Past-paper walk-through

Irrigation Methods ▪ 5.5

eXercise

Questions in this set

- 2023 Set 1 Q1

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(a) Identify the control group in this experiment.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(b) Identify the scientific question for the investigation.

Question 1

2023 Set 1 ▪ Q1

Question 1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

Question 1

(c) Researchers repeated the experiment by modifying the length of time for the spray irrigation to 20 minutes per day. Explain how the results of the experiment could be altered with this modification. Researchers also monitored the amount of sediment and fertilizer washing into the river from each plot in the original study. The soil temperature was also measured in each plot at the same depth and at the same time each day approximately 0.05 meters below the surface of the soil.

Genetically Modified Green Bean Experimental Results

Plot	Sediment Runoff (mg/L)	Phosphorus Runoff (mg/L)	Nitrogen Runoff (mg/L)	Soil Temperature (°C)
A (Type 1 GMO beans)	2.4	0.11	1.07	18.6
B (Type 2 GMO beans)	2.1	0.02	0.56	18.3
C (Type 3 GMO beans)	0.9	0.04	0.68	18.3
D (Unmodified	3.5	0.15	1.24	17.6

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(d) Based on the data in the table, identify the plot with the lowest soil temperature.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(e) Describe how sediment runoff and fertilizer runoff compare between the unmodified green beans and the genetically modified green beans.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(f) The Type 2 GMO beans in Plot B were developed to grow more quickly than the unmodified beans in Plot D. Researchers have hypothesized that the Type 2 beans would use fertilizer more completely than the other varieties. Based on the data in the

Question 1

table and the experimental design, explain whether the researchers' hypothesis was supported or refuted.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(g) Once the experiment was concluded, the researchers burned the plots to remove the crops that had been planted. After a few years, the researchers returned to the plots and observed a variety of plants, insects, and bird species living there.

Question 1

Describe the ecological process that occurred on the plots after the crops were burned.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(h) A survey indicated that one of the plots had twice the plant diversity that the other plots had. Over the next five years, the river occasionally flooded the plots, killing off many of the species that inhabited the plots.

Question 1

After each flooding event, the plot with twice the plant diversity returned to its prior level of biodiversity more quickly than the other plots did. Explain why a community with more plant diversity will recover more quickly from the flooding.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(i) After the last flooding event, a beetle not previously known in the area appeared in one of the plots with less plant diversity. Over a period of a few months, the new beetle population increased, whereas the existing beetle species in the plot had

Question 1

declining populations. Explain why the new beetle species could be better able to successfully populate this plot than the existing beetle species could.

Question 1

2023 Set 1 ▪ Q1

Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A-D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

(j) Describe one realistic method to prevent the new beetle from spreading beyond the experimental plot.

Solution 1

(a)

Mark scheme

- The control group is Plot D, the unmodified (non-GMO) green beans.

Solution 1

(b)

Mark scheme

- Any one of: Will genetically modified green beans have higher crop yields than unmodified green beans? / Is there a difference between the crop yields of genetically modified and unmodified green beans? / Does genetically modifying green beans affect crop yield?

Solution 1

(c)

Mark scheme

- With only 20 minutes/day of spray irrigation (less water than the original setup), crop yield/number of green beans harvested would be lower in all plots. Alternatively: the genetically modified beans would stay similar in yield because they are drought-resistant/need less water, while the unmodified beans would decrease in yield because they receive less water than they need.

Solution 1

(d)

Mark scheme

- Plot D (the unmodified green beans) has the lowest soil temperature, based on the data table.

Solution 1

(e)

Mark scheme

- Both sediment runoff and fertilizer (phosphorus/nitrogen) runoff are lower with the genetically modified beans than with the unmodified beans (equivalently: both types of runoff are higher with the unmodified beans).

Solution 1

(f)

Mark scheme

- The hypothesis is supported. Any one justification: there is less fertilizer (phosphorus/nitrogen) in the runoff from Plot B, so the Type 2 GMO beans are absorbing/taking up more fertilizer; or there is more fertilizer in the runoff from Plot D, so the unmodified beans in Plot D are taking up less fertilizer; or the Plot B beans produced more beans given the same amount of fertilizer.

Solution 1

(g)

Mark scheme

- Secondary succession occurred: fast-growing, early-successional (pioneer) organisms recolonized/returned to the soil after the fire (a major disturbance), since the soil itself was not destroyed.

Solution 1

(h)

Mark scheme

- Any one of: the higher-diversity plot has more species/organisms, so the flood harms a smaller proportion of the total species/organisms present; the higher-diversity plot has more connections between organisms (food-web links), so the flood disrupts a smaller percentage of those connections; or higher genetic diversity within species means more flood-tolerant individuals survive to repopulate.

Solution 1

(i)

Mark scheme

- Any one of: the new beetle is likely a generalist/r-selected species that can reproduce/spread quickly and outcompete the existing (native) beetle species; the flooding caused a natural disturbance to the existing community, eliminating predators/competitors and opening niches for the new/invasive beetle; low-diversity communities are more susceptible to disruption and recover poorly, allowing the new/nonnative beetle to invade; or the new beetle is an invasive species able to live outside its normal environment and threaten native species.

Solution 1

(j)

Mark scheme

- Any one realistic method: remove beetles by trapping/physical removal to reduce their population size; apply a chemical/pesticide to kill the beetles; or introduce a predator/parasite/pathogen (biological control) that harms the beetles.