU26S	0.007	2148.15	41.24	1.15	-0.91	5.13
LABA 9 × Pak. 81	0.031	3588.35	70.66	0.82	5.00	19.18
LABA 9 × K-1595	-0.013	-1983.40	-94.67	-0.46	1.70	-7.05
LABA 9 × LU26S	0.030	-1604.95	24.07	-0.36	3.33	-12.15
LABA 20 × Pak. 81	0.008	-476.29	-259.12	0.06	0.98	-16.13
LABA 20 × K-1595	0.001	-542.07	-108.78	-0.13	0.57	3.81
LABA 20 × LU26S	0.007	1018.36	367.90	0.19	-1.55	12.31
S.E.	0.023	2499.83	224.28	0.80	2.80	11.25

high yielding cultivars thus enabling to combat drought effectively. So keeping these points in mind and observing the results of the experiment, it is suggested that Pak. 81 was the best tester and HABA 7 was the best line. This was suggested because maximum values for the yield related traits and minimum for epidermal cell size were observed in Pak. 81 (Table 2). Furthermore all the crosses indicating maximum values for yield characters and minimum for specific flag leaf area and stomatal size, involved Pak. 81 as tester. Pak. 81 was also best general combiner for yield traits and specific flag leaf area. Similarly HABA 7 showed desirable negative GCA effects for specific flag leaf area, epidermal cell size, stomatal size and desirable positive GCA effects for yield characters. Cross HABA 7 × Pak. 81 showed the suitable SCA effects for all the characters except for epidermal cell size. Although the SCA effects of the cross HABA 20 × LU26S for the stress related traits were more suitable but negative SCA effect of this cross for grain yield made it less attractive. Similarly among the lines, HABA 7 performed well. It was good general combiner for all the traits except for tiller number. Although LABA 20 showed highest desirable negative GCA effects for specific flag leaf area and epidermal cell size but its GCA effect for grain yield was negative while HABA 7

showed positive GCA effect for grain yield and acceptable negative GCA effects for specific flag leaf area, epidermal cell size and stomatal size (Table 3).

Maximum positive SCA effects for grain yield was observed in the cross LABA 9 × Pak. 81 but again SCA effects for stress related characters were also positive which are not desirable. The most suitable cross with acceptable positive SCA effects for yield related characters and acceptable negative SCA effects for specific flag leaf area and stomatal size was HABA 7 × Pak. 81 (Table 4). Further selection in the subsequent generations may produce plants combined with drought tolerance and yield characters.

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Genotypic variation in photosynthetic characteristics and kinetic properties of RuBP carboxylase in \times Triticosecale Witt.

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Summary

The photosynthetic capacity of single leaves and kinetic properties of RuBP carboxylase were studied among seven genotypes of \times Triticosecale Witt. The photosynthetic rates among the genotypes ranged from 15.7 to 25.8 $\mu\text{mol m}^{-2}\text{s}^{-1}$ at an irradiance of 1500 $\mu\text{mol quanta m}^{-2}\text{s}^{-1}$. The cultivar 6A-1093 showed the highest rates of CO_2 fixation while 6A-854 showed the lowest. The photosynthetic rates were significantly correlated with RuBP carboxylase activities in leaf extracts. There was no apparent difference in the chlorophyll content among the genotypes. The K_m and V_{max} values for RuBP carboxylase in leaf extracts greatly varied among the genotypes. It was concluded that the variation in the rates of CO_2 fixation and kinetic characteristics of RuBP carboxylase among triticale genotypes is important in selection of varieties for improved photosynthetic productivity.

Introduction

Photosynthetic performance of higher plants could be used for prognosis of plant productivity. The photosynthetic rate per unit leaf area depends on the development of the photosynthetic system including energy transducing components and on enzymes of carbon reduction cycle (Evans and Terashima 1988; Geiger and Servaites 1994). Maintenance of active photosynthesis by leaves is a major requirement for production of adequate carbohydrates in crop plants (Lawlor et al. 1989).

Triticale has particular promise as a supplement to current foods, feeds and brewing grains. The crop has recently been known to be one of the most nutritious grains and is used in baking industry. The nutritional superiority of triticale is well known due to its higher protein levels than the other cereal grains (CIMMYT 1985). Much attention has been given to the agronomic and breeding aspects in triticale development programs. It is also important to understand the physiological limitations to the productivity of triticale which could be used in the evaluation and breeding programs for yield improvement. As photosynthesis is one of the most fundamental processes in relation to dry matter production and crop yields, it is necessary to obtain information on the photosynthetic performance among genotypes of this relatively under-exploited cereal crop. We have previously reported the genotypic differences in RuBP

carboxylase activity during ontogeny of certain triticale genotypes (Ramachandra Reddy et al. 1986). The primary objective of the work reported here is to analyze the relationship between leaf photosynthetic capacity and kinetic properties of RuBP carboxylase among seven genotypes of triticale.

Materials and methods

Plant materials and growth condition

Six American triticale lines; 6A-845, 6A-854, 6A-1092 (ROSNER++), 6A-1093 (ROSNER--), 801-1210 and Polish line 'Salvo' were used in this study. Plants were grown in 5-liter pots containing a mixture of vermiculate soil and chemical fertilizer (N:P:K=1:1:1). All plants were established outdoors under natural photoperiod with day/night temperature of 30/20 °C and an average photosynthetic photon flux density of 1600 $\mu\text{E m}^{-2}\text{s}^{-1}$. All plants were daily watered to avoid any water stress effects. Fully expanded leaves from five week-old plants were used in the experiments. Five independent measurements per accession were made, and the mean values and standard errors were calculated.

Photosynthesis

Leaf gas exchange rates were monitored with single attached leaf enclosed in an acrylic plastic leaf chamber (6×10×0.5 cm). 1 KW metal halide lamp provided the light source (1500 $\mu\text{E m}^{-2}\text{s}^{-1}$). The air stream (with 340 $\mu\text{L L}^{-1}\text{CO}_2$) was passed into the leaf chamber at a constant rate of 3L min^{-1} . The CO_2 uptake was measured with an infra red gas analyzer (Analytical Development Co., Hoddesdon U.K.). Photon flux at the surface of each leaf was measured with a quantum sensor (Li-Cor Corporation, Nebraska, U.S.A.). Leaf temperature was measured with finewire thermocouples pressed to the lower surface of the leaf and was maintained at 25 \pm 2 °C by adjusting the temperature of the chamber by running water through water jacket.

Enzyme assay and kinetic properties of RuBP carboxylase

The activity of RuBP carboxylase, its kinetic characteristics and total chlorophyll content were determined on the same leaves used for the gas exchange studies. The leaves (2g) were washed quickly, dried and homogenized in 10ml of 100mM HEPES buffer (pH 7.8) containing 5mM DTT, 1 mM EDTA, 25 mM MgCl_2 in a chilled mortar. The homogenate was centrifuged at 30,000 $\times g$ for 20 min at 0-3 °C. The supernatant was passed through Sephadex G-200 which was equilibrated with 100 mM HEPES buffer containing 20 mM MgCl_2 and 10 mM NaHCO_3 . The eluates were collected and assayed at 25 °C for enzyme activity. The reaction mixture contained 50 mM HEPES-NaOH buffer (pH 8.0), 5mM DTT, 20 mM MgCl_2 , 0.5 mM $\text{NaH}^{14}\text{CO}_3$, 0.5 mM RuBP and the enzyme extract. The acid stable radioactivity was determined in Beckman LS 1800 liquid scintillation system (Ramachandra Reddy and Das 1986). Chlorophyll was estimated according to Arnon (1949).

Results

Significant differences were observed in the net photosynthetic rates among the seven genotypes of triticale (Table 1). 6A-1093 consistently maintained highest photosynthetic rates ($25.8 \mu\text{mol m}^{-2} \text{s}^{-1}$) at an irradiance of $1500 \mu\text{mol m}^{-2} \text{s}^{-1}$ followed by 801/1208 ($23.2 \mu\text{mol m}^{-2} \text{s}^{-1}$).

Table 1. Rate of photosynthesis, chlorophyll content and RuBP carboxylase activity in leaves of seven triticale genotypes.

Genotype	Photosynthesis ($\mu\text{mol m}^{-2} \text{s}^{-1}$)	Chlorophyll ($\mu\text{mol m}^{-2}$)	RuBP carboxylase activity ($\text{mmol CO}_2 \text{mol}^{-1} \text{chl s}^{-1}$)
6A-845	19.8 ± 1.81	469.3 ± 23.5	158.5 ± 12.5
6A-854	15.7 ± 1.25	468.6 ± 20.9	153.6 ± 13.2
6A-1092	17.5 ± 1.86	498.7 ± 26.9	159.8 ± 13.0
6A-1093	25.8 ± 2.21	503.8 ± 30.8	204.8 ± 16.5
801/1208	23.2 ± 2.02	485.3 ± 28.3	195.4 ± 16.1
801/1210	22.8 ± 1.85	465.3 ± 21.2	174.5 ± 14.3
SALVO	20.6 ± 1.55	470.5 ± 22.9	169.3 ± 12.9

The activity of RuBP carboxylase in leaf extracts was significantly correlated with net photosynthetic rates. The leaves of 6A-1093 recorded highest enzyme activity ($298.6 \mu\text{mol mg}^{-1} \text{chl hr}^{-1}$) while the lowest activity was noticed in 6A-854 (Table 1). However there was no significant difference in the leaf chlorophyll content among seven triticale genotypes (Table 1). The kinetic characteristics of RuBP carboxylase in leaf extracts were compared in Table 2.

Table 2. Kinetic properties of RuBP carboxylase in the leaf extracts of seven triticale genotypes.

Genotype	RuBP carboxylase	
	Km(CO ₂) (μM)	V max $\mu\text{mol kg}^{-1} (\text{protein}) \text{s}^{-1}$
6A-845	11.91 ± 0.82	20.10 ± 1.81
6A-854	14.35 ± 0.39	18.15 ± 0.98
6A-1092	12.83 ± 0.79	18.89 ± 0.97
6A-1093	8.36 ± 0.59	28.95 ± 2.10
801/1208	9.59 ± 0.65	26.32 ± 1.82
801/1210	9.88 ± 0.61	24.56 ± 1.78
SALVO	10.65 ± 0.75	22.19 ± 1.65

The K_m (CO_2) values of the enzyme were significantly low ($8.36 \mu\text{M}$) with corresponding high V_{max} values ($28.95 \mu\text{mol kg}^{-1} \text{prot s}^{-1}$) in the leaves of 6A-1093. The highest K_m (CO_2) and lowest V_{max} values were obtained in the leaves of 6A-854 (Table 2).

Discussion

The present findings provide a strong correlation between the net CO_2 assimilation rates and RuBP carboxylase activity (Table 1). The results clearly show that the differences in the CO_2 assimilation rates were due to the differences in the levels of RuBP carboxylase in leaves. The rates of net photosynthesis and RuBP carboxylase activity were highly correlated ($r=0.93$, $P < 0.001$) and the linear regression equation of net photosynthesis on RuBP carboxylase activity was $Y=9.05+8.45X$. The positive correlation between net photosynthetic rates and RuBP carboxylase activity has been previously reported (Seeman and Berry 1982; Evans and Seeman 1984; Ramachandra Reddy and Das 1986). It is suggested that the differences in the *in vivo* activity of RuBP carboxylase in the leaves of triticale may also affect CO_2 assimilation.

The superior photosynthetic rates in 6A-1093 among the genotypes used in this study were presumed to be due to its efficient carboxylation capacities as evidenced by lower K_m (CO_2) and high V_{max} values of RuBP carboxylase in leaf extracts. The K_m (CO_2) values reported for triticale are comparable to those reported for certain other C_3 plants (Bird et al. 1982; Jordan and Ogren 1983; Makino et al. 1985; Ramachandra Reddy and Das 1986; Paul and Yeoh 1988). It is plausible that the genotypes with superior photosynthetic performance would be highly useful in selecting photosynthetically efficient triticale cultivars for obtaining greater photosynthetic productivity. The *in vitro* kinetic characteristics of RuBP carboxylase can be one of the useful targets to obtain greater CO_2 assimilation capacity in triticale. The significant differences in the catalytic properties of RuBP carboxylase also suggest that it might be possible to improve the photosynthetic performance of certain triticale genotypes through genetic manipulation of this enzyme.

Acknowledgements

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A very simple F₂ progeny segregating ratio from genotype HS 131 in winter wheat, facultative apomixis

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Summary

A five-year observation from progenies of three hybrid combinations derived from genotype Hengshui 86-171-131 (HS 131), a mutant selected from Cobalt irradiated progeny, showed:

(1) HS 131 possessed the ability to produce uniform lines in its F₃ generation probably due to facultative apomictic reproduction. (2) 62 segregating lines out of 84 lines were observed in its F₃ progeny from the combination of HS 90-4-11/HS 131. On the contrary, another 22 lines were distinguished by their morphological uniformity. (3) Characteristics of plant height (PH), ear length (EL), number of florets per head (FL/H) and seeds per head (S/H) were recorded, and their c.v's. were calculated and compared with the check variety, Jimai 24. For every line studied there were no differences between them by means of t-test and true-breeding lines could be obtained in its F₃ generation, i.e., F₂ generation can fix the hybrid heterosis. (4) The ratio of segregating to uniform F₃ lines was fit to 3 : 1 and 13 : 3 segregating models, but better fit to 3 : 1. It is suggested that there is only one pair of genes controlling the facultative character based on Chi-square test. (5) The genotype HS 131 is probably a facultative apomictic mutant from this experiment and demonstrated a very simple inheritance, which can be directly used to wheat apomictic breeding.

Keywords: Wheat, Facultative apomixis, Apomictic breeding

Introduction

Apomictic breeding, an old/new approach for fixing hybrid heterosis, has been raised much interest among geneticists and breeders in recent years. Much efforts have been paid to it during which some good results have been obtained in the aspects of theoretical as well as practical. The key point is to find the apomictic gene(s) which can be used in the breeding research. Our work over the past five years, has shown that the genotype HS 131 behaved like facultative apomictic based on the study of its progeny, and the results are reported below.

Materials and methods

The male genotype HS 131 was selected from a Cobalt irradiated *Triticum aestivum* population derived from the cross [(Jinfeng 1 / Xiaoyan 6) / (T 808 / Datuowang)] / (Xiaofeshou / Aifeng 1). Its pedigree no. is Hengshui 86-171-131. The female parent used in this experiment were HS 86-86 [(Yanda 1817 / Taishan1) / Weimai 5], HS 90-4-11 (Jimai 7 / Changshui 16) and HS 89-62 [(Punong 3665 / Jimai 3) / Hengshui 6404]. Three crosses were made (HS 86-86 / HS 131, HS 90-4-11 / HS 131 and HS 89-62 / HS 131) among 4 genotypes. All the crosses were made by hand emasculation and pollination under controlled condition. F₁, F₂ and F₃ generations were grown in the field using all seed obtained in the experiment. Before harvesting, characters such as plant height (PH), ear length (EL), number of florets per head (FL/H) and seed per head (S/H) were recorded on 100 F₃ plants from a single uniform line, and another 100 plants were used from the check. T-test method was used to compare the characters under study. Also, F₂ segregating ratio was calculated using χ^2 test.

Results and discussion

Above 100-120 florets from five heads were emasculated and bagged in all male and female parents. No seed sets was observed in any of them, suggesting that pollination was necessary for reproduction particularly for genotype HS 131. If it behaves like a facultative apomictic it belongs to pseudogamous apomixis. All the three combinations demonstrated good heterosis in the F₁ generation. But HS 90-4-11/HS 131 performed more vigorous than the other two, so more attention was paid to it. Among the F₂ segregating nurseries, the progenies of the three combinations (HS 86-86/HS 131, HS 90-4-11/HS 131 and HS 89-62/HS 131) showed a subsegregation. Only a few kind of types emerged comparing with others from the agronomic characters' point of view. This unexpected performance could not be explained based on Mendelian law, as the parents' pedigree or the agronomic characters were all much different. So single plants were selected from three of them and planted for F₃ observation. The F₃ progenies of all three combinations showed both uniform and segregating lines. Results presented in Table 1 show the apomictic gene(s) probably from the male parent, genotype HS 131.

Table 1. Recording of lines among F₃ generation from the same combination

Combination	Total no. of lines	No. of lines		% of uniform lines
		Uniform	Segregating	
HS86-86/HS 131	24	7	16	29.2
HS90-4-11/HS 131	84	22	62	26.9
HS89-62/HS 131	20	12	8	60.0
Pooled	128	41	86	32.0

One hundred plants were randomly selected from each of twenty two uniform or unsegregating single line for recording characters PH, EL, FL/H and S/H in the field and compared with the check by means of t-test for the combination of HS 90-4-11/HS 131, as it had more populations than the other two. Results shown in Table 2 suggest no difference within every single line for all tested characters, indicating that all the uniform lines behaved like true-breeding hybrids.

In order to identify F₂ segregating ratios, 120 seeds were collected and planted to produce F₃ line. χ^2 method was used to calculate the segregating ratio. Results in Table 3 show that at least 2 phenomena could not be explained by Mendelian law: First, several characters such as PH, EL, FL/H and S/H controlled by a number of genes can not attain homozygosity in one year of self-pollination. Second, by no means the proportion of 26.9% of uniform lines emerge in F₃ generation. This means some unexpected segregating proportion might have happened. This can be explained by the way other than sexual reproduction, i. e. both sexual and apomictic reproduction involved in the progeny and thus fixing the heterosis in the F₂ generation. Only in this genetic system the uniform F₃ lines can be emerged and this phenomenon could be explained.

Table 2. Variance analysis of significance of F₃ uniform lines with the check by t- test

Genotype line no.	Plant height (PH)		Ear length (EL)		Florets/head (FL/H)		Seeds/head (S/H)		Note n
	c.v.(%)	t 0.05	c.v.(%)	t 0.05	c.v.(%)	t 0.05	c.v.(%)	t 0.05	
	95A-01	3.66	a	4.98	a	3.71	a	9.53	
95A-02	3.86	a	5.03	a	3.73	a	9.37	a	100
.
95A-21	5.50	a	6.86	a	5.05	a	12.14	a	100
95A-22	5.51	a	6.89	a	5.06	a	12.17	a	100
Check	5.28	a	7.62	a	5.10	a	12.70	a	100

χ^2 test analysis did not fit into the ratios of 5 : 3 and 9 : 7 of segregating and uniform lines. Although other ratios of 13 : 3 and 3 : 1 could explain the behavior, 3 : 1 model is more acceptable based on the P value. If all the number were pooled together, it still agrees with this model. The 3 : 1 F₂ (F₃ lines) segregating to uniform ratio reported in Table 3 suggests one pair of recessive genes conditioning uniform and segregation in this experiment. The probable genetic constitution of HS 131 is *aa* conditioning apomixis. The genotype of female is *AA*. The F₁ hybrid genetic constitution would be *Aa*, typical sexual hybrid performance in field as dominant gene *A* conditions the sexual reproductive behavior. When selfed, as dominant gene *A* either homozygous or heterozygous conditions sexual reproductive behavior, Mendelian

Table 3. Ratios of F₂ plants / F₃ lines with numbers expected under every hypothesis and values of Chi-square

Observed ratio	Supposed ratio	Expected	Chi-square	P value
Sexual Apomictic	Sexual Apomictic	Sexual Apomictic	n=1,	$\chi^2_{0.05}=3.84$
62 : 22	3 : 1	63.00 : 21.00	0.0159	<0.90*
	5 : 3	52.50 : 31.50	4.7175	/
	9 : 7	47.25 : 36.75	9.8231	/
	13 : 3	68.25 : 15.75	2.5836	0.25-0.10

segregation would be expected. On the contrary, recessive apomictic gene *a* in homozygous condition would show uniformity. It yields the progeny of 3 segregating to 1 uniform proportion. According to this, the proposed genetic composition in F₂ generation is shown in Table 4.

Table 4 Proposed model for genetic composition of F₂ progeny

F ₂ genotypes from <i>Aa</i>	Frequency of genotype	Method of reproduction
<i>AA</i>	1/4	segregation
<i>Aa</i>	2/4	segregation
<i>a</i>	1/4	uniform

In this experiment the facultative apomictic gene demonstrated a simple inheritance. Also, the uniform lines were present in all combinations indicating that this trait is genetically controlled and can be easily manipulated in wheat breeding. This will reduce the breeding cycle, improve the progeny selection efficiency, improve the ideal genotype selection frequency, and also put apomixis into practical use in wheat breeding.

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II. Research Information

Transfer of stripe rust resistance to Unnath Sonalika and Unnath Kalyansona

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Unnath Sonalika and Unnath Kalyansona, improved varieties of Sonalika and Kalyansona respectively (Kochumadhaven et al. 1988), carrying linked resistance genes *Sr24 + Lr24*, were initially susceptible only to stripe rust. However, recently these varieties also became susceptible to stem rust. An attempt was made to transfer unidentified stripe rust resistance from the two hexaploid wheat lines in the background of Unnath Sonalika and Unnath Kalyansona.

Crosses of Unnath Sonalika and Unnath Kalyansona with the two wheat lines, i.e., CPAN 3057 and CPAN 3063, were made at Indian Agricultural Research Institute, Regional Station, Wellington, The Nilgiris, South India. The location is a 'hot spot' for all wheat diseases, where all the three wheat rusts occur in epiphytotic form throughout the year. Resistant hybrids were backcrossed to recurrent parents and lines showing resistance to stem, leaf and stripe rusts were constituted after fifth successive backcrosses. Screening for rust resistance was made under natural epiphytotic conditions.

Crosses of Unnath Sonalika and Unnath Kalyansona with the two wheat lines were successful. The lines constituted from the respective crosses between Unnath Sonalika and the two wheat lines were completely free to stripe rust, while the lines from the crosses between Unnath Kalyansona and the two wheat lines showed low incidence of stripe rust (TMR) (Table 1). These two wheat lines thus appeared to be good contributor for stripe rust resistance, though these failed to provide immunity to stripe rust in the latter case indicating that these lines are not virtually immune to stripe rust. It appears that a heavy inoculum load on the lines also leads to the breakdown of genetic resistance.

Interestingly, the new lines also exhibited good resistance to stem rust (TR), while Unnath Sonalika and Unnath Kalyansona were susceptible to stem rust (Table 1). Unnath Sonalika and Unnath Kalyansona and their derivatives were immune to leaf rust indicating the effectiveness of leaf rust resistance gene *Lr24*. The reason for breakdown of effective resistance gene *Sr24* in Unnath Sonalika and Unnath Kalyansona is not exactly known. Crossing-over between the two resistance genes can be ruled out, since these two genes are tightly linked to each other (McIntosh 1988). Occurrence of stem rust on a new resistance line could be due to previously unknown or new race with matching pathogenecity. However,

under the same experimental conditions at Wellington, the original Australian line TR-380 14* 7/3 Ag 14 from which the linked resistance genes *Sr24* + *Lr24* were transferred to Unnath Sonalika and Unnath Kalyansona, was free to stem rust. The stem rust race involved in the attack of Unnath Sonalika and Unnath Kalyansona was also not race 40-1 which is known to knock down the resistance gene *Sr24*, but it was only 40A, a common virulence of the Nilgiri hills. However, the Australian line was quite effective against the race 40A.

Thus, good resistance observed against stem rust in the new wheat lines possibly was due to combined effect of resistance gene *Sr24* and the additional unidentified gene(s) transferred from the two wheat lines which were resistant to stem rust (Table 1). It has been reported that rust resistance provided by single gene is not effective and durable resistance is provided only by a few gene combination (McIntosh 1988; Roelfs 1988; Roelfs et al. 1992). Since the new lines were simultaneously resistant to stem and stripe rust, it is possible that the resistance genes for stem and stripe rust derived from the donor parents are linked to each other.

Table 1. Reaction of Unnath Sonalika and Unnath Kalyansona and their derivatives to rusts

Cross / varieties	Reaction to		
	Stem rust	Leaf rust	Stripe rust
Unnath Sonalika (USLK)	20S	F	60S
CPAN 3057	TR	40S	F
USLK/CPAN 3057	TR	F	F
CPAN 3063	TR	5MR	F
USLK/ CPAN 3063	TR	F	F
Unnath Kalyansona(UKS)	40S	F	40S
USK/CPAN 3057	TR	F	TMR
UKS/ CPAN 3063	TR	F	TMR

F: Free, TR: trace resistant, TMR: trace moderately resistant, S: susceptible

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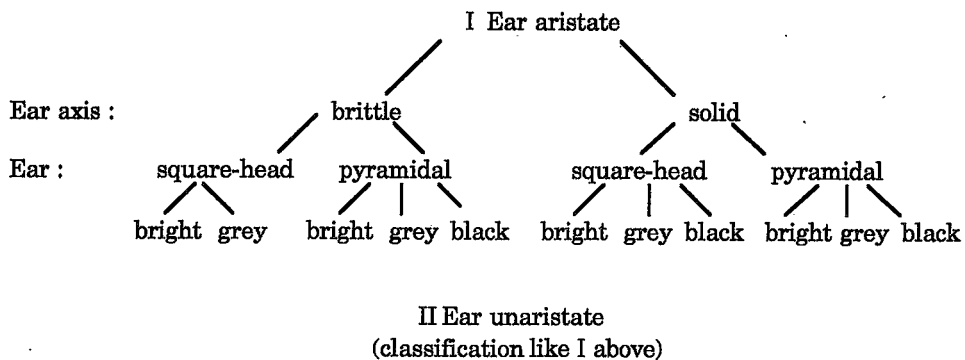
Recombination potencies by gene transfer of *Triticum monococcum* and *T. dicoccum* in *T. aestivum* — Assessment of thirty years of observation.

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Keywords: Transfer, Genetic information, *T. monococcum*, *T. dicoccum*, *T. aestivum*

The transfer and manifestation of genetic information from *Triticum monococcum* L. and *T. dicoccum* Schrank. var. *Farrum* Alef. (origins Dornburg) in *T. aestivum* (Schumann 1986) shall be assessed after thirty years of observations. Hybrids between *T. dicoccum* and *T. monococcum* are well stocked, very vigorous, healthy, sterile. Following the pollination of those F1 plants with pollens of seed wheat (*T. aestivum*) embryos will be generated in low-endosperm caryopses which may be cultivated in soil. In the segregating generations the plants differ considerably with regards to their tiller, stalk length, fungus infestation, fertility, ear shape and color:



Different grades of fertility disturbances in the segregating generations are indication of massive cytological recompositions. An accumulation of chromosomes was found around 28 and 42. Only fertile plants were further processed. They were compiled according to their respective phenotypes (Four groups: A - D) and tested on plots of different sizes (from 10 sqm to 2000 sqm) for a number of years.

- A. Ear unaristate, narrow, small
- B. Ear unaristate, square-headed
- C. Ear unaristate, pyramidal, large
- D. Ear aristate, pyramidal, large

The selected phyla of group A are similar to the *monococcum* parent. Following the sowing of 400 grains/sqm up to 1200 spicate stalks were counted. Stalk length 80 cm, stalk wall thin, stability insufficient at good fungus resistance. Yields below those of compared varieties, TKM (weight of thousand seed g rains) 38 g, raw protein content 12.5%.

The selected squarehead forms (group B) turned out to be stable due to their strong stalk walls, although their stalk length was 100 cm. Strong infestation with *Erysiphe*, *Septoria* and *Fusarium* were found in them. The grain yields was mainly unsatisfactory, TKM 45 g, raw protein content 13%.

The phyla classified under group C showed stalk length of 100 cm and more. Their stability varied. Different grades on infestations with *Erysiphe*, *Septoria* and *Fusarium* were found in them. Their yields achieved the levels of the compared varieties. Grain formation was good in most cases (TKM often 50 g) and a raw protein content of 13% was established.

The D phyla were predominantly long-stalked (above 100 cm), their stalks and stalk walls were strongly formed. Stability satisfactory, low susceptibility to fungus infestation. Upon the adding of nitrogen (N) of up to 100 kg/hectare their yields equal those of compared varieties. Their TKM is above 50 g, in 1979 its mean value of 24 tested specimen was 69.4 g. Throughout all the years under review higher raw protein contents were established than those in the certified varieties (14-16%).

The properties of the parents can be traced in the progenies. In selected phyla especially the fungus resistance from *T. monococcum*. Multiplied fully fertile phyla had 42 chromosomes. In contrast to *Triticale* products the former showed the development of all ovules. During comparative studies with certified varieties over a number of years none of the test samples obtained better yields. The hybrids classified under group D proved to have a high protein content, a good state of health and good yields. It seemed to be reasonable to submit one phylum to register test of the Bundessortenamt (German Federal Plant Registration Office) although it was known that even after twenty selections there are still 1% unaristate ears. Hence, according to the regulations issued by UPOV (International Union for the Protection of New Varieties) 1981-10-16-GT/3/8, the number of plant with lacking development of features was exceeded, it is determined at 5 out of 2000. The material under review offers the opportunity of transferring worthwhile properties into varieties and phyla of seed wheat.

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Development of rust resistant wheat lines using *Sr31*, *Lr26* and *Yr9* genes

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Presently no wheat varieties released in India is resistant to all the three rusts of wheat viz, stem (*Puccinia graminis* f. sp. *tritici*), leaf (*Puccinia recondita* f. sp. *tritici*) and stripe (*Puccinia striiformis*) under Wellington conditions. Efforts were made to develop wheat lines with durable resistance suitable for southern hills of India comprising Nilgiri and Palani hills. Development of a resistant line to all the three rusts is a hard task particularly in the absence of durable resistance genes for different rusts and the difficulties in while incorporating all these components in a single line without having any adverse effect on yield and quality. Hence, an effort was made to develop such varieties by crossing wheat cultivars HD 2380 and VL 616 susceptible to all the three rusts with MACS 2496 resistant to stem and stripe rusts.

The cultivars HD 2380 and VL 616 were individually crossed with MACS 2496. The resistant F₁ hybrids were backcrossed to recurrent parents and lines showing resistance to stem, leaf and stripe rusts were selected and constituted after 3rd successive backcrosses followed by repeated selfing. The resultant lines were extensively tested, for five generations, for possession of resistance to all the three rusts under natural epiphytotic conditions at Wellington.

The resultant lines showed resistance to stem and stripe rust and moderately resistance to brown rust (Table 1). The donor parent MACS 2496 carrying *Lr1*, *Lr23*, *Lr26*, unknown *Lr* genes and *Sr31* and *Yr9* showed high degree of resistance to stem and stripe rust. The genes, *Sr31* and *Yr9* offer high degree of resistance against the prevailing races of rusts in India (Sawhney 1985 ; Gupta 1985). Tomar et al. (1985) reported the effectiveness of *Yr9* against the prevailing races at Wellington. The variety HD 2380 carries specific genes *Lr13*, *Lr14a*, *Lr23* and *Sr30* and VL 616 carries *Lr14a* and *YrA* (Sawhney 1994). The resistance to stem and stripe rust in MACS 2496 is controlled by dominant genes *Sr31* and *Yr9*, respectively and since all the F₁ hybrids showed resistance to both stem and stripe rusts, it confirms that the transfer of these genes has occurred. However, the varieties HD 2380, VL 616 and MACS 2496 were susceptible to leaf rust (Table 1). Surprisingly, the constituted lines showed the susceptible reaction at seedling stage while it showed moderately resistance to leaf rust at adult stage. This may be due to the presence of *Lr13*, *Lr14a* and some unknown genes in HD 2380 and *Lr14a* in VL 616 which are known to be associated with adult plant resistance. Browder (1981) observed that *Lr12*, *Lr13*, *Lr14a* and *Lr22a* are only adult plant resistance genes. Moreover *Lr13* is

Table 1. Adult plant reactions of wheat parents and their derivatives to rusts

Parent / Cross	Reactions to rusts		
	Stem	Leaf	Stripe
HD 2380	20S	40S	10S
VL 616	40S	60S	5S
MACS 2496	Free	40S	Free
HD 2380 / MACS 2496	Free	TMR	Free
VL 616 / MACS 2496	Free	TMR	Free

TMR=Trace, moderately resistant

known to be highly interactive with other genes, and this might have resulted in the adult plant resistance in the new lines constituted. Gupta (1985) reported that the gene *Lr13* is highly interactive and it appears that some other unknown gene either alone or in combination with *Lr13* confers adult plant resistance. Similarly Samborski and Dyck (1982) also observed that *Lr13* is a highly interactive gene and its resistance can be enhanced by *Lr16* in cultivar Neepawa and *Lr30* in cultivar Columbus.

The resistance offered by different genes is also highly influenced by factors viz., environment under which plant is grown, age of the plant and genetic background of the host plants (McGregor and Manners 1985). It is known that adult plant resistance offered by the specific genes is not consistent under given environment. Gupta (1985) indicated that the adult plant resistance shown by *Lr13*, *Lr26* and *Lr14a* is not consistent against different cultures of the race 77A and hence classification of genes for a seedling resistance or adult plant resistance cannot be considered as absolute. Hence, the interactive effect of *Lr13* with various genes invites detailed study. The wider occurrence of *Lr13* in Indian wheats and its contribution of durable additional adult plant resistance are yet to be exploited. However, the extensive testing of the constituted lines and consistent result for rust resistance in the present study indicated that these lines may offer durable resistance against the prevailing rust races at Wellington. Sawhney (1994) opined that judicious combination of moderate adult plant resistance genes known for durability and other specific but short lived highly resistance genes provide the most practical and effective strategy for prolonged and complete resistance. Against this background the transfer of specific genes (*Sr31* and *Yr9*) and adult plant resistance genes may offer effective and durable resistance in the newly constituted lines.

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III. Genetic stock

Collection of wild *Aegilops* species in Israel

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In 1992, we made an extensive field survey on the distribution of wild *Aegilops* species, close relatives of cultivated wheats, from end of April to middle of June. A part of the collection is maintained as gene resource at the Plant Germ-plasm Institute, Faculty of Agriculture, Kyoto University, Mozume, Muko, Kyoto 617 Japan. The list and the maps published in the present report show collection sites of each accessions. The distribution of each species are summarized as follows;

Ae. speltoides

We found two upland (mountain) sites and one lowland (riverside) site of *Ae. speltoides*. Both awned (var. *speltoides*) and awnless (var. *ligustica*) types were found in these sites. But, the proportion of the two types was different. Most plants were awnless in the two upland sites but the majority of plants in the bank of Qishon River were awned. We tried but failed to find out some other populations in the places where this species has been reported. We assume that this species has been extinct due to the change of habitat in those localities.

Ae. bicornis

Ae. bicornis was restricted in the western part of Northern Negev where massive stands were found in near-by localities. A small mixed population with *Ae. sharonensis* was found in Philistean Plain.

Ae. longissima

Ae. longissima was collected at 25 localities covering from coastal regions to desert area, in Coastal Galilee, Acco Plain, Sharon Plain, Philistean Plain and Northern, Western and Central Negev. In a population at Wingate, south of Netanya, several plants of *Ae. sharonensis* and hybrid derivatives of the two species were found.

Ae. searsii

We found *Ae. searsii* in northern Judean Desert, southern Judean Mountains and southern Judean Desert.

Ae. sharonensis

We collected *Ae. sharonensis* at 12 localities along Mediterranean coast in Acco Plain, Sharon

Plain and Philistean Plain. Usually, this species do not grow near seashore. However, in the beach of Dor-haBonim Nature Reserve, haBonim, we found a large population on sand dunes about 50m from the seashore. A small population of *Ae. variabilis* was also found there. In Zahara, north Tel-Aviv, a massive stand of this species was found together with small amount of *Ae. longissima*.

Ae. ovata

This species distributed mainly in northern regions, Golan Heights, Dan Valley, Upper, Lower and Coastal Galilee, Acco Plain, Mount Carmel, Coast of Carmel and Northeast of Sharon Plain, and in Jerusalem. Few individuals were found at two sites, one in northern Judean Desert and another in southern Judean Mountains.

Ae. biuncialis

Ae. biuncialis was found in northern regions, Upper Galilee, Dan Valley and Golan Heights and in Jerusalem.

Ae. variabilis

We collected *Ae. variabilis* mainly in northern and coastal regions with mesic climates, Golan Heights, Dan Valley, Upper Jordan Valley, Upper, Lower and Coastal Galilee, Acco Plain, Mount Carmel, Coast of Carmel, Sharon Plain and Philistean Plain. It was also observed at inland sites in Beit Shean Valley, northern Judean Desert and Jerusalem. Few individuals were found in southern Judean Mountains.

Ae. kotschyi

Ae. kotschyi was collected at inland sites with continental climates in Beit Shean Valley, Lower Jordan Valley, Judean Desert, Judean Mountains and Northern, Western and Central Negev. *Ae. variabilis* and *Ae. kotschyi* have the same genome, UUS^vS^v, and produce fertile hybrids between them. However, the distribution area of the two species is different and rarely overlaps. We found both of the two species together only in three sites throughout Israel.

Ae. triuncialis

We collected this species only in Golan Heights.

Ae. cylindrica

Several plants were found at roadside near Haifa Port, Haifa, together with small plants of *Triticum aestivum* and *Secale cereale*. Apparently, this species is not native to Israel (Zohary and Feinburn-Dothan 1966), and therefore is not included in the maps.

Reference

Zohary M and Feinburn-Dothan N (1966) Flora Palaestina. Jerusalem Academic Press. Jerusalem.

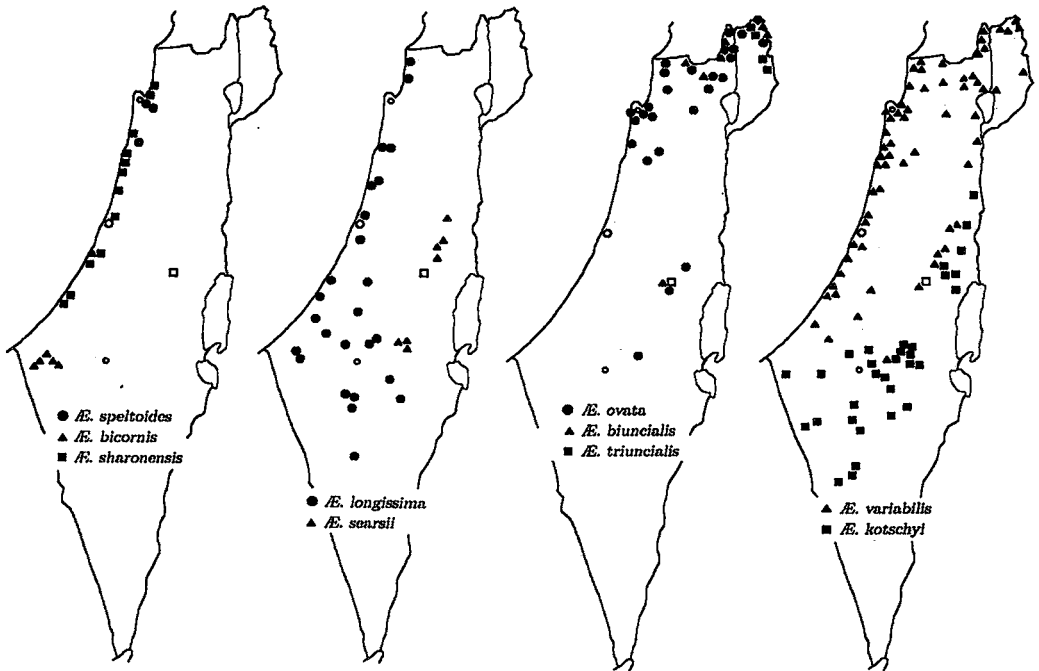


Fig. 1. Collection sites of *Aegilops* in Israel.

Accession Donor
No. (KU-) Number

Locality

Ae. speltoides

14601	92-6-17-1	Qishon, river bank E of the bridge, Haifa (awnless).
14602	92-6-17-1	Qishon, river bank E of the bridge, Haifa (awned).
14603A	92-6-7-1	Near the entrance of Technion, Haifa (awnless).
14603B	92-6-7-1	Near the entrance of Technion, Haifa (awnless).
14604	92-6-7-1	Near the entrance of Technion, Haifa (awned).
14605	92-6-4-1	Ramat haNadiv in Zikhron Ya'aqov (awnless).
14606	92-6-4-1	Ramat haNadiv in Zikhron Ya'aqov (awned).

Ae. bicornis

14610	92-5-8-7	Near Soreq Nuclear Center, roadside under pine trees.
14611	92-4-26-2	Open grassland by Magen Gas Station.
14612	92-4-26-5	Nir Yizhaq, near km15 along Hwy 232.
14613	92-4-29-1	2 km E of Kerem Shalom, near kml0 along Hwy 232.
14614A	92-4-29-3	Roadside along Hwy 222 from Gevulot Junction to Gevulot.
14614B	92-4-29-3	Roadside along Hwy 222 from Gevulot Junction to Gevulot.
14615	92-4-26-4	Gevulot, under <i>Eucaryptus</i> trees a long Hwy 222.

Accession No. (KU-)	Donor Number	Locality
<i>Ae. longissima</i>		
14621	92-6-10-1	Gesher haZiw, N of Nahariyya.
14622	92-6-6-2	North slope of Tel Akko.
14623	92-6-12-5	Beit Hananya, N of Zikhrom Ya'aqov, at the Bus Stop along Hwy 4 (brown spike).
14624	92-6-12-5	Beit Hananya, N of Zikhrom Ya'aqov, at the Bus Stop along Hwy 4 (white spike).
14625	92-6-11-3	W of Binyamina, about 300m E from Hwy 4, by <i>Eriobotrya japonica</i> orchard.
14626	92-6-12-1	Wingate, S of Netanya, along Hwy 2.
14627	92-5-29-4	Netanya, S of haSharon Junction of Hwy 4 and Hwy 57.
14628A	92-5-23-3	Zahara, north Tel Aviv.
14628B	92-5-23-3	Zahara, north Tel Aviv.
14629	92-6-16-1	Rishon le Ziyon, NE of the junction of Hwy 4 (brown spike).
14630	92-6-16-1	Rishon le Ziyon, NE of the junction of Hwy 4 (white spike).
14631	92-6-5-1	Nizzanim, by the way to Field School.
14632	92-5-23-6	Ziqim, about 0.5km W from the junction with Hwy 4.
14633	92-6-5-4	Sa'ad, at the junction of Hwy 25 and Hwy 232, NW of Netivot.
14634	92-6-5-2	Open grassland by Magen Gas Station
14635	92-6-5-3	NE of Ammi'oz, S of Gevulot Junction of Hwy 222 and Hwy 232 (ca. 12km NW of Ze'elim).
14636	92-6-5-6	2 km E of Kefar Mehanem, in a small grassland between Hwy 383 and a cotton field (ca. 20 km ESE of Ashdod).
14637	92-6-12-4	S of Ahuzzam, along Hwy 40 (ca. 8 km S of Qiryat Gat, brown spike).
14638	92-6-12-4	S of Ahuzzam, along Hwy 40 (ca. 8 km S of Qiryat Gat, white spike).
14639	92-6-5-5	Netivot, near the junction of Hwy 25 and Hwy 293.
14640	92-5-23-7	At haNashi Junction of Hwy 25 and Hwy 264.
14641	92-5-24-9Y	6km NW along Hwy 31 from Shoqet Junction with Hwy 60 (NE of Be'er Sheva).
14642	92-6-14-3	1.5 km N of Keramim, along the way to Lahav (ca. 17km NE of Be'er Sheva).
14643	92-5-24-3Y	21 km SE from Nevatim, along Hwy 25 (NW of Dimona).
14644	92-6-2-1	5 km SSW along Hwy 206 from Rotem Junction with Hwy 25 (SE of Dimona).
14645	92-6-2-6	Entrance of Haholot Nature Reserve, about 1km W of Mashabbim Junction of Hwy 40 and Hwy 222.
14646	92-6-2-5	W of Mashabbim Junction of Hwy 40 and Hwy 222 (ca. 25km S of Be'er Sheva).
14647	92-5-14-5	7 km S from Telalim Junction along Hwy 40, bottom of a wadi (N of Sede Boqer).
14648	92-6-2-4	6 km N of Mizpe Ramon, SW of the junction of Hwy 171 and Hwy 40

Accession No. (KU-)	Donor Number	Locality
<i>Ae. searsii</i>		
14651	92-5-20-6	Gitit, rocky slope N of Hwy 508 (alt 320 m, ca. 9km W of Massu'a).
14652	92-6-19-1	Kokhav haShahar, rocky slope W of the village.
14653	92-6-19-2	Kokhav haShahar, between Hwy 458 and the village.
14654	92-6-19-3	SW of the junction of Hwy 3 and Hwy 458 (ca. 32 km NNW of Jeriho).
14655	92-6-19-4b	3 km E of Ma'ale Mikhmas, slope along Hwy 458.
14656	92-6-14-2	Mahane Yattir, under pine trees (ENE of Be'er Sheva).
14657	92-5-24-7Y	North of Har Amassa Nature Reserve, at the junction to a Kibbutz (E of Mahane Yattir).
14658	92-5-24-6bY	8 km N of Tel Arad, NW of Arad.
<i>Ae. sharonensis</i>		
14661	92-5-16-14	Ein Hamifratz, south of Akko. Along Hwy 4.
14662	92-5-17-1	Qishon, open grassland near the Airport, Haifa.
14663	92-5-29-1	Beach in Dor haBonim Nature Reserve, near haBonim.
14664	92-5-11-1	Caesarea, entrance of the golf course (brown spike).
14665	92-5-11-1	Caesarea, entrance of the golf course (white spike).
14666	92-5-11-5Y	NE of Giv'at Olga Junction of Hwy 2 to Hadera, entrance of a Hospital.
14667	92-5-11-3	Mikhmoret, 10 km S from Hadera Junction of Hwy 2.
14668	92-5-23-2Y	Wingate, S of Netanya, along Hwy 2.
14669	92-5-8-10	Zahara, north Tel Aviv.
14670	92-5-8-7	Near Soreq Nuclear Center, roadside under pine trees.
14671	92-5-13-1	North of Ashdod along Hwy 41.
14672	92-5-13-5	South of Ashqeron.
14673	92-5-13-7	Ziqim, in Mango orchard on Kurkar hills.
<i>Ae. ovata</i>		
14681	92-6-21-3	W of Majdal Shams.
14682	92-6-21-2	S of Majdal Shams.
14683	92-5-28-5	In a field near Tel Dan (ca. 7 km ENE of Qir Shemona).
14684	92-5-28-4	Metulla, rocky slope under pine trees, 1 km S of the town (N of Qir Shemona).
14685	92-5-28-6	Along old road of Hwy 90, 0.5 km S from the junction the Hwy 977 (ca. 5km S of Qir Shemona).
14686	92-6-13-5	South Menara, along Hwy 988 (SW of Qir Shemona).
14687	92-6-13-4	Junction of Hwy 899 and Hwy 988, N of Ramot Naftali.
14688	92-6-13-3	W of Zefat, about 1 km N from the junction of Hwy 89 and Hwy 988.
14689	92-6-13-1	Meron, about 200m E from the junction of Hwy 89 and Hwy 866.
14690	92-6-6-4	Netu'a, along Hwy 899 (brown glume).
14691	92-6-6-4	Netu'a, along Hwy 899 (white glume).
14692	92-6-6-3	Near Hanita, 1.5 km NE from the junction of Hwy 70 and Hwy 899.
14693	92-5-16-13	Kabri, E of Nahariyya, 0.5 km N of junction of Hwy 70 and Hwy 89.

Accession No. (KU-)	Donor Number	Locality
14694	92-6-10-2	Ahihad, E of Akko, rocky hill at SE of the junction of Hwy 70 and Hwy 85.
14695	92-5-16-10	10 km W from the junction of Hwy 85 and Hwy 90, Entrance of a factory (ca. 15 km NNW of Tiberias).
14696	92-6-10-3	Bet Rimmon, 1 km N from the junction with Hwy 77 (ca. 18km W of Tiberias).
14697	92-5-26-1	Near the entrance of Technion, Haifa.
14698	92-6-7-2	Carmel Park, E of Haifa Univ., Haifa.
14699	92-6-9-1	W of Haifa Univ., Haifa.
14700	92-5-9-1Y	Karmel Y.H., Hof haKarmel, Haifa.
14701	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (black glume).
14702	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (white glume).
14703	92-6-18-1	Umm el Farm, along Hwy 65.
14704	92-5-30-1	Ma'agan Mikha'el, S of Tanninim River.
14705	92-5-29-3	Maanit, on rocky hill, E of Hwy 585 (ca. 6 km E of Hadera).
14706	92-6-19-4b	3 km E of Ma'ale Mikhmas, slope along Hwy 458.
14707	92-6-15-1	South of Hebrew Univ., Giv'at Ram, Jerusalem.
14708	92-5-24-8	12 km SW From Mahane Yattir, slope of a wadi (ENE of Be'er Sheva).
<i>Ae. biuncialis</i>		
14711	92-6-21-3	W of Majdal Shams (slender type).
14712	92-6-21-3	W of Majdal Shams (round type).
14713	92-6-21-2	S of Majdal Shams (round type).
14714	92-6-13-5	South Menara, along Hwy 988 (SW of Qir Shemona, slender type).
14715	92-6-13-4	Junction of Hwy 899 and Hwy 988, N of Ramot Naftali (routed type).
14716	92-6-13-1	Meron, about 200m E from the junction of Hwy 89. and Hwy 866 (round type).
14717	92-6-6-4	Netu'a, along Hwy 899 (round type).
14718	92-6-15-1	South of Hebrew Univ., Giv'at Ram, Jerusalem (slendar type). Shemona.).
<i>Ae. variabilis</i>		
14721	92-6-21-3	W of Majdal Shams.
14722	92-6-21-2	S of Majdal Shams.
14723	92-6-21-5	NE of Har Hushniyya, junction of Hwy 98 and Hwy 87.
14724	92-6-21-1	3 km E of Za'ura, along Hwy 99 from Qir-Shemona to Mas'ada.
14725	92-5-16-7	In a field near Tel Dan (ca. 7 km ENE of Qir Shemona.).
14726	92-5-28-4	Metulla, rocky slope under pine trees, 1 km S of the town (N of Qir Shemona).
14727	92-5-28-6	Along old road of Hwy 90, 0.5 km S from the junction with Hwy 977 (ca. 5km S of Qir Shemona).
14728	92-5-28-2	Elifelet, N of Sea of Galilee, under pine trees along Hwy 90.
14729	92-5-16-1	Sea level point along Hwy 90, N of Sea of Galilee, about 100 m N from

Accession No. (KU-)	Donor Number	Locality
		the road.
14730	92-5-28-7	2 km SE from the junction of Hwy 87 and Hwy 92 (NE of Sea of Galilee).
14731	92-6-13-5	South Menara, along Hwy 988 (SW of Qir Shemona).
14732	92-6-13-4	Junction of Hwy 899 and Hwy 988, N of Ramot Naftali.
14733	92-6-13-3	W of Zefat, about 1 km N from the junction of Hwy 89 and Hwy 988.
14734	92-6-13-1	Merom, about 200m E from the junction of Hwy 89 and Hwy 866.
14735	92-6-6-4	Netu'a, along Hwy 899.
14736	92-6-6-3	Near Hanita, 1.5 km NE from the junction of Hwy 70 and Hwy 899.
14737	92-6-10-1	Gesher haZiw, N of Nahariyya.
14738	92-5-16-13	Kabri, E of Nahariyya, 0.5 km N of the junction of Hwy 70 and Hwy 89.
14739	92-5-16-10	10 km W from the junction of Hwy 85 and Hwy 90, Entrance of a factory (ca. 15 km NNW of Tiberias).
14740	92-6-6-6	Nahf, along Hwy 85 (near Karmi'el).
14741	92-6-10-2	Ahihud, E of Akko, rocky hill at SE of the junction of Hwy 70 and Hwy 85.
14742A	92-5-21-1-1	NW slope of Tel Akko.
14742B	92-5-21-1-1	NW slope of Tel Akko.
14743	92-5-18-2	Poriyya, along Hwy 768 (ca. 5km S of Tiberias).
14744	92-6-10-3	Bet Rimmon, 1 km N from the junction with Hwy 77 (ca. 18km W of Tiberias).
14745	92-5-18-3	SW of Gesher, about 1 km W from Hwy 90 along Hwy 717 (ca. 12km N of Bet She'an).
14746	92-6-10-4	On the way to Mt. Gilbore, 3 km S from the junction with Hwy 669.
14747	92-5-19-6K	Jiftlik Post, N of Massu'a, rocky slope (short spike).
14748	92-5-19-6K	Jiftlik Post, N of Massu'a, rocky slope (long spike).
14749	92-5-20-6	Gitit, rocky slope N of Hwy 508 (alt 320 m, ca. 9km W of Massu'a).
14750	92-6-19-1	Kokhav HaShahar, rocky slope W of the village.
14751	92-6-19-3	SW of the junction of Hwy 3 and Hwy 458 (ca. 32 km NNW of Jeriho).
14752	92-6-19-4b	3 km E of Ma'ale Mikhmas, slope along Hwy 458.
14753A	92-5-24-8	12 km SW from Mahana Yattir, slope of a wadi (ENE of Be'er Sheva).
14753B	92-5-24-8	12 km SW from Mahana Yattir, slope of a wadi (ENE of Be'er Sheva).
14754	92-6-15-1	South of Hebrew Univ., Giv'at Ram, Jerusalem.
14755	92-6-6-1	Qishon, Haifa, roadside N of the bridge.
14756	92-5-26-1	Near the entrance of Technion, Haifa.
14757	92-6-7-2	Carmel park, E of Haifa Univ., Haifa.
14758	92-6-9-1	W of Haifa Univ., Haifa.
14759	92-5-9-1Y	Karmel Y.H., Hof haKarmel, Haifa.
14760	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (short, black spike).
14761	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (short, white spike).

Accession No. (KU-)	Donor Number	Locality
14762	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (long spike, black, long awn).
14763	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (long spike, white, awnless).
14764	92-6-11-1	Nahal Oren, S of Haifa, Basin along wadi (long spike, white, long awn).
14765	92-5-29-1	Beach in Dor haBonim Nature Reserve, near haBonim (black glume).
14766	92-5-29-1	Beach in Dor haBonim Nature Reserve, near haBonim (white glume).
14767	92-5-30-1	Ma'agan Mikha'el, S of Tanninim River.
14768	92-5-22-2	Ramat haNadiv in Zikhron Ya'aqov.
14769	92-6-18-1	Umm el Fahm, along Hwy 65.
14770	92-5-29-3	Maanit, on rocky hill, E of Hwy 585 (ca. 6 km E of Hadera).
14771	92-6-11-3	W of Binyamina about 300m E from Hwy 4, by <i>Eriobotrya japonica</i> orchard.
14772	92-5-11-1	Caesarea, entrance of the golf course.
14773A	92-5-11-5-1	NE of Giv'at Olga Junction of Hwy 2 to Hadera, entrance of a Hospital.
14773B	92-5-11-5-1	NE of Giv'at Olga Junction of Hwy 2 to Hadera, entrance of a Hospital.
14774	92-5-11-3	Mikhmoret, 10 km S from Hadera Junction of Hwy 2 (black glume).
14775	92-5-11-3	Mikhmoret, 10 km S from Hadera Junction of Hwy 2 (white glume).
14776	92-5-29-4	Netanya, S of haSharon Junction of Hwy 4 and Hwy 57.
14777A	92-5-23-2	Wingate, S of Netanya, along Hwy 2 (normal size spike).
14777B	92-5-23-2	Wingate, S of Netanya, along Hwy 2 (normal size spike).
14778A	92-5-23-2	Wingate, S of Netanya, along Hwy 2 (small size spike).
14778B	92-5-23-2	Wingate, S of Netanya, along Hwy 2 (small size spike).
14778C	92-5-23-2	Wingate, S of Netanya, along Hwy 2 (small size spike).
14779A	92-5-1-5	Herzliyya, along Hwy 2.
14779B	92-5-1-5	Herzliyya, along Hwy 2.
14780	92-5-11-4-5	Zahara, north Tel Aviv.
14781	92-6-16-1	Rishon le Ziyon, NE of the junction of Hwy 4.
14782	92-5-8-8	Rishon le Ziyon, near the beach.
14783	92-5-8-7	Near Soreq Nuclear Center, roadside under pine trees.
14784	92-5-13-2	North Ashdod, roadside under pine trees (short spike).
14785	92-5-13-2	North Ashdod, roadside under pine trees (long spike).
14786	92-5-23-5	Nizzanim, by the way to Field School (short awn).
14787	92-5-23-5	Nizzanim, by the way to Field School (long awn).
14788	92-5-8-3	5 km N of Ashqelon, along Hwy 4.
14789	92-5-8-1	Ashqelon, between the junction of Hwy 4 and the beach.
14790	92-6-5-6	2 km E of Kefar Mehanem, in a small grassland between Hwy 383 and a cotton field, ca. 20 km ESE of Ashdod (short spike).
14791	92-6-5-6	2 km E of Kefar Mehanem, in a small grassland between Hwy 383 and a cotton field, ca. 20 km ESE of Ashdod (long spike).

Accession Donor

No. (KU-) Number

Locality

14792	92-6-12-4	S of Ahuzzam, along Hwy 40 (ca. 8 km S of Qiryat Gat).
14793	92-6-5-4	Sa'ad, at the junction of Hwy 25 and Hwy 232, NW of Netivot.
14794	92-6-5-5	Netivot, near the junction of Hwy 25 and Hwy 293.
<i>Ae. kotschy</i>		
14801	92-5-15-5	Nahal Bitronet, along Hwy 90 (ca. 25 km S of Bet She'an Junction).
14802	92-5-19-6K	Jiftlik Post, N of Massu'a, rocky slope.
14803	92-5-19-4K	Niran, rocky hill near Hwy 90 (ca. 10km N of Jeriho).
14804	92-5-19-3K	3 km NE of Mizpe Jeriho (rocky slope, SW of Jeriho).
14805	92-6-1-1	Qumeran (NW of Dead Sea).
14806	92-6-19-4b	3 km E of Ma'ale Mikhmas, ditch along Hwy 458.
14807	92-6-19-6	E of Kefar Adummin, at the Junction of Hwy 1 and Hwy 458 (ca. 14km ENE of Jerusalem).
14808	92-5-24-4	Arad Park, W of Arad.
14809	92-5-24-5	0.5 km S of Tel Arad, W of Arad, bottom of a wadi.
14810	92-5-24-6b	8 km N of Tel Arad, NW of Arad.
14811	92-5-24-7	North of Har Amassa Nature Reserve, at the junction to a Kibbutz (E of Mahane Yattir).
14812	92-5-20-7	Mahane Yattir, under pine trees (ENE of Be'er Sheva).
14813	92-5-20-8	About 5 km SW from Mahane Yattir, near a wadi (ENE of Be'er Sheva).
14814	92-5-24-8	12 km SW from Mahane Yattir, slope of a wadi (ENE of Be'er Sheva).
14815	92-5-24-9	6 km NW along Hwy 31 from Shoqet Junction with Hwy 60 (NE of Be'er Sheva).
14816	92-5-14-1	6 km NE of Be'er Sheva, along Hwy 60.
14817	92-5-23-7-1	At haNashi Junction of Hwy 25 and Hwy 264.
14818	92-4-26-3	Ze'elim, along Hwy 222.
14819	92-4-29-1	2 km E of Kerem Shalom, near km10 along Hwy 232.
14820	92-6-2-1	5 km SSW along Hwy 206 from Rotem Junction with Hwy 25 (SE of Dimona).
14821	92-6-2-2	Bottom of the Great Crater, along Hwy 225 (ca. 8 km ESE of Yeroham).
14822	92-5-24-3	21 km SE from Nevatim, along Hwy 25 (NW of Dimona).
14823	92-5-24-2	6 km SE from Nevatim, along Hwy 25.
14824	92-5-24-1a	Nevatim, entrance of the village.
14825	92-5-14-2	W of Mashabbim Junction of Hwy 40 and Hwy 222 (ca. 25km S of Be'er Sheva, black glume).
14826	92-5-14-2	W of Mashabbim Junction of Hwy 40 and Hwy 222 (ca. 25km S of Be'er Sheva, white glume).
14827	92-5-14-3	5 km E from the Egyptian border, along Hwy 211 (E of Nizzana).
14828	92-5-14-4	15 km E from the Egyptian border, along Hwy 211 (E of Nizzana).
14829	92-5-14-5-2	7 km S from Telalim Junction along Hwy 40, bottom of a wadi (N of Sede Boqer).

Accession Donor

No. (KU-) Number

Locality

14830	92-5-14-6a	Entrance of Sede Boqer.
14831	92-6-2-4	6 km N of Mizpe Ramon, SW of the junction of Hwy 171 and Hwy 40.
14832	92-6-2-3	Mizpe Ramon, near Field Study Center.
14833	92-5-14-8	About 20km SW from haRuhot Junction along Hwy 171, WSW of Mizpe Ramon.

Ae. triuncialis

14841	92-6-21-3	W of Majdal Shams.
14842	92-6-21-2	S of Majdal Shams.
14843	92-6-8-1	Quneitra, along Hwy 98 (Quneitra - Merom Golan).
14844	92-6-21-5	NE of Har Hushniyya, Junction of Hwy 98 and Hwy 87.

Ae. cylindrica

14851	92-6-6-1	Qishon, Haifa, roadside N of the bridge (glume pubescent).
14852	92-6-6-1	Qishon, Haifa, roadside N of the bridge (glume glabrous).



IV. Recent publications on wheat genetics

Following references are selected from the original database, Life Sciences Collection of Cambridge Scientific Abstracts, using key words, Wheat and Genetics. The present list is continued from that in the last issue of WIS. The editor thanks CSA for authorizing WIS to publish the database.

1995

(3)

ACCN:001469856 CTLN:3720886

ABSJ:G (Genetics Abstracts); K (Microbiology Abstracts C: Algology, Mycology & Protozoology);
W2(Agricultural and Environmental Biotechnology Abstracts)

AUTH:Chen, X.M.;Jones, S.S.;Line, R.F.

AFFN:Dep. Plant Pathol., Washington State Univ., Pullman, WA 99164-6430, USA

TITL:Chromosomal location of genes for stripe rust resistance in spring wheat cultivars
Compair, Fielder, Lee, and Lemhi and interactions of aneuploid wheats with races of
Puccinia striiformis

HTIL:PHYTOPATHOLOGY

HSSN:0331-949X

HYER:1995

HCOL:vol. 85, no. 3, pp. 375-381

(4)

ACCN:001470021 CTLN:3721051

ABSJ:G (Genetics Abstracts); K (Microbiology Abstracts C: Algology, Mycology & Protozoology)

AUTH:Lutz, J.;Hsam, S.L.K.;Limpert, E.;Zeller, F.J.*

AFFN:Tech. Univ. Muenchen, Inst. Pflanzenbau und Pflanzenzuecht., D-85350 Freising-
Weiherstephen, FRG

TITL:Chromosomal location of powdery mildew resistance genes in *Triticum aestivum* L.
(common wheat). 2. Genes Pm2 and Pm19 from *Aegilops squarrosa* L.

HTIL:HEREDITY

HSSN:0018-067X

HYER:1995

HCOL:vol. 74, no. 2, pp. 152-156

(5)

ACCN:001474139 CTLN:3725597

ABSJ:G (Genetics Abstracts); W2(Agricultural and Environmental Biotechnology Abstracts)

AUTH:Suzuki, T.;Nakamura, C.;Mori, N.;Kaneda, C.

AFFN:Div. Biol. Res., Grad. Sch. Sci. Technol., Kobe Univ., Nada-ku, Kobe 657, Japan

TITL:Overexpression of mitochondrial genes in alloplasmic common wheat with a cytoplasm of
wheatgrass (*Agropyron trichophorum*) showing depressed vigor and male sterility

HTIL:PLANT MOL. BIOL.
HSSN:0167-4412
HYER:1995
HCOL:vol. 27, no. 3, pp. 553-565

(6)
ACCN:001480953 CTLN:3732032
ABSJ:K (Microbiology Abstracts C: Algology, Mycology & Protozoology); G (Genetics Abstracts)
AUTH:Hsam, S.L.K.;Cermeno, M.-C.;Friebe, B.;Zeller, F.J.
AFFN:Techn. Univ. Muenchen, Inst. Pflanzenbau und Pflanzenzuechtung, D 85350 Freising-
Weihenstephan, FRG
TITL:Transfer of Amigo wheat powdery mildew resistance gene Pm17 from T1AL. 1RS to the
T1BL.1RS wheat-rye translocated chromosome
HTIL:HEREDITY
HSSN:0018-067X
HYER:1995
HCOL:vol. 74, no. 5, pp. 497-501

(7)
ACN:001480972 CTLN:3732051
ABSJ:G (Genetics Abstracts)
AUTH:Fernandez-Calvin, B.;Benavente, E.;Orellana, J.
AFFN:Unidad Genet., ETSI Agron., Univ. Politec. Madrid, Ciudad Univ., E- 28040 Madrid,
Spain
TITL:Meiotic pairing in wheat-rye derivatives detected by genomic in situ hybridization and C-
banding A comparative analysis
HTIL:CHROMOSOMA
HSSN:0009-5915
HYER:1995
HCOL:vol. 103, no. 8, pp. 554-558

(8)
ACCN:001488773 CTLN:3740548
ABSJ:A (Microbiology Abstracts A: Industrial & Applied Microbiology); G (Genetics Abstracts)
AUTH:Broers, L.H.M.;Lopez-Atilano, R.M.
AFFN:Dep. Plant Breed., Wageningen Agric. Univ., P.O. Box 386, 6700 AJ Wageningen,
Netherlands
TITL:Effect of interplot interference on the assessment of partial resistance to stem rust in
durum wheat
HTIL:PHYTOPATHOLOGY
HSSN:0331-949X
HYER:1995
HCOL:vol. 85, no. 2, pp. 233-242

(9)

ACCN:001492953 CTLN:3744018

ABSJ:G (Genetics Abstracts)

AUTH:Upelniak, V.P.;Novoselskaya, A.Yu.;Sutka, J.;Galiba, G.;Metakovsky, E. V.*

AFFN:Ist. Spe. Cerealicult., Via Mulino 3, 20079 S. Angelo Lodigiano (Mi), Italy

TITL:Genetic variation at storage protein-coding loci of common wheat (cv 'Chinese Spring')
induced by nitrosoethylurea and by the cultivation of immature embryos in vitro

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 3-4, pp. 372-379

(10)

ACCN:001492982 CTLN:3744047

ABSJ:G (Genetics Abstracts)

AUTH:Zhong, G.-Y.;Dvorak, J.

AFFN:Dep. Agron. and Range Sci., Univ. California, Davis, CA 95616, USA

TITL:Chromosomal control of the tolerance of gradually and suddenly imposed salt stress in the
Lophopyrum elongatum and wheat, Triticum aestivum L., genomes

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 2, pp. 229-236

(11)

ACCN:001492983 CTLN:3744048

ABSJ:G (Genetics Abstracts)

AUTH:Van Eeuwijk, F.A.;Mesterhazy, A.;Kling, Ch.I.;Ruckenbauer, P.;Saur, L.; Buerstmayr,
H.;Lemmens, M.;Keizer, L.C.P.;Maurin, N.;Snijders, C.H.A.

AFFN:DLO-Cent. Plant Breed. and Reprod. Res. (CPRO -DLO) P.O. Box 16, NL- 6700 AA
Wageningen, Netherlands

TITL:Assessing non-specificity of resistance in wheat to head blight caused by inoculation with
European strains of Fusarium culmorum, F. graminearum and F. nivale using a
multiplicative model for interaction

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 2, pp. 221-228

(12)

ACCN:001492987 CTLN:3744052

ABSJ:G (Genetics Abstracts)

AUTH:Koebner, R.M.D.

AFFN:Cereals Res. Dep., John Innes Cent., Norwich Res. Park, Colney NR4 7UJ, UK
TITL:Generation of PCR-based markers for the detection of rye chromatin in a wheat
background
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 5, pp. 740-745

(13)
ACCN:001492989 CTLN:3744054
ABSJ:G (Genetics Abstracts)
AUTH:Devos, K.M.;Bryan, G.J.;Collins, A.J.;Stephenson, P.;Gale, M.D.
AFFN:Cambridge Lab., John Innes Cent., Norwich Res. Park, Colney, Norwich NR4 7UH, UK
TITL:Application of two microsatellite sequences in wheat storage proteins as molecular
markers
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 2, pp. 247-252

(14)
ACCN:001492991 CTLN:3744056
ABSJ:G (Genetics Abstracts)
AUTH:Mori, N.;Liu, Y.-G.;Tsunewaki, K.*
AFFN:Lab. Genet., Fac. Agric., Kyoto Univ., Sakyo-ku, Kyoto 606-01, Japan
TITL:Wheat phylogeny determined by RFLP analysis of nuclear DNA. 2. Wild tetraploid wheats
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 1, pp. 129-134

(15)
ACCN:001492995 CTLN:3744060
ABSJ:G (Genetics Abstracts)
AUTH:Lee, J.H.;Graybosch, R.A.*;Peterson, C.J.
AFFN:USDA-ARS, Univ. Nebraska, Lincoln, NE 68583, USA
TITL:Quality and biochemical effects of a 1BL/1RS wheat-rye translocation in wheat
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 1, pp. 105-112

(16)
ACCN:001493004 CTLN:3744069

ABSJ:G (Genetics Abstracts)

AUTH:Friebe, B.;Jiang, J.;Tuleen, N.;Gill, B.S.

AFFN:Dep. Plant Pathol., Wheat Genet. Resour. Cent., Throckmorton Hall, Kansas State Univ.,
Manhattan, KS 66506-5502, USA

TITL:Standard karyotype of *Triticum umbellulatum* and the characterization of derived
chromosome addition and translocation lines in common wheat

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 1, pp. 150-156

(17)

ACCN:001493013 CTLN:3744078

ABSJ:G (Genetics Abstracts)

AUTH:Tsujiimoto, H.

AFFN:Kihara Inst. Biol. Res., Yokohama City Univ., Mutsukawa 3-122-20, Minamiku,
Yokohama 232, Japan

TITL:Gametocidal genes in wheat and its relatives. IV. Functional relationships between six
gametocidal genes

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 283-289

(18)

ACCN:001493014 CTLN:3744079

ABSJ:G (Genetics Abstracts)

AUTH:Chee, P.W.;Lavin, M.;Talbert, L.E.

AFFN:Dep. Plant, Soil, and Environ. Sci., Montana State Univ., Bozeman, MT 59717, USA

TITL:Molecular analysis of evolutionary patterns in U genome wild wheats

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 290-297

(19)

ACCN:001493118 CTLN:3744183

ABSJ:G (Genetics Abstracts)

AUTH:Bai, D.;Scoles, G.J.;Knott, D.R.

AFFN:Univ. Saskatchewan, Saskatoon, SK S7N 0W0, Canada

TITL:Rust resistance in *Triticum cylindricum* Ces. (4x, CCDD) and its transfer into durum and
hexaploid wheats

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 1, pp. 8-16

(20)

ACCN:001493125 CTLN:3744190

ABSJ:G (Genetics Abstracts)

AUTH:Hsiao, C.;Chatterton, N.J.;Asay, K.H.;Jensen, K.B.

AFFN:USDA/ARS, For. and Range Res. Lab., Utah State Univ., Logan, UT 84322-6300, USA

TITL:Phylogenetic relationships of the monogenomic species of the wheat tribe, Triticeae
Poaceae), inferred from nuclear rDNA (internal transcribed spacer) sequences

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 211-223

(21)

ACCN:001493128 CTLN:3744193

ABSJ:G (Genetics Abstracts)

AUTH:Ghaemi, M.;Sarraf, A.*;Morris, R.

AFFN:Inst. Natl. Polytech. Toulouse, Lab. Biotechnol. et Amelior. Plantes, Dir. Rec. et Etud.
Doct. 832, 145, Ave. Muret, 31076 Toulouse Cedex, France

TITL:Reciprocal substitutions analysis of embryo induction and plant regeneration from anther
culture in wheat (*Triticum aestivum* L.)

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 1, pp. 158-165

(22)

ACCN:001493143 CTLN:3744208

ABSJ:G (Genetics Abstracts)

AUTH:Cooper, M.;Woodruff, D.R.;Eisemann, R.L.;Brennan, P.S.;DeLacy, I.H.

AFFN:Dep. Agric., Univ. Queensland, Brisbane, Qld. 4072, Australia

TITL:A selection strategy to accommodate genotype-by-environment interaction for grain yield
of wheat: Managed-environments for selection among genotypes

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 3-4, pp. 492-502

(23)

ACCN:001493165 CTLN:3744230

ABSJ:G (Genetics Abstracts)

AUTH:Ghannadha, M.R.;Gordon, I.L.*;Cromey, M.G.;McEwan, J.M.

AFFN:Seed and Crop Group, Plant Sci. Dep., Massey Univ., Palmerston N., New Zealand
TITL:Diallel analysis of the latent period of stripe rust in wheat
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 3-4, pp. 471-476

(24)

ACCN:001493168 CTLN:3744233
ABSJ:G (Genetics Abstracts)
AUTH:Pogna, N.E.;Redaelli, R.;Vaccino, P.;Biancardi, A.M.;Peruffo, A.D.B.; Curioni, A.;
Metakovsky, E.V.;Pagliaricci, S.
AFFN:Ist. Spe. Cerealicolt., Sect. Appl. Genet., Via Cassia 176, 00191 Roma, Italy
TITL:Production and genetic characterization of near-isogenic lines in the bread-wheat cultivar
Alpe
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 5, pp. 650-658

(25)

ACCN:001493170 CTLN:3744235
ABSJ:G (Genetics Abstracts)
AUTH:Francis, H.A.;Leitch, A.R.;Koebner, R.M.D.
AFFN:John Innes Cent., Norwich Res. Park, Colney NR4 7UJ, UK
TITL:Conversion of a RAPD-generated PCR product, containing a novel dispersed repetitive
element, into a fast and robust assay for the presence of rye chromatin in wheat
HTIL:THEOR. APPL. GENET.
HSSN:0040-5752
HYER:1995
HCOL:vol. 90, no. 5, pp. 636-642

(26)

ACCN:001493176 CTLN:3744241
ABSJ:G (Genetics Abstracts)
AUTH:Larkin, P.J.;Banks, P.M.;Lagudah, E.S.;Appels, R.;Xiao, Chen;Zhiyong, Xin;Ohm,H.W.;
McIntosh, R.A.
AFFN:CSIRO, Div. Plant Ind., P.O. Box 1600, Canberra, ACT 2601, Australia
TITL:Disomic Thinopyrum intermedium addition lines in wheat with barley yellow dwarf virus
resistance and with rust resistances
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 2, pp. 385-394

(27)

ACCN:001493182 CTLN:3744247

ABSJ:G (Genetics Abstracts)

AUTH:Ma, H.;Hughes, G.R.*

AFFN:Dep. Crop Sci. and Plant Ecol., Univ. Saskatchewan, Saskatoon, SK S7N 0W0, Canada

TITL:Genetic control and chromosomal location of *Triticum timopheevii*-derived resistance to
septoria nodorum blotch in durum wheat

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 332-338

(28)

ACCN:001493186 CTLN:3744251

ABSJ:G (Genetics Abstracts)

AUTH:Banks, P.M.;Larkin, P.J.*;Bariana, H.S.;Lagudah, E.S.;Appels, R.; Waterhouse, P.M.;
Brettell, R.I.S.;Chen, X.;Xu, H.J.;et al.

AFFN:CSIRO, Div. Plant Ind., P.O. Box 1600, Canberra, ACT 2601, Australia

TITL:The use of cell culture for subchromosomal introgressions of barley yellow dwarf virus
resistance from *Thinopyrum intermedium* to wheat

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 395-405

(29)

ACCN:001493199 CTLN:3744264

ABSJ:G (Genetics Abstracts)

AUTH:Das, M.K.;Griffey, C.A.*

AFFN:Dep. Crop and Soil Environ. Sci., Virginia Polytech. Inst. and State Univ., Blacksburg,
VA 24061, USA

TITL:Gene action for adult-plant resistance to powdery mildew in wheat

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 277-282

(30)

ACCN:001493200 CTLN:3744265

ABSJ:G (Genetics Abstracts)

AUTH:Dong, H.;Quick, J.S.

AFFN:Dep. Agron., Colorado State Univ., Fort Collins, CO 80523, USA

TITL:Detection of a 2.6 kb single/low copy DNA sequence on chromosomes of wheat (*Triticum*

aestivum) and rye (*Secale cereale*) by fluorescence in situ hybridization

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 246-249

(31)

ACCN:001493201 CTLN:3744266

ABSJ:G (Genetics Abstracts)

AUTH:Hartl, L.;Weiss, H.;Stephan, U.;Zeller, F.J.;Jahoor, A.*

AFFN:Lehrstuhl Pflanzenbau und Pflanzenzuecht., Tech. Univ. Munich, 85350 Freising-Weihenstephan, FRG

TITL:Molecular identification of powdery mildew resistance genes in common wheat (*Triticum aestivum* L.)

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 5, pp. 601-606

(32)

ACCN:001493202 CTLN:3744267

ABSJ:G (Genetics Abstracts)

AUTH:Islam-Faridi, M.N.;Mujeeb-Kazi, A.*

AFFN:CIMMYT, Lisboa 27, Apdo. Postal 6-641, 06600 Mexico, D. F., Mexico

TITL:Visualization of *Secale cereale* DNA in wheat germ plasm by fluorescen in situ hybridization

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 5, pp. 595-600

(33)

ACCN:001493203 CTLN:3744268

ABSJ:G (Genetics Abstracts)

AUTH:Autrique, E.;Singh, R.P.;Tanksley, S.D.;Sorrells, M.E.

AFFN:Dep. Plant Breed. and Biom., 252 Emerson Hall, Cornell Univ., Ithaca, NY 14853, USA

TITL:Molecular markers for four leaf rust resistance genes introgressed into wheat from wild relatives

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 1, pp. 75-83

(34)

ACCN:001493210 CTLN:3744275

ABSJ:G (Genetics Abstracts)

AUTH:Sibikeev, S.N.;Voronina, S.A.;Krupnov, V.A.

AFFN:Lab. Genet. and Cytol., Agric. Res. Inst. South-East Reg., Tulaikov St., 7, Saratov,
410020, Russia

TITL:Genetic control for resistance to leaf rust in wheat-Agropyron lines: Agro 139 and Agro 58

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 5, pp. 618-620

(35)

ACCN:001493211 CTLN:3744276

ABSJ:G (Genetics Abstracts)

AUTH:Lukaszewski, A.J.

AFFN:Dep. Bot. and Plant Sci., Univ. California, Riverside, CA 92521-0124, USA

TITL:Physical distribution of translocation breakpoints in homoeologous recombinants induced
by the absence of the Ph1 gene in wheat and triticale

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 90, no. 5, pp. 714-719

(36)

ACCN:001493215 CTLN:3744280

ABSJ:G (Genetics Abstracts)

AUTH:Sharma, H.;Ohm, H.;Goulart, L.;Lister, R.;Appels, R.;Benhabib, O.

AFFN:Dep. Agron., Purdue Univ., West Lafayette, IN 47907, USA

TITL:Introgression and characterization of barley yellow dwarf virus resistance from
Thinopyrum intermedium into wheat

HTIL:GENOME

HSSN:0831-2796

HYER:1995

HCOL:vol. 38, no. 2, pp. 406-413

(37)

ACCN:001493343 CTLN:3744443

ABSJ:G (Genetics Abstracts)

AUTH:Cox, T.S.;Sears, R.G.;Bequette, R.K.

AFFN:USDA-ARS, Agron. Dep., Throckmorton Hall, Kansas State Univ., Manhattan, KS 66506,
USA

TITL:Use of winter wheat x Triticum tauschii backcross populations for germplasm evaluation

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995
HCOL:vol. 90, no. 3-4, pp. 571-577

(38)
ACCN:001495845 CTLN:3747097
ABSJ:G (Genetics Abstracts)
AUTH:Kellogg, E.A.;Appels, R.
AFFN:Harvard Univ. Herbaria, 22 Divinity Ave., Cambridge, MA 02138, USA
TTTL:Intraspecific and interspecific variation in 5S RNA genes are decoupled in diploid wheat relatives
HTTL:GENETICS
HSSN:0016-6731
HYER:1995
HCOL:vol. 140, no. 1, pp. 325-343

(39)
ACCN:001496242 CTLN:3747531
ABSJ:V (Virology & AIDS Abstracts); N (Biochemistry Abstracts 2: Nucleic Acids)
AUTH:Chen, Jianping;Macfarlane, S.A.;Wilson, M.A.*
AFFN:Dep. Virol., Scottish Crop Res. Inst., Invergowrie, Dundee DD2 5DA, UK
TTTL:An analysis of spontaneous deletion sites in soil-borne wheat mosaic virus RNA2
HTTL:VIROLOGY
HSSN:0042-6822
HYER:1995
HCOL:vol. 209, no. 1, pp. 213-217

(40)
ACCN:001502015 CTLN:3753996
ABSJ:G (Genetics Abstracts)
AUTH:Dubcovsky, J.;Luo, Ming-Cheng;Dvorak, J.
AFFN:Dep. Agron. and Range Sci., Univ. California, Davis, CA 95616, USA
TTTL:Differentiation between homoeologous chromosomes 1A of wheat and 1A super(m of Triticum monococcum and its recognition by the wheat Ph1 locus
HTTL:PROC. NATL. ACAD. SCI. USA
HSSN:0027-8424
HYER:1995
HCOL:vol. 92, no. 14, pp. 6645-6649

(41)
ACCN:001502465 CTLN:3754447
ABSJ:K (Microbiology Abstracts C: Algology, Mycology & Protozoology); W2(Agricultural and Environmental Biotechnology Abstracts)
AUTH:Lees, A.K.;Nicholson, P.;Rezanoor, H.N.;Parry, D.W.
AFFN:Crop and Environ. Res. Cent., Harper Adams Coll., Newport, Shropshire TF10 8NB, UK

TITL:Analysis of variation within *Microdochium nivale* from wheat: Evidence for a distinct sub-group

HTIL:MYCOL. RES.

HSSN:0953-7562

HYER:1995

HCOL:vol. 99, no. 1, pp. 103-109

(42)

ACCN:001509357 CTLN:3760894

ABSJ:G (Genetics Abstracts); K (Microbiology Abstracts C: Algology, Mycology & Protozoology)

AUTH:McIntosh, R.A.;Friebe, B.;Jiang, J.;The, D.;Gill, B.S.

AFFN:Univ. Sydney Plant Breed. Inst. - Cobbitty, Priv. Bag 11, Camden, N.S. W. 2570, Australia

TITL:Cytogenetical studies in wheat XVI. Chromosome location of a new gene for resistance to leaf rust in a Japanese wheat-rye translocation line

HTIL:EUPHYTICA

HSSN:0014-2336

HYER:1995

HCOL:vol. 82, no. 2, pp. 141-147

(43)

ACCN:001509498 CTLN:3761035

ABSJ:G (Genetics Abstracts); K (Microbiology Abstracts C: Algology, Mycology & Protozoology)

AUTH:Gilbert, J.;Tekauz, A.;Woods, S.M.

AFFN:Agric. and Agri-Food Canada, Winnipeg Res. Cent., 195 Dafoe Rd., Winnipeg, MB R3T 2M9, Canada

TITL:Effect of *Phaeosphaeria nodorum*-induced seed shrivelling on subsequent wheat emergence and plant growth

HTIL:EUPHYTICA

HSSN:0014-2336

HYER:1995

HCOL:vol. 82, no. 1, pp. 9-16

(44)

ACCN:001509740 CTLN:3761277

ABSJ:G (Genetics Abstracts)

AUTH:Van Lill, D.;Purchase, J.L.

AFFN:Technikon Orange Free State, Priv. Bag X20539, Bloemfontein 9300, South Africa

TITL:Directions in breeding for winter wheat yield and quality in South Africa from 1930 to 1990

HTIL:EUPHYTICA

HSSN:0014-2336

HYER:1995

HCOL:vol. 82, no. 1, pp. 79-87

(45)

ACCN:001523281 CTLN:3774863

ABSJ:G (Genetics Abstracts)

AUTH:Lukaszewski, A.J.

AFFN:Dep. Bot. Plant Sci., Univ. California, Riverside, CA 92521-0124, USA

TITL:Chromatid and chromosome type breakage-fusion-bridge cycles in wheat (*Triticum aestivum* L.)

HTIL:GENETICS

HSSN:0016-6731

HYER:1995

HCOL:vol. 140, no. 3, pp. 1069-1085

(46)

ACCN:001524113 CTLN:3775783

ABSJ:G (Genetics Abstracts)

AUTH:Breiman, A.;Graur, D.

AFFN:Dep. Bot., George S. Wise Fac. Life Sci., Tel Aviv Univ., Tel Aviv 69978, Israel

TITL:Wheat evolution

HTIL:ISR. J. PLANT SCI.

HSSN:0792-9978

HYER:1995

HCOL:vol. 43, no. 2, pp. 85-98

(47)

ACCN:001526701 CTLN:3778452

ABSJ:G (Genetics Abstracts)

AUTH:Tosa, Y.;Kusaba, M.;Fujiwara, N.;Nakamura, T.;Kiba, A.;Noda, T.; Furutsu, Y.;Noguchi, H.;Kato, K.

AFFN:Fac. Agric., Kochi Univ., Nankoku Kochi 783, Japan

TITL:Geographical distribution of genes for resistance to formae speciales of *Erysiphe graminis* in common wheat

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752

HYER:1995

HCOL:vol. 91, no. 1, pp. 82-88

(48)

ACCN:001526704 CTLN:3778455

ABSJ:G (Genetics Abstracts)

AUTH:Naranjo, T.

AFFN:Dep. Genet., Fac. Biol., Univ. Complutense Madrid, 28040 Madrid, Spain

TITL:Chromosome structure of *Triticum longissimum* relative to wheat

HTIL:THEOR. APPL. GENET.

HSSN:0040-5752
HYER:1995
HCOL:vol. 91, no. 1, pp. 105-109

(49)

ACCN:001526715 CTLN:3778466
ABSJ:G (Genetics Abstracts)
AUTH:Slafer, G.A.;Rawson, H.M.
AFFN:Cent. Crop Improv., Dep. Agric., Univ. Melbourne, Parkville, Vic. 3052 Australia
TITL:Base and optimum temperatures vary with genotype and stage of development in wheat
HTIL:PLANT, CELL ENVIRON.
HSSN:0140-7791
HYER:1995
HCOL:vol. 18, no. 6, pp. 671-679

(50)

ACCN:001528917 CTLN:3780922
ABSJ:G (Genetics Abstracts)
AUTH:Delaney, D.E.;Friebe, B.R.;Hatchett, J.H.;Gill, B.S.;Hulbert, S.H.
AFFN:Dep. Plant Pathol., Kansas State Univ., Manhattan, KS 66506, USA
TITL:Targeted mapping of rye chromatin in wheat by representational difference analysis
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 3, pp. 458-466

(51)

ACCN:001528921 CTLN:3780926
ABSJ:G (Genetics Abstracts)
AUTH:Xu, S.J.;Joppa, L.R.
AFFN:Dep. Agron., Univ. Illinois, Urbana, IL 61801, USA
TITL:Mechanisms and inheritance of first division restitution in hybrids of wheat, rye, and
Aegilops squarrosa
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 3, pp. 607-615

(52)

ACCN:001528964 CTLN:3780969
ABSJ:G (Genetics Abstracts)
AUTH:Nelson, J.C.;Van Deynze, A.E.;Autrique, E.;Sorrells, M.E.;Lu, Y.H.; Merlino, M.;
Atkinson, M.;Leroy, P.
AFFN:Dep. Plant Breed. and Biom., 255 Emerson Hall, Cornell Univ., Ithaca, NY 14853, USA

TITL:Molecular mapping of wheat. Homoeologous group 2
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 3, pp. 516-524

(53)

ACCN:001528965 CTLN:3780970
ABSJ:G (Genetics Abstracts)
AUTH:Nelson, J.C.;Van Deynze, A.E.;Autrique, E.;Sorrells, M.E.;Lu, Y.H.;Negre, S.;Bernard, M.;Leroy, P.
AFFN:Dep. Plant Breed. and Biom., 255 Emerson Hall, Cornell Univ., Ithaca, NY 14853, USA
TITL:Molecular mapping of wheat. Homoeologous group 3
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 3, pp. 525-533

(54)

ACCN:001528967 CTLN:3780972
ABSJ:G (Genetics Abstracts)
AUTH:Penner, G.A.;Clarke, J.;Bezte, L.J.;Leisle, D.
AFFN:Winnipeg Res. Cent., Agric. and Agri-Food Canada, 195 Dafoe Rd., Winnipeg, MB R3T 2M9, Canada
TITL:Identification of RAPD markers linked to a gene governing cadmium uptake in durum wheat
HTIL:GENOME
HSSN:0831-2796
HYER:1995
HCOL:vol. 38, no. 3, pp. 543-547

(55)

ACCN:001529422 CTLN:3781479
ABSJ:W2(Agricultural and Environmental Biotechnology Abstracts); G (Genetics Abstracts); N (Biochemistry Abstracts 2: Nucleic Acids)
AUTH:Yang, P.;Taoka, K.;Nakayama, T.;Iwabuchi, M.*
AFFN:Dep. Botany, Fac. Sci., Kyoto Univ., Sakyo-ku, Kyoto 606-01, Japan
TITL:Structural and functional characterization of two wheat histone H2B promoters
HTIL:PLANT MOL. BIOL.
HSSN:0167-4412
HYER:1995
HCOL:vol. 28, no. 1, pp. 155-172

(56)

ACCN:001531564 CTLN:3784116

ABSJ:K (Microbiology Abstracts C: Algology, Mycology & Protozoology); G (Genetics Abstracts);
W2(Agricultural and Environmental Biotechnology Abstracts)

AUTH:Chen, Xianming;Line, R.F.

TITL:Gene number and heritability of wheat cultivars with durable, high-temperature, adult-
plant (HTAP) resistance and interaction of HTAP and race-specific seedling resistance to
Puccinia striiformis

HTIL:PHYTOPATHOLOGY

HSSN:0331-949X

HYER:1995

HCOL:vol. 85, no. 5, pp. 573-578

(57)

ACCN:001541144 CTLN:3793070

ABSJ:K (Microbiology Abstracts C: Algology, Mycology & Protozoology); G (Genetics Abstracts);
W2(Agricultural and Environmental Biotechnology Abstracts)

AUTH:Chen, Xianming;Line, R.F.

AFFN:Dep. Plant Pathol., Washington State Univ., ARS/USDA, Pullman, WA 99164-6430, USA

TITL:Gene action in wheat cultivars for durable, high-temperature, adult plant resistance and
interaction with race-specific, seedling resistance to *Puccinia striiformis*

HTIL:PHYTOPATHOLOGY

HSSN:0331-949X

HYER:1995

HCOL:vol. 85, no. 5, pp. 567-572

(58)

ACCN:001542688 CTLN:3794620

ABSJ:K (Microbiology Abstracts C: Algology, Mycology & Protozoology); W2(Agricultural and
Environmental Biotechnology Abstracts); G (Genetics Abstracts)

AUTH:Matsumura, K.;Tosa, Y.*

AFFN:Fac. Agric., Kochi Univ., Nankoku, Kochi 783, Japan

TITL:The rye mildew fungus carries avirulence genes corresponding to wheat genes for
resistance to races of the wheat mildew fungus

HTIL:PHYTOPATHOLOGY

HSSN:3331-949X

HYER:1995

HCOL:vol. 85, no. 7, pp. 753-756



V. Editorial remarks

Since the style of Wheat Information Service was renewed from the last issue, many responses have been sent from subscribers to the editorial office, most are positive. Also, we, the editorial members would like to express deep thanks to the contributors who understood the philosophy and responded to the donation system for funding of WIS. Summary of these contributions will be appeared in the future issues.

In the present issue, we can see a variation of articles, including a genetic stock list and literature information. Further contribution will be welcome anytime. The editorial board has been busy these days after introduction of judging system by reviewers on the research article. The proportion of acceptance is about 45%. Please be careful for your manuscript to follow the description manual. Judging system is functioning to improve the quality of journal. But, at the same time, since WIS is information journal, not complete research articles but also informative idea or experimental plan will be welcome for "Research Information".

In the last issue (No.81), we made a careless mistake of proofing which resulted in missing a few names of International Advisory Board members. We deeply regret to these persons and readers.

Eds.: Kaz. Noda and D.J. Mares

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