

The selection of homozygous lines of barley resistant to *Heterodera filipjevi* based on the nematode resistant Turkish k-6808 cultivar

Elena V. Osipova*, Marina I. Rudenko**, Vera P. Balakhnina* and Vitalii A. Pukhalskiy***

*The All-Russian K.I. Skrjabin Institute of Helminthology, Bol'shaya Cheremushkinskaya 28, Moscow, 117259, Russia,

**The Agricultural Scientific Research Institute of the Central Regions of the Non-Chernozem zone of Russia, Agrochimikov street 6, Nemchinovka, Odintsovsky district, Moscow region, 143013, Russia,

***The Institute of General Genetics of Russian Academy of Sciences, Gubkina 3, Moscow, 117809, Russia.

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Summary. New lines of barley with genetic resistance against *Heterodera filipjevi* were produced from crossing the high yielding but nematode susceptible cultivar Donetsky 4 with the low yielding but highly nematode resistant Turkish k-6808 cultivar. The Turkish cultivar of barley was used here for the first time as a source of resistance against the nematode. The yield characteristics of the new barley lines were comparable with that of Zazersky 85, the most widely grown cultivar in the former Soviet Union.

Key words: *Heterodera filipjevi*, barley, resistance, homozygous line.

The cereal-cyst nematode (CCN) complex is widely distributed in grain producing regions in the former Soviet Union (Tikhonova, 1978; Volchkova, 1978; Balakhnina & Tishenkov, 1981; Shiabova, 1982). More recently *Heterodera filipjevi* has been identified as being a component of the CCN complex and is now considered to be the most widely distributed and frequently occurring species in the former Soviet Union (Subbotin *et al.*, 1996). The preferred method for controlling CCN is the use of nematode resistant cultivars. However, the range of genetic material available for selection and use in breeding programmes to develop varieties resistant to *H. filipjevi* is very limited within the genus *Hordeum* L. The cultivars Morocco, Marocaine (gene Rha 3), L.P. 191 (gene Rha 2), Drost (gene Rha I) and Bajo-Aragon have been used in breeding programmes as a source of resistance to European pathotypes of *H. avenae* (Andersen & Andersen 1982; Cook & York, 1982; Lücke, 1976; Nielsen, 1982; Ireholm, 1994) but have been shown to be susceptible to *H. filipjevi* (Balakhnina & Tishenkov, 1981; Shiabova, 1982; Osipova, 1986). Previous investigations to identify nematode resistant local cultivars commonly grown in the Non-Chernozem zone (Zhuk, 1970; Tikhonova, 1978; Balakhnina & Tishenkov, 1980), the Povolzhie region (Osipova, 1985) and the Novosibirsk region (Mamonova, 1969) of the former

USSR were unsuccessful.

Screening of barley cultivars from the world collection of the N.I. Vavilov All-Russian Scientific Research Institute of Plant Genetic Resources (VIR) identified the Turkish cultivar of barley, k-6808, as being resistant to *H. filipjevi* (Balakhnina, 1985). The source of resistance was identified as being a dominant homozygous genetical trait (Osipova, 1989) and was used in a barley breeding programme reported here.

MATERIALS AND METHODS

F₂ hybrids were obtained from reciprocal crossings of the high yielding barley cultivar Donetsky 4 (Sportan/Donetsky 646; Ukraine), which is highly susceptible to *H. filipjevi*, with the nematode resistant cultivar k-6808. The single seed descent method reported by Grafius (1965) and Brim (1966) was used in this work. This method is based on the advancement of each selected F₂ plant to a desirable level of homozygosity by successive sowing of one seed from each plant (Fig. 1).

Hybrid plants resistant to *H. filipjevi* were evaluated and selected in field plots, and in pot experiments inoculated with 1000 eggs and juveniles of the Baimak population of *H. filipjevi* per 100 cm³ of soil. The hybrids were distinguished according to their

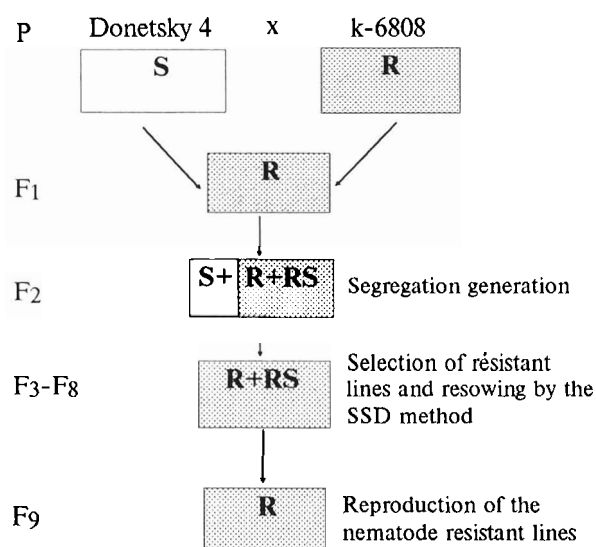


Fig. 1. Scheme for obtaining homozygous *Heterodera filipjevi* resistant barley lines by the Single Seed Descent method. S- susceptible cultivar, R- resistant cultivar.

resistance against the nematodes, using the method of Balakhnina & Osipova (1988). In this work, we combined random selection for resistance to the nematode among early segregating plants (F₂-F₄), because the genetic control of this trait in the donor k-6808 is re-established, with selection in virtually homozygous generations (F₆-F₉).

The lines selected from growth and yield experiments were tested in field experiments during 1993-1994 at the plant-breeding station of the Institute of Agriculture of the Non-Chernozem zone of Russia. The evaluation of experimental results on productivity and resistance of the barley lines was based on the methods of variance statistics and genetic analysis of Briggs & Knowles (1972) and Dospelkhov (1985).

RESULTS AND DISCUSSION

The analysis of segregation of F₂ hybrids tested in plots heavily infected with *H. filipjevi* provided 265 groups of plants with various degrees of resistance, and this represented about 47% of the total number of hybrid populations. Presumably the resistance is determined in this case by a single pair of genes, as on average 50% of the plants appeared to be heterozygous for resistance to *H. filipjevi* (Table 1). As the possibility of decreased resistance in new "genetic circumstances" for plants (Briggs & Knowles, 1972) could not be excluded, only plants *viz.* F₃-F₄ hybrids, with a 0-1 level of resistance were selected. In conclusion, the advancement of the hybrid plants was carried out to the almost homozygous generations F₈-F₉.

In this work, we succeeded in selecting 15 homozygous (non-segregating) nematode resistant barley lines. Preliminary and subsequent tests of these new barley lines in plots with nematodes confirmed their high resistance to *H. filipjevi*. Genetic determination of nematode resistance of selected lines and their genotypic equality were apparently confirmed by the high level of homozygosity present in the F₉ hybrids.

Growth and yield characteristics of the 15 homozygous lines of barley with genetically determined resistance to *H. filipjevi* are presented in Table 2. The newly selected lines had larger weights per 100 grains and also increased mean grain weights as compared with the standard, high yielding cultivar Zazersky 85. Also, these new lines were comparable with this standard commercial variety in the number of stems per single plant and the total number of grains per plant. The high yielding of the new lines probably results from the use of the cultivar Donetsky 4 in the initial crossings as this variety is a well established donor of dominant genes for high yield characteristics (Il'in, 1982).

Table 1. Examination of hybrid barley lines (Donetsky 4 x k-6808) for resistance to *Heterodera filipjevi* (Baimak population, 1987-1993).

Hybrid generation	Total lines tested	Total resistant lines (0-1)	Percentage of resistant lines
F ₂	563	265	47
F ₃	265	96	36
F ₄	96	33	33
F ₅	33	28	84
F ₆	28	22	75
F ₇	22	15	68
F ₈ -F ₉	15	15	100

Table 2. Productivity of resistant to *Heterodera filipjevi* barley lines (1993-1994).

N°	Line	Plant height (cm)	Productive stems	Grain weight/ plant (g)	Grain number/ plant	Weight of 100 grains (g)
1	14	80.0	3.8	1.85	33.1	5.6
2	16	60.0	3.5	2.62	62.4	4.2
3	32	85.0	2.7	2.14	41.1	5.2
4	33	90.0	3.5	2.50	43.9	5.7
5	72	95.0	1.5	2.80	50.0	3.6
6	77	94.0	3.5	2.55	42.5	6.0
7	89	70.0	3.2	1.95	44.3	4.4
8	100	88.0	1.5	0.92	48.8	4.9
9	121	85.0	2.1	1.65	44.6	3.7
10	135	85.0	1.2	1.85	42.0	4.4
11	180	75.0	3.0	1.86	36.5	5.1
12	188	80.0	1.5	1.20	25.0	4.8
15	192	75.0	1.2	1.14	25.3	4.8
13	210	70.0	2.2	2.92	57.3	2.1
14	216	80.0	3.3	2.20	42.3	5.2
Zazersky 85		68.0	2.6	1.79	41.9	4.3
Average		80.0	2.5	1.93	40.7	4.8
SD		9.8	0.88	0.56	10.7	0.68
Standart error of mean		2.45	0.22	0.14	2.67	0.17

The collaboration between geneticists and nematologists resulted in the first production of barley lines in Russia that carry a new resistance gene to *H. filipjevi* with good agronomic characteristics at the level of the highly yielding cultivar Zazersky 85. These new lines provide the basis for the future production of new nematode resistant barley cultivars.

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Осипова Е. В., Руденко М. И., Балахнина В. П., Пухальский В. А. Создание гомозиготных линий ячменя, устойчивых к *Heterodera filipjevi*, на основе нематодоустойчивого сорта ячменя к-6808 из Турции.

Резюме. В результате совместной работы генетиков и гельминтологов впервые в России созданы гомозиготные линии ячменя, устойчивые к *Heterodera filipjevi* и не уступающие по хозяйственно-ценным признакам высокопродуктивному сорту-стандарту Зазерский 85. В качестве донора нематоустойчивости при создании линий использовали местный сорт ячменя из Турции – к-6808, впервые выделенный из мировой коллекции Всесоюзного института растениеводства.
