J. Agric. Sci. Mansoura Univ., 27(5): 2969 - 2986, 2002

ANATOMICAL STUDIES ON RICE (*Oryza sativa* L.) PLANTS GROWN UNDER DIFFERENT LEVELS OF SALINITY AND TREATED WITH PACLOBUTRAZOL AND GIBBERELLIN

Sabbour, A. M.
Botany Department, Faculty of Agriculture, Cairo University

This study was carried out during the two successive summer seasons of 1998 and 1999. The aim was to determine the effect of salinity on anatomical characters of stem and leaf of rice plants and to ascertain to what extent the application of growth substances may compensate the reduction caused by salinity stress. Stem transverse sections illustrate that low salinity concentration of NaCl 68.4 mM reduced main stem diameter on account of the decrease occurred in number and average diameter of parenchymatous layers of the ground tissue. High concentration 205.5 mM NaCl caused a consecutive reduction in the diameter of the main stem. So, in general, salinity treatments cause a reduction in the dimensions of the vascular bundles, thickness of the bundle sheath and phloem tissue as well as the diameter of xylem vessels.

Application of paclobutrazol at 250 ppm on plants grown under stress of 68.4 mM NaCl show decrease in stem diameter. This reduction accompanies with decrease in bundle length, bundle width, bundle sheath thickness, air cavities diameter, phloem tissue and xylem vessels diameter. On the other hand, plants stressed by 205.5 mM NaCl and treated with 2000 ppm paclobutrazol show an irrespective increase in bundle length, bundle width, bundle sheath thickness, phloem tissue and diameter xylem vessels.

Rice plants grown under stress of 68.4 mM Na Cl and treated with GA_3 at 50 ppm show an increase in stem diameter due to the increase occurred in the thickness stem wall. Unless GA_3 treatments resulted in a decrease in the thickness of bundle sheath, thickness of phloem tissue and diameters of xylem vessels were increased.

Internal structures of leaf as affected by salinity treatment show a reduction in diameter of midvien as well as leaf lamina thickness. This reduction compressed all tissues shared in leaf structure. Application of paclobutrazol at 250 ppm on plants grown under stress of 68.4 mM NaCl induced a decrease in midvein thickness. At the same time, paclobutrazol treated plants show an increase in the leaf lamina thickness. Mesophyll thickness was increased as well as both upper and lower epidermal cells. Plants grown under salinity stress of 68.4 mM Na Cl and treated with GA_3 at 50 ppm show a considerable increase in the thickness of leaf lamina as a result to the increase occurred in the thickness of both upper and lower epidermis as well as mesophyll tissue.

It could be concluded that using paclobutrzol and GA_3 compounds may compensate the depression observed in internal structure of that moderately salinity stressed plants. But it did not compensate the inhibitory effects of the high level of salinity.

دراسات تشريحية على نباتات الأرز النامية تحت مستويات مختلفة من الملوحة والمعاملة بمركبات التريازول و الجبرلين

على محمود صبور
قسم النبات الزراعى ـ كلية الزراعة ـ جامعة القاهرة

أجرى هذا البحث بمزرعة كلية الزراعة جامعة القاهرة حلال الموسم الصيفى ١٩٩٨ و ١٩٩٩ بغرض دراسة تأثير أستخدام التركيزات المختلفة من مركبات التريازول و الجبرلين على الصفات التشريحية للنباتات النامية تحت مستويات مختلفة من الملوحة لصنف الارز جيزة ١٧٦ . و أوضح فحص القطاعات العرضية للساق و الورقة على :-

1- التركيز المنخفض من الملوحة أدى الى نقص في قطر الساق كنتيجة للنقص في سمك جدار الساق مع حدوث زيادة في قطر الفراغ محل النخاع و كان هذا النقص راجعا الى النقص في سمك و عدد طبقات برانشيمة النسيج الاساسى بالاضافة الى قطر فراغات الهواء. على الرغم من هذا النقص, تميزت كلا من البشرة و طبقة الاسكرانشيمة المبطنة للبشرة بزيادة ملحوظة في السمك . أظهر التركيب التشريحى للورقة نقص فى متوسط سمك نصل الورقة راجعا الى النقص الملحوظ فى سمك نسيج الميزوفيل و كلا من سمك البشرة العليا و السفلى.

2- التركيز المرتفع من الملوحة أدى الى نقص معنوى فى متوسط قطر الساق و كان هذا النقص مصحوبا باختزال كبير لسمك جدار الساق بالأضافة الى الزيادة فى قطر الفراغ محل النخاع. لوحظ أيضا نقص ملحوظ فى عدد و سمك طبقات الاسكلرانشيمة المبطنة للبشرة بالاضافة النقص فى ابعاد الحزم الوعائية. أظهر التركيب التشريحى للورقة نقص فى متوسط سمك نصل الورقة و العرق الوسطى و كان هذا النقص راجعا الى النقص الملحوظ فى سمك نسيج الميزوفيل و كلا من سمك البشرة العليا و السفلى. لوحظ نقص كبير فى طول و عرض الحزمة الوعائية و سمك نسيج اللحاء و متوسط قطر وعاء الخشب التالى.

3- أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى لحدوث نقص طفيف فى سمك الساق مصحوب بزيادة فى سمك جدار الساق. هذة الزيادة راجعة للزيادة فى عدد و قياسات اغلب الانسجة المشاركة فى تركيب الساق. تميزت الاوراق المعاملة بحدوث نقص فى سمك كلا من نصل الورقة و العرق الوسطى و بالتالى نقص سمك نسيج الميزوفيل . على الرغم من هذا النقص الملحوظ لوحظ زيادة فى طول و عرض الجزم الوعائية وسمك نسيج اللحاء و أوعية الخشب. مما يعنى أن استخدام أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى تعويض النقص الناتج من تأثير الملوحة.

4- أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع ادى لحدوث نقص ملحوظ فى سمك الساق مصحوب بنقص معنوى فى عدد الحزم الوعائية و سمك الغلاف الليفى للحزم الوعائية و متوسط ابعاد نسيج اللحاء. لوحظ ايضا أن هناك زيادة فى متوسط قطر الخلايا البارنشيمية المكونة للنسيج الاساسى للساق.

5- أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى لحدوث زيادة ملحوظة و معنوية فى عدد و قياسات اغلب الانسجة المشاركة فى تركيب الساق خاصة عدد و حجم الحزم الوعائية و عدد طبقات و متوسط حجم البارانشيمة المكونة للنسيج الاساسى. . تميزت الاوراق المعاملة بحدوث زيادة فى سمك كلا من نصل الورقة و العرق الوسطى و بالتالى زيادة فى سمك نسيج الميزوفيل و كلا من البشرة العليا و السفلى. على الرغم من هذه الزيادة الملحوظة لوحظ نقص فى سمك الغلاف الليفى للحزمة الوعائية بالأضافة الى طول و عرض الحزمة الوعائية. مما يعنى أن استخدام أستخدام الجبرلين بمعدل ١٠٠جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى تعويض النقص الناتج من تأثير الملوحة.

6- أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع أدى لحدوث نقص معنوي فى متوسط قطر الفراغ محل النخاع و سمك الغلاف الليفى للحزمة مع وجود زيادة فى سمك نسيج اللحاء و قطر أوعية الخشب التالى. أكدت الدراسة أن أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع ل يؤدى الى تعويض النقص الناشئ عن تركيزات الملوحة المرتفعة.

INTRODUCTION

Rice is the dominant staple food of the world, accounting for more than 70% of caloric intake in some countries. Furthermore, Asia is home to approximately 70% of the world's population (1.3 billion) poor and the most severe malnutrition in the world occurs in South Asia.

One of the major problems in agriculture of arid and semi-arid regions is salts stress. Therefore, this problem has special importance to Egypt where, out of 2 million feddans of salt affected land in Egypt Anon.(2001). Rice is an irrigated crop known as a mild sensitive to salinity. Many investigations recorded that both quality and quantity of the majority of cereal crops are greatly affected by soil salinity. Inhibition effects of salinity on plant growth and metabolism are well known. One possible management option for growers in dealing with decreases in rice production caused by salinity is to compensate yield reduction by application of some growth regulators (Kondo *et al*., 2000). Abdo (1997) concluded that application of growth regulators resulted in several distinct changes in the anatomy of vegetative organs of wheat plants grown under saline stress.

This paper was designed to study the effect of salinity on anatomical features of rice plant grown under different levels of salinity and to define the amount of compensating this reduction as a result of growth substances treatments.

MATERIAL AND METHODS

This study was conducted at the Experimental Station of the Faulty of Agriculture, Cairo University, during the two successive summer seasons of 1998 and 1999. Grains of rice cultivar Giza 176 were germinated in plastic trays. Thirty days latter a uniform seedlings were transplanted individually in 20 cm pots filled with clay loam soil (E.C.=1.24 ds/m, pH=7.6). Pots were arranged in a split plot design trail with three replicates; each experimental sub-plot contains 5 pots. All other field procedures for growing rice plants were followed. Plants were irrigated regularly, five days intervals by 750 ml saline water at the conentrations of 0, 68.4, 205.5 mM Na Cl solution. The adopted growth regulator were; Gibberellic acid (GA_3-$C_{19}H_{22}O_6$ =346.4 - DUCHEFA- BV. Holland) with the concentrations of 0, 25, 50, 100 ppm and Paclobutrazol ((2RS, 3RS) -1- (4-Chlorophenyl)- 4, 4-dimethyl 2(1, 2-4-triazol-1-41) Pantan-3-01) ICI, England) with concentrations of 0, 1000, 2000 and 3000 ppm. Salinity streesed 45 days old plants were sprayed with the adopted concentrations of growth regulator.

At heading stage (116 days), samples of stems and leaves were taken from ech sub-plot for antomical study. Stem and leaf specimens were taken from the upper most internode just below the flag leaf. Specimens were prepared for histological measurements and counts followed the microtehnique procedures described by (Nassar and El-Sahhr, 1998). Data were recorded over the two seasons and statistically analyzed using MSTAT (1990) microcomputer statistical program.

RESULTS

A- Stem structure as affected by salinity stress

Readings of microscopic counts and measurements as appearing in transverse sections of rice stem treated by different levels of Na Cl salinity are presented in Table (1) and Figure (1). It is apparent that relative to the control, low concentration of NaCl 68.4 mM reduced main stem diameter by 10.3%. This decrease could be attributed chiefly to the noticeable decrease in stem wall thickness, which amounted 35.2% beneath the control. The reduction observed in stem wall thickness, owing to salinity stress, could be attributed to the decrease in thickness of parenchymatous layers of the ground tissue as well as diameter of air cavities. Despite, the thickness of stem wall was decreased; the thickness of epidermis layer was increased by 7.7%. Another increase of 27.7% was observed in sclernchymatous layers beneath the epidermis. This increase could be attributed to the increase in number of the peripheral sclernchyma cells that increased by 6.0%. It is also obvious that the number of bundles was decreased by 11.9% less than the control. Nevertheless, relative to the control, the hollow pith cavity exhibits an increase in its diameter by 56.7%. However, bundle width and length show an increase of 5.6 and 9.8%, respectively. This increase in bundle dimensions was accompanied by an increase of 14.1% in diameter of metaxylem vessels. It was observed that, relative to the control, 68.4 mM NaCl treatment decreased thickness of bundle sheath and thickness of phloem tissue by 16.0 and 10.0%, respectively.

Table (1): Counts and measurements of certain anatomical characters in transverse sections in upper most internode of the main stem of rice plants treated with two concentrations of Na Cl salinity **stress**

Characters		Control	68.4 mM Na CL	± /control%	205.5 mM Na CL	± /control%
Average stem diameter µ		4702.0	4217.5	-10.3	3500.5	-22.9
Average Stem wall thickness µ		1600.0	1035.5	-35.2	859.5	-44.3
Av. Diameter of hollow pith µ		1350.0	2115.4	+56.7	1158.1	-14.2
Av. Thickness of epidermis µ		10.4	11.2	+ 7.7	11.3	+ 7.4
Av. Thick. of sclerenhyma layer		90.2	115.2	+27.7	95.6	+ 9.8
Av. diameter of air cavities µ		215.0	198.0	-7.2	178.2	-17.2
Av. diameter of ground cell µ		26.8	23.3	-12.8	23.5	-12.3
Av. No sclernchyma cell / layer		5.0	5.3	+ 6.0	5.4	+ 6.4
Av. Number of vascular bundles		11.0	9.7	-11.9	8.1	-24.2
Diam. of vascular bundles µ	L	238.1	261.4	+9.8	202.7	-14.8
	W	151.5	159.9	+5.6	129.8	-14.3
Av. Thickness of bundle sheath µ		18.1	15.2	-16.0	12.6	-27.8
Av. diam. of metaxylem vessel µ		52.9	60.4	+14.1	55.1	-5.2
Av. diameter of phloem tissue µ		36.8	33.1	+10.0	27.5	-22.6

It is realized that, relative to the control, high used concentration 205.5 mM NaCl cause a progressive reduction in the diameter of the main stem by 22.9% (figure, 1). This reduction mainly due to the decrease in the thickness of stem wall as well as in the diameter of hollow pith cavity. This reduction declined 44.3 and 14.2% for stem wall thickness and diameter of hollow pith cavity. This was due to the decrease in most measurements and counts of all included tissues outside the hollow pith cavity.

High salinity treatment caused remarkable reduction in average diameter of ground tissue cells 12.3% as well as a reduction of 17.2% in the diameter of air cavities. Another reduction was observed in number of sclerenchyma layers and total number of vascular bundles. The corresponding reduction percentages were 6.0 and 17.9%. It is also realized that, relative to the control, total number of vascular bundles was decreased by 17.9%. On the contrary, 7.4 and 9.8% increase was observed in thickness of both epidermis and mechanical tissue. Salinity stress caused a reduction in the dimensions of the vascular bundles, thickness of the bundle sheath and phloem tissue as well as the diameter of xylem vessels. The incline inferior to the control amounted 14.8, 14.3, 27.8, 22.6 and 5.2% for bundle length and width, thickness of bundle sheath, thickness of phloem tissue and diameter of xylem vessels, respectively.

II-Stem structure of stressed plants as affected by growth regulator

Data presented in Table (2) and Figure (2) illustrate that, relative to the control, application of pacloburazol at 3000 ppm on rice plants cv. Giza 176 grown under stress of 68.4 mM NaCl induced an inconsequential decrease of 5.5% in stem diameter. At the same time treated plants show an increase in the thickness of stem wall. This increase was 9.1% more than the control. Although, the diameters of hollow pith cavity showed decrease of 16.7% as compared with the control.

Table (2): Counts and measurements of certain anatomical characters in transverse sections in upper most internode of the main stem of rice plants grown under salinity stress and treated with 3000 ppm paclobutrazol

Characters	Control	68.4 mM NaCl 3000 (ppm) paclobutrazol	± /control%	205.5 mM Na Cl 3000 (ppm) paclobutrazol	± /control%
Average stem diameter µ	4702.0	4439.2	-5.5	4396.1	-6.5
Average Stem wall thickness µ	1600.0	1745.9	+9.1	1681.3	+5.0
Av. Diameter of hollow pith µ	1350.0	1124.3	-16.7	1997.2	+47.9
Av. Thickness of epidermis µ	10.4	10.9	+18.2	11.3	+8.7
Av. Thick. of sclerenhyma layer	90.2	105.8	+7.2	98.3	+ 9.0
Av. diameter of air cavities µ	215.0	233.8	+8.7	215.9	+0.0
Av. diameter of ground cell µ	26.8	28.9	+8.2	26.9	+0.0
Av. No sclernchyma cell / layer	5.0	5.1	+2.0	5.2	+4.0
Av. Number of vascular bundles	11.0	10.9	+1.0	10.2	-7.3
Diam. of vascular bundles µ L	238.1	218.5	-8.2	225.9	-5.1
W	151.5	136.1	-10.1	144.7	-4.4
Av. Thickness of bundle sheath µ	18.1	14.3	-20.9	13.7	-24.3
Av. diam. Of metaxylem vessel µ	52.9	54.1	+2.0	53.1	+0.4
Av. diameter of phloem tissue µ	36.8	34.9	-5.6	29.8	-19.0

The increase in stem wall thickness was accompanied by an increase in the thickness of epidermis and mechanical tissue as well as in the number of sclerenchyma layers of mechanical tissue. The corresponding increment values were 18.2, 7.2 and 2.0%. It realized that, total number of vascular bundles was slightly increased by 1.0% as a result of paclobutrazol treatments. On the other hand, bundle width, bundle length, bundle sheath thickness and diameter of phloem tissue of the treated plants were decreased by 8.2, 10.1, 20.95% and 5.6% below the control, respectively.

Plants stressed by 205.5 mM NaCl and treated by 3000 ppm pacloburazol showed 6.5% decrease in average stem diameter (table, 2 and figure, 2). However, remarkable decrease was noticed in number of vascular bundles, thickness of bundle sheath as well as average diameter of phloem tissue. The corresponding decreased percentages for such traits were 7.35, 24.3 and 19.0%. On the other hand, 3000 ppm paclobutrazol treatment caused an increase in diameter of hollow pith, average diameter of ground tissue cells and diameter of metaxylem vessels, as well as thickness of epidermis.

Table (3): Counts and measurements of certain anatomical characters in transverse sections in upper most internode of the main stem of rice plants grown under salinity stress and treated with 100 ppm GA_3

Characters	Control	68.4 mM Na CL 100 (ppm) GA3	± /control%	205.5 mM Na CL 100 (ppm) GA3	± /control%
Average stem diameter μ	47|02.0	4936.1	+4.7	4498.3	-4.3
Average Stem wall thickness μ	1600.0	1849.3	+15.5	1297.4	-18.9
Av. Diameter of hollow pith μ	1350.0	1074.3	-20.4	1008.3	-25.3
Av. Thickness of epidermis μ	10.4	11.1	+6.7	11	-5.8
Av. Thick. of sclerenhyma layer	90.2	92.4	+0.9	99.5	+10.9
Av. diameter of air cavities μ	215.0	219.2	0.0	218.3	0.0
Av. diameter of ground cell μ	26.8	29.4	+9.7	24.3	-9.4
Av. No sclernchyma cell / layer	5.0	5.0	0.0	5.2	+4.0
Av. Number of vascular bundles	11.0	11.1	+0.9	11.2	+1.8
Av. Diam. of vascular bundles μ L	238.1	251.4	+5.5	217.6	-9.8
w	151.5	159.7	+5.4	140.9	-7.3
Av. Thickness of bundle sheath μ	18.1	14.2	-21.5	15.4	-14.9
Av. diam. of metaxylem vessel μ	52.9	59.4	+12.3	53.8	+1.7
Av. diameter of phloem tissue μ	36.8	39.0	+6.0	40.7	+10.6

Rice plants stressed by 68.4 mM NaCl and sprayed by 100 ppm GA_3 showed a remarkable increase in most internal tissues as shown in the transverse sections Table (3) and Figure (3). Where, an increase of 4.9% in stem diameter was achieved and this increment was mainly due to the increase occurred in the thickness stem wall by 15.5%. However, epidermis, Average diameter of ground tissue cells and thickness of sclerenchymatous tissue layer were 6.7, 9.7 and 1.2% more than the control. It is also noticed that, total number of vascular bundles did not affect by that treatment as compared with the control. While, vascular bundle dimensions were increased as compared with control by 5.5 and 5.4% for bundle length and width, respectively.

On the other hand, 100 ppm GA_3 treatment caused a considerable decrease in average diameter of hollow pith cavity. This decrease amounted 20.4% less than the control.

So, the increase occurred in stem diameter as a result of GA_3 treatment could be attributed to the increase in the thickness of all tissues observed outside the hollow pith cavity. However, relative to the control the treated plants showed a decrease of about 21.5% in the thickness of bundle sheath. Conversely, the thickness of phloem tissue and diameter of xylem vessels were increased by 12.3 and 6.4, respectively.

A- Leaf structure as affected by salinity stress

Transverse sections of rice leaf as affected by different Na Cl salinity treatments are presented in table (4) and Figures (4). It is realized that, relative to the control, low saline concentration 68.4 mM NaCl reduced leaf lamina thickness and average thickness of midvein by 10.5 and 7.1%, respectively. Though, NaCl treatments caused thin leaves that could be attributed to the decrease in thickness of leaf mesophyll tissue and in both upper and lower epidermis. This contraction amounted 10.5, 14.3 and 8.3%, respectively.

Table (4): Counts and measurements of certain anatomical characters in transverse sections in flag leaf of rice plants treated with two concentrations of Na Cl salinity stress

Characters	Control	68.4 mM Na Cl	± /control%	205.5 mM Na Cl	± /control%
Average thickness of midvein µ	728	676	-7.1	572	-21.4
Average thickness of lamina µ	494	442	-10.5	380	-23.1
Av. thickness of upper epidermis µ	14	12	-14.3	11	-21.4
Av. thickness of lower epidermis µ	12	11	-8.3	10	-16.7
Av. Thickness of ground tissue µ	422	380	-10.0	350	-17.1
Av. Diam. of midvein bundles µ L	255	237	-11.6	209	-29.7
w	198	179	-9.6	154	-22.2
Av. Thickness of bundle sheath µ	22	19	-13.6	15	-31.8
Av. diam. of metaxylem vessel µ	59	49	-16.9	43	-27.1
Av. diameter of phloem tissue µ	38	31	-18.4	29	-23.7

It is clear that 68.4 mM NaCl treatment resulted in a remarkable decrease in bundle length, bundle width, thickness of phloem and diameter of metaxylem vessels by 11.6, 9.6, 18.4 and 16.9%. However, the thickness of bundle sheath was decreased by 13.6% as a result of salinity stress.

High used salinity treatment 205.5 mM Na Cl decreased both leaf lamina thickness and midvein by noticeable amount 23.1, 21.4% (table, 4 and figure, 4). This reduction could be attributed to the decrease occurred in all tissues shared in lamina structure. Likewise, remarkable decrements were recorded in measurements and counts of all shared internal structure i.e., bundle length, bundle width, thickness of phloem and diameter of metaxylem vessels. It is also obvious that, 205.5 mM NaCl salinity treatment resulted in sever reduction in average size of parenchymatous cells of spongy ground tissue. On the other hand, number of mesophyll layers did not affected by such treatment.

A- Leaf structure of stressed plants as affected by growth regulator

Data presented in Table (5) show that, relative to the control, application of pacloburazol at 3000 ppm on rice plants cv. Giza 176 grown under stress of 68.4 Mm NaCl induced a decrease of 4.0% and 5.5% in midvein thickness and average thickness of lamina, respectively. However, mesophyll tissue of treated plants was decreased by 5.0%.

Table (5): Counts and measurements of certain anatomical characters in transverse sections in flag leaf of rice plants grown under salinity stress and treated with 3000 ppm paclobutrazol

Characters	Control	68.4 mM Na CL 3000 (ppm) Paclobutrazol	±/control%	205.5 mM Na CL 3000 (ppm) Paclobutrazol	±/control%
Average thickness of midvein µ	728	699	-4.0	684	-6.0
Average thickness of lamina µ	494	467	-5.5	457	-7.5
Av. thickness of upper epidermis	14	13	-7.1	12	-14.3
Av. thickness of lower epidermis µ	12	11	-8.3	11	-8.3
Av. Thickness of mesophyll tissue µ	422	401	-5.0	394	-6.6
Number of spongy tissue layer	17	19	+11.7	17.3	0.0
Av. Diam. Of midvein bundles µ L	155	161	+4.5	139	+1.3
W	198	211	+6.6	174	+1.1

Av. Thickness of bundle sheath μ	22	22.9	+4.5	20	+2.1
Av. diam. Of metaxylem vessel μ	59	64	+8.5	54	+3.5
Av. diameter of phloem tissue μ	38	41	+7.9	33	+1.2

Although, the decrease observed in number of mesophyll layers and mesophyll thickness bundle length and width increased by 4.5 and 6.6% over the control as a result of pacloburazol treatments. It is obvious that, bundle sheath thickness, phloem tissue and diameter of xylem vessels of the treated plants were increased. The incline toward control amounts 4.5, 7.9 and 8.5% for bundle sheath thickness, phloem tissue and diameter of xylem vessels, respectively (figure, 5).

Table (6): Counts and measurements of certain anatomical characters in transverse sections in flag leaf of rice plants grown under salinity stress and treated with 100 ppm GA_3

Characters	Control	68.4 mM Na Cl 100 (ppm) GA_3	±/control %	205.5 mM Na Cl 100 (ppm) GA_3	±/contro %
Average thickness of midvein μ	728	777	+6.7	764	+4.9
Average thickness of lamina μ	494	526	+6.5	504	+2.2
Av. thickness of upper epidermis	14	16	+14.3	15	+7.1
Av. thickness of lower epidermis μ	12	14	+16.7	13	+8.3
Av. Thickness of mesophyll μ	422	469	+11.1	490	+16.1
Number of spongy tissue layer	17	18	+9.4	17	0.0
Av. Diam. of midvein bundles μ L	155	161	+3.9	149	-3.9
W	198	203	+2.5	174	-12.1
Av. Thickness of bundle sheath μ	22	21	-4.5	20	-9.1
Av. diam. of metaxylem vessel μ	59	61	+3.4	60	+1.7
Av. diameter of phloem tissue μ	38	39	+2.6	38	+0.0

Data presented in Table (6) proved that application of GA_3 at 100 ppm to the plants grown under stress of 68.4 mM Na Cl showed a considerable increase in the thickness of leaf lamina and midvein. This increase amounted 6.7 and 6.5% over the control. The increase occurred in leaf lamina as a result of GA_3 treatment could be attributed to the increase occurred in the thickness of both upper and lower epidermis as well as thickness of mesophyll tissue. The corresponding amounts of that increase were, 7.1, 8.3 and 16.1 for the above mentioned traits in the same order. It could be stated that, leaf lamina of plants grown under 68.4 mM NaCl salinity and treated with 100 ppm GA_3 showed a slight increase in counts and measurements of most internal tissues as shown in the transverse sections (figure, 6). On the other hand a decrease of 9.1% in bundle sheath thickness was observed. As long as, vascular bundle dimensions decreased by 3.9% in length and 12.1% in width as compared with the control.

Since, salinity stress caused a remarkable reduction in stem diameter by decreasing the thickness of stem wall as well as the diameter of the hollow pith. The decrease occurred in stem wall was accompanied by a decrease in the thickness of the epidermis, the ground parenchyma tissue, length and width of vascular bundles, thickness of the bundle sheath, thickness of the phloem tissue and diameter of metaxylem vessels. This may suggest that the available nutritional elements were less as plants were subjected to salt stress (Linghe zeng and Michael 2000). It is also noted that the decrease in the amount of vascular tissues resulting from saline treatment will reflect on growth habit and morphological aspects of stressed plants. Salinity stress as affected the internal structure of both the stem and the leaf were early studied by many workers; Kumar (1983) noticed that parenchymatous cells surrounding the midrib bundle of alfalfa were collapsed and intercellular spaces occulted under salinity. In this regard Azmi and Alam (1990) reported that, the thickness of the midrib, distance between veins and number of vascular bundles decreased significantly with increasing salinity. Moreover, Wanas (1996) disclosed that, stem shortening resulted by salinity was mainly due to the inhibition that occurred in elongation of parenchymatous cells of the ground tissue as well the other tissues shared in the stem structure. These suppressive effects of salinity on the internal structure reflect on morphological and yield aspects of plants. It is evident that salinity inhipition effects were highly significant on grain yield, plant stand, seed weight per plant, seed weight per panicle, and spikelets per panicle, but not significant on panicle density, kernel weight, and shoot weight per plant. This was confirmed by the anatomical findings presented in this study. Linghe Zeng and Michael (2000) reported that salinity treatments led to reductions in shoot and root fresh and dry weights as well as a severe reduction in measurements of vegetative organs. On the contrary, Salem, (1984) indicated that leaves of alfalfa plants stressed by salinity showed an increase in spongy cell diameter as well as a remarkable increase in diameter and length of palisade cells.

Rice plants grown under salinity stress of Na Cl and treated by GA_3 showed an increase in stem diameter. This increment mainly due to the increase occurred in the thickness stem wall. So, the increase occurred in stem diameter as a result of GA_3 treatments could be attributed to the increase in the thickness of all tissues observed outside the hollow pith cavity. In the mean time, a considerable decrease that occurred in diameter of hollow pith cavity and air cavities was observed as a result of growth regulator treatments. The total number of vascular bundles remarkably increased and vascular bundle dimensions were also increased as compared with those stressed by different salinity treatments.

For this reason, it could be suggested that application of GA_3 and paclobutrazol with salinity stressed plants increased rice stem diameter and its internal tissues in addition to leaf lamina thickness. In this relation Abdel–Gwad *et al.* (1989) stated that foliar application with 20 ppm Kinetin on wheat plants grown under saline condition of Wadi-Suder 3650 ppm salinity caused an increase in the percentages of epidermal layer and chlorenchyma in stem, while xylem elements of vascular bundles were decreased. It was also reported that, wheat plants treated with cycocel, and sprayed with GA_3 had thicker stem walls as compared with untreated ones. Nassar (1975) reported that maize plants (inbred G-8) treated with cycocel showed high number of bundles, while the vessel size is nearly similar and the fibrous bundle sheath is thicker with more layers. In this connection El–Shaarawi and Awatef (1976) found that GA_3 at the rate of 600 ppm promoted the development and differentiation of phloem tissue, especially fibers, average diameter of parenchymatous cells as well as pith diameter. While, the amount of xylem was negatively affected. In this affiliation El-Sgai and El-Sayd (1999) disclosed that paclobutrazol treatments have a simulative effect in increasing all histological measurements of stem including an increase in parenchymatous cells of both cortex and pith tissues as well as number and width of xylem vessels in Okra plants.

The out findings of this trail may suggest that using GA_3 and paclobutrzol compounds may compensate the depression observed in internal structure of that moderately salinity stressed plant. But it did not compensate the inhibitory effects of the high level of salinity.

REFERENCES

Abd El-Gwad, M.A.; M.O.M. Salem and A.M. Higazi (1989). Anatomy of ALFALFA leaflet as affected by NPK- fertilization and saline irrigation. Annals of Agric. Sc., Moshtohor, 27 (3): 1989.

Abdo, F.A.M. (1`997). Morphological, anatomical and physiological studies on wheat plants grown under different levels of salinity and treated with kinetin or gibberellin. Ph.D Thesis, Department, Agriultural Botany, Faculty of Agriculture, Cairo University. 232pp. (1997).

Anon. (2001). Department of Registration, Central Administration of Agricultural Economy. Ministry of Agriculture, Egypt. 2001.

Azmi, A. R. and S.A. Alam (1990). Effect of salt stress on germination, growth, leaf anatomy and mineral element composition of wheat ultivars. Acta Physiologiae Plantarum, 12 (3):215-224.

El-Sgai, M.U. and S.F. El-Sayed (1999). Effect of two triazole compounds on growth, fruiting and plant anatomy of Okra. Egypt. J. Appl. Sci., 14(7):1999.

El-Shaarawi, A. and M. Awatif (1976). Some morphological and histological responses of *Phaseolus vulgaris* L. to Chloromequat (CCC) and Gibberellic acid. Annals of Agric. Sc., Moshtohor, 6: 1976.

Kondo, M.; A. Aguilar; J. Abe and S. Morita (2000). Anatomy of nodal roots in tropical upland and lowland rice varieties. Plant Production Science (2000) © by American Society of Agronomy.

Kumar, D. (1983). Salt tolerance of alfalfa and wheat varieties. Current Agriulture, 7 (3-4):122-128.

Linghe Zeng, Michael C. Shannon (2000). Effects of Salinity on Grain Yield and Yield Components of Rice at Different Seeding Densities. Agron. J. 92: 418-422 (2000), © 2000 by American Society of Agronomy.

MSTAT, (1990). Micro Computer Software of Statistical analysis.Version 2.0/Em. Dept. Crop and Soil Sci., Michigan State Univ.

Nassar M. A. and K.F. El-Sahhar (1998). Botanical preparations and Microscopy (Microtechnique). Academic Bookshop, Dokki, Giza, Egypt, 219 pp. (In Arabic).

Nassar, M. C. (1975). Response of two local field corn inbred lines and their hybrid to treatment with Gibberellic acid and Cycocl. Ph.D. Thesis, Faculty of Agriculture, Cairo University.

Wanas, A. L.(1996).Botanical studies on some eonomical plants tolerating salinity. Ph.D. Thesis. Fac. Agric., Zagazig Univ.243 pp.

Salem M.I.O. (1984). Role of gibberellins and ytokinins in regulation of germination dring development and ripening of Triticale aryopses. Atca Societatis, Botaniorum Poloniae, 53(2):257-270.

دراسات تشريحية على نباتات الأرز النامية تحت مستويات مختلفة من الملوحة والمعاملة بمركبات الترايازول و الجبرلين

على محمود صبور
قسم النبات الزراعى – كلية الزراعة – جامعة القاهرة

أجرى هذا البحث بمزرعة كلية الزراعة جامعة القاهرة حلال الموسم الصيفى ١٩٩٨ و ١٩٩٩ بغرض دراسة تأثير أستخدام التركيزات المختلفة من مركبات الترايازول و الجبرلين على الصفات التشريحية للنباتات النامية تحت مستويات مختلفة من الملوحة لصنف الارز جيزة ١٧٦ . و أوضح فحص القطاعات العرضية للساق و الورقة على :-

7- التركيز المنخفض من الملوحة أدى الى نقص في قطر الساق كنتيجة للنقص في سمك جدار الساق مع حدوث زيادة في قطر الفراغ محل النخاع و كان هذا النقص راجعا الى النقص في سمك و عدد طبقات برانشيمة النسيج الاساسى بالاضافة الى قطر فراغات الهواء. على الرغم من هذا النقص, تميزت كلا من البشرة و طبقة الاسكرانشيمة المبطنة للبشرة بزيادة ملحوظة في السمك . أظهر التركيب التشريحى للورقة نقص فى متوسط سمك نصل الورقة راجعا الى النقص الملحوظ فى سمك نسيج الميزوفيل و كلا من سمك البشرة العليا و السفلى.

8- التركيز المرتفع من الملوحة أدى الى نقص معنوى فى متوسط قطر الساق و كان هذا النقص مصحوبا باختزال كبير لسمك جدار الساق بالأضافة الى الزيادة فى قطر الفراغ محل النخاع. لوحظ أيضا نقص ملحوظ فى عدد و سمك طبقات الاسكلرانشيمة المبطنة للبشرة بالاضافة النقص فى ابعاد الحزم الوعائية. أظهر التركيب التشريحى للورقة نقص فى متوسط سمك نصل الورقة و العرق الوسطى و كان هذا النقص راجعا الى النقص الملحوظ فى سمك نسيج الميزوفيل و كلا من سمك البشرة العليا و السفلى. لوحظ نقص كبير فى طول و عرض الحزمة الوعائية و سمك نسيج اللحاء و متوسط قطر وعاء الخشب التالى.

9- أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى لحدوث نقص طفيف فى سمك الساق مصحوب بزيادة فى سمك جدار الساق. هذة الزيادة راجعة للزيادة فى عدد و قياسات اغلب الانسجة المشاركة فى تركيب الساق. تميزت الاوراق المعاملة بحدوث نقص فى سمك كلا من نصل الورقة و العرق الوسطى و بالتالى نقص سمك نسيج الميزوفيل . على الرغم من هذا النقص الملحوظ لوحظ زيادة فى طول و عرض الجزم الوعائية وسمك نسيج اللحاء و أوعية الخشب. مما يعنى أن استخدام أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى تعويض النقص الناتج من تأثير الملوحة.

10- أستخدام الباكلوبيترازول بمعدل ٣٠٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع ادى لحدوث نقص ملحوظ فى سمك الساق مصحوب بنقص معنوى فى عدد الحزم الوعائية و سمك الغلاف الليفى للحزم الوعائية و متوسط

ابعاد نسيج اللحاء. لوحظ ايضا أن هناك زيادة فى متوسط قطر الخلايا البارنشيمية المكونة للنسيج الاساسى للساق.

11- أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى لحدوث زيادة ملحوظة و معنوية فى عدد و قياسات اغلب الانسجة المشاركة فى تركيب الساق خاصة عدد و حجم الحزم الوعائية و عدد طبقات و متوسط حجم البارانشيمة المكونة للنسيج الاساسى. تميزت الاوراق المعاملة بحدوث زيادة فى سمك كلا من نصل الورقة و العرق الوسطى و بالتالى زيادة فى سمك نسيج الميزوفيل و كلا من البشرة العليا و السفلى. على الرغم من هذه الزيادة الملحوظة لوحظ نقص فى سمك الغلاف الليفى للحزمة الوعائية بالأضافة الى طول و عرض الحزمة الوعائية. مما يعنى أن استخدام أستخدام الجبرلين بمعدل ١٠٠جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المنخفض ادى تعويض النقص الناتج من تأثير الملوحة.

12- أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع أدى لحدوث نقص معنوي فى متوسط قطر الفراغ محل النخاع و سمك الغلاف الليفى للحزمة مع وجود زيادة فى سمك نسيج اللحاء و قطر أوعية الخشب التالى. أكدت الدراسة أن أستخدام الجبرلين بمعدل ١٠٠ جزء فى المليون على نباتات الارز النامية تحت مستوى الملوحة المرتفع ل يؤدى الى تعويض النقص الناشئ عن تركيزات الملوحة المرتفعة.