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Оригинални научни рад

THE INFLUENCE OF CLIMATE FACTORS ON FLOWER DYNAMICS OF THE 20 CLONE SCOTS PINE (*Pinus sylvestris* L.)

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Abstract: The time of clones blossom depends on their biological – genetic traits and environmental conditions of which the greatest impact have climate factors. This work presents the results of a two-year study on the impact of climate factors (temperature, relative humidity of air and precipitation), the course and length of time blossom of embedded ramet from 20 clones in seed orchard of Scots pine (*Pinus sylvestris* L.) in the locality "Stanovi" – Doboj (central part of Bosnia and Herzegovina). Phenological observations were performed on 80 ramets where the observation of male inflorescence was done through 6 stages of development. During two years of research non significant differences were diagnosed in the beginning and the length of the phenophases of flowering among the analyzed clones. At the same time, significant differences of the observed phenomena were diagnosed between the years of monitoring (2005 and 2006), which can be attributed to the influence of fluctuations and differences in the values of air temperature, relative humidity and precipitation. However, a significant interaction "Clone x Year observations" indicates the possibility of selection of more or less adaptive clones in different climatic conditions, which is of special importance in the light of climate changes.

Keywords: air temperature, precipitation, flowering, scots pine

1. INTRODUCTION

Scots pine (*Pinus sylvestris* L.) is a species with a very wide distribution in the northern hemisphere, being found from northern Norway in the north to Spain and Greece in the south and from Scotland in the west to far eastern Russia and Mongolia in the east, and occurring on a wide range of soil types (Sarvas, R., 1964). It is also a species for which long dendrochronological records exist (Eronen, M. *et al*., 2002, Grudd, H. *et al*., 2002). In recent years, attention has focused on the possible impact of atmospheric and climatic changes on plants and vegetation. Studies of flowering frequency and phenology in conifer seed orchads are important as they may reveal contributions of different tree clones to the genetic composition of seed (Eriksson, G. *et al*. 1973; Jonsson, A. *et al*. 1976).

Climatic factors, as well as other ecological factors, have a crucial role in defining areas of a particular plant species. At the same time, the distribution of

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eco–types, inter- and intra-population variability are conditioned by the climatic conditions. The processes of blossom and pollination (cosequently gene exchange) are determined by hereditary traits, as well as the climate conditions during the blossom phase (Stančević, A., 1987). Also studying the endogenous aspect of the reproductive biology is an important step towards the identification of the climatic factors that influence seed production (Vidar, S. *et al*. 2002).

2. OBJECT OF RESEARCH AND METHOD

Monitoring the influence of the climatic factors on the blossom dynamics was performed on the clone seed stand Stanovi – Doboj- central part of BiH. It was established in autumn 1968 in Ozimice, but in spring 1972 the nursery was transplanted in Stanovi. The plantation containing 20 clones was established on a 1 ha plot, at an altitude of 155 m. The distance between the ramets of each clone is about 5m, and the distance between the rows is 4.5 m. By applying the method of individual selection in the area of Knežinski Palež on mountain Romanija, about 20 "plus" trees, ie. 20 best tree phenotypes were selected. In establishing the seed orchard, each orteta was represented through 20 copies-ramets, which makes a total of 400 ramets. Due to the war in Bosnia there was a reduction of the number of ramets compared to the plot size and the number of ramets in the plantations establishment. Since establishing the seed orchard in 1968 up to date out of 400 built-in ramets in twenty clones 46.5 % or 186 ramets failed. The total number of ramets today is 214, and the clones are represented as follows: clones 3, 7, 12 and 17 account for 40 %, clone 10 for 45 %, clones 15 and 19 for 50 %, clones 1, 2, 6, 11 and 13 for 55 %, clones 4 and 5 for 60 %, 18 and 16 for 65 % while clones 9 and 14 are most common, accounting for 70 % (Table 1). The plantation is located on the primary pseudogley with Aoh-A/Ig-IIg-C profile type, and the climate in the area where the plantation is is moderately humid (Danicic, V., 2008).

Table 1. Number of repetitions of 20 clones on a plantation

Clone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Number of ramets	11	11	8	12	12	11	8	12	14	9
Clone	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Number of ramets	11	8	11	14	10	13	8	13	10	8

Phenological observations were made on 80 ramets (Figure 1) over a two-year period, ie. in May 2005, and April–May 2006. The observations were made at 3 to 5-day intervals, which depended on the year when they were made. Also, the observation of the male inflorescence was made through six phases: 0 – no inflorescence; 1 – inflorescence growth (inflorescence in shells) – prolongation/extention phase; 2 – inflorescence swelling ie. green-coloured vegetative buds; 3 – yellow-coloured inflorescence (opening phase); 4 – pollen dispersal; 5 – brown-coloured inflorescence with no pollen.

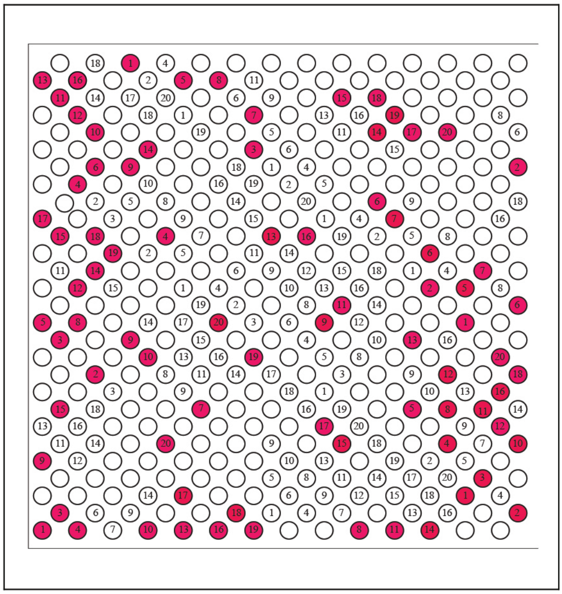

Figure 1. Ramets were made phenological observations

3. RESULTS AND DISCUSSION

The duration of the blossom period in 2005 was 28 days in total (from April 25th to May 22nd), and in 2006 it lasted 23 days (from April 20th to May 12th). With the aim of getting a better insight into the influence of the climatic factors on the blossom duration, comparative analyses of their influence on blossom phases were carried out. The results achieved were shown as graphs (Figures 2, 3,4).

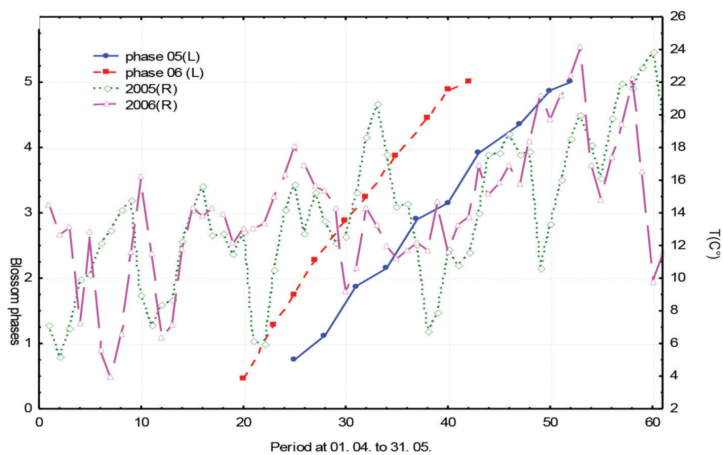

Figure 2. Blossom phases and average daily air temperature variations

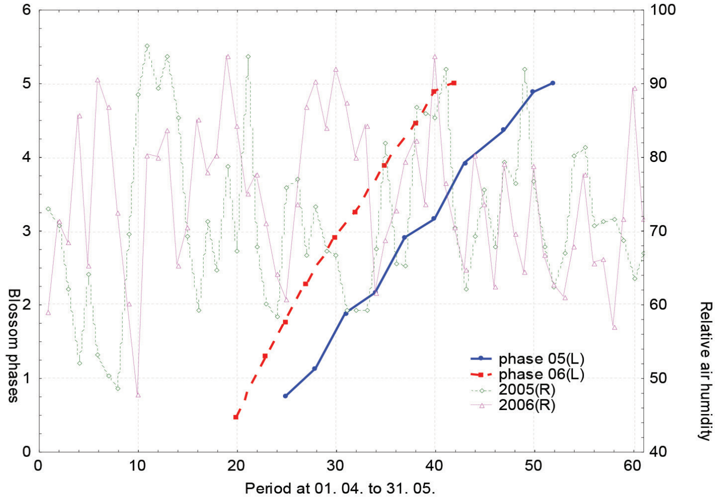

Figure 3. Blossom phases and relative air humidity variations

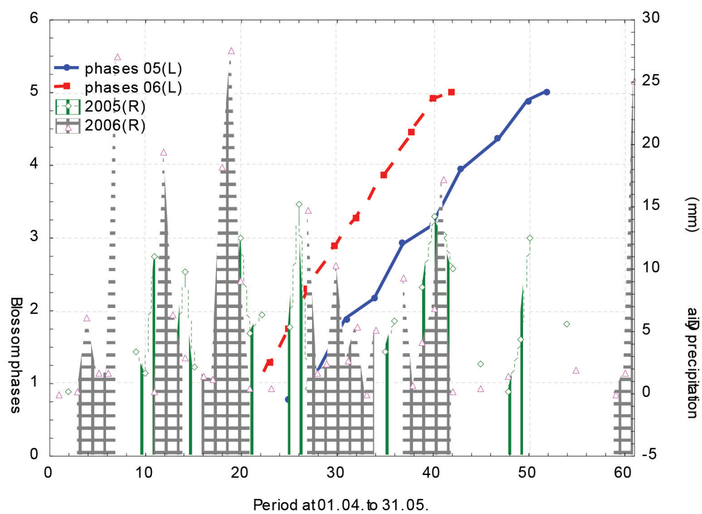

Figure 4. Blossom phases and daily precipitation variations

Inflorescence growth phase in 2006 started earlier than in 2005 because average daily air temperatures during that period were significantly higher, which had an impact on the earlier beginning of blossom (Figure 2). In 2005 there were two temperature extremes during the blossom period, when the average daily temperatures were about 6 °C, which slowed down the inflorescence growth and lenghtened the duration of the blossom period. We can see from Fugures 3 and 4 that in year 2006 relative air humidity and precipitation values were higher, and air temperatures were lower in the period when inflorescence growth was finished, and its colour was green. That resulted in postponing the beginning of pollen dispersal. From the same graphs in 2005 we can also see considerable fluctuation of these three climatic factors, which caused some phases to be longer, and that had an impact on the length of blossom period. Anthesis in northern Finland occurred at a later date than in the south as was expected, but at a lower heat sum. The variation in the timing of anthesis and the variation of pollen catches increased northwards (Luomajoki, A., 1993). According to Vidar, S. (2002) much rain in early summer, both in the flower inductionand flowering year, appeared to have a negative effect on seed production. The reason is probably that in the year prior to the seed production, a drought during early summer stimulates floral induction, while in the seed production year, dry weather favours the pollen dispersion by wind and then positively influences the fertilization of female cones. Although rain may assist the pollination drop in the pollenscavenging process of several conifers including spruce (Owens, J.N. *et al.* 1998), periods with heavy rain, which are common in southern Norway, may interfere with pollination and fertilization (Leadem, C.L. *et al.* 1997; Greene, D.F. *et al.*, 1999). Considerable differences in blossom time and intensity between the studied years were observed based on the statistics t-test ($t_0 = 20.37 > t_{0,05(79)} = 2.00$), and these diferrences are the consequence of the influence of the complex climatic factors.

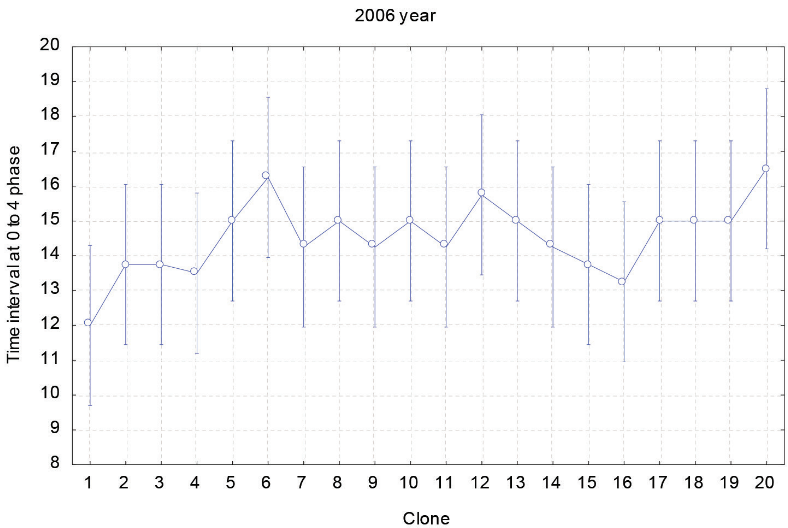

Figure 5. Time interval between inflorescence prolongation and pollen dispersal of 20 clones

Figure 5 and 6 show the process during which each clone enters different blossom phases in the years when the research was done. From the same graphs we can see the intra-clone and inter-clone variability of the blossom dynamics through the observed phases.

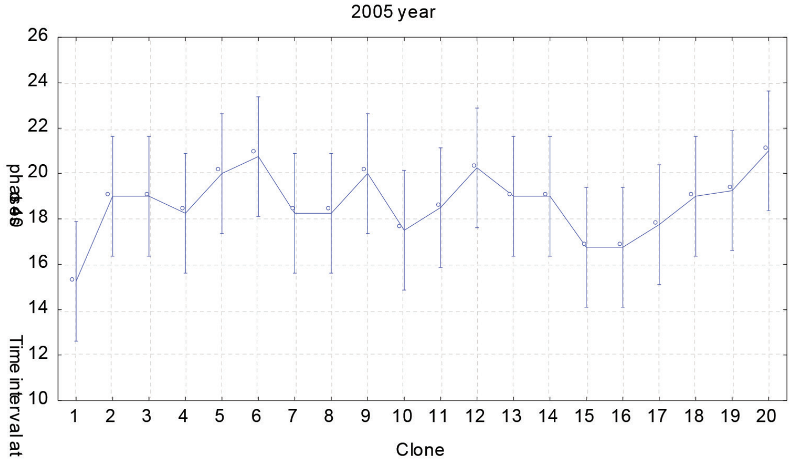

Figure 6. Time interval between inflorescence prolongation and pollen dispersal of 20 clones

4. CONCLUSIONS

Based on a two-year study of the influence of climatic factors on the dynamics and length of blossom period of 20 Scot pine clones, we can state the following:

- The differences relating the length of the blossom period during the studied years are the result of the complex influence of climatic factors.

- Lower daily air temperatures, rainy weather and high relative precipitation in 2006, compared to 2005, caused the occurence of differences in the initial phase of pollen dispersal.

In the years in which the process and duration of blossom were analyzed, no significant inter-clone variability was observed.

REFERENCES

Daničić, V. (2008): Betweenclonal variability in seed orchard of Scots pine (*Pinus silvestris* L.) on the "Sanovi" Doboj. [Međuklonski varijabilitet u sjemenskoj plantaži bijelog bora (*Pinus silvestris* L.) na lokalitetu „Stanovi" Doboj]. MS-thesis, Šumarski fakultet, Beograd: 1–105.

Eriksson, G., Jonsson, A.,Lindgreen, D. (1973): Flowering in a clone trial of *Picea abies* Karst. Studia Forestalia Suecica 110. 45p.

Eronen, M., Zetterberg, P., Briffa, K., Lindholm, M., Merilainen, J., Timonen, M. (2002): The supralong Scots pine tree-ring record for Finnish Lapland: Part 1, chronology construction and initial inferences. The Holocene 12: 673–680.

Greene, D.F., Zasada, J.C., Sirois, L., Kneeshaw, D., Morin, H.,Charron, I., Simard, M.J. (1999): A review of the regeneration dynamics of North American boreal forest tree species. Can. J. For. Res. 29: 824–839.

Grudd, H., Briffa, K.R., Karlen, W., Bartholin, T.S.,Jones, P.D., Kromer, B. (2002):

A 7400-year treering chronology in northern Swedish Lapland: natural climatic variability expressed on annual to millennial timescales. The Holocene 12(6):657–665.
Jonsson, A., Ekberg, I., Eriksson, G. (1976): Flowering in seed orchard of *Pinus sylvestris* L. Studia Forestalia Suecica 135. 38p.
Leadem, C.L., Gillies, S.L., Yearsly, H.K., Sit, V., Spittlehouse, D.L., Burton, P.J. (1997): Tree seed biology. B.C. Ministry of Forests, Research Branch, Victoria, B.C. Land Manage. Handb. 40.
Luomajoki, A. (1993): Climatic adaptation of Scots pine (*Pinus sylvestris* L.) in Finland based on male flowering phenology. Acta Forestalia Fennica 237: 1–27.
Owens, J.N., Takaso, T., & Runions, C.J. (1998): Pollination in conifers. Trends Plant Sci. 3: 479–485.
Sarvas, R. (1964.): Havupuut. WSOY, Porvoo–Helsinki. 518 p.
Stančević, A. (1987): General fruit growing. [Opšte voćarstvo]. Čačak, Litopapir. 299 p.
Vidar, S., Gianluc, P., Jonathan M. A., Mauro B. (2002): Climatic factors controlling reproduction and growth of Norway spruce in southern Norway Can. J. For. Res. 32: 217–225.

УТИЦАЈ КЛИМАТСКИХ ФАКТОРА НА ФЕНОЛОГИЈУ ЦВЈЕТАЊА 20 КЛОНОВА БИЈЕЛОГ БОРА (*Pinus sylvestris* L.)

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Резиме

У овом раду приказана су истраживања утицаја климатских фактора на ток и дужину цвјетања 80 рамета (20 клонова) у сјеменској плантажи бијелог бора на локалитету „Станови" Добој у периоду од двије године. Фенофаза цвјетања обухвата диференцијацију мушких и женских цвасти, почетак, оптимум и крај прашења микростробила односно рецептивности макростробила. Фенофаза цвјетања праћена је од почетка издуживања микростробила па до потпуног отварања цвасти, за период од двије године односно за 2005. годину и 2006. годину. На основу двогодишњег праћења фенофазе цвјетања микростробила може се констатовати да су уграђени клонови усклађени при опрашивању, као и да се рецептивност женских цвасти поклапа са прашењем, што обезбјеђује међусобно опрашивање уграђених рамета. У току двогодишњег проучавања констатоване су разлике између клонова у почетку и трајању цвјетања, али настале разлике између проучаваних клонова нису статистички значајне. Такође, испољене су статистички значајне разлике у дужини трајања фенофазе цвјетања по годинама што се може приписати утицају колебања и разлика у вриједностима температуре ваздуха, релативне влажности ваздуха и падавинама.