A Program for Determining Cocompost Blending Ratios

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■ A program is presented that computes blending ratios for two ingredients of a cocompost. The program is written in the RPN language, requires 61 lines of memory, and will support hand-held programmable calculators, making it suitable for use in the field. Use of this program allows the composter to determine blending ratios quickly and with increased precision and accuracy.

When horticulturists make their own compost, they usually learn very quickly that certain kinds of organic material compost more quickly than other kinds[2]. There are numerous, observable, parameters that influence the rate of composting (Table 1) and many of these can be conveniently and accurately measured. One important parameter which is relatively difficult to measure is the carbon to nitrogen ratio (C:N). If the other parameters are within optimum ranges, suboptimum or supra-optimum C:N can slow down the composting process significantly or cause compost management problems including generation of objectionable odors. Typical C:N ranges for many organic substances are given in Table 2, and it can readily be seen that many substrates that could be useful in composting are not within the optimum range for this important parameter[3].

One means by which organic materials that have a C:N outside the optimum range can be more efficiently composted is by mixing materials so that the mixture or cocompost, is within the optimum range. This practice has been used by commercial scale composters to successfully compost difficult substrates, such as sewage sludges, shellfish residues, and poultry carcasses.

The procedure for computing blending ratios for two ingredients in a cocompost requires the use of two equations, one to determine the C:N of the blend, and the second to determine the moisture level of the blend. The second equation is necessary to ensure that the C:N ratio selected does not result in a mixture that has too little or too much moisture, which can in itself, cause substantial management problems, including slow composting rates and anaerobic conditions in the pile.

The equations necessary to determine the ingredient ratios and their moisture contents are straight forward, but can involve complex manipulation of numbers[3]. For example, if a particular combination has an acceptable C:N but an unacceptable moisture level, the composter would normally select a different C:N within the range of acceptable values, recompute the blending ratios and recompute the moisture level of that particular blend until a ratio was found that would yield acceptable ranges for both parameters. The repeated manual computation and recomputation of blending ratios can be avoided by the use of a program. Moreover, using a program can drastically reduce the potential for computational errors, reduce the time necessary for computation, and increase the precision of calculation.

Various spreadsheets are available which can be used to compute these values with a personal computer. However, some composters may not have access to computers, and programmable battery-operated calculators can be more suitable for use in the field since the user can make calculations and corrections on-site, thereby increasing efficiency and allowing optimum ratio determinations to be more quickly implemented.

The program described here uses the RPN language[1,4] to compute S, the number of pounds of an ingredient (A) that must be added to 1.0 pound of a second ingredient (B) in order to achieve a particular C:N and to compute MC, the moisture content of the mixture, using the following equations:

$$S = \frac{(\text{C in 1.0 lb of B}) - (\text{Desired C:N})(\text{N in 1.0 lb of B})}{(\text{N in 1.0 lb of A})(\text{Desired C:N}) - (\text{C in 1.0 lb of A})}$$

$$MC = \frac{(\text{Wt. } H_2O\text{, A}) + (\text{Wt. } H_2O\text{, B})}{\text{Total Wt.}}$$

It is designed to be entered on the Hewlett-Packard HP 32SII programmable calculator but with minor transcriptional changes, will work on calculators made by other manufacturers. The program is entered on the calculator and will be stored, even after the calculator is turned off, and the program will not interfere with other calculator functions.

The program is listed on Table 3 and requires that the user key in certain data, including the desired C:N, % moisture of ingredient A, C:N of ingredient A, % nitrogen of ingredient A (the program determines % carbon by subtraction), % moisture of ingredient B, C:N of ingredient B, and the % nitrogen of ingredient B. The program, as listed, solves the equations at a very small quantity level. However, the user can apply multiples to compute quantity mixtures appropriate to any size composting operation. For example, if 0.982 pounds of hardwood chips are prescribed to be added to 1.0 pound of activated sewage sludge to get a C:N of 35 and a MC of 55.2%, the 0.982 can be multiplied by 1,000, and 982 pounds of chips added to 1,000 pounds of sludge. The resulting C:N and MC would still be 35 and 55.2%, respectively.

TABLE 1. Suggested optimum ranges of parameters for composting

Parameter	Optimum range
pH	6.0 - 8.5
Moisture content	40 - 65%
Oxygen content	5 - 15%
Particle size	0.1 - 2 inches
C:N	25:1 - 35:1

TABLE 2. Typical percent moisture content, percent carbon, percent nitrogen and carbon to nitrogen ratios for selected organic materials (Rynk *et. al.*[3])

Material	% moisture content	% carbon	% nitrogen	C:N
Mussel waste	63	7.9	3.6	2.2
Fish waste	76	38.2	10.6	3.6
Crab waste	47	29.9	6.1	4.9
Poultry carcasses	65	12.0	2.4	5
Activated sewage sludge	80	33.6	5.6	6
Broiler litter	37	37.8	2.7	14
Swine manure	80	43.4	3.1	14
Garbage	69	36.0	2.4	15
Digested sewage sludge	80	30.4	1.9	16
Grass clippings	82	57.8	3.4	17
Vegetable produce	87	51.3	2.7	19
Horse stable waste	63	49.2	1.2	41
Leaves	38	48.6	0.9	54
Corn cobs	15	58.8	0.6	98
Rice hulls	14	36.3	0.3	121
Wheat straw	15	50.8	0.4	127
Paper, domestic refuse	19	30.6	0.2	153
Hardwood chips & shavings	30	50.4	0.09	560
Corrugated cardboard	8	56.3	0.1	563
Softwood chips & shavings	30	57.7	0.09	641

TABLE 3. A program to compute co-compost blending ratios to achieve a specified C:N and a specified moisture level, in the RPN language, for use on the Hewlett-Packard HP 32SII programmable calculator

Keystroke	Display	
LBL A	A01	LBL A
1	A02	1
Enter	A03	Enter
RCL B	A04	RCL B
—	A05	—
STO H	A06	STO H
1	A07	1
Enter	A08	Enter
RCL E	A09	RCL E
—	A10	—
STO K	A11	STO K
RCL F	A12	RCL F
Enter	A13	Enter
RCL G	A14	RCL G
X	A15	X
RCL K	A16	RCL K
X	A17	X
STO N	A18	STO N
RCL G	A19	RCL G
Enter	A20	Enter
RCL K	A21	RCL K
X	A22	X
RCL A	A23	RCL A
X	A24	X
RCL N	A25	RCL N
—	A26	—
STO O	A27	STO O
RCL A	A28	RCL A
Enter	A29	Enter
RCL D	A30	RCL D
X	A31	X
RCL H	A32	RCL H
X	A33	X
STO P	A34	STO P
RCL C	A35	RCL C
Enter	A36	Enter
RCL D	A37	RCL D
X	A38	X
RCL H	A39	RCL H
X	A40	X
RCL P	A41	RCL P
—	A42	—
RCL O	A43	RCL O
÷	A44	÷
STO P	A45	STO P
RTN	A46	RTN
LBL B	B01	LBL B
RCL P	B02	RCL P
Enter	B03	Enter
1	B04	1
+	B05	+
STO Q	B06	STO Q
RCL P	B07	RCL P
Enter	B08	Enter
RCL E	B09	RCL E
X	B10	X
RCL B	B11	RCL Q
+	B12	+
RCL Q	B13	RCL Q
÷	B14	÷
RTN	B15	RTN
PRG	0.00	

A Sample Calculation

How many pounds of hardwood chips and shavings would have to be added to one pound of activated sewage sludge to have a C:N of 30 for the blend? For this example, use the typical values listed on Table 2: hardwood chips and shavings with MC = 30%, C:N = 560, % nitrogen = 0.09%; activated sewage sludge with MC = 80%, C:N = 6, % nitrogen = 5.6%.

Enter the desired C:N, 30, and press STO A; enter the moisture content of the activated sewage sludge as a decimal fraction, 0.80, and press STO B; enter the C:N of the activated sewage sludge, as a whole number (6:1 = 6), 6, and press STO C; enter the percent nitrogen of the activated sewage sludge, as a decimal fraction, 0.056, and press STO D; enter the moisture content of the hardwood chips, as a decimal fraction, 0.30, and press STO E, enter the C:N of the hardwood chips, as a whole number (560:1 = 560), 560, and press STO F; and enter the percent nitrogen of the hardwood chips, as a decimal fraction, 0.0009, and press STO G. Then press the XEQ key, then the A key. The word "running" will appear on the display briefly, followed by the number 0.805. This means that 0.805 pounds of hardwood chips should be added to 1.0 pound of activated sewage sludge for the mixture to have a C:N of 30. Next, press the XEQ key, and the B key. The word "running" will appear briefly, followed by the number 0.577. This means that the indicated mixture will have a moisture content of 57.7%.

If the composter wanted to evaluate a mixture that would yield a different C:N, it would not be necessary to re-enter all new data. The new C:N would be entered into storage register A, and the remaining registers would retain the previously entered data. For example, to determine the ratios that would yield a C:N of 35, enter 35 and press STO A. Then press XEQ key, then the A key. The word "running" will appear on the display briefly, followed by the number 0.982. This means that 0.982 pounds of hardwood chips would have to be added to 1.0 pound of activated sewage sludge for the mixture to have a C:N of 35. Next press the XEQ key, then the B key. The word "running" will appear briefly, followed by the number 0.552. This means that the indicated mixture will have a moisture content of 55.2%. The composter can manipulate the various factors in the blending equations in order to generate the most optimum blending ratios.

Acknowledgement

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References

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Table 4. Directions for computing the blending ratio of 2 ingredients to achieve a specified C:N and a specified moisture level, using a Hewlett- Packard HP 32SII programmable calculator

Step	Instructions	Keystrokes	Output data
1	If the calculator has been programmed, go to step 4. If not, switch into program mode.	⬅ PRGM	
2	Key in the program (Table 3)		
3	Switch calculator into run mode.	⬅ PRGM	
4	Enter the desired C:N	STO A	
5	Enter the % moisture content of ingredient A, as a decimal fraction (i.e., 70% = 0.7)	STO B	
6	Enter the C:N of ingredient A, as a whole number (i.e., 10:1 = 10)	STO C	
7	Enter the % N content of ingredient A, as a decimal fraction (i.e., 6% = 0.06)	STO D	
8	Enter the % moisture content of ingredient B, as a decimal fraction	STO E	
9	Enter the C:N of ingredient B, as a whole number	STO F	
10	Enter the % N content of ingredient B, as a decimal fraction	STO G	
11	Press XEQ key, then press key A		Number of pounds of ingredient B needed per pound of ingredient A
12	Press XEQ key, then press key B		Moisture content of the blend, expressed as a fraction