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POLYPHASE FLOWERING AND FRUCTIFICATION OF AMORPHA

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Attention has been focused on the occurrence of polyphase flowering and fructification of individual amorpha trees and the role of internal and external factors.

Key words: Amorpha fruticosa L., flowering, polyphase flowering, causes

INTRODUCTION

The phenophases of flowering and fructification and the morphology of reproductive organs attract the attention of researchers of tree and shrub weed vegetation in our country, especially the eco-physiological, taxonomic and similar studies. Flowering is a very complex process. This phenophase includes several inter-related levels affected by a series of internal and external factors. The study of morphology of flower and fertile inflorescences is still very significant, because it contributes to the solving of many phylogenetic issues and to the explanation of abnormal phenomena in the formation of flower and fruit organs. Attention has been focused to the effect of the internal and external factors on the polyphase flowering and fructification of the rare amorpha trees. In our country, polyphase flowering has been recorded of the Syrian hibiscus (*Hibiscus syriacus* L.).

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MATHERIALS AND METHODS

Multiannual monitoring of the phenophases of flowering and fructification of subspontaneous amorpha trees on the flooded forest sites (Salicetum albae, s.l.; Populetum nigrae s.l.; Populetum albae s.l.; Querceto-Fraxinetum s.l. etc.) is a part of a wider analysis of amorpha reproductive cycle biology in our country (TUCOVIĆ and ISAJEV, 2000, etc.). Phenological observations were performed in the time intervals of about 7 days. The comparative morphophysiological analysis included several characteristics of inflorescences, flowers and fruits of the extreme and control trees.

RESULTS AND DISCUSSION

Amorpha (*Amorpha fruticosa* L.) is an allochthonous and frequent subspontaneous species on the flooded forest sites in Serbia. It flowers for the first time between the ages of four and eight years. A great number of trees flowers and fructifies once a year (Figure 1). In our country, it flowers from May to the beginning of July, in longish, terminal, erect spike racemes, 10 to 15 cm long, and 1.3 to 2.5 cm wide. The flowers have no wings and keels. The vexillum is blue and the anthers are yellow. Polyphase flowering was first detected and observed on 9 out of 218 stationarily monitored shrubs (Figures 2, 3 and 4). There are notable differences in the parameters of polyphase shoots (Table 1), inflorescences (Table 2) and fertile inflorescences in the spring flowering and repeated summer and late summer flowering and fructification, when environmental conditions (temperature, humidity, photoperiod, etc.), as well as the metabolic processes differ markedly from those during the spring flowering and the first fructification. It is supposed that polyphase flowering, recorded of 9 trees, results from the continued growth of flower and fertile shoots. The favourable conditions of sylleptic growth towards the summer and autumn (temperature and humidity) stimulate the repeated, i.e. ± continual growth of shoots, much later than the primary growth (Table 3). The sylleptic growth includes several interrelated levels affected by a series of internal and external factors. Polyphase growth of shoots conditions the formation of false annual rings on current year shoots. The shoots of the third, and especially the fourth phases of sylleptic growth, do not lignify and are subject to injuries by low temperatures. Sylleptic growth also conditions the polyphase branching of shoots, which explains a considerable number of branches in the crowns of well-developed shrubs. It is supposed that polyphase flowering, so unusual for amorpha flowering and fructification, results from the interaction of the genotype and the specific environmental conditions (Table 3). The repeated flowering occurs in the interaction of the genotype (G) and environmental factor (E). This is expressed by the formula: P=G+E+EG; the interaction (EG) is differently expressed in the study shrubs. However, it should be noted that many scientists report that mechanical injuries or tree or shoot breaking cause the repeated flowering or fructification (ČAJLAHJAN, 1988; BERNER *et al.*, 1981, etc.).

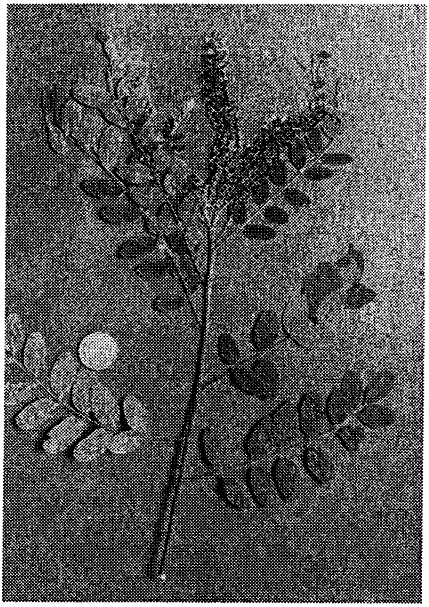

Fig. 1. - Amorpha shoot with terminal inflorescences during the optimal flowering phenophase

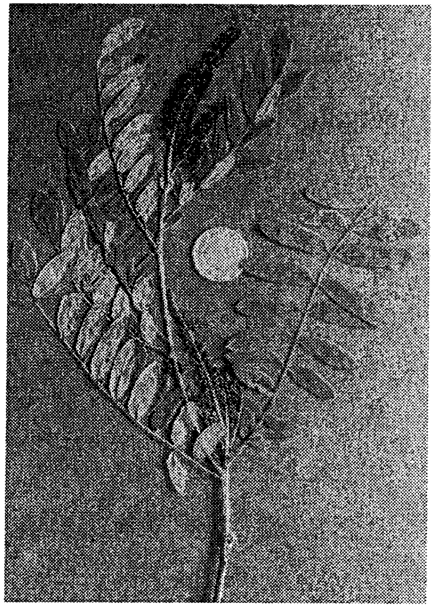

Fig. 2. - Sylleptic shoot in the second phase of flowering

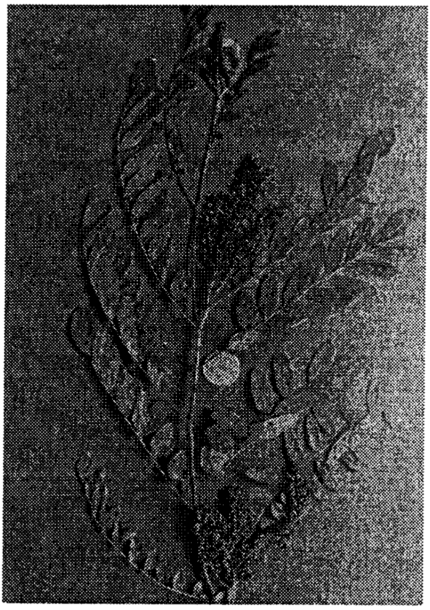

Fig. 3. - A twig with two sylleptic shoots in the third phase of flowering

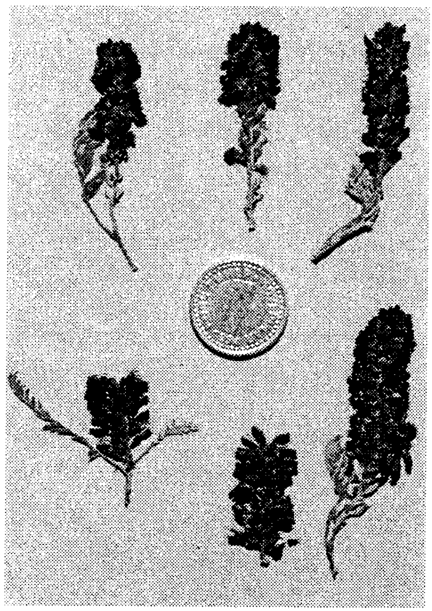

Fig. 4. - Variability of sylleptic shoots and inflorescences in the fourth phase of flowering

The polyphase flowering and fructification of the study amorpha shrubs is considered as the potential development of the new genotypes in the successive generations, since the biological reproduction is realised in different conditions of pollination (self-fertilisation, inbreeding, etc.) and environmental conditions (temperature, humidity, etc.). Still, it should be noted that polyphase flowering has not been sufficiently applied in the genetic analysis of amorpha genome to date.

Table 1. - Statistical parameters of the characters of amorpha (Amorpha fruticosa L.) flower (and sylleptic) shoots

Shoot phase	Limit values	$\xi \pm S\xi$	$S \pm Ss$	$V \pm Sv$
		Shoot length (twig) in cm		
First	20 – 70	35.20 ± 1.76	11.83 ± 1.25	33.61 ± 3.54
Second	10 – 40	22.85 ± 0.17	1.16 ± 0.12	5.08 ± 0.53
Third	10 – 19	13.80 ± 0.30	2.03 ± 0.21	14.70 ± 1.55
Fourth	2 – 6	4.26 ± 0.30	2.02 ± 0.21	47.41 ± 4.99
		Shoot width in mm		
First	4 – 12	6.72 ± 0.22	1.49 ± 0.16	22.17 ± 2.34
Second	3 – 8	4.49 ± 0.14	0.94 ± 0.10	20.93 ± 2.21
Third	1 – 5	2.73 ± 0.22	1.48 ± 0.16	54.21 ± 5.71
Fourth	0.8 – 2	1.48 ± 0.05	0.35 ± 0.04	23.65 ± 2.49
		Number of buds on a shoot		
First	12 – 24	18.00 ± 0.55	3.72 ± 0.39	20.66 ± 2.18
Second	6 – 18	12.00 ± 0.40	2.69 ± 0.28	21.96 ± 2.31
Third	4 – 10	7.00 ± 0.23	1.57 ± 0.16	22.43 ± 2.36
Fourth	1 – 5	3.00 ± 0.13	0.88 ± 0.09	29.33 ± 3.09

Table 2. - Characters of amorpha (Amorpha fruticosa L.) inflorescences in different phases of flowering

Phase of flowering	Limit values	$\xi \pm S\xi$	$S \pm Ss$	$V \pm Sv$
		Length of racemose inflorescence in cm		
First	9 – 16	13.12 ± 2.21	1.43 ± 0.15	10.90 ± 1.15
Second	6 – 14	10.05 ± 0.24	1.60 ± 0.17	16.00 ± 1.68
The third	4 – 12	7.77 ± 0.29	1.93 ± 0.20	24.84 ± 2.62
Fourth	1 – 7	4.23 ± 0.18	1.20 ± 0.13	28.37 ± 2.99
		Width inflorescences in mm		
First	1.3 – 2.4	21.45 ± 0.31	2.08 ± 3.22	9.70 ± 1.02
Second	1.3 – 2.2	15.90 ± 0.27	1.83 ± 0.19	11.50 ± 1.21
The third	0.8 – 1.5	10.28 ± 0.21	1.41 ± 0.15	13.71 ± 1.44
Fourth	1.0 – 1.2	10.27 ± 0.20	1.50 ± 0.18	14.60 ± 1.54
		Number of flowers in inflorescence		
First	140 – 300	206.00 ± 2.24	15.00 ± 1.59	7.28 ± 0.77
Second	60 – 180	125.00 ± 4.28	28.70 ± 3.02	22.96 ± 2.42
Third	40 – 140	90.00 ± 3.61	24.25 ± 2.55	26.94 ± 2.84
Fourth	6 – 80	44.00 ± 2.18	20.00 ± 2.11	45.45 ± 4.79

Table 3. - Dependence of amorpha phenotype on genotype and environment

Sources of phenotype differences		Forms of phenotype variability
Genotype		
Genes: DNA		
RNA		
Environment	Metabolic processes	Phenotype
Time	Chemical reactions	Age
Space	Photosynthesis	Site
Light	Breathing	Growth: rate
Temperature	Taking in of water and minerals	periodicity
Water	Transpiration	complexity
Soil	Cell division	variability
Mineral elements	Storing	Resistance to
Nutrients		pathogens
Other organisms		insects
		extreme conditions
		Symbiosis

CONCLUSIONS

The exceptional occurrence of polyphase flowering and fructification of 9 out of 218 stationarily analysed amorpha shrubs is affected by several internal factors, i.e. genotype, age of root system, minimal number of buds - leaves, ratio of developed and undeveloped leaves, etc., as well as by numerous external factors. The physiological significance of the total number of buds - leaves on the shoots, i.e. of the minimal number, etc., is not quite clear as it cannot be proved that each of them by itself induces the repeated, polyphase flowering. The synchronisation and the hierarchy of the supposed factors in the system of flowering regulation are still not clear. The study data are significant for the genetic analysis of the species genome in general and for the process of new genotype formation based on intraspecific hybridisation.

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VIŠEFAZNO CVETANJE I PLODONOŠENJE BAGRENCA

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Izvod

Fenofaza cvetanja, plodonošenja i morfologija reproduktivnih organa, privlače znatnu pažnju istraživača korovske vegetacije drveća i žbunja u našoj zemlji, naročito pri ekofiziološkim, taksonomskim i sličnim proučavanjima. Morfologija cvetnih i plodnih cvasti ni do danas nije izgubila svoj značaj jer doprinosi rešavanju mnogih pitanja filogenije i objašnjenju abnormalnih pojava pri obrazovanju ovih organa. U našoj zemlji višefazno cvetanje evidentirano je kod sirijskog hibiskusa (*Hibiscus syriacus* L.). Proučavanja su obuhvatila subspontana stabla bagrenca na plavnim šumskim staništima, kao dela šire analize biologije reproduktivnog ciklusa ove korovske vrste kod nas. Uporedna morfofiziološka analiza obuhvatila je više karakteristika cvasti, cvetova i plodova ekstremnih i kontrolnih stabala ove vrste. Višefazno cvetanje uočeno je i osmatrano na 9 od 218 žbunova. Evidentirana je razlika u morfologiji i merenim parametrima cvasti (Tabela 2) i plodova kod prolećnog i ponovljenih letnjih i kasno letnjih cvetanja i plodonošenja kada su spoljašnji uslovi sredine (temperatura, vlažnost, dužina dana i dr.) kao i metabolitički procesi osetno različiti od onih pri prolećnom cvetanju. Pretpostavlja se da su uočene razlike, tako neobične za cvetanje i urod žbunova bagrenca, rezultat kontinuiranog (sileptičkog) rasta cvetnih izdanaka, odnosno posebnog genotipa. Ponovljeno cvetanje obrazuje se u interakciji genotipa (G) i faktora spoljašnje sredine (E). Ovaj odnos iskazan je pomoću formule: P=G+E+EG; interakcija (EG) različito se iskazuje kod analiziranih žbunova. Istina, u literaturi ima ne malo pretpostavki da su mehaničke ozlede ili lomljenje stabala ili izdanaka, uzrok ponovljenog cvetanja ili plodonošenja. Višefazno (višestruko) cvetanje i plodonošenje pri osetno izmenjenim spoljašnjim uslovima uzima se kao mogućnost za odgajivanje novih genotipova s obzirom da se biološka reprodukcija ostvaruje u drugačijim uslovima oprašivanja i uslovima spoljašnje sredine. Ipak, do danas višestruko cvetanje je nedovoljno korišćeno u oplemenjivanju bagrenca.

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