

Perennial Ryegrass Response to Application of Composted Grass Seed Straw¹

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ABSTRACT

Compost from long and short perennial ryegrass (*Lolium perenne* L.) straw was formed by turning windrows six times throughout the year with a commercial, straddle-type compost turner. The long and short straw respectively had initial C/N ratios of 57:1 and 43:1. The final C/N ratios for the composted long and short straw were 15:1 and 11:1 respectively. The compost was broadcast over plots in an existing perennial ryegrass field at different rates based on equivalent nitrogen application of 0, 22, 50, 101, and 202 kg ha⁻¹ during October, 1993. One block of plots was established for application of both the normal rate of inorganic nitrogen (202 kg ha⁻¹) and compost. A second block of plots was established for application of a small initial amount of inorganic nitrogen in the autumn (28 kg ha⁻¹) and compost. Both blocks received normal pesticide applications including fungicides, molluscicide, insecticides and herbicides. Three replications of each treatment were made, resulting in a total of thirty randomized plots in each of the two blocks. Addition of compost had no significant effect on seed yield at any of the rates applied, but did significantly increase dry matter produced per hectare.

Additional index words: carbon, nitrogen, residue, fertilizer

INTRODUCTION

In addition to pure seed, grass seed growers in Oregon's Willamette Valley produce up to 11 tonnes of straw ha⁻¹ of land farmed. For the region's seed growers, this represents one-million tonnes of straw that must be removed annually from fields in order to maintain profitable yields. Removal of straw has historically been troublesome and cost prohibitive. During the 1940s, it was discovered that burning straw in the fields helped maintain good yields while controlling weeds, invertebrates and fungal diseases, and for several decades open field burning was standard practice in the region's grass seed cropping systems. However, as the region's urban populations grew during the 1970s and 1980s, the area permitted to be burned each year was steadily reduced and the need for alternatives to open field burning became apparent. The practice of open field burning may be entirely eliminated within the next few years. Other forms of disposal in the field, such as shredding and chopping, have been investigated (Young, Silberstein and Chilcote, 1993) but have been found to be not entirely satisfactory.

Markets for a portion of this straw exist as animal feed and bedding but the grower usually receives no compensation and often has to pay for its removal. This appears to be related to market conditions, with supply far exceeding demand. Other uses of grass straw have been proposed or investigated on a limited scale, including its use as a component in building materials and paper products, fuel for domestic heat and cogeneration of electricity, feed stocks for

methane and alcohol production, mushroom media, straw-hydroxide cubes, straw pellets, hydromulch and on-farm composting (Mackey, 1991). Since it is unaffected by market conditions, on-farm composting, in combination with other uses of straw, may benefit growers by creating a more balanced market while reducing the straw load on grass seed crops. Additionally, some long term benefits in soil nutrient levels, texture and moisture holding capacity may result from grass straw compost being returned to fields.

Growers annually apply an average of 202 kg N ha⁻¹ on grass seed production fields. Along with other macro- and micro nutrients, this represents considerable expense to growers, as well as a potential source of contamination to ground and surface waters. Elimination of some or all of the soluble inorganic fertilizer application would benefit growers and reduce non-point source contamination of water.

Composting of grass seed straw into an easily spread soil amendment has been shown to be possible without the addition of a high-nitrogen component such as inorganic nitrogen or manure (Churchill, Bilsland and Elliott, 1995). Reapplication of the soil-like product may benefit the crop by producing short term increases in yield and or long term improvement in soil quality. As a result, the objectives of this study were to determine the response of perennial ryegrass to addition of known rates of nitrogen as in composted grass seed straw, and to assess its value as a plant nutrient source and determine whether some or all of the inorganic nitrogen normally applied by grass seed growers could be replaced with composted grass straw.

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LITERATURE REVIEW

Composting of a variety of waste and agricultural by-products has been researched. Research has been dedicated to composting of solid waste both for its disposal and for recovery of its valuable by-products (Brodie, Gouin and Carr, 1993; Goldstein, 1991; Hornick *et al.*, 1984). End use of composted materials is usually as a soil amendment for agriculture and landscape (Rynk, 1992; Hoitink, Inbar and Boehm, 1991). Much of this research was centred on optimization of the composting process to reduce compostable material in the shortest possible time (MacGregor, Miller, Psarianos and Finstein, 1981; Gouleke, 1991). Automatic control of the composting process has been attempted (Keener, Hansen and Elwell, 1993). In this research, aeration by forced air based on internal compost stack temperature was controlled by a thermostat. There has been a great deal of research dealing with disposal of high nitrogen waste products such as municipal sludge, poultry and swine manure (Hansen, Keener and Hoitink, 1989; Keener, Hoitink, Marugg and Hansen, 1991; Collins and Parson, 1993). Strom, Morris and Finstein (1980) investigated low technology composting of leaves. In this research, odours and temperatures were related to windrow size. A ten-month period was required to break down leaves in the absence of an additional high nitrogen component. Collins *et al.* (1990) and Jenkinson (1965) investigated the cause and effects of plant decomposition in soils. These studies concluded that decomposition rate was determined by the quantity and composition of the original material. Young, Silberstein and Chilcote (1993) studied the effect of different post-harvest residue management procedures on seed yield, tiller development and soil chemistry in grass seed crops. This research showed that removal of straw generally improved seed yields in subsequent years. Churchill *et al.* (1995) showed

that composting of grass seed straw could be accomplished without supplementing with additional nitrogen. Volume reductions of up to 88% were achieved on two types of perennial ryegrass straw.

MATERIALS AND METHODS

Straw from the season's grass seed harvest was available in July and August, 1992 for compost windrow formation. In preparation for composting, perennial ryegrass straw was collected using the two most common methods available to the region's growers. The first method was to rake only long straw from the field to form compost windrows. This left finer material behind on the field for other forms of disposal. A ground-driven wheel rake and farm-built buck rake were used to collect long straw. The second method of straw collection was to rake, bale and remove long straw first and then form compost windrows with only the short straw flailed, brushed and vacuumed from the field. A Rears Mfg. Co.¹ Flail-vac machine and a Deere and Company forage wagon were used to collect short straw. Eight windrows were formed for temperature and volume monitoring with approximate dimensions of 2 m high by 5 m wide by 18 m long. The two methods of straw collection create windrows distinctly different in appearance. Long straw windrows are loose, composed almost entirely of straw, and proportionately contain very small amounts of seed and soil. Short straw windrows are denser, composed of finer material and contain relatively large amounts of soil and seed. All compost material for this study was prepared by turning six times throughout the year with a commercial, straddle-type compost turner. No addition of nitrogen or water, other than normal rainfall of about 900 mm, was made. Details of the composting procedure and results are described by Churchill *et al.* (1995).

Table 1. Chemical analysis of long and short straw compost

	Moisture (%wb)	pH	Total N (%)	(ppm)	(kg t ⁻¹)
Long Straw compost	49.0	7.6	1.14		
P				184	0.185
K				6045	6.045
Ca				4320	4.32
Mg				936	0.935
Na				336	0.335
B				3.05	0.00305
Short Straw compost	47.8	7.3	1.33		
P				213	0.215
K				4485	4.45
Ca				5280	5.28
Mg				1140	1.14
Na				274	0.275
B				1.7	0.017

¹ Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA or imply approval to the exclusion of other products that also may be suitable.

During July and August 1993, finished compost of both types of straw was collected and analyzed for moisture and nitrogen content and other plant nutrient levels (Table 1). Growers annually apply an average of 202 kg ha⁻¹ inorganic nitrogen. Rates of application of compost were then calculated based on equivalent nitrogen application of 0, 22, 50, 101, and 202 kg ha⁻¹. Quantities of compost were weighed and bagged based on moisture content, nitrogen content and application rate in preparation for later application to field plots. Two blocks of thirty 3.0 m x 3.0 m plots were established on an existing perennial ryegrass field. One block of plots was established for application of both the normal rate of nitrogen fertilizer and varying amounts of compost. This block of plots received approximately normal to 200% of the normal maximum rates of nitrogen application. The other block of plots was established for application of a small initial amount of inorganic nitrogen in the autumn (28 kg ha⁻¹) with the remaining nitrogen coming from compost. This block of plots received 14% to 114% of normal maximum nitrogen. Compost was broadcast over individual plots at prescribed rates during October, 1993. Three replications of each treatment were made resulting in a total of thirty randomized plots in each of the two blocks. Both blocks of plots received normal pesticide applications including fungicide, insecticide, molluscicide and herbicide.

Plots were periodically checked for visible differences in colour and plant growth throughout the autumn, winter and early spring and differences noted. During July, 1993, shortly before normal swathing of the field, approximately 2 m² from

the centre of each plot was harvested at ground level using a sickle bar mower. Straw with seed still attached was bagged, labelled and dried for later weighing, threshing and seed conditioning. Response to varying treatments was measured by comparing differences in total sample weights of straw and seed, clean seed weights and clean seed thousand seed weights.

RESULTS AND DISCUSSION

Average weights of plant material at 0% moisture (wet basis), seed yield ha⁻¹ and thousand seed weight values are shown in Table 2 for each of 20 different treatments (2 rates of inorganic nitrogen x 2 types of compost x 5 compost application rates). Few significant (p<0.05) differences in the dry matter produced, yield, and thousand seed weight resulted from the treatments. The average clean seed yield, weight of dry matter produced and thousand seed weight for five application rates of each type of compost material and inorganic nitrogen rate is shown in Figs 1, 2 and 3 respectively.

Differences in leaf colour and plant population density became visible approximately one month after compost application and remained visible throughout the growing season until the application of inorganic nitrogen fertilizer and the initiation of spring growth. Plots with higher application rates appeared greener and appeared to have higher plant densities than plots with lower application rates. This may have been the result of differences in moisture and/or nitrogen availability.

Table 2. Average dry matter, seed yield and thousand seed weights for different treatments

Straw type	N from compost (kg ha ⁻¹)	Inorganic N (kg ha ⁻¹)	Total N (% of Normal)	Wt of seed and straw (kg ha ⁻¹) ¹	Clean seed wt (kg ha ⁻¹) ¹	Thousand seed wt. (g) ¹
Long	202	28	114	4961 ^a	587 ^a	1.82 ^a
Long	101	28	64	5327 ^a	782 ^a	1.92 ^{ab}
Long	51	28	39	3796 ^a	665 ^a	1.96 ^b
Long	22	28	25	3246 ^a	586 ^a	1.92 ^{ab}
None	0	28	14	4125 ^a	801 ^a	1.94 ^{ab}
Short	202	28	114	5323 ^a	625 ^a	1.76 ^a
Short	101	28	64	4370 ^a	691 ^a	1.89 ^b
Short	51	28	39	3510 ^a	619 ^a	1.91 ^b
Short	22	28	25	3903 ^a	779 ^a	1.92 ^b
None	0	28	14	2014 ^a	398 ^a	1.84 ^{ab}
Long	202	202	200	8986 ^b	947 ^a	1.89 ^{ab}
Long	101	202	150	6169 ^a	1018 ^a	1.86 ^{ab}
Long	51	202	125	8021 ^{ab}	1073 ^a	1.87 ^{ab}
Long	22	202	111	6407 ^a	986 ^a	1.79 ^a
None	0	202	100	7057 ^{ab}	1048 ^a	1.92 ^b
Short	202	202	200	8107 ^a	1019 ^a	1.90 ^b
Short	101	202	150	6508 ^{ab}	873 ^a	1.76 ^a
Short	51	202	125	7892 ^a	1087 ^a	1.84 ^{ab}
Short	22	202	111	5349 ^b	806 ^a	1.85 ^{ab}
None	0	202	100	6561 ^b	1070 ^a	1.90 ^b

¹ Values in the same column with the same straw type and inorganic N rate with different letters are significantly different at P<0.05.

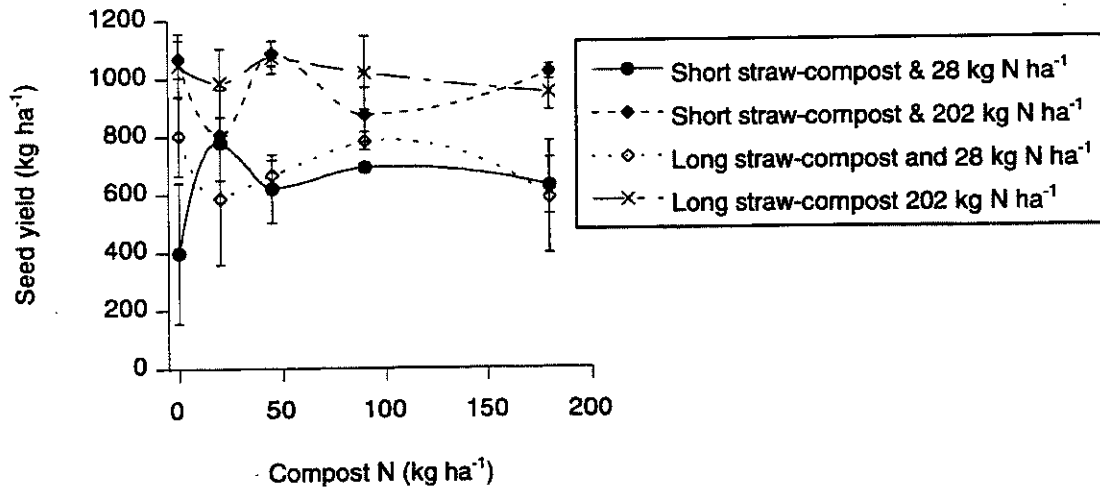


Figure 1. Seed yield weights from plots with varying amounts of added compost and two rates of inorganic N per hectare.

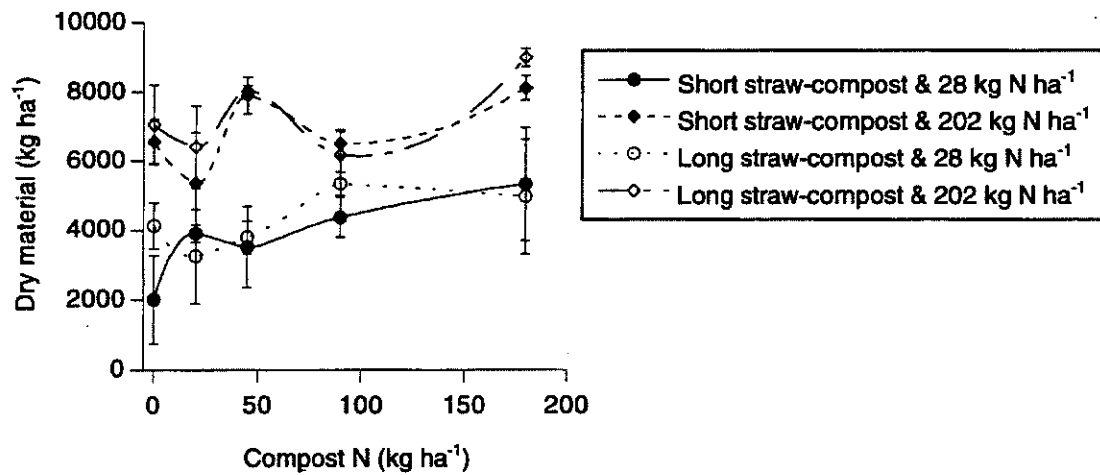


Figure 2. Dry matter weights from plots with varying amounts of added compost and two rates of inorganic N per hectare.

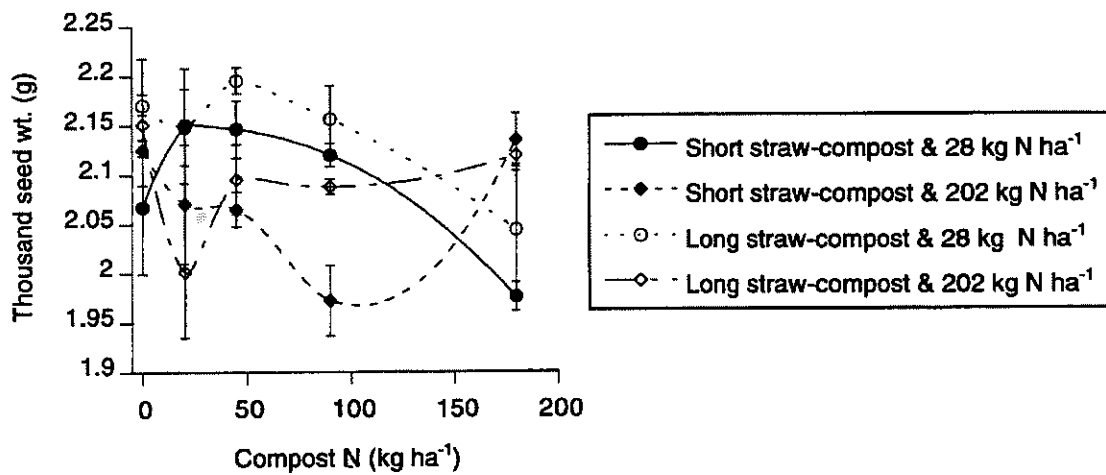


Figure 3. Thousand seed weights from plots with varying amounts of added compost and two rates of inorganic N per hectare.

These plots were established in a field during its fifth year of production and its overall stand strength was relatively low. An application of herbicide to control grass seedlings in the autumn of 1993 weakened the crop further. This weakness was visible in plots of all application rates and may have introduced variability to the study that would not be present in younger stands. Grass seed growers usually replant and re-establish perennial ryegrass fields during the fourth or fifth year of production because of declining stand strengths and seed yields. As a result, the grower took the field out of production in the spring of 1994 by spraying it with a non-selective herbicide, leaving only the experimental plots. Slug populations were also high in the field, causing additional damage to the plots.

Seed yield was significantly ($p < 0.001$) increased only by the addition of inorganic nitrogen fertilizer and not by compost application rate ($p = 0.987$) or compost straw type ($p = 0.330$). Dry matter produced was significantly increased by both inorganic nitrogen fertilizer addition ($p < 0.001$) and compost addition ($p = 0.025$) but not compost straw type. Thousand seed weight was surprisingly reduced significantly by addition of nitrogen fertilizer ($p = 0.059$) but not compost addition ($p = 0.173$). This may have been due to shading as a result of higher stand densities produced by the inorganic fertilizer. Interactions between application of inorganic nitrogen fertilizer and compost were found to have no significant effect on seed yield, dry material produced or thousand seed weight.

Total nitrogen application of the compost at its highest rate was equal to the normal maximum nitrogen of inorganic fertilizer, yet seed production was significantly ($p < 0.001$) lower in these plots than in plots with inorganic fertilizer alone or inorganic fertilizer and compost. Additionally, dry matter produced per hectare was significantly lower in the plots with compost alone than those with inorganic fertilizer alone or inorganic fertilizer and compost. This is probably due to a difference in the plants' ability to uptake soluble nitrogen provided by inorganic fertilizers and insoluble nitrogen provided by grass straw compost. As a result, application of inorganic fertilizer cannot be reduced or replaced in the short term by compost if seed yields are to be maintained. Difference in availability of nitrogen from the two different sources may possibly be seen in long term effects on seed yield. A cost analysis of fertilizer application compared to seed yield increases would show whether the amount of inorganic fertilizer applied is justified by the increased seed yield.

For the rates applied in this study and with the compost material used, there was no short term (one year) increase in seed yield resulting from the addition of composted grass seed straw as applied to this particular perennial ryegrass field. In this study, the highest compost application rate was equivalent to approximately 18 dry tonnes of compost ha^{-1} . At approximately 50% moisture, this amounts to 36 tonnes ha^{-1} of moist compost to be applied. This suggests that the considerable expense of composting grass seed straw and reapplying it to grass seed fields solely for its plant nutrient content is not justified by short term increases in yield. However, composting straw for its disposal in lieu of other more expensive or unacceptable methods may be cost effective. Additionally studies are underway.

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