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THE EFFECT OF DIFFERENT WINTER COVER CROPS ON SORGHUM NUTRITIONAL STATUS AND DRY MATTER YIELD

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Growing winter cover crops has a great agroecological meaning, since it allow maintaining the residual inorganic N in the soil/plant system, thus avoiding leaching of N (Rodrigues et al., 2002). As winter cover crops, it can be grown diverse species (Jensen, 1992). If legume species were used, they can access atmospheric N through the establishment of a symbiotic relationship with N-fixing bacteria (Russelle, 2008). Thus, the winter leguminous cover crops can have a dual role: to uptake residual inorganic N; and promoting the growth of the following crop through a green manuring effect, which may reduce the need for expensive N fertilizers. Lupine (*Lupinus albus*) appears as a suitable legume species to be grown in this region, since it presents high growth rates in winter and a great ability to fix N (Rodrigues et al., 2013). In this work, the use of lupine as a winter cover crop was compared to small grains and natural vegetation (weeds) by measuring their effect on irrigated sorghum grown as a summer crop. The effect of the different winter cover crops was evaluated by comparing sorghum dry matter yield, plant N nutritional status and N recovery by sorghum plants.

Materials and methods

In spring 2012 the biomass of the winter cover crops (lupine, cereal and weeds) was cut. Lupine was managed of two different ways, incorporating all the above-ground biomass in the soil and removing the above-ground biomass. Thus, four treatments were taken into account: weeds (natural vegetation); cereal (a mixture of small grains); lupine total (integral incorporation of plant residues in soil); and lupine root (aerial biomass removed). Sorghum [*Sorghum bicolor* (L). Moench] was sown after the incorporation of the residues of the winter cover crops in the soil at a rate of 10 kg seed ha^{-1}. No fertilizers were applied. During the growing season two cuts of biomass were performed. Dry matter (DM) yields were determined from samples of 0.25 m^2 after over-drying the samples at 70 °C. The dried samples were ground and analyzed for total N by a Kjeldahl procedure. Plant N recoveries were determined from DM yields and tissue N concentrations. Plant nutritional status was also accessed by determining N concentration in leaves and stems and performing SPAD readings (SPAD-502 chlorophyll meter).

Results and discussion

Sorghum DM yields varied significantly among the different cover cropping treatments (Table 1). Total DM accumulated in the two cuts reached 11.9 Mg ha^{-1} in the Lupine-total treatment and was only 5.7 Mg ha^{-1} in the Cereal treatment. N concentration in sorghum tissues was not significantly affected by the different cover crops. However, N recovery varied significantly among winter cover crop treatments due the differences found in DM yield. In the Lupine-total treatment, sorghum recovered 142.6 kg N ha^{-1} while in the Cereal treatment sorghum recovered only 60.3

kg N ha^{-1}. Leaf N concentration and SPAD readings showed that Cereal was the winter cover crop that decreased more the N nutritional status of sorghum (Table 2). The results also showed that the lupine promoted the sorghum DM yield, likely due to their N-rich residues. The N concentration in sorghum tissues and SPAD readings were not different in lupine plots in comparison with the uncultivated plots (weeds) probably due to a dilution effect caused by the increase in DM yield, since N recovery was higher in the plots where lupine was grown as winter cover crops. In the lupine plots, the removal of shoots did not reduce the beneficial effect on sorghum yield, having been obtained similar values when the above-ground biomass was buried or it was removed.

Table 1. Dry matter yield, tissue N concentration and N recovery by sorghum grown after three winter cover crops, weeds, cereal and lupine, determined in two cuts (August 8th and October 9th) in the summer season.

	DM yield (Mg ha^{-1})			Tissue N conc. (g kg^{-1})		N recovery (kg ha^{-1})		
Treatment	1st cut	2nd cut	total	1st cut	2nd cut	1st cut	2nd cut	total
Weeds	3.8 b	4.1 ab	7.9 b	12.2 a	11.4 a	46.3 b	46.9 ab	93.1 b
Cereal	2.4 b	3.3 b	5.7 b	11.5 a	10.0 a	26.9 b	33.4 b	60.3 b
Lupine-root	7.0 a	4.8 ab	11.7 a	12.6 a	11.1 a	86.5 a	52.2 ab	138.7 a
Lupine-total	6.5 a	5.4 a	11.9 a	11.9 a	12.0 a	77.1a	65.5 a	142.6 a

Means followed by the same latter in columns are not statistically different (Tukey HSD, $\alpha < 0.05$).

Table 2. Sorghum leaf and stem N concentrations and SPAD readings as a function of the previous winter cover crop treatment.

	Leaf N conc. (g kg^{-1})		Stem N conc. (g kg^{-1})	SPAD readings
Treatment	July 19th	August 8th	August 8th	August 9th
Weeds	30.5 a	16.0 a	2.8 a	32.2 ab
Cereal	22.2 b	13.9 b	3.2 a	27.8 c
Lupine-root	28.1 a	16.8 a	2.6 a	31.6 b
Lupine-total	33.2 a	17.7 a	2.4 a	34.5 a

Means followed by the same latter in columns are not statistically different (Tukey HSD, $\alpha < 0.05$).

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