GREEN-MANURED WINTER COVER CROPS IN IRRIGATED POTATO ROTATIONS

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INTRODUCTION

The use of winter cover crops as sources of green manure preceding potatoes has several potential benefits: i) providing a ground cover for reducing wind erosion during the late fall, winter and early spring months, ii) improving soil quality and soil aggregate stability, potentially decreasing wind erodability , iii) releasing natural pesticides for controlling weeds and insects and iv) serving as a catch crop for recovering deep-leached nutrients such as nitrate. Currently, winter wheat is commonly seeded after early or mid-season potatoes are harvested, however, the use of winter cover crops preceding potatoes is not as common (Stannard and Thornton, 1994). Bare soil is usually exposed to weathering during the fall, winter and spring months before planting of potatoes. Because the majority of the precipitation occurs in the winter, there is a high likelihood of N leaching, particularly in coarse textured soils (Hasselen and McCall, 1993). We are conducting a multidisciplinary study of the potential benefits of cover crop management in potato rotations. The objectives of the present study are to reduce potential N leaching, improve nitrogen use efficiency, and reduce fertilizer inputs while maintaining yield and quality.

The introduction of winter cover crops requires an increased level of understanding of the soil biological dynamics that influence changes in nutrient cycling (Appel and Mengel, 1990). Accounting for nutrients released from the green manure crop will reduce fertilizer inputs and potentially reduce nutrient leaching into local water supplies. Theoretically, the winter cover crop will absorb nitrate that has leached below the soil zone accessible by shallow-rooted potato plants, thus recycling the N to the surface (Keller, 1988). Subsequent decomposition of the green manure during the potato season should allow the potato plants to absorb the N. Knowledge of the N release rates will be critical in optimizing the benefits from this N source.

A two year research project is being conducted to determine nitrogen release rates from winter cover crops and to document changes in soil quality that potentially affect productivity.

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Five winter cover crops were evaluated in 1994 near Plymouth, WA. Treatments established on August 25, 1993 following sweet corn included sudangrass, rapeseed, white mustard, rye, wheat, and no cover crop to serve as a control. Two dates of incorporation were included to investigate the effect of timing on cover crop N mineralization and N availability on the following season's potatoes. The fall tillage of sudangrass and white mustard was accomplished on October 28,1993. Spring tillage of rapeseed, wheat, rye, and white mustard was completed five weeks before potato planting on March 3, 1994. The soil was intensively sampled to 180 cm (6 feet) at three week intervals throughout the potato growing season. Potato plant samples were analyzed at the same time. Cover crop biomass was sampled before each tillage date.

RESULTS AND DISCUSSION

Above-ground N accumulation in the cover crops ranged from 33 to 140 kg N/ha (29 to 125 lbs N/A) and up to 46 Mg/ha (2.0 tons/A) dry matter (table 1). The low N and dry matter content of sudangrass was due to the late planting. An early planted (July 1) sudangrass crop at Othello in 1994 accumulated 330 kg N/ha (290 lbs N/A) by the date of the first fall frost. The soil profile N distribution in the control and fall-tilled cover crops (sudangrass and white mustard) showed a large plume of nitrate between 30 and 90 cm (1 to 3 feet) below the soil surface from residual and preplant fertilizer as well as mineralized N from the previous summer's sweet corn (fig. 1). The high level of N accumulation by the spring-tilled crops (wheat, rye, and rapeseed) significantly reduced the magnitude of the nitrate plume due to plant N uptake and conservation of N in plant biomass during winter and early spring leaching periods.

Fall-tilled cover crops released N quickly which resulted in high pre-plant N levels and N leaching compared to the non-cover crop control (fig.2). Spring-tilled cover crops decreased soil N levels in early spring by storing the N in plant tissue, but mineralized tissue N to inorganic soil N by potato planting (April 10, 1994) and in time to supply N to partially meet the N requirement of the succeeding potato crop. The spring-tilled cover crops resulted in a sharp increase in rooting zone nitrate (0 to 2 feet) by potato planting due to cover crop N mineralization (fig. 3). This high level of soil nitrate was sustained through day 60. The spring-tilled white mustard was winter killed early in November of 1993 resulting in soil N concentrations intermediate between the fall tilled treatments and the other spring-tilled treatments. The spring-tilled cover crops (wheat, rye and rapeseed) significantly reduced N leaching and deep N accumulation compared to the bare soil of the control (fig. 4). High tuber yields (>800 cwt/A) obtained in 1994 season were sustained with cover crop management while reducing N leaching losses (fig. 5).

CONCLUSION

In the first year of this study we found that the N uptake by the spring-tilled cover crops ranged between 100 lbs/A and 125 lbs/A. The spring-tillage of cover crops synchronized the release of N with potato N uptake needs. The high N leaching in the fall-tilled cover crops was apparently a result of early mineralization and winter precipitation. The spring tilled cover crops reduced leaching by about 80 kg N/ha (about 75 lbs N/A).

This initial year of data indicates that cover crops have the potential for increasing the nitrogen use efficiency in potato crop rotations on the sandy soils of the Columbia Basin of Central Washington.

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Table 1.

Time of Incorporation	Cover Crop	Above-ground dry matter (Tons/A)	Above-ground N (lbs/A)
Fall	sudangrass	0.32	29
	mustard	1.42	126
Spring	rape	1.32	100
	rye	2.03	125
	mustard	1.29	55
	winter wheat	1.81	120

Fig. 1.

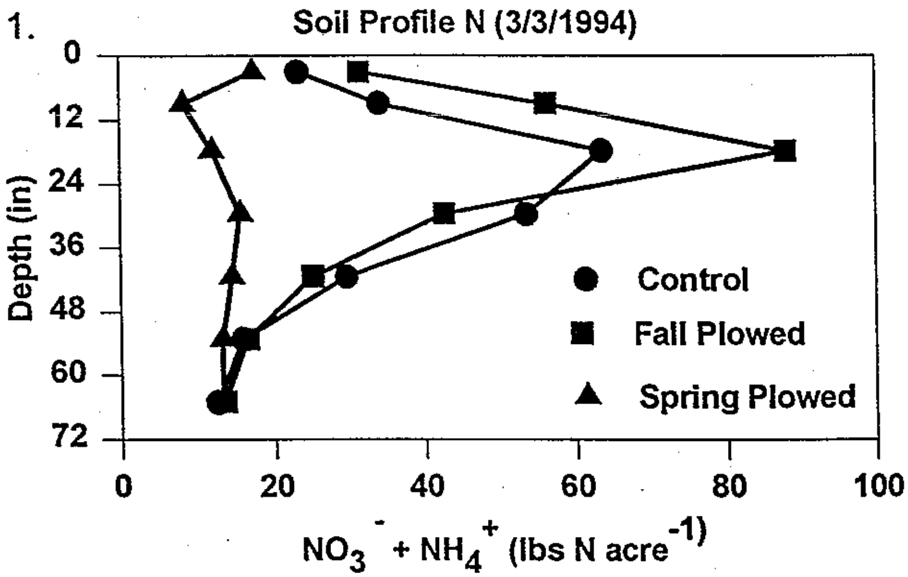
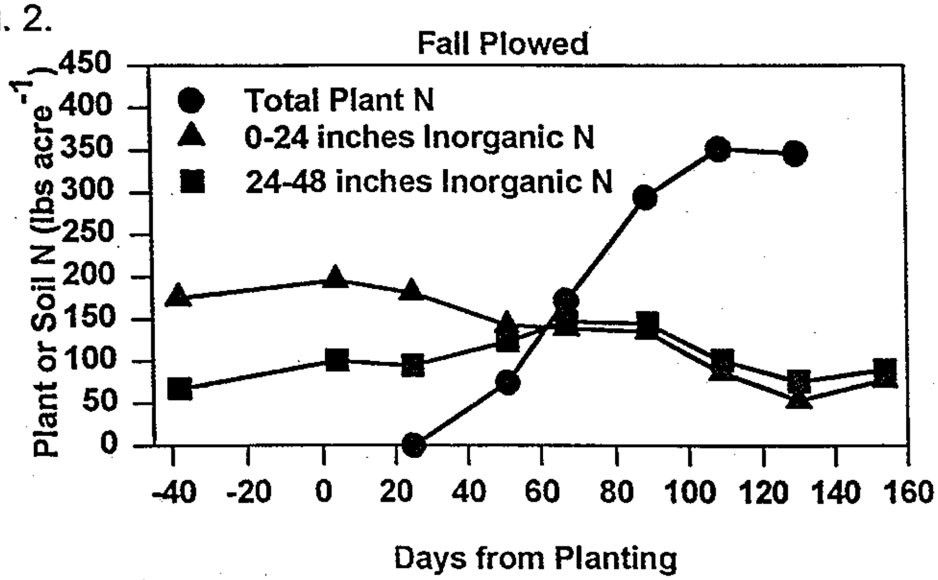


Fig. 2.



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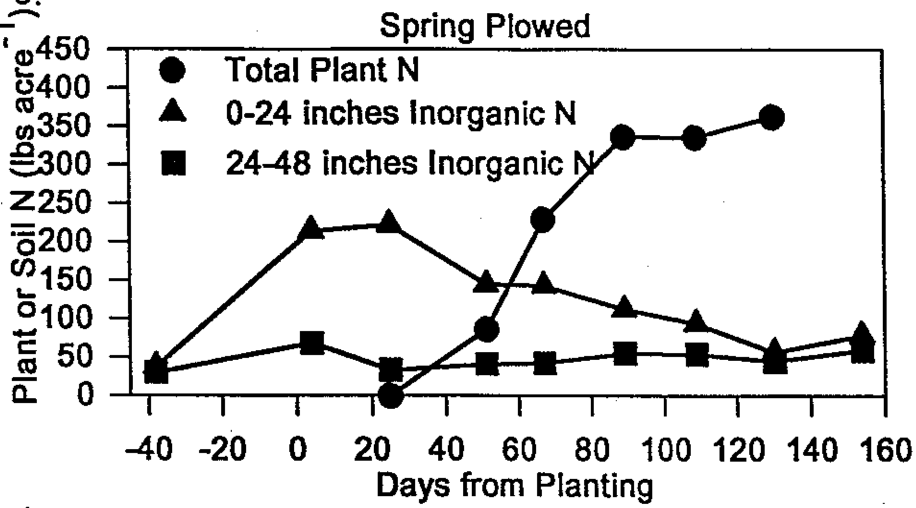

Fig. 4.

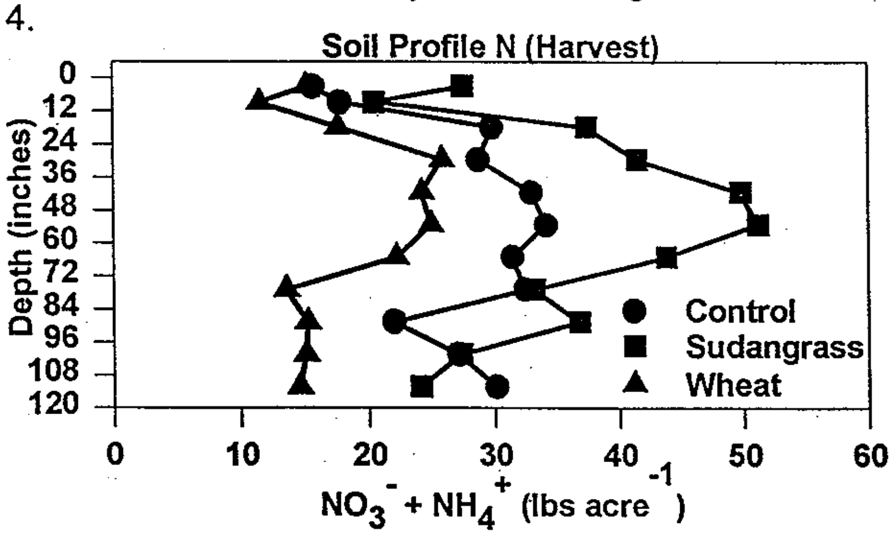

Fig. 5.