Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

MARK SCHEME

Maximum Mark: 30

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Question	Answer	Mark	Additional Guidance
1(a)(i)	*independent:* concentration of potassium chloride / KC*l* **;** *dependent:* number of stomata open / closed **;**	**2**	**A** different concentrations of potassium chloride **A** number open and closed
1(a)(ii)	*three from:* correct volumes of water and KC*l* solution for making all four dilutions with units **;;** method of measuring volumes **;** *ref. to* stirring / mixing **;**	**3**	**A** *volumes either in descriptions or a table* *max 1 for correct volumes making 1, 2 or 3 dilutions*
1(b)(i)	*idea of:* the higher the concentration of (potassium chloride / KC*l*) the greater the number of stomata open / **ora** **or** the higher the concentration of (potassium chloride / KC*l*) the lower the number of stomata open / **ora** **or** the number of open stomata is directly proportional / inversely proportional to the concentration of potassium chloride / **ora ;**	**1**	***R*** *in terms of degree / speed of opening and closing of stomata e.g. more* KC*l* *the stomata are wider.* **A** a null hypothesis:

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Question	Answer	Mark	Additional Guidance
1(b)(ii)	*five from:* 1 *ref. to* putting the strips into (all KC*l*) solutions in appropriate containers **;** 2 *ref. to* keeping in the dark (when in solution) **;** 3 *ref. to* mounting on a slide **and** using a (light) microscope (to count / observe the number of stomata) **;** 4 *ref. to* count / record the number of stomata that are open or closed **;** 5 *ref. to* a method standardising the counting open / closed stomata **;** 6 *ref. to* making several counts on each leaf strip **and** taking a mean / to identify anomalies **;** *control variables max 2 (7–9)* 7 *ref. to* using suitable equipment for cutting **and** measuring strips (of same length and width / size / area) **;** 8 *ref. to* a method of maintaining a constant temperature **;** 9 covering to prevent evaporation **;** 10 *one of:* *ref. to* low risk **;** examples of hazard and precaution **;**	**5**	e.g. beakers, watch glasses, Petri dishes **R** test-tubes / boiling tubes / cavity slides **R** electron / electronic microscope / hand lens / magnifying glass e.g. out of the same fixed number of stomata **or** in field of view (at the same magnification) **A** a minimum of 3 counts on one strip **I** *ref. to* repeating whole experiment three times **R** metre rule **A** incubator / temperature controlled room / water-bath if appropriate to apparatus **R** no risk

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Question	Answer	Mark	Additional Guidance
1(c)(i)	*ref. to* using (eyepiece) graticule to measure (the aperture) ; *one from* calibrating the (eyepiece) graticule with a (stage) micrometer AW ; convert / calibrate the eye piece units to μm / mm ;	2	**R** if use graticule **and** stage micrometer to measure **A** *ref. to* converting eyepiece units using conversion / calibration factor
1(c)(ii)	*two (for one mark) from* time / min | stomatal aperture / μm 0 | 0.5 | 0.1 | 0.2 | 0.3 | 0.4 | 0.1 | 0.5 | 0.2 | 0.3 | 0.3 | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 60 | 0.9 | 1.1 | 1.0 | 1.3 | 1.2 | 1.8 | 1.5 | 0.8 | **0.2** | 1.3 | 1.1 | 0.8 | 1.0 | 1.9 | 0.9 120 | **1.9** | 2.4 | 2.6 | 2.6 | 2.5 | 2.2 | 2.8 | 2.4 | 2.4 | **3.9** | 2.6 | 2.3 | 2.5 | 2.2 | 2.7 180 | 4.1 | 4.8 | 4.2 | 4.0 | **5.7** | 4.7 | 3.9 | 4.1 | **5.5** | 4.5 | 4.3 | 4.0 | **3.1** | 4.1 | 4.3	1	
1(c)(iii)	0.035 ;	1	

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Question	Answer	Mark	Additional Guidance
1(c)(iv)	*three from* measure more stomata / all the stomata (per epidermal strip) ; select stomata to be measured randomly ; use more leaves / epidermal strips ; measure at shorter (time) intervals / more frequently ;	**3**	*if specify a number, should be 10 or more* **R** use different types of plant
1(d)	*idea that* the longer the time of light exposure the wider stomata open / the wider the aperture ;	**1**	**R** *idea of* different light intensity
	Total:	**19**	

Question	Answer	Mark	Additional Guidance
2(a)	*two (for one mark) from* number of fields studied ; (width of) the headland / strip ; (type of) cereal / crop ;	**1**	**A** length *if qualified by 6 m*
2(b)(i)	data is nominal / categoric **or** testing the difference between observed (O) and expected (E) results ;	**1**	**A** data can be grouped / is discrete
2(b)(ii)	there is no <u>significant difference</u> between number of butterflies of each species when headland sprayed and when not sprayed ;	**1**	**A** without herbicide / not treated / control *for not sprayed* **A** with herbicide / treated *for sprayed*

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Question	Answer	Mark	Additional Guidance
2(b)(iii)	<table><tr><th>species **Q**</th><th>O</th><th>E</th><th>$(O-E)^2$</th><th>$\frac{(O-E)^2}{E}$</th></tr><tr><td>number on headland sprayed with herbicide</td><td>3</td><td>20</td><td>289</td><td>14.45 ;</td></tr><tr><td>number on headland not sprayed with herbicide</td><td>37</td><td>20</td><td>289</td><td>14.45 ;</td></tr></table> $\chi^2 = 28.9$;	**3**	*if E is correct, but one row is processed incorrectly, allow ecf for correct addition to obtain χ^2 value* *max 2*
2(b)(iv)	3.84 ;	**1**	
2(b)(v)	significant (at $p < 0.001$) / herbicide is causing the number of butterflies to decrease ;	**1**	**ecf** *from errors in* ***(iii)*** *and / or* ***(iv)***
2(c)	*three from* 1 *idea that* where herbicide has been used there are fewer / smaller population of all species investigated ; 2 *idea of* (decrease / difference) in species **S** is only one that is not significant / **ora** ; 3 herbicide has greatest effect on the population of **R** (and **Q**) ; 4 *ref. to* the sequence of the severity of the effect of the herbicide ; 5 probability of the results being due to chance is less than 5% for all species except **S** (and **Q**) ;	**3**	sequence is (**R** >) V / W > T / U > S *if **R** included in the sequence allow mp3 and mp4* **A** probability of the result being due to herbicide is more than 95% for all species except **S**
	Total:	**11**	

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BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

MARK SCHEME

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Published

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1(a)(i)	*independent:* concentration of potassium chloride / KC*l* **;** *dependent:* number of stomata open / closed **;**	**2**	**A** different concentrations of potassium chloride **A** number open and closed
1(a)(ii)	*three from:* correct volumes of water and KC*l* solution for making all four dilutions with units **;;** method of measuring volumes **;** *ref. to* stirring / mixing **;**	**3**	**A** *volumes either in descriptions or a table* *max 1 for correct volumes making 1, 2 or 3 dilutions*
1(b)(i)	*idea of:* the higher the concentration of (potassium chloride / KC*l*) the greater the number of stomata open / **ora** **or** the higher the concentration of (potassium chloride / KC*l*) the lower the number of stomata open / **ora** **or** the number of open stomata is directly proportional / inversely proportional to the concentration of potassium chloride / **ora ;**	**1**	***R*** *in terms of degree / speed of opening and closing of stomata e.g. more* KC*l* *the stomata are wider.* **A** a null hypothesis:

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Question	Answer	Mark	Additional Guidance
1(b)(ii)	*five from:* 1 *ref. to* putting the strips into (all KC*l*) solutions in appropriate containers **;** 2 *ref. to* keeping in the dark (when in solution) **;** 3 *ref. to* mounting on a slide **and** using a (light) microscope (to count / observe the number of stomata) **;** 4 *ref. to* count / record the number of stomata that are open or closed **;** 5 *ref. to* a method standardising the counting open / closed stomata **;** 6 *ref. to* making several counts on each leaf strip **and** taking a <u>mean</u> / to identify anomalies **;** *control variables max 2 (7–9)* 7 *ref. to* using suitable equipment for cutting **and** measuring strips (of same length and width / size / area) **;** 8 *ref. to* a method of maintaining a constant temperature **;** 9 covering to prevent evaporation **;** 10 *one of:* *ref. to* low risk **;** examples of hazard and precaution **;**	**5**	e.g. beakers, watch glasses, Petri dishes **R** test-tubes / boiling tubes / cavity slides **R** electron / electronic microscope / hand lens / magnifying glass e.g. out of the same fixed number of stomata **or** in field of view (at the same magnification) **A** a minimum of 3 counts on one strip **I** *ref. to* repeating whole experiment three times **R** metre rule **A** incubator / temperature controlled room / water-bath if appropriate to apparatus **R** no risk

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Question	Answer	Mark	Additional Guidance
1(c)(i)	*ref. to* using (eyepiece) graticule to measure (the aperture) **;** *one from* calibrating the (eyepiece) graticule with a (stage) micrometer AW **;** convert / calibrate the eye piece units to μm / mm **;**	**2**	**R** if use graticule **and** stage micrometer to measure **A** *ref. to* converting eyepiece units using conversion / calibration factor
1(c)(ii)	*two (for one mark) from* time / min | stomatal aperture / μm 0 | 0.5 | 0.1 | 0.2 | 0.3 | 0.4 | 0.1 | 0.5 | 0.2 | 0.3 | 0.3 | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 60 | 0.9 | 1.1 | 1.0 | 1.3 | 1.2 | 1.8 | 1.5 | 0.8 | **0.2** | 1.3 | 1.1 | 0.8 | 1.0 | 1.9 | 0.9 120 | **1.9** | 2.4 | 2.6 | 2.6 | 2.5 | 2.2 | 2.8 | 2.4 | 2.4 | **3.9** | 2.6 | 2.3 | 2.5 | 2.2 | 2.7 180 | 4.1 | 4.8 | 4.2 | 4.0 | **5.7** | 4.7 | 3.9 | 4.1 | **5.5** | 4.5 | 4.3 | 4.0 | **3.1** | 4.1 | 4.3	**1**	
1(c)(iii)	<u>0.035</u> **;**	**1**	

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Question	Answer	Mark	Additional Guidance
1(c)(iv)	*three from* measure more stomata / all the stomata (per epidermal strip) ; select stomata to be measured randomly ; use more leaves / epidermal strips ; measure at shorter (time) intervals / more frequently ;	**3**	*if specify a number, should be 10 or more* **R** use different types of plant
1(d)	*idea that* the longer the time of light exposure the wider stomata open / the wider the aperture ;	**1**	**R** *idea of* different light intensity
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Question	Answer	Mark	Additional Guidance
2(a)	*two (for one mark) from* number of fields studied ; (width of) the headland / strip ; (type of) cereal / crop ;	**1**	**A** length *if qualified by 6 m*
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2(b)(ii)	there is no <u>significant difference</u> between number of butterflies of each species when headland sprayed and when not sprayed ;	**1**	**A** without herbicide / not treated / control *for not sprayed* **A** with herbicide / treated *for sprayed*

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2(b)(iii)	<table><tr><th>species **Q**</th><th>O</th><th>E</th><th>$(O-E)^2$</th><th>$\frac{(O-E)^2}{E}$</th></tr><tr><td>number on headland sprayed with herbicide</td><td>3</td><td>20</td><td>289</td><td>14.45 ;</td></tr><tr><td>number on headland not sprayed with herbicide</td><td>37</td><td>20</td><td>289</td><td>14.45 ;</td></tr></table> $\chi^2 = 28.9$;	**3**	*if E is correct, but one row is processed incorrectly, allow ecf for correct addition to obtain* χ^2 *value* *max 2*
2(b)(iv)	3.84 ;	**1**	
2(b)(v)	significant (at $p < 0.001$) / herbicide is causing the number of butterflies to decrease ;	**1**	**ecf** *from errors in* ***(iii)*** *and / or* ***(iv)***
2(c)	*three from* 1 *idea that* where herbicide has been used there are fewer / smaller population of all species investigated ; 2 *idea of* (decrease / difference) in species **S** is only one that is not significant / **ora** ; 3 herbicide has greatest effect on the population of **R** (and **Q**) ; 4 *ref. to* the sequence of the severity of the effect of the herbicide ; 5 probability of the results being due to chance is less than 5% for all species except **S** (and **Q**) ;	**3**	sequence is (**R** >) V / W > T / U > S *if* ***R*** *included in the sequence allow mp3 and mp4* **A** probability of the result being due to herbicide is more than 95% for all species except **S**
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Question	Answer	Mark	Additional Guidance
1(a)(i)	*independent:* <u>concentration</u> of calcium chloride / $CaCl_2$; *dependent:* number of stomata closed / open ;	2	**A** closing / opening *for closed / open* **I** percentage
1(a)(ii)	serial dilution ;	1	**A** description **I** simple / standard dilution, or description of **I** proportional dilution
1(b)(i)	*idea of* the higher the concentration (of, calcium chloride / $CaCl_2$,) the greater the, number / percentage / proportion, of stomata that are closed / **ora** ;	1	*hypothesis must be testable and not repeat information given in question* **A** *idea that,* the number / proportion / percentage of closed stomata is (directly) proportional to the conc. of $CaCl_2$ **A** as $CaCl_2$ concentration increases more stomata close **ora** **A** a null hypothesis: different / changing concentrations of $CaCl_2$ have no (significant) effect on the number / proportion / percentage of, closed / open, stomata

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Question	Answer	Mark	Additional Guidance
1(b)(ii)	*five from* 1 *ref. to* putting (epidermal) strip(s) in the (different) solutions in appropriate containers **;** 2 *ref. to* keeping in the light (for the investigation) **;** 3 *ref. to* using a (light) microscope (to observe the stomata) **;** 4 count / record, (the number of / how many), closed / open stomata **;** 5 *ref. to* standardising the counting **;** 6 *ref. to* making **several** counts on **at least one** epidermal strip **and** taking a mean / to identify anomalies **;** 7 *max 2 for control variables (mps 7 – 9)* 8 *ref. to* using suitable equipment for cutting **and** measuring strips (to same size) ; 9 *ref. to* method achieving constant temperature **;** 10 *ref. to* method of preventing evaporation **;** 11 *one of* *ref. to* low risk **;** allergy to leaves / plants **and** wearing gloves / goggles **;** $CaCl_2$ irritant **and** avoid swallowing / wearing gloves / goggles **;** care when cutting with scalpel **and** cut on tile and away from, hand / body **;**	**5**	**A** named solutions **A** e.g. beakers, watch glasses, Petri dishes, test tubes, boiling tubes, measuring cylinders, (microscope) slide / cavity slide **I** *ref. to* volume of solution **I** *ref. to* time **A** in dark room with fixed light **R** electron / electronic microscope **I** calculate / observe if a number of counts is given it must be a minimum of 3 **I** average **A** mean average **I** repeat / replicate, the experiment *unqualified* e.g. scalpel or scissors **and** ruler / calipers **I** metre ruler e.g. incubator, temperature controlled room, water bath to keep temperature constant e.g. lid / film / coverslip (if slide) AW **R** no risk **I** allergy to $CaCl_2$ **I** scissors

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Question	Answer	Mark	Additional Guidance
1(c)(i)	*two (for 1 mark) from* (same calibrated eyepiece) graticule used ; (same) microscope ; (same) magnification ;	1	**A** same calibration for measuring **I** stage micrometer **I** same apparatus / method of measuring **I** random selection of stomata
1(c)(ii)	$0.75 / 7.5 \times 10^{-1}$ (μm) ;	1	**I** ¾

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Question	Answer	Mark	Additional Guidance
1(d)(i)	*one from* 1 up to / at, 0.001 μmol dm^{-3} ABA / initially / at first, upper epidermis mean has increased / not changed , lower epidermis has decreased **;** 2 lower epidermis responds at 0.001 μmol dm^{-3}, ABA upper epidermis responds at 0.01 μmol dm^{-3} ABA **;** 3 confidence intervals / error bars, do not overlap (until 1.00 μmol dm^{-3} ABA) **;** 4 stomata on upper epidermis have wider aperture at, all / increasing, concentrations of ABA (until 1.00 μmol dm^{-3} ABA) **;**	**1**	*idea that* upper epidermis at 0.001 μmol dm^{-3} has not decreased while lower epidermis has decreased lower epidermis (starts to) responds at lower concentrations of ABA ; **I** standard deviation / standard error **I** *ref. to* one stated ABA concentration **I** *ref. to* one stated ABA concentration **I** longer / shorter / higher, aperture / stomata **A** longer / shorter, diameter / width
1(d)(ii)	*one from* *definition*: e.g. the confidence limits are, the range / interval, in which the true value of the mean lies, with 95% probability / chance **;** *idea of* the true / AW, mean, lies within, ±, $2 \times S_M$ / SE, with 95% probability / chance **;** *idea of* the (calculated) mean is close to the true / actual mean **;** shows the reliability of the (calculated) mean **;** (the confidence intervals are small) so data is reliable **;** (the confidence limits do not overlap) so data is reliable **;**	**1**	*this must be a clear statement* **A** 95% confident / sure / certain, that the true / actual / population mean lies within this range **I ora** for 5% **I** 95% reliable

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Question	Answer	Mark	Additional Guidance
1(d)(iii)	*t*–test **;** data has a normal distribution / comparing the <u>means</u> of two samples **;**	**2**	*if test not correct allow reason if correct for stated test **and** t–test e.g. Pearson's linear correlation because gave normal distribution* **A** comparing two means / comparing a pair of means / to see if two means are different **A** data is continuous / not discrete **I** continuous variation
1(e)	*four from*: 1 large number of stomata / 50 stomata (from each epidermal surface) (for each ABA concentration) **;** 2 (left for) the same time / left for <u>2 hours</u> ; 3 same age of leaf / young leaves used **;** 4 describe how one (stated) environmental condition <u>is</u> controlled **;** 5 *ref. to* how one stated method of measurement has been standardised **;** 6 random selection of stomata (to avoid bias) **;**	**4**	**I** *ref. to* confidence intervals **I** large sample size unqualified **A** 10 stomata from each (epidermal) strip **I** time unqualified **A** seedling leaf / leaves just expanded **either** carbon dioxide-free air **or** pH by buffer **I** 'ensure no carbon dioxide in environment' calibrated, eye piece / graticule **or** same microscope **or** same magnification
	Total:	**19**	

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Question	Answer	Mark	Additional Guidance
2(a)(i)	*four from* **either** 1 *idea of* making extracts of couch grass roots, of different ages / grown for different times / 14 days old / old(er) root(s) **;** 2 grow barley (grains / young plants), supplied with (water containing) extract / has extract added **;** 3 grow (another) set of barley (grains / young plants), (supplied with water) without extract **;** **or** 1 grow couch grass for different times / to different ages / to 14 days / until older, **and** remove couch grass / cut off grass shoots **;** 2 grow barley (grains / young plants) where couch grass has been previously grown and removed / where couch grass shoots had been cut off leaving roots **;** 3 grow (another) set of barley (grains / young plants) on its own / where couch grass has not been grown **;** **then** 4 *ref. to* at least one standardised (environmental) condition **;** 5 measure / record, length / (dry) mass, of barley roots **;** 6 *idea of* compare / analyse statistically, the length / (dry) mass / growth, of the barley roots **;**	**4**	**I** *where barley / couch grass is grown, e.g. field, green house, plot, pot, paper in petri dish etc.* **A** extracts from separately sown couch grass **or** from couch grass from original experiment 2 **A** experiment 4 acts as / is, a control **A** *idea of* repeating experiment 2 but removing couch grass before barley is planted **A** *idea of* growing barley where only the roots are left **A e**xperiment 4 acts as / is, a control **A** e.g. same watering / temperature / light / humidity / time / nutrients / minerals **I** growth *unqualified* **I** measurement before investigation **I** compare growth of barley *unqualified* **I** chi squared test *must be clear that they have at least two treatments / values to compare*

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Question	Answer	Mark	Additional Guidance
2(a)(ii)	*one from* 1 *idea that* established / older couch grass, is (better) competitor than barley for stated resources (light / minerals / water / space) / **ora ;** 2 *idea that* by the time barley is grown couch grass has depleted stated soil resources (light / minerals / water / space) **ora ;** 3 *idea of* older couch spreads a, disease / herbivore, to barley **;** 4 *idea of* older couch produces a substance that inhibits / slows the germination of barley **;** 5 *idea of* older couch grass changes the pH of the soil **;**	**1**	**A** nutrients **I** nutrition **I** resources *unqualified* **A** nutrients **I** nutrition **I** resources *unqualified* **A** something that eats barley lives, in / on, older couch grass
2(a)(iii)	there is no significant difference between yield of barley grown with couch grass and, barley grown without couch grass **;**	**1**	**A** there is no significant difference between yield of, barley grown with couch grass / experiment(s) 1 / 2 / 3, and, (the yield of) the control / experiment 4 **A** no significant decrease / increase in yield when couch grass is present compared to when couch grass is not present

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Question	Answer	Mark	Additional Guidance
2(b)(i)	correct calculation for **both** ground beetles **;** ground beetles | 20 | <u>0.181</u> | 45 | <u>0.012</u> correct addition of **both** columns in table 2 **;** total | 47 | 0.300 | 414 | 0.188 *correct values for both values of D* with pesticides $D = 0.700$ **and** without pesticides $D = \underline{0.812}$ **;**	**3**	**ecf** *for wrong values for ground beetles* **A** 0.7 / 0.70 **ecf** *from wrong totals*

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<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>2(b)(ii)</td><td>two from
1 the use of pesticides reduces the numbers of all, the organisms / individuals / plants and animals ;

2 either the, biodiversity / species diversity, is reduced

or idea that D / diversity index / biodiversity / species diversity, does not appear to be much affected / only changed by 0.112 ;

3 either use of processed data to describe percentage decrease in any one group

or idea of beetles are less affected / have a much lower percentage decrease ;

4 bees (appear to have been) completely lost ;
5 idea that data collected is grouped, so cannot tell if any specific species has been lost ;
6 idea of reason for decline in, birds / small mammals , due to effect on food chain / non-specific nature of pesticides / herbicides ;</td><td>2</td><td>must be in terms of effect of pesticides causing the decrease
A pesticides decrease the number of organisms
I ora e.g. number of individuals in fields without pesticides is higher
A species richness
I diversity / D /, is reduced for either
I diversity for or

<table><tr><th>organism</th><th>percentage drop</th></tr><tr><td>dicot</td><td>95</td></tr><tr><td>monocot</td><td>88</td></tr><tr><td>beetles</td><td>56</td></tr><tr><td>butterflies and moths</td><td>89</td></tr><tr><td>bees</td><td>100</td></tr><tr><td>mammals</td><td>87</td></tr><tr><td>birds</td><td>94</td></tr><tr><td>total</td><td>89</td></tr></table></td></tr>
<tr><td></td><td>Total:</td><td>11</td><td></td></tr>
</table>

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