**Table 1** Basic data about provenance

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Ordinal number** | **Forest office** | **Provenance** | **Ecological- managerial forest type** | **Parent rock** | **Altitude**  **(m)** | **Longitude** | **Latitude** |
| 1 | Fužine | Brloško | I-C-10 | limestone | 812-975 | 45.18 N | 14.43 E﻿ |
| 2 | Skrad | Jasle | I-C-40 | silicates | 630 | 45.26 N | 14.55 E﻿ |
| 3 | Ravna gora | Višnjevica | I-C-10 | limestone | 770 | 45.30 N | 14.56 E |
| 4 | Skrad | Rudač | I-C-40 | silicates | 770-794 | 44.55 N | 14.56 E |
| 5 | Vrbovsko | Miletka | I-C-40 | silicates | 660-700 | 45.20 N | 15.05 E |
| 6 | Vrbovsko | Gluhe drage | I-C-10 | limestone | 680-750 | 44.55 N | 15.01 E |
| 7 | Gerovo | Lividraga | I-C-10 | limestone | 940-1022 | 45.35 N | 14.32 E |
| 8 | Gerovo | Vršice | I-C-10 | limestone | 820-900 | 45.35 N | 14.32 E |
| 9 | Tršće | Crni lazi | I-C-10 | limestone | 900-928 | 44.55 N | 14.59 E |
| 10 | Tršće | Rudnik | I-C-40 | silicates | 840-930 | 44.55 N | 14.38 E |
| 11 | Prezid | Milanov vrh | I-C-10 | limestone | 920-1067 | 44.55 N | 14.33 E |
| 12 | N.P. Risnjak | Risnjak 2 | I-C-40 | silicates | 685 | 45.25 N | 14.44 E |
| 13 | N.P. Risnjak | Risnjak 1 | I-C-11 | limestone,  dolomites | 680 | 45.25 N | 14.44 E |
| 14 | Krasno | Nađak bilo | I-C-10 | limestone | 885 | 44.50 N | 15.00 E |
| 15 | Krasno | Štirovača | I-C-10 | limestone | 1083 | 44.40 N | 15.03 E |
| 16 | N. Vinodolski | Duliba | I-C-10 | limestone | 718 | 45.09 N | 14.56 E |
| 17 | Imotski | Kaoci | III-C-20 | limestone | 1050 | 43.925 N | 17.15 E |

**Table 2** Descriptive statistic parameters of physiological and morphological properties of Silver fir seeds

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Seed**  **properties** | **No**  **Trees** |  | | | **s** | **CV (%)** | | |
| **Mean** | **Min** | **Max** | **Mean** | **Min** | **Max** |
| Germination capacity (%) | 351 | 27.9 | 16.2 | 39.3 | 20.9 | 74.9 | 50.3 | 91.1 |
| Ungerminated seeds (%) | 351 | 12.6 | 9.1 | 19.6 | 11.8 | 93.7 | 50.2 | 128.0 |
| Dead seeds (%) | 351 | 16.1 | 8.2 | 28.5 | 17.20 | 106.8 | 68.4 | 148.5 |
| Empty seeds (%) | 351 | 43.4 | 29.9 | 63.0 | 24.1 | 55.5 | 33.9 | 74.0 |
| 1000 seed weight (g) | 4248 | 57.4 | 49.4 | 73.6 | 20.90 | 36.4 | 28.0 | 45.0 |

**Table 3** Results of analysis of variance (ANOVA) for physiological and morphological properties of Silver fir seeds between and within provenances

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Source of variation** | **Sum of squares** | **Degrees of freedom** | **Mean square** | **F-value** | ***p*** |
| **Germination capacity** | | | | | |
| Between provenances | 16946.6 | 16 | 1059.2 | 2.601 | ***<0.001*** |
| Within provenances | 135990.6 | 334 | 407.2 |  |  |
| Total | 152937.1 | 350 |  |  |  |
| **Fresh ungerminated seeds** | | | | | |
| Between provenances | 3812.0 | 16 | 238.2 | 1.785 | ***<0.032*** |
| Within provenances | 44589.6 | 334 | 133.5 |  |  |
| Total | 48401.5 | 350 |  |  |  |
| **Dead seeds** | | | | | |
| Between provenances | 13444.5 | 16 | 840.3 | 3.116 | ***<0.001*** |
| Within provenances | 90063.1 | 334 | 269.7 |  |  |
| Total | 103507.7 | 350 |  |  |  |
| **Empty seeds** | | | | | |
| Between provenances | 30314.2 | 16 | 1894.6 | 3.657 | ***<0.001*** |
| Within provenances | 173037.9 | 334 | 518.1 |  |  |
| Total | 203352.1 | 350 |  |  |  |
| **1000 seed weight** | | | | | |
| Provenance (PRO) | 167768.5 | 16 | 10485.5 | 27.049 | ***< 0.001*** |
| Vitality (VIT) | 4508.3 | 2 | 2254.1 | 5.815 | ***0.003*** |
| Interaction:  PRO \* VIT | 47966.7 | 24 | 1998.6 | 5.156 | ***< 0.001*** |
| Model | 220243.5 | 42 | 5243.9 | 13.527 | ***< 0.001*** |
| Residuals | 1598659.2 | 4124 | 387.6 |  |  |
| Total | 1818902.7 | 4166 | 436.6 |  |  |

Table 4 Homogeneous subset of provenances (α = 0.05) of physiological and morphological properties of Silver fir seeds getting with Duncan’s tests

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Germination capacity (%)** | | | | | | | **Fresh ungerminated seeds (%)** | | | | **Dead seeds (%)** | | | | | | | **Empty seeds (%)** | | | | | |
| **Provenance** |  | **1** | **2** | **3** | **4** | **5** | **Provenance** |  | **1** | **2** | **Provenance** |  | **1** | **2** | **3** | **4** | **5** | **Provenance** |  | **1** | **2** | **3** | **4** |
| Štirovača | 16.2 |  |  |  |  |  | Štirovača | 9.1 |  |  | Miletka | 8.2 |  |  |  |  |  | Lividraga | 29.9 |  |  |  |  |
| Višnjevica | 16.8 |  |  |  |  |  | Vršice | 9.1 |  |  | Risnjak 1 | 9.2 |  |  |  |  |  | Milanov vrh | 32.9 |  |  |  |  |
| Rudač | 18.0 |  |  |  |  |  | Nađak bilo | 9.6 |  |  | Kaoci | 10.0 |  |  |  |  |  | Brloško | 33.4 |  |  |  |  |
| Brloško | 19.9 |  |  |  |  |  | Duliba | 10.0 |  |  | Duliba | 10.8 |  |  |  |  |  | Rudnik | 33.7 |  |  |  |  |
| Jasle | 23.2 |  |  |  |  |  | Miletka | 10.1 |  |  | Nađak bilo | 11.0 |  |  |  |  |  | Risnjak 2 | 36.3 |  |  |  |  |
| Vršice | 23.7 |  |  |  |  |  | Risnjak 1 | 10.2 |  |  | Štirovača | 11.7 |  |  |  |  |  | Gluhe drage | 36.7 |  |  |  |  |
| Miletka | 24.1 |  |  |  |  |  | Crni lazi | 10.8 |  |  | Risnjak 2 | 13.4 |  |  |  |  |  | Jasle | 37.3 |  |  |  |  |
| Gluhe drage | 27.9 |  |  |  |  |  | Višnjevica | 11.0 |  |  | Rudnik | 15.8 |  |  |  |  |  | Crni lazi | 41.6 |  |  |  |  |
| Crni lazi | 27.9 |  |  |  |  |  | Rudnik | 11.2 |  |  | Milanov vrh | 17.0 |  |  |  |  |  | Risnjak 1 | 41.8 |  |  |  |  |
| Kaoci | 29.4 |  |  |  |  |  | Rudač | 11.8 |  |  | Crni lazi | 19.7 |  |  |  |  |  | Rudač | 42.0 |  |  |  |  |
| Risnjak 2 | 30.8 |  |  |  |  |  | Gluhe drage | 13.7 |  |  | Višnjevica | 20.6 |  |  |  |  |  | Kaoci | 44.2 |  |  |  |  |
| Lividraga | 31.5 |  |  |  |  |  | Lividraga | 14.2 |  |  | Vršice | 21.6 |  |  |  |  |  | Duliba | 44.3 |  |  |  |  |
| Nađak bilo | 31.8 |  |  |  |  |  | Jasle | 16.2 |  |  | Gluhe drage | 21.8 |  |  |  |  |  | Vršice | 45.6 |  |  |  |  |
| Milanov vrh | 33.5 |  |  |  |  |  | Kaoci | 16.4 |  |  | Jasle | 23.4 |  |  |  |  |  | Nađak bilo | 47.6 |  |  |  |  |
| Duliba | 34.9 |  |  |  |  |  | Milanov vrh | 16.6 |  |  | Lividraga | 24.4 |  |  |  |  |  | Višnjevica | 51.6 |  |  |  |  |
| Risnjak 1 | 38.8 |  |  |  |  |  | Brloško | 18.3 |  |  | Rudač | 28.2 |  |  |  |  |  | Miletka | 57.5 |  |  |  |  |
| Rudnik | 39.3 |  |  |  |  |  | Risnjak 2 | 19.6 |  |  | Brloško | 28.4 |  |  |  |  |  | Štirovača | 63.0 |  |  |  |  |

Legend:

Different letter colour denote different seed regions: Gorski Kotar i Velika Kapela (3.3.1.); Velebit ( 3.3.2.); Biokovo (3.3.3.)

**Table 5** Spearmen’s correlation coefficients of morphological properties of cones. seeds and vitality

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | VIT | DC | SC | TSC | BSD | TSW |
| VIT | --- | 0.052\*\* | 0.059\*\* | 0.005 | 0.053\*\* | 0.009 |
| DC | 0.052\*\* | --- | 0.530\*\* | 0.725\*\* | 0.417\*\* | 0.386\*\* |
| SC | 0.059\*\* | 0.530\*\* | --- | 0.641\*\* | 0.275\*\* | 0.312\*\* |
| TSC | 0.005 | 0.725\*\* | 0.641\*\* | --- | 0.446\*\* | 0.529\*\* |
| BSD | 0.053\*\* | 0.417\*\* | 0.275\*\* | 0.446\*\* | --- | 0.076\*\* |
| TSW | 0.009 | 0.386\*\* | 0.312\*\* | 0.529\*\* | 0.076\*\* | --- |

|  |  |
| --- | --- |
| Legend: | \*\* p < 0.01 |
|  | VIT - vitality |
|  | DC – length of cones (mm) |
|  | SC – width of cones (mm) |
|  | TSC – weight of dried seeds (g) |
|  | BSD – number of filled seeds |
|  | TSW – 1000 seed weight (g) |