INFLUENCE OF PLANT DENSITY AND LEAF PRIMING ON SEED AND SEED OIL YIELD

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Introduction

The European Union's (EU) Common Agricultural Policy (CAP) reform of 2004, established a gradual reduction in the incentives for overproduction of tobacco. In Italy, there has been a significant reduction in the tobacco cultivated area since 2010. Added-value products, such as Tobacco

Figure 1. Tobacco seed pods at different ripening stage.

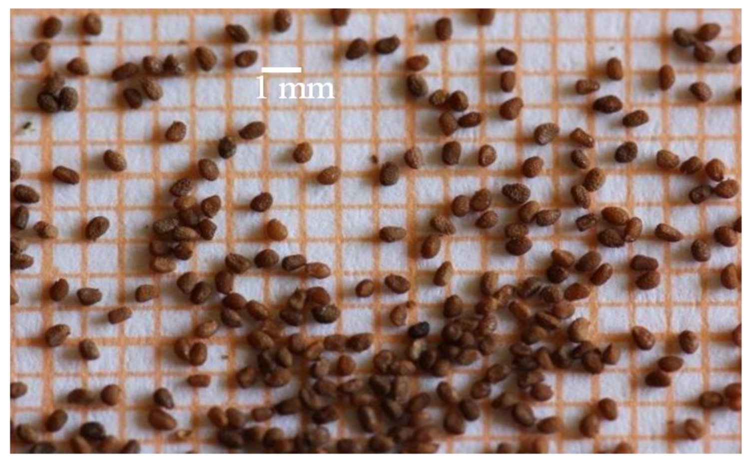


Figure 2. Tobacco seed.

Seed Oil (TSO), could enhance economic returns to tobacco farmers and avoid further reduction of the cultivated area. It is known that tobacco seed is rich in oil, free of nicotine and is classified as semi-drying oil. At maturity, the inflorescence of the tobacco plant (terminal panicles more or less expanded), present seed pods (two celled fruit) (Fig. 1). These pods bear numerous tiny oval-shaped seeds (Fig. 2), 0.7 mm long, 0.5 mm wide and 0.5 mm thick, weighing about 80-90 mg. TSO content varies from 30-40% (Paris, 1920; Chi and Tso, 1968; Abbas *et al.*, 2008) and is comparable to mustard, sunflower and sufflower. The main fatty acids in TSO are Linoleic acid (65-75%), Oleic acid (10-16%), Palmitic acid (8-11%) and Stearic acid (2-3%) (Frega *et al.*, 1991; Lotti e Izzo, 1971).

In the first half of the last century, Italy (Fig. 3 (A) and 3 (B)) and some Eastern European countries, used the tobacco seeds and by-product of tobacco leaf production for the extraction of oil as raw material in the production of soaps, paints, lubricants, fuel, or after refining, even as food (Balbi, 1959). In the last few years, due to the need to find renewable energy sources and reduce the environmental impact, the feasibility of using tobacco, a no-food crop, as a source of vegetable oil in different industrial sectors (Giannelos *et al.*, 2002) is being explored. Recent studies show that high quality biodiesel fuel can be produced from tobacco seed oil as a no-food renewable energy source (Usta *et al.*, 2011, Bucciarelli *et al.*, 2012).

Figure 3. (A) Tobacco panicles at drying. (B) Keystroke and ginning of tobacco panicles (from Francucci, 1937).

The possible use of seed cake and stalks must also be taken into account, in the economic evaluation of oil production from tobacco (Fig. 4). Seed cake, rich in protein and fiber, but devoid of alkaloids might be utilized for animal feed (Brozzetti, 1948a, 1948b; Masters and Guzman, 1993; Abbas *et al.*, 2008,) and stalks as biomass or for paper production (Shakhes *et al.*, 2011).

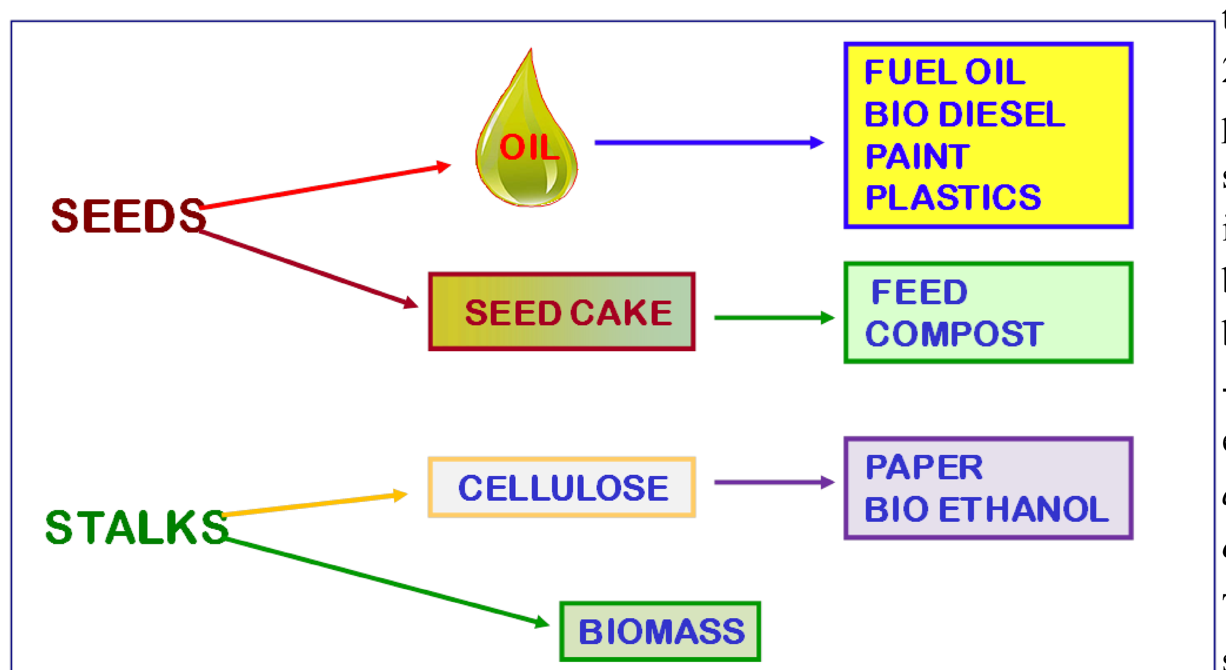


Figure 4. Added-value products of tobacco.

Objectives

This research aims at evaluating the effect of plant density and leaf priming on seed and seed oil yield in two tobacco lines in order to assess the possibility of diversifying the usage pattern of tobacco crop.

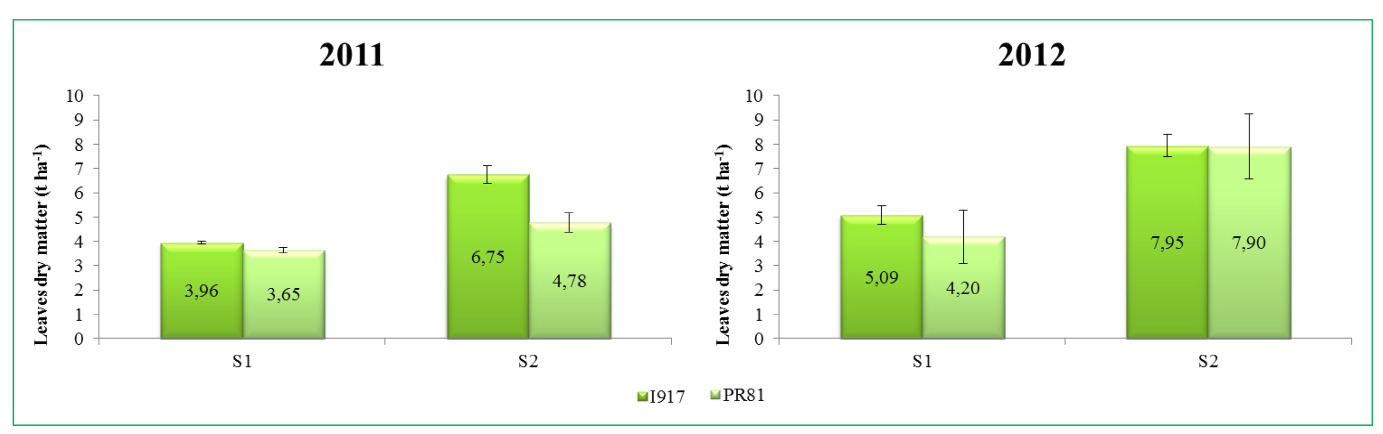
Materials and Methods

The trial was carried out in the year 2011 and replicated in 2012 in COTIR research center located in Vasto, province of Chieti (Abruzzo, Italy). The experiments were performed on a soil of alluvial origin with a medium texture, consisting of organic matter nitrogen and phosphorus and rich in potassium. Two tobacco genotypes, with high seed yield (I917 and Pr81), belonging to CRA-CAT, were assayed at two plant densities (S_1 = 4 plants m^{-2} and S_2 = 8 plants m^{-2} respectively) and using two harvesting procedures (M_1 and M_2). For M_1, three leaf priming was carried out during the growing period and the panicles were collected at the end of the vegetative cycle, together with the remaining leaves. Whereas, for M_2, leaves and panicles were harvested at the end of the vegetative cycle. A split-plot experimental design, with three replicates, was utilized; the experimental unit was 20 m^2 in size. The following parameters were recorded: height of the plant, the time of flowering, leaf dry matter production and seed yield. During the growth period, disease and pest control was practiced as usual for the culture.

Results and Discussion

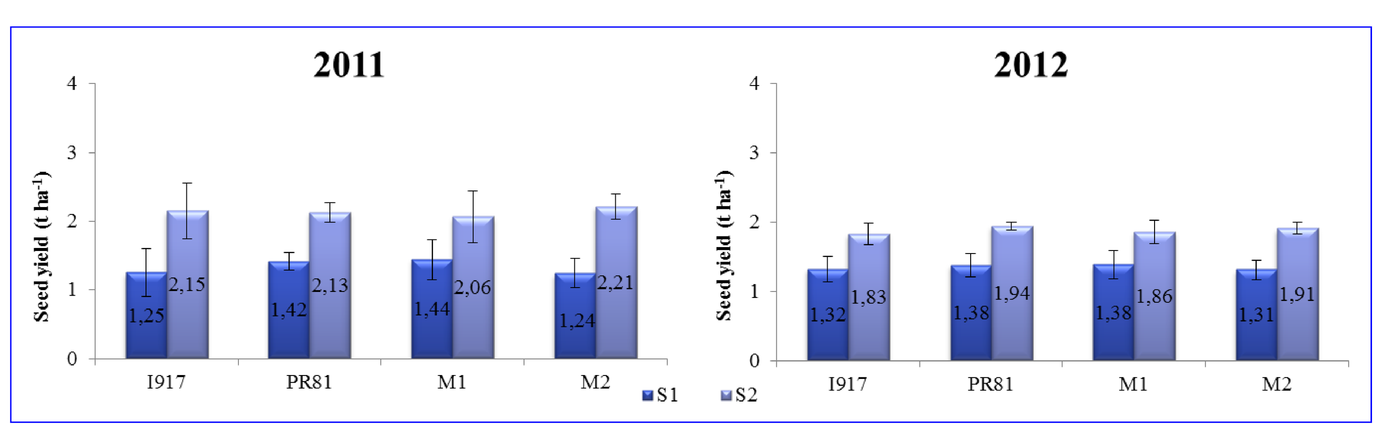
Throughout the trial no significant effects of harvesting procedures and genotypes were observed on plant height. Significant effect of plant density on plant height (162 cm at S_2; 156 cm at S_1), flowering (91 and 86 days after transplanting at S_2 and S_1 respectively) and leaf production was registered. Increase of 34% (5.76 t ha^{-1} vs 3.8 t ha^{-1}) and 41% (7.92 t ha^{-1} vs 4.64 t ha^{-1}) was registered at plant density S_2, in 2011 and 2012 respectively. As far as genotypes are concerned, I917 showed a leaf dry matter production higher than Pr81 (6.75 t ha^{-1} and 3.96 t ha^{-1} respectively), at plant density S_2, in the year 2011 only (Graph. 1).

No significant effects of harvesting procedure and genotype were registered on seed



Graph. 1. Leaves dry matter production of two tobacco genotypes at two plant density.

yield, both in year 2011 (2.14 t ha^{-1} vs 1.34 t ha^{-1}) and in 2012 (1.89 t ha^{-1} vs 1.35 t ha^{-1}) (Graph. 2). From the comparison of the two years it was noted that in 2012 a higher



Graph. 2. Seed yield of two tobacco genotypes under primed and unprimed condition at two plant density.

leaf production was obtained, than in 2011 (6.28 t ha^{-1} vs 4.78 t ha^{-1} respectively), but a slightly lower seed yield (1.62 t ha^{-1} vs 1.74 t ha^{-1}) was registered.

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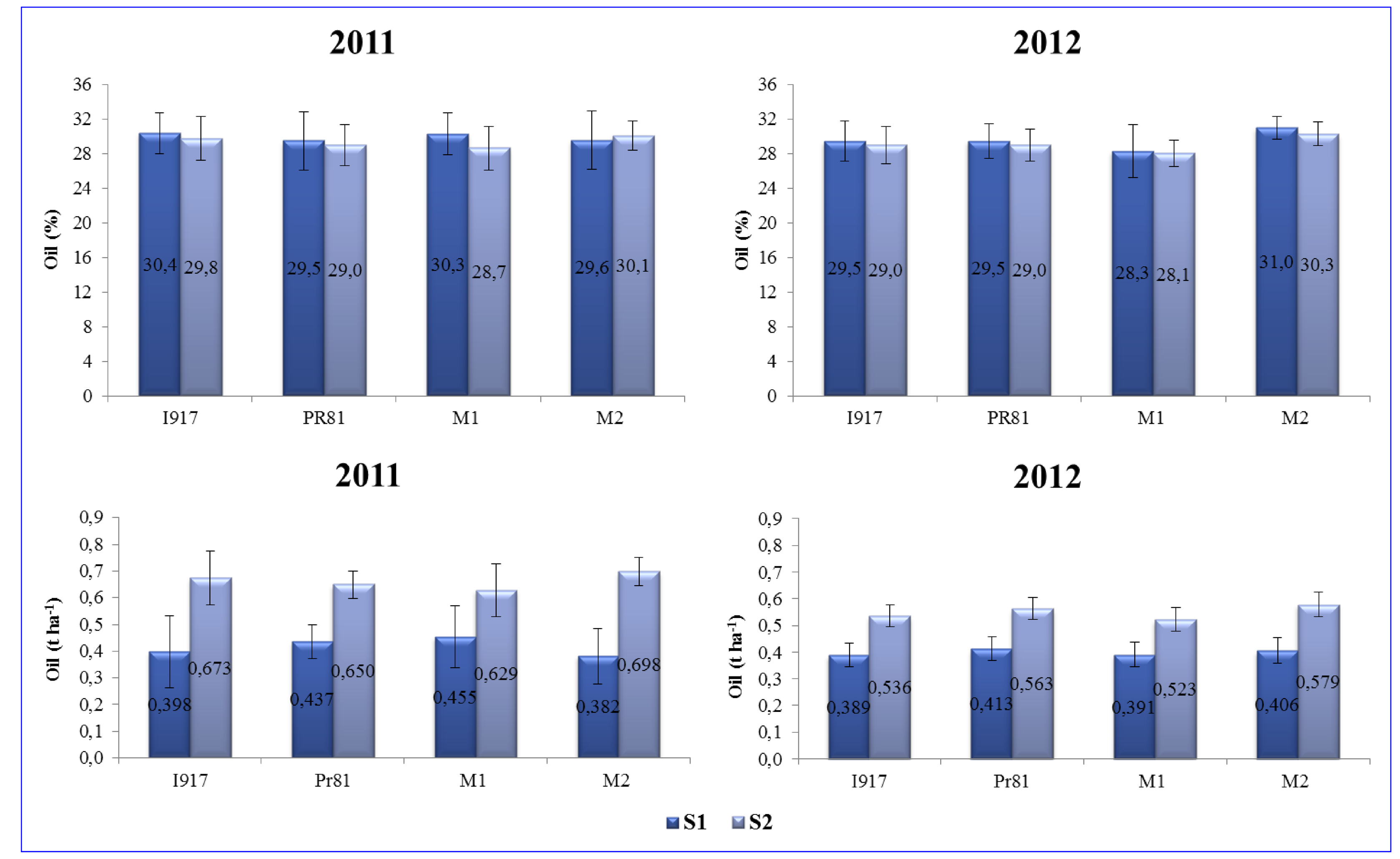
In Graph. 3 seed oil content and oil yield per hectare, with different harvesting procedures and at different plant densities, for both genotypes are shown. No significant effect of genotype and harvesting procedures was observed on seed oil content and oil yield per hectare. With regards to plant density, no significant effect was revealed on seed oil content (29.9% at S_1 vs 29.3% at S_2). A significant increase of oil yield at S_2, with respect to S_1 was observed (0.606 t ha^{-1} at S_2 and 0.409 t ha^{-1} at S_1). Average seed oil contents were similar in the two years, while oil production per hectare in the second year was slightly lower than the previous year (0.475 t ha^{-1} compared to 0.539 t ha^{-1} in 2011).



Graph. 3. Seed oil content and seed oil yield of two tobacco genotypes under primed and unprimed condition at two plant density.

Conclusion

The results obtained, show that seed production and seed oil content were not affected by unprimed and primed conditions for both the tobacco genotypes assayed. Seed and seed oil yield as well as leaf production increased at the plant density higher than what is usual for tobacco crop. Indeed, an increase of 33.3%, 32.5% and 38.5%, on average of seed, oil and leaf dry matter yield, respectively, was observed. Research is in progress to evaluate the quality of cured leaves of the tobacco genotypes for high seed yield.

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