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Root and shoot growth and yield of different grass-clover mixtures

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1. INTRODUCTION

The aim of the field experiment was to determine the yield and growth of different grass-clover mixtures. The results should contribute towards optimizing grass-clover in terms of shoot and root development, the total yield, the range of varieties as well as the health of livestock and animals.

2. MATERIAL AND METHODS

The field experiment (2007) was located in Freising, south Bavaria (mean annual temperature: 7,6 °C, annual precipitation: 800 mm; soil: loamy clay) in double replication. The field experiment compared the root system of a regular grass-clover (NF3) with two mixtures with more legumes and herbs (FMB and GDM) which were created by considering the different depths of the root penetration (figure 1).

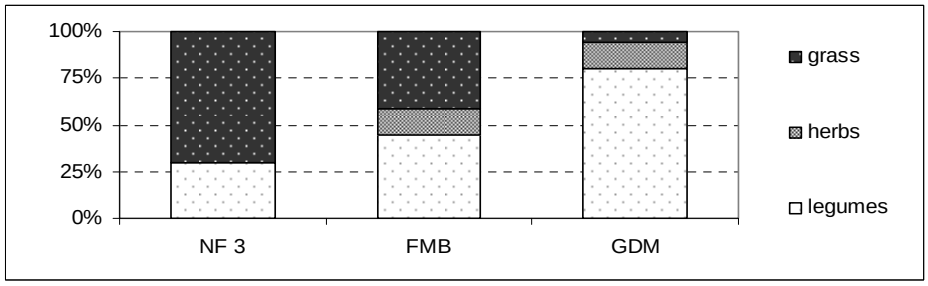

Figure 1: Different grass-clover mixtures with fractions of grass, legumes and herbs (%)

Grass-clover is used for forage as well as for green manure and therefore the assessment was conducted separately on two management systems (forage and green manure). For assessment of grass-clover as forage/green-manure, the composition of the grass-clover stands was analyzed, dry matter yield was measured, N- and C-content in shoots and roots were determined.

The sampling of the root samples (depths 0-30 cm) were done by the core method (Böhm 1979). The root length and diameter were directly measured based on Newman (1966). The quantify-cation of root biomass was calculated and analysed by desiccation. In order to determine the depth and width of the root system the roots were prepared on profile walls (Kutschera 1960). The symbiotic nitrogen fixation was calculated by Hülsbergen (2003) and Heuwinkel (1999).

3. RESULTS

In the variants of green manure, the stand composition (species richness) shifted in favour of the amount of grass. A few of the herbs managed to do well in the mixtures up to the end of vegetation despite intensive management.

The effect of mixture and management on root and shoot are shown in table 1. In both management systems (forage and green manure), the dry matter yield of shoots was about 165 dt

dm ha^{-1}. The level of symbiotically fixed nitrogen, which was accumulated in shoots and roots of NF3, was about 120-150 kg N ha^{-1}, of FMB 460 kg N ha^{-1} and of GDM about 540 kg N ha^{-1}.

The excavation method provides a clear picture of the entire root system. A constant penetration could be reached in FMB and GDM because of their crops with deep tap roots.
GDM showed, due to its lower amount of grass, the smallest root length (95 km m^{-2}). FMB and NF3 achieved a length of 130 km m^{-2} (depth: 0-30 cm). The root radius of NF3 (0.11 mm) was due to the high amount of fine roots. This was significantly lower than that of FMB and GDM, and both with more taproots. Measurements of root biomass gave high yields with significant differences (FMB 76 dt dm ha^{-1}, GDM 59 dt dm ha^{-1}, NF3 53 dt dm ha^{-1}). In the variants of green manure, the input on total organic C (shoot and root) was about 100-108 dt C ha^{-1}, in the forage variants about 26-36 dt C ha^{-1}.

Table 1: Effect of mixture and management on yield, N uptake and organic carbon

		NF 3		FMB		GDM	
		green manure	forage	green manure	forage	green manure	forage
shoot	dt dm ha^{-1}	165 [a]	162 [a]	165 [a]	159 [a]	164 [a]	162 [a]
stubble	dt dm ha^{-1}	10	10	10	10	10	10
root	dt dm ha^{-1}	53 [a]	52 [a]	73 [b]	78 [b]	60 [a]	57 [a]
N-uptake (shoot)	kg N ha^{-1}	458	445	526	504	542	558
N symbiotically fixed	kg N ha^{-1}	120	150	469	455	537	546
root length	km m^{-2}	138 [a]	132 [a]	128 [a]	136 [a]	99 [b]	93 [b]
root radius	mm	0,11 [a]	0,11 [a]	0,13 [b]	0,13 [b]	0,13 [b]	0,13 [b]
root length density	cm cm^{-3}	46 [a]	44 [a]	43 [a]	46 [a]	33 [b]	31 [b]
biomass (shoot + root)	dt C ha^{-1}	100	100	108	108	105	101
C-residues (shoot + root)	dt C ha^{-1}	100	26	108	36	105	28

3. CONCLUSION

The composition of grass-clover has a considerable effect on root biomass. The different management has non influence. The root branching patterns by Kutschera (1960) can be used to compose grass-clover mixtures with a higher root biomass.

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