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TESTS TO DETERMINE WHEAT STRAW DECOMPOSITION[1]

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ABSTRACT

Crop residues are important for erosion control and maintaining soil fertility, but these residues could also be used for other purposes. To determine the amount of excess residues available for other uses, we need a simple, accurate method to measure residue decomposition. Three methods were evaluated to determine residue losses by decomposition. Wheat (*Triticum aestivum* L.) straw was enclosed in nylon envelopes, buried 6 cm deep in a loam soil in greenhouse benches, and recovered periodically during 9 months. Assays for acriflavine (acriflavine hydrochloride) adsorption on 0.1 *N* NaOH-extractable humic materials, light absorption of the extracted humic materials, and the force necessary to break the straw were compared with weight loss by decomposition.

Light absorption and break force were linearly related to residue loss with regression coefficients of − 0.95 and − 0.92, respectively. Break force approached zero after 2 months. Acriflavine adsorption was poorly related to straw loss. The light-absorption technique may be used to measure decomposition of crop residues freely mixed within the soil once the relationships between percent transmittance and loss by decomposition are established.

Additional index words: **Acriflavine absorption, Residue loss, Humic materials, Break force, Light absorption, *Triticum aestivum* L.**

RESIDUES produced by crops like wheat (*Triticum* spp.), corn (*Zea mays* L.), sugarcane (*Saccharum officinarum* L.), and rice (*Oryza sativa* L.) are important for controlling erosion and maintaining soil fertility, but these residues could be used as fuel, paper pulp, and livestock feed (1). Before we can determine amounts of residues available for other uses, we must determine amounts that must be maintained on or in the soil to control wind and water erosion, decrease nutrient loss, and maintain soil productivity under all cropping systems. A simple, accurate method of measuring residue decomposition would aid in determining amounts of residue required for soil conservation and amounts available for other uses.

Previous measurements of residue decomposition have used weighed samples in wire or plastic netting that were placed in or on the soil, then later recovered and weighed to determine field losses (2, 3, 4, 7, 9, 10). This method requires many large samples, much time and labor, and cannot be used with residues mixed freely in the soil.

The research reported here evaluated one mechanical and two chemical tests for effectively estimating winter wheat straw losses due to decomposition.

MATERIALS AND METHODS

Winter wheat (*Triticum aestivum* L.) stubble was pulled from the soil immediately after grain harvest, leaves were removed, and straws were cut to 25 cm lengths by removing the roots. Ten straws were weighed, placed in plastic net envelopes, and buried 6 cm deep in an uncultivated loam soil in the greenhouse. When the soil at the residue level dried to 60% of field capacity by evaporation, the soil was surface irrigated with tap water to field capacity. Air temperature was maintained at about 20 C.

Thirty-nine envelopes were recovered at each sample date after 0, 1, 2, 3, 5, 7, and 9 months of burial. Their contents were washed, air-dried, weighed, break force recorded, ground (< 40 mesh), and assayed for acriflavine adsorption and light absorption.

Break force was determined by measuring the force needed to break each straw at the midpoint after it was placed horizontally across two points spaced 15.5 cm apart. Force was applied by a 2-mm wide plate attached to a 1-cm² beam, 15 cm long, equipped with strain gages. The strain gage signal was recorded by a Daytronic 300 D transducer amplified with type-90 strain gage module and a Texas Instruments millivolt recorder[3].

Acriflavine adsorption and light absorption were determined by the method described by Pauli (5, 6). One-half gram of ground straw was placed in a 200-ml Erlenmeyer flask containing 50 ml of 0.1 *N* NaOH and stoppered. After standing overnight, the contents were centrifuged at 11,000 × g for 10 min. Ten ml of the supernatant fluid was transferred to centrifuge tubes containing 5 ml of acriflavine solution (1-g acriflavine hydrochloride in 1,000-ml hot, distilled water). Five ml HCl (1% solution) was added, stirred, and centrifuged at 2,500 × g for 1 min. Five ml of the supernatant fluid was diluted (1:400) and unadsorbed fluorescent dye was read on a Beckman model 772 ratio fluorometer.[3] Results were recorded as milligrams of acriflavine adsorbed.

Light absorption was determined with a Beckman GB spectrophotometer on the supernatant fluid from the first centrifugation. Percent transmittance was recorded at each 50 nm within the 400 to 799-nm wavelength range.

Because we found that straw decomposed rapidly during the first month after burial, we prepared and buried 72 additional samples. We recovered nine envelopes weekly for 2 months and assayed them as previously described for monthly samples.

RESULTS AND DISCUSSION

Average straw weight loss, break force, arciflavine adsorption, and light absorption at 500 nm are given in Table 1. Straw losses for this greenhouse experiment were higher than those reported in field experi-

Table 1. Average weekly and monthly straw weight loss, break force, acriflavin adsorption, and light absorption.

Time buried	Weight loss	Break force	Acriflavine adsorption	Light absorption at 500 nm
weeks†	%	g	mg	% T
0	0	409	0.03	68
1	9	341	0.13	55
2	27	274	0.16	46
3	35	202	0.17	41
4	42	141	0.21	35
5	48	68	0.24	34
6	57	24	0.32	20
7	63	16	0.30	22
8	75	0	0.33	21
months‡				
0	0	397	0.38	58
1	52	33	0.22	24
2	58	5	0.14	15
3	68	0	0.30	15
5	81	0	0.29	6
7	83	0	0.17	15
9	83	0	0.16	5

† Each number is the average of 9 samples.
‡ Each number is the average of 39 samples.

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[3] Trade names are included for information only and do not constitute an endorsement by USDA.

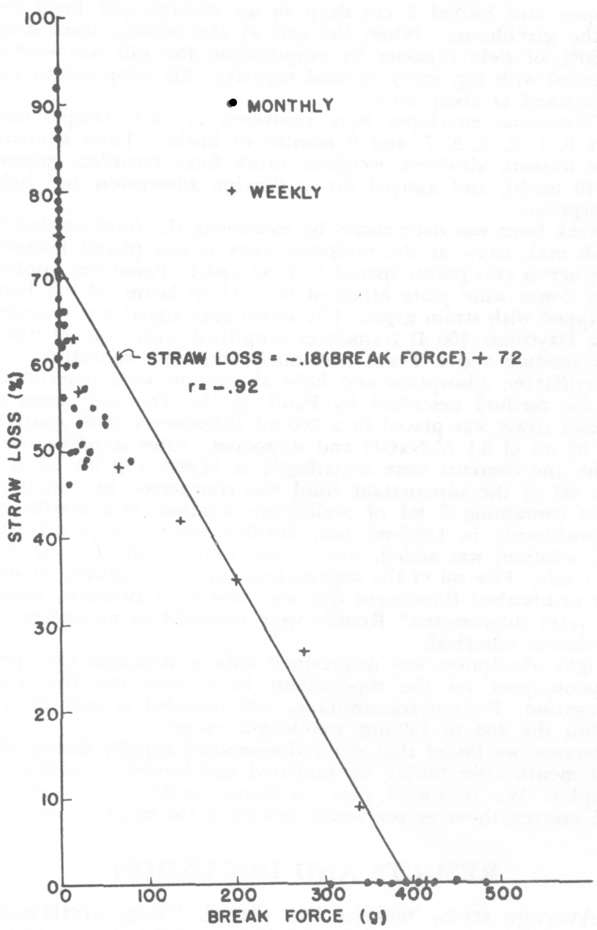

Fig. 1. Relationship between straw loss and the force necessary to break a straw at midpoint.

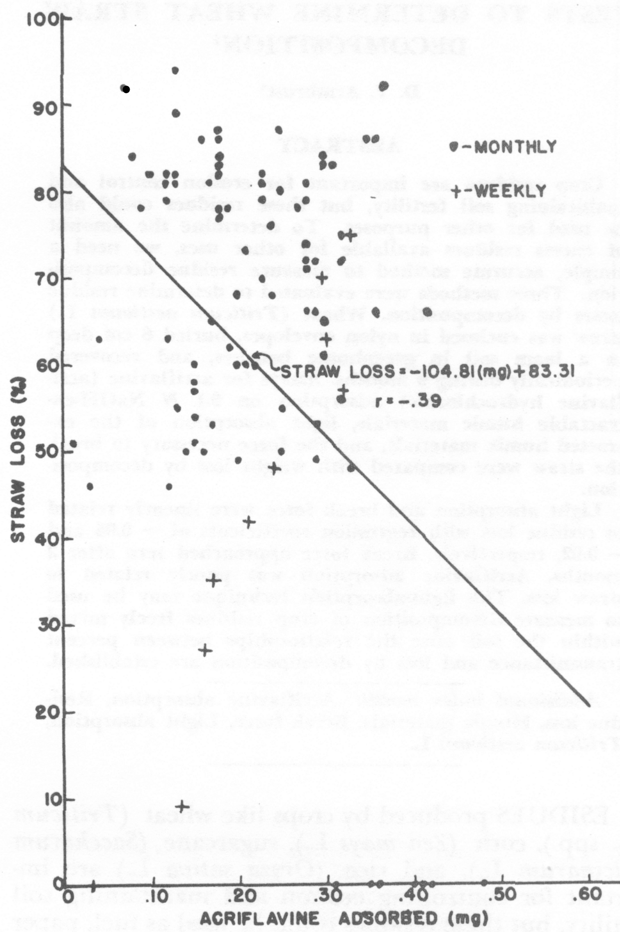

Fig. 2. Relationship between straw loss and adsorption of acriflavine on NaOH-extracted humic acids.

ments with wheat (9, 10), rice (7), and corn (4). However, losses were comparable with those reported by Brown and Dickey 2) for wheat at Huntley, Mont., except that our losses during the first 2 months exceeded theirs, perhaps because of higher average temperature, higher soil moisture, and more rapid loss of easily dissolved material from the straw into the soil. Smika (8) indicated that 6 to 30% of untilled, standing wheat stubble can be lost overwinter.

Force necessary to break the straw was highly related to loss by decomposition (r = −0.92) (Fig. 1). But straw decomposed so rapidly that straw strength approached zero within 2 months (Table 1). Wheat straw partially buried or maintained on the soil surface would decompose more slowly and retain its strength longer, but weight loss and strength would probably have the same relationship as buried straw.

Acriflavine adsorption was poorly related to straw loss (r = −0.39). Acriflavine adsorption decreased for monthly samples as decomposition increased but increased for weekly samples (Fig. 2). Because the fluorescent dye acriflavine is adsorbed by the humic acids formed during decomposition, the amount adsorbed should increase with decomposition. Perhaps, the unusual results for monthly samples were caused by soil microorganisms utilizing the humic acids that were produced as a food source, particularly after they had utilized the more easily digested material.

We selected light absorption at 500 nm over other wavelengths because it had the best relationship to residue loss (r = − 0.95). Wavelengths < 500 nm absorbed the light so strongly that most readings were approaching zero. Wavelengths > 500 nm did not vary enough to measure small differences in decomposition. Light absorption increased (transmittance decreased) as the straw decomposed (Fig. 3).

CONCLUSIONS

Winter wheat residue losses by decomposition can be accurately estimated by determining straw strength or the light absorbed by a solution from overnight digestion of ground (< 40 mesh) straw treated with 0.1 *N* NaOH. However, straw strength decreases rapidly and incorporation of residues may reduce the length of individual straws so that strength measurements can't be made. Measurement of fluorescent dye adsorption by the same solution gave inconsistent results.

The light-absorption technique was the most accurate and simplest. The only equipment required is a spectrophotometer and Wiley mill because samples can be filtered, rather than centrifuged. This technique could be used to measure decomposition of

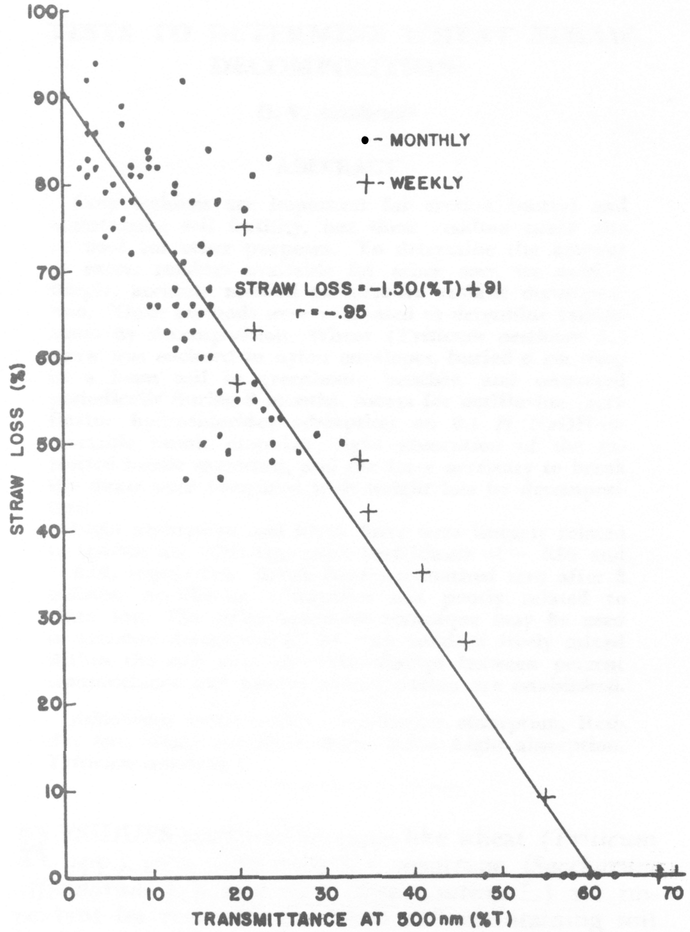

Fig. 3. Relationship between straw loss and transmittance of light by NaOH-extracted humic acids at 500-nm wavelength.

crop residues freely mixed within the soil once the relationships between percent transmittance and loss by decomposition are established.

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