Effect of living mulch management on nitrogen dynamics in the soil – plant system of cauliflower

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Key words: vegetable production; nitrogen uptake; soil mineral nitrogen

Abstract

Living mulch management may have an effect on production of the crop and nutrient competition between the plant species in the field. In this paper, the amount of soil mineral nitrogen (N) available in the top soil during the cauliflower growing cycle and N uptake of the different components of the system were determined in two experimental sites in Italy and Slovenia where two different systems of living mulch management (early sown, late sown) were compared with a no living mulch system. Moreover, nutritional competition of a hybrid and two open pollinated cultivars against weeds and living mulch was evaluated.

Introduction

Living mulches (LM) are cover crops which are kept alive during the whole growing cycle of the main crop (Hartwig and Ammon, 2002). The InterVeg research project (Core organic II ERA-NET) aims at verifying if the introduction and proper management of LM in vegetable production systems allow similar yields and produce quality reducing the use of auxiliary off-farm inputs. This paper reports part of the results obtained on N competition among LM, weeds and cauliflower (*Brassica oleracea L.* var. botrytis) in two case studies: Italy and Slovenia.

Material and methods

Experiment 1- Italy: It was carried out at the Vegetable Research Unit of the Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA-ORA) in Monsampolo del Tronto (AP), (latitude 42° 53' N, longitude 13° 48' E), Central Italy. In a strip plot experimental design with two factors (i.e. LM sowing time and crop cultivar) and three replicates, cauliflower was grown between August 2011 and January 2012 with Burr medic used as living mulch. Three treatments were compared: (i) control (no-LM), (ii) early sown living mulch (at cauliflower transplanting, es-LM) and (iii) late sown living mulch (three week after cauliflower transplanting, ls-LM). The cultivar factor compared a commercial hybrid (Hf_1 Emeraude) with two open pollinated local varieties (CRA-ORA 1B and CRA-ORA 2B).
Experiment 2 – Slovenia*:* It was carried out in the experimental site of the University of Maribor located at latitude 46° 28′ N, longitude 15° 38 ′E, 282 m a.s.l., in Slovenia. In a randomized block experimental design with two factors (i.e. LM sowing time and crop cultivar) and three replicates, cauliflower was grown between June and October 2012 with white clover as living mulch. In this paper, the effect of the first factor (LM sowing time) is discussed. Three treatments were compared: (i) control (no-LM), (ii) early sown living mulch (at cauliflower transplanting: es-LM) and (iii) late sown living mulch (three weeks after cauliflower transplanting: ls-LM). The cultivar factor compared two cultivars: Chambord and Snow ball. The no LM treatment was managed and weeded in accordance to the standard agronomic practices, commonly used by organic farmers in the area, both in Slovenia and Italy. Soil mineral N (sum of NO_3^--N and NH_4^+-N) at a 0-30 cm depth was determined, at planting, fast growing, start of harvest and end of harvest, in Italy, and at planting, fast growing and end of harvest, in Slovenia. Cauliflower yield and cauliflower crop residues, LM and weeds above ground biomass were measured. Total N content of each sample was determined.

Results

The main results regarding cauliflower quality and quantity yield parameters of the experimental sites of Italy and Slovenia are reported in the paper by Canali et al (2014) in the proceedings of this ISOFAR conference. In both sites, cauliflower in treatment es-LM suffered the competition of weeds and living mulch, while no-LM

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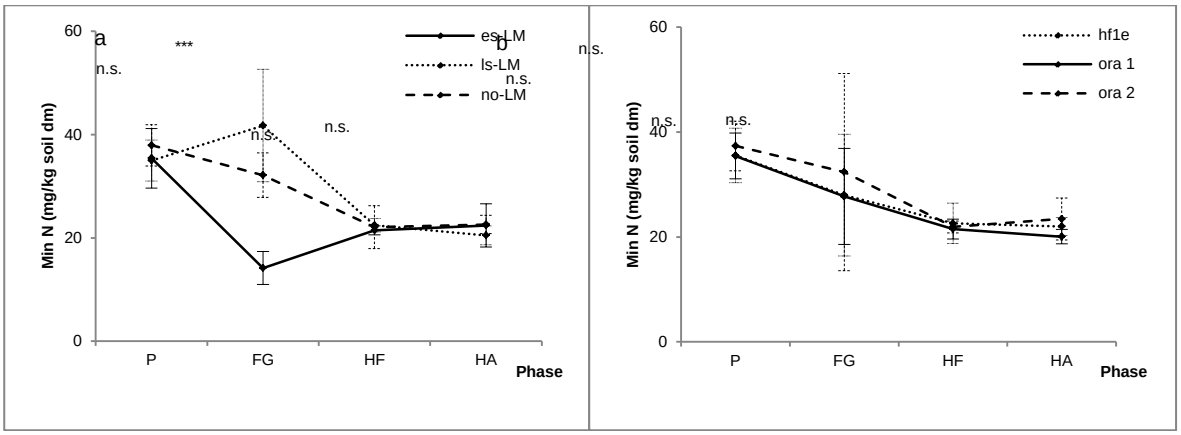
and ls-LM showed similar marketable yields (data not reported). In the Slovenian experiment, the competition of weeds and living mulch in es-LM was so strong that cauliflower was not harvested.

Soil mineral N availability

The amount of available soil mineral nitrogen along the cauliflower growth period is reported in Figure 1, for Italy. The systems of management showed (Figure 1 a) a significant effect on available soil mineral nitrogen at the fast growing phenological phase. At this phase, the early sown living mulch (es-LM) was characterized by a dramatic decrease of soil mineral nitrogen compared to the other two systems of management (no-LM and ls-LM). This trend was probably due to the high amount of mineral nitrogen taken up by weeds and LM whose growth was undisturbed in es-LM compared to ls-LM and no-LM (where mechanical weeding was operated). On the other hand, the cultivars showed no effects on the availability of soil mineral nitrogen during the whole cauliflower cycle (Figure 1 b).

N uptake and components partition in the systems

In Table 1, are reported the amount of nitrogen taken up by the different components of the system and their percentage respect to the total uptake. The es-LM showed the lowest amount of nitrogen taken up by the yield and crop residues and the highest values of N for the weeds. On the other side, no-LM and ls-LM were characterized by a comparable N uptake for all the components of the system showing a similar level of competition compared to weeds. The amount of nitrogen in the LM biomass was low and significantly higher in ls-LM than es-LM. On the other side, the system of management of LM significantly influenced the amount of nitrogen taken up by the weeds. In particular, for N uptaken by weeds, ls-LM was lower than es-LM, showing exactly the opposite pattern of the N uptake of the living mulch component. As far as the cultivar factor is concerned, the hybrid was characterized by a higher amount of nitrogen taken up by both crop yield and residues compared to CRA-ORA 1B and CRA-ORA 2B. For LM and weeds no significant differences were observed. In Figure 2, the amount of available soil mineral nitrogen along the cauliflower growth period**,** for Slovenia**,** is reported. Since in es-LM treatment cauliflower did not grow, soil mineral nitrogen was not determined.



es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch.Hf1e = Emeraude hybrid; ORA 1 = open-pollinated cultivar 1; ORA 2 = open-pollinated cultivar 2; n.s. = no significant differences; *** = P ≤ 0.001 according to DMRT. Bars = ± Standard deviation.

Figure 1 (a, b): Amount of available soil mineral nitrogen along the cauliflower growth period (a: by living mulch system of management) and (b: by cultivar) in Italy.

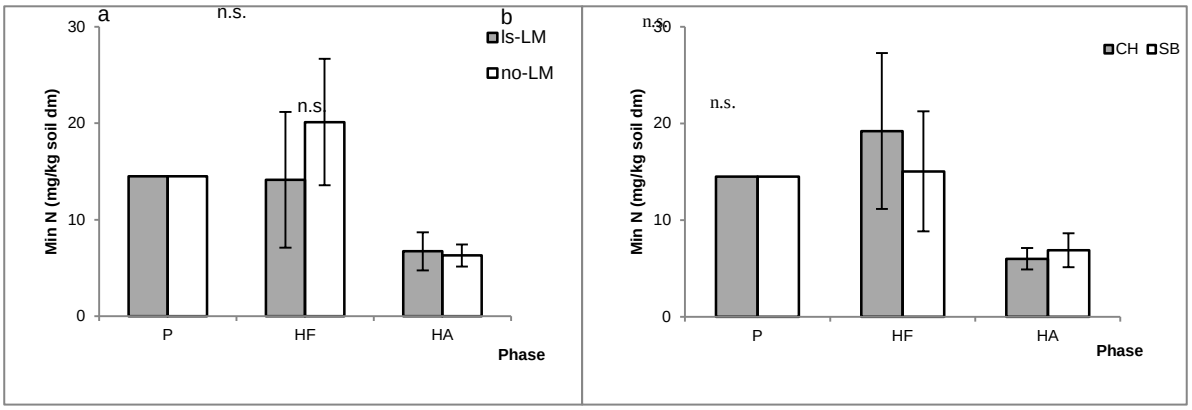
In the other two treatments, no significant differences were observed at the three sampling times (Figure 2a). A very similar trend was observed when soil mineral nitrogen is related to cultivar (Figure 2b).

Table 1:The amount of N taken up (kg N ha^{-1}) by the different components of the systems in Italy related to living mulch system of management and cultivar.

Source of variation	System						Cultivar					
	es-LM	%	ls-LM	%	no-LM	%	Hf1 Eme	%	CRA-ORA 1B	%	CRA-ORA 2B	%
N yield	39.1 b	37	82.3 a	30	95.3 a	36	92.0 a	36	70.9 b	33	60.9 b	33
N crop residues	37.4 b	35	164.2 a	60	164.4 a	63	148.7 a	58	115.4 b	54	81.9 c	45
N living mulch	3.8 b	3	16.8 a	6	-		7.3	3	12.2	6	15.2	8
N weeds	26.4 a	25	9.8 b	4	2.2 b	1	8.7	3	13.7	7	26.2	14
N total	106.7 b		273.1 a		261.9 a		256.7		212.2		184.2	

es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch. Hf1 Eme = Emeraude hybrid; CRA-ORA 1B = open-pollinated cultivar 1; CRA-ORA 2B = open-pollinated cultivar 2.The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the $P \leq 0.05$ probability level.

In Table 2, the amount of nitrogen taken up by the different components of the system is reported. The results showed that, in es-LM, 100% of the nitrogen taken up is in the combination of weeds and living mulch, because cauliflower was not harvested. In the other two treatments, comparable yields were obtained (data not reported) even if N taken up by yield was higher in no-LM than ls-LM.



P = planting, HF = head formation; HA = harvest.ls-LM = late sown living mulch; no-LM = no living mulch. CH = Chambord; SB = Snow Ball. n.s. = no significant differences according to LSD (two comparison). Bars = ± Standard Deviation.

Figure 2 (a, b): Amount of available soil mineral nitrogen along the cauliflower growth period (a: by living mulch system of management) and (b: by cultivar).

On the other hand, as far as the cultivar factor is concerned, weeds (and living mulch) grew more in plots where cv. Snow Ball rather than cv. Chambord was cultivated. An opposite pattern of N taken up was observed for crop residues.

Table 2: Amount of nitrogen taken up by the different components of the systems in Slovenia related to living mulch system of management and cultivar.

Source of variation	System						Cultivar			
	es-LM	%	ls-LM	%	no-LM	%	CH	%	SB	%
N yield	-	-	64.5 b	30	84.5 a	65	72.6	34	76.4	28
N crop residues	-	-	36.6	17	44.9	35	49.3 a	23	32.2 b	12
N weeds/living mulch	139.7	100	113.4	53	-	-	91.2 b	43	161.9 a	60
N total	139.7 b		214.5 a		129.4 b		213.1		270.5	

es-LM = early sown living mulch; ls-LM = late sown living mulch; no-LM = no living mulch. CH = Chambord; SB = Snow Ball.The mean values in each column followed by a different letter are significantly different according to LSD and DMRT (two and more than two comparisons, respectively) at the $P \leq 0.05$ probability level.

Discussion

The results obtained in both the Italian and Slovenian experimental sites showed that the time of living mulch sowing influenced the productive performances and the nutrient competition among cauliflower, LM and weeds. In particular, in Italy, sowing of living mulch legume species at cauliflower transplanting (es-LM) gives to weeds a competitive advantage compared to the cash crop. In Slovenia, weeds in es-LM did not allow cash crop yield at all. Hybrid cultivar, in Italy, showed a better performance compared to the two open pollinated cultivars. On the other side, in Slovenia, Chambord cultivar seemed to better compete respect to weeds and living mulch.

Acknowledgments

This study has been carried out in the frame of the ***InterVeg***research project: Enhancing multifunctional benefits of cover crops – vegetables intercropping (Core Organic II ERA-NET). The project is funded by the National Agricultural Ministries.

References

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