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FIFTH SUPPLEMENTARY LIST OF WHEAT VARIETIES CLASSIFIED ACCORDING TO THEIR GENOTYPE FOR HYBRID NECROSIS AND GEOGRAPHICAL DISTRIBUTION OF *Ne*-GENES

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SUMMARY

An account is given about the progress in the work of the last two years. Further work is being done on the geographical distribution of both the *Ne*-genes.

The fifth supplement consists of 144 Ne_1-carriers, 208 Ne_2-carriers and 326 non-carriers, together 678 varieties. The total number of varieties is 2513 being 597 Ne_1-(23.8%), 654 Ne_2-(26.0%) and 1262 (50.2%) non-carriers.

INTRODUCTION

This list is a continuation of a series of which the fourth appeared in 1969 (ZEVEN, 1969a). Many varieties have been investigated and old and new data are an aid to wheat breeders in avoiding necrotic F_1's.

It is interesting to see that in the last two years some reviews on hybrid necrosis have appeared making this phenomenon better known than up to now. These reviews were prepared by ALPTAUEROVÁ (1969, in Czech), DOROFEEV and MEREŽKO (1969, in Russian), PUHAL'SKY and KOZLENKO (1968, in Russian), and DEKAPRILEVICH and YASHAGASHWILI (1970, in Russian). Dekaprilevich is the one who started the research of hybrid necrosis in the twenties (DEKAPRELEVICH, 1930).

These and some other papers comprise new data. Many colleagues have presented me their information about necrotic hybrids. This makes the list more valuable. I highly appreciate their co-operation.

Very weak and weak alleles of both the *Ne*-genes may not always be detected owing to the use of male-sterile tester-lines producing sterile F_1's. So F_2's cannot be checked for the occurrence of necrotic plants.

CENTRE OF DIVERSITY OF THE *Ne*-GENES

DOROFEEV and MEREŽKO (1969, pers. comm. 1970; MEREŽKO, 1970) state that among Caucasian wheats both *Ne*-genes are found. They base this conclusion on the fact that DEKAPRELEVICH (1930), having worked according to these authors with Caucasian wheats only, observed necrotic crosses. The necrotic F_1's resulted from

crossing *T. vulgare velutinum* lines with *T. compactum erinaceum*, *T. vulgare erythrospermum* 077 and 28(77), *T. durum hordeiforme*-, 0192 and *coerulescens*, *T. polonicum villosum* and *T. monococcum*, respectively. In crosses of these *velutinum* lines with other material, F_1's were obtained in which part of the plants died.

In other crosses of the same parents all F_1 plants remained green. The origin of this material is not given. So nothing can yet be said about the presence of Ne_1- and Ne_2-genes in these indigenous Caucasian wheats because it is quite possible that Dekaprilevich used material that had been introduced. However, a new research (DEKAPRILEVICH and YASHAGASHWILI, 1970) with Georgian wheats showed that Ne_2 was found in wheat varieties of *T. vulgare* and *T. compactum*, while Ne_1 was identified in *T. macha*, *T. carthlicum* and *T. palaeocolchicum* (syn. *T. georgicum*).

Ne_2-GENE IN AEGILOPS SPELTOIDES?

Both the *Ne*-genes are located on chromosomes of the B genome: $Ne_1{}^w$ of Chinese Spring on $5B^L$ (unpublished), $Ne_1{}^m$ of Prelude on 5B (TSUNEWAKI, 1960) and $Ne_2{}^s$ of Kharkov on 2B (XIII) (TSUNEWAKI, 1960). Many facts point to *Aegilops speltoides* as the B genome donor of tetra- and hexaploid wheat. Therefore this species was checked for the presence of Ne_1- and Ne_2-genes. A preliminary start was made by crossing the $Ne_1{}^s$ carrying *T. durum* varieties Golden Ball (CI 11851) and KUBANKA (CI 1440) with a mixture of pollen from several *Ae. speltoides* accessions. The results are:

		F_1	
T. durum	2n	number of plants	expression
Golden Ball	21	1	moderately necrotic
Kubanka	21	4	green

This could mean that one of the *Ae. speltoides* accessions carries an $Ne_2{}^m$-allele. This work will be continued on a large scale.

GEOGRAPHICAL DISTRIBUTION OF Ne_1- AND Ne_2-GENES

The work on the geographical distribution of *Ne*-genes has been continued and new information on material covering many regions of the wheat growing area of the Old World supports the earlier conclusion (ZEVEN, 1966, 1969b) that his area can be divided into two by a belt roughly running through the Mediterranean Sea – Black Sea – Lake Bajkal – Japan. To the south and the east lies the Ne_1-area, to the north and the west the Ne_2-area. The intention of this study is to investigate the geographical spread of wheat by man. It is not necessary that this investigation would lead to the centre of origin of the hexaploid wheats because one or even both genes may have introgressed after the hexaploid wheat originated and left this centre. The above indication of a possible presence of an Ne_2-gene in *Ae. speltoides* could point to introgression. If an Ne_2-gene is definitely identified the geographical distribution of *Ae. speltoides*-carrying Ne_2 will be investigated.

In 1969 (ZEVEN, 1969a) I described the subdivision of the Ne_1- and Ne_2-areas into regions in which one of the alleles of the genes was common. As more data have beco-

me available it is possible to delimitate these areas more precisely and to point to new areas.

$Ne_1{}^w$-regions

In 1969 I indicated two $Ne_1{}^w$-regions. One roughly covering Italy – Southern France – Northern Spain – Northern Portugal. New data are Cologna Familia in Italy, Cabezoni and Rojo Basto in Spain and Tremes in Southern Portugal. So this region probably includes the whole of Portugal, but not Southern and Eastern Spain. The $Ne_1{}^w$ carriers Balkan 1941/1495 of Albania and Balkan 1941/2228 of Greece probably belong to this region too.

A second $Ne_1{}^w$-region lies in N.W. India, Southern West Pakistan and Eastern Iran. New data as Ajeba and Pusa 12 (selection from the local wheat Mundia) from Punjab, India and Shahpassand from Iran support this area.

Some varieties with weak Ne_1-alleles are found in China (Chinese Spring, a very weak $Ne_1{}^w$-allele), in Taiwan (Tainan–3, $Ne_1{}^w$) and in Tibet (Tibet 12, $Ne_1{}^w$). Chinese Spring resembles the Chinese *vulgare* wheats (Cambridge) V 12 and V 13, which have come from the region of Chungking (about 29 °N, 106 °E) (RILEY et al., 1967). Maybe Chinese Spring originally also came from this area. The *Ne*-genotype of V 12 and V 13 is not yet determined. It is too early to conclude that this area is an $Ne_1{}^w$-region.

$Ne_1{}^m$-regions

In 1969 I pointed to the large $Ne_1{}^m$-region Turkey – Caucasus – Kazakhstan – Omsk-district – possibly Northwestern Iran. The district south of Lake Aral and east of the Caspian Sea can be added to this region and so can the northern part of Saudi Arabia. No data are yet available about its southern part.

A second $Ne_1{}^m$-region is found in Northern Nigeria. It is possible that this area extends in an eastern direction (Sudan-4), but not into the Sahara, where non-carriers are found (see below).

Outside these areas some $Ne_1{}^m$-varieties are found e.g. in Japan, China, Northern India, Tibet, Canary Islands, Egypt, Tunisia, Southern France, Italy, Portugal, Rumania. Those of Japan and maybe China and Tibet will probably make out a third $Ne_1{}^m$-region. Others are found in non-carrier areas a Northern India, and Egypt. This allele is probably present in these local wheat populations at a low frequency.

$Ne_1{}^s$-region

An $Ne_1{}^s$-region has not been found. For an explanation see ZEVEN (1969a).

$Ne_2{}^{ms}$- and $Ne_2{}^s$-regions

In 1969 I indicated the Crim-Ukraine area as an $Ne_2{}^{ms}/Ne_2{}^s$-region. This region probably links up with that of Poland.

An $Ne_2{}^s$-region is found in-Southern Finland and Southern Sweden. The latter area also belongs to a non-carrier region.

An $Ne_2{}^{ms}$-region is observed in Western Europe (the Netherlands, Belgium and Western France).

An $Ne_2{}^s$-region is found West of Lake Bajkal; Japan is besides a possible $Ne_1{}^m$-area also an $Ne_2{}^{ms}$-region.

No $Ne_2{}^m$-, $Ne_2{}^{mw}$- and $Ne_2{}^w$-regions are found (so far). Improved varieties carrying $Ne_2{}^w$-allele often have a Scandinavian wheat as an ancestor.

Non-carrier regions

As shown in 1969 TSUNEWAKI and NAKAI (1957a) found a non-carrier region in Central and Northern Iran, Afghanistan and Central West Pakistan. This region can be extended into Western Turkestan (U.S.S.R.) and to Kashmir.

A second region of non-carriers is that of Southern Greece, including Creta, the Mediterranean islands, Southern Italy, Eastern and Southern Spain, North Africa (from Morocco to Egypt) and the Sahara. This region does include the Sahara wheats (DUCELLIER, 1920; AL-JIBOURI, 1966; JAKUBZINER, 1969a, 1969b), although these wheats do not morphologically resemble the wheats of Morocco and Tunisia. Very interesting might be the finding of the few tested Ethiopian wheats as being non-carriers.

Quite unexpected was the establishment of a non-carrier region running from probably Southern Norway – Southern Sweden – Denmark – Northern Poland – Eastern France – Germany – Switzerland – Austria – Hungary – Yugoslavia. Most wheats are non-carriers while a few carry the Ne_2 gene. This region separates the $Ne_2{}^{ms}$-region of Western Europe and the $Ne_2{}^{ms}/Ne_2{}^s$-region of Poland/Ukraine.

Non-carriers are also found south east of Lake Bajkal.

A final discussion will wait till more data are available.

VAVILOV ON ALBINO AND LETHAL F_1'S

DEKAPRELEVICH (1930) is thought to be the first to write about the hybrid weakness indicated by HERMSEN (1962) as hybrid necrosis. An account of his work is given on p. 239 and 240.

However VAVILOV and JAKUSHINA (1925) may have published about this phenomenon when writing about albino and lethal F_1 plants. They found an albino F_1 of a *T. durum* × *T. spelta*, while they reported about lethal F_1's between:

1. *T. carthlicum* × *T. vulgare lutescens* no. 134 from Tavritscheskoi, U.S.S.R.
2. *T. carthlicum* × *T. vulgare erythrospermum* no. 2823 (Bart-dünnähriger)
3. *T. carthlicum* × *T. compactum creticum* no. 2840 (Sizilianischer viereckiger)
4. *T. carthlicum* × *T. spelta coeruleum* (ex Vilmorin).

Albino F_1's were obtained from the crosses:

5. *T. durum* (ex Iran) × *T. spelta* no. 25 (var. *arduini* MAZZ. nr. 2851, ex Haage und Schmidt).
6. *T. vulgare lutescens* no. 134 (see no. 1) × *T. dicoccum pycnurum* (ex W. Europe)
7. *T. vulgare* no. 188 (Blé Birdes) × the same *T. dicoccum*
8. *T. vulgare* no. 2718 (Kirscher Kolben) × the same *T. dicoccum*

They reported that such albino's were seen by Farrer and Freeman, and on the Experimental Station at Saratow, U.S.S.R. At this station albino F_1's of *T. vulgare* × *T. durum* crosses were rarely seen.

It is difficult to decide whether these albino's and lethal F_1's refer to hybrid necrosis. In some crosses this hybrid weakness may have been involved because *T. durum* and

T. carthlicum are known to comprise Ne_1-carriers and *T. spelta* Ne_2-carriers. Our line of Sizilianischer viereckiger (Carré de Sicilie) does not carry Ne_2.

FIFTH SUPPLEMENTARY LIST

This list consists of 144 Ne_1-carriers, 208 Ne_2-carriers and 326 non-carriers making the total of 597 Ne_1-carriers, 654 Ne_2-carriers and 1262 non-carriers. So 2513 varieties now have a known *Ne*-genotype.

Some newly listed varieties need some comment. In 1969 I discussed the occurrence of the $Ne_1{}^s$-allele in *T. vulgare* and other hexaploid wheats. It was demonstrated by HERMSEN (1963a) that many vulgare varieties carrying an $Ne_1{}^s$ gene derive this gene from *T. durum* Iumillo which is one of the parents of Marquillo. It was shown in 1969 that *durum* cultivars carry $Ne_1{}^s$ or ne_1. In this list all *T. vulgare* varieties carrying $Ne_1{}^s$ have also derived this gene originally from an $Ne_1{}^s$-carrier or a durum wheat. E.g. BQ-A is derived from Bowie/Quanah (Texas 412–53–23A). Its $Ne_1{}^s$-allele comes from Quanah. C.T. 324 derives from South Africa 43 ($Ne_1{}^s$)/2 Thatcher. Both FET lines come from Felix ($Ne_1{}^s$)/Etoile de Choisy, while Felix was also the $Ne_1{}^s$-source of the S.V.P. lines 60.50 and 61.77. The pedigree of Langs Doerfler Stamm 9/56 is unknown to me. This breeding station often used Marquillo ($Ne_1{}^s$) as a parent. Parker obtains its $Ne_1{}^s$-allele from Marquillo, unless Quivira is an $Ne_1{}^s$-carrier. Reichersberger Stamm 19/64 is a cross population of Bruno/Berthold ($Ne_1{}^s$) Scout 66 obtained its $Ne_1{}^s$-allele from Ponca.

Other Ne_1-alleles than $Ne_1{}^s$ have been identified in *T. durum*, viz Ak Bug ($Ne_1{}^m$) and NP 408 ($Ne_1{}^w$). All other durum varieties carried $Ne_1{}^s$ or ne_1.

The $Ne_1{}^m$-allele of *T. durum* Ak Bug from Turkey might have introgressed from a *vulgare* variety. The $Ne_1{}^m$-allele is common in Turkish vulgare wheats.

NP 408 is a derivative of *T. durum* (Gaza × Egypt 8626) × *T. vulgare* Ekdamia 2. The Indian *vulgare* variety might be the source of $Ne_1{}^w$.

There are a few $Ne_1{}^m$-carrying varieties of which the given ancestry must be questioned on the basis of my investigations.

Two cases were already mentioned before (ZEVEN, 1968). Both the varieties General Von Stocken ($Ne_2{}^s$) and Bielers Edelepp ($Ne_1{}^m$) are said to be selected from the East Preussian/Silecian local variety Epp. Our two samples of Epp wheat (Epp and Ostpreussicher Epp) are non-carriers. As many other local wheats of the same area are $Ne_2{}^s$-carriers it is believed that Bielers Edelepp is selected from a spontaneous hybrid with an $Ne_1{}^m$-variety or a contaminant. The Japanese variety Akasabishirazu 1 also is an $Ne_1{}^m$-carrier. It is said to be derived from Turkey Red/Martin Amber. Both parents have been received from Japan. Turkey Red was found to be a non-carrier while Martin Amber does carry the ne_1-allele. The origin of Akasabishirazu 1 might also be a result of spontaneous hybridization e.g. with one of the many $Ne_1{}^m$-carrying Japanese varieties.

Teverson ($Ne_1{}^w$) is probably a derivative of Scholey's Squarehead/Goldendrop (JONARD, 1951). Goldendrop is an $Ne_1{}^w$ carrier. HERMSEN (1963b) suggested that the $Ne_1{}^w$-allele of Professor Delos might have come from Teverson line 19. This is supported by our observation, but Hermsen's suggestion that Teverson might have obtained its $Ne_1{}^w$-allele from the ($Ne_2{}^s$-carrying) Browick cannot be true.

Noé is shown by HERMSEN (1963) to be an $Ne_2{}^{ms}$-carrier. Lamed ($Ne_2{}^{s}$) is derived from Noé/Prince Albert. Prince Albert is the variety from which Browick ($Ne_1{}^{s}$) was selected. This suggests that Prince Albert also is an $Ne_2{}^{s}$-carrier.

Hunters ($Ne_2{}^{s}$) was probably introduced from Western Europe (England?) into Australia/New Zealand (MCEWAN, 1969). It probably comes from Hunter, a wheat found by a Mr. Hunter in a wheat field in Berwickshire (HEUZÉ, 1896). It is likely, that it is related to the group of wheat varieties to which Prince Albert also belongs. Another introduction from England is Braemer Velvet, which was introduced into Tasmania in 1850 (TILT, 1965). It is a non-carrier, so it cannot be concluded that this one also belonged to the above group. Its hairy chaff (velvet) makes this unlikely.

The winter wheat Hostianum 237 ($Ne_2{}^{s}$) has caused several Russian authors to report on its lethal F_1 plants with spring wheat Erythrospermum 1160. ANDREEV (1947) reports the F_1 to be sterile. AVAKJAN and JASTREB (1948) mention, that the F_1 never survives and that this lethality could be bypassed by using a mixture of pollen of Erythrospermum 1160 and other winter varieties. SISOV and IVANOV (1959) related that the F_1 withered at a three leaves' stage. They overcame this problem by using a winter type of Erythrospermum 1160. These data suggest Erythrospermum to carry $Ne_1{}^{m}$. The origin of this variety is not known to me.

AVAKJAN and JASTREB reported that most F_1 plants survived while all had the spring habit. SISOV and IVANOV's method might mean that in the material used some spring lines have the genotype $SgNe_1{}^{m}$ and the converted winter lines have $sgne_1$.

FLAKSBERGER et al. (1938) state that Hostianum 237 came from the Kharkov area. This is in accordance with this district being a $Ne_2{}^{ms}/Ne_2{}^{s}$-region. He himself believed however in a Central Asian origin because of its resemblance with the ecotype *sub-rigidum*-ecotype *sicco-campestris*. This ecotype is distributed in the steppe region of Southern and Eastern Ukraine and the semi-steppe of Northern Caucasus. However it will still belong to this $Ne_2{}^{ms}/Ne_2{}^{s}$-region.

Stepnaja 135 ($Ne_2{}^{s}$) is a derivative of an open pollinated Hostianum 237 plant,

Suprêsa is like its sister variety Fronteira an $Ne_2{}^{m}$-carrier. Both derive from a cross of two Brazilian local varieties Polissú and Alfredo Chaves 6. This Ne_2-allele is rare among the European local wheats. It is interesting to note that the Argentine local wheat Barleta 10 also is an $Ne_2{}^{m}$-carrier.

The variety Equator is an $Ne_2{}^{ms}$-carrier. It is often used in Kenya as a parent. Its origin is not known (DIXON, 1960).

MENDEL II ($Ne_2{}^{m}$) is derived from Sol III ($Ne_2{}^{ms}$) × Wilhelmina ($Ne_2{}^{m}$ and non). Wilhelmina must have been a mixture of $Ne_2{}^{m}$-carriers and non-carriers because *Trifolium* ($Ne_2{}^{m}$) is a selection of Wilhelmina. This is supported by the fact that its breeder Prof. Dr. L. Broekema actually mixed sister lines to create this variety in 1900 (ZEVEN, 1969).

Sol III ($Ne_2{}^{ms}$) is a selection of Sol II (non). This variety must also be a mixture of $Ne_2{}^{ms}$-carriers and non-carriers, because Sol IV selected from Sol II × Kronen also carries $Ne_2{}^{ms}$.

Manitou (Ne_2) very likely carries the $Ne_2{}^{m}$-allele, being derived from Frontana.

Salmon is an $Ne_2{}^{ms}$-carrier. It is a hexaploid derivative of the octoploid Salmon's Triticale. The latter is a hybrid of Taylor's Mains 56 Triticale (Purdue no. 1 wheat + rye) and Taylor's Bledsoe Triticale (Chinese Spring wheat + rye) (TSUNEWAKI, 1964).

Salmon must have obtained its Ne_2-allele from Purdue no. 1 which is an $Ne_2{}^{ms}$-carrier while Chinese Spring is an $Ne_1{}^{w}$-carrier. No *Ne*-genes have yet been found in cultivated rye.

Gotland is an old local variety collected by HELMQVIST (1966) near Ardre in Gotland, Sweden. It is an $Ne_2{}^{wm}$-carrier. The name Gotland is applied by me; Helmqvist refers to it as Begrannter Weizen (bearded wheat).

There are a few wheat varieties which carry the same $Ne_2{}^{wm}$ allele. E.g. Gluten which is a result of a complex cross. One pedigree is Svea II ($Ne_2{}^{m}$)/2/Grenadier/Thule II; another is Pansar ($Ne_2{}^{s}$)/Thule II/2/English Squarehead/3/Swedish local variety. Maybe this local variety is related to Gotland. But another $Ne_2{}^{wm}$-carrier is Igen 3. This variety is derived from Squarehead/Ukrainka. Ukrainka is a non-carrier while varieties selected from Squarehead are $Ne_2{}^{ms}$ and $Ne_2{}^{s}$ carriers. Maybe Squarehead or a variety to which this name has wrongly applied is an $Ne_2{}^{wm}$-carrier too. Then it could be also the source of the $Ne_2{}^{wm}$-allele in Gluten.

PUHAL'SKY and KOZLENKO (1969) found Lutescens 62 to carry $Ne_2{}^{w}$. My two accessions of this variety are non-carriers, but a derivative Lutescens 758 (Lutescens 62/Kitchener) also is an $Ne_2{}^{w}$-carrier. Lutescens 62 is a selection of the local wheat Poltavka. Caesium 111 ($Ne_1{}^{m}$) also is a selection from it. The *Ne*-genotype of Poltavka is not known.

Poltavka refers to a group of local varieties with a large distribution in U.S.S.R. It is quite possible that the name refers to a common morphological characteristic. So this group of agricultural varieties may easily posses Ne_1-carriers, Ne_2-carriers and non-carriers.

Puhal'sky may have observed hybrid necrosis while reporting on lethal F_1's of winter wheat $\times$ *T. durum* (from the southern part of the U.S.S.R.) (UKOLOV et al., 1965).

Richelle hâtive 110 (non) was found in Algeria in Tuzelle Allora wheat. This last variety is synonymous to Allora, which was introduced into Australia from California, U.S.A. (MCINDOE and WALKDEN BROWN, 1958) and also synonymous to Sonora (non), which was already cultivated in ca 1770 in Northern Sonora, Mexico, and by the Pima and Yuma Indians in Arizona, U.S.A. in ca 1820 (CLARK et al., 1922). Both varieties are non-carriers.

In 1966, the non-carriers (Venezuela A and B) were collected by J. de Bruijn, Wageningen (DB S.N.,) is a field along the road Apartaderos – Mérida, near Mucuchien at an altitude of 3000 m. Venezuela A is top-awned and Venezuela B is bearded, while Richelle hâtive 110 and Sonora are awnless.

Ghirka, CI 1517 is an $Ne_1{}^{w}$-carrier, while Ghirka CI 7383 is a non-carrier (TSUNEWAKI and NAKAI, 1967b). These authors found Pacific Bluestem, CI 4067 to be an Ne_1-carrier and Rice, CI 5734 an Ne_2-carrier. Our lines under the same CI-number are non-carriers.

Steinwedel was found by Dr. R. J. Metzger, Corvallis, USA (pers. comm. 1970) to be a non-carrier.

Florence-Aurore is like its selections Blé d'Avril, Cailloux and Koudiat A-2 a non-carrier.

The identification of an $Ne_2{}^{s}$-carrying *T. spelta* var. *saharense* might be important. Like so many European spelts which often carry $Ne_2{}^{s}$ too, it also carries an *Rf*-gene!

This certainly points to a relationship with these European wheats. Whether it is an old introduction from Europe or a recent one is not known. Whether its *saharense* characteristics are derived from introgression with African wheats can only be guessed. ANDREW (1964) suggested that Romans introduced spelts to other countries. This Sahara-spelt, received from the I.N.R.A. at Rabat, Morocco, could be derived from such an introduction. Another *T. spelta* var. *saharense* (also from the I.N.R.A., Rabat) has the genotype ne_1ne_2Rf.

Its *Rf*-gene points also to a European relationship. Like so many European spelts it has also a purple coleoptile.

Perozeramek 1/36 was received from Rabat as *T. spelta* (no. 2674). Its tough rachis and other vulgare-characteristics show that it is a *T. vulgare*-wheat. It is a non-carrier like other Moroccan wheats.

At Abby, Gotland, Sweden HELMQVIST (1966) found *T. spelta* and *T. dicoccum*. The first is non-carrier like *T. vulgare* 'Gotland' discovered in the same area. The *Ne* genotype of the emmer is not yet determined. It is important that this Swedish spelt is an *Rf* carrier like many spelt accessions from Germany-Switzerland. This suggests that the Swedish spelt is related to the German-Swiss spelts. However, it could be argued that the Swedish spelt originated in that area from a cross between *T. vulgare* and *T. dicoccum*. In that case *T. dicoccum* must carry *Rf* gene, because this gene is not found in *T. vulgare* 'Gotland'. This will be investigated.

The *T. spelta* 'Spelz aus Tsari Brod' is the much used source var. *album* of yellow rust resistance in wheat breeding (ZEVEN et al., 1968). Its name 'Spelt from Tzaribrod' suggests a Bulgarian origin.

Artifact Canthatch Tetra + *Ae. squarrosa* RL 5288 has been made by Dr. E. R. Kerber, Winnipeg, Canada (KERBER, 1964).

A number of varieties coded with E. and Esk. are listed. Their parentages are:
E.-varieties (KULSHRASTHA and RAWAT, pers. comm. 1969; NARULA, pers. comm. 1970), E. 952 = Río Negro (see also Esk. 658, and ZEVEN, 1969a), E. 2842 = Yaqui 53 (Y × E.T.), E. 4642 = Mentana (?), but Mentana is an Ne_1^w-carrier, E. 4647 = Frontana × Kenya 58 – Newthatch (see also Esk. 2667), E. 4906 = (MY × Y48 – Kt48) × Po 122, E. 5000 = II. 50–17 × II. 42–39–702, E. 5008 = II. 50–25 × II. 45(–)6(–)716, E. 5021 = Willet, E. 5555 = ?, E. 5580 = V–238–4160, E. 5583 = (Nor. 10 × Y53) × Y50} Kt 54B, E. 5985 = II.53–723 = II. 50–25 × II. 44–653, E. 6058 = II.54–79 = II.Sa72 × Tc, E. 6159 = SK-Mida-MM-Ech., 60 SRR 47, E. 6160 = = Tc-Mida-MM-Ech., 60 GRS 57, E. 6181 = Sin Valocho (Frontana × K58) 29, E. 6309 = (Willet × Nor. 10-B) Kt54B, E. 6360 = (Frontana × G.U.) × (ME – K × Y), E. 6361 = as E. 6360, E. 6365 = as E. 6360, E. 6407 = II.55–41A = M 5824[2] × II.50–70, E. 6883 = (Ch. 53 × N10B) × Y54, E. 6912 = (Willet × N10B) × Y54, E. 6914 = as E. 6912. E. 6989 = Rescue, E. 7104 = ?, E. 8625 = ?, E. 8627 = Lerma Rojo[2] × Sonora 64, E. 8628 = as E. 8627, E. 8630 = as E. 8627, E. 8632 = Pitic 62 × Yaqui 52 × TZPP × Nainari 60, E. 8639 = TZPP × Sonora 64, E. 8641 = Pitic 62 × Lerma Rojo 64[2], E. 8647 = LR 64A × TZPP[2] × Anchuao, E. 8648 = as E. 8647.
Esk. varieties (ATAY, pers. comm. 1970): Esk. 4–11 = (Kizildil 706 × Akdil 707) × Mentana, Esk. 100 = Esk. 220/39 = Kirik, Esk. 632 = Lageadinho, PI 197660, Esk. 658 = Rio Negro, CI 12469, (see also E. 952 and ZEVEN, 1969a), Esk. 924 = ?,

Esk. 1685 = N.S. II.50–18, 42433, ex Minnesota, Esk. 2619 = Supremo 51 – Nazas 3382–6c–3c–1c–3c I, Esk. 2667 = Frontana × Kenya 58 – Newthatch (see also E. 4647), Esk. 2898 = Kentena × Río Negro, Esk. 2900 = as Esk. 2667, Esk. 2943 = (Fn × Th) × Casteler, Esk. 3007 = Frontana × Cheyenne, Esk. 3008 = as Esk. 3007, Esk. 3184 = as Esk. 2943, Esk. 3205 = (S-Mt) × M-Rw-Rw, Esk. 3226 = Men. sib × My 58, Esk. 3227 = as Esk. 3226, Esk. 3228 = as Esk. 3227, Esk. 3632 = *A. speltoides* Amp × Coastal 56C.

These pedigrees show that much related material is introduced in India and Turkey. It is used as a breeding parent with their own wheat varieties. This often results in necrotic crosses.

Ne_1-carriers
T. vulgare
mAgent, CI 13523
wAjeba
wAlmora, ATRI 2768
mApulia Precoce, PI 157908
Aquilon (6)
wBalkan 1941/2228*
mBalleret Blue, CI 6621
sBQ-A (Texas 412–53–23A)
Burgweizen (2)
wCabezoni de Goni, PI 191033
mCarosella
mCatriso (6)
mCésar
mChaochow White, CI 5089
mChina-2, var. *tarakanovi*
wChina F 32, PI 83256, CI 10765
wChinese Spring di iso 5BL
wChinese Spring di telo 5BL
mCIV-41* (4)
wCologna Familia, PI 191891
mConcurrent, CI 6655
Corto (MGH 65.3) (12)
sC.T. 324 (23)
mDiana I
mDolis Puri 35–4, HTRI 4495
Dmitrovka, VIR 45201 (6)
wDundee A.R.I.
E. 173 (17)
wEarly Gluyas
mEjuiea, PI 87117
Erythrospermum 1160 (21)
Esk. 4–11 (3)
mEsk. 100 (3)
sFET 1–4 (7)
sFET 26–12 (7)
mGamma, PI 42130, CI 5007
mGentil Rosso, PI 174639
wGhirka, CI 1517
mGiza 155
mGjul'gjani mestnaja, HTRI 6760
wGrifo
mHadejia-4
mHindi 144
mHinta Madina
HPG 2706–67–Mex. (16)
HPG 6471.3.65 (12)
wHybride de la Paix
wIdaed, CI 11706
mKamir Slfaat mestnaja, HTRI 6769
mKaragac mestnaja, HTRI 6767
mKara Kel'tek mestnaja, HTRI 6768
mKatsina-2
mKatsina-8
mKatsina-12
mKaukasischer 4, ATRI 3457
mKyrmyzy bugda, VIR 39879
mKyrmyzy bugda, PI 262629
wLagodechis Grdzeltavtava mestnaja
sLang Doerfler Stamm 9/56 (9)
Mandel Gehun, PI 163052
mMars sans barbes ordinaires MGH 9.62 (12)
mMontana 14–2–1*
mNemra Hufouf-A
mNieuwe Angel*
wNovi Sad 58 (7)
NP 883 (24)
NP 891 (24)
sParker (4)
Pb. C 273 (14)
mPictet
Pilot (16)
mPotchefstroom, PI 38619, CI 4179
wPréparateur Etienne
Produttore (2)
mPseudo-meridionale, HTRI 4501
wPusa 12
Red Mace (19)
sReichersberger Stamm 19/64 (9)
Ridley (17)
mRieti II
mRingot 01 (2)
mRingot 6 (2)
wRojo Basto
wRoseworthy
S–1 (12)
mSabanero
mSaisette, PI 221373
sScout 66
wShahpassand
mSibirischer Altai, ATRI 3469
mSudan-4, VIR 44711
sSVP 60.50 (10)
sSVP 61.77 (10)
mTalavera Red
m(Tataria-3), VIR 36581
w(Tataria–4), VIR 36588
sTexas 412–53–23A
wTeverson*
wTibet 12, ATRI 2501
wTimstein-Newthatch, CI 12634
mTouzelle anone
wTremes
mTriminia
mTunesia-5, Cambridge V282
Vernstein
VIR 047387 (ex Azerbaijan) (6)
VIR 048837 (ex Azerbaijan) (6)

[m]VK 65.37 (18)
[m]VK 65.42 (18)
[w]W 83, Teneriffa 1964
[m]Yaqui 53
[m]305 Yayla
[m]Zarda mestnaja
[m]Zaria-3

T. carthlicum
[m]var. *stramineum* (parent of ABD-22)

T. compactum
[m]Kamtschatka mestnaja, PI 295001

T. durum
[m]Ak-Bug
[s]Anatolien II/4
[s]Arnautka
[s]Eretreia
[s]Kara Kylčyk, VIR 17043
[s]Malta-3, PI 278378
[w]NP 408
[s]Sara bugda, VIR 38687
Sofia no. 13 (26)
Sofia no. 1522 (26)
[s]var. *coerulescens*

T. macha
10 accessions (25)

T. spelta
2 accessions (25)

T. sphaerococcum
K-23830 (6)

T. vavilovi
1 accession (25)

Artifacts
[m]ABD-22 (*T. carthlicum* var. *stramineum* + *Ae. squarrosa* var. *meyeri*, no. 2144)
[s]UM 6301 (*T. durum* Stewart[2] × *A. elongatum*, 2n = 28).

Ne$_2$ carriers
T. vulgare
[ms]Akasabishirazu I
[s]Als
[s](Ambjärby)
[s]American Falls Turkey Sel. 1, IWWRN 001137
[ms]Aurèle Gaby*
Authari (2)
[ms]Benign
Benoist 261 (12)
Bezostaja 1* (2)
[s]Blackhawk
[ms]Blé de Nuisement barbu
[ms]Borg
[m]Borovičskaja mestnaja, HTRI 5180
[s]Browick Old True
[ms]Butler, CI 12527
[ms]Cabezorro
Cama (7,8)
Capitole (7)
[ms]Cebeco 97
Chhoti Lerma (S. 331) (13, 24)
Ciano 67 (4)
[ms]Coker 55–15
[s]Cornell 595
[s]Crépi
Desprez 2818–31 (12)
Diekhuistarwe
E. 952 (1, 13)
E. 2842 (24)
E. 4642 (13)
E. 4647 (31)
E. 4906 (24)
E. 5000 (13, 24)
E. 5008 (13)
E. 5021 (13)
E. 5555 (13)
E. 5580 (13)
E. 5583 (13)
E. 5985 (13)
E. 6058 (13)
E. 6159 (13)
E. 6160 (13)
E. 6181 (13)
E. 6309 (13)
E. 6360 (13)
E. 6361 (13)
E. 6365 (13)
E. 6407 (13)
E. 6883 (13)
E. 6912 (13)
E. 6914 (13)
E. 6989 (13)
E. 7104 (13)
E. 8625 (13)
E. 8627 (13)
E. 8628 (13)
E. 8630 (13)
E. 8632 (13)
E. 8639 (13)
E. 8641 (13)
E. 8647 (13)
E. 8648 (13)
[ms]Equator
[ms]Eroica II
Erythrospermum 11 (26)
Esk. 632 (3)
Esk. 658 (3)
Esk. 924 (3)
Esk. 1685 (3)
Esk. 2619 (3)
Esk. 2667 (3)
Esk. 2898 (3)
Esk. 2900 (3)
Esk. 2943 (3)
Esk. 3007 (3)
Esk. 3008 (3)
Esk. 3184 (3)
Esk. 3205 (3)
Esk. 3226 (3)
Esk. 3227 (3)
Esk. 3228 (3)
Esk. 3632 (3)
[ms]Essex Conqueror
Fanal (2)
[ms]Ferto
[ms]Fortyfold Sel. 54, CI 10064
[ms]Froment des Polders
[m]Fronthatch
[s]General Von Stocken
[s]Glebovskaja mestnaja, HTRI 5182
[mw]Gluten
[ms]Gorkovčanka, VIR 41155
[mw](Gotland)
[ms]Gyllen
[s]H-1 (ex Finland)
[ms]Hansa
[ms]Haroch
[ms]Hen Gymro no. S 70
[ms]Hon Iku 49
[s]Hostianum 237
HPG-3950.68 (16)
HPG-4392 (12, 18)
HPG-7892 (12)
HS-488 (13)
[s]Hunters
[mw]Igen 3
[ms]Imbler
[m]Inia 66
[s]Itasoumalainen
Joss Cambier (8)
[m]Karelskaja bezostaja, VIR 40579
[s]Kastická osinatka (2, 20)

[ms]Keltischer Glattweizen, HTRI 1363
[ms]Kessingland
[s]Kis Tur
[s]Klein 157
[s]Konge
[s]La Lande
Lada (2)
[s]Lamed
[ms]Lapis (5)
[m]Lerma Rojo 64
[ms]Limburgse Kleine Rode Lr-line (13)
[w]Lutescens 758
[m]Main's Standup
Manitou (23)
[ms]Mansholt's Japhet, ATRI 801
Marco (7)
[s]Märkischer Landweizen, HTRI 1139
MGH-17.67 (12)
MGH-47.67 (12)
[ms]Mildres
Mx-5392-2 (Kalyan Sona line) (13, 24)
[m]Nadadores 63
New 824 (12)
[m]Nickerson 517.65 (12)
Nickerson 575.65 (12)
[m]Norda (7)
NP 846 (24)
[mw]Odin
Pano (HPG 4392–63)
[ms]Panonija
[s]Pansar II (Pantser II)
[m]Panthus (7)
[ms]Peragis WW
Pergamino Gaboto (12)
[s](Perm-2), VIR 30706
[m]PLM*, T.I.–1–3835
[ms]Purdue 4930A6–28–2–1
Qualitas* (Hadmersleben) (2)
[s]Raclin
[w]Rannjaja 12, K-45347
[ms]Reichersberger St. 2/57–518
[s]Reichersberger St. 5/61–43 (9)
[m]Rimpaus Bastard II
[ms]Rimpaus Braun
[ms]Rival (Austrian)
[ms]Robur
[ms]Rouge prolifique barbu
[ms]Ruzyňská
S 227 (13)
S 307 (24)
S 308 (13)
S 331 (14)
SA-2 (ex Finland)
SA-5b (ex Finland)
Safed Lerma (S 307) (24)
[ms]Salmon
[s]Sandomierska
[s]Sandomirka
[s]Saumur, ATRI 487
[ms]Saumur d'Automne
[ms]Selpek (MGH 2393, HPG 2393.63)
[s]Sibirka jarcevskaja, VIR 38587
[s]Smitovka, VIR 32017
[ms]Sol III
[ms]Spaldings Prolific
[ms]Stahlweizen aus Svalöfs 0987
[ms]Stamm 24,555
[s]Stepnaja 135, VIR 38282
Strube 703 (7)
[s]Sturm (Dippes)
[m]Surprêsa
[ms]Svalöf 28/105b
[m]Svea
SVP–55–75 (18)
SVP–61–54
SVP–61–61 (10)
[s]T–2 (ex Finland)
[s]T–3 (ex Finland)
[s]Titan
[ms]Turkovskaja mestnaja, VIR 41278
[s]U–1 (ex Finland)
[s]U–2 (ex Finland)
[s]U–4 (ex Finland)
[ms]Uhřetická
[s]V–1 (ex Finland)
[s]V–2 (ex Rinland)
[s](Väfdesboda)
[ms]Vilmorin 53
VL-108 (17)
[s]Vysokolitovskaja mestnaja, HTRI 5178
Weihenstephan 421/59 (8)
[ms]Weique

T. spelta
[s]Lohnauer Sommerspelz
[s]Neuegg Weisskorn
var. *saharense*
60 accessions (25)

Non-carriers

T. vulgare
Aegylop 14.257
Ak-buudaj
Ak-Topaz, PI 166809
Alentejano, ATRI 3153
Algebra
Algeria–1, VIR 16163
Algeria–3, VIR 16598
Ali ben Makhlouf, PI 48592, CI 6558
Alton, PI 5637, CI 1438
Alty-Agač mestnaja, HTRI 674
Ankar
Aotea
Aragón 03
Ardent
Argentine-3, PI 116223
Argentine-4, PI 116297
Argentine-5, PI 116298
Argentine-9, PI 117491
Argentine-13, PI 191984
Äring
Aronde
Aurèle Gaby**
Autonomia
Axminster
Bačka, NS 33/1–2
Bahatans 87
Balkan 1941/1531, HTRI 1706
Balkan 1941/2230, ATRI 1722
Balkan 1941/2288**, HTRI 2293
Balkan 1942/276, ATRI 2724
Balkan 1942/963, HTRI 621
Banatka, T.I.-1-97
Banatka, PI 184260
Barbela
Barbilla
Barbu de Crussol
Barhatnaja, VIR 44269
Barwang
Bayernkönig
Belocerkovskaja 198, VIR 41153
Beloglina Sel., CI 8884
Bersée
Bezencukskaja 98, VIR 40583
Bhotai Dze, PI 176241
Bladette de Puylaurens, PI 49573, CI 6563
Blanc de pays (précoce)
Blé blanc de Flandres

Blé Russe
Blé Seigle
Blue Jacquet, CI 12502
Braemer Velvet
(Buratia-A), VIR 41377
(Buratia-B), VIR 41382
Cailloux, Rabat 2511
(Can. Islands-5), CI 4075
Carlotta
Carlotta Strampelli
Chamorro
Chikugo
China-5, PI 69296
Chinese, CI 6223
Chlumecká 12,
Chul, CI 2227
CI 12632 (Wis. 249)
Cowers Red Wheat
Cross no. 7
Crown
Currawa
Currawa A.R.I.
Dalmatinischer Inselweizen, HTRI 3723
Da Maia 2740
Dan
Daura-3
Defiance, CI 6477
Defiant
Densi
Diamant II
Diószegi, T.I.–1–1370
Diplomat (8, 20)
Dolis Puri 18–46, HTRI 6956
Draegers Dickkopf III
Dr. Mazet
Dubrovická
Duvanska Krasnokoloska, VIR 35819
EAP 63A
Ebersbacher Weiss
Ecksteen, CI 4186
Ekstein, CI 6108
Engelens F.4
Epp, P.R. 01–665
Erythrospermum 82/2, VIR 32048
Espanhol Chamorro, ATRI 3046
Estacao
(Ethiopia-3), PI 226573
Extreme Sur Argelino
Ferrugineum 9, VIR 32088
Flevina
Fondar Crespin
Furutsu daruma
Galego Barbado, ATRI 3093
Gandom, PI 223465
Gandom-i-lallmi, PI 223473
Gandom-i-lami, PI 223469
Gandom-i-Sorkh, PI 223542
Gefir
Gelderse 42
Gironde, P. R. 01–781
Goldene Aue
Gray-4, Cambridge V 538
Gray-11, Cambridge V 539
Griechischer Weizen 13, ATRI 510
Gua, PI 174641
Gudin**
Gyllen I
Haidenburger Landweizen, HTRI 4800
Hallett's Pedigree White
Harvest Queen × Kawvale, CI 12284
Heines I
Hononínska osinatka
Hohenheimer, CI 11458
Holzapfels Darwin, HTRI 248
Hosar
Hubertus
Hybride Carter
Iduna
Illinois no. 2, CI 11537
Illinois-W 38, CI 12061
Imperiaal I, HTRI 11537
Imperiaal Ia, HTRI 4832
Imperiaal II
Inalettabile Semiaristata, T.I.–1–5587
Inversal
Iowin, CI 10017
(Iran-2)
(Iran-3), PI 225256
Ithkair-III, Rome no. 4380
Janetzkis Früh
Jarinegro White Sel., CI 6528
Jeja
Jeja de Torrecillo, PI 191246
Jonathan
Jumbuck
K3 (Schribaux)
Kahi-8, VIR 41149
Kanak, PI 163039
Kärtner Landweizen, HTRI 1289
Katsina-White-6
Kenya 58
Kenya 117A
Kenya 334–CA1, PI 58581
Kenya Ploughman
Kerand, PI 174663
Kinney (ex Hohenthurm)
Kiril-bigdai, CI 3755
Klein 49a
Kloka
Kooperatorka
Kotte
Koudiat A-2, PI 174665
Krohinskaja, VIR 37216
Krymka, VIR 11221
Larranaga, ATRI 3124
Lera
Lutescens 62, VIR 15183
Macquarie
Magdalena
Magueija 2713
Mahmoudi-1
Maiorca
Maly-Italien 1950/332, ATRI 4016
Maris Ensign
Maris Ranger
Marokko–3, PI 91844
Marokko-5, VIR 16465
Marokko-14, Cambridge V 579
Marokko-15, Cambridge V 580
Marroqui 388 Sel., PI 168700
Mars barbu ordinaire
Marselage
Mars rouge barbu
Martin
Matador, HTRI 1578
Mauerner Grannenweizen
Mauerner Unbegrannt
Mexico 63 (7)
Millioen III
Milturum 307, VIR 15191
Niederbayerischer Braun
Noe, VIR 14950
Non Plus Ultra
Non Plus Ultra I
Non Plus Ultra III
Norin 33
Normandie ou Cent Jours
Novokrumka 0267
NP 734
NP 736
NP 740
O–2 (ex Finland)
Oktavia
Orange Devon Blue Rough Chaff
Orguello
Orhon, VIR 43602
Osjećka šišulja

Ostpreussischer Epp, HTRI 5059
Pacific Bluestem**, CI 4067
Pansar III
Pärl II
Parsel
Paskinskaja uluč̌ennaja, VIR 41156
Pelon, CI 6869
Perozeramek 1/36
Perro
Pewter
Pia
Pohjola, PI 105095
PPG 186
Preston, CI 2958
P.W. 327 × Thatcher[8] 3–2–5–1–4–1
P.W. 327 × Thatcher[8] 98–1–5
Rabat 0507
Rabat 0528
Red Fern
Red Hart, CI 8898
Red Stettin-C
Reliant, CI 12144
Remo
Rice, CI 11536
Richelle blanche hâtive, HTRI 4176
Richelle blanche de Naples, P.R. 01–787
Richelle hâtive 110
Río Negro, PI 168687
Ritchie
Robusta
Rojo de Humanes
Romanello
Roter Sachsischer Landweizen, HTRI 1408
Rouge d'Alsace
Rouge de Cernier
Rouge d'Ecosse
Rouge de Marchissy
Rouge de Saint-Laud
Rouge de Vaumarcus
Rubi, ATRI 3069
Ruskea
Russische tarwe
Rustique
SA-4 (ex Finland)
SA-10 (ex Finland)
Sakya komugi
Sametka Squarehead
Samlandsweizen
Saratovskaja 36, VIR 43286
Saratovskaja 38, VIR 43403
Saumur de Mars, ATRI 488
Secano-3, PI 191401
Sel. 1403 (11)
Seu Seun 6, PI 157593
Sibirka 1818, VIR 38490
Skorospelka uluč̌ennaja, VIR 38505
Slovenska 200
Somme
Sonora
Spanischer Weizen 86, ATRI 492
Spanischer Weizen 172, ATRI 494
Spinkcota, CI 12375
Steinwedel** (11)
Strickhoff
Sturdy
Svalöfs 36/175
(Sverdlovsk-2), VIR 37317
Székacs, P. R. 01–622
Székacs 1055, T.I.–1–1820
Talisman
Temporao de Coruche, PI 56208, CI 7016
Terminillo, ATRI 3188
Terroir
Thule II
Tibet 96, HTRI 2373
Tosson
Touzelle blanche barbu, ATRI 3088
Touzelle blanche de Provence, HTRI 68721
Transec Winter
Traublinger
Tremês Ruivo, ATRI 3188
Trigo de Primavera
Trubilo
Turkey Red
Tuscan wheat
(Tuva-D), VIR 38764
Ul'janovka, VIR 29439
Ungarischer Gebirgsweizen, HS 4176
Vehmelainen
(Venezuela-A)
(Venezuela-B)
Vilosa Mole
Vilron
Vuiteboeuf
W 82, Teneriffa 1964
W 86, Teneriffa 1964
Wachtel
Wageninger, HTRI 5119
Westphal 12
White Fife
Whittington
Wika
Yatung
Zlatka
202,01/1 (ex New Zealand)
202,01/2 (ex New Zealand)

T. compactum
Mayr nr. 164
Mayr V2
Mayr V 53
Rouge de la Gruyère
var. *erinaceum*

T. durum
Candeal–1, PI 56237

T. spelta
Gotland, near Alby
Roter Sommerspelz
Spelz aus Tsari Brod
41 accessions (24)

T. macha
3 accessions (24)

Artifact
Canthatch Tetra + *A. squarrosa* R.L. 5288

Key:
w, *wm*, *m*, *ms*, *s*: symbols of the multiple alleles of Ne_1 and Ne_2; w = weak, m = moderate and s = strong.

* Carrier line of variety or selection
** Non-carrier line of variety or selection.

ATRI = Institut für Kulturpflanzenforschung, Gatersleben, E. Germany (spring wheat)
CI = Cereal Investigation, U.S.D.A., Beltsville, U.S.A.
E = Wheat of Indian Agricultural Research Institute, New Delhi, India.
HS = see HTRI
HTRI = see ATRI (winter wheat)
IWWRN = International Winter Wheat Rust Nursery
PI = Plant Inventory, see further CI
T = National Institute of Agricultural Botany, Tapioszele, Hungary
VIR = N.I. Vavilov Institute of Plant Industry, Leningrad, U.S.S.R.
( ) = local variety of that area

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20. Personal information in addition to one of the above

Extracted from

21. ANDREEV (1947); AVAKJAN and JASTREB (1948); SISOV and IVANOV (1959)
22. APLTAUEROVÁ (1969)
23. KNOTT and SINDAGI (1969)
24. KULSHRESTHA and RAWAT (1968)
25. TSUNEWAKI (1969)
26. TSVETKOV (1968)

REFERENCES

AL-JIBURI, H. A., 1966. Wheat growing in Libya. World Crops 18(2):25–30.

ANDREEV, G., 1947. Gorki deninskie. Selekcija i Semen. 14(11):41–52. Pl. Breed. Abstr. 19(1949) no. 1454.

ANDREWS, A. C., 1964. The genetic origin of spelt and related wheats. Züchter 34:17–22.

APLTAUEROVÁ, M., 1969. Hybridní nekróza u pšenice. Genetika a Šlechtení 5(42):229–235.

AVAKJAN, A. A. & JASTREB, M. G., 1948. (On the presence of characters of two male parent varieties in hybrid offspring). Agrobiologija (5):58–69. Pl. Breed. Abstr. 19(1949) no. 194.

CHEVALIER, A., 1932. Les productions végétales du Sahara et ses confins Nord et Sud, passé, present, avenir. Rev. Bot. Appl. et Agric. trop. 12:669–814; blé: 742–749.

CLARK, J. A., MARTIN, J. H. & BALL, C. B., 1922. Classification of American wheat varieties. USDA-bull. no. 1074. Washington. 238 p.

DEKAPRELEVICH, L. L., 1930. [On the obtaining of non-viable and partially viable combinations in wheat crosses]. Proc. U.S.S.R. Congress genet., Pl. Anim. Breed. 2:221–227. Pl. Breed. Abstr. 1(1931) no. 495.

DEKAPRILEVICH, L. L. & YASHAGASHWILI, G. G., 1970. [Genes of hybrid necrosis in endemic species and indigenous populations of Georgian wheats]. Genetika 6:106–111.

DIXON, G. E., 1960. A review of wheat breeding in Kenya. Euphytica 9:209–221.

DOROFEEV, V. F. & MEREŽKO, A. F., 1969. [The problem of hybrid necrosis in wheats]. Genetika 5(4):161–167.

DUCELLIER, L., 1920. Les blés du Sahara. Alger. Cited by CHEVALIER, 1932.

FLAKSBERGER, K. A. et al., 1939. [Determination des vraies céréales]. Trad. Roussine-Chevalier.

HJELMQVIST, H., 1966. Some notes on the old wheat species of Gotland. Hereditas 56:382–393.

HERMSEN, J. G. TH., 1962. Bastaard-necrose bij tarwe (Hybrid necrosis in wheat). Doctor's thesis, also Repts. Agric. Res. no. 68.5 129 pp.

HERMSEN, J. G. TH., 1963a. Hybrid necrosis as a problem for the wheat breeder. Euphytica 12:1–16.

HERMSEN, J. G. TH., 1963b. Sources and distribution of the complementary genes for hybrid necrosis in wheat. Euphytica 12:147–160.

HEUZÉ, G., 1896. Les plantes céréales. Paris.

JAKUBZINER, M. M., 1969a. [Livian wheats]. Bull. Appl. Bot. Gen. and Pl. Breed. 39(3):189–191.

JAKUBZINER, M. M., 1969b. [The wheats of Libya]. Trud. prikl. Bot. Genet. Selek 39(3)9189–191. Pl. Breed. Abstr. 39(1969) no. 6547.

JONARD, P. 1951. Les blés tendres (*Triticum vulgare* VILL.) cultivés en France. Paris. 491 p.

KERBER, E. R., 1964. Wheat: reconstitution of the tetraploid component (AABB) of hexaploids. Science 143:253–255.

KNOTT, D. R. & SINDAGI, S. S., 1969. Heterosis in diallel crosses among six varieties of hard red spring wheat. Can. J. Genet. Cytol. 11:810–822.

KULSHRESTHA, N. P. & RAWAT, D. S., 1968. Inheritance of necrosis in wheat. Curr. Sci. 37:653–654.

MACINDOE, S. L., & WALKDEN BROWN, C., 1958. Wheat breeding and varieties in Australia. Sci. Bull. no. 76. New South Wales, Dept. of Agric. 223 p.

MCEWAN, J. M., 1959. The wheat varieties of New Zealand. Dep. scient. ind. Res. Bull. 131. 36 pp.

MEREŽKO, A. F., 1970. [Genetic basis of hybrid necrosis in wheats]. Genetika 6:112–117.

PUHAL'SKY, V. A. & KOZLENKO, TH. L. V. 1968. [Hybrid necrosis in wheat]. J. Sel'skohoz. Biol. 4(1):4750. Pl. Breed. Abstr. 39(1969) no. 4473.

RILEY, R., COUCOLI, H. & CHAPMAN, V., 1967. Chromosomal interchanges and the phylogeny of wheat. Heredity 22:233–247.

SISOV, I. A. & IVANOV, A. P., 1959. [Selection and seed production of agricultural crops]. Trad. J. W. Lackamp. Moskov/Leningrad: 102–104.

TILT, J. 1965. The history of wheat growing in Tasmania. Tasm. J. Agric. 36:25–31.

TSUNEWAKI, K., 1960. Monosomic and conventional gene analysis in common wheat III. Lethality. Jap. J. Genet. 35:71–75.

TSUNEWAKI, K., 1964. Genetic studies of a 6x-derivative from an 8x Triticale. Can. J. Genet. Cytol. 6:1–11.

TSUNEWAKI, K., 1969. Necrosis genes in *Triticum macha*, *T. spelta* and *T. vavilovi*. Wheat Inf. Serv. no. 28:1–4.

TSUNEWAKI, K. & NAKAI, Y., 1967a. Distribution of necrosis genes in wheat. I. Common wheat from Central Asia. Can. J. Genet. Cytol. 19:69–74.

TSUNEWAKI, K. & NAKAI, Y., 1967b. Necrosis genes in U.S. varieties of common wheat. Wheat Inf. Serv. no. 25:9–18.

TSVETKOV, S., 1968. [A study on cross compatibility between the species *Triticum aestivum* L. × *T. durum* DESF. and the viability of the F_1 hybrids]. Genetika i Selekcija 1:193–202.

UKOLOV, A. A., PUHAL'SKY, V. A. & MAKSIMOV, J. L., 1965. [Grain set in hard winter wheat on pollinating by different methods]. Dokl. sel'skohoz. Acad. Timirjazev no. 108:237–242. Pl. Breed. Abstr. 26(1966) no. 3558.

VAVILOV, N. I. & JAKUSHINA, O. V., 1925. [A contribution to the phylogeny of wheat and the interspecies hybridization in wheats]. Bull. Appl. Bot. Pl. Breed. 15:110–159.

ZEVEN, A. C., 1966. Geographical distribution of genes causing hybrid necrosis in wheat. Euphytica 15:281–284.

ZEVEN, A. C., 1968. Third supplementary list of wheat varieties classified according to their genotype for hybrid necrosis. Euphytica 17:46–53.

ZEVEN, A. C., 1969a. Fourth supplementary list of wheat varieties classified according to their genotype for hybrid necrosis. Euphytica 18:43–57.

ZEVEN, A. C., 1969b. L. Broekema's segregation ratios of three wheat characters in 1887. Euphytica 18:286–292.

ZEVEN, A. C., TURKESTEEN, L. J. & STUBBS, R. W., 1968. Spelt (*Triticum spelta* L.) as a possible source of race-non-specific resistance to yellow rust (*Puccinia striiformis* WEST.). Euphytica 17:381–384.