

**AN-Najah National University**  
**Faculty of Agriculture and Veterinary Medicine**  
**Department Plant Production and Protection**

**Effect of Bacteria on Germination of Barley Grown  
Under Wide Salt Range Stress**

Prepared By: Wael Sakhen , Omar Daragmeh, Ansam Al Fares, Donia Qarash, Abdullah Jabi, Nidal Howari, Mohammad Ayoub.

Supervised By: Dr. Heba AL-Fares

## Introduction:

Barley (*Hordeum Vulgare*)

Barley is the fourth most important cereal crop in the world after Wheat, Maize and rice. Barley originated in or near the area bordering Syria and Iraq with Iran and Turkey (fertile crescent).

Barley can be adapted under semiarid conditions and is most tolerant of extreme conditions of salinity and drought.

## Barley economic importance:

Barley was mainly cultivated and used for human food.

Producing malt (beer).

Nowadays its primary use is for animal feed.

Salinity is a problem of great concern. This problem restricts crop yields on almost 40 million hectares of irrigated lands. Due to increasing world population and food needs, it is recommended to use all available soil and water resources.

Many studies have confirmed the inhibitory effect of salinity on the germination, vegetative growth and yield of barley and other crops.

Several microorganism are known to have the ability to tolerate high salt concentration and survive under wide salinity range

*Pseudomonas fluorescens* is plant growth promoting rhizobacterium and live in the plant rhizosphere.

*P. fluorescens* have received particular attention throughout the global science because of excellent root colonizing ability and its capacity to produce a wide range of enzymes and metabolites that help plant to withstand under varied biotic and a biotic stress condition.

*B. megaterium* has often used in the laboratory , and is used as in industrial organism that is able to produce a variety of proteins and sources of bioremediation , *B. megaterium* is a good sources of industrial proteins because it is desirable cloning host and produce large variation of enzymes.

## Objectives:

The aim of this study's was to evaluate the impact of P. Florscens and B.Megaterium on germination of Barley grown under wide salt range stress.

## Material:

Two varieties of Barley seeds (local variety and Axad).

Two bacteria (*P. Florscens* and *B. Megaterium*).

NaCl three concentration:

(0, 4, 8 ) ds

Plate.

Paper filters.

Distilled water

## Experimental design:

The Axad Barley seed was placed in plate number 15 and saline solution was added at a concentration of 4/ds and 2ml of *Pesudomouns Florscens*.

The Axad Barley seed was placed in plate number 15 and saline solution was added at a concentration of 8/ds and 2 ml of *Pesudomouns Florscens*.

The Axad Barley seed was placed in plate number 15 and saline solution was added at a concentration 0/ds and 2 ml *Pesudomouns Megaterium*.

The Axad Barley seed was placed in plate number 15 and saline solution was added at a concentration of 4/ds and 2 ml of *Bacillus Megaterium*.

The Axad Barley sees was placed in plate number 15 and saline solution was added at a concentration of 8/ds and 2 ml of *Bacillus Megaterium* .

The Axad Barley seed was placed in plate number 15 and saline solution was added at a concentration 0/ds and 2 ml of *Bacillus Megaterium*.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration of 0/ds and 2 ml of Pesudomouns Florscens.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration of 4/ds and 2 ml of Pesudomouns Florscens.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration 8/ds and 2 ml Pesudomouns Florscens.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration of 0/ds and 2 ml Bacillius Megaterium.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration of 4/ds and 2 ml Bacillius Megaterium .

The local Barley seed was placed in plate number 15 and added saline solution at a concentration of 8/ds and 2 ml Bacillius Megaterium

The Axad Barley seed was placed in plate number 15 and added saline solution at a concentration 0/ds without bacteria.

The Axad Barley seed was placed in plate number 15 and added saline solution at a concentration 4/ds without bacteria.

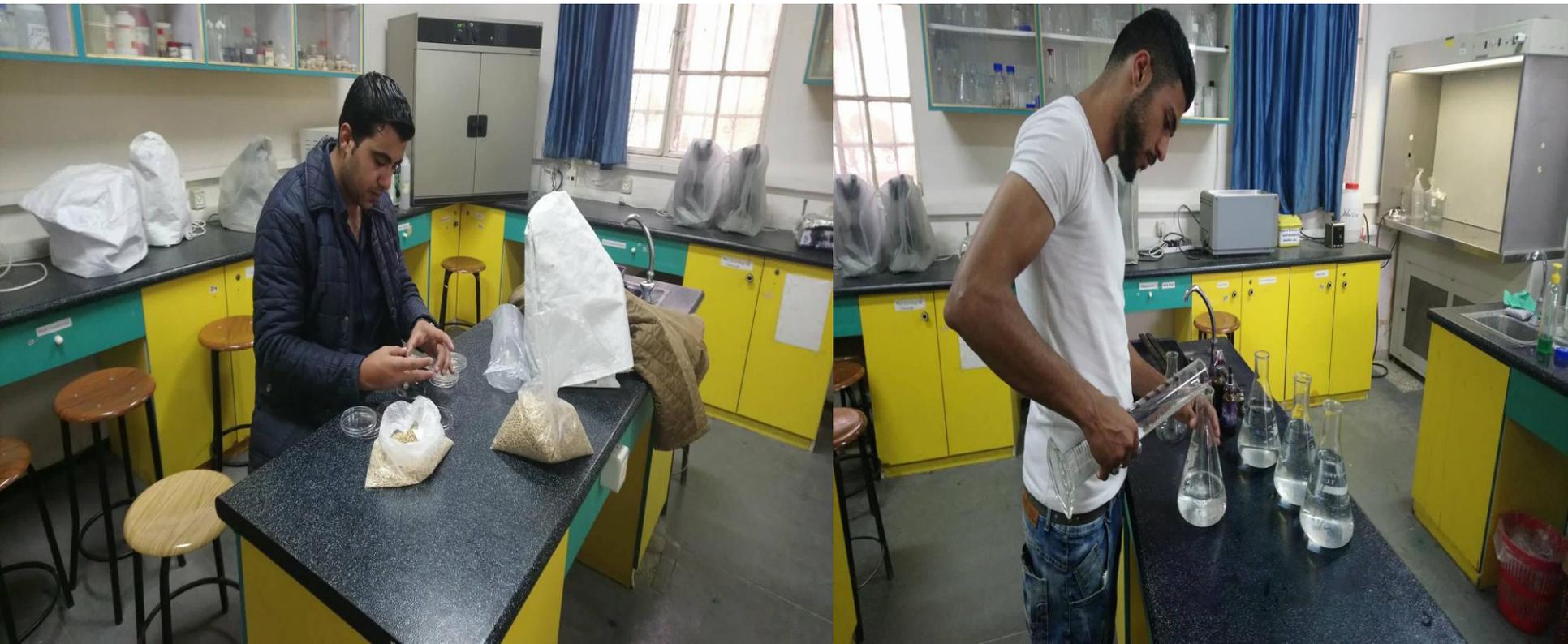
The Axad Barley seed was placed in plate number 15 and added saline solution at a concentration 8/ds without bacteria.

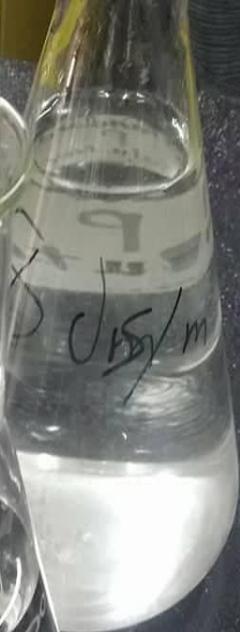
The local Barley seed was placed in plate number 15 and added saline solution at a concentration 0/ds without bacteria.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration 4/ds without bacteria.

The local Barley seed was placed in plate number 15 and added saline solution at a concentration 8/ds without bacteria.

Each step repeated three times.



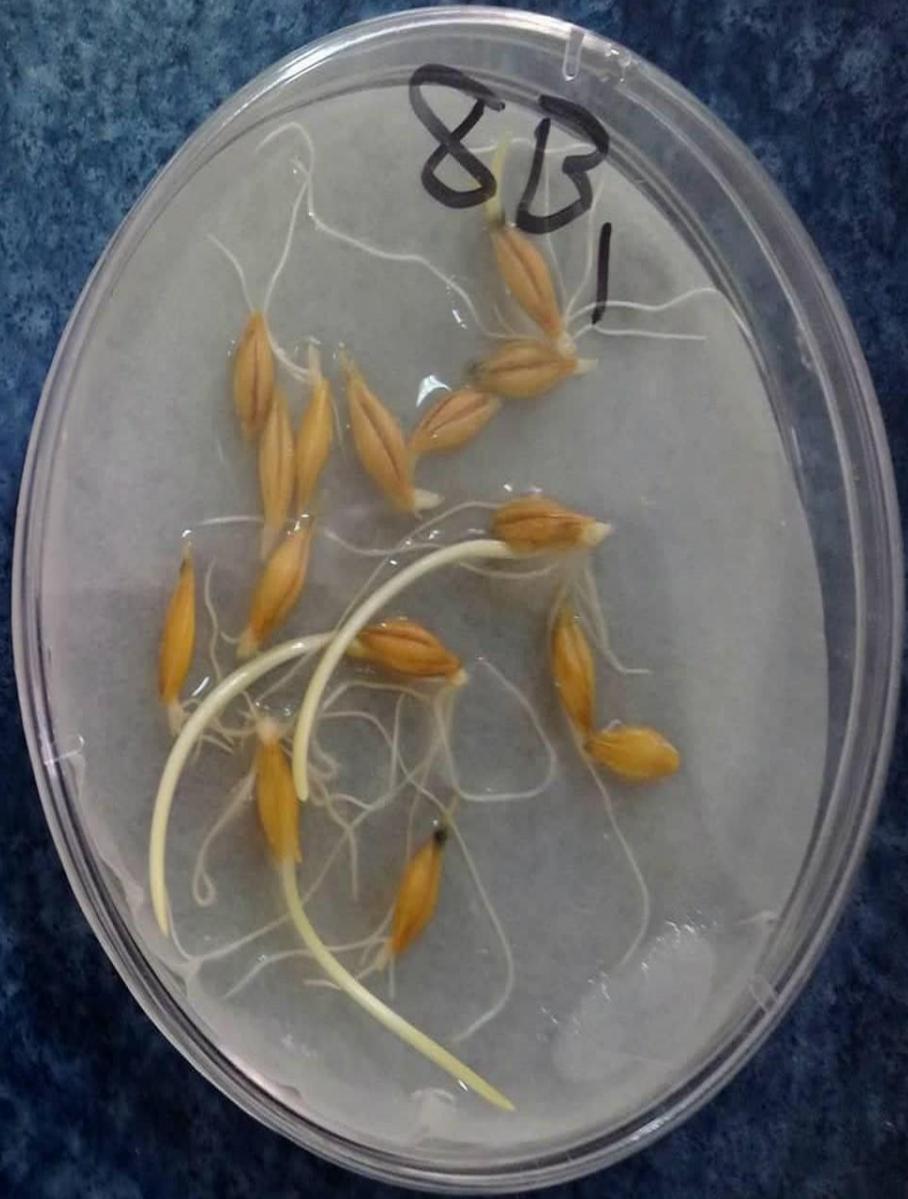












## **Data Analysis:**

All data were subjected to analysis of variance(ANOVA) by using SAS software.

## Result:

ANOVA for the effect of bacteria and salinity on Shoot length of two barley varieties

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
Replication	2	32	1.49	0.2405
Bacteria	2	32	2.81	0.0752
Salinity	2	32	33.24	<.0001
Bacteria*Salinity	4	32	2.63	0.0525
V	1	32	162.33	<.0001
V*Bacteria	2	32	2.74	0.0795
V*Salinity	2	32	2.18	0.1300
V*Bacteria*Salinity	4	32	0.71	0.5938

## Mean separation for the effect of salinity on shoot length

Salinity	Estimate	Standard Error	Letter Group
0	1.9650	0.1196	B
4	2.4362	0.1170	A
8	1.0759	0.1218	C

**Mean separation for based on the response of two barley varieties for shoot length**

<b>V</b>	<b>Shoot length</b>	<b>Standard Error</b>	<b>Letter Group</b>
1	0.9476	0.09630	B
2	2.7038	0.09878	A

# Effect of variety and bacteria on shoot length:

Obs	V	Bacteria	Salinity	Estimate	Standard Error	Letter Group
18	1	0	—	1.0456	0.1621	B
19	1	1	—	1.0578	0.1621	B
20	1	2	—	0.7394	0.1759	B
21	2	0	—	3.0502	0.1488	A
22	2	1	—	2.3610	0.1759	A
23	2	2	—	2.7002	0.1900	A

**Effect variety and salinity on shoot length:**

<b>Obs</b>	<b>V</b>	<b>Bacteria</b>	<b>Salinity</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>Letter Group</b>
<b>24</b>	1	—	0	1.2022	0.1621	C
<b>25</b>	1	—	4	1.3578	0.1621	C
<b>26</b>	1	—	8	0.2827	0.1759	D
<b>27</b>	2	—	0	2.7277	0.1759	B
<b>28</b>	<b>2</b>	<b>—</b>	<b>4</b>	<b>3.5146</b>	<b>0.1689</b>	<b>A</b>
<b>29</b>	2	—	8	1.8691	0.1689	C

## Effect of variety , bacteria and salinity on shoot length:

Obs	V	Bacteria	salinity	Estimate	Standard Error	Letter Group
30	1	0	0	1.6200	0.2807	BCDE
31	1	0	4	1.2533	0.2807	BCDE
32	1	0	8	0.2633	0.2807	E
33	1	1	0	1.3333	0.2807	BCDE
34	1	1	4	1.4967	0.2807	BCDE
35	1	1	8	0.3433	0.2807	E
36	1	2	0	0.6533	0.2807	DE
37	1	2	4	1.3233	0.2807	BCDE
38	1	2	8	0.2414	0.3474	E
39	2	0	0	3.1700	0.2807	A
40	2	0	4	3.6128	0.2443	A
41	2	0	8	2.3678	0.2443	ABC
42	2	1	0	2.7464	0.3474	AB
43	2	1	4	3.2867	0.2807	A
44	2	1	8	1.0500	0.2807	CDE
45	2	2	0	2.2667	0.2807	ABC
46	2	2	4	3.6445	0.3473	A
47	2	2	8	2.1895	0.3473	ABCD

**ANOVA for the effect of bacteria and salinity on root length of two barley variety.**

<b>Type 3 Tests of Fixed Effects</b>				
<b>Effect</b>	<b>Num DF</b>	<b>Den DF</b>	<b>F Value</b>	<b>Pr &gt; F</b>
<b>rep</b>	2	32	0.44	0.6504
<b>Bacteria</b>	2	32	3.32	0.0489
<b>salinity</b>	2	32	5.38	0.0097
<b>Bacteria*salinity</b>	4	32	1.91	0.1328
<b>V</b>	1	32	54.32	<.0001
<b>V*Bacteria</b>	2	32	1.51	0.2361
<b>V*salinity</b>	2	32	0.12	0.8830
<b>V*Bacteria*salinity</b>	4	32	0.42	0.7935

## Mean separation for the effect of salinity on root length:

Obs	V	Bacteria	salinity	Estimate	Standard Error	Letter Group
4	—	—	0	2.6732	0.2684	A
5	—	—	4	2.5578	0.2627	A
6	—	—	8	1.5328	0.2733	B

## The effect of variety and bacteria on root length:

Obs	V	Bacteria	salinity	Estimate	Standard Error	Letter Group
18	1	0	—	1.4211	0.3638	BC
19	1	1	—	1.2178	0.3638	BC
20	1	2	—	0.7042	0.3947	C
21	2	0	—	4.1753	0.3341	A
22	2	1	—	2.7597	0.3947	AB
23	2	2	—	3.2494	0.4264	A

## The effect of variety and salinity on root length:

Obs	V	Bacteria	salinity	Estimate	Standard Error	Letter Group
24	1	—	0	1.4233	0.3638	BC
25	1	—	4	1.4756	0.3638	BC
26	1	—	8	0.4442	0.3947	C
27	2	—	0	3.9231	0.3947	A
28	2	—	4	3.6400	0.3791	A
29	2	—	8	2.6214	0.3791	AB

## The effect of variety , bacteria and salinity on root length:

Obs	V	Bacteria	salinity	Estimate	Standard Error	Letter Group
30	1	0	0	1.9933	0.6302	BCD
31	1	0	4	1.5933	0.6302	BCD
32	1	0	8	0.6767	0.6302	BCD
33	1	1	0	1.7700	0.6302	BCD
34	1	1	4	1.6433	0.6302	BCD
35	1	1	8	0.2400	0.6302	D
36	1	2	0	0.5067	0.6302	CD
37	1	2	4	1.1900	0.6302	BCD
38	1	2	8	0.4159	0.7799	BCD
39	2	0	0	5.4767	0.6302	A

<b>40</b>	2	0	4	3.7483	0.5485	AB
<b>41</b>	2	0	8	3.3008	0.5485	ABCD
<b>42</b>	2	1	0	3.2859	0.7799	ABCD
<b>43</b>	2	1	4	3.7133	0.6302	ABC
<b>44</b>	2	1	8	1.2800	0.6302	BCD
<b>45</b>	2	2	0	3.0067	0.6302	ABCD
<b>46</b>	2	2	4	3.4583	0.7796	ABCD
<b>47</b>	2	2	8	3.2833	0.7796	ABCD

**AVOVA for the effect of bacteria and salinity on fresh weight of two barley variety:**

<b>Type 3 Tests of Fixed Effects</b>				
<b>Effect</b>	<b>Num DF</b>	<b>Den DF</b>	<b>F Value</b>	<b>Pr &gt; F</b>
<b>rep</b>	2	34	1.61	0.2144
<b>Bacteria</b>	2	34	4.65	0.0164
<b>salinity</b>	2	34	35.02	<.0001
<b>Bacteria*salinity</b>	4	34	2.96	0.0336
<b>V</b>	1	34	25.22	<.0001
<b>V*Bacteria</b>	2	34	2.98	0.0643
<b>V*salinity</b>	2	34	1.21	0.3103
<b>V*Bacteria*salinity</b>	4	34	1.05	0.3980

## The effect of salinity on fresh weight:

Obs	V	Bacteria	Salinity	Estimate	Standard Error	Letter Group
4	—	—	0	1.6420	0.03422	A
5	—	—	4	1.7126	0.03494	A
6	—	—	8	1.3252	0.03494	B

## The effect of variety on fresh weight:

Obs	V	Bacteria	Salinity	Estimate	Standard Error	Letter Group
16	1	—	—	1.4593	0.02794	B
17	2	—	—	1.6606	0.02875	A

**The effect of bacteria on fresh weight:**

Obs	V	Bacteria	Salinity	Estimate	Standard Error	Letter Group
1	—	0	—	1.6408	0.03285	A
2	—	1	—	1.5011	0.03422	B
3	—	2	—	1.5379	0.03727	AB

**The effect of variety bacteria and salinity on fresh weight:**

Obs	V	Bacteria	Salinity	Estimate	Standard Error	Letter Group
30	1	0	0	1.7000	0.08381	ABC
31	1	0	4	1.6333	0.08381	ABCD
32	1	0	8	1.2933	0.08381	CDE
33	1	1	0	1.4900	0.08381	BCDE
34	1	1	4	1.6067	0.08381	ABCD
35	1	1	8	1.2867	0.08381	CDE
36	1	2	0	1.3467	0.08381	CDE
37	1	2	4	1.5533	0.08381	ABCDE
38	1	2	8	1.2233	0.08381	DE
39	2	0	0	1.9420	0.08381	A

<b>40</b>	2	0	4	1.8286	0.07294	AB
<b>41</b>	2	0	8	1.4473	0.07294	BCDE
<b>42</b>	2	1	0	1.7000	0.08381	ABC
<b>43</b>	2	1	4	1.8033	0.08381	AB
<b>44</b>	2	1	8	1.1200	0.08381	E
<b>45</b>	2	2	0	1.6733	0.08381	ABC
<b>46</b>	2	2	4	1.8503	0.1036	AB
<b>47</b>	2	2	8	1.5803	0.1036	ABCDE

**ANOVA for the effect of bacteria ,variety and salinity on dry weight of two barley varieties:**

<b>Type 3 Tests of Fixed Effects</b>				
<b>Effect</b>	<b>Num DF</b>	<b>Den DF</b>	<b>F Value</b>	<b>Pr &gt; F</b>
<b>rep</b>	2	34	0.17	0.8449
<b>Bacteria</b>	2	34	1.23	0.3056
<b>salinity</b>	2	34	1.22	0.3091
<b>Bacteria*salinity</b>	4	34	0.45	0.7721
<b>V</b>	1	34	546.17	<.0001
<b>V*Bacteria</b>	2	34	1.46	0.2458
<b>V*salinity</b>	2	34	1.94	0.1600
<b>V*Bacteria*salinity</b>	4	34	0.41	0.8004

## The effect of variety on dry weight of two barley varieties:

<b>Obs</b>	<b>V</b>	<b>Bacteria</b>	<b>salinity</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>Letter Group</b>
<b>16</b>	<b>1</b>	—	—	<b>0.6820</b>	<b>0.007069</b>	<b>A</b>
<b>17</b>	<b>2</b>	—	—	0.4449	0.007274	B

The effect of variety , bacteria and salinity on dry weight:

<b>Obs</b>	<b>V</b>	<b>Bacteria</b>	<b>salinity</b>	<b>Estimate</b>	<b>Standard Error</b>	<b>Letter Group</b>
<b>30</b>	1	0	0	0.6630	0.02121	A
<b>31</b>	1	0	4	0.6913	0.02121	A
<b>32</b>	1	0	8	0.6707	0.02121	A
<b>33</b>	1	1	0	0.6640	0.02121	A
<b>34</b>	1	1	4	0.6987	0.02121	A
<b>35</b>	1	1	8	0.7103	0.02121	A
<b>36</b>	1	2	0	0.6633	0.02121	A
<b>37</b>	1	2	4	0.7033	0.02121	A
<b>38</b>	1	2	8	0.6730	0.02121	A
<b>39</b>	2	0	0	0.4253	0.02121	B

<b>40</b>	2	0	4	0.4384	0.01846	B
<b>41</b>	2	0	8	0.4337	0.01846	B
<b>42</b>	2	1	0	0.4320	0.02121	B
<b>43</b>	2	1	4	0.4197	0.02121	B
<b>44</b>	2	1	8	0.4537	0.02121	B
<b>45</b>	2	2	0	0.4707	0.02121	B
<b>46</b>	2	2	4	0.4396	0.02623	B
<b>47</b>	2	2	8	0.4911	0.02623	B

## Conclusion:

Local variety responded better to bacteria.

Compared to the axad the local variety was more tolerant to salinity.

## Recommendation :

Its recommended to use PF bacteria on salinity 4/ds on more then one type of barley because it works to germinate the seeds better.