THE INFLUENCE OF SOIL TILLAGE ON THE DISTRIBUTION OF MEDIC SEED IN THE SOIL AND SUBSEQUENT REGENERATION OF MEDICS IN A MEDIC WHEAT ROTATION.

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ABSTRACT

The success of annual medics (*Medicago spp*.) in ley farming systems with wheat (*Triticum aestivum* L.) depends largely on the ability of tillage systems to maintain sufficient seed reserves (200 kg ha^{-1}) in the topsoil (0-50 mm) without decreasing the yields of the successive wheat crop. The effect of six methods of tillage i.e. fieldspan (50 mm), shallow scarifier (50 mm), deep scarifier (150 mm), shallow disc plough (50 mm), deep disc plough (150-200 mm) and mouldboard plough (250 mm), on the distribution of the medic seed reserves in the soil profile and yields of successive wheat crops were investigated. Shallow tine cultivations favours the regeneration of medics, but more deep scarifier cultivations may be needed to ensure high wheat yields.

KEYWORDS

Ley farming, *Medicago* spp., soil tillage, wheat yields

INTRODUCTION

The poor regeneration and persistence of annual medics is one of the major problems in the persuasion of farmers to incorporate medics in a ley farming system in the winter rainfall area of the Republic of South Africa. Insufficient seed reserves and the distribution of seeds in the soil profile after being rotated with a wheat crop are regarded as the most important factors responsible for poor regeneration and persistence of medics (Carter *et al*., 1988). Sowing depths of 10 to 15 mm are regarded as optimum. Increasing the sowing depth from 10 to 50 mm in a heavy loam soil, reduced emergence of medic seedlings from 80 to 5% (Carter and Challis, 1987). Tine implements and shallow cultivations which ensure more crop residue on or in the surface layers of the soil during tillage (Mannering, Griffith and Richey, 1975) may improve medic swards, but may reduce the yield of crops when compared to deep mouldboard and disc tillage (Hargrove and Hardcastle, 1984). In this study the effect of different methods of tillage on the distribution of medic seed, pasture establishment and wheat yield in a medic wheat crop rotation were investigated.

EXPERIMENTAL PROCEDURE

The experiment was conducted at Tygerhoek Experimental Farm (average annual rainfall of 425 mm) near Riviersonderend in the southern Cape. The experiment was laid out as a randomised block with six replications on a one hectare paddock of Glenrosa soil (Mac Vicar, *et al*, 1977) which were sown in 1989 with a mixture of *M truncatula* cv's Paraggio and Parabinga at a seeding rate of 6 kg ha^{-1} each. Plot sizes were 5 x 20 m and medics and wheat were rotated annually. Normal management practises were applied during the medic years when plots were left undisturbed to allow a volunteer medic pasture. Before the tillage treatments commenced 5 samples of 0.25 m^2 per plot were taken to determine the amount of seed on the soil surface. This procedure was repeated at the end of the pasture year in 1991. After the six tillage treatments (Table 1) were applied the distribution of the medic pods/seed in the profile were determined, using steel cylinders of 117 mm in diameter to remove soil cores at depths of 0-50 and 50-150 mm in 1990 and 0-25, 25-50 and 50-150 mm in 1992. In 1991 and 1992 at the end of May when most of the medics had germinated medic plants were recorded on five sub-plots of 0.05 m^2 per plot. All tillage treatments were applied prior to the seeding of wheat cultivar Palmiet at 120 kg ha^{-1} in May of 1990 and 1992. No fertilizer was applied in 1990 while 60 kg N ha^{-1} were applied in 1992. To determine wheat yields strips of 1.3 x 20 m were harvested from each plot. Data were analysed using analyses of variance and significant differences between means and were determined using least significance difference (P=0.05) as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Seed recovery and distribution in the soil profile. Determinations of the seed mass, prior to tillage in 1990, showed an average of 549 kg medic seed ha^{-1} on the soil surface (see Table 1).

No significant differences were found in the seed mass recovered from the topsoil (0-50 mm) of the tine treatments (fieldspan and scarifier) regardless the depth of cultivation (see Table 1). Therefore soil compaction could be eliminated with deep tine cultivations without any detrimental effect on the distribution of medic seed reserves in the topsoil.

Although it was very difficult to control the exact tillage depth with the shallow disc treatment, this treatment also resulted in a large quantity (approximately 80%) of the seed in the 0-50 mm soil profile. However this figure dropped severely when repeated in 1992. In the deep disc and mouldboard plough treatments, 39.5 and 67.5 % of the seed was not recovered and must have been placed deeper than 150 mm. After deep disc ploughing and mouldboard ploughing only 33% and 23% of the seed mass which was on the soil surface before tillage, was left within the top 50 mm of the soil profile.

From Table 1 it is clear that seed mass recovered in 1992 was considerably less than in 1990 for all treatments. Although surprising it corresponds with losses of more than 50% reported by Crawford and Nankivell (1989). In general results of 1992 confirmed these of 1990, where tine tillage resulted in the highest and deep disc and mouldboard ploughing in the lowest seed mass in the topsoil (0-50 mm).

According to Carter (1987) and Brahim and Smith (1993) seed reserves of 200 kg ha^{-1} in the topsoil (Carter and Challis, 1987; Crawford and Nankivell, 1989) are considered to be adequate to provide a productive medic pasture after regeneration. From Table 1 it is clear that this requirement was, with the exception of mouldboard ploughing, easily met by all tillage treatments in 1990, but in 1992 only shallow (50 mm) tine tillage satisfied this requirement.

Medic regeneration and seed production. In general lower plant populations in 1993 correlated with the reduction in seed mass found in the soil after the tillage treatments were applied for wheat productions in 1992 (Table 2). Shallow tine cultivations resulted in the highest and deep mouldboard ploughing in the lowest number of medic plants in both years (see Table 2).

Highly significant correlations between seed reserves in the topsoil

0-50 mm (X) and regeneration of medic seedlings (Y) were found over the trial period ($Y_{1990} = 1.15 X^{0.942}$ and $Y_{1992} = 20.36 X^{0.445}$ with r = 0.96 and 0.98 and Prob Level of 0.0029 and 0.0004 respectively). The pod and seed production at the end of 1991 showed the same trend as the number of medic seedlings (Table 2). The fieldspan treatment resulted in the highest and mouldboard ploughing in the lowest seed production. No significant differences were found between the two scarifier treatments, but the tine cultivations produced almost twice as much seed as the disc and mouldboard plough treatments. Although it is acknowledged that there are a lot of other factors influencing seed production such as grazing management, these results clearly showed that tined cultivations which leaves more seed in the 0-50 mm soil profile favours the regeneration and seed production of medics after the wheat crop.

Wheat yield. There was a trend that deeper tine cultivations may be needed to maintain high wheat yields - data not shown (Agenbag and Maree, 1989; Agenbag and Maree, 1991).

CONCLUSIONS

This study showed that the distribution of medic seed in the soil profile had a major effect on the regeneration and productivity of medic pastures in a medic/wheat rotation. Regeneration was improved when most seeds were distributed in the 0-50 mm soil profile. Such a seed distribution can be best achieved by using tine implements for seedbed preparation for the follow-up wheat crops. However, deeper tine cultivations may be necessary to ensure adequate root development and to maintain high wheat yield in follow-up wheat crops.

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Table 2
The influence of different tillage methods on the number of medic seedlings regenerated during 1991 and 1993 and seed production of volunteer medics during 1991 in a medic wheat rotation at Tygerhoek.

Tillage methods	Plants m2		Seed kg ha-1
	1991	1993	1991
Fieldspan	582 a	215 a	
Shallow Scarifier	419 b	220 a	86 ab
Deep Scarifier	406 b	200 ab	65 bc
Shallow Disc Plough	257 cd	160 b	47 c
Deep Disc Plough	165 de	105 c	45 cd
Mouldboard Plough	106 e	95 c	23 d
Average	323	166	61

Table 1
The influence of soil tillage on the distribution of medic seed in the soil profile in a medic-wheat rotation at Tygerhoek Experimental Farm in 1990 and 1992.

Seed Recovered (kg ha-1)	Fieldspan (50mm)	Shallow Scarifier (50mm)	Deep Scarifier (150mm)	Shallow Disc Plough (50mm)	Deep Disc Plough (150 mm)	Mouldboard Plough (250mm)	Average	LSD (P-0.05)
1990:								
Topsoil (0-50mm)	544 ab*	489 ab	601 a	403 b	181 c	124 c	391	176
Subsoil (50-150mm)	14 c	37 c	127 a	108 a	152 a	55 bc	82	63
Total	558	526	728	511	332	179	472	
1992:								
Topsoil (0-25mm)	175 a	142 a	70 b	49 bc	16 c	14 c	78	39
Topsoil (25-50mm)	47 bc	98 a	67 ab	40 bc	25 c	23 c	50	33
Subsoil (50-150mm)	5 c	20 c	84 a	40 abc	59 ab	39 abc	41	52
Total	227 a	260 a	220 ab	129 bc	99 c	75 c	169	96

[xy] Values on the same line with different superscripts are different, P-0.05.