ALL-UNION INSTITUTE OF PLANT BREEDING AND GENETICS, ODESSA
and
INSTITUTE OF ECOLOGICAL GENETICS OF MOLDAVIAN ACADEMY OF SCIENCES, KISHINEV
U.S.S.R.

1) Varietal differences of soybeans sensitivity to low temperature during germination.

Developing of cold-tolerant soybean varieties is one of the new main trends in soybean breeding. Such studies were started in the USA (Veitenheimer et al., 1984; Unander and Orf, 1984; Harrison and Nickell, 1984; Hillsman et al., 1977; Hicks, 1978; Seddigh and Jolliff, 1984; Littlejohns and Tanner, 1976; Hume and Jackson, 1981; Voldeng et al., 1984; Sanbuichi, 1980; Goto and Yamamoto, 1972; Schmid and Keller, 1980; Szyrmer and Janicka, 1985; Gromova, 1975; Lunin, 1981; Malysh and Bobrikov, 1984; Sherepitko and Balashow, 1985).

The experiments demonstrated that low temperatures reduced germination, field emergence, the rate of early growth and soybean yield. The same results have been obtained in our previous experiments (Sichkar and Beversdorf, 1980, 1982). Our objective in this study was evaluation of soybean varieties from world germplasm collection for cold tolerance and determination of the nature of inheritance of the character.

Materials and methods: In 1980-1985, over 500 soybean varieties from the world germplasm collection were tested for reaction to low temperatures in growth chambers. Seeds were placed on filter paper discs in petri dishes or in sand in growth boxes. The experiment was conducted at 7°, in a check it was 23 or 25°. Under low temperature regime, the number germinated seeds was counted every day. The final germination was determined on the 28th or 30th day after soaking. In the checks, germination was determined on the 7th day after the beginning of the experiments. The length of the radicles in the experiments was measured on the 28th or 30th day, in the check on the 7th day. Earlier planting in the field was carried out in the period from the end of March to the beginning of April. The optimum sowing was made at 18-20° soil temperature in seed bed.

Results and discussion: Germination of seeds from a large number of world germplasm collection of soybean made it possible to differentiate the studied forms as cold-resistant and sensitive to low temperature (Tables 1 and 2). Such varieties as 'Grant', 'Severnaya 2', 'Lincoln', 'Norchief', 'Kishinevskaya 5', 'Kievskaya 71', 'SRF 100', 'Man-Szan-tsin' and 'Hawkeye' showed high germination at 7°. Varieties such as: 'Amurskaya buraya', 'VIR-4956', 'Vengerskaya 45', 'Gieso', 'Altona' and others were sensitive to the same temperature. In another experiment such varieties as 'Comet', 'Amurskaya 41', 'Dobrudschanka 18', 'Vengerka', 'Salut 216' and 'Nairn' showed cold resistance during several seasons (Table 3). The varieties 'Chabarovskaya 33', 'Yantarnaya', Gieso and others were inferior as far as that character is concerned. Figure 1 shows germination dynamics of the seeds differing in sensitivity to low temperatures. The seeds of cold-resistant variety 'Negrutsa' showed high germination on 12th day after soaking, while first germinated seeds of Gieso variety appeared only in 24 days at low temperature.

Table 1. Germination and growth of the radicles of cold-tolerant soybean varieties

| Variety | Temperature | | | |
|---|---|---|---|---|
| | 25° | | 7° | |
| | Germination energy (%) | Germination (%) | Germination (%) | Length of radicles (cm) |
| Grant | 95 | 96 | 84 | 0.89 ± 0.07 |
| Amurskaya 147 | 95 | 96 | 80 | 1.37 ± 0.09 |
| Severnaya 2 | 98 | 99 | 88 | 1.16 ± 0.06 |
| Lincoln | 99 | 99 | 84 | 1.27 ± 0.06 |
| Norchief | 86 | 90 | 83 | 1.30 ± 0.07 |
| Kishinevskaya 5 | 92 | 93 | 95 | 1.18 ± 0.18 |
| Kievskaya 71 | 76 | 87 | 76 | 1.10 ± 0.06 |
| SRF 100 | 96 | 96 | 92 | 1.22 ± 0.08 |
| Amurskaya 400 | 96 | 92 | 74 | 0.99 ± 0.06 |
| Man-Szan-tsin | 87 | 89 | 75 | 0.89 ± 0.05 |
| Hawkeye | 65 | 86 | 74 | 0.86 ± 0.06 |
| Steele | 94 | 98 | 82 | 0.90 ± 0.05 |
| Bombay | 93 | 98 | 80 | 0.77 ± 0.04 |

Table 2. Germination and growth of radicles of sensitive soybean varieties

| Variety | Temperature | | | |
|---|---|---|---|---|
| | 25° | | 7° | |
| | Germination energy (%) | Germination (%) | Germination (%) | Length of radicles (cm) |
| Amurskaya 411 | 86 | 87 | 40 | 0.64 ± 0.05 |
| Ruest | 88 | 90 | 37 | 0.83 ± 0.10 |
| Amurskaya buraya | 96 | 97 | 18 | 0.77 ± 0.04 |
| Karona | 95 | 97 | 44 | 0.73 ± 0.06 |
| Gieso | 92 | 100 | 42 | 0.80 ± 0.07 |
| Altona | 69 | 89 | 37 | 0.67 ± 0.04 |
| VIR-4956 | 97 | 98 | 38 | 0.88 ± 0.07 |
| 075-2 (Canada) | 90 | 95 | 42 | 1.14 ± 0.09 |
| Vengerskaya 48 | 77 | 91 | 34 | 0.85 ± 0.09 |

Table 3. Germination of soybean seeds from world collection at optimum and low temperature

| Variety | Temperature 23° 1981 | 1982 | 1983 | 7° 1981 | 1982 | 1983 |
|---|---|---|---|---|---|---|
| Amurskaya 41 | 91.3 | 97.3 | 93.0 | 96.0 | 97.0 | 87.9 |
| Comet | 92.5 | 98.5 | 91.0 | 90.2 | 96.4 | 93.5 |
| Dobrudschanka 18 | 97.0 | 95.0 | 94.0 | 96.8 | 96.2 | 93.7 |
| Negrutsa | 98.0 | - | 96.0 | 95.4 | 94.6 | 91.2 |
| Vengerka | 94.6 | 94.5 | 93.5 | 95.2 | 95.1 | 87.6 |
| Salut 216 | 92.0 | 90.0 | 93.0 | 92.2 | 91.1 | 80.8 |
| Da-Li-Huan | 99.0 | 95.5 | 95.5 | 93.9 | 88.7 | 87.1 |
| Vytka 3 | 99.0 | 93.0 | 98.0 | 94.8 | 83.6 | 94.4 |
| Beltskaya 25 | 99.0 | 98.0 | 96.0 | 92.8 | 71.8 | 53.0 |
| Gieso | 94.0 | 98.0 | 98.0 | 40.3 | 58.1 | 65.5 |
| Dalnevostochnaya 913 | 99.0 | 98.5 | 96.5 | 91.0 | 56.8 | 70.8 |
| Boby buryje maslichnyje | 97.0 | 97.3 | 94.0 | 32.6 | 52.0 | 62.7 |
| Yantarnaya | 97.0 | 89.0 | 93.5 | 59.5 | 50.1 | 49.5 |
| Habarovskaya 33 | 98.0 | 93.5 | 96.0 | 89.7 | 21.3 | 77.9 |
| P 73-2 | 94.0 | 93.0 | 95.5 | 29.6 | 17.5 | 47.0 |

Table 4. Field emergence of soybean varieties from world germplasm collection at early sowing

| Variety | Optimum sowing | | | | Early sowing | | | |
|---|---|---|---|---|---|---|---|---|
| | 1981 | 1982 | 1983 | Ave. | 1981 | 1982 | 1983 | Ave. |
| Amurskaya 41 | - | 82.0 | 81.0 | - | - | 56.6 | 77.0 | - |
| Comet | - | 77.0 | 80.5 | - | - | 68.7 | 81.8 | - |
| Dobrudschanka 18 | 86.5 | 88.0 | 83.5 | 86.0 | 84.6 | 77.8 | 84.9 | 82.4 |
| Negrutsa | 80.0 | 79.5 | 85.0 | 81.5 | 81.0 | 71.3 | 93.7 | 82.0 |
| Vengerka | 84.0 | 86.5 | 84.5 | 85.0 | 77.0 | 69.3 | 85.2 | 77.2 |
| Salut 216 | 68.0 | 78.0 | 70.0 | 72.0 | 57.9 | 42.1 | 59.1 | 53.0 |
| Da-Li-Huan | 75.0 | 88.5 | 86.0 | 83.2 | 67.0 | 55.7 | 91.9 | 71.5 |
| Vytka 3 | 82.5 | 80.0 | 86.5 | 83.0 | 85.5 | 43.7 | 85.5 | 71.6 |
| Beltskaya 25 | 82.9 | 84.5 | 81.5 | 83.0 | 53.5 | 45.2 | 53.2 | 50.6 |
| Gieso | 53.5 | 86.5 | 83.5 | 74.4 | 44.5 | 29.1 | 60.0 | 44.5 |
| Dalnevostochnaya 913 | 78.5 | 83.5 | 86.0 | 82.7 | 65.8 | 14.9 | 60.7 | 47.1 |
| Boby buryje maslichnyje | 76.0 | 86.0 | 87.5 | 83.3 | 81.9 | 71.6 | 89.4 | 81.0 |
| Yantarnaya | 62.5 | 76.0 | 81.5 | 73.3 | 28.8 | 14.3 | 61.1 | 34.7 |
| Altona | 81.5 | 84.0 | 85.5 | 83.7 | 66.9 | 35.0 | 58.3 | 53.4 |
| P 73-2 | 59.5 | 81.0 | 86.0 | 75.5 | 44.6 | 20.4 | 50.0 | 38.3 |

It should be noted that, in general, at 7°, cold-resistant genotypes exceeded the others in length of the radicles (Figure 2). In the first experiment, the exception was Canadian line 075-2. It showed low field germination at low temperature, and the growth of radicles was equal to that of cold-resistant genotypes.

In the second experiment, variety Comet showed the decreased radicle growth, though it was cold-tolerant during seed germination. The results suggested that some soybean genotypes showed specific reactions to low temperature.

In field conditions, such varieties as Amurskaya 41, Comet, Dobrudschanka 18, Negrutsa, and Vengerka confirmed high germination under early sowing. Low field germination of several varieties at optimum sowing date in 1981 is attributed to unfavorable temperature regime during May.

Thus, the results of laboratory and field experiments demonstrated substantial genotypic variability of soybean varieties to germinate at low temperature. It is important that the local Moldavian varieties Dobrudschanka 18 and Negrutsa showed high cold resistance. Germination of the majority of studied varieties varied in different years. Apparently, it depended on conditions in the period of seed formation.

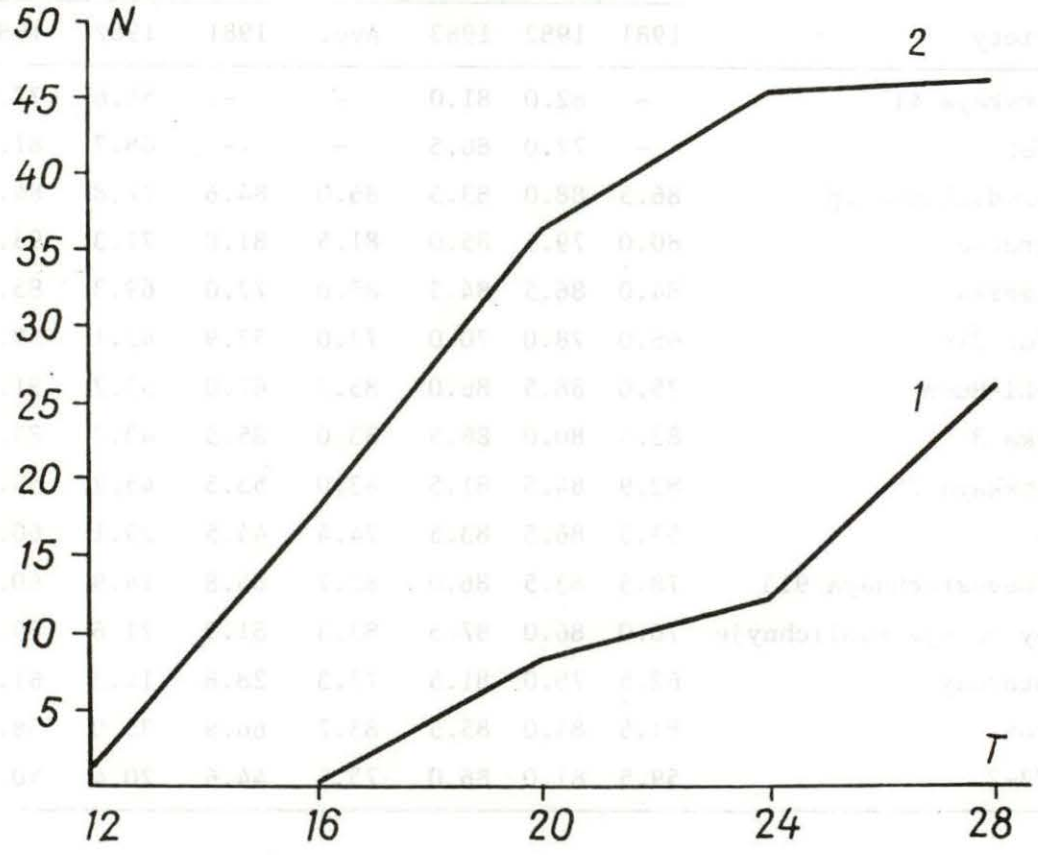


Figure 1. The germination dynamics of sensitive Gieso variety and cold-resistant Negrutsa variety under low temperature

Axis of ordinates - the number of germinated seeds (N)
Axis of abscissas - the number of days (T)

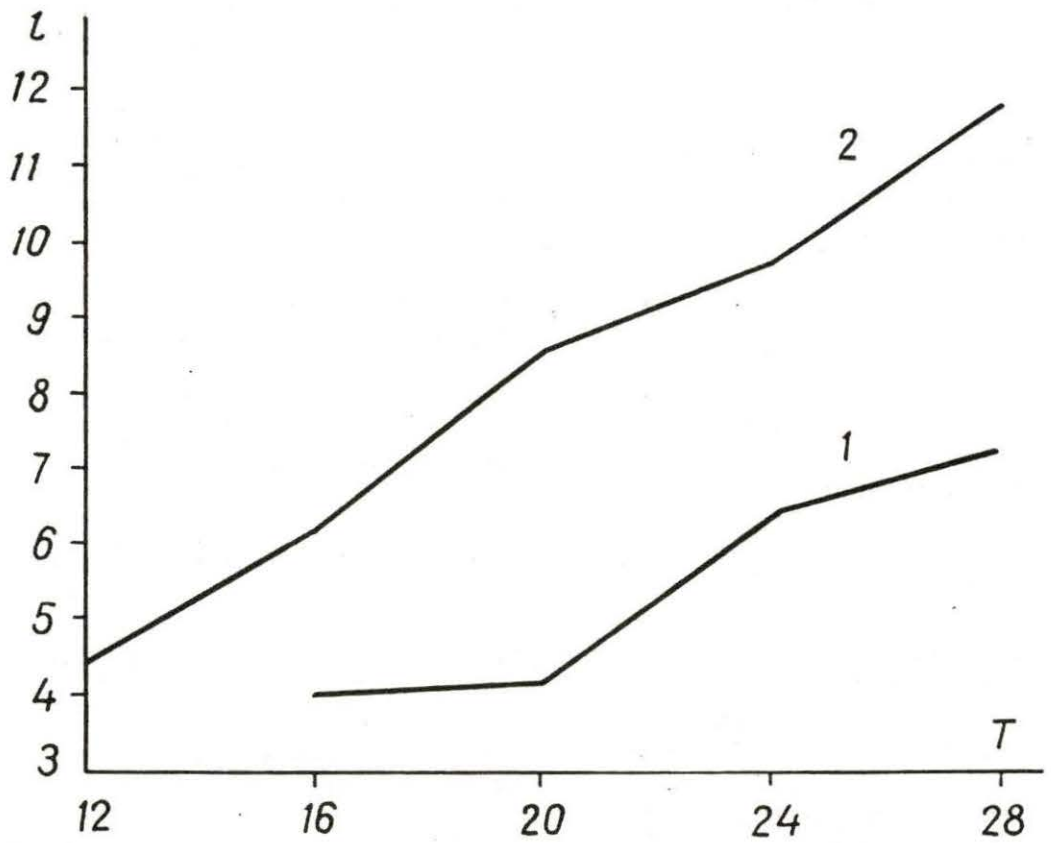


Figure 2. The growth dynamics of the radicles of sensitive Gieso variety (1) and cold-resistant Negrutsa variety (2) under low temperature

Axis of ordinates - average length of the radicles, l, mm
Axis of abscissas - the number of days (T)

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V. I. Sichkar
V. V. Sherepitko
T. N. Balashov