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THE EFFECT OF AGRICULTURAL FERTILIZER IQ COMBI AND BRASSINOLIDE HORMONE ON SOME GROWTH CHARACTERISTICS, YIELD AND ACTIVE COMPOUNDS OF *PETROSELINUM HORTENSE* PLANT

Omar Ali Luaibi Al-Maliki* and Maher Zaki Faisal Al Shammari
Department of Biology, College of Education for Pure Sciences (Ibn Al- Haitham),
University of Baghdad, Baghdad, Iraq
*Corresponding email: ali198007@yahoo.com

Abstract

The field experiment for the winter growth season 2017-2018 was carried out to study the effect of nano agricultural fertilizer (IQ combi) with concentrations (0, 0.5, 0.75, 1.0, 1.5) gm.L^{-1} and brassinolide hormone with concentrations (0, 0.5, 1.0, 1.5, 2.0) mg.L^{-1} and their interaction in certain chemical characteristics as well as the rate of carbohydrate, protein and active compounds of the parsley plant. The experiment was designed by Randomized Complete Blocks Design (R.C.B.D). The experiment was conducted with three replicates per treatment and the mean were compared to the use of the lowest significant difference at the probability level (0.05). The results showed the following:

The effect of nano agricultural fertilizer (IQ combi) has led to a significant increase in all the characteristics studied, exceeding a concentration of 1.5 gm. L^{-1} in both nitrogen, potassium, Ferric and zinc contents, and the proportion of protein, Myristicinl and Apiol.

The effect of the brassinolide in the various concentrations resulted a significant increase in all characteristics studied. The highest increase was recorded at concentration of 1.5 mg.L^{-1} as well as all duel interactions were have significant effect in all characteristics studied with exceeded treatment (1.5) gm.L^{-1} of nano agricultural fertilizer and (1.5) mg.L^{-1} of brassinolide in nitrogen, potassium, Ferric and zinc contents, and the proportion of protein, Apiol and Myristicin.

***Key words*: Nano agricultural fertilizer IQ Combi, brassinolide, parsley, chemical characteristics, protein proportion, active compounds.**

Introduction

Petroselinum hortence Hoffmis biennial herbal plants, 60-100 cm high, belong to Apiaceae family, it is considered to have medical and nutritional importance. As for anatomical characteristics, it have canals containing essential oils at all parts of plant, the original home of the flora, the Mediterranean area, Russia and most of the world (Mozafarian, 2007; Al-Saeed and Hussein, 2010).

The parsley plant has important medical benefits and therapeutic properties, such as antibacterial and anti-oxidants, for the presence of phenolic compounds in the plant (Peter and David, 2006). The plant is diuretic and this is because of the high content of essential oils and the therapeutic effect of plantis due to present of Apiol and Myristicin (Darias *et al*., 2001). It also reduces blood sugar because of the presence of active compounds such as vitamin C, glycosides, coumarins, terpenes and flavonoid (Davey *et al*., 1996). The therapeutic characteristics are also the efficacy against inflammation (anti-inflammation), it is used in the treatment of dermatitis and irritations and ulcers (Yousofi *et al*., 2012). As for the side-effects and toxicity of parsley, most studies have confirmed the safety and safety of plant use, but excessive use or high doses may cause abortion to pregnant women because of the presence of apiol substance and may cause some laxity (Al-Saeed, 2014). Nano agricultural fertilizers containing micronutrient (B, Fe, Zn, Mu and Cu). These elements are important for the healthy growth of plants and the acquisition of abundant production, as global crop production relies widely on the use of mineral fertilizers, particularly in developing countries (Ryan *et al*., 2013). Thus, micronutrient and nanotechnology were used to facilitate the penetration of these elements into the cuticle layer in the leaves and in the soil system. The plants were interacting with the fertilizer of micronutrients and with macronutrients, leading to a synergistic, antagonistic, or neutral response effect on crops and food quality (Monreal *et al*., 2015). The importance of using nano-nutrients is to facilitate their penetration and to satisfy the need for these elements in nutrition, because human nutrition is directly linked to plants and nutrient production, so it requires a balanced content of macro-, meso- and micronutrients (Panuccio *et al*., 2009). Brassinolide is a hormone-based steroidal compound that has been recognized long ago in animals, but the idea of its presence in the plants was not known until 1970 as the brassinolides were discovered by the Mitchell *et al.* through their examination of the pollen and it was named Brassins (Al-Khafaji, 2014).

It also plays an important role in organizing a number of cellular and physiological processes occurring in the plant, such as cell division and elongation, the biosynthesis of the components of the cell wall, as well as synthesis of DNA, RNA and varied proteins, additionally the regulation of microtubules, nitrogen fixation, in addition, distributes the material represented to the plant organs, the growth of the pollen tube and the differentiation of the vascular system, and also formation the transverse roots, efflorescence, seed germination, the resistance to biotic and abiotic stresses, senescence and other processes (Bajguzand Hayat, 2009; Hayat and Ahmad, 2011).

Materials and methods

The experiment was conducted for the 2017-2018 growth season to study the effect of nano agricultural fertilizer (IQ combi), which contains the micronutrient element (B, Fe, Zn, Mn, Cu), and brassinolide as well astheir interaction in some chemical characteristics, protein proportion and active compounds of the parsley plant that were obtained from local markets. The soil samples were taken prior to cultivation for the purpose of estimating the chemical and physical characteristics as shown in the following table

Table 1 : Some physical and chemical characteristics of the soil in the experiment prior to cultivation.:

Element	Value	Unit
Soil texture	Loam	–
Sand	40.0	%
Silt	35.0	%
Clay	25.0	%
Soil reactivity	7.08	pH
Nitrogen available	51	$mg.kg^{-1}$.soil
Phosphor available	20	$mg.kg^{-1}$.soil
Potassium available	322	$mg.kg^{-1}$.soil
Ferric	25	$mg.kg^{-1}$.soil
Zinc	0.4	$mg.kg^{-1}$.soil

According to the method described by Page *et al*. (1982), the analysis was carried out in the Central laboratory at Collegeof Science, University of Baghdad. The plowing, smoothing and levelling operations were conducted, after which the experiment was divided into three replicates, each with 25 experimental units, and the experimental unit area (1m²). The experiment was designed to study the effect of nano agricultural fertilizer (IQ combi) and brassinolide as well as their interaction in some chemical characteristics, the proportion of protein and the active compounds of the parsley plant, as the treatments were organized in Randomized Complete Blocks Design (R.C.B.D). Seeds were cultured on the date of 25/10/2017 after it was sieved and tested its germination rate (98%). Three seeds were cultured in each holes, depending on the experience treatments and in the form of straight lines. Theirrigation and bush removal processes followed them up. Samples were taken on 10/1/2018, i.e. 62 days after germination date for the purpose of measuring some of the morphological characteristics, this regarded as a preliminary sampling date, and other samples were taken on 9/2/2018, i.e. 92 days after the date of the germination and this regardedas a second date to measure some of the growth characteristics. Some chemical characteristics, protein proportion and active compounds of the plant were studied:

Digested samples:

Powdered dried samples were digested according to the method proposed by Gresser and Parson (1979).

1. Estimation of nitrogen concentration in vegetative total (%): Nitrogen concentrations were estimated in the digested samples of the vegetative total in a Kjeldhal method (Jackson, 1958).
2. Estimation of potassium content in vegetative total ($mg.kg^{-1}$): The potassium content of the digested samples were estimated in the vegetative total of Atomic absorption spectrophotometer and by Chapman and Partt (1961) method.
3. Estimation of ferric and zinc content in vegetative total ($mg.kg^{-1}$): The content of ferric and zinc in the digested samples in the vegetative total was estimated using Atomic absorption spectrophotometer by Allon (1961) method.
4. Estimation of protein ratio in vegetative total (%): The protein proportion in the vegetative total was estimated by multiplying the nitrogen rate by a constant factor (6.25) and by method of Vopyan (1984).
5. Estimation of the proportion of Myristicin and Apiol in the essential oil of the plant leaf (%): The ratio of Myristicin and Apiol was estimated in the parsley plant leaf by high-performance liquid chromatography (HPLC) and by A.O.A.C. (1995) method.

Results and Discussion

1. Nitrogen concentration in vegetative total of plant (%)

The results of table (2) indicated that there were significant differences in the mean of nitrogen concentration in the parsley plant, with the effect of different concentrations of nano agricultural fertilizer. The mean character increased at concentration 1.5 $g.L^{-1}$ and the highest value was given of 2.273%, with an increase rate of 23.93% compared to non-treated plants. The reason for the role of nano agricultural fertilizer is to increase the root growth of the length, size and diameter of the root, which increases the root's ability to absorb nutrients from soil solution, including nitrogen. The mass flow phenomenon of the ions plays an important role in this area as the elements move to surface of the roots with the movement of water this mechanism helps root to absorb the largest amount of nutrients due to the speed movement with water (Silber *et al*., 2003). Sathya *et al*., (2008) showed that use of nano ferric and zinc increase the evolution and growth of the roots and the penetration of the soil, thereby increasing the absorption food elements.

As for the effect of different concentrations application of brassinolide the results showed that there were significant differences in the mean of nitrogen concentration. The concentration of 1.5 mg.L^{-1}was excessed with the best mean 2.242% of character and an increase rate of 26.45% compared to non-treated plants. This may be due to brassinolide role for increases the root growth of the length, size and diameter of the root, which improves the plant's ability to absorb nutrients, including nitrogen (Bera *et al*., 2008). The positive effects of brassinolide may be attributed to the fact that it assists in increasing the absorption and utilization of mineral elements of the soil in plant growth, as well as increasing the leaves contented of nitrogen in the treated plants, which can be attributed to the high absorption of mineral nitrogen such as nitrate from soil and representation (El-Khallal *et al*., 2009). The effect of the duel interaction between nano agricultural fertilizer and brassinolide was significantly in nitrogen concentration and treatment 1.5 g.L^{-1}of nano agricultural fertilizer and 1.5 mg.L^{-1} of brassinolide gave the highest value (2.528)% and an increase rate of 60.60% compared to non-treated plant.

Table (2): The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean concentration of nitrogen (%) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	1.574	1.652	1.891	2.114	1.940	1.834
0.5	1.637	1.826	1.928	2.163	1.998	1.910
0.75	1.786	1.890	1.977	2.168	2.054	1.975
1.0	1.799	1.910	2.039	2.238	2.106	2.019
1.5	2.067	2.394	2.456	2.528	1.920	2.273
L.S.D. 0.05	0.139					0.062
Mean	1.773	1.934	2.058	2.242	2.004	
L.S.D. 0.05	0.062					

2. Potassium content in vegetative total (mg.kg^{-1})

The results of table (3) indicated that there are significant differences in the mean potassium content of the parsley plant, with the effect of different concentrations of nano agricultural fertilizer. The concentration of 1.5 g.L^{-1} gave the highest value of 309.7 mg.kg^{-1} and an increase rate of 49.46% compared to non-treated plants. The reason may due to the role of nano agricultural fertilizer which increases the efficiency of the root growth of the length, size and diameter of the root, which contains the ferric where it plays an important role in targeting the cell wall and increases the effectiveness of the biochemical conversion process, making it easier for nutrients to penetrate into the plant and this helps to increase cellular divisions and encourage the formation of branches, which provides a constant demand for nutrients, including potassium, as the plant is taken from the soil (Yang *et al*., 2016).

As for the effect of different concentrations application by brassinolide, the results showed significant differences in the mean of potassium content, with excessing concentration of 1.5 mg.L^{-1} by giving it the highest mean 300.8 mg.kg^{-1}of character with an increase rate of 54.81% compared to non-treated plants. This is due to the role of brassinolide to increase the root growth length of the lengthsize and diameter of the root, which increases the plant's ability to absorb nutrients including potassium. It is positively reflected in the work of brassinolide in increasing the concentration of potassium in the vegetative total (Bera *et al*., 2008). The results also indicated that the role of brassinolide in increasing the content of the leaves from nutrients and hormonal content was due to its role of increasing most of the characteristics studied and reflected positively with the absorption of nutrients from soils (Ross and Quittenden, 2016).

As to the effect of duel interaction between the nano agricultural fertilizer and the brassinolide, it was significantly in the potassium content, giving a concentration 1.5 g.L^{-1} of nano agricultural fertilizer and concentration 1.5 mg.L^{-1} of brassinolide highest value 376.7 mg.kg^{-1} and an increase rate of 144.76% compared to plants that are not treated.

Table (3): The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean potassium content (mg.kg^{-1}) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	153.9	168.6	217.8	268.3	227.5	207.2
0.5	166.1	203.5	224.8	279.8	240.8	223.0
0.75	197.4	215.8	236.6	280.7	254.2	236.9
1.0	197.7	221.2	250.0	298.5	266.3	246.7
1.5	256.5	335.3	356.6	376.7	223.5	309.7
L.S.D. 0.05	55.9					25.0
Mean	194.3	228.9	257.2	300.8	242.5	
L.S.D. 0.05	25.0					

3. Ferric and zinc content in vegetative total (mg.kg^{-1})

The results of a table (4 and 5) show that there are significant differences in the mean content of the micronutrient elements (Fe and Zn) in the vegetative total of the parsley plant, with the effect of different concentrations of nano agricultural fertilizer. The mean content of the microelements increased from 0 to 1.5 g.L^{-1}. The concentration 1.5 g.L^{-1} gave the highest values (643.8 and 97.73) mg.ng^{-1}respectively with an increase rate of (22.34 and 22.73)% in respectively compared to non-treated plants. The increase in the content of the micronutrient elements (Fe and Zn) may revert to nano agricultural fertilizer in increasing the root growth of the length, size and diameter of the root and then the composition of large root total helps to absorb larger amounts of nutrients. The reason for this is the role of nano agricultural fertilizer, which has led to increased vegetative growth, requiring the absorption of a larger amount of nutrients necessary to sustain the plant's biological processes. Also, when application offerric oxide on soybean plant and through the soil, it has led to a significant increase in the elongation of root and photosynthesis using foliar application (Alidoust and Isoda, 2013). This will reflect positively on the increased absorption of micronutrient elements in the plant.

As for the effect of different concentrations application by brassinolide, the results indicate that there are significant differences in the mean content of (Fe and Zn), with exceeded of concentration 1.5 mg.L^{-1}by gave the best mean for micronutrient elements (638.7 and 96.95) mg.L^{-1}respectively and an increase rate of (25.40 and 25.86)% respectively compared to non-treated plants. The increase in the content of micronutrient elements (Fe and Zn) is due to the influence of brassinolide in increasing the root growth length of the length, size and diameter of the root, which improves the efficiency of the plant and its ability to absorb nutrients (Bera*et al.*, 2008). Bajguzand Hayat (2009) also confirmed that the brassinosteroids improve the permeability of cellular membranes in all parts of the plant and this increases the absorption of essential nutrients.

The effect of the duel interaction between nano agricultural fertilizer and the brassinolide was significant in the content of the micronutrient elements (Fe and Zn), giving a treatment of 1.5 g.L^{-1} of nano agricultural fertilizer and 1.5 mg.L^{-1}ofmicronutrient a significant increase in the content of the micronutrient elements, where the highest values 713.8 and 108.46 mg. kg^{-1}respectively and with an increase rate of (57.57 and 59.17)% respectively compared to non-treated plants.

Table 4 : The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean ferric content (mg.kg^{-1}) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	453.0	474.9	542.5	604.6	556.1	526.2
0.5	470.8	523.3	552.0	618.2	571.8	547.2
0.75	513.1	541.8	566.3	619.6	587.5	565.7
1.0	515.8	547.2	583.5	637.4	602.5	577.3
1.5	593.7	667.5	694.0	713.8	550.0	643.8
L.S.D. 0.05	**44.5**					**19.9**
Mean	509.3	550.9	587.7	638.7	573.6	
L.S.D. 0.05	**19.9**					

Table 5 : The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean zinc content (mg.kg^{-1}) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	68.14	71.82	82.19	91.72	84.28	79.63
0.5	71.19	79.25	83.66	93.81	86.69	82.92
0.75	77.69	82.08	85.85	94.02	89.10	85.75
1.0	78.10	82.92	88.48	96.74	91.40	87.53
1.5	90.04	101.37	105.43	108.46	83.34	97.73
L.S.D.0.05	**5.73**					**2.56**
Mean	77.03	83.49	89.12	96.95	86.962	
L.S.D.0.05	**2.56**					

4. Protein ratio in vegetative total (%)

The results of table (6) indicated the existence of significant differences in the mean of protein proportion, with the effect of different concentrations of nano agricultural fertilizer, as the mean character increased by concentrations increased from 0 to 1.5 g. L^{-1}. The concentration 1.5 g.L^{-1}, gave a higher value of 14.21% with an increase rate of 23.99% compared to non-treated plant. The increase in protein is due to the role of nano agricultural fertilizer. The application of nano agricultural fertilizer led to a higher nitrogen rate in the plant (table 2) and also contains the zinc inn nano agricultural fertilizer which is an important element in the synthesis of proteins because of its role in nitrogen metabolism and its transformation into essential acids amino (Barrameda-Medina *et al.*, 2017).

As for the effect of different concentrations application by brassinolide the results showed that there were significant differences in the mean protein proportion, with exceeded theconcentration 1.5 mg.L^{-1}which gave the highest mean of 14.02% and an increase rate of 26.53% compared to non-treated plants. The increase of the proportion protein when application bybrassinolide it is due to the exceedance of nitrogen rate as showed in table (2), which is the most important source of the necessary violence in the synthesis of amino acids that are the cornerstone of protein synthesis (Havlin*et al.*, 2005). Al-Khafaji (2014) also confirmed that the addition of brassinosteroids to the plants had led to a significant increase in the efficacy of DNA and

RNA (DNA, RNA polymerase) and thus the synthesis and formation of DNA, RNA and protein, and also noted that the treatment of wheat plants with brassinolide stimulated enzyme activity ATPase Which in turn stimulates the carboxylase enzyme responsible for increasing dissolved protein.

The effect of duel interaction was significantly difference in the protein proportion between nano agricultural fertilizer and brassinolide, giving a treatment of 1.5 $g.L^{-1}$of nano agricultural fertilizer and 1.5 $mg.L^{-1}$ofbrassinolide the highest value (15.80)% and an increase rate of (60.56)% compared to non-treated plants

Table 6 : The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean protein proportion (%) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer $gm.L^{-1}$	Concentrations of brassinolide $mg.L^{-1}$					Mean
	0	0.5	1.0	1.5	2.0	
0	9.84	10.33	11.82	13.22	12.13	11.46
0.5	10.23	11.41	12.05	13.52	12.49	11.94
0.75	11.17	11.83	12.36	13.55	12.84	12.35
1.0	11.24	11.94	12.75	13.99	13.17	12.62
1.5	12.92	14.97	15.35	15.80	12.00	14.21
L.S.D.0.05	0.87					0.39
Mean	11.08	12.09	12.86	14.02	12.52	
L.S.D.0.05	0.39					

5. Concentration of Myristicinl and Apiolin vegetative total (%)

The results of a table (7, 8) confirmed that there was a significant difference in the mean concentration of Myristicinl and Apiol in oil of parsley, with the effect of different concentrations of nano agricultural fertilizer. The mean concentration of active compounds increased from 0 to 1.5 $g.L^{-1}$and the concentration of 1.5 $gm.L^{-1}$, gave the highest value reached (45.61 and 1.528)% respectively with an increase rate of (24.14 and 24.12)% respectively compared to non-treated plants. The increase in the mean characteristic is due to the role of the nano agricultural fertilizer which contains the micronutrient elements and increased absorption by parsley plant, which enters zinc in the formation of tryptophan that is important in the synthesis of the alkaloids (Al-Nuaimi, 1999). The role of ferric is also due to the fact that it is coenzyme for some of the biotic interactions that occur within the plant, which in turn inters in formation of the secondary products that are involved in the synthesis of active compounds in medical plants (Al-Halabousi, 2015).

Farooqi *et al*. (2012) noted that the micronutrient elements (ferric, zinc and manganese) play an important role in most of the enzymatic interactions and have an indirect role in the creation of many growth regulators, which, in turn, is reflected in increased vegetative growth and hence the content of active compounds and oils. The increase in active compounds is due to the role of zinc, which enters nitrogen metabolism and converts it into a basic amino acids (Barrameda-Medina *et al*., 2017). This leads to a further stimulation of the synthesis of active compounds in medical plants. Moreover, micronutrient elements are no less important than the macronutrient elements in their effect on biotic processes and in increasing the production of active compounds (Al-Hadwani, 2004). The role of the nano agricultural fertilizer may be caused by increased vegetative, root and flowering growth and the subsequent increase in medically active compounds.

As for the effect of different concentrations application by brassinolide, the results show that there are significant differences in the mean concentration of Myristicin and Apiolin the leaf of the parsley plants. The concentration 1.5 $mg.L^{-1}$exceeded and gave the highest mean (44.99 and 1.507)%respectively and an increase rate of (26.76 and 26.74)% compared to non-treated plants. These increases in meancharacter is due to evaluate in nitrogen when application of brassinolide. The increased root growth leads to more efficient absorption and this element significantly increases total content of the terpenes. Also due to the role ofsprayed hormone with appropriate concentrations in the parsley plants to maximize the use of growth factors such as water, light and important nutrients by increasing the efficiency of the photosynthesis process and its primary and secondary products such as essential oils, improving its physical characteristics and increasing the concentration active compounds (Youssef and Talaat, 1998). The brassinolide also has a role in increasing vegetative and flowering growth, resulting in increased primary and secondary metabolism of medically active compounds in essential oil, and may also be attributed to the role of brassinolide, which is mainly a secondary metabolic derivative in medical plants and is shared as a product of oils compounds from sterols metabolism (Dutta, 2004). Kuhn (2016) also confirmed that the reason for the increase in active compounds is due to the brassinolide, which is a plant steroid hormone and it is one of the metabolites of the terpenes that formation the largest part of the plant's active compounds.

The effect of duel interaction between the nano agricultural fertilizer and brassinolide was a significant in the mean concentration of Myristicinl and Apiol, giving a treatment of 1.5$g.L^{-1}$ of nano agricultural fertilizer and 1.5 $mg.L^{-1}$of brassinolide highest values (50.77 and 1.701) respectively and an increase rate (61.32 and 61.38)% respectively compared to non-treated plants.

Table 7 : The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean concentration of Myristicin(%) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	31.47	33.06	37.89	42.4	38.87	36.74
0.5	32.76	36.57	38.62	43.39	40.04	38.28
0.75	35.77	37.87	39.62	43.49	41.18	39.59
1.0	36.02	38.27	40.88	44.90	42.24	40.46
1.5	41.44	48.05	49.30	50.77	38.47	45.61
L.S.D.0.05	3.27					1.46
Mean	35.49	38.76	41.26	44.99	40.16	
L.S.D.0.05	1.46					

Table 8 : The effect of application by nano agricultural fertilizer and brassinolide as well as their interaction in the mean concentration of Apiol(%) of the vegetative total in the parsley plant.

Concentrations of nano fertilizer gm.L^{-1}	Concentrations of brassinolide mg.L^{-1}					Mean
	0	0.5	1.0	1.5	2.0	
0	1.054	1.108	1.269	1.421	1.302	1.231
0.5	1.098	1.225	1.294	1.454	1.342	1.283
0.75	1.198	1.269	1.327	1.457	1.380	1.326
1.0	1.207	1.282	1.370	1.504	1.415	1.356
1.5	1.388	1.610	1.652	1.701	1.289	1.528
L.S.D.0.05	0.109					0.049
Mean	1.189	1.299	1.382	1.507	1.346	
L.S.D.0.05	0.049					

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