EFFECTS OF GIBBERELLIC ACID, 6-BENZYLAMINOPURINE, α-NAPHTHALENEACETIC ACID AND ETHEPHON ON GROWTH AND FLOWERING OF TULIP BULBS CV. 'APELDOORN' AND THEIR BULBLETS

J. van Bragt and H. van Gelder
Department of Horticulture, Agricultural University,
P.O.Box 30, Wageningen,
The Netherlands
Publication 461

Abstract

Effects of gibberellic acid, 6-benzylaminopurine, α-naphthaleneacetic acid and ethephon on growth and flowering of tulip bulbs cv. Apeldoorn and their bulblets

Gibberellic acid /GA_3/, 6-benzylaminopurine /BA/ and α-naphthaleneacetic acid /NAA/ were injected into 5°C bulbs at the time of planting at 15°C. Ethephon was sprayed on the plants at the onset of flowering. GA_3 reduced forcing-time, increased the number of bulblets, but decreased their size. BA and NAA did not affect forcing-time, number and size of bulblets. A lower number of bulblets from BA-treated bulbs formed flower buds. Flower buds were not induced in bulblets from ethephon-treated plants.

Introduction

Earlier work demonstrated that GA_3 enhances the development of the tulip plant, thus reducing the time of forcing /Van Bragt and Van Ast, 1976/. The initial growth of the plant primarily depends on the mobilization of substrates in the scales of the mother bulb /Ho and Rees, 1976; Aung et al., 1976/. Other substrates are formed in the leaves /Ho and Rees, 1976 and 1977/. De Munk and Gijzenberg /1977/ assumed that flower buds compete with daughter bulbs for substrate from the mother bulb, gibberellins and cytokinins strengthening the sink, ethylene weakening it.
Thus, growth regulators in the mother plant affect the growth of the daughter bulbs. The experiments presented in this paper were designed to study the effect of growth regulators on the formation of bulblets. The bulblets were temperature-treated and replanted to investigate carry-over effects, especially with regard to flowering.

Material and methods

Bulbs /size 12 cm and up/ of the tulip cv. Apeldoorn were harvested in July 1974, stored at 20°C followed by

2 weeks at 17°C and then 12 weeks at 5°C. They were planted in January 1975 in soil in a greenhouse and forced at about 15°C. On the day of planting, bulbs were injected with 0.5 ml water containing 1 mg GA_3 /Van Bragt and Zijlstra, 1971/, 0.1 mg BA or 1 mg NAA. Other plants were not treated /control/ or sprayed with 2400 mg/l ethephon at the onset of flowering. Preliminary experiments showed that 1 mg BA, 10 mg NAA and higher concentrations of ethephon were toxic. Omitted in this paper are 0.01 mg BA, 0.1 mg NAA and lower concentrations of ethephon which seemed to have less effect than the concentrations chosen for the experiments. Bulblets were harvested after senescence of the plants, weighed, counted and their size measured. They were planted in the mother bulbs. The bulblets were weighed again before planting. The presence of flower buds was registered when plants were growing in the greenhouse. For each treatment 30 bulbs were used. The experiments were carried out 3 times; one experiment is given in this paper.

Results

The results of the treatments with GA_3, BA, NAA and ethephon on the development of the mother bulbs and on the yield of bulblets are given in table 1.

Table 1– Effects of treatment with GA_3, BA, NAA /injection/ or ethephon /spray/ on forcing-time and length of the plant, on the yield of daughter bulbs, their loss of weight during subsequent temperature treatment before replanting, and on the number of daughter bulbs per mother bulb. Numbers in one column followed by the same letter are not different at $P \leq 0.05$.

Treatment	Mother bulbs			Daughter bulbs		
	Forcing time /days/	Length /cm/ at flowering	Length /cm/ final	yield in % of planted weight	Loss of weight during treatment in % of yield	Number of bulblets per bulb
control	43^a	44^a	55^a	96^a	19^a	2.5^a
1 mg GA_3	33^b	36^b	56^a	90^a	38^b	3.4^b
0.1 mg BA	39^a	42^a	52^a	96^a	20^a	2.4^a
1 mg NAA	44^a	50^c	57^a	87^a	26^a	2.4^a
2400 mg/l ethephon	45^a	38^b	41^b	75^b	6^c	2.4^a

GA_3- treated bulbs flowered earlier, confirming earlier results /Van Bragt, 1972/. BA, NAA and ethephon did not affect forcing time and length of stem at the onset of flowering. In agreement with earlier observations /e.g. Kamerbeek and De Munk, 1976/ ethephon reduced the final length of the stem. Ethephon reduced the total weight of the daughter bulbs as recorded after harvest and before temperature treatment. Loss of weight during temperature treatment was appreciably increased by GA_3, but reduced by ethephon. GA_3 increased the total number of daughter bulblets per bulb. It reduced their average weight. Treatments also affected the number of days from planting until senescence. Compared with ethephon-treated plants, controls were senescent /leaves start to yellow/ on day 7, GA_3 on day 12, BA on day 7 and NAA on day 5.
The number of bulblets per size, expressed as a percentage of the total number of daughter bulblets per bulb is given in table 2.

Table 2 – Effects of treatment of mother bulbs with GA_3, BA, NAA or ethephon on size of daughter bulbs and on formation of flower buds in daughter bulbs.
Number of bulbs per size is given in % of total number of daughter bulbs per mother bulb /romans/.
Number of bulbs with flower buds is given in % of number per size /italics/.

Treatment	Size / cm /						
	3 to 6	7	8	9	10	11	12
Control	18	4	19	21	24	13	1
	0	*0*	*10*	*25*	*65*	*90*	*100*
1 mg GA_3	44	16	28	8	3	1	0
	0	*0*	*0*	*10*	*55*	*100*	–
0.1 mg BA	19	4	26	8	21	15	7
	0	*0*	*0*	*0*	*25*	*20*	*0*
1 mg NAA	20	12	24	22	32	8	2
	0	*0*	*0*	*10*	*55*	*100*	*100*
2400 mg/l ethephon	9	12	19	17	33	6	0
	0	*0*	*0*	*0*	*0*	*0*	–

GA_3 treatment led to a high percentage of smaller sized bulblets. Within each treatment the number of bulblets of one size and having a flower bud was recorded and is also listed in table 2. BA reduced the number of bulblets in which a flower bud was formed. Bulblets from ethephon-treated plants did not from a flower bud at all.

Discussion

Bulbs

Gibberellins always increase the development of the flower, i.e. if applied to buds in dry bulbs /Van Bragt and Van Ast, 1976; present experiments/, to buds in rooted bulbs /Van Bragt and Zijlstra, 1971/ or to buds which had just passed the neck of rooted bulbs /De Munk and Gijzenberg, 1977/. With BA, however, the results are different. In our experiments application of 0.1 mg BA per bulb had no effect, while De Munk and Gijzenberg /1977/, who applied 0.05 mg BA per bud to buds which had passed the neck of rooted bulbs, found larger flowers on longer stems with thicker internodes. In this respect it is interesting to note that Mynett and Saniewski /1974/ observed that application of BA to the basal plate of dormant tulip bulbs led to the formation of parrot-type flowers.
We did not observe an effect of NAA while De Munk and Gijzenberg /1977/ found that 0,05 mg NAA per bulb had a dwarfing effect on the stem. Apparently the effects of BA and NAA differ with the condition of the plant material. The inhibitory effect of ethephon is in agreement with earlier findings /Kamerbeek and De Munk, 1976/.

Daughter bulblets

Gibberellin treatment of bulbs led to an increased number of smaller bulblets per bulb and to extension of the life of the plants. These bulblets lost relatively much weight after harvest during the following temperature treatment of the dry bulbs. Apparently, gibberellins release apical dominance, thus stimulating the growth of axillary buds and decreasing their weight due to competition for substrates among the daughter bulbs. In connection with the observed extension of the period between planting and senescence caused by GA_3, the bulblets might not have reached a sufficient physiological state of dormancy to withstand the dry conditions after harvest, resulting in a relatively high loss of weight. In this respect it is interesting to note the small loss of weight of bulblets from ethephon-treated plants.
Flowering of daughter bulbs was almost 100% in size 11 bulbs, and a low 10% in size 8. The explanation can be found in the circumstance that the experiments were conducted in a greenhouse where size 11 bulbs were of about the same weight as found for outdoor grown bulbs of size 9. BA reduced the number of bulblets which formed a flower bud. An explanation in terms of sink-source relationships does not seem applicable in this case, since BA did not affect the number, size or weight of

daughter bulbs. It is the relation between bulb size and flower formation which is affected. At present we cannot offer an explanation for this observation.

References

Aung, L. H., Wright, R. D. and De Hertogh, A. A., 1976. Carbohydrate and dry matter changes in organs of Tulipa gesnerisna L. during low-temperature treatment. HortScience 11: 37-39.

De Munk, W. J. and Gijzenberg, J., 1977. Flower bud blasting in tulip plants mediated by the hormonal status of the plant. Scientia Hortic. 7: 255-268.

Ho, L.C. and Rees A. R., 1976. Re-mobilization and redistribution of reserves in the tulip bulb in relation to new growth until anthesis. New Phytol. 76: 59-68.

Ho, L. C., and Rees, A. R., 1977. The contribution of current photosynthesis to growth and development in the tulip during flowering. New Phytol. 78: 65-70.

Kamerbeek, G.A. and De Munk, W. J., 1976. A review of ethylene effects in bulbous plants. Scientia Hortic. 4: 101-115.

Mynett, K. and Saniewski, M., 1974. The morphological changes in tulip flower after growth regulator treatment. Proc. XIX Internat. Hortic. Congress, vol. 1B: 840.

Van Braght, J. and Zijlstra, F., 1971. Effects of Gibberellins on flowering of tulip cv. 'Apeldoorn'. Zeitschrift für Pflanzenphysiologie 64: 139-144.

Van Bragt, J., 1972. Effect of forcing temperature and gibberellin A_3 on flowering of tulips. Meded. Fak. Landbouwwetenschappen Gent 37: 619-622.

Van Bragt, J. and Van Ast, K. J., 1976. Substitution of the cold requirement of tulip c.v. 'Apeldoorn' by GA_3. Scientia Hortic. 4: 117-122.