Arginine and tryptophan treatment method's impact on some gladiolus plant vegetative development traits

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Abstract

The study was conducted in one of the greenhouses affiliated with the Department of Horticulture and Landscape Engineering Research Station, College of Agriculture, University of Diyala, during the autumn season 2023-2024 to investigate how different arginine and tryptophan concentrations and application techniques affect the vegetative development traits of Gladiolus plants.The tryptophan treatment at a concentration of 200 mg L-1 gave a significant increase in the number of sprouted buds for each corm, 1.68 bud plant-1, plant height, 145.40 cm, dry weight of leaves, 31.17 g. The arginine treatment at a concentration of 150 mg L-1 gave a significant increase in the number of leaves, 8.84 leaf plant-1, leaf area, 640.1 cm2, and fresh weight of leaves, 62.21 g. The treatment method of soaking + spraying gave a significant increase in the plant height, 138.30 cm, number of leaves, 8.35 leaf plant-1, leaf area, 615.9 cm2, and dry weight of leaves, 27.78 g.

Keywords. Gladiolus, arginine, tryptophan

Introduction

Gladiolus (Gladiolus hybridus) is known as the queen of bulbous plants, which is valued for its beautiful flower spikes. It is very popular for its beautiful flower spikes. The variety of colors of its inflorescences and the number of its beautiful flowers make it attractive for various uses in the garden. It is an important flower in both local and international markets. Gladiolus is one of the few plants that produces beautiful flowers with long flower spikes. The quality of flowers and the length of flower spikes can be improved by adopting a suitable set of cultural practices, such as timely planting, proper distances between rows and plants, weeding, and proper irrigation. Besides these cultural practices, the method of application of plant growth regulators can play a vital role in producing good quality flowers [10.[

Many studies have shown that the use of amino acids causes increased growth and development of plants, as amino acids are the primary precursors and components of proteins, and many amino acids also act as primary precursors for other nitrogen-containing compounds, for example, nucleic acids. Amino acids also affect the synthesis and activity of some enzymes, gene expression, and oxidation suppression [13]. Amino acids represent the building blocks of proteins. They are known as growth factors for higher plants and are also known as components of the protein part of the enzyme. Amino acids participate in the construction of many organic compounds, including proteins, amines, alkaloids, vitamins, terpenes, and others. There are approximately 20 important amino acids that participate in all functional processes and stimulate the physiological functions of the plant during periods of maximum activity, such as seedling emergence, flowering, and the development of roots, bulbs, and flowers. Amino acids are of great importance in plant nutrition because

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they obtain the highest yield and best quality and shorten the production cycle with the best dry matter, in addition to giving abundant and consistent flowers [8]. They are necessary in stimulating cell growth and act as stores to provide a source of carbon and energy and protect cells from ammonia toxicity [1]. The use of amino acids, including arginine and tryptophan, plays a role in many vital processes, so their importance is in their effectiveness in all stages of plant growth in addition to being a basic component of proteins as important building blocks for important compounds such as nucleotides, porphyrins, and many coenzymes [7,17.[

In the traditional production system of gladiolus, one bud is sprouted from the mother corm to produce one new corm, but sprouting multiple buds is preferred to increase the production of flower spikes and corms through the use of amino acid and the method of their application, as they play a vital role in improving growth, producing good quality flowers, and increasing the yield of corms. Therefore, the study aims to evaluate the impact of various concentrations of arginine and tryptophan, and their application methods, on the vegetative growth characteristics of Gladiolus plants.

Materials and methods

The experiment was carried out in one of the greenhouses affiliated with the Department of Horticulture and Landscape Engineering Research Station, College of Agriculture, University of Diyala, during the autumn season 2023-2024. The experiment was conducted from 19-11-2023 to 22-4-2024. The research steps began with planting corms of the gladiolus plant Red Beauty cultivar, which is characterized by its red flowers imported from DeReeHolland Royal company through one of the agricultural offices in Baghdad. The land of the greenhouse was prepared by cleaning the soil, leveling it, and covering it with a black plastic cover (polyethylene) to prevent the growth of weeds and maintain the cleanliness of the experimental site. The planting medium used in the experiment was prepared and consisted of a mixture of soil and peat moss at a ratio of 3 soil: 1 peat moss. The soil was obtained from the banks of the Tigris River, and the peat moss from the Green Countryside Company in Baghdad Governorate. Random samples of agricultural soil were taken, and some of their chemical and physical properties were analyzed in the Central Laboratory for Soil, Water and Plant Analysis, University of Baghdad/College of Agricultural Engineering Sciences, Table (1). The agricultural medium was sterilized using a systemic fungicide and bactericide, Baltanoil (liquid pesticide) with the active ingredient Chinosol 50% - Adjuvants & Solvents 50% as a preventive addition to the plant from infection with soil fungi and was used at a concentration of 1 ml. L-1. According to the manufacturer's instructions. The corms were planted on 19/11/2023 in plastic pots 27.5 cm high and 25.5 cm in diameter, with one corm in each pot. The experiment was fertilized with the balanced chemical fertilizer NPK (20-20-20) every two weeks, as it was added to the vegetative part of the plants by spraying at a rate of 1 g L-1 according to the manufacturer's recommendation throughout the research period

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Table 1. The physical and chemical properties of soil

Measurements	Value	Unit of measurement
Texture of soil	Sandy loam	-
Sand	846.4	g. kg^{-1}
Silt	82.4	g. kg^{-1}
Clay	71.2	g. kg^{-1}
Ph	7.2	-
Ec	1.54	$ds.m^{-1}$
N	31	mg. kg^{-1}
P	6.14	mg. kg^{-1}
K	238.1	mg. kg^{-1}
Organic matter	2.5	%
$CaCO_3$	208.1	g. kg^{-1}

The experiment included two factors; the first factor represented the use of amino acids in soaking and spraying, which were arginine at concentrations of 50, 100, and 150 mg.L-1. and tryptophan at a concentration of 100, 150, and 200 mg.L-1, in addition to the comparison treatment (distilled water). Arginine and Tryptophan were obtained by importing them from the American company Sigma through one of the local offices. The second factor represents the application method by three methods, including corm soaking, spraying the vegetable part, and soaking the corms + spraying the vegetable part with the used concentrations of amino acids.

The corms of Gladiolus were soaked in the aqueous solution of the used concentrations of amino acids for 24 hours on 16/11/2023, in addition to soaking in distilled water as a comparison treatment, the corms were divided into seven groups, each group containing 36 corms.

The first group was soaked in distilled water only.

The second group was soaked in arginine solution at a concentration of 50 mg/L.

The third group was soaked in arginine solution at a concentration of 100 mg/L.

The fourth group was soaked in arginine solution at a concentration of 150 mg/L.

The fifth group was soaked in tryptophan solution at a concentration of 100 mg/L.

The sixth group was soaked in tryptophan solution at a concentration of 150 mg/L.

The seventh group was soaked in tryptophan solution at a concentration of 200 mg/L.

After 24 hours of soaking the corms, the bulbs were dried by placing identification marks for each group and placed on cardboard for 48 hours under normal room conditions of lighting and ventilation. After 48 hours, and when it was confirmed that the corms were dry, all soaked and unsoaked corms were treated with the fungicide Baltanoil for 20 minutes as a preventive measure for Fusarium wilt disease before planting.

The corms were placed in paper envelopes and then planted in pots equipped with sterile culture medium and planted at a depth of 7 cm, and a drip irrigation system was used to water the plants. The diameters of the planted corms ranged from 5 to 8 cm. A solution of arginine and tryptophan was prepared by dissolving the substance according to the specified concentrations in distilled water. The plants were sprayed twice, the first time after 30 days from emergence when the plants

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reached the 2-3 leaf stage and the second time after 45 days from emergence. A spreading matter (liquid soap) was added to the spray solution. The plants were sprayed with the used concentrations until completely wet using a 2-liter hand sprayer.

Experimental design

The study was conducted as a factorial experiment (3×7) with three replicates according to the Randomized Complete Block Design (RCBD). The number of treatments and their combinations used in the experiment is 21 treatments, and the number of experimental units is 63. Each experimental unit has 6 plants; thus, the number of experimental plants is 378 plants. The data were analyzed according to the statistical program SAS (2003), and the arithmetic means were compared using Duncan's multiple range test at a probability level of 0.05 [4.[

Vegetative growth traits

Number of days required for germination (day(

It was calculated by the number of days from the date of planting the corms until the first bud appears above the soil surface.

Number of sprouted buds for each corm (bud.plant-1(

It calculated for each planted corm.

Plant height (cm(

Plant height was measured using a measuring tape for three plants, and the height was taken from the contact of the plant stem with the soil surface of the pot to the end of the top of the inflorescence when the inflorescence of the plant was fully grown.

Number of leaves (leaf.plant-1(

The number of leaves was calculated for all plants in the experimental unit, and their average was calculated.

Leaf area (cm2(

The leaf area was calculated on the basis of dry weight, as 4 leaf discs of known area were taken at an oven and dried until the weight was constant, and for four plants from each experimental unit in an electric oven at a temperature of 70 degrees Celsius. From the total dry weight of the plant leaves, the leaf area was calculated using the following equation:

Leaf area (cm2) = leaf area of the discs × total dry weight of the plant leaves / dry weight of the discs [16.[

Fresh weight of leaves (g(

The fresh weight of leaves was calculated using a sensitive balance by taking 8 leaves randomly from each plant in each experimental unit and calculating their fresh weight, then calculating the average fresh weight of the leaves of one plant according to what [5] mentioned as follows:

Fresh weight of leaves (g) = total fresh weight of the eight leaves / 8 × number of leaves in the plant

Dry weight of leaves (g(

After calculating the fresh weight of the eight leaves, they were air-dried at room temperature in a shaded place for about two weeks until the weight stabilized, and then the dry weight of the leaves was calculated in the same way used to calculate the fresh weight of the leaves.

Results and discussion

Number of days required for germination (day(

The results of Table (2) showed that all concentrations of arginine and tryptophan led to an early germination period, and the tryptophan treatment at a concentration of 200 mg L-1 recorded the shortest germination period of 8.69 days, but it did not differ significantly from the arginine treatment at a

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concentration of 150 mg L-1, which reached 8.74 days compared to the control treatment, which led to a delay in the germination period to 11.54 days. There are no significant differences between the treatment method in the number of days required for germination. The interaction between the spraying method and the arginine treatment at a concentration of 150 mg L-1 led to an early germination period, which reached 7.57 days, compared to the interaction between the control with the soaking method, which led to a delay in the period required for germination, which reached 12.70 days.

Number of sprouted buds for each corm (bud.plant-1(

The results of Table (3) showed that all concentrations of arginine and tryptophan led to a significant increase in the number of sprouting buds per corm, and the tryptophan treatment at a concentration of 200 mg L-1 was superior in giving the highest number of sprouting buds per corm, which amounted to 1.68 bud.plant-1, but it did not differ significantly from the arginine treatment at a concentration of 150 mg L-1, as the number of sprouting buds amounted to 1.61 bud.plant-1, compared to the other treatments and the control treatment, which gave the lowest number of sprouting buds, which amounted to 1.02 bud.plant-1. There were no significant differences between the treatment method in the trait of the number of sprouting buds per corm. The interaction between the soaking + spraying method and the tryptophan treatment at a concentration of 200 mg L-1 outperformed and recorded the highest number of sprouted buds, reaching 1.80 bud.plant-1, while the interaction between the control with the spraying method, the soaking + spraying method, and the soaking method recorded the lowest number of sprouted buds, reaching 1.00, 1.00, and 1.07 bud.plant-1, respectively.

Plant height (cm(

The results of Table (4) showed that all concentrations of arginine and tryptophan led to a significant increase in plant height compared to the control treatment, as the tryptophan treatment at a concentration of 200 mg L-1 was superior in giving the highest plant height of 145.40 cm, while the lowest plant height was in the control treatment, reaching 119.20 cm. The results of the table show that there are significant differences between the treatment methods in the plant height, as the soaking + spraying method was significantly superior by giving the highest plant height of 138.30 cm, while the soaking method recorded the lowest height of 129.40 cm. The interaction between the spraying method and the tryptophan treatment at a concentration of 200 mg L-1 was superior in recording the highest plant height of 151.00 cm, while the interaction treatment between the control and the soaking method recorded the lowest plant height of 112.30 cm.

Number of leaves (leaf.plant-1(

The results of Table (5) indicated that the arginine treatment at a concentration of 150 mg L-1 led to a significant increase in the number of leaves compared to the control treatment, reaching 8.84 leaf plant-1, but it did not differ significantly from the tryptophan treatment at a concentration of 200 mg L-1, which reached 8.77 leaf plant-1, while the control treatment recorded the lowest number of leaves, reaching 6.79 leaf plant-1. The results showed significant differences between the treatment method in the number of leaves, as the soaking + spraying method was significantly superior by giving the highest number of leaves, reaching 8.35 leaf plant-1, while the soaking method recorded the lowest

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number of leaves, reaching 7.70 leaf plant-1. The interaction between the soaking + spraying method and the arginine treatment at a concentration of 150 mg L-1 was superior, reaching 9.13 leaf plant-1, while the interaction between the control with the soaking method recorded the lowest number of leaves, as it reached 6.30 leaf plant-1.

Leaf area (cm2(

The results of Table (6) indicated that the arginine treatment at a concentration of 150 mg L-1 led to a significant increase in leaf area compared to the control treatment, reaching 640.1 cm2, but it did not differ significantly from the tryptophan treatment at a concentration of 200 mg L-1, reaching 631.8 cm2, while the lowest leaf area was in the control treatment, as it reached 479.4 cm2. The results showed that there were significant differences between the treatment method in the leaf area, as the soaking + spraying method outperformed by giving the highest average leaf area, which reached 615.9 cm2, while the soaking method recorded the lowest average leaf area, which reached 520.3 cm2. The interaction between the soaking + spraying method and the tryptophan treatment at a concentration of 200 mg L-1 outperformed in recording the highest average leaf area of 684.5 cm2, while the interaction treatment between the control with the soaking method recorded the lowest leaf area of 428.9 cm2.

Fresh weight of leaves (g(

The results of Table (7) showed that the treatment of arginine at a concentration of 150 mg L-1 led to a significant increase in the fresh weight of leaves compared to the control treatment, reaching 62.21 g, while the lowest average in the control treatment reached 44.15 g. There were no significant differences between the treatment method in the fresh weight of leaves. The interaction between the soaking + spraying method with the arginine treatment at a concentration of 150 mg L-1 outperformed in recording the highest fresh weight of 65.94 g, while the interaction treatment between the control and the soaking method recorded the lowest fresh weight of 42.70 g.

Dry weight of leaves (g(

The results of Table (8) indicated that the treatment of tryptophan at a concentration of 200 mg L-1 led to a significant increase in the dry weight of the leaves compared to the control treatment, reaching 31.17 g, while the lowest dry weight was in the control treatment, as it reached 19.56. The results of the table showed significant differences between the treatment method in the average dry weight of the leaves, as the soaking + spraying method outperformed by giving the highest dry weight of 27.78 g, while the soaking method recorded the lowest dry weight of 23.42 g and did not differ significantly from the spraying method, which recorded a dry weight of 14.86 g.

The results of the interaction coefficients between the two studied factors showed significant differences in the dry weight of the leaves. The interaction between the soaking + spraying method and the tryptophan at a concentration of 200 mg L-1 resulted in the highest dry weight of 38.23 g, while the interaction between the control with the soaking method recorded the lowest dry weight of 17.70 g.

Discussion

The results showed that the treatment method with arginine and tryptophan had a significant effect on some vegetative growth traits, and the soaking + spraying method was significantly superior in most traits: plant height, number of leaves, leaf area, dry weight

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of leaves, and number of days required for germination. The reduction in the number of days required for germination may be attributed to the use of the seed-soaking technique with amino acids because it stimulates germination enzymes, including alpha-amylase, protease, and gluconease, which help in development and emergence [11]. The reason for this may be due to the soaking method, which leads to reducing moisture requirements and water absorption during germination, which leads to improving germination and seedling growth [15]. Increasing the soaking period also improves the characteristics by increasing the absorption of the corms or seeds from the soaking material and thus leads to increasing the speed and percentage of germination, as it enhances the early and uniform germination of seedlings by reducing the time of seedling emergence and improving the performance and productivity of seedlings that emerged from prepared seeds [9]. Also, soaking with different chemicals before planting enhances their ability to absorb and metabolic processes before germination to improve the emergence, growth, vitality, and productivity of seedlings [6.[

The results showed that the use of amino acids arginine and tryptophan at different concentrations significantly affected the vegetative growth characteristics, and the arginine treatment at a concentration of 150 mg L-1 was superior in giving the best results for the characteristics of the number of days required for germination, the number of sprouted buds per corm, the number of leaves, leaf area, and fresh weight of leaves. The reason may be attributed to the amino acid arginine, which acts as a critical metabolite for a variety of biological, developmental, and cellular processes [12], and the reason may be attributed to arginine for its role as a growth stimulant in plants and an important source of nitrogen necessary for the synthesis of proteins and enzymes important for physiological processes, especially growth, division, and expansion processes in plant cells; in addition to that, arginine is absorbed directly through the stomata to guard cells [2]. Or the reason for this may be attributed to the high percentage of nitrogen in arginine, as nitrogen stimulates the plant to produce auxins and proteins, which encourages the longitudinal and lateral growth of cells. Arginine also reduces the water capacity of the cell, which increases the cell's ability to absorb water and dissolved nutrients from the growth medium, which leads to increased vegetative growth of the plant [14]. The reason for the superiority of leaf area is also due to its physiological effect in reducing the resistance of cell walls to cell elongation during the growth process [3]. It also increases the dry matter of the green parts and total chlorophyll. This may be due to amino acids, which are the building blocks of proteins, which increases their quantity within the plant. Proteins perform several functions, including regulating metabolic processes and transporting and storing nitrogen. Arginine also increases the chlorophyll pigment in the plant, which increases the efficiency of the photosynthesis process, thus contributing to increasing the amount of carbohydrates produced. It also plays a role in delaying leaf aging [2.[

Conclusion

The treatment method of soaking + spraying and the tryptophan treatment at a concentration of 200 mg L-1 had a positive effect on improving most of the vegetative growth characteristics of gladiolus plants.

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Table 2. Effect of treatment method with arginine and tryptophan and their interaction on the number of days required for germination (day(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	12.70 a	11.27 b	10.64 bcd	11.54 A
Arginine 50	11.07 bc	9.95 d-h	10.13 c-f	10.38 B
Arginine 100	10.10 c-f	9.01 h-k	8.84 i-k	9.32 C
Arginine 150	9.13 f-j	7.57 l	9.53 e-i	8.74 D
Tryptophan 100	10.90 bcd	10.03 d-g	10.13 c-f	10.35 B
Tryptophan 150	10.27 cde	9.03 g-k	9.32 e-j	9.54 C
Tryptophan 200	9.60 e-i	8.13 kl	8.33 j-l	8.69 D
Mean	10.54 A	9.28 A	9.56 A	

Table 3. Effect of treatment method with arginine and tryptophan and their interaction on the number of sprouted buds for each corm (bud.plant-1(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	1.07 i	1.00 i	1.00 i	1.02 E
Arginine 50	1.40 e-h	1.30 h	1.30 h	1.33 D
Arginine 100	1.40 d-h	1.47 d-h	1.43 d-h	1.43 BC
Arginine 150	1.53 c-g	1.57 b-f	1.73 ab	1.61 A
Tryptophan 100	1.37 e-h	1.30 h	1.33 h	1.33 C
Tryptophan 150	1.47 d-h	1.43 d-h	1.60 bcd	1.50 B
Tryptophan 200	1.57 b-e	1.67 abc	1.80 a	1.68 A
Mean	1.40 A	1.39 A	1.46 A	

Table 4. Effect of treatment method with arginine and tryptophan and their interaction on plant height (cm(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	112.30 j	121.70 i	123.60 hi	119.20 E
Arginine 50	123.20 hi	128.50 gh	130.00 g	127.20 D
Arginine 100	131.60 fg	136.00 def	138.70 cde	135.40 C
Arginine 150	139.50 cde	136.80 def	147.60 ab	141.30 B
Tryptophan 100	123.50 hi	128.80 gh	134.20 efg	128.80 D
Tryptophan 150	134.00 efg	137.00 def	143.30 bc	138.10 C
Tryptophan 200	141.30 cd	143.90 bc	151.00 a	145.40 A
Mean	129.40 C	133.20 B	138.30 A	

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Table 5. Effect of treatment method with arginine and tryptophan and their interaction on the number of leaves (leaf plant-1(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	6.30 g	6.86 f	7.21 ef	6.79 D
Arginine 50	7.20 ef	7.32 ef	8.04 cd	7.52 C
Arginine 100	7.99 cd	8.16 c	8.52 bc	8.23 B
Arginine 150	8.56 abc	8.82 ab	9.13 a	8.84 A
Tryptophan 100	7.31 ef	7.47 de	8.12 c	7.64 C
Tryptophan 150	7.97 cd	8.15 c	8.58 abc	8.23 B
Tryptophan 200	8.57 abc	8.88 ab	8.86 ab	8.77 A
Mean	7.70 C	7.95 B	8.35 A	

Table 6. Effect of treatment method with arginine and tryptophan and their interaction on leaf area (cm2(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	428.9 g	489.5 fg	519.8 ef	479.4 D
Arginine 50	475.4 fg	529.6 def	585.2 b-e	530.1 C
Arginine 100	530.7 def	604.7 a-d	624.4 abc	586.6 B
Arginine 150	585.4 b-e	655.4 ab	679.5 A	640.1 A
Tryptophan 100	485.9 fg	574.9 b-e	581.2 b-e	547.3 BC
Tryptophan 150	543.4 c-f	591.0 b-e	636.5 ab	590.3 B
Tryptophan 200	592.6 b-e	618.4 abc	684.5 a	631.8 A
Mean	520.3 C	580.5 B	615.9 A	

Table 7. Effect of treatment method with arginine and tryptophan and their interaction on the fresh weight of leaves (g(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	42.70 f	44.93 ef	44.83 ef	44.15 C
Arginine 50	46.85 def	51.57 b-f	52.45 b-f	50.29 B
Arginine 100	52.54 b-f	54.33 B-e	54.73 b-e	53.87 B
Arginine 150	61.63 ab	59.07 abc	65.94 a	62.21 A
Tryptophan 100	48.47 def	49.49 c-f	56.31 a-d	51.42 B
Tryptophan 150	52.00 b-f	55.97 a-d	59.15 abc	55.71 B
Tryptophan 200	56.64 a-d	59.55 abc	43.81 f	53.34 B
Mean	51.55 A	53.56 A	53.89 A	

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Table 8. Effect of treatment method with arginine and tryptophan and their interaction on the dry weight of leaves (g(

Amino acids mg L^{-1}	Application method			Mean
	Soaking	Spraying	Soaking+ Spraying	
Control	17.70 h	19.60 gh	21.37 fgh	19.56 C
Arginine 50	22.69 efg	25.21 c-f	25.93 b-f	24.61 B
Arginine 100	23.17 d-g	25.46 c-f	24.94 c-f	24.52 B
Arginine 150	25.48 c-f	26.31 b-e	29.11 bc	26.97 B
Tryptophan 100	24.48 def	22.75 efg	27.69 bcd	24.97 B
Tryptophan 150	25.37 c-f	24.47 def	27.18 b-e	25.67 B
Tryptophan 200	25.06 c-f	30.22 b	38.23 a	31.17 A
Mean	23.42 B	24.86 B	27.78 A	

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