**Paired t -test**

**QUESTION** **3: 2009**

An agricultural scientist was testing the effects of a new insecticide on the growth of wheat. She hypothesised that removing insect pests would increase plant growth but was concerned that the compound may also be toxic to plants. She set up five plots, each containing two plants. Within each plot, she applied the insecticide to one of the two plants and left the other untouched. After one month, the plants were harvested and the mass of wheat grains (g) recorded:

|  |  |  |
| --- | --- | --- |
| Plot | Insecticide added | No insecticide added |
| 1 | 67 | 55 |
| 2 | 55 | 37 |
| 3 | 54 | 52 |
| 4 | 62 | 55 |
| 5 | 45 | 40 |

1. What statistical test would be suitable to contrast wheat growth between the two treatments? (2 marks)
2. For the test you have chosen, state the null and alternative hypotheses. (3 marks)
3. What is the value of the test statistic? (Use appropriate formulae and values from tables below.) (5 marks)
4. Is your null hypothesis rejected or retained? (Use appropriate formulae and values from tables below.) (2 marks)
5. Provide a brief written statement that interprets the results. (3 marks)

In a separate experiment, the scientist collected 100 leaves from plants that had been exposed to the insecticide, and counted those that displayed insect damage. She counted 14 damaged leaves and 86 complete leaves. How does this differ from the 10% damage rate recorded when using other insecticides?

1. What statistical test would be suitable to test this hypothesis? (2 marks)
2. Present the value of the test statistic chosen and state whether the null hypothesis is rejected or retained (use appropriate formulae and values from tables below). (3 marks)

**QUESTION 2.** 2010

An environmental scientist was testing the effectiveness of a bush regeneration program. At ten sites, a fixed 10 x 10 m plot was censused before and after the regeneration efforts. In each census all plant species were recorded and the percentage of weed species calculated. The following data were obtained.

|  |  |  |
| --- | --- | --- |
| Site | Before | After |
| 1 | 45 | 35 |
| 2 | 37 | 38 |
| 3 | 23 | 20 |
| 4 | 12 | 11 |
| 5 | 38 | 25 |
| 6 | 24 | 12 |
| 7 | 18 | 22 |
| 8 | 5 | 8 |
| 9 | 27 | 28 |
| 10 | 8 | 12 |

Answer all parts 2A-1E.

**2A)** What statistical test could be used to test whether the bush regeneration program had any effect on the percentage of plant species that were weeds? (4 marks)

**2B)** What are the null and alternative hypotheses for the test you have chosen? (2 marks)

**2C)** Conduct the test, give the value of the test statistic, and whether the null hypothesis is rejected or retained. (6 marks)

**2D)** Does your test support the proposition that money spent on bush regeneration at these sites is an effective way to control weeds? Give reasons for your answer. (4 marks)

**2E)** What aspects of the sampling design could be improved to increase the statistical power to detect differences between the plots before and after the bush regeneration program? (4 marks)

**QUESTION 4.**  2011

An agricultural scientist was testing the effects of a new chemical wetting agent aimed at improving soil moisture at a farm with several different soil types. He collected soil from eight locations and brought the samples back to laboratory. From each location, 10 g of the soil was treated with the wetting agent and 10 g left untouched. All samples were then weighed, wet with a constant volume of water, allowed to dry for 24 hours and then reweighed. He obtained the following data on the final weights of the samples:

|  |  |  |
| --- | --- | --- |
| Location | Treated (g) | Control (g) |
| 1 | 25.2 | 13.1 |
| 2 | 17.8 | 14.8 |
| 3 | 32.5 | 11.5 |
| 4 | 23.1 | 16.0 |
| 5 | 18.2 | 18.0 |
| 6 | 24.9 | 20.1 |
| 7 | 19.6 | 14.4 |
| 8 | 22.3 | 18.6 |

Answer all parts 4A to 4D.

**4A)** What statistical test could you use to detect whether the wetting agent had an effect on the moisture retention of the soil? (2 marks)

**4B)** Conduct the test, and give the value of the test statistic. (6 marks)

**4C)** Is your null hypothesis rejected or retained? (2 marks)

**4D)** Discuss whether this sampling design was appropriate given that the farm contained several soil types? If there were only two soil types, describe a sampling program that would effectively test the hypothesis that the wetting agent improved soil moisture. With reasons, state which statistical test would be appropriate for your sampling design? (10 marks)

**QUESTION** **3: 2006**

Male fiddler crabs have one normal-sized claw and one extremely enlarged one. Whether it is the left or the right claw that is enlarged appears to be random, with 49% in the population having bigger left claws and 51% having bigger right claws. A behavioural ecologist wishes to know whether the duration of fights among fiddler crabs (a measure of the energetic cost involved) is independent of the side of the major claw of a crab relative to his opponent. She did a series of replicate trials in which she took a male and placed him into an arena with either a crab with a claw on the same side or on the opposite side as his claw. She then gave the male 2 days break and conducted another trial with an opponent of the other type. The order of the treatments was randomised for each of the 14 replicate trials. The times for the contests were as follows:

|  |  |  |
| --- | --- | --- |
|  | Opponents claw (relative to focal male) | |
| Male | Same side | Opposite side |
| 1 | 117 | 66 |
| 2 | 102 | 54 |
| 3 | 137 | 100 |
| 4 | 55 | 61 |
| 5 | 185 | 22 |
| 6 | 39 | 50 |
| 7 | 67 | 75 |
| 8 | 96 | 86 |
| 9 | 181 | 204 |
| 10 | 152 | 108 |
| 11 | 223 | 172 |
| 12 | 190 | 100 |
| 13 | 83 | 52 |
| 14 | 75 | 82 |

(a) How would you test the null hypothesis “fights between males with claws on the same side last longer than those between males with claws on opposite sides”? Give reasons for your answer. 5 marks

(b) Based on your answer above, test the null hypothesis and show your full working. 12 marks

(c) Do you reject or accept the null hypothesis? In plain language explain your interpretation of your results. 3 marks