

Review article

Interspecific and intergeneric hybrids of the *Lolium-Festuca* complex obtained in Poland in the years 1964-1994 and maintained in the collection at the Institute of Plant Genetics in Poznań

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Abstract. In the years 1964-1994 an extensive programme of wide hybridization within the *Lolium-Festuca* complex was carried out in Poland. Six *Lolium* (ryegrass) and five *Festuca* (fescue) species at different ploidy level were used for crosses. Hybrids were obtained from 72 cross combinations: 19 interspecific (five *Lolium* × *Lolium* and 14 *Festuca* × *Festuca*), 51 intergeneric (39 *Lolium* × *Festuca* and 12 *Festuca* × *Lolium*) and two trispecific (*Lolium* × *Festuca* × *Festuca*), most of them being derived from crosses of four important forage grass species: *Lolium multiflorum*, *L. perenne*, *Festuca pratensis* and *F. arundinacea*. Interspecific and intergeneric *Lolium-Festuca* hybrids from 50 cross combinations are maintained at present in the collection of the Institute of Plant Genetics in Poznań. This article presents a complete list of *Lolium-Festuca* hybrids obtained in Poland in the years 1964-1994 and maintained in the collection. The available literature concerning these hybrids is cited.

Key words: collection, *Festuca*, intergeneric hybrids, interspecific hybrids, *Lolium*, *Lolium* × *Festuca*, wide hybridization.

Introduction

Interspecific and intergeneric hybridization of plants has been widely used for taxonomic, genetic and evolutionary studies as well as for plant breeding. Wide hybrids in the grasses within the *Lolium-Festuca* complex have attracted the attention of scientists and plant breeders for over forty years. There is

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a close phylogenetic relationship between *Lolium* and *Festuca* genera, and hybrids can be obtained between most of the species.

Interspecific and intergeneric *Lolium-Festuca* hybrids and their derivatives have been studied extensively in many countries: Great Britain (e.g. JENKIN 1954, 1955a-f, BEDDOWS 1965, LEWIS 1966, 1980, 1981, MALIK, THOMAS 1966, 1967, CHANDRASEKHARAN, THOMAS 1971, JAUHAR 1975, 1976, MORGAN et al. 1988, THOMAS et al. 1988, HUMPHREYS 1989, MORGAN 1990, HUMPHREYS, THOMAS 1993), the United States (e.g. BUCKNER 1960, BUCKNER et al. 1961, 1963, 1965, 1976, 1985, WEBSTER, BUCKNER 1971, EIZENGA, BUCKNER 1986, KING et al. 1987, BURNER et al. 1989, 1991, EIZENGA et al. 1990), Germany (e.g. HERTZSCH 1959, 1960, 1961, 1966, NITZSCHE 1966, 1974, GRÖBER et al. 1974, 1976, MATZK 1976, WACKER, NETZBAND 1980, MATZK, SEYFFERT 1981, KAISER 1988, NETZBAND 1991), France (e.g. ESSAD 1956, 1962a, b, 1964, 1968, POISSON et al. 1988, JADAS-HÈCART et al. 1991, GHESQUIÈRE et al. 1993), the Netherlands (WIT 1959, 1964, DIJKSTRA, DE VOS 1975), Switzerland (BADOUX 1973, KLEIJER 1984, 1987, KLEIJER, MOREL 1984), Czech Republic (FOJTÍK 1974, 1994, FOJTÍK, SVĚTLÍK 1979, ŠEVČÍK 1981, JANEČEK 1987) and Lithuania (SLIESARAVICIUS et al. 1986, SLIESARAVICIUS 1988, 1992).

In Poland, investigations on *Lolium-Festuca* hybrids and their allopolyploid derivatives were initiated by professor Stanisław SULINOWSKI in the sixties and are being continued now (SULINOWSKI 1966a, b, 1967, 1972a-c, 1973, SULINOWSKI et al. 1968, 1976a, b, WERNER 1976, 1983a-c, ZWIERZYKOWSKI, RYBCZYŃSKI 1976, 1981, 1994, ZWIERZYKOWSKI 1980a, b, 1987, RYBCZYŃSKI et al. 1983, ZWIERZYKOWSKI et al. 1985, 1993, 1994, ŚLUSARKIEWICZ-JARZINA et al. 1994, ZWIERZYKOWSKI, NAGANOWSKA 1994, ZWIERZYKOWSKI, ZWIERZYKOWSKA 1994).

Some of interspecific and intergeneric ryegrass-fescue hybrids constitute potential initial material for obtaining new, widely adapted varieties of forage grasses. They combine desirable agronomic characters of parental forms, such as high nutritive value of ryegrasses, with persistence, winterhardiness and drought resistance of fescues. The main objective of the breeding programmes within the *Lolium-Festuca* complex is to combine complementary characters from different species in fertile amphiploids (THOMAS, HUMPHREYS 1991, ZWIERZYKOWSKI, NAGANOWSKA 1994). Although a range of amphiploids has been synthesized, their development as commercial varieties has not been satisfactory. So far, a number of varieties have been produced from tetraploid hybrids of *L. perenne* × *L. multiflorum* (BRESE, LEWIS 1984, THOMAS, HUM-

PHREYS 1991) and only a few varieties from tetraploid hybrids of *L. multiflorum* × *F. pratensis* (LEWIS et al. 1973, NETZBAND 1991, ZWIERZYKOWSKI et al. 1993, 1994, FOJTÍK 1994) and *L. perenne* × *F. pratensis* (LEWIS et al. 1973). An alternative approach to amphiploid breeding is an attempt to transfer some of the useful genes of one species into another. Some introgressive tall fescue varieties have been obtained on the base of *L. multiflorum* × *F. arundinacea* hybrids (BUCKNER et al. 1977, 1983, FOJTÍK 1994). Recently, a great effort has been concentrated on developing procedures for a controlled introgression of *Festuca* characters into *Lolium* species (e.g. MORGAN et al. 1988, HUMPHREYS 1989, HUMPHREYS, THOMAS 1993, HUMPHREYS, GHESQUIÈRE 1994).

In Poland, the most progress in exploiting ryegrass-fescue hybrids in breeding concerns amphitetraploids of *Festulolium* (*F. pratensis* × *L. multiflorum*). *Festulolium* strains, bred at Szelejewo Plant Breeding Station, are characterized by high yields and good forage quality as well as by a better persistence and winterhardiness as compared with Italian ryegrass (ZWIERZYKOWSKI et al. 1993, 1994).

As mentioned earlier, hybrids between *Lolium* and *Festuca* are also a very important tool for studies of taxonomy and phylogeny of the *Lolium-Festuca* complex (TERRELL 1966, MALIK 1967b, JAUHAR 1993, ZWIERZYKOWSKI, NAGANOWSKA 1994, 1996). Recently, for example, HUMPHREYS et al. (1995) have discriminated the ancestral progenitors of hexaploid *Festuca arundinacea* by genomic in situ hybridization using *F. pratensis* (4x) × *F. arundinacea* var. *glaucescens* (4x) and *F. pratensis* (4x) × *F. arundinacea* (6x) hybrids – both derived from our Institute collection.

Studies concerning *Lolium-Festuca* hybrids have been reviewed by several authors (JENKIN 1959a, b, CARNAHAN, HILL 1961, TERRELL 1966, SULINOWSKI 1968a, b, 1969, BERG et al. 1979, JAUHAR 1983, 1991, 1993, SLIESARAVICIUS 1992, ZWIERZYKOWSKI, NAGANOWSKA 1996).

The aim of this article is to present a list of all interspecific and intergeneric hybrids of the *Lolium-Festuca* complex obtained in Poland during 1964-1994, and hybrids which are maintained in the collection of the Institute of Plant Genetics in Poznań. The available literature concerning all these hybrids is cited.

Lolium and *Festuca* species used for crosses

Six species of the genus *Lolium* and five species of the genus *Festuca* were used in the interspecific and intergeneric hybridization programmes carried out in Poland during 1964-1994 (Table 1). Although all species of the genus *Lolium* are diploids ($2n=2x=14$), in the case of *L. multiflorum* and *L. perenne*

Table 1. Species of *Lolium* and *Festuca* genera used for interspecific and intergeneric hybridization performed in Poland in the years 1964-1994

Species	Chromosome number (2n)
<i>Lolium</i>	
<i>L. multiflorum</i>	2x=14, (4x=28)*
var. <i>oldenburgicum</i>	2x=14
var. <i>westerwoldicum</i>	2x=14, (4x=28)
<i>L. perenne</i>	2x=14, (4x=28)
<i>L. rigidum</i>	2x=14
<i>L. loliaceum</i>	2x=14
<i>L. persicum</i>	2x=14
<i>L. temulentum</i>	2x=14
<i>Festuca</i>	
<i>F. pratensis</i>	2x=14, (4x=28)
var. <i>apennina</i>	4x=28
<i>F. arundinacea</i>	6x=42
var. <i>genuina</i>	6x=42
var. <i>aspera</i>	6x=42
var. <i>montana</i>	6x=42
var. <i>orientalis</i>	6x=42
var. <i>rochelli</i>	6x=42
var. <i>glaucescens</i>	4x=28
var. <i>atlantigena</i> f. <i>pseudomairei</i>	8x=56
var. <i>letourneuxiana</i>	10x=70
<i>F. gigantea</i>	6x=42
<i>F. rubra</i>	6x=42
<i>F. mairei</i>	4x=28

* in parentheses – colchitetraploids (in *F. pratensis* also spontaneous tetraploids)

both diploids and colchitetraploids ($2n=4x=28$) were used for crossings. Within the genus *Festuca* species with different ploidy level, from diploid ($2n=2x=14$) to decaploid ($2n=10x=70$), were used. Most of 72 hybrid combinations involved four important agricultural species, *L. multiflorum* (Italian ryegrass), *L. perenne* (perennial ryegrass), *F. pratensis* (meadow fescue) and *F. arundinacea* (tall fescue), and diverse populations (cultivars or/and ecotypes) of each of these species were used for crosses. Both natural seed setting (especially in the hybridization programmes performed by SULINOWSKI in the sixties and seventies) and embryo culture (ZWIERZYKOWSKI, RYBCZYŃSKI 1976, 1981,

ZWIERZYKOWSKI 1987, ŚLUSARKIEWICZ-JARZINA et al. 1994, ZWIERZYKOWSKI, ZWIERZYKOWSKA 1994) were applied for obtaining F₁ plants.

Part of F₁ hybrids from most combinations, mainly hybrids with sufficient perenniality and winterhardiness, are maintained in the field collection as clones. The collection is transferred from one place to another every three-four years.

Interspecific hybrids (*Lolium* × *Lolium* and *Festuca* × *Festuca*)

Hybrids from five *Lolium* × *Lolium* combinations (Table 2, nos. 1-5) were obtained: diploid and tetraploid hybrids from reciprocal crosses between *L. multiflorum* and *L. perenne*, and the diploid hybrid *L. multiflorum* × *L. temulentum*. Hybrids from four of these cross combinations are now in our collection.

Within the genus *Festuca*, hybrids were obtained from 14 cross combinations (Table 2, nos. 6-19), 12 of which involved three species of the section *Bovinae* (*F. arundinacea*, *F. pratensis* and *F. gigantea*) and only two were intersectional, one – between the sections *Bovinae* and *Scariosae* (*F. pratensis* × *F. mairei*) and another – between the sections *Bovinae* and *Ovinae* (*F. arundinacea* × *F. rubra*). Hybrids from ten *Festuca* × *Festuca* combinations are maintained in the collection.

From three *Festuca* × *Festuca* hybrids induced allopolyploids were obtained and reported in details: *F. pratensis* × *F. arundinacea* (SULINOWSKI 1972a), *F. pratensis* × *F. gigantea* (SULINOWSKI 1972b) and *F. gigantea* × *F. arundinacea* (SULINOWSKI 1972c).

Intergeneric hybrids (*Lolium* × *Festuca* and *Festuca* × *Lolium*)

The most numerous hybrid combinations (51) were between *Lolium* and *Festuca* (Table 2, nos. 20-70). Generally, *Lolium* × *Festuca* hybridization is more successful when a *Lolium* species is used as a female parent. Hybrids were obtained from 39 *Lolium* × *Festuca* and 12 *Festuca* × *Lolium* combinations. Out of these, hybrids between cross-pollinated *Lolium* species (*L. multiflorum* and *L. perenne*) and *Festuca* species belonging to the section *Bovinae* (*F. arundinacea*, *F. pratensis* and *F. gigantea*) constituted a majority. Besides, hybrids were derived from eight cross combinations between self-pollinated *Lolium* species (*L. loliaceum*, *L. persicum* and *L. temulentum*) and *Festuca* sect. *Bovinae* as well as one combination between *Lolium* and *Festuca* sect. *Scariosae* (*L. multiflorum* × *F. mairei*). At present, hybrids of 36 *Lolium-Festuca* combinations are maintained in the collection.

Table 2. Interspecific and intergeneric hybrids of the *Lolium-Festuca* complex obtained in Poland in the years 1964-1994

(* hybrids maintained in the collection of the Institute of Plant Genetics, Polish Academy of Sciences in Poznań)

No.	Hybrid combination	References
<i>Lolium</i> × <i>Lolium</i>		
1*	<i>L. multiflorum</i> (2x) × <i>L. perenne</i> (2x)	NILSSON (1930), JENKIN (1931, 1954), NAYLOR (1960), NITZSCHE (1966), SULINOWSKI (1968a), EVANS, MACEFIELD (1974), AHLLOOWALIA (1981), ARCIONI, MARIOTTI (1983), ZWIERZYKOWSKI (unpublished), and others
2*	<i>L. perenne</i> (2x) × <i>L. multiflorum</i> (2x)	NILSSON (1930), JENKIN (1931, 1954), NAYLOR (1960), FOJTIK (1974), JAUHAR (1975), AHLLOOWALIA (1981), ARCIONI, MARIOTTI (1983), ZWIERZYKOWSKI (unpublished), and others
3*	<i>L. multiflorum</i> (4x) × <i>L. perenne</i> (4x)	HERTZSCH (1966), SCHUMANN (1968), SULINOWSKI (1968a), STUCZYŃSKI et al. (1969), EVANS, MACEFIELD (1974), BREESE et al. (1975), AHLLOOWALIA (1977), BREESE, THOMAS (1978), LEWIS (1980, 1981), ZWIERZYKOWSKI (unpublished), and others
4*	<i>L. perenne</i> (4x) × <i>L. multiflorum</i> (4x)	HERTZSCH (1966), SCHUMANN (1968), SULINOWSKI (1968a), STUCZYŃSKI et al. (1969), FOJTIK (1974), CLARKE, THOMAS (1976), AHLLOOWALIA (1977), LEWIS (1980), JONES, HUMPHREYS (1993), ZWIERZYKOWSKI (unpublished), and others
5	<i>L. multiflorum</i> (2x) × <i>L. temulentum</i> (2x)	JENKIN (1954), HOVIN et al. (1963), SULINOWSKI (1967)
<i>Festuca</i> × <i>Festuca</i>		
6	<i>F. pratensis</i> (2x) × <i>F. arundinacea</i> var. <i>glaucescens</i> (4x)	MALIK (1967a), MALIK, THOMAS (1967), CHANDRASEKHARAN, THOMAS (1971), CHANDRASEKHARAN et al. (1972), SULINOWSKI et al. (1976a)
7*	<i>F. pratensis</i> (2x) × <i>F. arundinacea</i> (6x)	JENKIN (1933, 1955a, c), NILSSON (1940), CROWDER (1953), HERTZSCH (1960, 1961), SULINOWSKI (1966a, 1972a), MALIK (1967a), MALIK, THOMAS (1967), SULINOWSKI et al. (1968), GRÖBER et al. (1974, 1976), MATZK (1976), CAGAŠ, JANEČEK (1981), ŠEVČÍK (1981), SLIESARAVICIUS et al. (1986), JANEČEK (1987), ZWIERZYKOWSKI (1987)
8	<i>F. pratensis</i> (2x) × <i>F. gigantea</i> (6x)	JENKIN (1933, 1955b, c), SULINOWSKI (1966a, 1972b), GRÖBER et al. (1974, 1976), MATZK (1976)
9*	<i>F. pratensis</i> (2x) × <i>F. mairei</i> (4x)	CHANDRASEKHARAN, THOMAS (1971), CHANDRASEKHARAN et al. (1972), SULINOWSKI et al. (1976b)

Table 2, cont.

No.	Hybrid combination	References
10*	<i>F. pratensis</i> (4x) × <i>F. arundinacea</i> var. <i>glaucescens</i> (4x)	ZWIERZYKOWSKI (1987)
11*	<i>F. pratensis</i> (4x) × <i>F. arundinacea</i> (6x)	HERTZSCH (1960, 1961), CHANDRASEKHARAN et al. (1972), GRÖBER et al. (1974, 1976), MATZK (1976), SLIESARAVICIUS et al. (1986), JANEČEK (1987), ZWIERZYKOWSKI (1987)
12*	<i>F. pratensis</i> (4x) × <i>F. arundinacea</i> var. <i>rochelli</i> (6x)	SULINOWSKI et al. (1976b)
13	<i>F. pratensis</i> (4x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1967), GRÖBER et al. (1974, 1976), MATZK (1976)
14*	<i>F. arundinacea</i> var. <i>glaucescens</i> (4x) × <i>F. pratensis</i> (4x)	CHANDRASEKHARAN et al. (1972), ZWIERZYKOWSKI (1987)
15*	<i>F. arundinacea</i> (6x) × <i>F. pratensis</i> (2x)	JENKIN (1933, 1955a, c), NILSSON (1940), CROWDER (1953), HERTZSCH (1960, 1961), MALIK, THOMAS (1967), GRÖBER et al. (1974, 1976), MATZK (1976), ŠEVČÍK (1981), SLIESARAVICIUS et al. (1986), JANEČEK (1987), ZWIERZYKOWSKI (1987)
16*	<i>F. arundinacea</i> (6x) × <i>F. pratensis</i> (4x)	HERTZSCH (1960, 1961), CHANDRASEKHARAN et al. (1972), GRÖBER et al. (1974, 1976), MATZK (1976), SLIESARAVICIUS et al. (1986), ZWIERZYKOWSKI (1987)
17*	<i>F. arundinacea</i> (6x) × <i>F. gigantea</i> (6x)	JENKIN (1933, 1955a, b), NILSSON (1935), SULINOWSKI (1966a), GRÖBER et al. (1974, 1976), BUCKNER et al. (1976), MATZK (1976), KING et al. (1987), BURNER et al. (1989, 1991), EIZENGA et al. (1990)
18*	<i>F. arundinacea</i> (6x) × <i>F. rubra</i> (6x)	ZWIERZYKOWSKI (1987)
19	<i>F. gigantea</i> (6x) × <i>F. arundinacea</i> (6x)	JENKIN (1933, 1955a, b), SULINOWSKI (1966a, 1972c), GRÖBER et al. (1974, 1976), MATZK (1976), BURNER et al. (1989, 1991), EIZENGA et al. (1990)
<i>Lolium</i> × <i>Festuca</i>		
20*	<i>L. multiflorum</i> (2x) × <i>F. pratensis</i> (2x)	LEWIS (1959), HERTZSCH (1960, 1961), SULINOWSKI (1967), GRÖBER et al. (1974, 1976), NITZSCHE (1974), MATZK (1976), WERNER (1976, 1983a-c), LEWIS, THOMAS (1983), ZWIERZYKOWSKI (1987)
21*	<i>L. multiflorum</i> (2x) × <i>F. pratensis</i> (4x)	WIT (1959, 1964), HERTZSCH (1960, 1961), SULINOWSKI (1967), CHANDRASEKHARAN et al. (1972), GRÖBER et al. (1974, 1976), JAUHAR (1975), MATZK (1976), MATZK, SEYFFERT (1981), ZWIERZYKOWSKI (1987)

Table 2, cont.

No.	Hybrid combination	References
22*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> var. <i>glaucescens</i> (4x)	SULINOWSKI et al. (1976b), LEWIS, THOMAS (1983), LEWIS (1984), POISSON et al. (1988)
23*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> (6x)	CROWDER (1953), LEWIS (1959, 1966), BUCKNER (1960), HERTZSCH (1960, 1961), BUCKNER et al. (1961, 1963, 1965), ESSAD (1962b), BEDDOWS (1965), SULINOWSKI (1966b), HESZKY (1971, 1972), WEBSTER, BUCKNER (1971), BADOUX (1973), WIT (1973), GRÖBER et al. (1974, 1976), DIJKSTRA, DE VOS (1975), MATZK (1976), FOJTÍK, SVĚTLÍK (1979), ZWIERZYKOWSKI (1980a, b), TERADA (1981), LEWIS, THOMAS (1983, 1985), KLEIJER (1984, 1987), KLEIJER, MOREL (1984), RIBEIRO (1986), JANEČEK (1987), KOMATSU et al. (1990), SLIESARAVICTUS (1992), ŚLUSARKIEWICZ-JARZINA et al. (1994), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
24*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> var. <i>montana</i> (6x)	SULINOWSKI et al. (1976b), ZWIERZYKOWSKI (1987)
25*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> var. <i>orientalis</i> (6x)	SULINOWSKI et al. (1976b), ZWIERZYKOWSKI (1987)
26*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> var. <i>atlantigena</i> (8x)	CHANDRASEKHARAN et al. (1972), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
27*	<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> var. <i>letourneuxiana</i> (10x)	MALIK, THOMAS (1966), SLIESARAVICTUS (1988), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
28	<i>L. multiflorum</i> (2x) × <i>F. gigantea</i> (6x)	NILSSON (1940), SULINOWSKI (1967), GRÖBER et al. (1974, 1976), MATZK (1976), LEWIS, THOMAS (1983, 1986), LEWIS (1984), MORGAN et al. (1988)
29*	<i>L. multiflorum</i> (2x) × <i>F. mairei</i> (4x)	SULINOWSKI (unpublished)
30	<i>L. multiflorum</i> var. <i>oldenburgicum</i> (2x) × <i>F. pratensis</i> (2x)	SULINOWSKI (1966a)
31	<i>L. multiflorum</i> var. <i>oldenburgicum</i> (2x) × <i>F. arundinacea</i> (6x)	SULINOWSKI (1966a)
32	<i>L. multiflorum</i> var. <i>oldenburgicum</i> (2x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1966a)
33	<i>L. multiflorum</i> var. <i>westerwoldicum</i> (2x) × <i>F. arundinacea</i> (6x)	SULINOWSKI (1966a), HESZKY (1971, 1972)
34	<i>L. multiflorum</i> var. <i>westerwoldicum</i> (2x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1966a)
35*	<i>L. multiflorum</i> (4x) × <i>F. pratensis</i> (2x)	HERTZSCH (1960, 1961), FOJTÍK (1974), MATZK (1976), HUMPHREYS (1986), JANEČEK (1987), ZWIERZYKOWSKI (1987), HUMPHREYS, THOROGOOD (1993)

Table 2, cont.

No.	Hybrid combination	References
36*	<i>L. multiflorum</i> (4x) × <i>F. pratensis</i> (4x)	HERTZSCH (1960, 1966), LEWIS (1970, 1971, 1972, 1973), GRÖBER et al. (1974, 1976), CREMADES, BEAN (1975), MATZK (1976), ZWIERZYKOWSKI, RYBCZYŃSKI (1976, 1981), HUMPHREYS (1978), WACKER, NETZBAND (1980), MATZK, SEYFFERT (1981), FOJTÍK, VACEK (1983), JANEČEK (1987), ZWIERZYKOWSKI (1987), NETZBAND (1991), FOJTÍK (1994), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
37*	<i>L. multiflorum</i> (4x) × <i>F. arundinacea</i> var. <i>glaucescens</i> (4x)	LEWIS, THOMAS (1983), THOMAS et al. (1983), LEWIS (1984), POISSON et al. (1988), JADAS-HÉCART et al. (1992), GHESQUIÈRE et al. (1993)
38*	<i>L. multiflorum</i> (4x) × <i>F. arundinacea</i> (6x)	HERTZSCH (1960), GRÖBER et al. (1974, 1976), CLARKE et al. (1976), MATZK (1976), MATZK, SEYFFERT (1981), KLEJER (1984), JANEČEK (1987), ZWIERZYKOWSKI (1987), HUMPHREYS (1989), ŚLUSARKIEWICZ-JARZINA et al. (1994), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
39*	<i>L. multiflorum</i> (4x) × <i>F. arundinacea</i> var. <i>atlantigena</i> (8x)	CHANDRASEKHARAN et al. (1972), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
40*	<i>L. multiflorum</i> (4x) × <i>F. arundinacea</i> var. <i>letourneuxiana</i> (10x)	ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
41	<i>L. multiflorum</i> var. <i>westerwoldicum</i> (4x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1967), MORGAN et al. (1988)
42*	<i>L. perenne</i> (2x) × <i>F. pratensis</i> (2x)	JENKIN (1933, 1955d), PETO (1933), CROWDER (1953), ESSAD (1956, 1962a, 1964), LEWIS (1959), HERTZSCH (1960, 1961), REUSCH (1960), GYMER, WHITTINGTON (1973a, b, 1975a, b), GRÖBER et al. (1974, 1976), JAUHAR (1975), MATZK (1976), TERADA (1981), LEWIS, THOMAS (1983), LEWIS (1984), ZWIERZYKOWSKI (1987)
43*	<i>L. perenne</i> (2x) × <i>F. pratensis</i> (4x)	CARNAHAN, HILL (1955), WIT (1959, 1964), HERTZSCH (1960, 1961), HILL, CARNAHAN (1962), SULINOWSKI (1967), ESSAD (1968), GRÖBER et al. (1974, 1976), JAUHAR (1975), MATZK (1976), ZWIERZYKOWSKI (1987)
44*	<i>L. perenne</i> (2x) × <i>F. arundinacea</i> (6x)	JENKIN (1933, 1955e), PETO (1933), CROWDER (1953), LEWIS (1959), BUCKNER (1960), HERTZSCH (1960, 1961), BUCKNER et al. (1961), SULINOWSKI (1967), HESZKY (1971, 1972), WIT (1973), GRÖBER et al. (1974, 1976), MATZK (1976), TERADA (1981), LEWIS, THOMAS (1983), LEWIS (1984), RIBEIRO (1986), JANEČEK (1987), ZWIERZYKOWSKI (1987), SLIESARAVICIUS (1992), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
45	<i>L. perenne</i> (2x) × <i>F. gigantea</i> (6x)	JENKIN (1933, 1955e), SULINOWSKI (1967, 1973), GRÖBER et al. (1974, 1976), MATZK (1976)

Table 2, cont.

No.	Hybrid combination	References
46*	<i>L. perenne</i> (4x) × <i>F. pratensis</i> (4x)	HERTZSCH (1960, 1961, 1966), LEWIS (1970, 1972, 1973), CREMADES, BEAN (1975), LEWIS, THOMAS (1983), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
47*	<i>L. perenne</i> (4x) × <i>F. arundinacea</i> var. <i>glaucescens</i> (4x)	LEWIS (1984), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
48*	<i>L. perenne</i> (4x) × <i>F. arundinacea</i> (6x)	HERTZSCH (1960), SLIESARAVICIUS (1988, 1992), ŚLUSARKIEWICZ-JARZINA et al. (1994), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
49*	<i>L. rigidum</i> (2x) × <i>F. arundinacea</i> (6x)	SULINOWSKI (1966a)
50	<i>L. rigidum</i> (2x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1966a)
51*	<i>L. loliaceum</i> (2x) × <i>F. arundinacea</i> (6x)	JENKIN (1955f), SULINOWSKI (unpublished)
52	<i>L. persicum</i> (2x) × <i>F. pratensis</i> (2x)	ZWIERZYKOWSKI (1987)
53	<i>L. persicum</i> (2x) × <i>F. pratensis</i> (4x)	SULINOWSKI (1967)
54	<i>L. persicum</i> (2x) × <i>F. arundinacea</i> (6x)	SULINOWSKI (1966a)
55*	<i>L. persicum</i> (2x) × <i>F. arundinacea</i> var. <i>orientalis</i> (6x)	SULINOWSKI et al. (1976b)
56	<i>L. persicum</i> (2x) × <i>F. gigantea</i> (6x)	SULINOWSKI (1967)
57	<i>L. temulentum</i> (2x) × <i>F. pratensis</i> (2x)	CUGNAC, CAMUS (1944), GRÖBER et al. (1974, 1976), MATZK (1976), ZWIERZYKOWSKI (1987)
58	<i>L. temulentum</i> (2x) × <i>F. arundinacea</i> var. <i>aspera</i> (6x)	SULINOWSKI et al. (1976b)

Festuca × *Lolium*

59*	<i>F. pratensis</i> (2x) × <i>L. multiflorum</i> (4x)	HERTZSCH (1960, 1961), CHANDRASEKHARAN et al. (1972), FOJTIK (1974), GRÖBER et al. (1974, 1976), JAUHAR (1975, 1976), MATZK (1976), JANEČEK (1987), ZWIERZYKOWSKI (1987)
60*	<i>F. pratensis</i> (4x) × <i>L. multiflorum</i> (2x)	HERTZSCH (1960, 1961), CHANDRASEKHARAN et al. (1972), MATZK (1976), ZWIERZYKOWSKI (1987)
61*	<i>F. pratensis</i> (4x) × <i>L. multiflorum</i> (4x)	HERTZSCH (1959, 1960), GRÖBER et al. (1974, 1976), MATZK (1976), MATZK, SEYFFERT (1981), ZWIERZYKOWSKI (1987), KAISER (1988), ZWIERZYKOWSKI et al. (1993), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
62*	<i>F. pratensis</i> var. <i>apennina</i> (4x) × <i>L. multiflorum</i> (4x)	CLARKE et al. (1976), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
63*	<i>F. pratensis</i> (4x) × <i>L. perenne</i> (4x)	HERTZSCH (1960, 1961), GRÖBER et al. (1974, 1976), MATZK (1976), MATZK, SEYFFERT (1981), SLIESARAVICIUS (1992), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)

Table 2, cont.

No.	Hybrid combination	References
64*	<i>F. arundinacea</i> var. <i>glaucescens</i> (4x) × <i>L. multiflorum</i> (2x)	ZWIERZYKOWSKI (1987)
65*	<i>F. arundinacea</i> var. <i>glaucescens</i> (4x) × <i>L. multiflorum</i> (4x)	ZWIERZYKOWSKI (1987), POISSON et al. (1988)
66*	<i>F. arundinacea</i> (6x) × <i>L. multiflorum</i> (2x)	CROWDER (1953), HERTZSCH (1960), KLEIJER (1982), EIZENGA, BUCKNER (1986), TAKAMIZO et al. (1991), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
67*	<i>F. arundinacea</i> (6x) × <i>L. multiflorum</i> (4x)	HERTZSCH (1960), GRÖBER et al. (1974, 1976), MATZK (1976), ZWIERZYKOWSKI (1987), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
68*	<i>F. arundinacea</i> var. <i>atlantigena</i> (8x) × <i>L. multiflorum</i> (4x)	ZWIERZYKOWSKI (1987)
69*	<i>F. arundinacea</i> (6x) × <i>L. perenne</i> (2x)	CROWDER (1953), GRÖBER et al. (1974, 1976), MATZK (1976), EVANS, AUNG (1986), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
70*	<i>F. arundinacea</i> (6x) × <i>L. perenne</i> (4x)	SLIESARAVICIUS (1992), ZWIERZYKOWSKI, ZWIERZYKOWSKA (1994)
Trispecific hybrids (<i>Lolium</i> × <i>Festuca</i>) × <i>Festuca</i>		
71	[<i>L. multiflorum</i> (2x) × <i>F. arundinacea</i> (6x)] × <i>F. gigantea</i> (6x)	SULINOWSKI (1966b)
72	[<i>L. multiflorum</i> var. <i>oldenburgicum</i> (2x) × <i>F. pratensis</i> (2x)] × <i>F. arundinacea</i> (6x)	SULINOWSKI (1969)

Although most of *Lolium-Festuca* hybrids are sterile, fertility may be restored through chromosome doubling by colchicine treatment (SULINOWSKI 1966b, 1972a-c, 1973, ZWIERZYKOWSKI 1980a, WERNER 1983b) or by tissue culture (RYBCZYŃSKI et al. 1983, ZWIERZYKOWSKI et al. 1985, ZWIERZYKOWSKI, RYBCZYŃSKI 1994). From several *Lolium* × *Festuca* hybrids, allopolyploid derivatives were induced and extensively studied, i.e. *L. multiflorum* × *F. arundinacea* (SULINOWSKI 1966b, ZWIERZYKOWSKI 1980a, b), *L. perenne* × *F. gigantea* (SULINOWSKI 1973) and *L. multiflorum* × *F. pratensis* (WERNER 1976, 1983a-c, ZWIERZYKOWSKI, RYBCZYŃSKI 1976, 1981, ZWIERZYKOWSKI et al. 1985, ZWIERZYKOWSKI et al. 1993, 1994).

SULINOWSKI also obtained trispecific hybrids from two cross combinations: (*L. multiflorum* × *F. arundinacea*) × *F. gigantea* (SULINOWSKI 1966b) and (*L. multiflorum* × *F. pratensis*) × *F. arundinacea* (SULINOWSKI 1969).

The collection of the interspecific and intergeneric hybrids of the *Lolium-Festuca* complex, maintained at the Institute of Plant Genetics in Poznań, can still be an important source of materials for basic studies and for breeding.

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