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INFLUENCE OF AMELIORATIVE PLANTS AND MULCH ON SOME SOIL AGROCHEMICAL CHARACTERISTICS IN AN ORGANIC EDIBLE ROSE CROP

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Abstract

The paper presents the evolution of some soil agrochemical parameters: pH, mineral N, P_{AL}, K_{AL} and humus, between March 2015 and November 2016, in an organic edible rose culture under the influence of three ameliorative species and two mulching systems. With the goal of planting three edible rose varieties, in the experimental field of USAMV Bucharest, a special soil preparation was applied in the spring of 2015. Three ameliorative plants, Sinapis alba L., Tagetes patula L. and Phacelia tanacetifolia L., with role in soil disinfection were used in seven different combinations (V1-V7) and a control plot was kept without seeding (V8). After flowering and seed formation, the mature plants were trimmed and incorporated into the soil. After the organic roses planting, the same variants were seeded between the rose rows in the spring of 2016. In the summer of 2016, two mulching variants were applied for each initial variant (Vn), on the roses rows: Vn.1. wood chips and Vn.2. wool, while the control Vn.3., was represented by unmulched soil. The results show important changes on soil characteristics due to the influence of ameliorative species and mulch systems. All the wool variants (Vn.2.) have an important increase of N mineral, from an initial average of 3.375 ppm to 51.375 ppm at V1.2. Sinapis compared to 23.125 at V8.2.Control. The P content increased from 192 ppm to 398 ppm in V4.3. - Sinapis + Tagetes variant. The K content increased from 274.56 ppm in the initial stage to a maximum of 800 ppm in the V1.2. - Sinapis variant on wool mulched row. The humus content modified from 2.37% to 3.12% in more variants (V1.2., V2.3., V2.2., V6.1.). V1.2. Sinapis with wool mulch variant presents the best improvement of agrochemical parameters (pH 7.09; mineral N 51.375 ppm; K 800 ppm and humus 3.12%) compared with the others variants.

Key words: *pH, NPK, humus, wood chips, wool.*

INTRODUCTION

The first principle of organic agriculture, Health, established by IFOAM (IFOAM, 2010) sustain that health of soil, plant, animal, human and planet to be viewed as one and indivisible.

Cover crops and living mulch can be an important component of increasing the fertility and health of soil (Crossland et al., 2015).

Different kind of organic matter have additional positive effects on yield through amelioration of soil life, water retention, humus content and other aspects (van Opheusden et al., 2012; Butcaru et al., 2016; Butcaru et al., 2015).

Intercropping can be a way of increasing crop diversity, especially in the perennial culture (Andersen, 2005; Butcaru et al., 2016).

In the same time, as it is stated by principle of ecology (IFOAM, 2010), the organic agriculture should be based on living ecologicalsystems and cycles, work with them, emulate them and help sustain them.

One of the most important aspects in organic agriculture is improving and maintaining soil organic matter (Reeve, 2007; Berca, 2011).

The availability of nutrients is an important factor in plant growth and was investigated in different organic substrates (Madjar et al., 2004).

The present paper presents the results after using an alternative and innovative method for improving the soil activity by using three ameliorative species: *Sinapis alba* L., *Tagetes patula* L. Sparky Mix and *Phacelia tanacetifolia* L., before and after the plantation of an organic edible rose culture.

From the first year of plantation, two kind of mulch was used: wood chips and wool.

The soil parameters (pH, mineral N, P_{AL}, K_{AL}, humus content), measured before the establishment of the edible rose culture and after one year, reflect the potential of the ameliorative plants and in the same time of the mulch as fertilizer.

MATERIALS AND METHODS

With the special goal of planting three edible rose varieties using an organic technology, an experimental plot at the University of Agronomic Sciences and Veterinary Medicine of Bucharest of a total area of 1,350 m^2 was used.

A special soil preparation was applied beginning with the spring of 2015. Three ameliorative plants, *Sinapis alba* L., *Tagetes patula* L. and *Phacelia tanacetifolia* L., with rolein soil disinfection were used.

Sinapis alba L. (Fam. *Brassicaceae)* is an important spicy and honey plant withmedicinal properties, widely usedas agreen manure and also as an ameliorative plant, effective in fighting soil erosion (De Baets et al., 2011) and weeding etc.

Phacelia tanacetifolia L.(Fam. *Boraginaceae*) has a strong nematocide action; it fixes nitrates in the roots; eliminates weeds, being used to control couch grass (Berca, 2011); presents allopathic effects (Dhimaet et al., 2010). It is a very good honey plant. Liuet et al., 2013, showed the high potential for both cultures to take up phosphorus from the soil and release it later. *Tagetes patula* L. Sparky Mix (Fam. *Asteraceae)* is an ornamental and medicinal plant, used in crop protection due to its natural content of fungicides, insecticides and nematocides substances; controls many nematode species (Hookset et al., 2010).

Crops were sown in late March, by combining the three species in 7 variants: V1 *Sinapis*, V2 *Sinapis* + *Phacelia*, V3 *Phacelia*, V4 *Sinapis* + *Tagetes*, V5 *Sinapis* + *Tagetes* + *Phacelia*, V6 *Tagetes* + *Phacelia*, V7 *Tagetes* and a control parcel V8, was kept as black field, without sowing. After plugging and soil preparation with a rotary cutter, sowing was done simultaneously for all three cultures, with 19kg seeds/ha for *Sinapis*, 38.5 kg seeds/ha for *Phacelia* and 7.5 kg seeds/ha for *Tagetes*.

Sinapis alba L. and *Phacelia tanacetifolia* L. were cultivated without irrigation in the period March to June 2015, the date on which they were trimmed and incorporated into the soil. *Tagetes patula* L. Sparky Mix was irrigated from June to September 2015, when it was incorporated into the soil.

After the organic roses planting, the same variants were seeded between the rose rows in the spring of 2016 and the mature plants were trimmed and incorporated into the soil, all three species in the same time in June 2016.

The roses, planted on three rows on each variant (V1-V8), were supported by wire trellis. A drip system, beginning with July 2016, was installed and operational.

In the summer of 2016, two mulching variants were applied for each initial variant (Vn), on the roses rows: Vn.1. wood chips and Vn.2. wool, while the control Vn.3., was represented by unmulched soil. Both mulched rows had the same 1 m width with the specific material.

Wool is an organic compound recommended also as fertilizer, with 5-6% N, 2-4% P, 1-3% K with a range of effectiveness of 4-9 months after applying (Penhallegon, 2003).

Wood chips are widely recommended in horticulture as mulch.

The inter-row was kept grassy through repeated mowing.

For each variant (V1-V8) was applied the same scheme of treatment, including: fertilising with manure in autumn 2015 at planting and organic products in 2016; plant protection with different organic products; bio stimulatory and caw milk for increasing the immunity system.

For the analysis of the agrochemical characteristics, soil samples were collected from the total area in March 2015, from each variant (Vn.) in October 2015 and from each subvariant (Vn.1. Vn.2., Vn.3.) in November 2016. Agrochemicalanalysisdetermined themineral N, mobile forms of P_{AL} and K_{AL}, the amount of humus and soil pH on two horizons 0-20 cm and 20-40 cm. Measurements were carried out according to the following methodologies: soil moisture by gravimetric method, pH by potentiometric method in aqueous suspension (1:2.5),mineral nitrogen as sum of ammonium and nitrate available in soil evaluated by spectrophotometry, mobile forms of $P_{AL}$and $K_{AL}$by Egner - Riehm - Domingo method, humus content was calculated from organic carbon determination with Walkley - Black - Gogoașă method.

RESULTS AND DISCUSSIONS

The results show important improvement in the soil parameters, specific on each variant.

Table 1. Evolution of pH parameter for 0-20 cm horizon between March (2015) and November (2016) period

Variant	Mar. 2015	Oct. 2015	Nov. 2016		
			Vn.1. Wood chips	Vn.2. wool	Vn.3. un-mulched
V1 – *Sinapis*	7.33	7.58	7.56	7.09	7.60
V2 – *Sinapis* + *Phacelia*		7.27	7.58	7.24	7.61
V3 – *Phacelia*		7.68	7.59	7.54	7.67
V4 – *Sinapis* + *Tagetes*		7.78	7.09	7.07	7.05
V5 – *Sinapis* + *Tagetes* + *Phacelia*		7.68	7.14	7.06	7.24
V6 – *Tagetes* + *Phacelia*		7.93	7.44	7.26	7.48
V7 – *Tagetes*		8.01	7.60	7.31	7.56
V8 – Control		7.90	7.61	7.38	7.55

After an increase of the pH value during the 2015 year for all variants (V1-V8) from a very slightly alkaline to slightly alkaline, at the end of the 2016 year the pH attended values in the scale of neutral reaction for V1.2.-*Sinapis* with wool mulch, V4 –*Sinapis* + *Tagetes* in all three sub-variants (V4.1., V4.2., V4.3.), V5.1.-*Sinapis* + *Tagetes* + *Phacelia* with wood chips and wool.

The sub-variants Vn.2. mulched with wool presents the bigger decreases towards the wood chips mulched and un-mulched sub-variants (Figure 1).

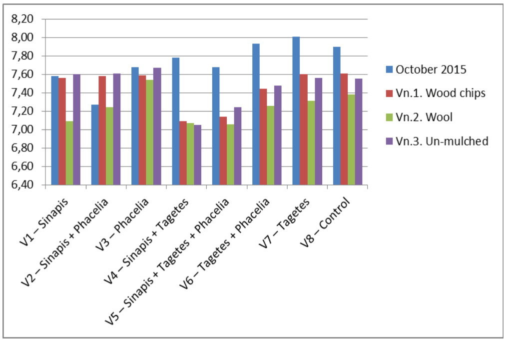

Figure 1. Influence of ameliorative species and mulch on the evolution of pH parameter

In the 0-20 cm horizon, an important evolution was made by the mineral nitrogen, mobile forms of phosphorus and potassium and by humus content.

Table 2. Evolution of mineral N (ppm) for 0-20 cm horizon between March (2015) and November (2016) period

Variant	Mar. 2015	Oct. 2015	Nov. 2016		
			Vn.1. Wood chips	Vn.2. Wool	Vn.3. Un-mulched
V1 – *Sinapis*	3.125	3.625	3.250	51.375	4.500
V2 – *Sinapis* + *Phacelia*		15.875	3.375	41.125	5.250
V3 – *Phacelia*		1.625	13.875	39.250	16.000
V4 – *Sinapis* + *Tagetes*		3.250	3.250	47.250	10.500
V5 – *Sinapis* + *Tagetes* + *Phacelia*		3.500	3.500	40.750	12.750
V6 – *Tagetes* + *Phacelia*		2.500	10.000	53.000	19.375
V7 – *Tagetes*		4.750	3.000	25.375	7.000
V8 – Control		7.375	8.875	23.125	16.125

The bigger mineral N value increases were at all Vn.2. sub-variants, from 1.625 ppm to 39.250 ppm (V3.2. *Phacelia*), 2,500 ppm to 53.000 ppm (V6.2.*Tagetes* + *Phacelia*) or 3.625 ppm to 51, 375 ppm (V1.2.*Sinapis*).

The smallest value at Vn.2. was in the V8 - control variant.

In the V3 - *Phacelia* variant were important increase in all three sub-variants with mulch or un-mulched (Figure 2).

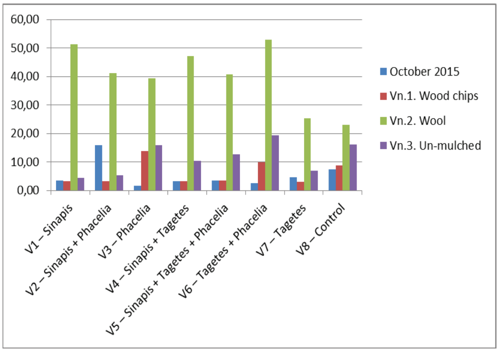

Figure 2. Influence of ameliorative species and mulch on the evolution of mineral N (ppm) parameter

In the wood chips sub-variants, some of them showed a small increase of mineral N (V3.1., V6.1., V8.1.) but most of them presented not influence or decrease of mineral N.

The un-mulched sub-variants present increases of mineral N due to the incorporating the mowed weeds.

Table 3. Evolution of P (ppm) for 0 - 20 cm horizon between March (2015) and November (2016) period

Variant	Mar. 2015	Oct. 2015	Nov. 2016		
			Vn.1. Wood chips	Vn.2. Wool	Vn.3. Un-mulched
V1 – *Sinapis*	192.00	204.40	215.20	281.20	270.40
V2 – *Sinapis* + *Phacelia*		158.80	280.80	242.00	293.20
V3 – *Phacelia*		189.20	174.40	222.40	244.80
V4 – *Sinapis* + *Tagetes*		457.20	329.60	326.00	398.00
V5 – *Sinapis* + *Tagetes* + *Phacelia*		200.00	216.80	222.80	200.40
V6 – *Tagetes* + *Phacelia*		186.40	216.00	238.80	243.20
V7 – *Tagetes*		163.30	192.80	268.80	216.20
V8 – Control		107.60	184.40	181.60	202.40

The P content increases in general in the second year of the research, being at a very high level on the scale.

The V4 variant present a decrease from the October 2015 value, but all the values are bigger than the initial one (March 2015).

The influences of wool much were bigger that of wood chips in the variation of P content. The un-mulched variants presents on average bigger increases than the mulched rows (Figure 3).

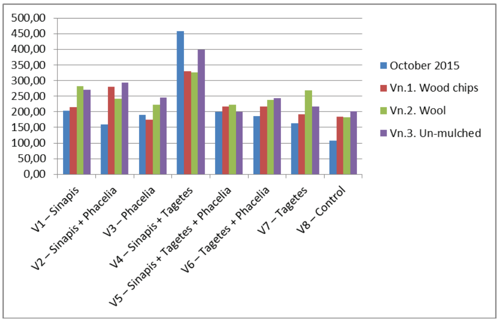

Figure 3. Influence of ameliorative species and mulch on the evolution of P (ppm) parameter

In general, all the variants influenced more the increase of P content than the V8 - control plot.

Table 4. Evolution of K (ppm) for 0 - 20 cm horizon between March (2015) and November (2016) period

Variant	Mar. 2015	Oct. 2015	Nov. 2016		
			Vn.1. Wood chips	Vn.2. Wool	Vn.3. Un-mulched
V1 – *Sinapis*	274.65	349.30	400.00	800.00	420.00
V2 – *Sinapis* + *Phacelia*		287.56	426.00	720.00	440.00
V3 – *Phacelia*		301.93	280.00	560.00	426.00
V4 – *Sinapis* + *Tagetes*		316.31	420.00	600.00	400.00
V5 – *Sinapis* + *Tagetes* + *Phacelia*		388.20	402.00	520.00	410.00
V6 – *Tagetes* + *Phacelia*		474.47	404.00	640.00	430.00
V7 – *Tagetes*		316.31	320.00	524.00	390.00
V8 – Control		316.31	280.00	390.00	320.00

The potassium content increases in general in all variants and sub-variants to a very high content on the scale.

The most important ones are in the Vn.2. sub-variants were are practically more than doubled the amount of potassium (V1.2., V2.2.).

The control plot (V8) had the smallest increase from 316,31 to 390, 00 ppm (Figure 4).

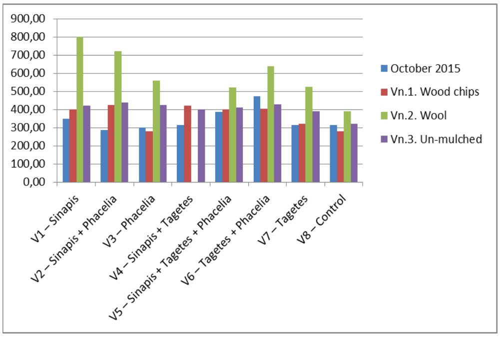

Figure 4. Influence of ameliorative species and mulch on the evolution of K (ppm) parameter

The wood chips and un-mulched sub-variants presented closed values of potassium content.

Table 5. Evolution of humus content (%) for 0-20 cm horizon between March (2015) and November (2016) period

Variant	Mar. 2015	Oct. 2015	Nov. 2016		
			Vn.1. Wood chips	Vn.2. Wool	Vn.3. Un-mulched
V1 – *Sinapis*	2.37	2.49	2.99	3.12	2.87
V2 – *Sinapis* + *Phacelia*		2.24	2.87	3.12	3.12
V3 – *Phacelia*		1.87	2.24	2.99	2.24
V4 – *Sinapis* + *Tagetes*		2.12	2.87	2.49	2.99
V5 – *Sinapis* + *Tagetes* + *Phacelia*		2.37	2.87	2.62	2.62
V6 – *Tagetes* + *Phacelia*		2.74	3.12	2.62	2.87
V7 – *Tagetes*		2.80	2.62	2.87	2.74
V8 – Control		2.49	2.74	2.24	2,24

The humus content increased, being at a medium range on the scale.

The mulched rows influenced in average the same the increase of humus content, more than the un-mulched row (Figure 5).

The control plot has the smallest increases in general comparative with the other variants.

Ameliorative plants used: *Sinapis alba*, *Phacelia tanacetifolia*, *Tagetes patula* `Sparky mix` proved good qualities as ameliorative plants combined also with the two mulch systems – wood chips and wool.

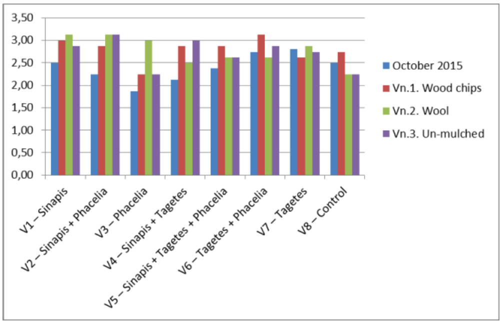

Figure 5. Influence of ameliorative species and mulch on the evolution of humus content (%)

Humus content (%) increased from the initial stage and maintained the positive evolution, as noted also by Crossland et al. (2015), van Opheusden et al. (2012); Butcaru et al. (2016), Reeve (2007), Berca (2011).

Using the ameliorative plants between the rose rows increased crop diversity with positive effects on the basic culture (Andersen, 2005; Butcaru et al., 2016).

Wool, used as mulch, proved also its capacity as fertilizer. Notable increases in Nmineral, P and especially on K in four months after applying recommended it as a good material in orchards as noted also by Penhallegon (2003).

CONCLUSIONS

All three ameliorative plants *Sinapis alba, Phacelia tanacetifolia* and *Tagetes patula* proved important qualities regarding the improvement of the soil parameters (pH, mineral N, mobile forms of P and K, humus content).

Wood chips and wool used as two mulched variants showed important increases in mineral N, K and humus content, especially the second, demonstrating the fertilising quality as well.

In the same time, the pH decreased to a neutral and very slightly alkaline reaction.

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