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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 2786-2791

www.thepharmajournal.com
Received: 21-07-2022
Accepted: 01-09-2022

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Growth and flowering of chrysanthemum in hydroponics

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Abstract
An experiment to investigate “growth and flowering of chrysanthemum in hydroponics” was conducted at Assam Agricultural University, Department of Horticulture. The experiment was laid out factorial completely randomized design with three replications. In this Experiment chrysanthemum plants were grown in seven different growing media combinations *viz.* M_1: coco peat, M_2: coarse sand, M_3: cinder, M_4: coarse sand cinder (1:1 v/v), M_5: coarse sand and coco peat (1:1 v/v), M_6: coco peat and cinder (1:1 v/v) and M_7: coco peat, coarse sand and cinder (1:1:1 v/v) and 2 different concentrations of nutrient solution (modified Hoagland solution) *viz.* N_1: EC 1.5 dS/m and N_2: EC 1.8 dS/m. The results revealed that soilless growing media and concentration of nutrient solution significantly influenced the growth and flowering of chrysanthemum *cv.* “Rajkumari”. Among the growing media, coco peat+ cinder was found significantly superior to all other growing media and among the nutrient solution concentrations, EC 1.8 dS/m was found superior to EC 1.5 dS/m in terms of growth of the plants and quality flower production. Thus, from the floriculture perspective it can be concluded that growing media coco peat+ cinder with EC 1.8 dS/m is suitable for chrysanthemum production.

Keywords: Chrysanthemum, EC, flower, growing media, nutrient

Introduction
In majority of flower industries, chrysanthemums are the most widely used commercial flower due to its appealing colours, distinctive crown forms, textures, making them the preferred flower for the mass market in the bouquet industry and are also cultivated as a pot plant in various parts of the world. After roses, chrysanthemum is the most prominent dollar earner in the United States. Chrysanthemum belongs to the family *Asteraceae* and also regarded as ‘Autumn Queen’, or ‘Queen of East’.
The hydroponics or soilless culture sector has expanded fast all over the world. Hydroponics is a cultivation method that involves growing plants without soil by using mineral nutrient solutions in an aqueous solvent. The hydroponic system is perhaps the most intensive crop production technique in modern agriculture (Jensen, 2008) [14]. "Hydroponic" comes from two Greek words: "hydro" means "water," and "ponos" means "labour”. Numerous organic and inorganic substrates such as cocopeat, perlite, vermiculite, and sand, are the most widely used substrates in aggregate hydroponic systems. They can be used either individually or in combination to substitute soil because they are disease and pest-free inert materials that can contain adequate moisture and can be utilized for several seasons. Hydroponic farming is becoming rapidly popular around the world due to its efficient resource management and high-quality food production. Agricultural regions are being depleted on a daily basis as a result of expanding urbanization, industrialization, and population increase. As a result, hydroponic cultivation provides the way for reducing modern agricultural difficulties such as indiscriminate chemical usage, soil-borne diseases, and lack of land, labour, and water resources.
Gardeners who have grown chrysanthemums in the same area for a long period have faced soil-borne diseases, nematode issues, and increasing saline levels in the soil, all of which have reduced productivity and impaired flower quality. Soilless culture was a method of cultivating plants which was unaffected by soil conditions, thus, soil-borne diseases in chrysanthemum like wilt caused by *Fusarium oxysporum f. sp. chrysanthemi* and damping off caused by *Pythium sp.* can be prevented with hydroponic culture. When compared to open field conditions, hydroponic cultivation in a controlled environment allows us to shorten the blooming time, also, growth and yield qualities are much higher under hydroponic system.

Plants grow faster because they obtain all of the nutrients they need in the optimum amounts and proportions, which are provided directly to the roots. Which helps to grow more vegetative parts and ultimately, larger blooms. Plants in hydroponics grow up to two times quicker and yield more than plants in conventional soil farming methods because of high oxygen levels to the root system, appropriate pH levels for increased nutrient and water uptake. (Ghazvini *et al*., 2007) [11].

The biggest worries for farmers in our country now are variable temperatures caused by global warming, a scarcity of cultivable land, and soil infertility due to excessive chemical use over time. With the Indian government's aim of doubling our farmers' incomes, we have yet another opportunity for a revolution. This revolution might come in the shape of hydroponic farming, which could assist not just agricultural areas but also city people who are troubling from the city's poor environmental conditions. Hydroponic farming is becoming increasingly popular in India. However, in India and most other developing nations, the use of hydroponic systems for commercial crop development is limited. Hydroponically grown floricultural crops are still in their infancy in terms of research. Hydroponic culture can make cut flower production more productive and profitable. To maximise returns by efficiently utilizing water and nutrients from applied nutrient solution in soilless media mixture for potted chrysanthemums, the cost effectiveness of the hydroponic system is required. As a result, there is a lot of potential in hydroponic flower research.

Materials and Methods

An investigation entitled, Growth and flowering of chrysanthemum in hydroponics was carried out at Experimental Farm, Department of Horticulture, AAU, Jorhat in the year 2021-2022 to find out best soilless media and EC of hydroponic nutrient solution for quality chrysanthemum production. The Experiment was laid out in Completely Randomized Design with two factors.

Seven different growing media were used for the experiment *viz.*, M_1: coco peat, M_2: coarse sand, M_3: cinder, M_4: coarse sand cinder (1:1 v/v), M_5: coarse sand and coco peat (1:1 v/v), M_6: coco peat and cinder (1:1 v/v) and M_7: coco peat, coarse sand and cinder (1:1:1 v/v) and two levels of hydroponic nutrient solution concentration *viz.*, EC 1.5 dS/m and EC 1.8 dS/m. Thus, there were 14 treatment combinations with three replication and one control (soil). In this experiment seedlings of chrysanthemum *cv.* Rajkumari height of 5 cm were planted into 12 inches/ 30 cm diameter plastic pots.

A stock solution was prepared for this experiment was different for the growth and flowering stages, *i.e.*, 'Grow solution' and 'Bloom solution' by dissolving different inorganic salts at different concentration. Growth stage requires a nutrient solution rich in nitrogen, since nitrogen promotes the production of chlorophyll, which is key for a robust vegetative growth phase. Other essential nutrients that are needed in greater quantities during vegetative growth are magnesium (at the centre of every chlorophyll molecule) and calcium (which provides structure and support for the stem). The higher quantities of potassium and phosphorus are required during the flowering stage. The elements phosphorus and potassium act as flower growth enhancers, while potassium works as a ripener or finisher of flowers (Veg vs Bloom Requirements, 2017). Under this study, nutrient solution was applied manually at the rate of 20 ml per day in the base of the plant. The EC of the nutrient solution was adjusted according to the treatments, and filtered water was used as irrigation on alternate days. The EC and pH were monitored regularly by portable EC and pH meter and adjusted accordingly. Data are recorded at different growth stages of crop in terms of growth, yield and quality parameters. Data were statistically analyzed at 5 per cent significance level the mean separation was carried out by Duncan's Multiple Range Test (DMRT) by using Microsoft Excel.

Results and Discussion

The study revealed that the growth parameters *viz.*, plant height (cm) at 60 DAT, plant spread (cm), stem diameter (cm), leaf area (cm^2), leaf fresh weight (g), were significantly influenced by different growing media and hydroponic nutrient solution concentration (Table 1). For quality and yield parameters *viz.*, days to flower bud initiation (days), flowers per plant, flower head diameter (cm), flower fresh weight (g), duration of flowering (days) were significantly influenced by growing media and concentration of nutrient solution (Table 2).

Growth parameters

Plant height

The maximum plant height (35.67 cm) at 60 DAT was recorded in M_6 (coco peat+ cinder 1:1 v/v) and minimum plant height (28.83 cm) was found in M_3 (cinder). The results might be due to having better physical properties of coco peat and cinder and optimum concentration of nutrient solution. Coco peat has higher water holding capacity, aeration, slow water and nutrient releasing ability whereas, cinder has excellent drainage properties and it is effectively aerating the roots. Therefore, the treatment with the mixture of coco peat and cinder led to enhanced vascular tissue development, which assisted in maximizing water and nutrient absorption. Similar result was found by Padhiyar *et al.* (2017) [19], Thakur *et al.* (2019) [25] in chrysanthemum and Rajan *et al.* (2020) [20] in gerbera. Between EC levels significantly influenced on plant height in chrysanthemum. Maximum plant height (33.98 cm) was recorded in EC 1.8 dSm^{-1}. In the interaction of growing media and concentration of nutrient solution, maximum plant height (36.83 cm) was recorded in treatment combination M_6N_2 (coco peat+ cinder with EC 1.8 dSm^{-1}. This is might be due to the sufficient nutrient uptake and optimal macro- and micronutrient availability in the right ratios in the solution ensured greater photosynthetic activities and source-sink relationships, which led to higher vegetative growth. Azeezahmed *et al.* (2016) [3] reported that Chrysanthemum performance was increased as N-K concentration increased. The highest nutrient concentration of N_{250}+ K_{200} during vegetative growth gave maximum plant height (34.55 cm) and plant canopy (35 cm).

Plant spread

The maximum plant spread (32.54 cm) was obtained in coco peat+ cinder (M_6) whereas, minimum plant spread (26.38 cm) was in plants grown in cinder (M_3). The maximum plant spread in the coco peat and cinder growing medium may be due to its superior water holding capacity, aeration, available organic matter of the cocopeat medium, low bulk density, ideal pH and optimal nutrient supply. Which may maintain the osmotic potential required for chrysanthemum which had enhanced more photosynthesis and translocation of the assimilate to the sink. This result is supported by Nair *et al.* (2015) [18] and Chauhan *et al.* (2014) [8] in chrysanthemum. In nutrient solution concentration, maximum plant spread (30.96 cm) was recorded in EC 1.8 dS/m and the treatment combination M_6N_2 was produced maximum plant spread (34.67 cm). This may be the result of improved nutrient uptake by continuous supply of nutrients and better sink for faster mobilization of photosynthates, which leads to vigorous expansion in the plant.

Stem diameter

Maximum diameter of stem (0.51 cm) was obtained in M_7 (coco peat+ coarse sand+ cinder). This may be the result of the better physical properties of the growing media. Adequate aeration, water holding capacity, and provision of a significant amount of nutrients through root absorption, which converts to photosynthates and aids in cell division and cell elongation had resulted in the increase in stem diameter. This result is supported by Dutt *et al.* (2002) [10], Hicklenton (1983) [12] and Kala *et al.* (2020) [15] in chrysanthemum, Kiran *et al.* (2007) [17] in dahlia. The interaction effect of different treatment combination for stem diameter was found significant. The maximum stem diameter (0.53 cm) was recorded in M_7N_2 (coco peat+ coarse sand+ cinder with EC 1.8 dS/m). This might be due to the right amounts of nitrogen and phosphorus in relation to other nutrients resulted in the synthesis of protein, increased cell division, and increased cell enlargement, which led to an increase in the plant's stem diameter.

Leaf area

The plant's leaves serve as the primary site for food synthesis. Maximum leaf area (36.55 cm^2) was obtained in coco peat+ cinder (M_6). The maximum leaf area in coco peat and cinder growth media may be related to increased water and nutrient uptake due to improved physicochemical properties of both media, as water and nutrients are essential for plant growth resulting highest leaf area per plant. Chung *et al.* (1999) [9], Barreto (2000) [5] in gerbera, Saha *et al.* (2016) [23] in chrysanthemum. Between EC levels significantly maximum leaf area (35.58 cm^2) was recorded in EC 1.8 dS/m. In the interaction of growing media and nutrient solution concentration, significantly maximum leaf area (38.69 cm^2) was found in treatment combination M_6N_2. This might be due to better physical properties of growing media and roots received a continuous supply of nutrients, water, and oxygen, which accelerated plant growth through improved nutrient uptake and photosynthate sinking, resulting in increased cell division, elongation, and tissue differentiation. The results supported by Kang and Van Iersels theories (2004) [16], that with increasing nutrient solution concentrations, leaf area increased significantly.

Leaf fresh weight

The highest fresh weight of leaf (0.65 g) was obtained in coco peat cinder (M_6). The highest leaf fresh weight and dry weight in these media could be attributed to substrate properties such as better water retention, aeration, low bulk density, optimal pH, and optimal nutrient supply. This result supported by Badran *et al.* (2017) [4] in *Gardenia jasminoides* plants. Among nutrient solution concentration EC 1.8 dS/m has shown better result than EC 1.5 dS/m. In interaction of nutrient and growing media was significantly recorded in maximum leaf fresh weight (0.74 g) in coco peat+ cinder with EC 1.8 dS/m (M_6N_2). This might be due to the physical properties of growth media and with the proper nutrient intake, plant growth and photosynthetic activity were quick in higher EC 1.8 dS/m, which led to the accumulation of additional cell mass to make the leaves thicker and heavier. Similar result was found by Chadha *et al.* (1999) [7] and Ajitkumar (2002) [1] in marigold.

Yield and quality parameters

Days to flower bud initiation: Early floral bud emergence was observed in coarse sand (M_2) (52.17 DAP). However, coco peat recorded maximum (62.67 days after transplanting) for emergence of floral buds. This is might be due to cocopeat provides better proliferation of roots and maximum vegetative growth of plants due to nutrient released gradually from coco peat as a result of slow mineralization. This implies that nutrients will be released for a longer time, delaying the start of the reproductive phase by a certain number of days. Earliest flower bud appeared in coarse sand might be due to faster draining the water with nutrients so plants try to uptake more and more nutrients and complete their life cycle with less period of time. Similar result found by Sarmah *et al.* (2020) [22] in marigold, Singh *et al.* (2015) [24] in chrysanthemum and Rajvanshi *et al.* (2014) [21] in zinnia. Flower bud initiation significantly minimum in higher EC levels (EC 1.8 dS/m) (55.55 days). In the interaction of growing media hydroponic nutrient solution, minimum days (51.00) required for bud appearance was found in M_2N_2 (coarse sand with EC 1.8 dS/m). Early initiation of buds might be due to fast nutrient absorption by the plants and simultaneous transportation of growth stimulating substances like cytokine in to the axillary buds thus, resulting in inhibition of apical dominance. Kang and Van Iersel (2004) [16], agrees with the findings that at low nutrient solution concentrations compared to high concentrations, plants flowered 8 days later.

Flowers per plant

Maximum number of flowers (34.50) were obtained in when plants grown in coco peat+ cinder (M_6). Whereas, lowest number of flowers (23.67) was obtained in plants grown in cinder (M_3). The increased number of flowers per plant might be attributed to the overall vegetative growth of chrysanthemum plants grown in these substrates which may helped greater carbohydrate accumulation as a consequence of enhanced photosynthesis may have led to production of more flowers per plant. Similar result was found by Padhiyar *et al.* (2017) [19], Dutt *et al.* (2015) [10] and Bisht *et al.* (2012) [6] in chrysanthemum, Grassotti *et al.* (2003) [11] in Lilium, Chauhan *et al.* (2014) [8] in gerbera. In nutrient solution concentration, the highest of number (30.90) of flowers per plant obtained in EC 1.8 dS/m (N_2). In interaction of nutrient and growth media significantly highest number of flowers (37.00) when it grown in coco peat+ cinder with EC 1.8 dS/m (M_6N_2). This might be due to better physical properties of growing media and with the proper nutrient intake, plant growth and photosynthetic activity were quick in higher EC which may helped greater carbohydrate accumulation as a consequence of enhanced photosynthesis may have led to production of more flowers per plant. Similar result was found by Azeezahmed *et al.* (2016) [3] in chrysanthemum.

Flower head diameter

Maximum flower head diameter (5.48 cm) was recorded in coco peat+ cinder (M_6). Whereas, minimum flower head diameter (4.72) was found in cinder (M_3). This is may be due to higher nutrient availability, good aeration and which result in better root growth and more leaf area that helped in accumulation of more assimilates. Therefore, luxuriant growth with a higher green biomass of the plant has more availability of primary and secondary metabolites resulting in a higher source sink ratio leading to a larger diameter of bud and bloom. Smaller size of bud in cinder and minimum flower diameter in cinder could be attributed to lower availability of assimilates. The result is supported by the findings of Padhiyar *et al.* (2017) [19] in chrysanthemum, Anuje *et al.* (2004) [2] in gerbera. In nutrient solution concentration at higher EC shows the greater result in terms of flower head diameter. The interaction of nutrient and growth media for maximum flower head diameter (5.61 cm) was found in coco peat+ cinder with EC 1.8 dS/m (M_6N_2). This may be due to balanced nutrition and growing medium that can improve amino acid synthesis, chlorophyll creation, and carbohydrate transformation, all of which lead to greater bud and flower growth.

Flower fresh weight

In this experiment, the growth media utilized were known to significantly differ in flower fresh weight. The highest fresh weight of the flower (4.17 g) was found in coco peat+ cinder (M_6). This might be due to better water holding capacity, aeration, higher cation exchange capacity in these substrates which helped in increased the water uptake and nutrients. Thus, it increases the photosynthates resulting to increasing the fresh weight of the flower. Whereas, the minimum fresh weight and dry weight of the flower was recorded among all the treatment combination in control (T_0- soil only). This may be due to poor structure and less available nutrients in the soil. Similar result was found by Rajan *et al.* (2020) [20] and Chung *et al.* (1999) [9] in gerbera, Sarmah *et al.* (2020) [22] in marigold. In nutrient concentration maximum fresh weight (3.84 g) of flower were found in higher EC level (N_2). In interaction of nutrient and growth media the maximum fresh weight (4.36 g) of flower were recorded in coco peat+ cinder with EC 1.8 dS/m (M_6N_2). This might be due to greater physical properties of growth media and adequate uptake of nutrients resulting maximum fresh weight and dry weight of the flower.

Duration of flowering

Maximum number of days (63.17) from appearance of flower to 100% fading of flowers were recorded when plants grown in coco peat+ cinder. This might be as a result of the substrate's favourable conditions and plants grown in these substrates utilizing nutrients more effectively. Thus, it may increase the plant's photosynthetic activities and the accumulation of carbohydrates in the flower. Furthermore, the increased solubility of nutrients easily available for uptake by the roots is ensured by the enhanced moisture content in the coco peat and cinder medium mixture. Similar result was found by Dutt *et al.* (2002) [10] and Padhiyar *et al.* (2017) [19] in chrysanthemum. Minimum number of days (51.83) till 100% fading of the flower was found in growing media cinder. This could be due to large pore space of cinder which drain out maximum water along with nutrients. Between EC levels, EC 1.8 dS/m showed better result than EC 1.5 dS/m. In the interaction of growing media and nutrient solution significantly maximum result was found in the treatment combination M_6N_2 (66.00 days). This is may be due to physical properties of growing media and adequate uptake nutrients with the optimal dose of P and K started acting as proceed elements, slowing the rate of flower senescence.

Based on the experimental findings it can be concluded that growing media consisting mixture of coco peat and cinder gave significantly superior performance than other media in growth and quality parameters whereas, sole cinder has shown poor result. Between hydroponic nutrient solution concentration, EC 1.8 dS/m shown best result and treatment combination M_6N_2 (coco peat+ cinder with EC 1.8 dS/m) was considered best in terms of growth and flowering of chrysanthemum in hydroponics.

Table 1: Growth of chrysanthemum influenced by different growing media and hydroponic nutrient solution

Treatment	Plant height (cm)			Plant spread (cm)			Stem diameter (cm)			Leaf area (cm^2)			Leaf fresh weight (g)		
	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean
Coco peat (M_1)	31.50	34.00	32.75	30.42	32.00	31.21	0.47	0.51	0.49	31.80	35.17	33.48	0.53	0.65	0.59
Coarse sand (M_2)	28.67	31.17	29.92	25.67	27.75	26.71	0.36	0.40	0.38	28.97	33.10	31.03	0.39	0.58	0.49
Cinder (M_3)	27.33	30.33	28.83	25.50	27.25	26.38	0.36	0.39	0.37	28.76	32.67	30.71	0.44	0.50	0.47
Coarse sand + Cinder (M_4)	31.00	34.00	32.50	28.83	31.08	29.96	0.39	0.41	0.40	34.36	35.06	34.71	0.46	0.53	0.50
Coarse sand + Coco peat (M_5)	34.00	35.17	34.58	29.58	32.08	30.83	0.45	0.47	0.46	34.57	36.77	35.67	0.53	0.56	0.55
Coco peat + Cinder (M_6)	34.50	36.83	35.67	30.42	34.67	32.54	0.45	0.48	0.47	34.41	38.69	36.55	0.57	0.74	0.65
Coco peat + Coarse sand + Cinder (M_7)	33.83	36.33	35.08	30.92	31.92	31.42	0.48	0.53	0.51	33.99	37.63	35.81	0.54	0.73	0.63
Mean	31.55	33.98	32.76	28.76	30.96	29.86	0.42	0.46	0.44	32.41	35.58	33.99	0.49	0.61	0.55
Control			20.50			16.67			0.32			21.06			0.32
	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)
Control Vs Rest	0.95		1.94	1.40		2.85	0.05		0.11	1.66		3.38	0.05		0.10
Nutrient (N)	0.61		1.25	1.02		2.09	0.04		NS	1.17		2.40	0.04		0.07
Media (M)	0.33		0.67	0.54		1.12	0.02		0.04	0.63		1.29	0.02		0.04
Interaction (M x N)	0.86		1.77	1.44		2.95	0.05		0.11	1.66		3.40	0.05		0.11

Table 2: Yield and quality of chrysanthemum influenced by different growing media and hydroponic nutrient solution

Treatment	Days to flower bud initiation (days)			Flowers per plant			Flower head diameter (cm)			Flower fresh weight (g)			Duration of flowering (days)		
	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean	EC 1.5 dS^{-1}(N_1)	EC 1.8 dS^{-1}(N_2)	Mean
Coco peat (M_1)	64.67	60.67	62.67	29.00	32.67	30.83	4.88	5.29	5.08	3.66	3.84	3.75	57.67	61.00	59.33
Coarse sand (M_2)	53.33	51.00	52.17	24.33	27.00	25.67	4.55	4.93	4.74	3.33	3.54	3.43	46.00	55.33	50.67
Cinder (M_3)	54.67	52.00	53.33	21.67	25.67	23.67	4.54	4.90	4.72	2.98	3.34	3.16	49.00	54.67	51.83
Coarse sand+ Cinder (M_4)	56.33	52.67	54.50	24.00	29.33	26.67	4.71	5.06	4.88	3.46	3.62	3.54	56.67	59.00	57.83
Coarse sand+ Coco peat (M_5)	59.33	56.00	57.67	25.33	29.67	27.50	4.96	5.10	5.03	3.56	3.96	3.76	54.67	62.00	58.33
Coco peat+ Cinder (M_6)	62.33	56.67	59.50	32.00	37.00	34.50	5.36	5.61	5.48	3.97	4.36	4.17	60.33	66.00	63.17
Coco peat+ Coarse sand+ Cinder (M_7)	62.00	58.33	60.17	30.00	35.00	32.50	5.25	5.58	5.41	3.83	4.24	4.03	61.33	64.67	63.00
Mean	58.95	55.33	57.14	26.62	30.90	28.76	4.89	5.21	5.05	3.53	3.84	3.69	55.10	60.38	57.74
Control			75.67			10.33			2.94			2.42			42.67
	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)	S.Ed (±)		C.D. (5%)
Control Vs Rest	1.78		3.64	2.93		5.96	0.20		0.40	0.21		0.44	2.47		5.03
Nutrient (N)	1.05		2.15	2.14		NS	0.14		0.29	0.15		0.30	1.78		3.64
Media (M)	0.56		1.15	1.14		2.34	0.08		0.15	0.08		0.16	0.95		1.95
Interaction (M x N)	1.49		3.04	3.03		6.20	0.20		0.41	0.21		0.43	2.51		5.15

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