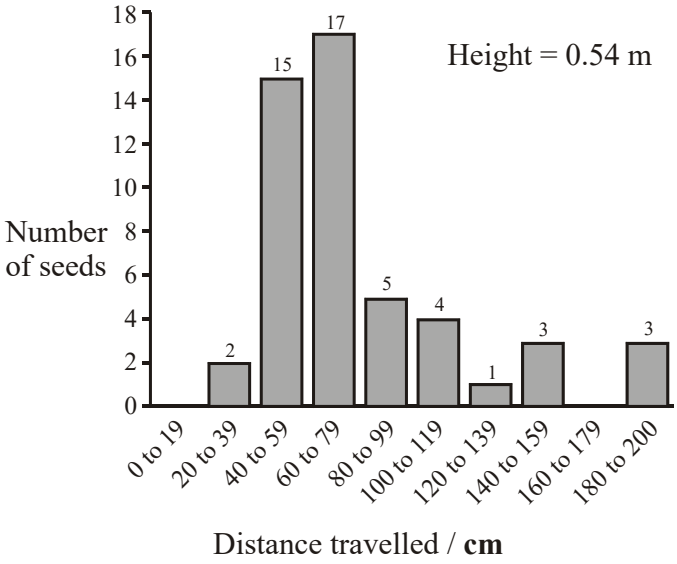
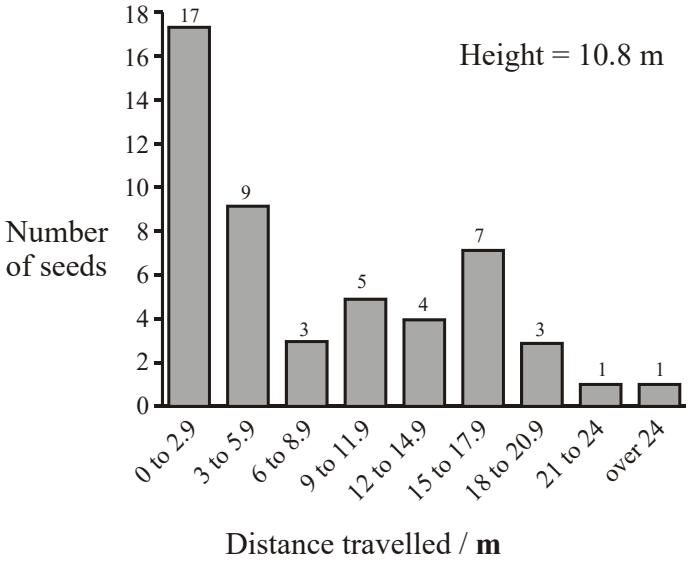
TOPIC 8 – PLANT SYSTEMS

Seed Dispersal (17 marks)

Seed dispersal is important in the migration of plants from one area to another area. Plants have evolved many methods, both physical and biological, by which to disperse their seeds. 50 maple seeds, which are wind dispersed, were dropped one at a time from two different heights, 0.54 m and 10.8 m respectively. The histograms below show the distribution of the distance the maple seeds travelled.





a. For each height, identify the distance travelled by the greatest number of seeds. *(1 mark)*

i. Height = 0.54 m: .....

ii. Height = 10.8 m: .....

b. State the effect of height on seed dispersal. *(1 mark)*

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c. Suggest **two** reasons for the effect of the drop height on the distance travelled by the seeds. *(2 marks)*

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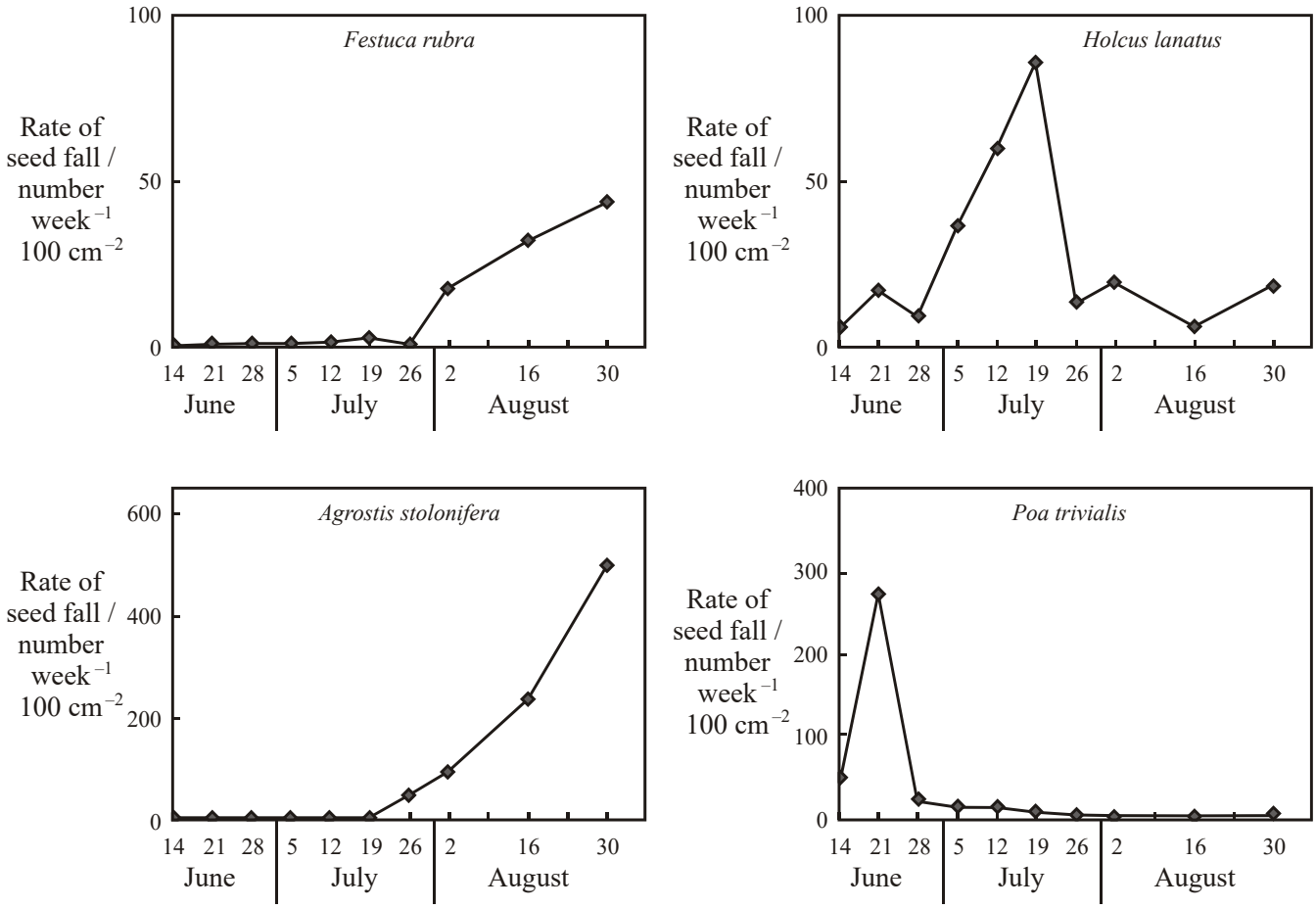
The following graphs show the rate and timing of seed release from different species of grass in the same area during the summer.



d. Identify the grass species which produces the most seeds in this area. *(1 mark)*

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e. Identify the grass species which produces the most seeds in June. *(1 mark)*

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f. Compare seed production for all species relative to the timing of their release. *(3 marks)*

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g. Suggest **two** benefits for these plants in the timing of seed release. *(2 marks)*

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Biological seed dispersal is usually dependent on the nutritional content of the seed or fruit. The following table gives the nutritional content for fruits of different species in temperate and tropical climates.

Common Name *(genus)*	Percentage by Dry Weight			
	Protein	Lipid	Carbohydrate	Dispersal Agents
		Temperate		
Cranberry *(Vaccinium)*	3	6	89	Birds
Hawthorn *(Crataegus)*	2	2	73	Birds
Pin cherry *(Prunus)*	8	3	84	Birds
Pokeberry *(Phytolacca)*	14	2	68	Birds
Strawberry *(Fragaria)*	6	4	88	Birds
		Tropical		
Bird palm *(Chamaedorea)*	14	16	55	Birds
Fig *(Ficus)*	7	4	79	Bats
Mistletoe *(Viscum)*	6	53	38	Birds
Monkey fruit *(Tetragastris)*	1	4	94	Monkeys
Wild nutmeg *(Virola)*	2	63	9	Birds

h. Compare tropical fruits to temperate fruits in relation to the mean values for lipid, carbohydrate and protein content. *(2 marks)*

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i. Explain which fruit would have the highest energy content. *(2 marks)*

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j. Suggest **one** advantage and **one** disadvantage of dispersal of seeds by animals. *(2 marks)*

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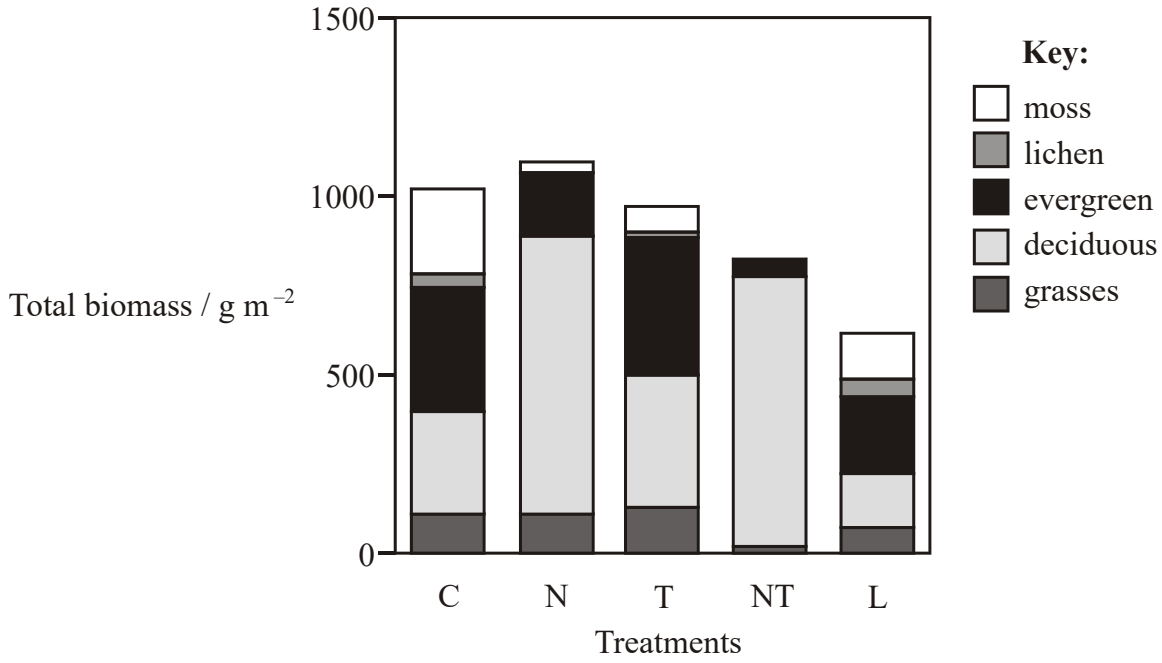
Tundra Plants (6 marks)

A nine-year study was carried out on plants in the arctic tundra. The effects of different factors were studied:

- nutrient addition
- use of a greenhouse to raise the summer air temperature by 3°C
- use of a "fertilized greenhouse" (increased temperature plus nutrient addition)
- shade to reduce light by 50%.

The results are shown in the graph below.



a. Identify the treatment that produced the greatest evergreen biomass. *(1 mark)*

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b. Identify the treatment that produced the greatest lichen biomass. *(1 mark)*

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c. Compare the effects of nutrient addition, raising the temperature and shading on the biomass of deciduous plants. *(2 marks)*

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d. Suggest reasons for differences in total biomass of plants in response to different treatments. *(2 marks)*

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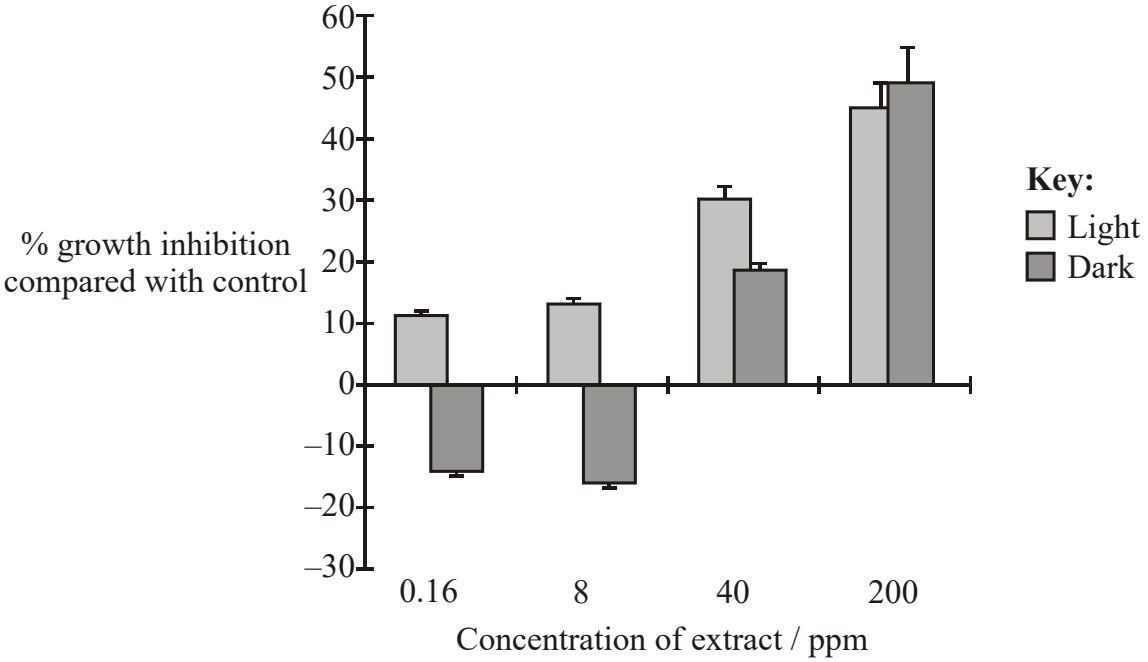
Plant Chemicals (6 marks)

The leaves of the plant Tree of Heaven (*Ailanthus altissima L.*) have been reported to contain compounds that act as both herbicides and pesticides. Chemicals were extracted from the leaves and the bioactivity of these was tested on the growth of alfalfa seedlings. The results are shown in the bar chart below. Negative values for growth inhibition indicate increased growth.



a. Determine the concentration of the extract that had the greatest difference between dark and light conditions. *(1 mark)*

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b. State the largest percentage growth inhibition for seedlings grown in the light. *(1 mark)*

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c. Outline the effect of extract concentration on growth in the dark. *(2 marks)*

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d. Suggest reasons for testing the bioactivity of the extract on seedlings in the dark and in the light. *(2 marks)*

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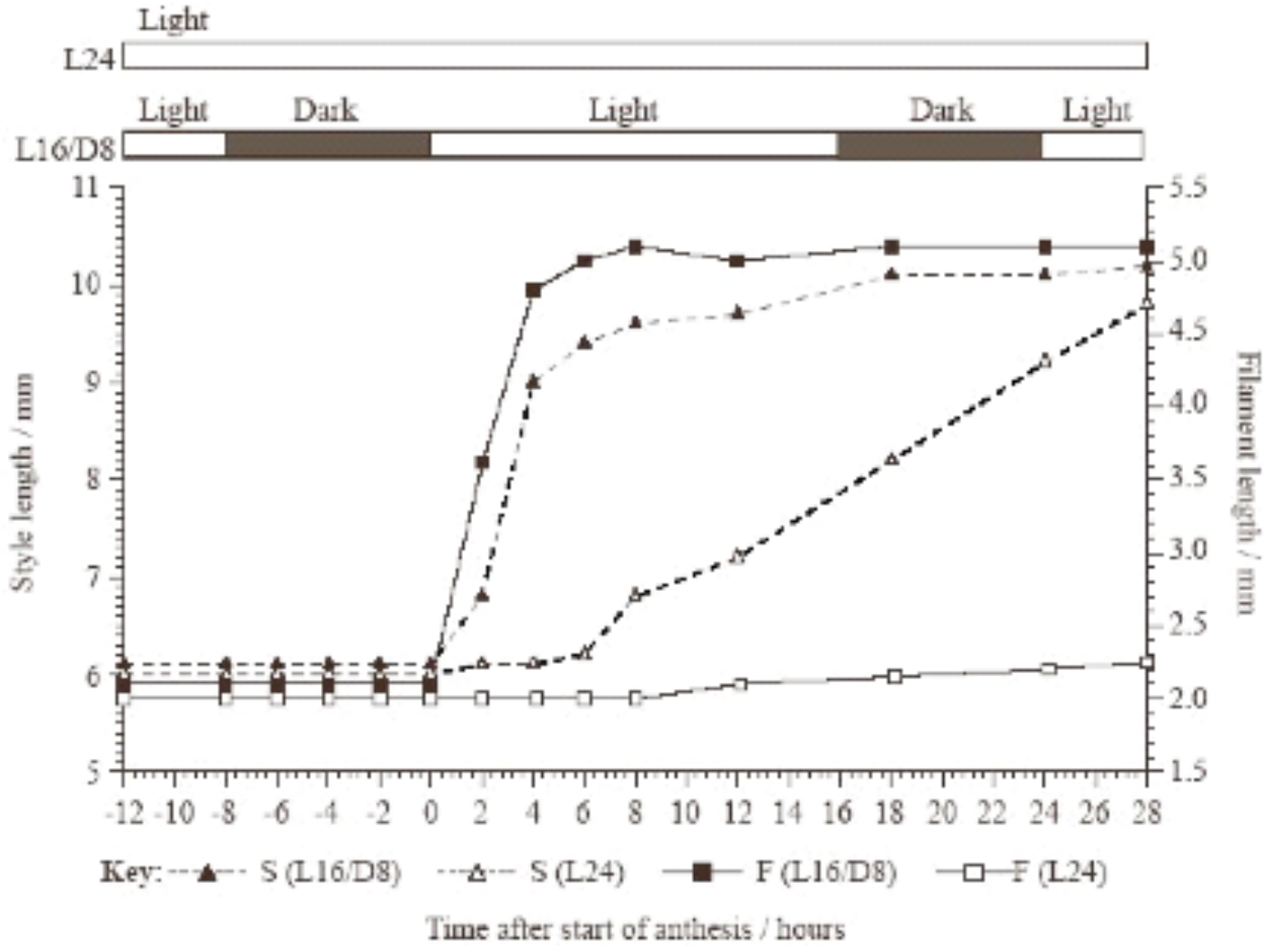
Pollination Barriers (14 marks)

In order to prevent transfer of pollen from an anther of one plant to the stigma of the same plant (self-pollination), the sunflower (*Helianthus spp*) anther sheds its pollen before the stigma is mature enough to receive it. Early in the morning the anther is exposed by elongation of the filaments. The anthers open at this time to release their pollen (anthesis). The stigma appears above the anthers by late afternoon, and by the following morning it is fully receptive. To see how the filament (F) and the style (S) are affected by light, their lengths were measured at time intervals starting 12 hours before anthesis (-12). Some plants were grown in continuous white light (L24) and some plants grown under cycles of 16 hours white light followed by 8 hours dark (L16/D8). The results are shown in the graph.



a. Filaments of the plants grown in continuous white light increased in length by 0.25 mm in the 28 hours after anthesis. Calculate how much the filaments of the plants grown in alternating white light and dark increased during the same period. *(1 mark)*

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b. Compare the increase in the length of the style in the plants grown in continuous white light with those grown in alternating white light and dark. *(2 marks)*

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The table compares the percentage of ovules that have been fertilized and developed into seeds in sunflower plants grown under continuous white light with those grown under alternating light and dark. The numbers represent the mean ± one standard deviation.

Light treatments	**Percentage of fertilized ovules**
Continuous white light (L24)	11.40 ± 7.76
Alternating light and dark (L16/D8)	58.26 ± 4.06

c. Explain the differences in the percentages of ovules fertilized using the data in the graph about the growth of filaments and styles. *(3 marks)*

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d. Explain how standard deviation (SD) shown in this table can be used to help in comparing the effect of light treatments on the fertilization of ovules. *(3 marks)*

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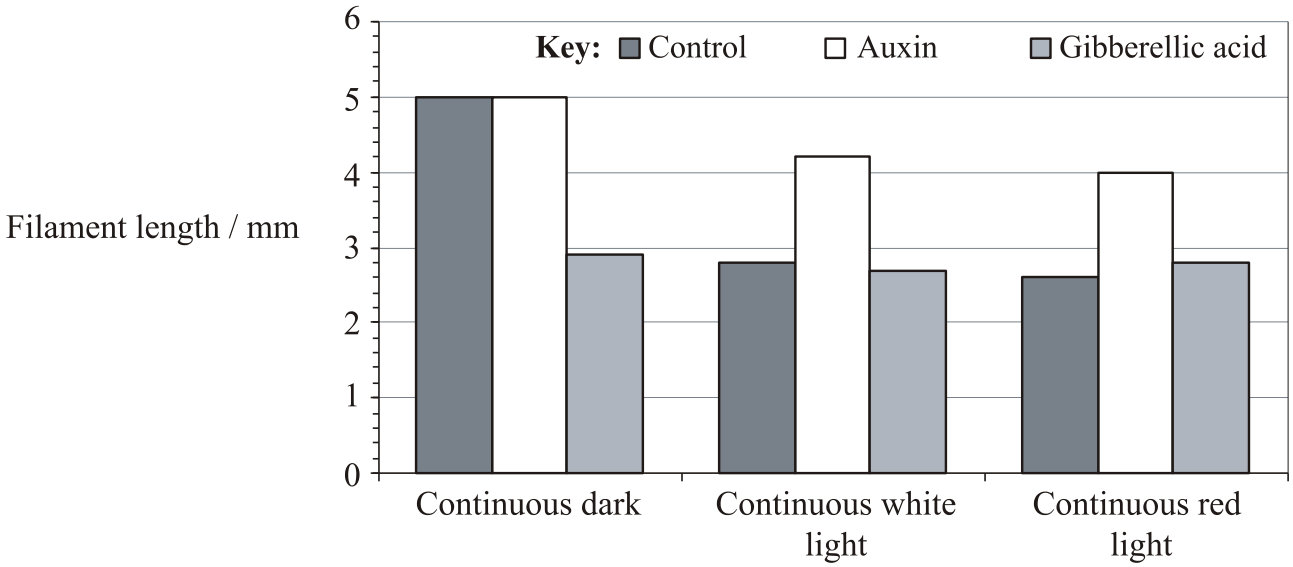
To analyse the effect of growth regulators on filament elongation, further experiments were performed in the dark, white light and red light. The flowers were treated with auxin or with gibberellic acid and compared to a control with no growth regulator. The results are shown in the bar chart below.



e. Identify, with reasons, which factors promote and which inhibit the elongation of filaments. *(3 marks)*

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f. Explain the disadvantages to a plant of self-pollination. *(2 marks)*

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Answers

1a *(1 mark)*

a. height 0.54 m: 60–79 cm / 0.60–0.79 m (from the plant)

b. height 10.8 m: 0–2.9 m (from the plant)

c. *Units needed for both parts of the answer.*

1b *(1 mark)*

the greater the height from which the seed fell, the further it travelled from the parent plant

1c *(2 marks)*

At the greater height:

a. seed can catch the wind to travel further / updrafts / more wind at greater height

b. farther to the ground and does not travel straight down / more time to be blown before hitting the ground

At lower height:

c. seed can fall straight down

d. seed can hit downdraft and fall faster

Any point must explain the difference in distance travelled from the two heights.

1d *(1 mark)*

Agrostis stolonifera

1e *(1 mark)*

Poa trivialis

1f *(3 marks)*

a. *Poa* produces seed earliest in the summer / June

b. *Holcus* produces most seed in July

c. *Agrostis* and *Festuca* produce seed in (late July to) August

d. *Holcus* and *Poa* have a peak time of seed fall / short period of seed fall

e. *Agrostis* and *Festuca* may continue to increase in seed production to September

Accept any of these points made conversely as an alternative.

1g *(2 marks)*

*Award **[1]** each for any two of the following*.

a. to avoid predation / disperse at times when other species are dispersing their seeds

b. to avoid competition

c. late in the year to allow seeds to germinate over winter / better germination conditions

d. better dispersal conditions / more wind / animals for dispersal

e. photoperiod – required day length for flowering

f. more energy stored at the end of the summer for seed production

g. more light / warmth / better conditions for seedling photosynthesis / growth

1h *(2 marks)*

*Award **[1]** each for any two of the following*.

a. tropical fruits have higher lipid content than temperate fruits

b. temperate fruits (80%) have greater carbohydrate content than tropical fruits (55%)

c. protein levels are similar in both groups of fruits / slightly higher in temperate fruits than tropical fruits *(slight must be clear)*

1i *(2 marks)*

a. mistletoe

b. high proportion of lipid and carbohydrate (lipid has approximately twice the energy content of protein and carbohydrate)

1j *(2 marks)*

*Award **[1]** for advantage and **[1]** for disadvantage*.

a. *advantage:* travel further / digestion cracks seed coat for better germination / deposited in feces with organic matter / better in areas with little wind
b. *disadvantage*: predation / seeds eaten / deposited in poor environment / buried too deep / buried too shallow (if deposited with feces) / animal might become extinct / scarce

2a *(1 mark)*

greenhouse / T

2b *(1 mark)*

shaded / reduced light / L

2c *(2 marks)*

a. adding nutrients / raising temperature increased biomass (compared to control)
b. more shading decreased biomass (compared to control)
c. nutrients cause greatest increase in biomass

Accept numerical answers.

2d *(2 marks)*

a. adding nutrients increase deciduous biomass so soil deficient in nutrients / nutrients were limiting factor
b. shading decreases biomass as light is a limiting factor for all plants (except lichens)
c. nutrients and increased temperature increase deciduous plants which out-compete the others
d. increased temperature decreases overall biomass / plants are adapted to arctic temperatures
e. mosses are best adapted to control / arctic conditions

Any other valid reasons.

3a *(1 mark)*

8 ppm (units required)

3b *(1 mark)*

44 (± 2)

3c *(2 marks)*

a. with increasing concentration of extract growth stimulation turns into growth inhibition / *vice versa*
b. concentrations of 0.16 and 8 ppm have a growth stimulating effect of 13%, 18% respectively, ± 1 on figures
c. at 40 and 200 ppm extract shows 18% and 48% growth inhibition respectively, ± 1 on figures
d. five fold increase of extract (40 to 200 ppm) does not lead to a five fold increase in growth inhibition
e. fifty fold increase in extract (0.16 to 8 ppm) does not have a noticeable / significant effect on the growth stimulation

3d *(2 marks)*

a. light might break down the extract
b. light might activate the extract
c. darkness may lengthen the activity period
d. find out when it works best; light may stimulate reaction between extract and seedling
e. light may inhibit reaction between extract and seedlings

4a *(1 mark)*

2.9 (± 0.2) mm (*units required*)

4b *(2 marks)*

a. cyclic light makes style grow almost immediately while with continuous light it takes longer to start to grow / L16 / D8 starts growing in first hour while L24 style starts growing after 6 hours / growth is more gradual in L24
b. with continuous light the style grows less / continuous (L24) grows to 9.8 mm while cyclic (L16 / D8) grows to 10.2 mm / little difference after 28 hours
c. in both cases growth only starts with anthesis

4c *(3 marks)*

a. 47% / more fertilized ovules in cyclic light
b. filament grows more in cyclic light than continuous
c. pollen closer to stigma so pollination more probable
d. in continuous light anthers do not become exposed

Accept converse wording.

4d *(3 marks)*

a. standard deviation is a measure of variability / indicates the spread of values around the mean
b. continuous light data is more variable (because it has a higher standard deviation)
c. helps to decide whether the difference between two means is significant
d. 68% of values are 1 SD from mean
e. difference between means is approximately 47 / is significantly different / light treatment makes a significant difference

4e *(3 marks)*

a. darkness promotes / white light inhibits because filaments shorter than in darkness
b. red light inhibits because filaments shorter than in darkness
c. auxins promote because filaments are longer than in control / in white and red light
d. gibberellic acid inhibits because filaments are shorter in continuous white light / darkness

Reason must be present to receive the mark. Accept if converse wording.

4f *(2 marks)*

a. self-pollination reduces / does not promote variation / no new combination of alleles
b. no variation for natural selection
c. more susceptible to infectious diseases
d. more prone to genetic disease / (inbreeding) more likely to be homozygous for disease