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Influence of foliar application of Ecohume® (containing 6% Humic substances) on nursery seedling growth in tomato

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Abstract
Experiments were conducted to study the influence of Humic substances on the growth of tomato seedlings raised in nursery plug trays. Foliar application of HS is effective in improving growth of seedlings raised over all three rooting medias used. Seedlings raised over Vermicompost rooting medium showed superior growth compared to the seedlings raised over coir pith and Red soil-sand-FYM (1:1:1) mixture.

In the second study, the effect of foliar application of Ecohume, NPK, Ecohume+NPK on seedling growth was monitored. Ecohume and Ecohume+NPK nutrient application stimulated additional growth. Increase in fresh weight and leaf area monitored during different developmental stages of the seedlings indicated that Ecohume+NPK and Ecohume were effective in improving leaf area development and fresh weight of tomato seedlings, as compared to NPK.

Multilocation studies were conducted at 67 seedling nurseries around Bangalore India, has proved that the growth stimulatory effect of Ecohume is stable over varying agro-climatic conditions. These three sets of experiments conducted, suggest that a foliar application of Ecohume is highly potent in stimulating additional growth of tomato seedlings in the nursuries.

Keywords: tomato seedlings, Ecohume, growth traits, rooting media, Humic substances, NPK mixture

Introduction
A number of earlier studies have reported that exogenous application of Humic Based Product promotes growth in diverse plant species (Canellas and Olivares 2014; Trivisan *et al.* 2010; Muscola *et al.*, 2013) [3, 16, 11]. The growth stimulatory properties of Humic were found associated with improvement in uptake of mineral nutrition (Nardi *et al.* 2002; Chen *et al.* 2004; Verlinden *et al.* 2009) [12, 5, 17] and improvement in plant metabolism and physiology (Canellas *et al.* 2002; Zandonadi *et al.* 2007) [4, 18]. Humic application was found effective in enhancing growth and yield in vegetable crops like Cucumber (Li and Evans 2000) [9] Okra (Poksoy *et al.* 2010) [13] pepper (Karakurt *et al.* 2009) [8] Tomato (Lua Hoang and Bohme 2001) [10] and Water melon (Salman *et al.* 2005; Silvamatos *et al.* 2012) [14, 15]. There are not many studies on the influence of Humic on growth of seedlings in vegetable crops. Transplanting nursery grown seedlings to main field is becoming the common practice to raise vegetable crops in India. Development of healthy and robust seedlings ensures high post-transplant growth, development and productivity. Plastic plug trays are extensively used by nursery to raise uniform quality seedlings for easy handling, avoid damage to the roots and to retain the root media intact while transplanting to main field. Different types of root growth media like coir pith, Vermicompost, Red soil-sand-FYM mixtures etc., are used to raise the seedlings. The influence of Humic on growth of tomato seedlings raised over different rooting media is not known. The present study aims at assessing the potential of Humic application on growth of tomato seedlings raised over different rooting media. Ecohume® Liquid – manufactured by Margo Biocontrol Pvt Ltd (extracted from renewable agriculture biomass) was used for a multi-location trial which was conducted at 67 seedling nursery establishments to assess the efficiency of Humic on tomato seedling growth over different agro-climatic conditions.

Materials and Methods
The influence of Ecohume on the growth of nursery seedling in tomato was studied in a series of experiments. The effectiveness of Ecohume on growth of seedlings raised over different rooting media and the influence of Ecohume with or without macro nutrient NPK was assessed in the first two trials. In the third experiment the consistency in bio-efficacy of Ecohume on tomato seedling growth was examined at varying agro-climatic conditions at 67 seedling

nurseries located around Bangalore, India.

Experiment 1

The influence of Ecohume on growth of tomato seedlings raised over different growth media.

Tomato seeds of Cv. Pusa Hybrid 2 were sown in plastic plug trays filled with three different rooting media viz. 1. Coir pith 2. Vermicompost 3. Red soil: sand: FYM (1:1:1) mixture. Plastic plugs trays with 98 round shaped cells with a volume of 14.5 cm^3 per cell were used for this study and five trays were maintained per treatment. Seedlings were raised for 30 days under greenhouse conditions, covered with plastic shade nets allowing 60% sun light. Seedlings were irrigated twice everyday. Ecohume was applied three times at 10, 15 and 20 days interval after sowing by giving a foliar drenching spray each time @ 100 ml/tray. Observations on seedling growth traits were recorded on the 30th day after sowing.

Experiment 2

Influence of Ecohume, NPK, Ecohume+NPK on seedling growth rate in tomato.

Tomato seedlings (Cv. Pusa Hybrid 2) were raised in plastic plug trays on coir pith rooting media as mentioned in experiment 1. The influence of Ecohume, NPK and Ecohume+NPK was studied on seedling growth rate in tomato. NPK was supplied by dissolving mixed fertilizer formulation NPK (17:17:17) @ 5 grams per litre of water. Ten plastic plug trays were maintained per treatment. The treatment solutions were applied as foliar drenching sprays at 10, 15 and 20 day interval after sowing. The influence of treatments on periodical increase in seedling growth rate was monitored by taking observation on fresh weight of seedlings and total leaf area developed per seedlings at 10, 16, 22 and 28 days after sowing.

Final observations on other seedling growth parameters such as shoot length, maximum root length and stem diameter were also recorded at the end of seedling growth on the 28th day.

Experiment 3

To study the influence of Ecohume on Tomato nursery seedling growth at different Agro climatic conditions, experiments were conducted at the 67 Seedling nurseries located around Bangalore, India. The micro climatic conditions, rooting media; varieties of tomato seeds used; size, shape and volume of plug trays, Irrigation schedule followed for raising seedlings differs between one nursery to other. The influence of foliar drenching application of Ecohume on seedling growth was determined. Only two treatments were included for the study. The influence of foliar drenching application by Ecohume on seedling growth over and above the normal agronomic practices followed for raising seedlings at each nursery was monitored. Foliar drenching application of Ecohume was done to tomato seedlings raised on plug trays three times i.e. 10, 15 and 20 days after sowing, the final observations on seedling growth parameters were recorded on 30 days after sowing.

Results

Experiment 1

The influence of Ecohume on growth of tomato nursery seedlings raised on different rooting medium was examined. Seedlings raised over vermicompost showed more shoot length, stem diameter and fresh weight of roots (Fig 1A, 1C, 1D). Root length was maximum in seedlings raised over coir pith medium (Fig 1B). The data on growth parameters indicated that growth is poor in seedlings raised over Red soil-sand-FYM medium.

Application of Ecohume improved the growth traits of seedlings raised over all the three rooting medium used in this study. The extent of stimulation of growth parameters by Ecohume application was significant over all the three rooting medium. On an average Humic application improved shoot length by 38%, maximum root length by 33%, stem diameter by 25% and root fresh weight by 20% over and above the nursery practice.

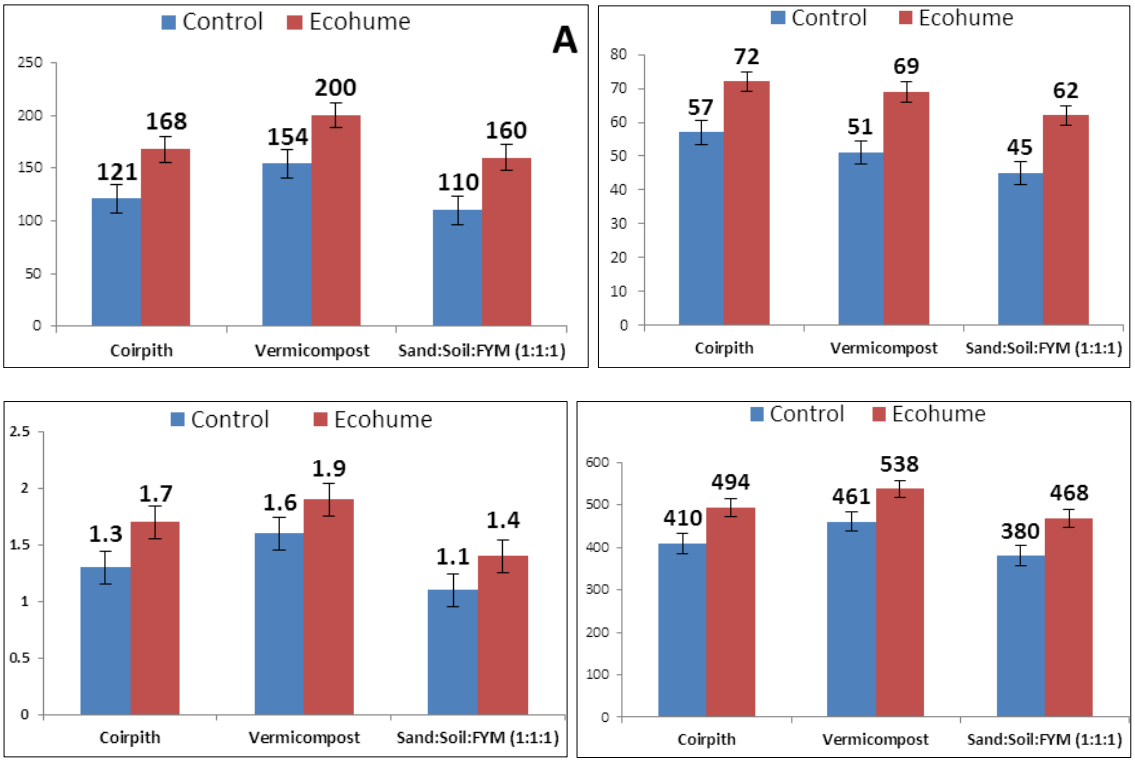

Fig 1: Influence of HS on growth parameters in tomato seedlings raised over different rooting media. A: Shoot Length; B: Maximum Root Length; C: Stem Diameter; D: Root Fresh Weight

Experiment 2

Influence of foliar drenching application of Ecohume, NPK and Ecohume + NPK on seedling growth traits were recorded on 28th day after sowing. Table 1 gives the data on seedling growth traits. Application of Ecohume, NPK and Ecohume + NPK stimulated seedling growth significantly. Application of Ecohume alone or Ecohume + NPK were significantly more stimulatory than NPK alone. Ecohume treatment increased seedling height, maximum root length, stem diameter and fresh weight of seedlings by 28.3, 56.6, 36.7 and 49.1 per cent respectively over control. Whereas, Ecohume + NPK treatment improved seedling growth traits even further, however, the differences in stimulatory effect on growth traits between Ecohume and Ecohume + NPK were not highly significant.

Data on leaf area and fresh weight of seedlings were recorded at five stages of seedling development from 12 to 28 days after planting at 4 days interval. The influence of Ecohume, NPK and Ecohume + NPK on periodical increase in leaf area and fresh weight of seedlings was visually marked from 16 days after sowing, which corresponding to 6 days after first foliar application of treatment solutions. Two more applications of treatment solutions sustained increased leaf area and seedling's fresh weight till 28 days after sowing. The increase in leaf area and fresh weight of seedlings was maximum between 16 to 22 days after sowing. The influence of Ecohume and Ecohume + NPK was more stimulatory than compared with NPK alone (Fig 2A & 2B).

Table 1: Influence of HS, NPK, HS + NPK on Tomato seedling growth parameters on 30th day after sowing

Treatments	Shoot length (cm)	Maximum Root Length (cm)	Stem Diameter (mm)	Fresh Weight of Seedlings (Grams/10 seedlings
Control	5.80	4.47	1.20	4.24
H.S	7.44	7.00	1.64	6.32
N.P.K	6.22	5.14	1.44	5.80
HS + NPK	7.85	7.36	1.64	7.01
CD (P: 0.05)	1.02	0.85	0.19	0.82

Experiment 3

The influence of Ecohume on tomato seedling growth was assessed from 67 seedling nurseries. Table 2 summarises the results on vegetative growth traits of seedlings from all these nurseries. Seedling growth parameters showed wide variations between the nurseries. Seedling growth traits both under existing Farmer's practices and also in response to addition of Ecohume showed large variations between the experimental locations. However, the stimulatory effect of Ecohume on growth trails was marked at all locations. The mean values for growth traits from 67 location showed 38.2, 33.3, 29.1, 20.9 per cent increase in seedling height, stem diameter, maximum root length and root fresh weight respectively in response to Ecohume application over and above the existing Farmer's practice.

Table 2: Range, mean and per cent increase in tomato seedling growth traits in response to Farmer's practices and Ecohume application over and above the normal agronomic practices followed by Farmer's in 67 seedling nurseries

Growth trails	Farmer's practices		Farmer's practices + Ecohume		Percent Increase in response to Ecohume
	Range	Mean	Range	Mean	
Plant Height (cm)	6.80 – 8.85	8.41	9.08 – 11.2	11.63	38.2
Maximum Root Length (cm)	5.86 – 8.13	6.28	9.00 – 16.0	13.98	33.3
Fresh Root Mass (Gram per plant)	0.42 – 0.51	0.47	0.52 – 0.81	0.67	29.1
Stem Diameter	0.11 – 0.17	0.15	0.14 – 0.23	0.27	20.9

Discussions

The influence of Ecohume on nursery seedling growth in tomato was studied. Enhancing nursery seedling growth and vigour was shown to improve post transplantation growth, development and productivity in many crops. The effect of foliar application of Ecohume on growth of nursery seedlings raised over different rooting medium, the influence of Ecohume, NPK, Ecohume + NPK on rate of growth of tomato seedlings and the effect of Ecohume on growth of seedlings raised over a wide range of micro climatic and agronomic practices were studied.

In the first set of experiments, the influence of foliar drenching application of Ecohume on growth of tomato seedlings raised in plastic plug trays over three different rooting medium was studied. Tomato seedling growth was maximum in vermicompost root media followed by coir pith media, seedling raised over soil-sand-FYM mixture showed less growth. Arancon *et al.*, (2008) [2] recommended vermicompost as the best rooting media for enhancing seedling growth. Leachates derived from vermicompost and Ecohume was shown to be highly valuable as plant growth promoter in enhancing productivity in vegetables (Arancon and Archana Pant 2012, Gutierrez- Miceli *et al.*, 2011, Zandonadi and Busato 2012) [1, 7, 19]. Ecohume application was effective in improving plant height, root growth, stem diameter and fresh weight of roots in seedlings raised over all the three rooting media. Application of Ecohume to crop plants was shown to improve root growth, nutrient uptake and plant metabolism (Chen *et al.*, 2004; Zandonadi *et al.*, 2007) [5, 18]. The stimulatory effect of Ecohume was significant over all the three rooting media used in this study. Mean values arrived over all the three root growth media indicated that additional increment in shoot length, maximum root length, stem diameter and root fresh weight was 28.3, 56.6, 36.7 and 49.1 per cent respectively in response to Ecohume application.

Tomato seedlings growth rate as measured by gain in leaf area and fresh weight of seedlings with time indicated that Ecohume and Ecohume+NPK treatments were more effective in improving growth within six days after foliar application of Ecohume. The increase in seedling growth rate was sustained with addition of second and third application of Ecohume. The seedling developed from Ecohume and Ecohume + NPK was more vigorous at the end of nursery growth. The effect of Ecohume and Ecohume + NPK was almost similar suggesting

that application of Ecohume alone is enough to sustain high growth rate of tomato seedlings.

Results indicated that Ecohume application enhances seedling growth similar to the effect of well recognized phyto hormones. Many earlier workers showed that Ecohume stimulates plant physiological activities in the absence of any nutritional influence but retaining activities similar to mode of action of phyto-hormone (Dobbss *et al.* 2007: Zandonadi *et al.* 2007) [6, 18]. Environment and management factors will likely to alter the bio efficacy of Ecohume. The consistency of Ecohume effects in improving tomato seedling growth across environment and agronomical management practices were studied. Multi-location trial was conducted in 67 seedling nurseries around Bangalore, India. The HS formulation Ecohume 6% (w/w) was found effective in stimulating tomato nursery seedling growth across different environmental and management conditions. Foliar application of Ecohume was found to be highly potential management practice to stimulate nursery seedling growth in tomato.

Conclusion

Improving seedling vigour by foliar application of Humic Substances (Ecohume 6%) enhances growth and development of plants immediately after transplanting seedlings to the main field. In tomato nursery, seedlings raised over vermicompost rooting media showed more growth. Foliar application of humic substances significantly improved growth of seedlings raised over coir pith, vermicompost as well as on soil: sand: FYM mixture rooting medium. Ecohume and Ecohume+NPK foliar application stimulated tomato seedling growth. Multi-location trail conducted over 67 seedlings nurseries indicated that formulation Ecohume is highly potential in improving tomato seedling growth in all agro-climatic conditions.

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