

Analysis of pH, Cress Weight, Cress Germination and Maturity Index for Changes Over Time

One area of interest CWMI and stakeholders hoped the Marketing and Labeling Project would address is whether important factors that affect compost quality – such as pH, cress weight, cress germination, and maturity – change over time. This is important because compost consumers need a product that is uniform and does not change, especially if the buyer has a specific use in mind for the compost, such as potting soil or as an ingredient for seed starter mix. To examine this aspect of compost quality, CWMI asked the question, “Do selected compost parameters change over time on NYS compost producing farms?”

To answer this, a statistical procedure called a **t-test** was used to analyze data from each farm in the Marketing and Labeling Project. Because an analysis over time requires two separate sets of samples, only farms that had more than one date of sample collection were used. Overall, 25 farms met this criteria; 17 dairy operations and 4 poultry operations. Dairy samples were collected from several farms producing compost made from separated manure, and the rest were taken at operations using un-separated manure.

The statistical procedure carried out for each farm consisted of a three-step process. First, the variance (a measure of how far data are spread about the mean) of sample sets collected at two points in time, day X (first sampling date) and day Y (last sampling date), were calculated. Next, the larger variance calculated in step 1 was divided by the smaller variance, producing a value called **Hartley’s test statistic**. This was calculated for each farm using pH, cress weight, cress germination, and maturity data (see tables 1 through 4). Statistical convention states that if Hartley’s test statistic is less than three, one can assume that the variances of sample sets analyzed are equal, and if it is more than three, variances are unequal – important to know for the last step of analysis.

In the last step, each farm was analyzed for changes over time in pH, cress weight, cress germination, and maturity using one of two types of t-test. If a farm’s Hartley value for a given parameter was less than three, a t-test assuming equality of variance was performed. If the Hartley value was greater than three a t-test assuming unequal variance was carried out. This is important because a t-test can compensate for errors that can occur if two data sets are analyzed assuming equal variance, but in fact do not. For a complete summary of t-test results, see tables 5 through 8.

Change Over Time - pH

		t Statistic	Critical Value	Result	value @ T1	value @ T2
<i>Dairy Farms</i>						
<i>1</i>	<i>15VA</i>	6.38	2.353	change	7.22	7.06
<i>2</i>	<i>17CFS</i>	-0.19	-2.015	no change		
<i>3</i>	<i>16ME</i>	1.62	2.132	no change		
<i>4</i>	<i>2B</i>	-0.21	-1.943	no change		
<i>5</i>	<i>4G</i>	5.99	6.314	no change		
<i>6</i>	<i>29SH</i>	4.85	2.920	change	8.46	7.97
<i>7</i>	<i>11KN</i>	-0.06	-2.132	no change		
<i>8</i>	<i>22J</i>	0.79	2.353	no change		
<i>9</i>	<i>13BE</i>	1.62	2.353	no change		
<i>10</i>	<i>14EW</i>	-1.86	-2.132	no change		
<i>11</i>	<i>7WA</i>	-0.81	2.353	no change		
<i>13</i>	<i>3F</i>	0.00	6.314	no change		
<i>14</i>	<i>8WI</i>	-0.09	-1.943	no change		
<i>15</i>	<i>1A</i>	0.27	6.314	no change		
<i>16</i>	<i>5H</i>	-1.56	-6.314	no change		
<i>17</i>	<i>26KW</i>	-6.00	-2.353	change	7.72	7.95
<i>18</i>	<i>25P</i>	2.21	2.353	no change		
Poultry Farms						
<i>19</i>	<i>12AC</i>	0.03	2.132	no change		
<i>22</i>	<i>24WG</i>	-10.89	-2.353	change	9.05	9.26
<i>24</i>	<i>18BR</i>	0.51	2.353	no change		
<i>25</i>	<i>9K</i>	7.95	2.353	change	8.34	8.27

Table 5. Results of statistical analysis using t-tests to examine change over time in pH values for dairy farms and poultry farms participating in Market and Labeling Project.

Change Over Time – Cress Weight

		t Statistic	Critical Value	Result	value @ T1	value @ T2
<i>Dairy Farms</i>						
1	15VA	-0.36	-2.132	no change		
2	17CFS	1.66	1.943	no change		
3	16ME	-0.20	-2.132	no change		
4	2B	2.01	1.943	change	88.25	85.50
5	4G	-14.41	-2.920	change	86.50	128.5
6	29SH	2.00	2.920	no change		
7	11KN	2.38	2.132	change	118.75	89.00
8	22J	0.02	2.920	no change		
9	13BE	4.12	2.353	change	91.25	63.00
10	14EW	0.48	2.132	no change		
11	7WA	2.98	2.353	change	98.50	83.33
13	3F	15.367	6.314	change	91.50	57.00
14	8WI	-0.41	-1.943	no change		
15	1A	5.50	6.314	no change		
16	5H	5.82	2.920	change	73.00	52.00
17	26KW	-0.89	-2.353	no change		
18	25P	0.21	2.920	no change		
Poultry Farms						
19	12AC	4.67	2.132	change	87.00	60.00
22	24WG	3.87	2.353	change	64.67	53.00
24	18BR	0.10	2.353	no change		
25	9K	-0.13	-2.132	no change		

Table 6. Results of statistical analysis using t-tests to examine change over time in Cress weight for dairy farms and poultry farms participating in Market and Labeling Project.

Change Over Time – Cress Germination

		t Statistic	Critical Value	Result	value @ T1	value @ T2
<i>Dairy Farms</i>						
<i>1</i>	<i>15VA</i>	4.02	2.353	change	105.00	101.00
<i>2</i>	<i>17CFS</i>	0.08	2.015	no change		
<i>3</i>	<i>16ME</i>	2.93	2.132	change	101.50	94.00
<i>4</i>	<i>2B</i>	0.72	1.943	no change		
<i>5</i>	<i>4G</i>	-0.69	-6.314	no change		
<i>6</i>	<i>29SH</i>	8.49	2.353	change	98.67	89.00
<i>7</i>	<i>11KN</i>	1.25	2.132	no change		
<i>8</i>	<i>22J</i>	1.46	2.353	no change		
<i>9</i>	<i>13BE</i>	0.56	2.132	no change		
<i>10</i>	<i>14EW</i>	0.85	2.132	no change		
<i>11</i>	<i>7WA</i>	2.54	2.353	change	96.50	88.33
<i>13</i>	<i>3F</i>	0.78	2.920	no change		
<i>14</i>	<i>8WI</i>	1.54	2.943	no change		
<i>15</i>	<i>1A</i>	-1.19	-6.314	no change		
<i>16</i>	<i>5H</i>	-2.61	-6.314	no change		
<i>17</i>	<i>26KW</i>	-1.73	-2.920	no change		
<i>18</i>	<i>25P</i>	1.80	2.353	no change		
Poultry Farms						
<i>19</i>	<i>12AC</i>	1.69	2.353	no change		
<i>22</i>	<i>24WG</i>	4.31	2.353	change	101.33	89.50
<i>24</i>	<i>18BR</i>	0.79	2.290	no change		
<i>25</i>	<i>9K</i>	2.19	2.132	change	37.50	13.50

Table 7. Results of statistical analysis using t-tests to examine change over time in Cress germination for dairy farms and poultry farms participating in Market and Labeling Project.

Change Over Time – Maturity

		t Statistic	Critical Value	Result	value @ T1	value @ T2
<i>Dairy Farms</i>						
1	15VA	0.00	0.00	no change		
2	17CFS	12.34	2.02	change	6.88	6.00
3	16ME	*	*	*		
4	2B	0.00	0.00	no change		
5	4G	0.00	0.00	no change		
6	29SH	-2.05	-2.353	no change		
7	11KN	-0.63	-2.353	no change		
8	22J	-0.89	-2.353	no change		
9	13BE	12.00	2.353	change	5.75	5.00
10	14EW	-20.00	-2.353	change	5.75	5.00
11	7WA	0.00	0.00	no change		
13	3F	*	*	*		
14	8WI	21.164	2.015	change	5.13	6.00
15	1A	1.34	2.920	no change		
16	5H	2.00	6.314	no change		
17	26KW	0.29	2.353	no change		
18	25P	-1.46	-2.353	no change		
Poultry Farms						
19	12AC	-4.00	-2.353	change	6.75	7.00
22	24WG	-1.39	-6.314	no change		
24	18BR	0.70	2.353	no change		
25	9K	0.73	2.132	no change		

Table 8. Results of statistical analysis using t-tests to examine change over time in maturity for dairy farms and poultry farms participating in Market and Labeling Project.

* Statistical inference is not possible because neither sample group has variance.

Change Over Time – Organic Matter

		t Statistic	Critical Value	Result	value @ T1	value @T2
<i>Dairy Farms</i>						
<i>1</i>	<i>15VA</i>	-0.779	-1.533	no change		
<i>2</i>	<i>17CFS</i>	5.042	1.415	change	48.61	39.75
<i>3</i>	<i>16ME</i>	-0.533	-3.078	no change		
<i>4</i>	<i>2B</i>	7.068	1.368	change	25.15	17.10
<i>5</i>	<i>4G</i>	-2.900	-1.533	change	23.85	26.30
<i>6</i>	<i>29SH</i>	3.474	1.886	change	37.00	33.05
<i>7</i>	<i>11KN</i>	-0.531	-1.533	no change		
<i>8</i>	<i>22J</i>	-0.869	-1.638	no change		
<i>9</i>	<i>13BE</i>	0.340	1.533	no change		
<i>10</i>	<i>14EW</i>	3.369	1.638	change	34.20	18.95
<i>11</i>	<i>7WA</i>	-2.222	-1.886	change	34.85	39.53
<i>13</i>	<i>3F</i>	1.833	3.078	no change		
<i>14</i>	<i>8WI</i>	-9.569	-1.476	change	58.50	44.95
<i>15</i>	<i>1A</i>	0.686	3.078	no change		
<i>16</i>	<i>5H</i>	0.958	1.638	no change		
<i>17</i>	<i>26KW</i>	-0.158	-1.886	no change		
<i>18</i>	<i>25P</i>	13.371	3.078	change	80.60	57.70
Poultry Farms						
<i>19</i>	<i>12AC</i>	2.522	1.533	change	24.80	22.50
<i>22</i>	<i>24WG</i>	-1.633	-1.886	no change		
<i>24</i>	<i>18BR</i>	0.451	1.638	no change		
<i>25</i>	<i>9K</i>	0.495	3.078	no change		

Table 9. Results of statistical analysis using t-tests to examine change over time in maturity for dairy farms and poultry farms participating in Market and Labeling Project.

* Statistical inference is not possible because neither sample group has variance.