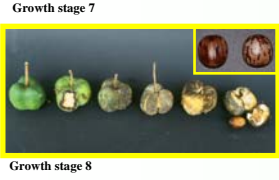
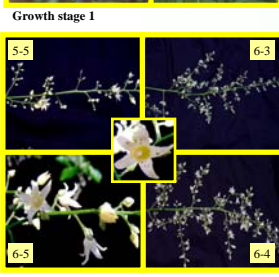
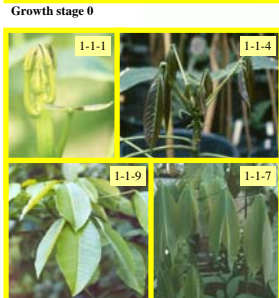
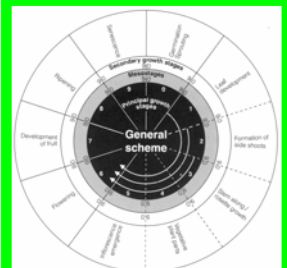


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We describe the growth stages of *Hevea brasiliensis* cultivated commercially world wide in tropical regions for rubber production. We prepare the basis for comparisons of epidemiological studies of disease, of growth patterns under different environmental factors and of genetical clone specific parameters. Each growth stage described has some relevance for management practices.

The extended BBCH-scale is a system for a uniform coding of phenologically similar growth stages of all mono- and dicotyledonous plant species. It results from teamwork between the German Federal Biological Research Centre for Agriculture and Forestry (BBA), the German Federal Office of Plant Varieties (BSA), the German Agrochemical Association (IVA) and the Institute for Vegetables and Ornamentals in Grossbeeren/Erfurt, Germany (IGZ). The abbreviation BBCH derives from Biologische Bundesanstalt, Bundessortenamt and CChemical industry. BBCH codes are recently well established for more than forty species and used in agricultural practice, agrometeorology, climate change observations or agricultural insurance.



Growth stage	Code	Description		
Germination	0	0 Seed resting period (relative seed drought)		
Leaf and canopy development	1	1 Beginning seed swelling		
	2	2 Swelling complete		
	3	3 Horizontal hypocotyl emergence		
	4	4 Radicle formation		
	5	5 Crown root formation		
	6	6 Beginning tap root formation, growth of crown roots		
	7	7 Emergence of plumule		
	8	8 Erection of epicotyl, ramification of crown roots		
	9	9 Bud formation of first true leaf		
Tillering	1	1 0 Bud burst of first leaf whorl, leaf's upstanding, folded, sprout not elongated		
	1	1 1 first leaf of the whorl beginning to unfold, with petioles in a 90° angle to sprout, leaf length < 1.5 cm, surface turning downwards, colour green, starting to become reddish		
	2	2 all leaflets of the first whorl unfolded, turned downwards, sprout starting to elongate, largest leaf's < 2.5cm: colour green to red		
	3	3 largest leaf's > 2.5cm, reddish, green nerves visible, surface gleaming; beginning elongation of petioles		
	4	4 largest leaf's > 3.5cm, reddish, green nerves visible, surface gleaming; proceeding elongation of petioles		
	5	5 largest leaf's > 6.5cm, reddish, green nerves visible, surface gleaming; elongation of petioles finished		
	6	6 continuation of leaf area increase; starting colour change to light green; surface smooth, leaf's hanging downwards		
	7	7 leaf area increase of the latest leaf of the first whorl finished; colour light green; surface smooth, leaf's hanging downwards, sprout elongation finished		
	8	8 starting change of colour to dark green; starting consolidation of leaf's, leaf's starting to come up		
	9	9 leaf's dark green, consolidated; positioned 45°-90° to sprout		
Development of harvestable vegetatively propagated organs	2	2 Development of the second to fifth whorl		
	3	3 Development of the fifth to tenth whorl		
	4	4 10-33% of the canopy have leaf's in growth stage 1-1-2 to 1-1-5		
	5	5 33-66% of the canopy have leaf's in growth stage 1-1-2 to 1-1-5		
	6	6 66-100% of the canopy have leaf's in growth stage 1-1-2 to 1-1-5		
	7	7 10-33% of the canopy have decaying, yellowish, senescent, falling leaf's		
	8	8 33-66% of the canopy have decaying, yellowish, senescent, falling leaf's		
	9	9 66-100% of the canopy have decaying, yellowish, senescent, falling leaf's		
	Inflorescence emergence	2	2 not relevant for <i>Hevea brasiliensis</i>	
		3	3 0 Stem > 1.5m high, 2cm circumference in 5cm height	
1		1 Stem 1.5m high, 4cm circumference in 5cm height		
2		2 Stem 1.5-2m high, < 10cm circumference in 5cm height		
3		3 Stem 2-3m high, > 10cm circumference in 1.50 height		
5		5 Stem 40cm circumference in 1m height		
9		9 Stem > 100cm circumference in 1m height		
Flowering		4	4 0 Seedling grafted with bud from scion	
		1	1 Beginning callus formation	
		5	5 End of callus formation	
	9	9 Bud and seedling tidely fixed		
	Development of fruit	5	5 1 Inflorescence buds visible	
		1	1 Half of inflorescence emerged	
		9	9 Inflorescence fully emerged	
		Ripening of fruit and seed	6	6 0 First flowers opening
			1	1 Beginning of flowering: 10% flowers open
			3	3 30% flowers open
5			5 Full flowering: 50% flowers open	
7			7 Flowering finishing: majority of petals dry or fallen	
9			9 End of flowering: fruit set visible	
Senescence and death			7	7 1 10% of fruits have final size
	3		3 30% of fruits have final size	
	5		5 50% of fruits have final size	
	7		7 70% of fruits have final size	
	9	9 Nearly all fruits reached final size		
	Senescence and death	8	8 1 Beginning of ripening	
		5	5 Advanced ripening and starting fruit browning	
		7	7 starting fruit flesh degradation	
		9	9 beginning fruit abscission and seed liberation	
		9	9 decay of plant productivity, maximum economically acceptable age of tree	

Application example 1: Integration of BBCH codes in a generalized ICM-concept of *Hevea brasiliensis*

Growth stage	Exemplary management practice
0	0 Sawing
5	5 Inoculation with growth promoting microorganisms (e.g. mycorrhizal fungi)
8	8 First selection of seedlings (piquering)
1	1 1 beginning monitoring of leaf pathogens
2	2 decision making for application of chemical control agents in nurseries
3	3 starting application of plant protection products in nurseries
7	7 last application of plant protection products in nurseries
4	4 decision making for application of biocontrol or chemical control agents in plantations
5	5 starting application of plant protection products
6	6 frequent application of plant protection products
3	3 0 „green budding“ of seedlings with buds from clonal scions
1	1 „brown budding“ of seedlings with buds from clonal scions
2	2 preparation of „budded stumps“
3	3 crown budding in plantations
5	5 beginning of tapping
9	9 decay of latex production
4	4 9 Ripping of budded seedlings
6	6 3 Beginning breeding activities
8	8 9 collection of seeds for seedling production
9	9 9 harvest of stem for rubberwood production



Application example 2: Studying host-pathogen interrelationships of *Hevea brasiliensis* at defined developmental stages



Studying occurrence of physiological changes in leaves (here: clone Fx4098 at BBCH 1-3-5)



Studying epidemiology of disease with respect to plant protection procedures (here: clone RRIM 600 at BBCH 1-4-6 after mycorrhizal treatment)



Comparison of individual plant reactions after breeding process (here: clone Fx4098 X *H. pauciflora* at BBCH 1-3-8)

BBCH-codes allow exact adjustments of agro-ecological parameters with management practices world wide