Grafting of vegetable plants

History of grafting of vegetable plants

- **A.D. VI.th century – first mentioned in China**
- **1710 – Korea, description of grafting of cucurbits**
- **1920-30's – used in commercial cultivation in the Far East, beginning of scientific investigations**
- **1960's – widespread use in Japan and Korea**
- **1980's – appears in Europe, (used also in soilless cultivation)**
- **mid 1990's – beginnings in Hungary**
- **1995 – grafting robots are commercialised**
- **2000's – Italy, Spain, Greece – ratio of grafting of watermelon (melon) reaches 90%**
- **Hungary – ratio of grafting of watermelon is about 2/3, grafting of melon has just started; it became a basic element in year-round greenhouse tomato cultivation**

Number of grafted seedlings and cultivation area in some leading countries

	million seedlings	thousand ha
• South-Korea	700<	38
• Japan	700<	36
• China		997
• Taiwan		7
• North-America	40-45	
• Spain	130	
• Italy	48	
• France	28	

/Lee et al., 2010/

Why grafting of vegetables is used?

- **Effects of soil born diseases**
- **Difficulties with crop rotation, ban of methylbromide; need for successive cropping (monoculture)**
- **Need for more stress tolerant plants (soil temperature, soil water content, salt level, irrigation water quality)**
- **Need for plants with more extensive root system, better condition and bigger growing vigor**
- **Need for higher yield and better product quality**
- **Need for better water and nutrient use efficiency**

Which vegetable crops are grafted?

	Japan		Korea	
	field	house	field	house
Watermelon	92%	98%	90%	98%
Cucumber	55%	96%	42%	95%
Melon	0%	42%	83%	95%
Tomato	8%	48%	0%	5%
Eggplant	43%	94%	0%	2%
Green pepper			0%	5%

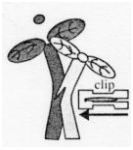
Lee and Oda, 2003

Cucurbitaceous and solanaceous crops

Rootstocks

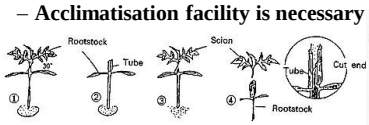
- **Watermelon (melon): interspecific hybrids (*Cucurbita maxima* x moschata), bottle gourd (*Lagenaria vulgaris*), pumpkin, watermelon, bur cucumber (*Sicyos angulatus*), wax gourd (*Benincasa hispida*)**
- **Cucumber: interspecific hybrids, figleaf gourd (*Cucurbita ficifolia*), bur cucumber (Harry), *C. moschata***
- **Tomato, eggplant: different *Solanum* species (e.g. *Solanum lycopersicum, S. torvum, S. integrifolium*)**
- **Green pepper: different *Capsicum* species**

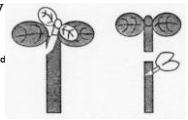
Grafting methods



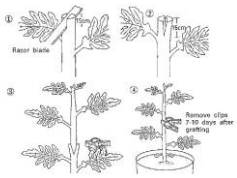
- **Tongue approach grafting**
  - Mainly used for cucurbits
  - A downward cut in the rootstock and an upward cut in the scion
  - Scion is cut down from its root just after the healing
  - Can be sucessfull with little experience and without special facilities
  - Higher seedling survival rate even for beginners
  - Needs more space and labour, complicated
  - Matching of stems is not 100%, not all the vesicular bundles will be fused
  - Rooting of scion is a possibility

- **Hole insertion grafting**
  - Mainly for cucurbits (solanaceous crops)
  - A hole is made at a slant direction into the rootstock, and the scion - prepared with a tapered end - is placed into this hole
  - Stem pith in the rootstock can present problems
  - The scion can be much smaller than the rootstock at the time of grafting
  - It is difficult to place clip or tube on the graft union – is it necessary at all?
  - Acclimatisation facility is necessary

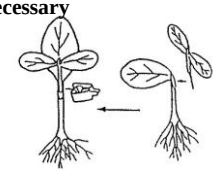




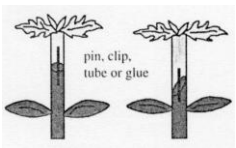
- **Cleft grafting**
  - Can be used both for cucurbits and solanaceous crops
  - Rootstock is cut longitudinally downward 1 to 1,5 cm long, the scion is cut to make a tapered wedge, and placed into that split
  - Quick method, needs less labour
  - Fixing of the grafting point can be difficult
  - Acclimatisation facility is necessary



- **Splice grafting**
  - Used both for cucurbits and solanaceous crops
  - Nowadays the most popular method for commercial seedling producers and expert growers
  - Both part is cut at a 45° angle; one cotyledon is also removed for cucurbit rootstocks
  - Very quick and simple method, needs less labour
  - Offers complete fusion of the stems
  - Acclimatisation facility is necessary



- **Pin grafting**
  - Used both for cucurbits and solanaceous crops
  - Basically is the same as splice grafting, just the fixing of the grafted position is made by a special ceramic pin
  - Very quick and simple method, needs less labour
  - Offers complete fusion of the stems
  - The pin can be expensive
  - Acclimatisation facility is necessary



General process of vegetable grafting

- (Trials for timing of sowing, trial grafting)
- Sowing of rootstock and scion seeds
- Preparation of the necessary facilities
- Grafting (matching graft interfaces; knife, razor blade, grafting machine/robot)
- Fixing the graft position (clips, tubes, pins)
- Healing of graft union (21-28°C, 90% rh)
- (Transplanting)
- Post-grafting operations
- Removal of rootstock shoots (scion roots)
- Planting to the field or greenhouse

Advantages of grafting

- **Root system**
  - **Resistance, tolerance to soil-born diseases and pests → possibility of successive cultivation (monoculture), lower soil disinfection cost**
  - **Cold tolerance → earlier transplanting to the filed, lower heating cost in greenhouse**
  - **Improved water and nutrient use efficiency → smaller amounts water and fertilizer are used**
  - **Better stress tolerance (temperature, water, salt)**
  - **More extensive root system → enhanced mineral uptake; bigger cytokinin production**

Safer, more reliable cultivation!

Advantages of grafting

- **Above ground parts**
  - **Bigger vigor, better shoot growth → smaller plant density, less incidence of sunburn**
  - **Bigger fruit size**
  - **Higher yield → higher income**
  - **More uniform and continuous fruit production; extended harvest period**
  - **Earlier ripening – *disputed***
  - **Improved nutritional quality - *disputed***

Disadvantages of grafting

- **Higher cost – *disputed***

– **additional cost of rootstock seed**

– **extra labour cost**

– **cost of the necessary facilities and tools**

- **Longer transplant raising period – *disputed***
- **Risk of infection during the grafting operation**
- **Later harvest - *disputed***
- **Excess vegetative development – *can be corrected with fertigation***
- **Inferior nutritional quality – *disputed***
- **Requires more knowledge, higher skill level; difficulties of rootstock selection**

How the higher transplant price can be compensated

- **Smaller number of transplants**
- **Lower soil disinfection cost (in greenhouse soil culture)**
- **Smaller amount of materials (e.g. drip tapes/tubes, plastic mulch, low tunnels) used for the cultivation**
- **Reduced fertilizer and agrochemical application**
- **Higher income**

Cultivation costs (thousand Ft/ha) (Sohajda, 2009)

Item	Own-rooted (7.500/ha)		Grafted (3.000/ha)	
Bed preparation	55		35	
Plastic mulch	97		54	
Low tunnel	112	714	62	740
Dript tube	70		39	
Transplants + planting	380		550	
Plant protection	110		90	
Fertigation, irrigation	60		40	
Harvest	200		250	
Liquidation	35		25	
Other, unvariable costs	257		257	
Alltogether	1.377		1.402	

What changes are induced in the technology by the grafting?

- **Deeper base soil tillage**
- **Lower plant density**
- **Different fertigation recipe, higher ratio of K, and lower ratio of N; even smaller amount of applied nutrients is a possibility**
- **Irrigation technology (dose, irrigation interval) could be different**
- **More precise phytotechnic (pruning) in greenhouse cultivation**