THE EFFECT OF GRAFTING ON GROWTH AND EARLY PRODUCTION OF CUCUMBERS AT LOW TEMPERATURE

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Abstract

Plants of several varieties and breeding lines of cucumber (*Cucumis sativus* L.), grown at air temperatures of 20°C days and either 12°C or 7°C nights with soil temperature ranging from 14-22°C, grew faster and gave higher early yields, when grafted onto *Cucurbita ficifolia* L. rootstock. More than half of the ungrafted plants died following transplanting in soil of 14-16°C, whereas all grafted plants survived. Grafting increased early yield by maximally 200%.

Introduction

Reduction of energy expenditures appears an important prerequisite for the continuance of early glasshouse cucumber production in The Netherlands. Lower temperatures in the period of vegetative growth before the start of production result in decreased earliness, although breeding lines are now available, that grow and produce well at a night temperature of 12°C (Den Nijs, 1980). Heating the soil by fermentation (straw bales) or piped hot water is essential to the earliness of the Dutch crop. In Japan the soil heating is practised, but cucumbers are grafted onto rootstocks in order to adapt them to the low soil temperatures. This contribution reports a preliminary trial with grafted cucumber plants under low temperature condition in winter in The Netherlands.

Materials and methods

Plants of Dutch variety Corona, Japanese variety Salad Ace, and of four advanced breeding lines adapted to lower temperatures, were grafted onto rootstock *Cucurbita ficifola* L. on November 21, 1979, two weeks after sowing. The approach graft technique was employed, which is common for cucumbers (De Stigter, 1956). Temperature after grafting was 23°C D/20°C N, and artificial light was supplied in addition to daylight. After seven days the grafts were severed from their own roots. Seeds of control plants were sown November 9, and the plants were grown at moderate temperatures, so that their size at planting time was about the same as that of the grafted plants.

Two air temperature regimes were introduced at planting time (December 21): 20°C D/12°C N and 20°C D/7°C N, the natural day-length being about 8 hrs. At both temperatures half of the plants were grown with soil heating, set at 18-20°C, half without. Soil temperature was periodically monitored at 5 cm depth. Actual soil temperatures showed a daily pattern, ranging in the 12°C N house from 19-22°C with soil heating, and 15-18°C without soil heating.

In the 7°C N house it varied between 18 and 20°C with, and between 14 and 16°C without soil heating.

Five grafted and five ungrafted plants of each of the six genotypes were planted in each of the four environments. Survival, plant length and number of leaves were measured three times, and the number and weight of individual fruits were recorded during the first five weeks of harvest. The night temperature was raised to 20°C in both houses in the beginning of April for reasons not related to the present experiment.

Results

Grafted plants possessed a remarkable advantage over the ungrafted controls. At the 7°C N temperature without soil heating 52% of the ungrafted plants succumbed within a few weeks after transplanting, which often left only two plants per genotype for further study. All grafted plants survived and thrived. With soil heating only few control plants died early, as in the 12°C N house. The effect of grafting on vegetative growth was pronounced, as illustrated in Table 1. At eight weeks from planting, grafted plants were up to 95% taller than ungrafted controls. The average increase per treatment ranged from 30-53%. Line 9-404 reacted only slightly to grafting at the 12°C N, whereas 9-407 benefitted most. The number of expanded leaves increased in general along with plant length. Grafted plants of 9-407 however, had not more leaves at 12°C N with soil heating, despite an almost 100% increase in stam length.

Differences in fruit production from March 3 until April 9 between grafted and ungrafted plants are in Table 2. At 12°C N the number of fruits was always higher for the grafted plants except for 9-404 with soil heating. The figures for 7°C N are not very reliable because of low plant numbers and very much disturbed growth. The mean fruit number at 12°C N is doubled by grafting in heated soil, and almost tripled in soil without heating. Breeding line 9-403 and Salad Ace exhibited the most spectacular rise in fruit production.

Cumulative production curves were drawn up for three representative genotypes in Fig.1. Corona was the slowest variety to start production, but 3-4 weeks in earliness were gained by grafting. Total production was still small, however. Both grafted and control plants of Salad Ace yielded considerably better, and there was a clear advantage of the grafted plants. Breeding line 9-403 exhibited a pattern like Salad Ace. Soil heating hardly influenced production of grafted and ungrafted plants. In Fig. 1 one production curve of 9-403 at 7°C N is also included as an example of this very low temperature-regime. Again, the grafted plants outyielded the two control plants without soil heating. The ungrafted plants in heated soil did surprisingly well.

Discussion and conclusion

The data must be considered with reserve, because of the very limited numbers of plants. Nevertheless a distinct advantage in vegetative growth and earliness of grafted plants is indicated.

The reason for the observed differences may most probably be

found in the larger and/or more efficient root system of the rootstock. Plants of C u c u r b i t a f i c i f o l i a grown in the winter of 1978 at low temperatures grew very vigorously. The cold tolerance of the rootstock was also reported earlier by Hori, Akai and Toki (1970). C. f i c i f o l i a is commonly used as a rootstock for autumn cultivation of cucumbers in The Netherlands because of its tolerance to several soil pathogens. It has been noted, that grafted crops lasted longer, when the soil temperatures dropped in early winter. However, the earliness of plants grown at normal temperatures is decreased by grafting but the present experiment shows the reverse.

The high percentage of dead control plants in the non-heated soil (actual temperature 14-16°C) indicates that this temperature was too low for survival and growth of cucumber roots. The lower limit for root growth of cucumbers was earlier set at 16°C in solution culture by Foelster (1974). It is interesting, that the limiting temperature for growth of the rootstock appears to be lower.

Fruit quality was not adversely affected by grafting and the grafted plants did not grow excessively wild at the end of the trial, after the night temperature had been raised.

Different genotypes reacted differently to grafting, irrespective of their yield at low temperature. There may be differences in the effectiveness of their own root systems, or in the interactions between root and shoot, which warrants further study in relation to breeding for low temperature adaptation.

The very low night temperature of 7°C was evidently detrimental to growth of all genotypes. Also the grafted plants exhibited disturbed growth, and uneven expansion and chlorotic streaks of the leaves. The few produced fruits were of remarkably good quality and length.

The close similarity of the production curves of grafted plants, grown with and without soil heating, would indicate little dependance of the root system of C. f i c i f o l i a on soil temperature. This preliminary conclusion needs further experimentation.

A larger scale, grower-oriented trial with grafted plants may help to decide on the economic potential of this technique of Japanese origin for Dutch glasshouse conditions.

Literature

Fölster, E., 1974. The influence of the root space temperature on the growth of young cucumbers. Acta Hortic. 39: 153-159.

Hori, Y., Akai, K., and Toki, T., 1970. Studies on the effects of root temperature and its combination with air temperature on the growth and nutrition of vegetable crops. Bull. Hort. Res. Station Hiratzuka, Japan Nr.9.

Den Nijs, A.P.M., 1980. Adaptation of the glasshouse cucumber to lower temperatures in winter by breeding. Acta Hortic. 118

De Stigter, H.C.M., 1956. Studies on the nature of the incompatibility in a cucurbitaceous graft. Meded. L.H. Wag. 56(8):1-51.

Table 1 : Mean plant length and number of leaves at 8 weeks after planting.

Variety/Line	Without soilheating				With soilheating			
	Plant length (cm)		Number of leaves		Plant length		Number of leaves	
	C	G	C	G	C	G	C	G
	Air temperature				20°C D/ 12°C N			
9-402 Corona	135	181	19,5	21,6	99	167	17,3	20,8
9-403	143	202	20,4	23,6	136	182	22,8	22,6
9-404	182	189	21,5	20,4	166	197	19,8	22,0
9-405	180	223	20,0	22,6	135	206	17,0	21,0
9-406 Salad Ace	140	207	17,7	20,4	125	214	17,2	21,4
9-407	-	261	-	23,5	130	252	25,0	24,8
mean	156	210	19,9	22,0	132	203	19,9	22,1
	Air temperature				20°C D/ 7°C N			
9-402 Corona	80	92	19,0	17,4	97	111	19,0	18,2
9-403	70	138	15,0	22,2	105	145	19,8	20,8
9-404	102	132	18,0	19,6	123	140	20,8	20,8
9-405	103	142	17,5	20,0	118	177	19,5	21,0
9-406 Salad Ace	108	130	17,5	18,6	103	159	16,6	21,2
9-407	83	138	17,5	21,3	98	144	18,0	22,0
mean	91	129	17,4	19,8	107	146	19,0	20,7

C = control
G = grafted

Table 2 : Number of fruits per plant produced during the first five weeks of harvest.

	Without soilheating		With soilheating	
	Control	Grafted	Control	Grafted
Variety/Line	Air temperature		20°C D/ 12°C N	
9-402 Corona	0	1,8	0,3	1,6
9-403	2,8	8,4	4,2	8,2
9-404	2,0	3,6	2,6	2,2
9-405	2,0	2,6	0,5	2,3
9-406 Salad Ace	1,0	6,0	1,4	4,8
9-407	-	4,3	1,5	4,3
mean	1,6	4,5	1,8	3,9
	Air temperature		20°C D/ 7°C N	
9-402 Corona	0	1,2	1,0	1,2
9-403	1,5	5,0	5,0	4,8
9-404	1,5	1,6	0,8	1,3
9-405	1,0	1,8	0	0,4
9-406 Salad Ace	2,0	2,6	2,4	3,8
9-407	1,0	1,8	2,3	2,0
mean	1,2	2,3	1,9	2,3

Fig. 1 : Cumulative yield (kg per plant) of grafted and control plants of three cucumber genotypes.
(+: with soilheating, -: without soilheating)

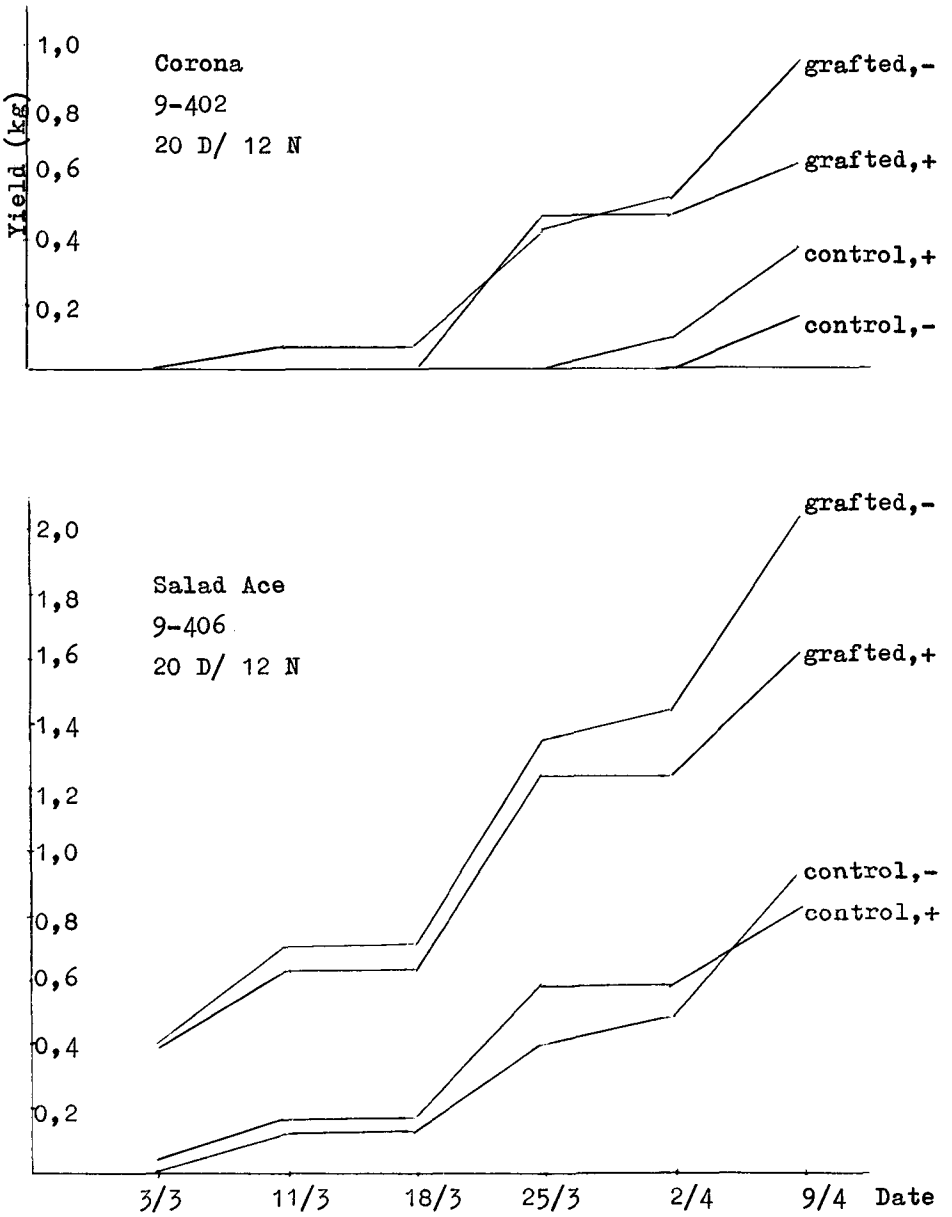
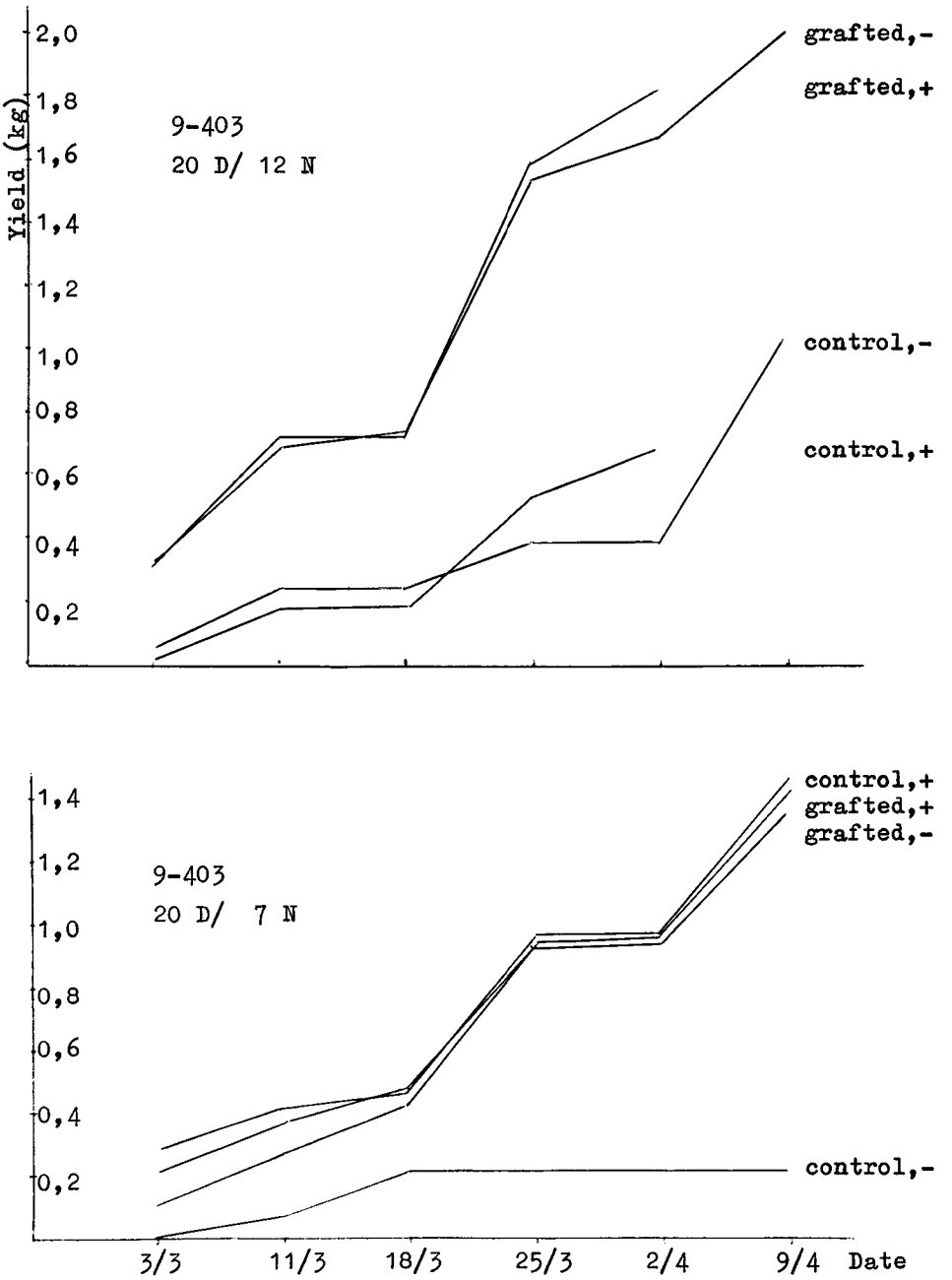


Fig. 1 ctd.


Yield (kg)
2,0
1,8
1,6
1,4
1,2
1,0
0,8
0,6
0,4
0,2
9-403
20 D/ 12 N
grafted,-
grafted,+
control,-
control,+
1,4
1,2
1,0
0,8
0,6
0,4
0,2
9-403
20 D/ 7 N
control,+
grafted,+
grafted,-
control,-
3/3
11/3
18/3
25/3
2/4
9/4
Date