



Humic Acid on Growth, Yield & Biochemical Properties of Field crops with particular reference to peanut: A Review

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Abstract: *The poor nutrition management in field crops hinders the production as well as quality parameters. To enhance the productivity, integrated use of organic sources and inorganic fertilizers is essential. Several studies indicated that the applications of HA in adequate quantities improves soil condition and yield parameters in Field crops. There are reports that application of Humic acid alters the soil characters thereby increase Growth, development and crop yield.*

Key words: *Humic acid, Field crops, Physiological Parameters and Yield.*

I. Introduction

A majority of the population of the developing countries, including India, is affected by serious problems of under nutrition and malnutrition. Nutritionally important and energy foods, which are rich in proteins and oils are beyond the reach of majority the world population, owing to an increasing gap in the demand and supply and higher costs. Recent population projections of India are a grim reminder that agricultural production must continue to increase to meet the demand of the ever increasing population. The agricultural science aims at increasing crop yields and improvement in their quality, which is however, are the complex end products of series of metabolic reactions and biological process. Meager effort was devoted to the understanding of these process until recently. Under high input production system, productivity can not be further increased with increment in the use of mineral fertilizers alone. Integrated use of organic sources and inorganic fertilizers is essential for obtaining substantial productivity in peanut. Organic wastes like ammonium humate from coal, paper sludge, cotton wastes, rice husks and pressmud of sugar factory can affect 10 per cent yield improvement.

Humic substances arise from chemical and biological degradation of plant and animal residues and from synthetic activities of micro-organisms (Schnitzer, 1968). It enriches the soil and facilitates fertilizer nutrients to reach their maximum potential in improving plant growth. Humic acid (HA) contains heterocyclic compounds with carboxylic, phenolic, alcoholic and carboxyl functions. (Khungar and Manoharan, 2000). It is extracted from lignite, a low rank coal. It is a complex with high molecular weight humic constituents containing plant growth stimulating substances. Thus in soil serves as the reservoir of plant nutrients and prevents leaching, in addition to stabilizing soil structure. It imparts buffering capacity to prevent sudden variation in soil pH. About 91 per cent of total Indian lignite source of 29,000 million tones is available in Tamil Nadu alone. The annual production of lignite at Neyveli, Tamil Nadu is about 2,300 million tones. The Neyveli lignite is rich in humic acid. As a source of humic acid for crop production, it needs a critical study.

The use of organic manure has recently been reduced due to non availability, in adequate quantities and high cost factor involved. Under such situation, the present study was taken up with a view to understand the effect of humic acid (Potassium sulphate extracted from lignite) and its influence on growth, physiological and chemical process, nutrient uptake and yield determinants of peanut crop. As humic acid is known to influence the nutrient availability to plants, the effect of different treatments of humic acid has to be evaluated under optimal, sub optimal and no fertilizer levels. Reports are there to indicate that humic substances influence growth regulating properties also. Hence, need arises to test humic acid by foliar spray and also by soaking seeds in a reasonable concentration of humic acid, in addition to trying different doses of humic acid by soil application. Peanut production has been increased by means of many crop improvement practices in the last few decades. In spite of this high production, the productivity is still low in India. The reasons for low productivity in peanut may be due to unwanted vegetative growth, unsynchronized flower initiation and pod development by

lacking source back up, shedding of flowers and presence of Immature Pods due to the imbalance between source and sink capacity. Regulating growth with balanced supply and uptake of nutrients, and developing an optimum balance between source and sink development may result in high activity in any crop. One of the naturally occurring organic substances which has growth regulating properties is humic acid (HA). Humic acid as potassium sulphate, is commercially available as "Humi Gold". Vaughan and Malcom (1985) reviewed numerous studies, carried out pot culture, to find out the effect of humic substances on several crop plants, the precise effect of humic acid on crop plants are more pronounced in the presence of inadequate aqueous media, which are either toxic or deficient in nutrients. Kononova (1966) speculated that humic substances entered the plant in the early stages of growth and were additional sources, of poly phenols that acts respiratory catalyst. Addition of HA tends to increase the rate of respiration, metabolism and growth of plants (Fagbenro. A and Agboola, 1993). Mylonas and McCants (1980) brought out the beneficial effects of humic acids on the biochemical grounds. It has been suggested that the lower molecular weight humic acids, as such, taken up by the plant, thereby influencing its growth and metabolism (Vaughan and Ord, 1985). The results of the earlier works with lignite humic acid clearly showed and its influence on the yields, and contents and uptake of nutrients in plants.

Humic acids may increase the growth of legumes by improving the biological Nitrogen fixation. It is known that humic substances exert favourable influence on the Nutrient uptake and health of crops. It is known that Humic substances have a direct physiological effect on plant growth as they are growth regulating substances and have contributed to increased dry matter production (Lee and Bartlett, 1976; Linehan, 1976). They alter the permeability of membranes and also form stable complexes with metal ions and thereby, increase the availability of nutrients to the plants (Vaughan and Malcom, 1985).

Vaughan and Ord (1985) doubted the major direct beneficial effects of humic (HA) on crop plants under field conditions despite many observations that externally applied HA could stimulate plant growth. However, they suggested the direct beneficial effects of HA on soil fertility through supply of nutrients, soil absorbing capacity and greater soil water retention (Khungar and Manoharan, 2000). Humic acid based organic / inorganic fertilizers have the following benefits.

- It enhances water retention and air-water relationship in soil.
- Humic acid in the form of potassium humate is highly soluble in water.
- It prevents nutrient loss from leaching and acts as absorbent for nutrients.
- Increases the porosity of soil.
- Complete assimilation of chemical fertilizers and other nutrients.
- Increases cation exchange capacity and population of micro-organism in soil.
- Reduces the cost of fertilization by reducing the loss from the soil and increases crop yield in an eco-friendly way.

Reports dealing with biological influence of humus on the plants give evidence of far-reaching effects on many physiological processes. Such as chemotrophic irritation, stimulation, changes in stomatic structure, increased absorption of mineral ions, changes in the enzymatic activity increase in growth, intensification of synthetic processes and respiration fertility and more rapid development. Humus, with their varying biological activity, depending on the origin of material, the method of isolation and the sensitivity of the experimental object concern. As very limited number of research works have been reported on the effect of Humic Acid on peanut, information's pertaining to the influences of humic on various crops have been gathered in order to understand the potential of humic acid enhancing the crop yields and the extent of its influence on various aspects of crop growth and on the nutrient uptake pattern of individual crop.

II. Morphological Characters

Smidova (1960) found out that length of root increased in maize and gourd application of humic acid. Schnitzer and Poapst (1967) reported that humic substances enhances stimulated the root development of bean plants. Schnitzer and Poapst (1967) and Schnitzer (1970) revealed initiation of roots and fast root growth in rice. According to Linehan (1976), humic substances increased the root growth of tomato. Tan and Tantiwiranond (1983) reported that application of humic acid related root growth in corn, soybean, peanut and clover. Malik and Azam (1985) observed that humic acid increased root length in wheat and increased root weight. According to Singhvi (1991), radical root length of *Raphanus Sativus* L. was increased by 25-100 mg of humic acid/litre. It has been shown by O'Donnell (1973) that humate possessed properties that were extremely beneficial to initiation and growth of roots of geranium. Tan and Tantiwiranond (1983) stated that application of humic acid stimulated shoot growth in corn, soybean, and clover in nutrient solution and sand culture. Malik and Azam (1985) showed that humic acid increased shoot length in wheat. Balasubramaniam (1989b) found that humic acid application @ 20 kg ha⁻¹ increased shoot length IR-50 paddy. Sladky and Tichy (1959) observed that humus substances applied to the leaves caused lengthening of plant organs and increased their fresh and heights.

III. Growth Attributes

Sladky and Tichy (1959) opined that humus substance sprayed on leaves resulted lengthening of leaves and increased the size of leaves in Begonia. A progressive increase in the size of individual leaves of tomato was observed by Sladky (1959) with the increase in humic acid concentration in the culture. Rajamohan (1989) reported an increase in SLW in soybean due to application of HA. NAA significantly increased the SLW of cowpea (Shinde and Jadhav, 1995). Leaves are the functional units of plant, which decide the final yield. Pandey (1975) reported influence of triacontanol on the number of cobs in maize. Shindle and Jadhav (1995) reported that in cowpea, the number of pod per plant increased by the application of NAA. Yadav (1989) observed that humic acid spray at 1000 ppm increased dry matter yield of maize shoot. Lee and Bartlett (1976) reported that foliar spray of humic acid induced only a small increase in dry matter production in maize.

Gaur and Bharadwaj (1971) stated that application of HA solutions to the soil in green house conditions enhanced the dry matter production of crops, such as, *Triticum vulgare* and *Sesbania aculeata*. Lee and Bartlett (1976) documented that spray of HA produced a small increment in dry matter production of maize. Tan and Tantiwiramanond (1983) suggested that sand cultures containing fertilizer culture and 800 mg kg⁻¹ of HA (or) fulvic acid (FA) were capable of stimulating dry matter production in soybean, peanut and clover. Yadav (1989) reported that lignite HA was found to be effective in increasing the dry matter yield of maize. Fagbenro and Agboola (1993) observed increased growth rates of teak seedlings with the increase in the concentration of humic acid in the culture. Subburamu (1983) stated that foliar application of one per cent KCI at maturing stage markedly increased the relative growth rate (RGR) in greengram. Bora and Bora (1989) reported an increase in RGR in soybean by ethrel application. Arun Kumarshankar (1990) recorded higher values of RGR in soybean, when sprayed with urea. Barua (1990) stated that foliar spraying of triacontanol (5 ppm) significantly increased the RGR in wheat. Ethrel 200 ppm at flower initiation stage increased the CGR over control in green gram (Seetharani, 1986) and in blackgram (Padmavathi, 1987). Influence of Potassium on CGR was reported by Nazar (1989) in greengram. In peanut, Enyi (1977) observed that CGR increased from low value to a maximum at about 60-90 days after sowing (DAS). Baghel and Yadav (1992) reported that foliar application of 40 ppm NAA increased the CGR at pod filling stage in blackgram.

IV. Biochemical Parameters

Sladky and Tichy (1959) found out that chlorophyll content and amount of CO₂ dioxide increased with humic acid application in tomato and maize respectively. Sladky (1959) also reported that humic acid increased the amount of chlorophyll in tomato. Singhvi (1991) observed that basis of synthesis chlorophyll precursor in *Raphanus sativus* L. was increased with HA treatment. Soluble protein serves as an indicator of photosynthetic rate in terms of Rubilose 1,5 biphosphate carboxylase activity (Evans, 1975). Chatterjee (1975) showed a slight stimulatory effect (14-33%) on photosynthetic CO₂ fixation in rice when spraying with GA₃ and IAA. Diethelm and Shibles (1989) established a positive correlation between soluble protein and Rubisco content unit leaf area. According to Chandrasekaran (1992), humic acid along gypsum increased crude protein.

According to Alexander (1961), humic acid has phenylalanine as one of the Indigenous constituents. Tomazewski (1964) reported that ortho-dihydric phenols, content in humic substances, influenced the indole acetic acid oxidase systems. Kononova (1966) believed that humic compounds entered the plant during early stages of growth and were additional sources of polyphenol and acted as a respiratory catalyst and hence, metabolism and growth of plants were affected. Sridhar and Mahadeven (1979) reported that feeding the rice plants with phenyl alanine through soil or leaves were found to cause significant increase in phenolic acids, because phenolic acids in the plant system are formed from the aromatic amino acids phynyl alumina and tyrosine by the action of two enzymes, namely phynyl alanine ammonia and tyrosine ammonia lyase respectively. Govindasamy and Chandrasekaran (1989) stated that phenolics beyond 270 mg/100 g of soil inhibited the rice plant growth. He also stated that the decrease in total phenol content of the treated plants might be due to the influence of humic acids on the enzymes which are responsible for the overall Metabolism and phenolic substances polymerized with other organic compounds for the lignin synthesis.

The first and rate limiting step in nitrate utilization is catalyzed by the substrate soluble enzyme, nitrate reductase, which plays a key role in nitrogen metabolism in wheat (Eilrich and Hageman, 1973) and thereby associated with plant growth and development. They also stated that the maximum effect of humus concentration on the increment of nitrate was obtained at 100 mg I⁻¹. The activity of nitrate reductase enzyme was related to the same level as that of the uptake rate of nitrogen.

V. Nutrient Uptake

A. Nitrogen

Malik and Azam (1985) studied the effect of humic acid on the growth of plant at seedlings in the presence and absence of N. In N free medium also humic acid showed significant N uptake, Tan and Nopamornbodi (1979) found that application of humic acid increased nitrogen content significantly, in maize. Mishra and Srivastava (1988) also observed that humic acid significantly increased nitrogen content in oats.

Chandrasekaran (1992) opined that application of humic acid increased nitrogen content in peanut. Yadav (1989) recorded that foliar application of humic acid at 1000 ppm increased nitrogen content of root in maize. Thangavelu and Ramabadrhan (1993) opined that lignite humic acid increased the content of total nitrogen levels.

B. Phosphorus

Mishra and Srivastava (1988) found that there was a significant increase in phosphorus with humic acid addition. Chandrasekaran (1992) reported that phosphorus content increased in peanut by application of humic acid.

C. Potassium

Flaig and Sochtig (1962) stated humic acid enhanced the content and uptake of K in various crops. Mylonas and McCants (1980) stated that HA enhanced uptake of P in tobacco plants.

D. Calcium and magnesium

Cheminade and Blanchet (1952) showed the beneficial effect of HA enhances on the uptake and content of Ca and Mg in Rye. Fernandez (1968) showed that the exact response of HA depended on the source of humic substances Mylonas and McCants (1980) observed that HA/FA enhanced Ca in tobacco and facilitated the translocation of Ca and Mg.

VI. Yield and Yield Components

An optimum level of biomass production must take place with an attendant assimilate partitioning to the developing sink to ensure high productivity in peanut. For this, the individual nutrient element should not be a limiting factor. Reports beneficial effects of humic acid treatments in improving soil condition and ensuring optimum supply of nutrients in order to harness the potential in terms of improving various yield determining parameters are furnished hereunder: Chandrasekaran (1992) recorded increased kernel weight and shelling percentage in peanut by soil application of humic acid. Freeman (1969) reported that greater yields of bean and potatoes have been obtained using humic acid. Mishra and Srivastava (1988) opined that an increase in yield of oats could be important by with application of humic acid. Chandrasekaran (1989) observed that grain was maximized in paddy by urea addition in the presence of humic acid. Govidasamy and Chandrasekaran (1989) reported that seedlings root dipping in humic acid increased yield of grain and straw in rice, while Chandrasekaran (1992) found that in peanut, number of pods/plant was increased by humic acid application. He also revealed that humic acid application induced capsules/plant in sesamum

Varshney and Gaur (1974) reported that spraying soybean with HA solution increased crop yields. Dry matter yield of corn shoots was stimulated by HA, chemically by treatment with 640 ppm HA (Tan and Nopamornbodi, 1979). Dubrova (1984) stated that watering green house tomatoes with humates, which were treated with NaOH from lignite, increased the fruit yields by 17.3 per cent to 23 per cent depending on the cultivar. Chen and Aviad (1985), based on their studies on the effect of humic substances on plant growth under the conditions of adequate mineral nutrition showed positive effects on plant biomass and yield.

VII. Conclusion

The average yield level is low and thereby increases the demand of food products in our country. The reasons may be due to using low yield potential varieties, poor soil fertility, low level of nutrition management. Along with the increase in production, Sustainability of yield and soil productivity is the need of the hour. In recent past attempts are being made in identifying organic manures which play a major role in nutrient management and crop yield. Organic manures acts as source of nutrients as well as for sustainability of productivity. Application of Humic Acid improves morphological, physiological, growth and yield attributes in field crops.

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