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Evaluation of Humic Acid Effect on Essential Oil Yield in Yarrow Medicinal Plant by View of Approaches in Sustainable Agriculture

Behzad Sani[1] and Vida Jodaeian[2]

[1]Department of Agronomy, Shahr-e-Qods Branch, Islamic Azad University, Tehran, Iran
[2]Department of Chemistry, Islamshahr Branch, Islamic Azad University, Tehran, Iran
E-mail1: [1]dr.b.sani@gmail.com, [2]hvidajodaian@yahoo.co.nz

Abstract—*There is increasing concern about human health and environmental contamination risks associated with the extensive use of mineral fertilizer. Organic matter is a fundamental in soil, but dynamic component of soils that influences the many chemical, physical and biological properties that regulate soil productivity. Objective of using humic substances in plant is to balance vegetative and reproductive growth as well as to improve yield. This experiment was conducted to complete randomized block design with four replications at Islamic Azad University Shahr-e-Qods Branch, Tehran, Iran. In this study, field trials were conducted to evaluate the influence of Humic Acid on the development and yield of yarrow (Achillea millefolium L.). Results showed that the Humic Acid significantly improved the development and yield. The finding may give applicable advice to eco farmer and agricultural researchers and the objectives of this study were to effect of Humic Acid on Essential oil and Flowering shoot yields in yarrow (Achillea millefolium L.).*

Keywords*: Humic Acid, Essential oil, Yarrow and Sustainable Agriculture.*

1. INTRODUCTION

Achillea millefolium or yarrow is a flowering plant in the family Asteraceae, native to the Northern Hemisphere. In Spanish-speaking New Mexico and southern Colorado, it is called plumajillo, or "little feather", for the shape of the leaves. In antiquity, yarrow was known as herbal militaris, for its use in staunching the flow of blood from wounds. Other common names for this species include common yarrow, gordaldo, nosebleed plant, old man's pepper, devil's nettle, sanguinary, milfoil, soldier's woundwort, thousand-leaf (as its binomial name affirms), and thousand-seal. Common yarrow is an erect herbaceous perennial plant that produces one to several stems (0.2 to 1m tall) and has a rhizomatous growth form.

Leaves are evenly distributed along the stem, with the leaves near the middle and bottom of the stem being the largest. The leaves have varying degrees of hairiness (pubescence). The leaves are 5–20 cm long, bipinnate or tripinnate, almost feathery, and arranged spirally on the stems. The leaves are cauline and more or less clasping. The inflorescence has 4 to 9 phyllaries and contains ray and disk flowers which are white to pink. There are generally 3 to 8 ray flowers that are ovate to round. Disk flowers range from 15 to 40. Yarrow has also been used as a food, and was very popular as a vegetable in the seventeenth century. The younger leaves are said to be a pleasant leaf vegetable when cooked as spinach, or in a soup. Yarrow is sweet with a slight bitter taste. The leaves can also be dried and used as a herb in cooking. Yarrow has seen historical use as a medicine, often because of its astringent effects. Decoctions have been used to treat inflammations, such as hemorrhoids, and headaches. Confusingly, it has been said to both stop bleeding and promote it. Infusions of yarrow, taken either internally or externally, are said to speed recovery from severe bruising. The most medicinally active part of the plant is the flowering tops. They also have a mild stimulant effect, and have been used as a snuff. Today, yarrow is valued mainly for its action in colds and influenza, and also for its effect on the circulatory, digestive, excretory, and urinary systems. In the nineteenth century, yarrow was said to have a greater number of indications than any other herb. It is believed that anti-allergenic compounds can be extracted from the flowers by steam distillation. The flowers are used to treat various allergic mucus problems, including hay fever. Flowers used in this way are harvested in summer or autumn, and an infusion drunk for upper respiratory phlegm or used externally as a wash for eczema. Inhale for hay fever and mild asthma, use fresh in boiling water. The dark blue essential oil, extracted by steam distillation of the flowers, is generally used as an anti-inflammatory or in chest rubs for colds and influenza. On the other hand, humic acid has beneficial effects on nutrient uptake by plants and was particularly important for transportation and availability of micro nutrient (Bohme and Thi, 1997).

Humic acids (HAs) are termed polydisperse because of their variable chemi-cal features. From a three dimensional aspect these complex carbon containing compounds are considered to be flexible linear polymers that exist as random coils with cross-linked bonds. On average 35% of the humic acid (HA) molecules are aromatic (carbon rings), while the remaining compounds are in the form of aliphatic (carbon chains) molecules. The molecular size of humic acids range from approximately 10,000 to 100,000. Atiyeh *et al.* (2002) stated that humic acid could enhance seedling growth of tomato and cucumber plant. Soil organic matter contains residues of plants and animals and primary and high polymer organic compounds formed by their decomposition. Soil organic matter has not certain chemical formula due to its dynamic structure. Soil organic matter mainly consists of humic and fulvic acids which are called humin materials (Schnitzer 1982; Andriesse 1988). Humic is technically not a fertilizer, although in some walks, people do consider it that, Humic is an effective agent use as a complement to synthetic or organic fertilizers. In many instances, use of Humic regularly, will reduce the need for fertilization due to the soil's and plant's ability to make better use of it. In some occurrences, fertilization can be eliminated entirely if sufficient organic material is present and the soil can become self sustaining through microbial processes and humus production. Whenever possible, the use of Humic with fertilizer, Humics' ability to absorb fertilizer components and increases their release to plants is well documented. The judicious use of Humic and fertilizer, will improve the performance of marginally fertile soils, of soils with low native organic matter, and of crops grown in arid regions (Chen and Aviad, 1990). One of the used organic-mineral fertilizers is humic acid. By the application of Humic substance to plants, the growing plants are supplied with food, its application also results in productive and fertile soil, which increase the water holding capacity of soil. It plays a pivot role in making the plants more resistant against drought stress, and also stimulates germination. The application of Humic reduces the requirement of other fertilizers. It also increases crop yield, soil aeration, and drainage can also be improved by Humic, theestablishment of desirable environment for the development of microorganisms. Increase in the protein and mineral contents of most crops is possible by the application of Humic substances. The application of Humic substances increased the yield in soybeans, potatoes, and algae cultures. It also plays an important role in increasing the fruit yield, also the quality of squash plants are increased by Humic substances application. 100% increase in the yield of potatoes and cabbage can be achieved by combined application of NPK fertilizers and Humics (Syabryai *et al.*, 1965). Humic acids are negatively charged colloid recalcitrant to biodegradation so it can be stored in soil for a long time (Qualls, 2004). In particular, they increase membrane permeability, facilitate transport of essential elements within roots and favor respiration. As indicated by Vaughan (1985), humic substances act in a very similar way to growth hormones. HA were found to promote soil water holding capacity and reduce watering requirements for plants (Hynes and Naidu, 1998). Humic substances are major components of organic matter, often constituting 60 to 70% of the total organic matter (Schnitzer and Khan, 1972). The objectives of this study were to evaluation of humic acid effect on essential oil yield in yarrow medicinal plant by view of approaches in sustainable agriculture.

2. MATERIALS AND METHODS

This study was conducted on experimental field of Islamic Azad University, Shahr-e-Qods Branch at Iran (27°38' N, 40°21' E; 1417 m above sea level), with clay loam soil (Table 1). The experimental unit had designed by achieved treatments in completely randomized block design with four replicates. The soil consisted of 25% clay, 30% silt and 45% sand (Table 1) and further the field was prepared in a 15 m2 area (5m × 3 m). At the end of growth stage we collected 10 plants from each plot randomly for determination of plant characteristics and selected 100g flower from each plot for determination of essential oil percentage. The soil consisted of 25% clay, 30% silt and 45% sand (Table 1) and further the field was prepared in a 15 m2 area (5m × 3 m).

Table 1. The results of soil analysis

Soil texture	**Sand (%)**	**Silt (%)**	**Clay (%)**	**K (mg/kg)**	**P (mg/kg)**
Ca.L	35	30	35	142.2	5.2
N (mg/kg)	Na (Ds/m)	EC (1: 2.5)	pH	Depth of sampling	N (mg/kg)
38.7	0.05	0.18	7.9	0-30 cm	38.7

Finally, essential oil was determined by the following formula:

Essential oil yield = essential oil percentage × flowering shoot yield

Data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) and followed by Duncan's multiple range tests. Terms were considered significant at $P < 0.05$.

3. RESULTS AND DISCUSSIONS

The results showed that Humic Acid significantly affected essential oil percentage and flowering shoot yield. The effects of humic substances on plant growth depend on the source and concentration, as well as on the molecular fraction weight of humus. Application of humic acid not only effectively improves soil physical and chemical properties, to provide a more suitable environment for plant growth, but also significantly reduces the use of chemical fertilizers and pesticides in soils. As an important way for increasing yield in agricultural production, the use of humic acid can also accelerate remediation of contaminated soil by heavy metals (Xu *et al.*, 2010). The mechanism of humic acid in promoting plant growth may enhance the uptake of nutrients and reduce the uptake of some toxic elements. However, increasing cell membrane permeability, oxygen uptake, respiration, photosynthesis, phosphate uptake and root cell elongation of plant growth factors have been proposed by some authors to explain positive effect of humic acid (Masciandaro *et al.,* 2002). Also, Humic substances constituting 65-75% of organic matter in soils are the subjects of studies in various areas of agriculture such as soil chemistry, fertility, plant physiology as well as environmental sciences, as the multiple roles played by these materials can greatly improve plant growth. Humic substances are formed through the process of humification of organic materials as by-product of microbial metabolism and are found in soil, coal, sediments water, peat and organic matter (Stevenson, 1994). HA is a complex molecule and is considered an alkali soluble, polymeric organic acid of aromatic structure substituted by carboxyl, phenolic, hydroxyl and alkyl groups linked together by ester linkages (Gaines and Yilmaz, 1983). The major functional groups of humic acid (HA) include carboxyl, phenolic hydroxyl, alcoholic hydroxyl and ketone (Cacco and Agnolla, 1984). Lower molecular size fraction easily reaches the plasma lemma of plant cells, determining a positive effect on plant growth, as well as a later effect at the level of plasma membrane, that is, the nutrient uptake, especially nitrate. The effects on intermediary metabolism are less understood, but it seems that humic substances may influence both respiration and photosynthesis (Nardi *et al.,* 2002). Humic acids preparations have been commonly used in many greenhouses. Majority of them are produced domestically although some of them are imported. The effect of organic matter on the soil properties such as physical, chemical, and biological ones has been well known for a long time. Humic acid is one of the major components of humic substances. Humic matter is formed through the chemical and biological humification of plant and animal matter and through the biological activities of microorganisms (Anonymous, 2010). In soils, humic compounds are recognized to exert a number of essential physical, chemical and biological functions to sustain soil fertility and to protect soil from degradation. Humic compounds consist of humic acid, fulvic acid and humin fraction. These materials are polyelectrolyte of structurally heterogeneous composition, various molecular weights and consist of aromatic and aliphatic structures associated with carboxyl, alcoholic and phenolic hydroxyl, carbonyl, amine, amide and other functional groups (Fernandez *et al.,* 2007). Humic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms. Foliar sprays of these substances also promote growth, and increases yield and quality in a number of plant species (Karakurt *et al.,* 2009) at least partially through increasing nutrient uptake serving as a source of mineral plant nutrients and regulator of their release (Atiyeh *et al.,* 2002). Most organic or agricultural wastes are applied to soil in the form of compost containing humic compounds. Humic compounds are the production of biologically mature, stable and chemically complex organic compounds other than carbon dioxide, water and minerals that are released during decomposition of organic matter (Plaza *et al.,* 2005). Therefore, humic compounds can control the biological availability, physicochemical behavior, and environmental fate of macro and micronutrients, toxic metal ions, and xenobiotic organic cations such as pesticides or organic and inorganic pollutants (Angin *et al.,* 2008). Adani, (2006) pointed that all humic substances are composed for chemically complex, non-biochemical organic components, which are largely hydrophilic amorphous, dark colored liquid, or powder and resistant to chemical and biological degradation. Improvement of soil conditions and establishing equilibrium among plant nutrients are also important for soil productivity and plant production. Albayrak and Camas (2005) found that increasing application of humic acid significantly promoted root and leaf yield of forage turnip (Brassica rape L.). Application of humic acid increased head weight of lettuce (Lactuca sativa L. var. longifolia) by increasing the availability of phosphorus and nitrogen (Cimrin and Yilmaz, 2005). The positive effects of the humic substances were also observed on the studies such as dry matter yield increases on corn and oat seedling (Celik *et al.,* 2008), yield increases on radish and green bean seedlings (Russo and Berlyn, 1992). Ayas and Gulser (2005) reported that the increase of yield of spinach (Spinacia oleracea, var. spinoza) by application of humic acid. Ayas and Gulser (2005) concluded that increased nitrogen uptake caused by humic acid application was the main reason of enhanced vegetation growth of spinach. In another study Cimrin and Yilmaz (2005) stated that application of humic acid increased head weight of lettuce (Lactuca sativa L. var. longifolia) by increasing the availability of phosphorus and nitrogen. Cimrin and Yilmaz (2005) stated that application of humic acid increased head weight of lettuce (Lactuca sativa L. var. longifolia) by increasing the availability of phosphorus and nitrogen. Kaya *et al.* (2005) reported as compared to the control, combined zinc and foliar humic acid or zinc and separate applications have increased the grain yield of bread wheat. The effect of HA on the availability of P and micronutrients has been given particular attention because of observed increases in uptake rates of these nutrients following application of HA (Ayuso *et al.,* 1996). However, their affects on soil have not yet been clearly elucidaded.

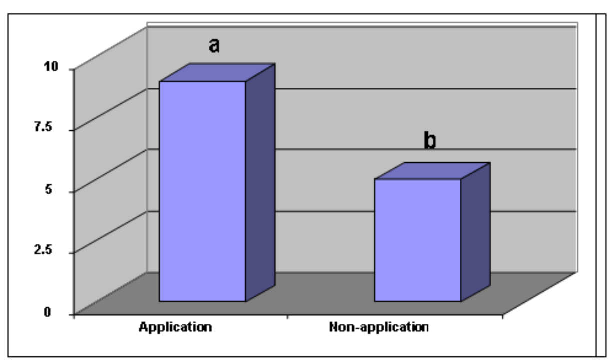

Figure 1: Essential oil percentage under Humic Acid application

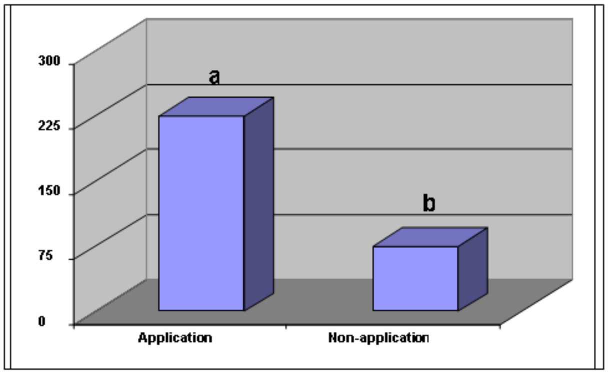

Figure 2: Flowering shoot yield (kg/ha) under Humic Acid application

Due to the positive effect of humic substances on the visible growth of plants, these chemicals have been widely used by the growers instead of other substances such as pesticides etc. This, however, has led to growers using higheramounts of these substances.

4. CONCLUSION

In general, it appears that, as expected, application of Humic Acid improved yield and other plant criteria. Therefore, it appears that application of Humic Acid could be promising in production of yarrow (*Achillea millefolium* L.) by reduction of chemical fertilizer application. Our finding may give applicable advice to farmers for management and concern on fertilizer strategy and carefully estimate chemical fertilizer supply by Humic Acid application.

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