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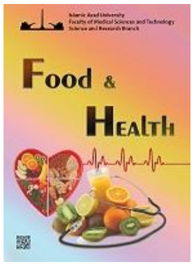

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Evaluation the impact of different polyamines on some nutritional composition of basil (*Ocimum basilicum* L.) hydroponic culture conditions

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ABSTRACT

This research was carried out in Pakdasht private greenhouse, to evaluate the effect of putrescine, spermine, and spermidine on the quantity of Basil under conditions of salt stress as a factorial experiment in a completely randomized block design with three replications in 2016-2017. The treatments included the application of putrescine, spermine, and spermidine at levels 4 (0, 50, 100, and 150 mg/l), salinity stress at four levels (0, 50, 100, and 150 mM), and control treatment (distill water). The results showed that the interaction effects between polyamines, salinity, and concentration on Potassium, Phosphorus, Calcium, Manganese, Manganese Zinc, Iron, Cupper content, was statistically significant at 1% level. K, P, Ca, Mg, Mn, Zn, Fe, Cu content raised in all polyamine treatments. Interaction and simultaneous exposure of 150 mg/l spermidine and low salinity had a positive effect on all the studied plant traces. In addition, the findings indicated that the concentration of 150 mM sodium chloride solution reduced the mentioned traits. However, spermidine improved this condition and symptoms of stress and damages were less observed in spermidine-treated plants. Therefore, it seems that the enhancement synthesis of compounds in plant tissues acts as a health activator in the human body.

1. Introduction

Basil (*Ocimum basilicum* L.) belongs to the *Lamiaceae* family, and it has been considered an important herb traditionally used worldwide, which has been stated as a pharmaceutical herb in most of the sources of Pharmacopoeia. Commonly, basil has been applied as a pharmaceutics shrub in the therapy of headaches, coughs, diarrhoea, constipation, warts, worms, kidney malfunctions, heart problems, and abdominal pains. Green parts of basil can provide an additional amount of several minerals in human nutrition, particularly micronutrients (1, 2). They contain protein, vitamins E, A, K, B_6, and C; as well as calcium, iron, zinc, magnesium, copper, phosphorous, and even potassium. There are several chemicals in basil microgreens (the young seedlings of edible veggies and herbs), including citronellol and linalool, which are known to reduce inflammation in the body and even tackle bacterial infections. This makes it a great addition to your diet, especially if already suffering from aches and pains. The calcium in basil microgreens ensures that your bones and teeth will stay strong. The array of nutrients can even help to keep osteoporosis at bay. the body needs protein, zinc, magnesium, and several of the other nutrients in these plants. Adequate quantities of these will help to ensure hormones remain balanced; helping humans to stay healthy. The iron and vitamin K in basil microgreens will help to ensure your blood clots properly after a cut and have the maximum number of red blood cells possible (3). These plants are very susceptive to

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dehydration reaction and salinity. Therefore, favourable irrigation for growth, yield, and essential oil during the growing period because it has been noted that in the dry and semiarid lands, water deficit and salinity reduce the vegetative development and leaf area. Polyamines are a novel category of plant growth regulators. The presentment of polyamines in all plant tissue indicated their important role in plant growth regulating and retaining the quality of the horticultural crop. Polyamines are widely used in physiological processes like growth and development, cell division, DNA replication, protein synthesis, tuberculosis decomposition, embryogenesis, root induction, flowering, development of reproductive organs, growth, and the emergence of fruits, aging and reacting to living and non-living environmental stresses. Polyamines are separated into classes of putrescine, spermidine and spermine (4). Hydroponics allows the farmer to grow more crops in a shorter time with less effort. Hydroponics has demonstrated that plants do not need soil to grow, but the elements that minerals, organic matter are needed. As a rule, hydroponic crops are superior in terms of nutrition to soil plantation. Therewith, this is due to the revision of the traces that are used by the plant. Hamedi & Khorshidi (5) displayed that salinity, polyamines, and the interaction of salinity, polyamines had a considerable influence on the factors, and it can be mentioned that the consumption of these polyamines will have an affirmative impact on the bean. In previous research by applying two kinds of polyamine in salinity positions in the hydroponic culture of putrescine incremented and spermidine decreased tobacco growth (6). The purpose of this research was to figure out the impact of spermidine, spermine, and putrescine on salinity stress conditions in hydroponic culture on basil nutritional value.

2. Method and materials

Seeds were disinfected for 5-7 minutes with commercial sodium hypochlorite 5% and then rinsed with distilled water. The seeds were put on wet perlite in the dark state for germination and each day was treated with calcium sulphate (0.05 mM). After 7 days, seedlings were carried over to light condition for 24 hours; after appearing on the leaves, they were kept in the hydroponic media. 10-day seedlings were consistently adapted to Hoagland solution for one week. Four weeks old seedlings were transferred to NaCl (50, 100, and 150 mM). After one week, polyamines such as putrescine, spermidine, and spermine at concentrations of (50, 100, and 150 mg/l), was applied in a nutrient medium. Hence, salinity treatment for 2 weeks and polyamide treatment was used for one week. The plants were retained in a growth chamber of 23-23 ° C, 70-80% RH, and (17 hours of light: 7 hours of dark). The media solution was formulated every 6 weeks. Six weeks after planting (two weeks after salinity treatment), the basils were harvested and carried out in the laboratory for parameter easements. Samples after filtration were dried in an air oven for 15 h at 80°C. The dried specimen was ground and put into ceramic vessels and combusted in a muffle furnace at 550°C for 8 h. Mineral nutrient concentrations in the investigated samples were determined by an atomic absorption spectrophotometer (model 3400, Perkin Elmer, Wellesley, Mass) according to AOAC methods (1990).

3. Results and discussion

Results of analysis of variance indicated that there were highly significant differences among basil for all measured mineral elements (p<0.01) (Table 1). The amounts of the mineral elements of basil landraces are given in Table 2. In this study, the concentration of potassium changed from 278 to 170 mg/100 g DW. The highest potassium value belonged to '150 mg/l spermine'' and '100 mg/l spermine''. The average amount of potassium content is in accordance when measured to the value indicated by (7). Potassium is necessary for the growth and transmission of the nervous system to transmit the message as well as regulate the contractions of muscles and is necessary for the function of all living cells (8). The experiment demonstrated that the phosphorus value of basil ranged from 358 to 170 mg/100 g DW in '150 mg/l spermine' and 'control', respectively (Table 2). The phosphorus content of the present study was inconsistent with the rate described by Ozcan (7). The results obtained by the treatment procedure showed basil calcium contains 15.8 to 9 mg/100 g DW in '150 mg/l spermine' and 'control', respectively. The human body is the main constituent of bones and tooth and it has keys metabolic functions. A significant variation has been found between the content of elements in the plant of each investigated basil treated, presenting the mineral Magnesium of examined treatment. Mg, participate with the largest amount in basil biomass at '150 mg/l spermine', where the level of the control was at 7.2 mg/100 g DW. Because manganese is, an essential trace for human health shortages of manganese can also stimulate health negative consequences. The manganese amount differed in basil ranging from 0.32 to 0.01 mg/100 g DW. The maximum and the minimum values of manganese were appeared in '150 mg/l spermine' and 'control', respectively. These rates are higher than shown by Maghrabi (9) and lower than the results of (7), (10), and (11). The function of manganese in the keeping of normal glucose

Table 1. Analysis of variance of traits.

SOV	DF	P	K	Ca	Mg	Mn	Zn	Fe	Cu
Polyamine	2	8.29^{ns}	.002^{ns}	0.003^{ns}	0.04^{ns}	0.18^{ns}	0.24^{ns}	0.17^{ns}	111.21^{ns}
Salinity	2	34.54*	0.14*	0.20*	0.04*	0.20*	0.40*	0.04*	76.3*
Polyamine× Salinity	4	10.51*	0.116*	12.14*	9.45*	12.14*	12.14*	9.45*	0.70**
error	-	209.2	1.018	0.07	0.02	0.07	0.09	0.02	0.12
CV	-	11.73	10.2	12.14	9.45	11.14	12.5	9.45	12.04

*and **: Significant at the 5% and 1% probability levels, respectively; 'ns' is not significant.

Table 2. Changes in mineral content to polyamine applications under salinity stress in basil.

Salinity	Treatment	Ca (mg/100gDW)	Mg (mg/100gDW)	P (mg/100gDW)	K (mg/100gDW)	Fe (mg/100gDW)	Zn (mg/100gDW)	Mn (mg/100gDW)	Cu (mg/100gDW)
Control	**Put1**	13.5±0.43 de	15.9±0.28 de	358±0.14 de	269.59±5.89 de	0.29±0.43 c	7.9±0.28 bc	0.2±0.14 d	0.19±5.89 c
	Put2	13.7±0.30 de	16.1±0.14 de	360±0.09 d	267±12.18 d	0.3±0.30 c	7.9±0.14 bc	0.21±0.09 d	0.21±12.18 cd
	Put3	14±0.24 d	16.3±0.20 d	362±0.09 d	270±3.34 cd	0.31±0.24 bc	8±0.20 bc	0.23±0.09 d	0.22±3.3 c
	Spd1	14.4 ±0.24 d	16.5±0.24 d	367±0.03 d	265±9.20 cd	0.31±0.24 bc	8.1±0.24 bc	0.24±0.03 d	0.24±9.20 c
	Spd2	14.8±0.17 cd	17.1±0.14 cd	368±0.06 cd	268±19.05 c	0.32±0.17 bc	8.7±0.14 b	0.25±0.06 cd	0.24±19.05 cc
	Spd3	15±0.24 c	17.2±0.22 c	368±0.07 b	270±7.12 c	0.34±0.24 b	8.9±0.22 ab	0.27±0.07 b	0.27±7.12 bc
	Spm1	15.3±0.37 c	17.3±0.21c	371±0.10 b	265±20.35 c	0.35±0.37 b	8.69±0.21 ab	0.29±0.10 b	0.28±20.35 b
	Spm2	15.6±0.31b	18.3±0.32 b	375±0.10 ab	268±13.51b	0.36±0.31 ab	9.1±0.32 b	0.3±0.10 ab	0.29±13.51 b
	Spm3	15.8±0.35 a	15.7±0.14 a	378±0.08 a	278±26.04 a	0.37±0.35 a	9.8±0.14 a	0.32±0.08 a	0.34±26.04 a
	Control	12.8±0.14 e	7.7±0.30 e	128±0.07 e	260±12.05 e	0.28±0.14 d	7.8±0.30 c	0.19±0.07 e	0.18±12.05 d
50 mM	**Put1**	10.6±0.72 c	13.6±0.37 c	331±0.19 c	230±9.65 de	0.19±0.72 c	5.8±0.37 b	0.1±0.19 c	0.11±9.65 cd
	Put2	10.8±0.35 c	13.8±0.31 c	334±0.10 bc	215±12.89 d	0.19±0.32 c	5.8±0.31 b	0.11±0.10 c	0.11±12.89 cd
	Put3	11 ±0.24 bc	14±0.26 bc	337±0.04 bc	212±25.97 d	0.2±0.24 bc	6±0.26 b	0.12±0.04 c	0.11±25.97 cd
	Spd1	11.4±0.43 b	14.3±0.44 b	339±0.12 bc	229±18.53 bc	0.21±0.43 bc	6.1±0.44 ab	0.13±0.12 bc	0.12±18.53 cd
	Spd2	11.5±0.41 b	14.5±0.45 b	341±0.16 b	207±40.26 c	0.22±0.41 b	6.5±0.45 b	0.14±0.16 bc	0.13±40.26 c
	Spd3	11.7±0.31 b	14.7±0.44 b	346±0.22 b	215±0.21bc	0.23±0.21 b	6.9±0.41 ab	0.15±0.24 b	0.14±0.33 b
	Spm1	12.1±0.23 ab	15.1±0.35 ab	348±0.22 b	208±0.32 bc	0.25±0.31 b	7±0.41 ab	0.16±0.21 b	0.15±0.31 ab
	Spm2	12.3±0.43 ab	15.3±0.44 ab	350±0.32 ab	219±0.31 b	0.26±0.31 ab	7.2±0.36 ab	0.17±0.21 ab	0.16±0.31 b
	Spm3	12.5±0.32 a	15.6±0.43 a	352±0.34 a	235±0.32 a	0.27±0.42 a	7.3±0.35 a	0.18±0.23 a	0.17±0.33 a
	Control	7.2±0.21 d	6.8±0.33 d	18.8±0.21 d	194±0.31 e	0.13±0.41 d	6±0.41 c	0.10±0.55 c	0.1±0.41 d

Table 2. Changes in mineral content to polyamine applications under salinity stress in basil.

Salinity	Treatment	Ca (mg/100gDW)	Mg (mg/100gDW)	P (mg/100gDW)	K (mg/100gDW)	Fe (mg/100gDW)	Zn (mg/100gDW)	Mn (mg/100gDW)	Cu (mg/100gDW)
100 mM	**Put1**	9.2±0.43 bc	8.8±0.37 c	257±0.14 d	200±5.89 c	0.14±0.43 d	4.8±0.28 b	0.04±0.14 bc	0.04±5.89 c
	Put2	9.3±0.30 bc	9±0.31 b	263±0.09 cd	201±12.18 ab	0.15±0.30 d	4.9±0.14 b	0.05±0.09 bc	0.04±12.18 c
	Put3	9.5±0.24 b	9±0.26 b	275±0.09 dc	201±3.34 b	0.15±0.24 d	5 ±0.20 ab	0.05±0.09 bc	0.05±3.34 c
	Spd1	9.8±0.24 b	9.4±0.44 b	277±0.03 dc	202±9.20 ab	0.16±0.24 cd	5.1±0.24 ab	0.06±0.03 b	0.06±9.20 c
	Spd2	9.8±0.17 b	9.6±0.45 b	282±0.06 c	206±19.05 a	0.16±0.17 cd	5.2±0.14 ab	0.07±0.06 b	0.06±19.05 c
	Spd3	10.1±0.24 ab	9.8±0.44 ab	287±0.07 b	207±7.12 e	0.17±0.24 b	5.2±0.22 ab	0.08±0.07 ab	0.07±7.12 c
	Spm1	10.4±0.37 ab	10±0.35 b	288±0.10 b	208±20.35 c	0.17±0.37 b	5.3±0.21 ab	0.09±0.10 ab	0.09±20.35 b
	Spm2	10.6±0.31 ab	10.1±0.44 ab	292±0.10 ab	219±13.51 b	0.19±0.31 a	5.5±0.32 ab	0.1±0.10 ab	0.09±13.51 b
	Spm3	10.7±0.35 a	10.4±0.43 a	297±0.08 a	226±26.04 a	0.19±0.35 a	5.7±0.14 a	0.11±0.08 a	0.11±26.04 a
	Control	6.5±0.14 c	6.8±0.33 d	179±0.07 e	190±12.05 d	0.12±0.14 e	5.8±0.30 c	0.03±0.07 d	0.10±12.05 d
150 mM	**Put1**	7.5±0.72 b	9±0.37 b	220±0.19 c	175±9.65 cd	0.13±0.72 c	3.4±0.37 bc	0.02±0.19 bc	0.02±9.65 b
	Put2	7.5±0.35 b	9.2±0.31 b	223±0.10 c	187±12.89 cd	0.14±0.35 bc	3.6±0.31 bc	0.03±0.10 b	0.03±12.89 b
	Put3	7.6±0.24 b	9.3±0.26 b	226±0.04 c	188±25.97 cd	0.15±0.24 bc	3.8±0.26 b	0.03±0.04 b	0.03±25.97 b
	Spd1	7.8±0.43 b	9.4±0.44 b	227±0.12 c	190±18.53 c	0.15±0.43 bc	3.9±0.44 b	0.04±0.12 b	0.03±18.53 b
	Spd2	8±0.41 b	9.5±0.45 b	230±0.16 c	192±40.26 c	0.16±0.41 b	4.1±0.45 ab	0.04±0.16 b	0.04±40.26 ab
	Spd3	8.3±0.22 b	9.8±0.21 a	235±0.21 b	194±0.25 c	0.17±0.22 ab	4.2±0.31 ab	0.04±0.32 b	0.04±0.11 ab
	Spm1	8.7±0.22 ab	9.8±0.23 a	237±0.20 b	195±0.24 c	0.17±0.22 ab	4.2±0.43 ab	0.05±0.29 ab	0.04±0.21 ab
	Spm2	8.9±0.32 ab	10±0.34 a	240±0.33 ab	240±0.31 b	0.18±0.20 a	4.4±0.01 ab	0.05±0.27 ab	0.04±0.21 ab
	Spm3	9±0.34 a	10.1±0.37 a	242±0.19 a	260±0.32 a	0.18±0.14 a	4.6±0.31 a	0.06±0.26 a	0.05±0.34 a
	Control	6.1±0.21 c	7.2±0.25 c	170±0.11 d	170±0.22 d	0.10±0.27 d	3.1±0.35 d	0.01±0.11 c	0.01±0.22 d

put1: putrescine (50 mg), put2: putrescine (100 mg), put3: putrescine (150 mg), spd1: spermidine (50 mg), spd2: spermidine (100 mg), spd3: spermidine (150 mg), Spm1: spermine (50 mg), Spm2: spermine (100 mg), Spm3: spermine (150 mg); Means within each column followed by the same letter are not different according to the Duncan test. Data are the mean ± standard error (n=3).

tolerance and the distribution of insulin from B-cell is being raised identified (12). In terms of zinc quantity, as expressed in Table 2, a wide difference was declared among basil under treatment by salinity and polyamines from 9.8 to 3.1 mg/100 g DW. Similar results were observed by Licina (10). Zinc is a required micronutrient for human well-being and is recognized as a portion of more than 300 enzymes and hormones (13). The iron element of basil under salinity stress and polyamines treatment illustrated the highest amount was represented in '150 mg/l spermine' and the lowest in 'control'. This is lower than the values observed by Mihaljev (14). Iron has long been found in its duty in healthy immune systems and disease prevention and producing energy (15). Iron deficiency is a notice in women and children, and attention must be paid to certify that the diet reserves adequate sales of the trace. A considerable difference in cupper content was found among basil treatments, which can be linked to the variation of the testing basil compound, or its adaptation to the growing conditions. Moreover, this could maybe persuade the presence of various chemical compositions in herbal tissues (16).

4. Conclusion

The use of exogenous polyamines has been reported to reduce the effect of salinity on photosynthetic efficiency by preventing the degradation of DNA molecules by oxygen free radicals produced under salinity stress, but this effect strongly depends on the concentration of polyamines or the type and level of stress. According to our finding, it seems that the treatment of basil with putrescine, spermine, and spermidine, leads to enhancing the nutritional value of basil in response to the conjugation of these polyamines with protein molecules and prevention of their breakdown. However, based on this research, to rise of trace, 1.5 mg/l spermidine treatment is the most effective factor. Micro and macro elements are influenced by polyamines remarkably, which enhancement synthesis of compounds in plant tissues acts as a health activator in the human body.

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