JOURNAL OF ENGINEERING annals OF FACULTY OF ENGINEERING HUNEDOARA

EXAMINATION OF BLACK LOCUST (*ROBINIA PSEUDOACACIA L.*) AFFORESTATIONS IN BÁCS-KISKUN COUNTY

Tamás BARNA, Gábor SZULCSÁN

KEFAG Zrt. 6000 Kecskemét, József A. u. 2., HUNGARY

Abstract

The traditional methods of soil examination are nowadays not sufficient any more to predetermine the productivity of the given tree species. The nutrient content analysis of the soil is also necessary. We should however know the nutrient demand of tree species, including black locust as well, more exact. Therefore examinations aiming the determination of the plants nutrient content would be necessary. In the course of these examinations the correlation between the nutrient reserves of the soil and the nutrient element content of the plant should be found. If in possession of these data we can complete the traditional soil examination to be performed before afforestations with the determination of the nutrient reserves of the soil, we will be able to prepare a much more exact forecast on the expectable growth of the planned target stand.

Key words:

Robinia pseudoacacia, black locust, afforestation, soil examination

1. INTRODUCTION

In Hungary there has been afforestations done in agricultural areas of significant extent during the recent decades. These were mainly concentrated to the sand regions of the Great Hungarian Plain. The main reason therefore is, that the traditional field plant production is on these sand-textured soils with little nutrient content the most uneconomical. Afforestation can be considered in these areas also as an activity bringing income, because due to the claimable subsidy system the subsidies cover nearly 100% of the implementation costs and the expenses arising from maintenance until the age of 5-6 years, and the subsequent maintenance costs again can be covered by the incoming revenues from selling timber. The maintenance expenses do not arise every year regularly, but from time to time about every 10 year in comparison with the yearly arising expenses in case of field plant production. Although the earning capacity of sylviculture only amounts to 5-6 % even in the best case, the relatively short cutting interval of 15-30 years ensures an acceptable income even for farmers being used to yearly income. Due to the above considerations an increasing proportion of people making their living from agriculture afforest their fields. This economic approach requires from afforestation planners as well to review traditional planning principles and to work out some new, more precise methods to make the predetermination of stand growth more accurate.

Farmers afforest yearly 2500 – 3000 ha in Bács-Kiskun County. Among the applied tree species black locust is used most frequently. The reason is that it accomodates itself well to the site extremes, the proportion of its surviving in the afforestations is good, and its timber can be used from relatively young age, at least as firewood. In case of end use at the age of 30-35 years it can be used for several reasons, it is producing timber of a high value. It was not by chance, that the black locust became, 50 years ago already, the tree of the Great Hungarian Plain. The majority of the Hungarian farmers think it is a native tree species and do not know, that it was brought in to Hungary from North-America just 250 years ago. Since – as mentioned – the afforestations can also be considered as a business activity, the quality of the stands being established in the course of the investment really matters. The findings during exploration of the natural sites before afforestation planning determine the investments for 30-40 years. That is why we have undertaken to examine the progress of some black locust afforestations and to compare the findings in the natural sites exploration reports with the growth data of the 6-26-year-old stands. We have tried to explain why the growth of an actual stand is good or actually poor.

In our opinion it is more so since necessary to reconsider the aspects of selecting tree species, because the currently used aspects were written down in the 1960's by Dr. Imre Babos and his associates (BABOS et al. 1966). The environmental changes, which have meanwhile taken place and the growing business requirements lead us to reconsider the methods of natural sites exploration. We expect our work to improve the planning of afforestations and as a result to lead to the establishment of better tree stands in the future.

2. INSTRUMENTS

Soil drill; soil laboratory – various examining instruments; SUUNTO for measuring tree height and slope, tape measure for measuring diameter

3. METHOD

Site exploration in 25 forest tracts, collection and examination of 71 soil samples, in an area of total 113,4 ha.

Determination of site characteristics based on laboratory test and examinations on site. Measuring the height and diameter of at least 30 trees in each forest tracts, calculating average tree measures on this basis.

Determination of stand productivity on the basis of Károly RÉDEI edit. (1997): Handbook of black locust management. (in Hungarian) ERTI, Budapest.

Short, written evaluation of the site and the stand. The evaluation of the soil characteristics happened due to the following aspects (Barna 1994), presented in Chart 2.

Chart 1 Forest improvement model of black locust stands, seed and coppice origin (Rédei edit. 1997)

Description of improvement cutting	Remaining stand after improvement cutting					
	Age	Average height (Hm)	Basal Area (G)	Average diameter (Dm)	Number of stems (N)	Average stem distance (am)
	year	m	M^2	cm	pcs	M
	PRODUCTIVITY GROUP I.					
Cleaning	5-6	7	7	6	2500	2,2
Cleaning	9-10	12	14	10	1800	2,5
Selective thinning	14-15	16	14	14	900	3,6
Increment thinning	23-24	22	17	22	450	5,1
End use	35	25	30	29	450	5,1
	PRODUCTIVITY GROUP II.					
Cleaning	7-8	7	8	6	2700	2,7
Cleaning	12-13	11	14	10	1800	2,5
Selective thinning	18-19	15	14	14	900	3,6
End use	30	18	28	20	900	3,6
	PRODUCTIVITY GROUP III					
Cleaning	9-10	7	8	6	3000	2,0
Cleaning-like selective thinning	15-16	10	8	8	1600	2,7
End use	25	13	21	13	1600	2,7

Chart 2 Determination of fertile layer thickness of the forest soils depending on climate conditions

Categories	Beech and hornbeam-oak climate	Turkay and Sessile oak - forest steppe climate
	cm	
Very shallow (ISE)	0-20	0-40
Shallow (SE)	20-40	40-60
Medium-deep (KMÉ)	40-60	60-90
Deep (MÉLY)	60-100	90-140
Very deer (IMÉ)	100-	140-

Chart 3 Specific values of physical soil types

Physical soil types	Hy (%)	Soil plasticity according to Arany	5-hour capillary water rise (mm)
Rubble (TÖ)	-	-	-
Coarse sand (DHO)	-0,3	-	450-
Sand (HO)	0,3-1,0	-50	450-300
Loam (V)	1,0-5,0	30-50	300-75
Clay (AG)	5,0-6,0	50-60	75-40
Heavy clay (NAG)	6,0-	60-	-40

Chart 4 pH-value of soils

Categories	pH
Very strongly acidic	-3,0
Strongly acidic	3,0-4,0
Sour	4,0-5,0
Slightly acidic	5,0-6,8
Neutral	6,8-7,2
Slightly alkaline	7,2-8,0
Alkaline	8,0-9,0
Strongly alkaline	9,0-10,0
Very strongly alkaline	10,-11,0

Chart 5 Lime content of soils

Categories	Lime content (%)
Calciferous in patches	0-1
Low-lime	1-5
Calciferous	5-

Chart 6 Humus content of soils

Categories	Humus content (%)
Humus free	0
Low humus	1-2
Humus	2-4
High humus	4-10
Moorland	10-

4. CONCLUSIONS

In the course of the examination we have evaluated at the end 22 forest tracts. The total area amounts to 113,4 ha. The facts of the forest tracts are summarized in the chart 7/1-5.

Unfavourable soil characteristics (marked with red in the charts 7/1-5.)

1. The growth of the examined black locust stands is first and foremost influenced by the fertile layer thickness of the soil. Generally is a shallow fertile layer less than 40 cm already unfavourable.
2. This unfavourable effect is intensified, if the lime-content of the surface soil is about 5 % , and
3. straight below the sodium content reaches or exceeds 0,02%.
4. Furthermore the mechanical composition of the soil impacted also on the stand growth. The growth was further harmed, if the proportion of coarse sand in the surface soil exceeded 25%.

Chart 7/1. Soil examinations

	Village, member, item									
	Császártöltés 247A		Császártöltés 247B		Császártöltés 16H			Császártöltés 81B		
Area (ha)	14,4		4,2		1,8			10,0		
Sstand	Robinia pseudoacacia		Robinia pseudoacacia		Robinia pseudoacacia			Robinia pseudoacacia		
Age in 2005 (years)	6		6		16			26		
Examined soil layers (cm):	0-70	70-200	0-80	80-200	0-60	60-100	100-200	0-20	20-140	140-200
Climate	ESZTY		ESZTY		ESZTY			ESZTY		
Hydrology	VFLEN		VFLEN		VFLEN			VFLEN		
Gen. soil type	HH		HH		HH			HH		
Thickness of fertile layer of the soil (cm):	KMÉ		KMÉ		KMÉ			ISE		
Physical soil types	HO		HO		HO			HO		
pH H_2O	8,1	8,5	7,9	8,5	7,9	8,0	8,4	8,0	8,3	8,5
pH KCl	7,7	8,1	7,6	8,0	7,3	7,4	7,7	7,4	8,0	8,1
$CaCO_3$ (%)	10,4	12,7	10,1	11,1	3,8	23,1	31,5	10,0	9,2	11,3
Sodium (%)		0,035		0,037			0,042		0,023	0,026
Total salt (%)										
hy (%)	0,35	0,31	0,39	0,27	1,29	1,15	0,72	0,38	0,34	0,27
K_A					33	34				
5-hour capillary water rise (mm)	310	415	280	430	380	340	325	225	380	360
Humus (%)	0,39	0,16	0,49	0,14	1,40	1,21		0,60	0,35	0,16
Mechanical composition: clay	0,68	1,03	0,80	0,88	6,00	8,35	2,80	1,30	1,40	1,20
silt	2,64	2,85	3,00	2,71	14,20	18,40	20,70	2,70	2,60	1,80
fine sand	81,18	84,12	79,50	80,00	77,00	71,35	73,20	82,00	79,10	72,80
coarse sand	15,50	12,00	16,70	16,40	2,30	1,90	3,30	14,00	16,90	24,20
Average height (m)	5,0		5,0		14,0			15,0		
Average diameter (cm)	5,0		4,0		14,0			12,0		
Classification	Productivity group I.		Productivity group I.		Productivity group II.			Productivity group III.		
Notes	The medium-deep fertile layer of the soil can compensate the unfavourable effects of the high lime- and sodium content for the time being! Supplementary examinations are necessary!		The medium-deep, slightly loaming fertile layer of the soil can compensate the unfavourable effects of the high lime- and sodium content for the time being! Supplementary examinations are necessary!		The depth of the low humus content in the fertile layer of the soil can compensate the unfavourable effects of the high lime- and sodium content only on a limited scale!			The very shallow fertile layer of the soil and the high lime- and sodium-content measurable in the whole section collectively cause the poor growth!		

Among the above mentioned soil characteristics the soil drought is increased by the shallow, calciferous fertile layer of soil composed of coarse sand. The examined sites belong to the water resources management levels very dry – dry. And the sodium content of about 0,02% has already a toxic effect on the roots. The situation is aggravated thereby, that straight below the shallow – very shallow fertile layer significant sodium content can be detected!

Chart 7/2. Soil examinations

	Village, member, item											
	Császártöltés 91B$_3$			Bugac 315C		Bugac 272C			Kisszállás 73F		
Area (ha)	4,4			12,1		2,2			8,8		
Target stand	Robinia pseudoacacia			Robinia pseudoacacia		Robinia pseudoacacia			Robinia pseudoacacia		
Age in 2005 (years)	27			8		6			7		
Examined soil layers (cm):	0-10	10-50	50-200	0-60	60-200	0-55	55-80	80-	0-30	30-60	60-
Climate	ESZTY			ESZTY		ESZTY			ESZTY		
Hydrology	VFLEN			VFLEN		VFLEN			VFLEN		
Gen. soil type	HH			HH		HH			HH		
Thickness of fertile layer of the soil (cm):	ISE			KMÉ		SE			ISE		
Physical soil types	HO			HO		HO			HO		
pH H_2O	7,6	8,5	8,7	8,1	8,6	8,1	8,5	8,6	7,7	8,3	8,3
pH KCl	7,5	7,9	8,2	7,6	8,3	7,6	7,7	7,9	7,3	7,9	7,5
$CaCO_3$ (%)	9,9	10,2	8,4	4,0	11,5	3,3	12,5	15,7	1,1	7,1	17,7
Sodium (%)		0,03	0,032		0,031		0,028	0,047		0,026	0,044
Total salt (%)											0,010
hy (%)	0,50	0,27	0,22	0,46	0,20	1,00	0,59	0,37	0,61	0,30	1,08
K_A											
5-hour capillary water rise (mm)	170	390	410	300	510	390	415	465	110	435	395
Humus (%)	0,86	0,23		0,81		1,30	0,57	0,19	1,12	0,13	0,67
Mechanical composition: clay	2,52	1,50	0,62	1,35	0,95	1,80	2,90	0,95	1,70	1,50	0,10
silt	2,58	2,15	3,38	3,50	0,88	12,50	6,03	3,98	3,80	2,40	22,40
fine sand	79,50	82,65	85,60	70,85	78,37	72,25	80,77	78,67	74,20	77,90	72,10
coarse sand	15,70	13,70	10,40	24,30	19,80	13,50	10,30	16,40	20,30	18,20	5,40
Average height (m)	10,0			9,0		10,0			9,0		
Average diameter (cm)	4,0			10,0		7,0			10,0		
Classification	**Productivity group III.**			**Productivity group I.**		**Productivity group I.**			**Productivity group I.**		
Notes	The very shallow fertile layer of the soil and the high lime- and sodium-content measurable in the whole section collectively cause the poor growth!			The low humus, medium-deep fertile layer of soil can compensate the high lime- and sodium-content of the lower layers for time being!		The low humus content of the fertile layer of the soil can be classified as nearly medium-deep! This is sufficient for the primarily well growth of the black locust!			The root system of the stand has presumably not filled out fertile layer of soil yet. Supplementary data are necessary for verifying the showed well growth in contempt of the relatively poor site!		

Favourable soil characteristics (marked with green in the charts 7/1-5.)

1. At least medium-deep (deeper than 50 cm) fertile layer of soil.
2. Low lime content of fertile layer of soil (below 5%).
3. Low sodium content of the subsoil (below 0,02 %).
4. Humus content more than 1,00 %.
5. Loaming soil (silt content about 10%), and low proportion of coarse sand.

These soil characteristics should be accordingly taken into consideration to a greater extent in the course of afforestation planning. The data also show that we could classify only young, at most 10 years old stands into the productivity group I. The older stands of 26-27 years all belong due to their growth to the poorest productivity group III. *It can be accordingly expected, that the growth of the at first well growing black locust stands will later fall back thus far, as the root system fills out the lime- and sodium-free fertile layer of soil.* Since it is in the examined forest tracts generally shallow, it can be stated with certainty that this quality decrease is due to happen soon!

Abbreviations used in the Charts 7/1-5:

Climate: ESZTY – forest steppe
Hydrology: VFLEN – independent of the phreatic water
Genetically soil type: HH – sandy soil with poor humus content
Thickness of nfertile layer of the soil: ISE – very shallow
SE – shallow
KMÉ – medium deep
Physical soil type: HO – sand

Chart 7/3. Soil examinations

	Village, member, item											
	Kisszállás 73D			Kelebia 138C			Kelebia 169N		Kelebia 164C		
Area (ha)	8,9			3,2			4,9		4,0		
Target stand	Robinia pseudoacacia			Robinia pseudoacacia			Robinia pseudoacacia		Robinia pseudoacacia		
Age in 2005 (years)	7			6			8		8		
Examined soil layers (cm):	0-30	30-60	60-	0-45	45-60	60-	0-50	50-	0-30	30-60	60-
Climate	ESZTY			ESZTY			ESZTY		ESZTY		
Hydrology	VFLEN			VFLEN			VFLEN		VFLEN		
Gen. soil type	HH			HH			HH		HH		
Thickness of fertile layer of the soil (cm)	ISE			SE			SE		SE		
Physical soil types	HO			HO			HO		HO		
pH H_2O	8,3	8,4	8,3	7,4	7,8	8,4	7,9	8,2	7,9	8,3	8,5
pH KCl	7,8	7,9	7,4	7,1	7,4	7,9	7,6	7,8	7,6	7,9	8,1
$CaCO_3$ (%)	3,3	3,2	6,0	1,6	2,6	4,2	3,8	3,2	3,0	4,4	7,2
Sodium (%)		0,025	0,014			0,033		0,012		0,021	0,022
Total salt (%)			0,010								
hy (%)	0,33	0,30	0,86	0,34	0,27	0,29	0,25	0,25	0,36	0,28	0,21
K_A											
5-hour capillary water rise (mm)	350	395	465	150	420	440	350	430	175	410	475
Humus (%)	0,22	0,17	0,43	0,46	0,22	0,18	0,19	0,19	0,58	0,22	
Mechanical composition: clay	1,70	1,80	1,30	1,80	1,50	0,90	0,80	0,50	1,30	1,30	0,70
Silt	1,70	1,10	8,40	0,90	0,80	2,80	1,10	1,30	1,80	1,20	1,60
fine sand	81,90	80,70	84,60	79,30	81,60	77,10	75,30	82,20	80,70	80,50	75,80
coarse sand	14,70	16,40	5,70	18,00	16,10	19,20	22,60	16,00	16,20	17,00	21,90
Average height (m)	7,0			6,0			9,0		9,0		
Average diameter (cm)	7,0			6,0			8,0		8,0		
Classification	Productivity group II.			Productivity group I.			Productivity group I.		Productivity group I.		
Notes	Despite very shallow fertile layer of the soil and shallow presented sodium-content the black locust shows medium growth. We have expected poorer results due to the facts! Therefore supplementary examinations are necessary for reliable evaluation!			Despite very shallow fertile layer of the soil and relatively shallow presented high sodium-content the black locust is well-grown for the time being. The examined soil characteristics do not explain it! Therefore supplementary examinations are also necessary for reliable evaluation of the site! The decreasing of the stand growth is to be expected soon!			The fertile layer of the soil nearly classifiable as medium-deep and the relatively low lime- and sodium-content enable the black locust to grow well for the present. Supplementary examinations would be still necessary!		Despite shallow fertile layer of the soil and relatively shallow presented high sodium-content the black locust is well-grown for now. The examined soil characteristics do not explain that! Therefore supplementary examinations are also necessary for reliable evaluation of the site!		

Chart 7/4. Soil examinations

	Village, member, item										
	Tompa 89D		Kisszállás 58E		Kerekegyháza $47K_1$		Kerekegyháza $47K_2$		Kerekegyháza $45F_1$		
Area (ha)	5,2		3,0		2,5		2,5		2,3		
Target stand	A		A		A		A		A		
Age in 2005 (years)	8		8		9		9		10		
Examined soil layers (cm):	0-40	40-180	0-10	10-180	0-85	85-180	0-60	60-180	0-50	50-80	80-
Climate	ESZTY		ESZTY		ESZTY		ESZTY		ESZTY		
Hydrology	VFLEN		VFLEN		VFLEN		VFLEN		VFLEN		
Gen. soil type	HH		HH		HH		HH		HH		
Thickness of fertile layer of the soil (cm):	SE		ISE		KMÉ		KMÉ		KMÉ		
Physical soil types	HO		HO		HO		HO		HO		
pH H_2O	7,5	8,3	7,5	8,2	8,3	8,5	8,4	8,7	8,2	8,8	8,5
pH KCl	7,0	7,9	7,0	7,9	7,7	7,9	7,9	8,2	7,9	8,3	8,6

Chart 7/4. Soil examinations (continuing)

	Village, member, item										
	Tompa 89D		Kisszállás 58E		Kerekegyháza $47K_1$		Kerekegyháza $47K_2$		Kerekegyháza $45F_1$		
$CaCO_3$ (%)		12,0		10,9	6,8	13,3	7,2	11,5	9,3	11,5	7,3
Sodium (%)		0,037		0,032		0,028		0,027		0,024	0,030
Total salt (%)											
hy (%)	0,89	0,35	0,92	0,38	0,41	0,43	0,36	0,25	0,37	0,22	0,46
K_A											
5-hour capillary water rise (mm)	335	390	350	500	285	480	390	415	215	425	200
Humus (%)	1,32	0,29	1,30	0,21	0,45	0,18	0,38		0,37		0,29
Mechanical composition: clay	1,60	5,80	1,60	2,30	1,80	1,60	1,70	1,30	1,80	1,40	3,80
silt	10,20	4,20	10,80	4,00	2,70	4,90	2,20	1,50	2,10	0,80	1,90
fine sand	69,00	59,90	73,10	72,10	31,00	80,10	64,70	70,40	62,60	55,00	79,60
coarse sand	19,20	30,10	14,50	21,60	26,50	13,40	31,40	26,80	33,50	42,80	14,70
Average height (m)	9,0		8,0		9,5		3,2		6,8		
Average diameter (cm)	9,0		9,0		10,0		3,0		8,0		
Classification	**Productivity group I.**		**Productivity group I.**		**Productivity group II.**		**Productivity group III.**		**Productivity group III.**		
Notes	The unfavourable effects of shallow fertile layer of the soil and shallow presented sodium are compensated by loaming structure and low humus content!		The unfavourable effects of shallow fertile layer of the soil and shallow presented sodium are compensated by loaming structure and low humus content!		The relatively high lime-content damages the unfavourable effects of medium-deep fertile layer of the soil! Supplementary examinations are necessary!		The above facts do not explain such poor growth of the young black locust stand! Supplementary examinations are necessary!		Despite medium-deep fertile layer of the soil because of high lime- and sodium-content in the whole section and low humus content the black locust shows poor growth. Nevertheless supplementary examinations would be necessary for reliable evaluation of the site!		

Chart 7/5. Soil examinations

	Village, member, item							
	Kerekegyháza $45F_2$		Lajosmizse 110H		Lajosmizse 110J		Lajosmizse 111E	
Area (ha)	2,3		2,3		2,6		7,5	
Target stand	A		A		A		A	
Age in 2005 (years)	10		10		10		7	
Examined soil layers (cm):	**0-35**	35-180	**0-60**	60-180	**0-70**	70-130	**0-55**	55-140
Climate	ESZTY		ESZTY		ESZTY		ESZTY	
Hydrology	VFLEN		VFLEN		VFLEN		VFLEN	
Gen. soil type	HH		HH		HH		HH	
Thickness of fertile layer of the soil (cm):	**ISE**		**KMÉ**		**KMÉ**		**SE**	
Physical soil types	HO		HO		HO		HO	
pH H_2O	8,2	8,9	8,2	8,5	8,2	8,4	8,2	8,5
pH KCl	7,8	8,3	7,6	7,8	7,7	7,6	7,8	7,9
$CaCO_3$ (%)	**7,6**	**17,2**	**3,0**	**24,2**	**6,0**	**3,0**	**2,1**	**1,0**
Sodium (%)		**0,031**		**0,052**		**0,026**		**0,030**
Total salt (%)								
hy (%)	0,40	0,20	0,52	0,73	0,47	0,67	0,46	0,38
K_A								
5-hour capillary water rise (mm)	320	450	355	460	430	445	390	380
Humus (%)	0,51		**0,66**		**0,40**	**0,57**	**0,31**	**0,32**
Mechanical composition: clay	1,50	0,10	0,20	0,08	2,60	5,80	3,20	1,40
silt	2,90	1,70	5,20	9,90	2,90	3,00	2,40	2,20
fine sand	62,00	81,60	78,80	87,50	75,80	71,20	74,20	67,80
coarse sand	33,60	16,60	15,80	2,50	18,70	20,00	20,20	28,60
Average height (m)	3,7		8,0		6,0		3,0	
Average diameter (cm)	3,5		10,0		8,0		2,0	

Chart 7/5. Soil examinations (continuing)

	Village, member, item			
	Kerekegyháza 45F₂	Lajosmizse 110H	Lajosmizse 110J	Lajosmizse 111E
Classification	**Productivity group III.**	**Productivity group II.**	**Productivity group III.**	**Productivity group III.**
Notes	The very shallow fertile layer of the soil, the high lime- and sodium-content and the soil poor in organic materials and rich in coarse sand explain properly the extremely poor growth of the black locust. Extremely dry site!	Despite high lime- and sodium-content the black locust stand shows surprisingly well growth. The well growth is due to the medium-deep fertile layer of the soil! Supplementary examinations would be necessary! Extremely dry site!	The above facts do not explain such poor growth of the black locust. Supplementary examinations would be necessary! Extremely dry site!	The above facts do not explain such poor growth of the black locust. Supplementary examinations would be necessary! Extremely dry site!

After all it has become obvious, that the afforestation planning nowadays can not be based only on these, traditional examination aspects any more. We have come namely to contradictory or unexplainable results in more cases. Glaring examples for that show the forest tracts Kelebia 169N and Kerekegyháza 47K. In these and similar cases detailed nutrient testing would be also necessary for evaluating site quality. The examinations should be extended at least to the following elements: N, P, K, Ca, Mg, Zn, Fe, Mn.

And the case Kisszállás 58E shows that the depth situation of lime and sodium should be determined more exact!

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