

Effects of by-product of the olive oil mill process on germination and early seedling growth of grasspea (*Lathirus sativus* L.), common vetch (*Vicia sativa* L.) and hairy vetch (*Vicia villosa* Roth) seeds

Fatih Killi and Adem Erol

University of Sutcu Imam, Faculty of Agriculture, Department of Field Crops, Kahramanmaras 46060, Turkey

(Received: 07 August, 2004 ; Accepted: 21 March, 2005)

Abstract: This experiment was undertaken to study the effects of by-product (vegetation water) of the olive oil mill on seed germination and early seedling growth of grasspea (*Lathirus sativus* L.) common vetch (*Vicia sativa* L.) and hairy vetch (*Vicia villosa* Roth). Characteristics of seed such as imbibition, germination percentage, length and dry weight of radicle and hypocotyl were studied at three different durations [0 (control), 5, 15 and 25 hours] of vegetation water. It was found that vegetation water has a great bio-stimulant potential due to its positive effects on germination percentage and early seedling growth.

Key words: By-product, Olive mill waste, Vegetation water, Legume seeds, Germination, Seedling growth.

Introduction

Environmental pollution problems resulting from wastes of factories have been one of the most controversial problems for the public in recent years. Olive mill waste such as vegetation water is a significant source of potential or existing environmental pollution in the Mediterranean countries (Bejerano and Madrid, 1992). Olive oil mills are small agro-industrial units located mainly in the Mediterranean, Aegean and Marmara regions that account for approximately 95% of the worldwide olive oil production. They process olives for the extraction of olive oil either by a discontinuous press (classical process) or a solid/liquid centrifuge (centrifugal process). Both of these processes produce two waste streams, namely olive pomace (or prina) and vegetation water (or black water). In the olive growing countries of the Mediterranean zone (Greece, Italy, Lebanon, Portugal, Spain, Syria, Tunisia and Turkey) olive oil mill effluents production is more than 30 million m³ per year (Beccari *et al.*, 1996). Isikli (1992) reported that 120 m³ of vegetation water is produced from each 100 ton olive in olive oil mills that use continuous extraction system of oil. Vegetation water has the appearance of a brown colour and a pleasant odour but a bitter taste. This effluent, which has relatively high organic matter content, constitutes a source of pollution which creates a serious problem for the olive industry. Vegetation water is utilized for different purposes such as fertilizer (Garcia-Ortiz *et al.*, 1999; Tejada and Gonzalez, 2003), maintenance of soil fertility (Tejada *et al.*, 2001; Tejada and Gonzalez, 2004), mixing with irrigation water (Briccoli-Bati and Lombardo, 1990; Ben Rouina *et al.*, 1999; Garcia-Ortiz *et al.*, 1999) and in animal rations (Martilotti, 1983). Although there is available information about the utility of vegetation water for different purposes, partly mentioned above, there is little information on the effects of vegetation water on the germination and seedling growth of field crops such as legumes, especially on vetch having hard seeds.

The objective of this work was to study the effect of vegetation water on germination and early seedling growth of seeds of three legume crops and to evaluate its utility to increase germination rates of hard seeds.

Materials and Methods

Seeds of three legume crops, grasspea (*Lathyrus sativus* L.), common vetch (*Vicia sativa* L.) and hairy vetch (*Vicia villosa* Roth) were selected based on adaptation to the East Mediterranean Region of Turkey. Vegetation water used as liquid was obtained from one of the running olive oil mill in the Kahramanmaras province. In this study, general properties of vegetation water were not evaluated. Many studies have evaluated the general properties of vegetation water. According to these studies, general properties of the vegetation water are listed in Table 1 (Codounis, 1973; Cucurachi, 1973; Fiestas Ros de Ursinos, 1981). The study was conducted at Agricultural Faculty's laboratory of Kahramanmaras Sutcu Imam University using a completely randomized design with five replications (twenty seeds were tested in each replication). Firstly, all seeds and equipment were sterilized in 5% sodium hypochlorite for 5 minutes and rinsed well with double distilled water (Anonymous, 1985). The seeds were treated one week after the vegetation water collected. Until the treatment it was kept in plastic container at the lab conditions. Seeds were fully immersed in vegetation water at the room temperature for 0, 5, 15 and 25 hours. The same vegetation water was used for all treatments. At the end of the immersions, seeds were rinsed thoroughly with distilled water and lightly hand dried using blotting paper. After that, seeds were placed between two layers of filter paper in petri dishes. Petri dishes were placed into a germination cabinet at 25°C constant temperature at 3000 lux-florescent light (12 hours/day) (Maguire, 1962; Anonymous, 1985). All seeds were considered as physiologically germinated when the radicle was approximately 3 mm length. At the end of the 7th day, germination percentage, radicle and hypocotyl length were

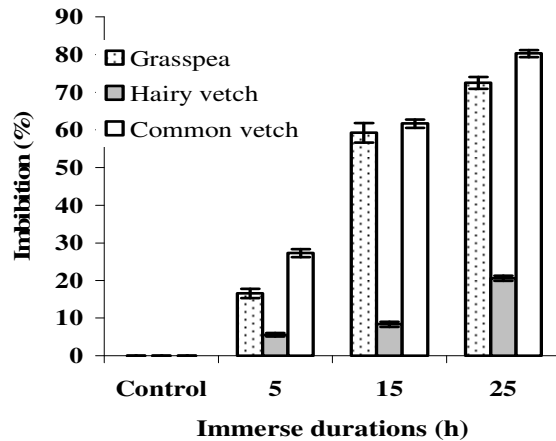


Fig. 1: Effect on imbibition of three legume seeds immersed in vegetation water at different durations.

Table-1: General properties of the vegetation water.

Chemical content	Minimum	Maximum
pH	4.42	5.41
Water (%)	83	88
Solid matter (%)	4.0	6.0
Organic matter (%)	20.0	24.0
Salt (μ mhos/cm)	5463	5806
Ash (%)	1.5	2.0
Crude protein (%)	1.25	8.0
Polyphenols (%)	1.0	1.5
Colour	Red	-
Oil (%)	0.10	1.50
N (%)	0.50	1.50
P (%)	0.50	3.85
K (%)	1.0	1.1
Ca (%)	2.36	3.98
Mg (%)	0.98	1.86
Na (%)	0.01	2.06
Fe (%)	1000	9318
Zn (%)	230	430
Mn (%)	100	977
Cu (%)	68	110
B (%)	28	35
Co (%)	negligible	0
Mineral matters (550°C)	2085	6728
Volatile solid matter (ppm)	12071	40691
Biological oxygen demand (ppm)	23000	44000

determined as described by Dalanian (1982). Imbibition ratio was calculated by equation [(imbibed seed weight-dry seed weight)/dry seed weight] x 100 (Ahmad and Ibrar, 1996). Samples of radicle and hypocotyl were dried in the air-forced oven at 70 °C and weighed. Statistical analysis was performed

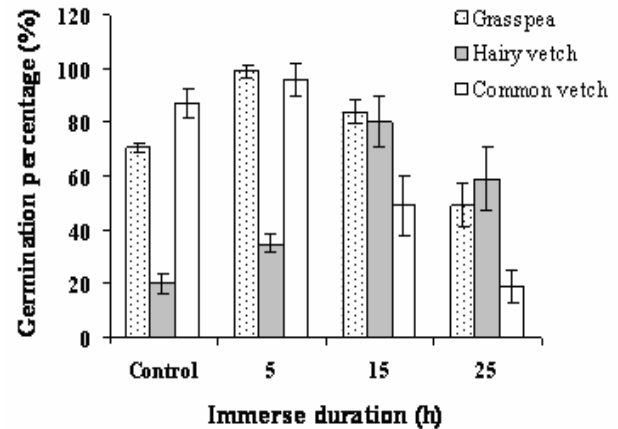


Fig. 2: Effect on germination percentage of three legume seeds at different immerse durations in vegetation water.

by the MSTAT-C statistical programme, and means were separated by use of LSD test at $p < 0.05$.

Results and Discussion

Effects of vegetation water at different immerse durations on seed imbibition, germination percent, radicle and hypocotyl length, dry weight of radicle and hypocotyl of seeds three legume crops were significant (Figs. 1, 2, 3, 4, 5 and 6). Response of legume seeds to vegetation water was different in different species. As a general trend, seed imbibition increased as immerse durations increased (Fig.1). Hairy vetch had significantly lower seed imbibition than the other seeds in three immerse durations and seed imbibition was highest at 25 hr duration. The low imbibition in hairy vetch seeds can be explained by low seed coat permeability or hard seed (Mayer and Poljakoff-Mayber, 1963).

Germination percentages of three different legume seeds were significantly affected by immerse durations (Fig. 2). The five-hour immerse duration produced the highest germination percentage (approximately 95%) for grasspea and common vetch. But it produced the lowest germination percentage for hairy vetch. When duration was lengthened from 5 hr to 15 hr, the germination percentage of hairy vetch increased 100% because of pH degree of vegetation water. Kacar (1989) reported that treating with acid or alcohol of hard seeds increased the germination percentage of seeds. The positive effect of vegetation water on seed germination has been verified in field studies (Tejada and Gonzalez, 2003). There was reduction in the germination percentage in grasspea and common vetch at 15 hr and 25 hr immerse durations, while germination percentage increased in hairy vetch at 15 hr immerse durations. These different results by species can be explained by structure of seed coat of species.

The five-hour treatment for grasspea and common vetch seeds, and 15 hr treatment for hairy vetch seeds improved radicle and hypocotyl length compared with untreated (control) seeds (Fig. 3 and 4). The twenty-five treatment with

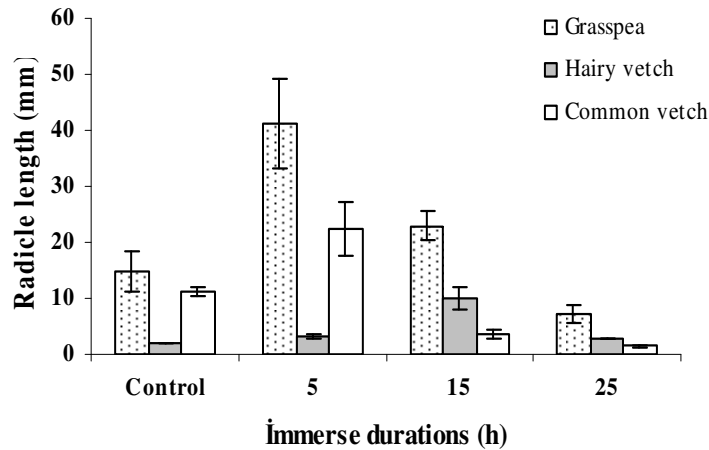


Fig. 3: Effect on radicle length of three legume seeds at different immerse durations in vegetation water.

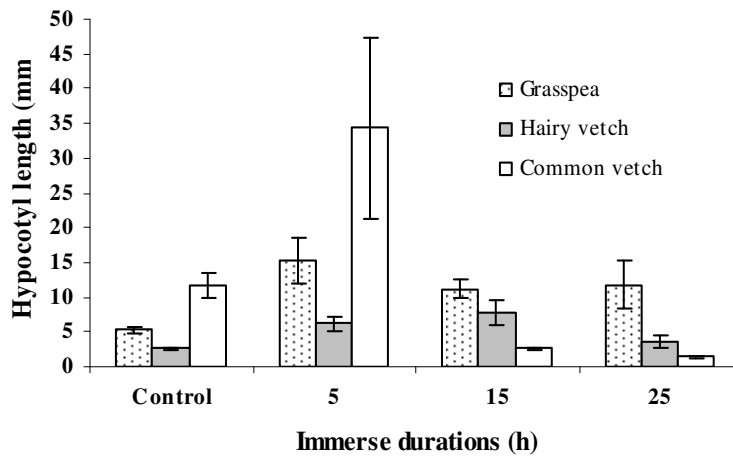


Fig. 4: Effect on hypocotyl length of three legume seeds at different immerse durations in vegetation water.

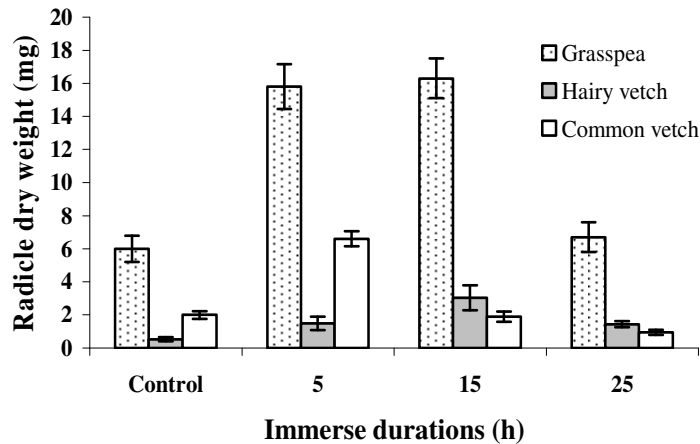


Fig. 5: Effect on radicle dry weight of three legume seeds at different immerse durations in vegetation water.

vegetation water for the three legume seeds gave the lowest radicle and hypocotyl lengths. The effects of vegetation water on radicle and hypocotyl dry weight were significant (Fig. 5 and 6). The highest radicle and hypocotyls dry weight were

obtained with 5 hr treatment in grasspea and common vetch, and 15 hr treatment in hairy vetch compared with control treatment. As the immerse durations of vegetation water increased radicle and hypocotyl dry weight decreased.

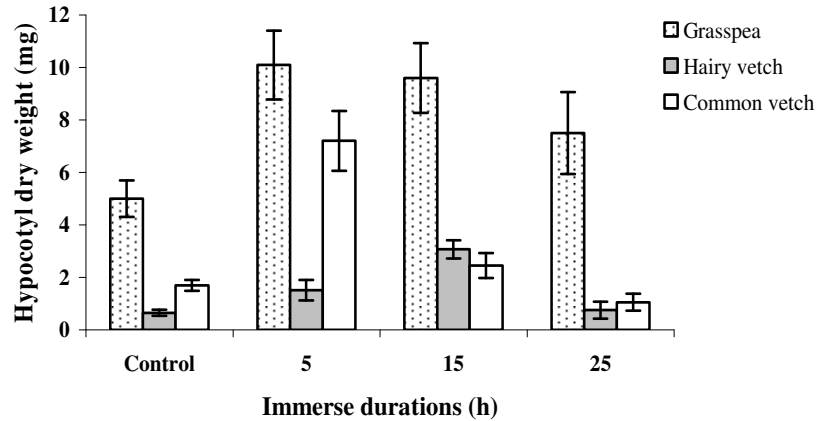


Fig. 6: Effect on hypocotyl dry weight of three legume seeds of vegetation water at different immerse durations.

In conclusion, immerse durations in vegetation water provided rapid and highest imbibitions and germination percentage, and also the highest values of early seedling growth characteristics. Improved radicle and hypocotyl length compared with untreated, which was found in 5 hr immerse durations for grasspea and common vetch seeds and 15 hr immerse durations for hairy vetch seeds may be as alternative bio-stimulant for germination and early seedling growth characteristics. Therefore, treating of seeds especially hard seeds with vegetation water before planting may be useful to provide a good stand establishment and to utilize of this by-product as bio-stimulant.

References

- Ahmad, S. and R. Ibrar: Differential water imbibitions in wheat varieties related to germination. *Pak. J. Bot.*, **28**, 103-108 (1996).
- Anonymous: International rules for seed testing. *Seed Sci. Technol.*, **13**, 299-520 (1985).
- Beccari, M., F. Bonemazzi, M. Majone and C. Riccardi: Interactions between acidogenesis and methanogenesis in the anaerobic treatment of olive mill effluents. *Water Res.*, **30**, 183-189 (1996).
- Bejerano, M. and L. Madrid: Solubilization of heavy metals from a river sediment by a residue from olive oil industry. *Environ. Tech.*, **13**, 979-985 (1992).
- Ben Rouina, B., H. Taamallah and E. Ammar: Vegetation water used as a fertilizer on young olive plants. *ISHS Acta Hortic.*, **474**, 72-74 (1999).
- Briccoli-Bati, C. and N. Lombardo: Effects of olive oil waste water irrigation on young olive plants. *ISHS Acta Hortic.*, **286**, 99-101 (1990).
- Codounis, M.: Report on the possibilities of utilizing residues of the Greek agricultural industries (plant production) as feeding stuffs. Ministry of National Economy, Athens, Greek (1973).

- Cucurachi, A.: Aspetti del problema dello smaltimento delle acque di vegetazione delle olive in relazione agli inquinamenti, con particolare riferimento alla Regione Abruzzo. *Ann. Ist. Sper. Elaiot.*, **3**, 69-86 (1973).
- Dalianis, C.D.: Rate of radicle emergence as measure of seedling emergence and vigor in cotton (*G. hirsutum* L.). *Seed Sci. Tech.*, **10**, 35-45 (1982).
- Fiestas Ros de Ursinos, J.: Differentes utilisations des margines: recherches en cours, resultats obtenus et applications. Seminaire International sur la valorisation des sous-produits de l'olivier - PNUD/FAO/COI - Monastir, Tunisia, 93-95 (1981).
- Garcia-Ortiz, A., G. Beltran, M. Uceda, M. Hermoso, P. Gonzalez, R. Ordonez and J.V. Giraldez: Vegetation water application effects on soils and plants. *ISHS Acta Hortic.*, **474**, 155-157 (1999).
- Işıklı, T.: Farklı Teknoloji Uygulanan Zeytinyağı Fabrikalarında Elde Edilen Karasuyun Analitik Özelliklerinin Tespiti Üzerine Araştırma. Tarım ve Köy İşleri Bakanlığı Zeytincilik Araştırma Enstitüsü Yayınları No: 56, Bornova, İzmir (1992).
- Kacar, B.: Plant Physiology: Seed and germination. Ankara University, Agricultural Faculty, Soil Science Department, Publish No: 1153, p.1-42, Ankara, Turkey, (1989).
- Maguire, J.D.: Seep of germination aid in selection and evaluation for seedling emergence and vigor. *Crop Sci.*, **2**, 176-177 (1962).
- Martilotti, F.: Use of olive by-products in animal feeding in Italy. Animal production and health division, FAO, Rome, (1983).
- Mayer, A.M. and A. Poljakoff-Mayber: The germination of seeds. The Macmillan Co., New York, (1963).
- Tejada, M. and J.L. Gonzalez: Application of a byproduct of the two-step olive oil mill process on rice yield. *Agrochimica*, **47**, 94-102 (2003).
- Tejada, M. and J.L. Gonzalez: Effects of application of a by-product of the two-step olive oil mill process on maize yield. *Agron. J.*, **96**, 692-699 (2004).
- Tejada, M., C. Ordonez and J.L. Gonzalez: Utilization of a byproduct of the two-step olive oil mill process on wheat yield under dry-land conditions. *Agrochimica*, **45**, 199-206 (2001).

Correspondence to :

Dr. Fatih Killi

Assoc. Prof., Kahramanmaraş Sutcu Imam University

Agriculture Faculty, Field Crops Department

46060 Kahramanmaraş, Turkey

E-mail: fakilli@ksu.edu.tr

Tel.: +90-344-223 76 66

Fax: +90-344-223 00 48