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RESEARCH ARTICLE

THE INFLUENCE OF ORGANIC SUBSTANCE ON HEAD FOLDING, BITTERNESS AND QUALITY OF PRODUCED SEEDS OF LETTUCE (*LACTUCA SATIVA* VAR. *LONGIFOLIA)* CV. NADER, PARIS ISLAND AND MARUL GROWN ON POLYETHYLENE MULCHED AND UNMULCHED SOILS

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ABSTRACT

Nader, Paris Island and Marul lettuce cultivars grown on polyethylene mulch and bare soils treated with either Nitrobein, Rhyzobactrein, or Hupotas. The objective of this study was to evaluate the responses of these cultivars to mulching and organic substance treatments. The obtained results revealed that lettuce grown on mulched soil significantly reduced IAA, GA_3, ABA, CK, N, K, Ca, B, Na, and Fe in varying lettuce tissues. Owing to the increased root zone temperatures caused by polyethylene mulching in late summer. However, during ensuing winter mulched lettuce recovered and substantially improved yield, head fresh weight, TSS, Chlorophyll, seed yield and weight of 1000 seeds. Organic substances highly improved the growth performance of lettuce, particularly Rhyzobactrein, which sowed the best-performed yield and most other detected parameters. Nader was the most potent cultivar, where Paris Island and Marul failed to perform folded heads. Bitterness, Tip burns and Cu were not detected in all treatments and lettuce tissues. Dual and treble interaction treatments included in results and discussion sections

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INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a globally important leafy vegetable, which belongs to the family Asteraceae (Compositae). Lettuce is an annual, self-fertile species that has been cultivated all around the world. The center of origin of lettuce is probably the Middle East and south-west Asia, Plant growth regulators (also known as growth regulators or plant hormones) are chemicals used to alter the growth of a plant or plant part. Hormones are substances naturally produced by plants, substances that control normal plant functions, such as root growth, fruit set and drop, growth and other development processes. Plants as essential components of natural ecosystems and agro-systems represent the first compartment of the terrestrial food chain. Due to their capacity of toxic metals accumulating, when they grow on soils polluted with such metals, they represent a threat to the living beings, which consume them; also, their development and growth may be affected at high levels of metal concentration implying reduced cultures and economic loss. Fresh vegetables are of great importance in the diet because of the presence of vitamins and mineral salt the nutritive composition of both gains and vegetable amaranth has been extensively studied (Bressani, 1990), lettuce (*Lactuca sativa* L.) is one of the most popular vegetables. It grown on the green belts of small, median, and large cities of the State. Intrinsic traits, such as good adaptation to different climatic conditions, short cycle, and possibility of consecutive crops on a same year, regular market, among others, make lettuce one of the favorite vegetables among producers (Filgueira, 2003). Metals distribution in plants is quite heterogenous and controlled by genetic factors, environment, and toxic factors. The metal immobilization in plant roots determines the recuperation of a high proportion of metals in roots (80 – 90 %). Some species of plants can accumulate the highest quantity of absorbed metals in their high parts Organic fertilizers can therefore be used to reduce the amount of toxic compounds (such as nitrates) produced by conventional fertilizers in vegetables like lettuce, hence, improving the quality of leafy vegetables produced as well as human health. Increased consumer awareness of food safety issues and environmental concerns has contributed to the development of organic farming over the last few years (Worthington, 1998; Worthington, 2001; Relf *et al.,* 2002).

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Commercial applications of PGPR being tested and are frequently successful; however, a better understanding of the microbial interactions that result in plant growth increases will greatly increase the success rate of field applications (Burr *et al*., 1984). PGPR, root-colonizing bacteria known to influence plant growth by various direct or indirect mechanisms. Several chemical changes in soil are associated with PGPR. Plant growth-promoting bacteria (PGPB) reported to influence the growth, yield, and nutrient uptake. Some bacterial strains directly regulate plant physiology by mimicking synthesis of plant hormones, whereas others increase mineral and nitrogen availability in the soil as a way to augment growth. The isolates could exhibit more than two or three PGP traits, which may promote plant growth directly, or indirectly or synergistically (Joseph *et al*., 2007; Yasmin *et al*., 2007). The objectives of this study were demonstrate competition and performance of Nader, Paris Island and Marul lettuce cultivars grown on black polyethylene mulched soil and bare soil besides testing the capabilities of Rhizobactrein, Nitrobein and Hupotass in improving the yield and seed yield qualities.

MATERIALS AND METHODS

Location

Trail were carried out during lettuce growing at Bakrajo field of researches, Horticulture Department, Agriculture College, Sulimani Governorate, Kurdistan Region, Iraq. The field is located on Latitude (35^0, $32.134^{'}$ N) Altitude (732 m) and Longitude (45^o, $21.879^{'}$E).Lettuces (Lactuca sativa L. Var. Longifolia, Marul, Paris Island, and Nader cvs.) evaluated for lowest bitterness, unfolded and physiological disorders incidences. Subsequently, seeds purchased from Agricultural Bureau, Suleimani where Marul seeds produced by Argeto Company for vegetable seed production, under lot number TR7913120AY, germination percentage was 83% and seed purity was 99%.

Table (M1): Physical and Chemical properties of soil of the experiment in field of Faculty of Agricultural Science in Bakrajo

Soil Properties	Values
P.S.D	Silty Clay
Silt(g.kg^{-1})	449.7
Clay(g.kg^{-1})	501.8
Sand(g.kg^{-1})	48.5
$CaCO_3$(g.kg^{-1})	331.9
O.M(g.kg^{-1})	20.95
pH	7.42
E.C(dS.m^{-1})	0.4
Total N(ppm)	19.96
Na^+ (ppm)	27.89
K^+(ppm)	2.85
Cl^- (Meq.l^{-1})	2.66
$CO3^{-2}$(Meq.l^{-1})	0.001
HCO_3^{-2}(Meq.l^{-1})	7.99
Ca^{++}(Meq.l^{-1})	2.75
Mg^{++}(Meq.l^{-1})	2.00

The soil analysis performed in Soil and Water Department of Faculty of Agriculture science / University of Sulaimani.

Experimental design

Split within factorial randomized complete Block Design (Split F-RCBD) selected where the main plots (A) was bare unmulched soil (a_1) and soil mulched with black polyethylene (a_2). The sub main plot (B) was represented by Nader (b_1), Paris Island (b_2) and Marul (b_3). Whereas, the sub sub main plot (C) was the applications of distilled water (c_1), 5ml.l^{-1}Hupotass (c_2), transplants dipped in Nitrobein (c_2) transplants dipped in Rhyzobactrein (c_4). Therefore, 24 treatments were included in the trail, each treatment was reiterated four times, each replicate represented by a furrow 5m length and 0.8m width planted on both sides with 0.25m plant intra space.

Cultural practices

Soil was flowed twice horizontally and then vertically (table, M1),with phosphorus P_2O_5 fertilizer broadcasting at rate of 10g.m^{-2} then soil was minced and thereafter dissected to match the experimental design that previously proposed. Half of experiment area left bare while the other half covered with black polyethylene where the polyethylene edge covered with soil to fix it. Slice of 20 cm length made by cutter in the bottom of furrow covered with soil to ease rainfall and irrigation water penetration to the root zone. Soil analysis made in Soil Department, Agriculture College, Sulimani University, while Meteorological data (table, M2) obtained from Sulimani Meteorological Station. In the second season DAP mixed with urea 1:1, and applied once at rate 20:20 g.m^{-2} on October 1st 2011 then on October 15th 2011. Plants were fertilized with DAP at rate of 20 g.m^{-2}.In 2011-2012, lettuce plants were sprayed twice on January 1st 2012 and repeated again on February 1st 2012 with very chemicals and their concentrations fitted their corresponding experiments. Transplants dipped with Nitrobein and Rhyzobactrein before planting thereafter both of them broadcasted twice with 15 days intervals on the soil around the plants.

A Beltanol-L 50% SL systematic fungicide was applied at 1ml.l^{-1} on April 15th 2012 against soil borne disease. Agrinate 90% SP was sprayed at rate of 1g.L^{-1} April 20th 2012, to control black cut worm. Engeo 274 SC at 0.5ml.l^{-1} to eradicate leafhopper mixed with antibiotics 250mg.l^{-1} tetracycline as bacterial protective spray. However, in the second season Stroby W.G was sprayed to control watery leaf mold on February 1st 2012 at rate 1ml.l^{-1}, Cyren 48% EC insecticide 1ml.l^{-1} to eradicate cut worm.

Lettuce plants were matured on March, 25th 2012. However, plants harvested on June 13th 2012. These unequivocal discrepancies were emerged owing to the variation of planting dates among experiments. Well-performed heads chopped at 5cm above soil surface and left for seed stalk formation to collect their seeds at the end of the growing season. Thus, the left stem of chopped plants fertilized and watered to burst new shoots and further flowered to give the collected seeds. Unfolded and poor performed heads pulled out of soil and disposed to avoid pollination with the flowers of desired plants proposed for seed production.

Finally, harvested plants enclosed in polyethylene bags and brought to the laboratory for further measurements. Seeds were completely dried in the florescence on July 15th 2012. Inflorescence were harvested once they completely dried and preserved in open polyethylene bags thereafter seeds were obtained from inflorescence cleaned and later on their parameters were recorded.

Measurements

Vegetative growth and reproductive parameters

Stem length (cm), stem diameter (cm) branches length (cm) measured by ruler and caliper. Unfolded leaves, folded leaves, branches number of chopped heads, number of leaves on formed branches, branches number of inflorescence counted. Head fresh weight (g), yield of head fresh weight (kg.m^{-2}) fresh weight of folded (g), weight of unfolded leave base (g), fresh weight of unfolded leaves (g), yield of meter square (g), individual plant (g), weight of 1000 seeds (g) were weighed by four decimal electrical balances. Folded leaves, unfolded leaves and stems, stem and leaves base weighed and then oven dried at 55°C for 48hrs then reweighed to calculate their dry matter percentages.

Total Soluble Solids and Chlorophyll

Total Soluble Solids of folded leaves, unfolded leaves, stem and the base of folded leaves vein were measured by Hand Refrectometer, chlorophyll percentage out of the gross pigments of folded and unfolded leaves were measured by Chlorophyll Meter (model spad 502).

RESULTS AND DISCUSSION

1. Hormonal Homeostasis

A. Hormonal Homeostasis responses to mulched and bare soils

Lettuce grown on bare unmulched soils was the paramount treatment. It substantially exceeded lettuces grown on mulched soil in bounded IAA folded leaves (26.7%), unfolded leaves (1.38%), free IAA in folded leaves (3.36%), unfolded leaves (2.93%). These results suggested IAA synthesis reduced in lettuce grown on mulched soil, which attributed to the effects of high temperatures at root zone caused by mulching during the early growth stages where even the air temperature was high (Table 1-4). Global climate change is making high temperature (HT) a critical factor for plant growth and productivity; HT is now considered to be one of the major abiotic stresses for restricting crop production (Hasanuzzaman *et al*., 2012).

Bare soil grown lettuce exceeded that of mulched grown lettuce in terms of bounded GA_3 (3.55%), free GA_3 (3.77%) in folded leaves, free GA_3 in unfolded leaves (5.73%).

Table (M2) Metrological Data

Years	Months	Air temp. °C		%Humidity		vap pressure		Precipitation Depth mm.		Sunshine Duration Hours		Wind		evap. mm.	
		Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
2012	January	10.3	1.8	95.0	0.0	7.6	5.6	237	0.0	8.5	0.0	4.8	0.0	3.0	0.2
	February	11.6	2.2	95.0	0.0	6.9	4.8	330	236	9.5	0.0	6.5	0.0	7.7	0.1
	March	14.1	4.4	95.5	0.0	7.1	4.8	472	0.0	10.2	0.0	6.9	0.0	7.9	0.2
	April	25.0	14.3	95.	0.0	11.4	8.2	506	427	11.0	0.0	5.8	0.0	9.2	2.3
	May	30.7	18.8	95.0	0.0	12.5	8.2	809	506	10.8	0.0	4.6	0.0	11.2	1.5
	June	39.6	24.9	33.1	0.0	12.7	8.4	0.6	0.0	11.0	1.4	4.2	0.0	17.3	8.2
	July	39.9	27.1	28.5	0.0	15.4	10.5	0.0	0.0	11.3	4.7	4.9	0.0	19.0	7.7
	August	40.6	26.3	25.1	0.0	14.0	9.2	0.2	0.0	11.1	6.8	4.2	0.0	14.7	5.2

Total Nitrogen determination

Nitrogen percentages determined by Kjeldahl (Ryan *et al*., 2001).

Boron determination

Boron in plant samples was determined by dry digestion, ash (Chapman and Pratt, 1961) and subsequently by colorimeter using Azomethine-H (Bingham, 1982), with aid of Spectrophotometer, 420-nm wavelength (Shimdzu, Japan).

Mineral determination

Iron, copper, and calcium determined by Atomic Absorption Spectrophotometer. Sodium and potassium determined by Flame Photometer.(AOAC,2003)

Growth regulators determinations

ABA, GA_3, and IAA determination: g Lettuce folded and unfolded leaves powder mixed with (36+15+9ml) (meOH: $CHCI_3$:2N NH_4OH,) with 25 of distilled water. ABA, GA_3, and IAA were determined according to (Ergün *et al*., 2002).

It can be inferred that high temperature imposed by black polyethylene mulching at root zone substantially reduced the bounded and free GA_3 in lettuce leaves (Table, 5-8). High temperature stress defined as the rise in temperature beyond a critical threshold for a period sufficient to cause irreversible damage to plant growth and development (Wahid, 2007).

Bar soil grown-lettuce, significantly bypassed lettuce grown on mulched soil in bounded ABA in folded leaves (6.93%), free ABA in folded leaves (2.21%), and free ABA of unfolded leaves (2.04%). Mulched soil tended to reduce bounded and free ABA in both folded and unfolded lettuce leaves (Table,9-12) due to high temperature caused by black mulching where hot prevailing ambient environment I late summer. The growth and development of plants involves a countless number of biochemical reactions, all of which are sensitive to some degree to temperature (Zrobek-sokolnik, 2012). Consequently, plant responses to HT vary with the extent of the temperature increase, its duration, and the plant type. Bare soil grown lettuce apparently exceeded lettuce grown on black polyethylene mulched soil (Table 13-16) in bounded CK in folded leaves (3.86%), bounded Ck in unfolded leaves (2.94%), free CK in folded and unfolded leaves (4.25 and 3.54%, respectively).

Table 1. Bounded Indole Acetic Acid (mg.l^{-1}) content of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>26.71a-g</td><td>25.48hij</td><td>26.14f-i</td><td>26.49d-g</td><td>26.67b-g</td><td>26.95a-f</td><td>26.41b</td></tr>
<tr><td>Hupotass</td><td>26.03g-i</td><td>25.25ij</td><td>25.03j</td><td>25.48hij</td><td>27.31a-e</td><td>26.72a-g</td><td>25.97c</td></tr>
<tr><td>Nitrobein</td><td>27.42a-d</td><td>26.64c-g</td><td>26.48e-g</td><td>26.99a-f</td><td>27.49abc</td><td>27.59ab</td><td>27.1a</td></tr>
<tr><td>Rhyzobactrein</td><td>26.39efg</td><td>26.69a-g</td><td>26.52d-g</td><td>26.35f-i</td><td>27.61a</td><td>27.47abc</td><td>26.84a</td></tr>
<tr><td>Mul*Cv (AB)</td><td>26.65b</td><td>26.02c</td><td>26.04c</td><td>26.33bc</td><td>27.27a</td><td>27.18a</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">26.23b</td><td colspan="3">26.93a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">26.61abc</td><td colspan="2">26.08cd</td><td colspan="2">26.54bc</td></tr>
<tr><td>Hupotass</td><td colspan="2">25.75d</td><td colspan="2">26.28cd</td><td colspan="2">25.87d</td></tr>
<tr><td>Nitrobein</td><td colspan="2">27.2a</td><td colspan="2">27.07ab</td><td colspan="2">27.04ab</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">26.37cd</td><td colspan="2">27.15ab</td><td colspan="2">26.99ab</td></tr>
<tr><td>Cultivar means (B)</td><td></td><td colspan="2">26.48a</td><td colspan="2">26.64a</td><td colspan="2">26.61a</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">26.11d</td><td colspan="3">26.71bc</td></tr>
<tr><td>Hupotass</td><td colspan="3">25.44e</td><td colspan="3">26.5cd</td></tr>
<tr><td>Nitrobein</td><td colspan="3">26.85bc</td><td colspan="3">27.36a</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">26.54cd</td><td colspan="3">27.14ab</td></tr>
</table>

Table 2. Bounded Indole Acetic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>27.64a</td><td>26.40jk</td><td>26.40jk</td><td>26.72gh</td><td>27.18ef</td><td>27.33de</td><td>26.95b</td></tr>
<tr><td>Hupotass</td><td>26.39jk</td><td>26.49ij</td><td>26.42jk</td><td>26.02l</td><td>27.39cd</td><td>27.23e</td><td>26.66c</td></tr>
<tr><td>Nitrobein</td><td>27.54abc</td><td>26.69gh</td><td>26.69gh</td><td>27.05f</td><td>27.46bcd</td><td>27.54abc</td><td>27.16a</td></tr>
<tr><td>Rhyzobactrein</td><td>26.62hi</td><td>26.85g</td><td>26.79g</td><td>26.29k</td><td>27.65a</td><td>27.57ab</td><td>26.96b</td></tr>
<tr><td>Mul*Cv (AB)</td><td>27.05b</td><td>26.61c</td><td>26.58cd</td><td>26.52d</td><td>27.42a</td><td>27.41a</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">26.75b</td><td colspan="3">27.12a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">27.18ab</td><td colspan="2">26.79d</td><td colspan="2">26.87c</td></tr>
<tr><td>Hupotass</td><td colspan="2">26.21f</td><td colspan="2">26.94c</td><td colspan="2">26.82d</td></tr>
<tr><td>Nitrobein</td><td colspan="2">27.29a</td><td colspan="2">27.08b</td><td colspan="2">27.12b</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">26.46e</td><td colspan="2">27.25a</td><td colspan="2">27.18ab</td></tr>
<tr><td>Cultivar means(B)</td><td></td><td colspan="2">26.78b</td><td colspan="2">27.01a</td><td colspan="2">26.99a</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">26.82ef</td><td colspan="3">27.08c</td></tr>
<tr><td>Hupotass</td><td colspan="3">26.44g</td><td colspan="3">26.88e</td></tr>
<tr><td>Nitrobein</td><td colspan="3">26.98d</td><td colspan="3">27.35a</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">26.75f</td><td colspan="3">27.17b</td></tr>
</table>

Table 3. Free Indole Acetic Acid (mg.l^{-1}) content of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>26.95abc</td><td>24.42gh</td><td>27abc</td><td>26.57a-d</td><td>26.95abc</td><td>26.58a-d</td><td>26.41a</td></tr>
<tr><td>Hupotass</td><td>27.01abc</td><td>25.15fg</td><td>24.06h</td><td>26.16b-e</td><td>27.3a</td><td>26.04c-f</td><td>25.95b</td></tr>
<tr><td>Nitrobein</td><td>26.36 a-e</td><td>25.53ef</td><td>26.52a-d</td><td>27.07ab</td><td>26.85abc</td><td>26.47 a-e</td><td>26.47a</td></tr>
<tr><td>Rhyzobactrein</td><td>26.38 a-e</td><td>25.75def</td><td>25.19fg</td><td>27.06ab</td><td>26.79abc</td><td>26.91a-c</td><td>26.35a</td></tr>
<tr><td>Mul*Cv (AB)</td><td>26.67ab</td><td>25.21d</td><td>25.69c</td><td>26.71ab</td><td>26.97a</td><td>26.5b</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">25.86b</td><td colspan="3">26.73a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">26.76a</td><td colspan="2">25.69c</td><td colspan="2">26.79a</td></tr>
<tr><td>Hupotass</td><td colspan="2">26.58ab</td><td colspan="2">26.22abc</td><td colspan="2">25.05d</td></tr>
<tr><td>Nitrobein</td><td colspan="2">26.72ab</td><td colspan="2">26.19abc</td><td colspan="2">26.5ab</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">26.72ab</td><td colspan="2">26.27abc</td><td colspan="2">26.05bc</td></tr>
<tr><td>Cultivar means (B)</td><td></td><td colspan="2">26.69a</td><td colspan="2">26.09b</td><td colspan="2">26.1b</td></tr>
<tr><td rowspan="5">Mulch*Treatment(AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">26.12bc</td><td colspan="3">26.7a</td></tr>
<tr><td>Hupotass</td><td colspan="3">25.41d</td><td colspan="3">26.49ab</td></tr>
<tr><td>Nitrobein</td><td colspan="3">26.14bc</td><td colspan="3">26.79a</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">25.77cd</td><td colspan="3">26.92a</td></tr>
</table>

Table 4. Free Indole Acetic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.94a	24.61e	27a	27.04a	27.02a	26.32abc	26.49ab
Hupotass	26.92a	25.37de	25.03de	27.02a	26.77a	26.38abc	26.25b
Nitrobein	26.95a	25.66cd	26.91a	27.01a	26.96a	26.49ab	26.66a
Rhyzobactrein	27a	25.82bcd	25.3de	25.81bcd	26.97a	26.65a	26.26b
Mul*Cv (AB)	26.96a	25.37d	26.06c	26.72ab	26.93a	26.46b	
means (A)	26.13b			26.71a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.99a	25.82de	26.66ab
	Hupotass	26.97a	26.07cde	25.7e
	Nitrobein	26.98a	26.31bcd	26.69ab
	Rhyzobactrein	26.41bc	26.39bc	25.97cde
Cultivar means (B)		26.84a	26.15b	26.26b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.19bc	26.79a
	Hupotass	25.77c	26.72a
	Nitrobein	26.51ab	26.82a
	Rhyzobactrein	26.04c	26.48ab

Table 5. Bounded Gibberellic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	27.17b	26.02b	26.04b	26.59b	27.24b	27.23b	26.71a
Hupotass	26.17b	26.02b	25.94b	27b	27.21b	27.26b	26.6a
Nitrobein	27.48b	26.34b	29.93a	26.86b	26.9b	27.48b	27.5a
Rhyzobactrein	26.58b	26.51b	26.46b	27.27b	27.51b	27.47b	26.97a
Mul*Cv (AB)	26.85a	26.22a	27.09a	26.93a	27.21a	27.36a	
means (A)	26.72a			27.17a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.88b	26.63b	26.64b
	Hupotass	26.58b	26.62b	26.6b
	Nitrobein	27.17b	26.62b	28.7a
	Rhyzobactrein	26.93b	27.01b	26.96b
Cultivar means (B)		26.89a	26.72a	27.23a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.41b	27.02ab
	Hupotass	26.04b	27.16ab
	Nitrobein	27.92a	27.08ab
	Rhyzobactrein	26.52b	27.42ab

Table 6. Bounded Gibberellic Acid (mg.l^{-1}) content of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.27cde	25.71efg	25.61fg	25.94d-g	26.52cd	26.63c	26.12b
Hupotass	24.83h	24.88h	25.33gh	26.58cd	26.51cd	26.52cd	25.78c
Nitrobein	27.37ab	26.33cde	26.24c-f	26.81bc	27.46a	27.48a	26.95a
Rhyzobactrein	26.19c-f	26.47cd	26.16c-f	27.28ab	27.43ab	27.32ab	26.81a
Mul*Cv (AB)	26.17c	25.85d	25.84d	26.65b	26.98a	26.99a	
means (A)	25.95b			26.87a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.11b	26.12b	26.12b
	Hupotass	25.71b	25.7b	25.93b
	Nitrobein	27.09a	26.89a	26.86a
	Rhyzobactrein	26.73a	26.95a	26.74a
Cultivar means (B)		26.41a	26.41a	26.41a

		Mulched	Unmulched
Mulch* Treatment (AC)			
	0	25.87d	26.37cb
	Hupotass	25.02e	26.54bc
	Nitrobein	26.65b	27.25a
	Rhyzobactrein	26.27c	27.34a

Table 7. Free Gibberellic Acid (mg.l^{-1}) content of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.7cd	24.72k	26.52de	25.55ij	26.49de	27bc	26.16b
Hupotass	26.69cd	24.73k	24.63k	25.75hi	26.74cd	27.19b	25.96c
Nitrobein	25.83ghi	25.64ij	26.06fgh	26.79cd	26.16fg	27.73a	26.37a
Rhyzobactrein	25.89ghi	25.63ij	25.39j	26.7cd	26.32ef	27.64a	26.26ab
Mul*Cv (AB)	26.28bc	25.18e	25.65d	26.2c	26.43b	27.39a	
means (A)	25.7b			26.67a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.13cd	25.6f	26.76a
	Hupotass	26.22c	25.73ef	25.91de
	Nitrobein	26.31bc	25.89de	26.89a
	Rhyzobactrein	26.29bc	25.97d	26.51b
Cultivar means (B)		26.24b	25.8c	26.52a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	25.98d	26.35c
	Hupotass	25.35f	26.56b
	Nitrobein	25.84d	26.89a
	Rhyzobactrein	25.64e	26.88a

Table 8. Free Gibberellic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.66b	25.29b	26.5b	26.65b	27.05b	27.56b	26.62a
Hupotass	26.57b	25.32b	24.91b	26.64b	26.53b	27.42b	26.23a
Nitrobein	26.7b	25.69b	26.55b	32.68a	26.65b	27.65b	27.65a
Rhyzobactrein	26.53b	25.67b	25.49b	26.67b	26.71b	27.58b	26.44a
Mul*Cv (AB)	26.62abc	25.49c	25.86bc	28.16a	26.73abc	27.55ab	
means (A)	25.99b			27.48a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.66b	26.17b	27.03ab
	Hupotass	26.61b	25.93b	26.17b
	Nitrobein	29.69a	26.17b	27.09ab
	Rhyzobactrein	26.59b	26.19b	26.54b
Cultivar means (B)		27.39a	26.11a	26.71a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.15b	27.09ab
	Hupotass	25.59b	26.86ab
	Nitrobein	26.31b	28.99a
	Rhyzobactrein	25.89b	26.99ab

Table 9. Bounded Abscisic Acid (ABA mg.l^{-1}) content of Folded Leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.63b	24.8b	25.04b	26.6b	27.01b	33.26a	27.22a
Hupotass	24.96b	25.05b	25.45b	26.91b	26.52b	26.79b	25.95a
Nitrobein	27.39b	26.5b	26.5b	26.94b	27.42b	27.67b	27.07a
Rhyzobactrein	26.44b	26.48b	26.45b	27.6b	27.41b	27.45b	26.97a
Mul*Cv (AB)	26.35b	25.71b	25.86b	27.01ab	27.09ab	28.79a	
means (A)	25.97b			27.63a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.61ab	25.91b	29.15a
	Hupotass	25.93b	25.79b	26.12ab
	Nitrobein	27.17ab	26.96ab	27.08ab
	Rhyzobactrein	27.02ab	26.94ab	26.95ab
Cultivar means (B)		26.68a	26.4a	27.33a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	25.49b	28.96a
	Hupotass	25.15b	26.74ab
	Nitrobein	26.79ab	27.34ab
	Rhyzobactrein	26.46b	27.49ab

Table 10. Bounded Abscisic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	27.41b	26.08b	26.1b	26.68b	27.39b	27.42b	26.85ab
Hupotass	26.22b	26.09b	26.06b	27.27b	26.8b	27.28b	26.62b
Nitrobein	27.78b	26.51b	26.62b	26.88b	27.67b	27.68b	27.19ab
Rhyzobactrein	30.3a	26.55b	26.61b	27.52b	27.7b	27.56b	27.71a
Mul*Cv (AB)	27.93a	26.31b	26.35b	27.09ab	27.39ab	27.48ab	
means (A)	26.86a			27.32a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	27.05b	26.74b	26.76b
	Hupotass	26.74b	26.44b	26.67b
	Nitrobein	27.33b	27.09b	27.15b
	Rhyzobactrein	28.91a	27.13b	27.09b
Cultivar means(B)		27.51a	26.85a	26.92a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.53ab	27.16ab
	Hupotass	26.12b	27.12ab
	Nitrobein	26.97ab	27.41ab
	Rhyzobactrein	27.82a	27.59a

Table 11. Free Abscisic Acid (mg.l^{-1}) content of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.71abc	25.17hi	26.56a-d	26.86a	25.93c-h	26.14a-g	26.23a
Hupotass	26.54a-d	25.17hi	24.95i	26.04b-g	26.75ab	25.59f-i	25.84b
Nitrobein	25.87d-h	25.68e-i	25.79d-h	26.91a	26.04b-g	26.81ab	26.19a
Rhyzobactrein	26.26a-g	25.72e-i	25.53ghi	26.88a	26.34 a-f	26.44 a-e	26.19a
Mul*Cv (AB)	26.34ab	25.44c	25.71c	26.67a	26.27b	26.25b	
means (A)	25.83b			26.4a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.78a	25.55cd	26.35ab
	Hupotass	26.29ab	25.96bc	25.27d
	Nitrobein	26.39ab	25.86bc	26.3ab
	Rhyzobactrein	26.57a	26.03bc	25.99bc
Cultivar means (B)		26.51a	25.85b	25.98b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.14bcd	26.31abc
	Hupotass	25.55e	26.13cd
	Nitrobein	25.78de	26.59a
	Rhyzobactrein	25.84de	26.55ab

Table 12. Free Abscisic Acid (mg.l^{-1}) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.58c-g	25.08k	26.56c-g	26.71a-d	26.45fg	26.42fg	26.3b
Hupotass	26.43fg	25.41j	25.41j	26.84ab	26.42fg	26.06h	26.09c
Nitrobein	26.49d-g	25.75i	26.47d-g	26.75abc	26.60a-f	26.33g	26.4a
Rhyzobactrein	26.59b-f	25.84h	25.62ij	26.84a	26.68a-e	26.42fg	26.33ab
Mul*Cv (AB)	26.52b	25.52e	26.01d	26.78a	26.54b	26.31c	
means (A)	26.01b			26.54a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.64ab	25.77gh	26.49bc
	Hupotass	26.63ab	25.91fg	25.73h
	Nitrobein	26.62ab	26.18e	26.4cd
	Rhyzobactrein	26.72a	26.26de	26.02f
Cultivar means (B)		26.65a	26.03c	26.16b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.07 d	26.53ab
	Hupotass	25.75e	26.44b
	Nitrobein	26.24c	26.56ab
	Rhyzobactrein	26.02d	26.65a

Table 13. Bounded Kinetin (CK mg.l^{-1}) content of Folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.47de	25.25f	25.25f	25.68f	26.63cde	26.77b-e	26.02b
Hupotass	25.46f	24.68g	24.52g	26.79b-e	26.76b-e	26.99a-d	25.87b
Nitrobein	27.44a	26.45de	26.28e	26.65cde	27.32ab	27.29ab	26.9a
Rhyzobactrein	26.24e	26.51de	26.27e	27.28ab	27.46a	27.15abc	26.82a
Mul*Cv (AB)	26.4b	25.72c	25.58c	26.59b	27.05a	27.05a	
means (A)	25.9b			26.9a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.07b	25.96b	26.01b
	Hupotass	26.12b	25.72b	25.75b
	Nitrobein	27.04a	26.89a	26.78a
	Rhyzobactrein	26.76a	26.98a	26.71a
Cultivar means (B)		26.5a	26.39a	26.31a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	25.65e	26.38d
	Hupotass	24.89f	26.84bc
	Nitrobein	26.72c	27.09ab
	Rhyzobactrein	26.34d	27.29a

Table 14. Bounded Kinetin (CK mg.l^{-1}) content of unfolded leaf responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	27.4c	26.12ij	26.03jk	26.49g	27.27de	27.29de	26.77b
Hupotass	26.05jk	26.18i	26k	27.22e	27.36cd	27.27de	26.68c
Nitrobein	27.67 a	26.39h	26.49g	26.69f	27.57ab	27.54b	27.06a
Rhyzobactrein	26.54g	26.64f	26.5g	27.44c	27.61ab	27.59ab	27.05a
Mul*Cv (AB)	26.91b	26.33c	26.26d	26.96b	27.45a	27.42a	
means (A)	26.5b			27.28a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.95c	26.69e	26.66e
	Hupotass	26.63e	26.77d	26.63e
	Nitrobein	27.18a	26.98bc	27.02bc
	Rhyzobactrein	26.99bc	27.13a	27.05b
Cultivar means (B)		26.94a	26.89b	26.84c

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.52e	27.02c
	Hupotass	26.08f	27.28b
	Nitrobein	26.85d	27.26b
	Rhyzobactrein	26.56e	27.54a

Table 15. Free Kinetin (CK mg.l^{-1}) content of folded Leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.51de	24.39j	26.48de	25.69fgh	26.76cde	26.84bcd	26.11ab
Hupotass	26.55de	24.95ij	24.58j	25.73fgh	26.69cde	27.43ab	25.99b
Nitrobein	25.78fgh	25.53ghi	26.3def	26.73cde	26.12efg	27.58a	26.34a
Rhyzobactrein	25.28hi	25.72fgh	25.55ghi	27.27abc	26.29def	27.66a	26.3a
Mul*Cv (AB)	26.03c	25.15e	25.73d	26.36b	26.47b	27.38a	
means (A)	25.64b			26.73a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.1c	25.57d	26.66ab
	Hupotass	26.14c	25.82cd	26cd
	Nitrobein	26.26bc	25.82cd	26.94a
	Rhyzobactrein	26.28bc	26.01cd	26.61ab
Cultivar mean (B)		26.19b	25.81c	26.55a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	25.79de	26.43c
	Hupotass	25.36f	26.62bc
	Nitrobein	25.87d	26.81ab
	Rhyzobactrein	25.52ef	27.08a

Table 16. Free Kinetin (CK mg.l^{-1}) Content of unfolded leaf responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.43c	25.26h	26.65c	26.59c	27.23b	27.33b	26.58a
Hupotass	26.18d	25.44gh	25.57fg	26.63c	26.47c	27.35b	26.27c
Nitrobein	26.45c	25.7ef	26.49c	26.61c	26.42c	27.64a	26.55ab
Rhyzobactrein	26.59c	25.81e	25.53fg	26.65c	26.62c	27.67a	26.48b
Mul*Cv (AB)	26.41c	25.55e	26.06d	26.62b	26.68b	27.5a	
means (A)	26.01b			26.93a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	26.51bc	26.24d	26.99a
	Hupotass	26.4c	25.95f	26.46bc
	Nitrobein	26.53bc	26.06ef	27.07a
	Rhyzobactrein	26.62b	26.22de	26.6b
Cultivar means (B)		26.52b	26.12c	26.78a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	26.11d	27.05a
	Hupotass	25.73f	26.81c
	Nitrobein	26.22d	26.89bc
	Rhyzobactrein	25.98e	26.98ab

These results suggested that aerial portion of lettuce exposed to irregular prevailing environment during growth. Therefore, fluctuations in the content of hormones observed, particularly, in unfolded leaves, which experienced senescence. Worldwide, extensive agricultural losses attributed to heat, often in combination with drought or other stresses (Mittler, 2006).

B. Hormonal homeostasis responses to Organic substance

Nitrobein highly exceeded untreated in bound IAA in folded and unfolded leaves (2.61 and 0.78%), Free IAA in unfolded leaves (0.64%). Nitrobein significantly exceeded Hupotass in bounded IAA of folded and unfolded leaves (4.35 and 1.88%, respectively), free IAA in folded and unfolded leaves (2 and 1.56%). Nitrobein substantially by passed Rhyzobactrein in bounded and free IAA in unfolded leaves (0.74, 1.52%, respectively). Diverse bacterial species possess the ability to produce the auxin phytohormone IAA. Different biosynthesis pathways identified and redundancy for IAA biosynthesis is widespread among plant-associated bacteria. Interactions between IAA-producing bacteria and plants lead to diverse outcomes on the plant side, varying from pathogenesis to phytostimulation. Reviewing the role of bacterial IAA in different microorganism–plant interactions highlights the fact that bacteria use this phytohormone to interact with plants as part of their colonization strategy, including phytostimulation and circumvention of basal plant defense mechanisms. Moreover, several recent reports indicate that IAA can also be a signaling molecule in bacteria and therefore, can have a direct effect on bacterial physiology (Spaepen *et al.,* 2007). Nitrobein substantially by passed Rhyzobactrein in free GA_3 in folded leaves (0.42%).Nitrobein highly exceeded untreated in bounded and free GA_3 in folded leaves (3.18 and 0.8%, respectively). Nitrobein substantially by passed Rhyzobactrein in bounded and free GA_3 of folded leaves (4.54 and 1.58%, respectively). Phosphorus oxidizing bacteria help in making this phosphorus available to the plants. Nitrobein highly exceeded untreated in Nitrobein substantially by passed Rhyzobactrein in bounded CK of folded and unfolded leaves (3.98 and 1.42%, respectively) and free CK of folded and unfolded leaves (1.35 and 1.07%, respectively). Nitrobein substantially by passed Rhyzobactrein in free ABA in unfolded leaves (0.27%). Nitrobein substantially by passed Rhyzobactrein in free ABA of folded and unfolded leaves (1.35 and 1.19%, respectively). Nitrobein highly exceeded untreated in free ABA in unfolded leaves (0.38%). These results suggested that nitrobein highly improved the hormonal homeostasis in lettuce through improving the hormone synthesis. Soil incorporation with the recommended rates of each of three bio-fertilizers, namely nitrobein, phosphorein, and potash, generally led to enhancement of the photosynthetic pigment contents of leaves in 30-day-old peanut and sunflower plants. Bio-fertilizer treatments stimulated net assimilation rates and plant growth indirectly via the production of growth promoting substances and bioactive substances such as hormones and enzymes. The phytohormones they produce include indole-acetic acid, cytokinins, gibberellins, and inhibitors of ethylene production. Rhizoremediers PGPR also help in degrading organic pollutants. *Azospirillum sp.* shows osmo-adaptation and can survive under salinity/osmolarity due to the accumulation of compatible solutes. The bacteria like *P. fluorescen*s can survive under dry conditions and hyperosmolarity (Saharan and Nehra, 2011).

Rhyzobactrein substantially bypassed untreated in bounded IAA in folded leaves (1.63%). Rhyzobactrein highly bypassed Hupotass in bounded IAA in folded and unfolded leaves (3.35 and 1.13%, respectively), free IAA of folded leaves (1.54%). The simultaneous screening of rhizobacteria for growth promotion under biotic conditions and *in vitro* production of auxin is a useful approach for selecting effective PGPR. Some PGPR releases a blend of volatile components like 2, 3-butanediol and acetoin that promote growth of *Arabidopsis thaliana* (Ryu *et al*., 2003).Rhyzobactrein substantially bypassed untreated in bounded GA_3 of folded leaves (2.64%). Rhyzobactrein highly bypassed Hupotass in bounded and free GA_3 of folded leaves (4 and 1.16%, respectively). Rhyzobactrein substantially bypassed untreated in bounded ABA of unfolded leaves (3.2%). Rhyzobactrein substantially exceeded Nitrobein in bounded ABA of unfolded leaves

(1.91%). Rhyzobactrein highly bypassed Hupotass in bounded ABA in unfolded leaves (4.09%), free ABA of folded and unfolded leaves (1.35 and 0.92%, respectively). Rhyzobactrein substantially bypassed untreated in bounded CK of folded and unfolded leaves (3.07 and 1.05%, respectively) and free CK of folded leaves (0.73%). Rhyzobactrein highly bypassed Hupotass in bounded CK of folded and unfolded leaves (3.67 and 1.39%, respectively), free Ck in folded and unfolded leaves (1.19 and 0.8%, respectively). These results suggested that Rhyzobactrein come next to Nitrobein in their effects on hormonal homeostasis then the lowest effects confined to Hupotass. The obtained results attributed to the Bactria and their products, which proved to produce hormones and other substances. Each response is often the result of two or more hormones acting together. Because hormones stimulate or inhibit plant growth, many botanists also refer to them as plant growth regulators. Botanists recognize five major groups of hormones: auxins, gibberellins, ethylene, cytokinins, and abscisic acid. IAA (indole-3-acetic acid) is the member of the group of phytohormones andgenerally considered the most important native Auxin (Ashrafuzzaman *et al*., 2009). It functions as an important signal molecule in the regulation of plant development including organogenesis, tropic responses, cellular responses such as cell expansion, division, and differentiation, and gene regulation (Ryu and Patten 2008). There are numerous soil micro flora involved in the synthesis of auxins in pure culture and soil. The potential for auxin biosynthesis by rhizobacteria can be used as a tool for the screening of effective PGPR strains (Khalid *et al*., 2004). Accumulating evidence indicates that PGPR influence plant growth and development by the production of phytohormones such as auxins, gibberellins, and cytokinins. The effects of auxins on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory (Arshad and Frankenberger, 1991).

C. Cultivar responses to hormonal homeostasis

Nader lettuce cultivar significantly exceeded Marul cultivar (Table 1-5) in free IAA in folded and unfolded leaves (2.26 and 2.21%, respectively). This cultivar also highly exceeded Paris Island in free IAA in folded and unfolded leaves (2.3 and 2.64%, respectively). These results suggested that Marul was the most potent cultivars in performing growth, since Auxin required establishing vascular tissues to facilitate conducting of assimilate to their sink (Taiz and Zeiger, 2002). The strains which produce the highest amount of auxin i.e. indole acetic acid (IAA) and in dole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop (Khalid *et al.,* 2004). Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth (Tsavkelova *et al*., 2007).

Nader lettuce cultivar significantly exceeded Marul cultivar in free ABA in folded and unfolded leaves (2.04 and 1.87%, respectively). This cultivar also highly exceeded Paris Island in free ABA in folded and unfolded leaves (2.55 and 2.38%, respectively). These results suggested that Nader cultivar possesses better capability in producing ABA. However, the ratio between bounded and free ABA is stationary through conjugating the hormone active sizes with any other substance and release them when cells required them free in metabolism (Abdel, 2011).

Nader lettuce cultivar significantly exceeded Marul cultivar (table, 13-16) in bounded CK of unfolded leaves (0.37%).This cultivar also highly exceeded Paris Island inbounded CK of unfolded leaves (0.19%), free CK of folded and unfolded leaves (1.47 and 1.53%, respectively). However, Paris Island significantly prevailed over Marul in bounded CK of unfolded leaves (0.19%). However, Marul significantly exceeded Nader in bounded IAA of unfolded leaves (0.78%), free GA_3 in folded leaves (1.07%) and free CK in folded and unfolded leaves (1.37 and 0.98%, respectively). In general, the obtained differences among investigated cultivars attributed to the genome diversity of individual cultivar and to the techniques that used during seed production from mother plants. Hormone content of leaves is not effective as much as the ration between growth hormone promoters and growth inhibitors (Goodwin and Mercer, 1985).

D. Cultivars response to mulching and bare soil

The best interaction treatment was Nader cultivar grown on mulched soil it showed the highest values and at least revealed non-significant difference with the highest values in free IAA of unfolded leaves (26.96%), bounded ABA in unfolded leaves (27.93%). Moreover The best interaction treatment was also Nader cultivar grown on unmulched soil it showed the highest values and at least revealed non-significant difference with the highest values in free GA_3 of unfolded leaves ($28.16 mg.l^{-2}$), free ABA of folded leaves and unfolded leaves ($26.67 mg.l^{-2}$ and 26.78%, respectively).

E. Lettuce responses to organic substances and mulching

Lettuce plants treated with Nitrobein grown on mulched soil gave the best interaction results as it gave the highest values in bounded GA_3 in unfolded leaves ($27.92 mg.l^{-2}$). Mulching creates root zone favoured by roots and microorganisms. Since, it reduces evaporation preventing weed growth (Abdel and Al-Juboori, 2006). *Pseudomonas fluorescens* B16 is a plant growth-promoting rhizobacterium and produces Pyrroloquinoline Quinone, which is a factor for plant growth promotion. However, the ability of Azotobacter to produce plant growth promoting substances such as phytohormone and IAA is attributed more to yield improvement rather than to diazotrophic activity.

*Pseudomona*s bacteria, especially *P. fluorescens* and *P. putida* are the most important kinds of PGPR, which produce auxin and promote the yield. Khakipour *et al*. (2008) evaluated the auxin productivity potential in studied *Pseudomonas* strains through chromatography, using HPLC devise; comparing the methods used and appointing IAA synthesize method by the studied strains in the applied cultivars. In fact, a variety of auxins like indole-3-acetic acid (IAA), indole-3-pyruvic acid, indole-3-butyric acid and indole lactic acid (Costacurta *et al*., 1994; Martínez-Morales *et al*., 2003); cytokinins (Horemans *et al*., 1986; Cacciari *et al.,* 1989), and gibberellins (Bottini *et al*., 1989) are detected, with auxin production being quantitatively most important (Barassi *et al.,* 2007).

F. Cultivar responses to organic substances

Nader lettuce cultivar treated with Rhyzobactrein gave the highest values in free IAA in folded leaves (26.72mg.l^{-1}), bounded GA_3 in folded leaves (26.73mg.l^{-1} bounded ABA folded and unfolded leaves(27.02, 28.91mg.l^{-1}, respectively), free ABA in folded and unfolded leaves (26.57 and 26.72mg.l^{1}, respectively) and bounded CK in folded leaves(26.76mg.l^{-1}). *Azospirillum brasilense* strain SM has the potential to be a competent rhizospheric bacterium as it triggers the IAA accumulation under nutrient stresses, likely environmental fluctuations, and long-term batch cultures and beneficially influences the growth of sorghum. Further, it also has the ability to promote the growth of a number of other plants like Mung bean, Maize, and Wheat (Malhotra and Srivastava, 2008). Some of the P-solubilizing bacteria and fungi act as plant growth promoters due to their ability to produce IAA but there is a different IAA production potential among PSB and PSF isolates (Souchie *et al*., 2007). Bacillus megaterium from tea rhizosphere is able to produce IAA and thus it helps in the plant growth promotion (Chakraborty *et al.,* 2006). The cytokinin receptors play a complimentary role in plant growth promotion by *B. megaterium* (Ortiz-Castro *et al*., 2008). Some microorganisms produce auxins in the presence of a suitable precursor such as L-tryptophan. The tryptophan increases the production of IAA in *Bacillus amyloliquefaciens* FZB42 (Idris *et al*., 2007).

G. Cultivar responses to mulching and organic substances

Nader lettuce cultivar treated with Nitrobein grown on mulched soils gave the highest values as compared to other triple interactions in free IAA in unfolded leaves (26.95mg.l^{-1}), bounded CK of folded and unfolded leaves (27.44 and 27.67mg.l^{-1}, respectively). Organic substances and polyethylene mulching ameliorate the environment stresses to facilitate better performance of lettuce growth. The growth of plants in the field is determined by the numerous and diverse interactions among its physical, chemical and biological components of soil as modulated by the prevalent environmental conditions. In particular, the varied genetic and functional activities of the extensive microbial populations have a critical impact on soil functions and plant growth, based on the fact, that microorganisms are driving force for fundamental metabolic processes involving specific enzyme activities (Nannipieri *et al*., 2003). The crop production in general and productivity in particular inhibited by a large number of both biotic and abiotic stresses. These stresses include extremes of temperature, high light, flooding, drought, the presence of toxic metals and environmental organic contaminants, radiation, wounding, insect predation, high salt, and various pathogens including viruses, bacteria, fungi, and nematodes (Abeles *et al.,* 1992).

2. Mineral accumulations

A. Mineral accumulation in response to mulching

Lettuce plants grown on mulched soils manifested the best results (Table, 17-20), since it substantially exceeded lettuce plants grown on bare unmulched soil in N content in stem (71.67%), N content of folded leaf base (16.67%). However, unmulched treatments preponderates its corresponding mulched in N content of folded leaves (8.79%), N content of unfolded leaves (22.16%). These results suggested that polyethylene mulch drastically reduced the accumulation of Nitrogen in both folded and unfolded leaves, where nitrogen accumulated in stem and leaf bases. Nitrogen accumulated in the stem and lea bases might be in the form of nitrate. Since, nitrate and nitrite detection detected in the leaf base (Abdel, 2011). Notwithstanding, reduction in N accumulation attributed to the high temperature that occurred in Rhizophere, which highly influenced nutrient absorptions. Increasing and reducing soil temperatures from the optimal temperatures usually confined to substantial reduction in ion absorption. Low and freezing temperatures lead to cellular dehydration, reduce water and nutrient uptake and conduction by the roots in some plants, thus causing osmotic stress (Chinnusamy *et al*., 2007). Bare soil grown lettuce substantially exceeded mulched soil (Table 21-24), in K content in folded leaves (33.46%), K content in stem (27.14%). Lettuce plants grown on mulched soils manifested the best results (Table 21-24). Since it substantially exceeded lettuce plants grown on bare unmulched soil in Ca content in folded leaves (55.59%), and Ca content in stem (3.94%). Lettuce plants grown on mulched soils (Table 25-28) manifested the best results (table, 29-32), since it substantially exceeded lettuce plants grown on bare unmulched soil in B content of unfolded leaves (32.99%), B content in stem (38.03%), B content in folded leaf base (6.76%). Yadav (2010) stated that dehydration during cold occurs mainly due to reduction in water uptake by roots and a hindrance to closure of stomata. The success or failure of a seedling in the field strongly related to the development of its root system under cold stress (Enns *et al*., 2006). Chilling caused injury to the cortical cells of cucumber root and further long time exposure increased the density of cytoplasm and damage the endoplasmic reticulum (Lee *et al*., 2002).

B. Mineral accumulation in response to organic substance

Untreated highly exceeded Rhyzobactrein in B in unfolded leaves and stem (14.87 and 92%, respectively). Untreated highly exceeded Rhyzobactrein in N content of folded leaves and stem (20.45 and 69.81%, respectively). Untreated exceeded Hupotass in N content of folded leaves (53.62%). Untreated highly exceeded Rhyzobactrein in K content of unfolded leaf and stem (43.61 and 15.56%, respectively), K content of folded leaf base (29.77%). Untreated also showed superiority on Nitrobein in K content of unfolded leaves and stem (19.39 and 40.8%, respectively), K content of folded leaf base (48.62%). Untreated exceeded Hupotass in K content of unfolded leaves, stem, and folded leaf base (11.79, 12.89 and 5.77%, respectively). Untreated also showed superiority on Nitrobein in B content of folded leaves (70.94%). Untreated exceeded Hupotass in B content of folded leaf base(32.45%). Untreated highly exceeded Rhyzobactrein in Na content of folded leaves and stem (16 and 78.38%, respectively). Untreated exceeded Hupotass in Na content of folded leaf and stem (11.54 and 144.44, respectively). Untreated highly exceeded Rhyzobactrein (Tables 37-40) in Fe content of folded leaves (10.76%) and Fe content of stem (22.42%). Untreated also showed superiority on Nitrobein in Fe content of stem and folded leaf base (11.8 and 6.83%, respectively). Untreated exceeded Hupotass in Fe content of stem and folded leaf base (11.4 and 6.42%, respectively).

Rhyzobactrein apparently preponderated Hupotass (Table 17-20) in N content of folded leaves (27.54%). Rhyzobactrein substantially bypassed untreated in N content of folded leaf base (39.02%). Rhyzobactrein profoundly surpassed Nitrobein in N content of folded leaf base (26.67%). Plant growth-promoting rhizobacteria (PGPR) reported to influence the growth, yield, and nutrient uptake by an array of mechanisms. They help in increasing nitrogen fixation in legumes, help in promoting free-living nitrogen-fixing bacteria, increase supply of other nutrients, such as phosphorus, sulphur, iron and copper, produce plant hormones, enhance other beneficial bacteria or fungi, control fungal and bacterial diseases and help in controlling insect pests. There has been much research interest in PGPR and there is now an increasing number of PGPR commercialized for various crops. Several reviews have discussed specific aspects of growth promotion by PGPR. In this review, we have discussed various bacteria which act as PGPR, mechanisms and the desirable properties exhibited by them (Saharan and Nehra, 2011). The bacteria isolated from composts which included farm waste compost (FWC), rice straw compost (RSC), *Gliricidia* vermin compost (GVC), and macro fauna associated with FWC when applied with composts show the synergistic effect on the growth of pearl millet (Hameeda *et al.,* 2006).

The plant growth stimulating efficiency of bacterial inoculants affected by soil nutritional condition. The bacterial inoculation has a much better stimulatory effect on plant growth in nutrient deficient soil than in nutrient rich soil (Egamberdiyeva, 2007). Applying the combined inoculation of PGPR as bio fertilizer affects beneficially the yield and growth of chickpea in field conditions. Biological nitrogen fixation contributes 180 X 106 metric tons/year globally, out of which symbiotic associations' produces 80% and the rest comes from free-living or associative systems. The ability to reduce and derive such appreciable amounts of nitrogen from the atmospheric reservoir and enrich the soil confined to bacteria and Archaea. These include symbiotic nitrogen fixing (N_2-fixing) forms, viz. *Rhizobium,* the obligate symbionts in leguminous plants and *Frankia* in non-leguminous trees, and non-symbiotic (free-living, associative, or endophytic) N_2-fixing forms such as cyanobacteria, *Azospirillum*, *Azotobacter*, *Acetobacter diazotrophicus*, *Azoarcus* etc. Rhyzobactrein substantially bypassed untreated (Tables 21-24) in K of folded leaves (14.1%).

Some bacterial strains directly regulate plant physiology by mimicking synthesis of plant hormones, whereas others increase mineral and nitrogen availability in the soil as a way to augment growth. The isolates could exhibit more than two or three PGP traits, which may promote plant growth directly, or indirectly or synergistically (Joseph *et al*., 2007; Yasmin *et al*., 2007). The plant growth stimulating efficiency of bacterial inoculants affected by soil nutritional condition. The bacterial inoculation has a much better stimulatory effect on plant growth in nutrient deficient soil than in nutrient rich soil (Egamberdiyeva, 2007).

Rhyzobactrein profoundly surpassed Nitrobein (Tables 21-24) in K content of folded leaves (18.13%), K content of stem (21.84%). Rhyzobactrein apparently preponderated Hupotass in K content of folded leaves (18.13%). Rhyzobactrein substantially bypassed untreated Tables, 25-28) in Ca content of unfolded leaves (87.75%), Ca content of stem (6.8%) and Ca content of folded leaf base (16.41%). Rhyzobactrein profoundly surpassed Nitrobein in Ca content of unfolded leaves (3.37%) and Ca content of folded leaf base (7.13%). Rhyzobactrein apparently preponderated Hupotass in Ca content of unfolded leaves (49.77%) and Ca content of folded leaf base (3.17%). Rhyzobactrein profoundly surpassed Nitrobein (tables, 29-32) in B in folded leaf base (74.93%). Rhyzobactrein apparently preponderated Hupotass in B content of folded leaf base (35.54%). Rhyzobactrein apparently preponderated Hupotass in Na content of stem (37.04%). Isolates producing IAA have stimulatory effect on the plant growth. When the crop inoculated with the isolates capable of IAA production significantly increases the plant growth by the N, P, K, Ca, and Mg uptake of sweet potato cultivar (Farzana and Radizah, 2005). There is a significant increase in rooting and root dry matter of cuttings of eucalypts when grown on IAA producing rhizobacteria-inoculated substrate. Some rhizobacterial isolates stimulates the rhizogenesis and plant growth, maximizing yield of rooted cuttings in clonal nurseries (Teixeira *et al*., 2007). When cucumber, tomato, and pepper inoculated with different strains of PGPR, which produce IAA, there is a significant increase in the growth of the vegetables (Kidoglu *et al*., 2007).

Rhyzobactrein profoundly surpassed Nitrobein in Fe content of folded leaf base (4.18%). Rhyzobactrein apparently preponderated Hupotass in Fe content of folded leaf base (3.78%). Iron is an essential growth element for all living organisms. The scarcity of bioavailable iron in soil habitats and on plant surfaces foments a furious competition (Loper and Henkels, 1997). Under iron-limiting conditions, PGPB produce low-molecular-weight compounds called siderophores to competitive acquire ferric ion (Whipps, 2001). Siderophores (Greek: "iron carrier") are small, high-affinity iron chelating compounds secreted by microorganisms such as bacteria, fungi and grasses (Neilands, 1995; Miller and Marvin, 2008). Microbes release siderophores to scavenge iron from these mineral phases by formation of soluble Fe^{3+} complexes that taken up by active transport mechanisms. Many siderophores are non-ribosomal peptides, although several are biosynthesized independently (Challis, 2005). Siderophores are also important for some pathogenic bacteria for their acquisition of iron (Miethke and Marahiel, 2007). Siderophores are amongst the strongest binders to Fe^{3+} known, with enterobactin being one of the strongest of these (Raymond *et al*., 2003).

Nitrobein highly exceeded untreated in N content of folded and unfolded leaves (9.43 and 15.94%, respectively), Na content of folded leaf base (8.57%), Ca content of unfolded leaves (81.53%), Ca content of stem and folded leaf base (32.87 and 8.66%, respectively). Nitrobein profoundly exceeded Rhyzobactrein in B content of unfolded leaves and stem (18.1 and 82.35%, respectively), N content of folded, unfolded leaves and stem (31.82, 25, and 64.15%, respectively). Besides, its superiority over Rhyzobactrein in Na content of folded leaves and stem (16 and 81.8%, respectively), Na content of folded leaf base (22.58%), Fe content of folded leaf and stem (9.7 and 9.49%, respectively) and Ca content of stem (24.41%).

Nitrobein highly exceeded Hupotass in N content of folded and unfolded leaves (68.12 and 31.87%, respectively), Na content of folded leaves and stem (11.54 and 148.15%, respectively), Na content of folded leaf base (46.15%), Ca content of unfolded leaves and stem (44.81 and 9.52%, respectively).

Hupotass significantly exceeded untreated in B content of unfolded leaves (10.87%), N content of stem (7.78%), N content of folded leaf base (58.54%), Fe content of folded leaves (19.61%), Ca content of folded leaves and stem (18.25 and 21.32%, respectively) and Ca content of folded leaf base (12.83%). Hupotass significantly exceeded Rhyzobactrein in B content of folded leaves and stem (27.35 and 61.65%, respectively), N content of stem and folded leaf base (83.02 and 14.04%, respectively), Fe content of folded leaves and stem (32.49 and 9.98%, respectively) and Ca content of folded leaves and stem (34.14 and 13.59%, respectively). Hupotass apparently preponderated Nitrobein in B content of unfolded leaves (7.84), N content of stem and folded leaf base (11.49 and 44.44%, respectively), K content of stem (24.73%), Fe content of folded leaves (20.77%), Ca content of folded leaves and folded leaf base (17.29 and 3.84%, respectively).

C. Cultivar responses

Nader cultivar profoundly bypassed Marul in B content in unfolded leaves (11.84%). This cultivar apparently exceeded Paris Island (tables, 29-32) in B content of unfolded leaves (13.62%).Nader cultivar profoundly exceeded Marul (table33-36) in Na content of unfolded leaves (41.86%). Unequivocal discrepancies observed among investigated cultivars could be attributed to genetic variations, techniques had been adopted by producing companies which highly reflected on gene switch off /and or on in response to ambient environments. The observed cultivar differences attributed to their differences in genome diversities and to the techniques that utilized during production from the mother plants (Abdel, 2005).

D. Lettuce responses to mulching and organic substances

Lettuce plants treated with Nitrobein grown on mulched soil gave the best interaction results as it gave the highest values in N content of folded leaves (1.19%) and unfolded leaves of bare soil grown lettuce (2.68%), which insignificantly differing from lettuce grown on bare soil treated with Hupotass (2.37%). The highest N content of stem of lettuce grown on polyethylene mulched soil (1.46%). The highest N content of folded leaf base of lettuce grown on bare soilwas (0.78%). The results revealed that unfolded leaves possessed higher N content than folded leaves, particularly on bare soil combined with nitrobein, Hupotass and Rhyzobactrein (Tables 17-20). These results revealed that organic substances did not ameliorate raised temperature adversity caused by mulching. Biofertilizers-nitrogen fixing bacteria are also available for increasing crop nutrient uptake of nitrogen from nitrogen fixing bacteria associated with roots (Azospirillum). Nitrogen fixing biofertilizers provide only a modest increase in crop nitrogen uptake (at best increase of 20 Kg N acre^{-1}). The elemental sulphur present in the soil transformed or oxidized by bacteria to available sulphate for plants. The inoculation of sulphur-oxidizing bacteria (*Thiobacillus*) onto the seeds of high S-demanding crops has proved to be quite successful in making sulphur more available for the plants. The rock phosphate is an approved source of phosphorus but its availability to plants limited under most growing conditions (Saharan and Nehra, 2011). Therefore, the percentages of N and p elements in the leaves were increased and this increment led to promote the growth and yield of roselle plants. Similar results have been reported by Kandeel *et al.* (2001), Mahfouz and Sharaf-Eldin (2007) on fennel, Hassan (2009) on sunflower.In addition to their beneficial N2-fixing activity with legumes, rhizobia can improve plant P nutrition by mobilizing inorganic and organic P. Many rhizobia isolates from different cross-inoculation groups of rhizobia, isolated from soils in Iran are able to mobilize P from organic and inorganic sources (Alikhani *et al.*, 2006). Conjunctive use of *Rhizobium* with Phosphate Solubilizing Bacteria (PSB) revealed synergistic effect on symbiotic parameters and grain yield of mungbean. Phosphate solubilizing bacteria improves the competitive ability and symbiotic effectiveness of inoculated *Rhizobium* sp. in lentil under field conditions (Kumar and Chandra, 2008). Data recorded from tillage versus no-tillage experiment revealed more nodulation and leghaemoglobin content in no-tillage treatment (Sharma *et al.*, 2007).

The highest K (Tables 21-24) obtained from folded leaves of lettuce grown on bare soil sprayed by Rhyzobactrein (14.38µg.g^{-1} dwt), unfolded leaves of lettuce untreated lettuce grown on bare soil (54.59 µg.g^{-1} dwt), stem of lettuce grown on bare soil treated with Rhyzobactrein (5.48µg.g^{-1} dwt). Insignificant differences detected between all mulching and organic substances combinations except untreated lettuce grown on bare soil (10.57 µg.g^{-1} dwt). These results showed that the most potent interaction treatment was lettuce grown on bare soils treated with Rhyzobactrein. Biofertilizers improved nutrient absorption through transferring unavailable mineral ions to available and through producing growth regulators. There are numerous soil microflora involved in the synthesis of auxin in pure culture and soil (Barazani and Friedman, 1999). The potential for auxin biosynthesis by rhizobacteria can be used as a tool for the screening of effective PGPR strains (Khalid *et al.*, 2004).

Accumulating evidence indicates that PGPR influence plant growth and development by the production of phytohormones such as auxins, gibberellins, and cytokinins. The effects of auxins on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory (Arshad and Frankenberger, 1991). Different plant seedlings respond differently to variable auxin concentrations (Sarwar and Frankenberger, 1994) and type of microorganisms (Ahmad *et al.*, 2005). The strains which produce the highest amount of auxins i.e. indole acetic acid (IAA) and indole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop (Khalid *et al.,* 2004). Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth (Tsavkelova *et al.*, 2007). The isolates producing a large amount of IAA support the plant like *L. bescens* in adverse ecological conditions (Giongo *et al.*, 2007). The survival of bacteria in the rhizosphere as well as the root and shoot weight of wheat plants positively affected by the addition of IAA (Narula *et al.*, 2006).

The highest Calcium (630.88 $\mu g.g^{-1}$dwt) observed in folded lettuce grown on mulched soil sprayed by Hupotass and in unfolded leaves (1740.6 $\mu g.g^{-1}$dwt) coincided to lettuce grown on mulched soil treated with Nitrobein. In stem (277.38$\mu g.g^{-1}$dwt) concomitant to lettuce grown on mulched soil sprayed with Nitrobein and in folded leaf base (216.54 $\mu g.g^{-1}$dwt) confined to lettuce grown on mulched soil treated with Hupotass (tables, 25-28). These results suggested that lettuce grown on polyethylene mulched Calcium partitioning among lettuce plants parts. Owing to the Calcium translocation with evapotranspiration water (Abdel, and Bamarni, 2011). Black mulches tended to reduce weed growth. Black polyethylene mulch was found to be more effective in raising soil surface temperature which was about 2 and 5^oC, as compared to clear polyethylene and bare soil, respectively (Abdel and Al-Juboori, 2006; Abdel, 2009). .Hassan *et al.* (1995) found higher levels of nitrogen, phosphorus, potassium, and calcium in leaf tissue of chilies grown over plastic reflective mulch compared to those grown over bare soil.

Insignificant differences detected among combination of organic substances and mulching in term of boron content of folded leaves. However, the highest boron content of unfolded leaves observed in lettuce grown on mulched soil sprayed to with Hupotass (29.58 $\mu g.g^{-1}$dwt), stem content of boron (10.19 $\mu g.g^{-1}$dwt) and folded leaf base (8.52 $\mu g.g^{-1}$dwt). These results suggested that mulching and Hupotass tended to increase Boron as they increased Ca which might be due to the Ca and B means of translocations. Mulching seems to provide lettuce roots with nutrients, moisture, lowest pest competitions. Black plastic mulch typically used for spring seeded crops. Since, it increases soil temperatures about (2.8ºC) at a depth of (5 cm) and (1.7ºC) at (10 cm), compared to those of bare soil (Lamont 2001).Wien and Minotti (1987) found plastic mulching increased shoot concentrations of nitrogen (N), nitrate (NO3-N), phosphorus (P), potassium (K), calcium(Ca), magnesium (Mg), copper (Cu) and boron (B) in transplanted tomatoes. Bhella (1988), also working with tomatoes, found higher levels of ammonium (NH4-N), nitrate (NO3-N), and magnesium in plastic mulched soils. Boron is essential for plant growth and development, and adequate boron nutrition of cultivated plants can be of great economic importance.

Boron affects the yield of fruits, vegetables, nuts, and grains as well as the quality of harvested crops. Increased boron applications may promote root elongation in acidic, high-aluminum soils. In one of his last articles, Joe Varner listed the boron requirement as one of the important unknowns in plant biology (Varner, 1995). Although recent progress in the isolation and characterization of plant boron-polyol transport molecules and pectin RG-II-B complexes greatly improved our understanding of boron mobility and boron chemistry in plant cell walls, it also highlighted the need to learn more about boron complexes with glycolipids and/or glycoproteins in membranes. The concept of boron-binding apoplastic proteins, as well as the effect of boron on manganese-activated enzymes, may be of importance in many metabolic processes. Molecular investigations of boron requirement in plants open new possibilities for improving boron deficiency/toxicity stress tolerance of crops. Elucidation of these aspects of boron nutrition will be a challenging goal for future research.

The highest Na content of folded leaves (0.36 $\mu g.g^{-1}$dwt) observed in untreated lettuce grown on mulched soil, unfolded leaves (1.14 $\mu g.g^{-1}$dwt), stem (0.72 $\mu g.g^{-1}$dwt) and folded leaf base (0.39 $\mu g.g^{-1}$dwt).These results suggested that mulching overwhelmed the distribution of Na among varying lettuce tissues (tables, 33-36). The highest Iron content of folded leaves ((138.75 $\mu g.g^{-1}$dwt) observed in lettuce grown on mulched soil treated with Hupotass, unfolded leaves (658.25 $\mu g.g^{-1}$dwt) of lettuce grown on unmulched sprayed with Rhyzobactrein, in stem (134.58 $\mu g.g^{-1}$dwt) of untreated lettuce grown on mulched soil and in base of untreated lettuce leaves (120.4 $\mu g.g^{-1}$dwt) grown on unmulched soil. These results revealed that unfolded leaves contained higher amount of iron, owing to their chlorophyll where its synthesis required iron for chlorophyllide as a coenzyme, more antioxidant, as they directly exposed to sunlight, and more metabolism (Goodwin and Mercer, 1985). A myriad of environmental factors modulate siderophores synthesis, including pH, the level of iron and the form of iron ions, the presence of other trace elements, and an adequate supply of carbon, nitrogen, and phosphorus (Duffy and Defago, 1999). The bacterial growth as well as siderophore production is stimulated by (NH4)2SO4 and amino acids however, the optimum siderophore yield obtained with urea (Sayyed *et al.,* 2005). The rhizobacteria able to produce siderophores in vitro increases early soybean growth in non-sterile soil (Cattelan *et al.,* 1999). Siderophores usually classified by the ligands used to chelate the ferric iron. The major groups of siderophores include the catecholates (phenolates), hydroxamates, and carboxylates (e.g. derivatives of citric acid). Xie *et al.* (2006) found that the high-resolution analysis of catechol type siderophores using polyamide thin layer chromatography performed by TLC methods effective for separating simple catechol compounds such as 2, 3-dihydroxybenzoic acid (2, 3-DHBA) and catechol after. The carrying out the sidero-analysis of *Pseudomonas putida* revealed that this siderophore molecule contains hydroxamate as well as catecholate iron chelating groups and confirmed that this siderophores belongs to pyoverdine type (Sarode *et al.,* 2007).

E. Cultivar responses to mulching

Nader cultivar grown on mulched soil (tables, 17-20) showed the highest N content in stem and folded leaf base (3.1 and 1.68%, respectively).Lettuce plants treated with Nitrobein grown on mulched soil gave the best interaction results as it gave the highest values in N content of unfolded leaves (1.19%).Nader cultivar grown on mulched soil showed the highest values and at least revealed non-significant difference with the highest values (Tables 29-32) in B of folded and unfolded leaves, stem and folded leaf base (12.09, 27.25, 23.51, and 15.62$mg.l^{-1}$, respectively).Nader cultivar grown on mulched soil showed the highest (Tables 33-36) values Na of folded, unfolded leaves and stem (0.82, 1.27 and 1.5$g.kg^{-1}$, respectively).Very close results were reported by Abdel (2009) and other investigators where they attributed their results to the influence of mulching on mineral availabilities. Plastic mulches also influence nutrient levels and uptake. There was complete elimination of weeds under black polyethylene mulch, whereas in unmulched plots weeding manually seven times during both years of experimentation (Singh *et al.,* 2009).

F. Cultivar responses to foliar sprays of organic substances

Nader lettuce cultivar treated with Nitrobein grown on mulched soils gave the highest values as compared to other triple interactions N content (tables, 13-20) in folded leaves (3.58%).Nader lettuce cultivar treated with Rhyzobactrein gave the highest values (tables, 21-24) in K content of folded leaves (31.07µg.g^{-1}). Nader lettuce cultivar treated with Rhyzobactrein gave the highest values (tables, 25-28) in Ca content of folded leaf base (635.69 g.Kg^{-1}). Nader lettuce cultivar treated with Nitrobein grown on mulched soils gave the highest values as compared to other triple interactions Ca content of stem (832.13 µg.g^{-1}). Nader lettuce cultivar treated with Rhyzobactrein gave the highest values in B content of folded leaves (18.41mg.l^{-1}). Nader lettuce cultivar treated with Nitrobein grown on mulched soils gave the highest values as compared to other triple interactions in B content of stem (25.82 µg.g^{-1}). Tien *et al.* (1979) showed that Azospirillum is able to produce auxins when exposed to tryptophan. Plants inoculated with the rhizobia together with Ag ion and L-tryptophan (Trp), give the highest root dry weight, and significantly increase the uptake of N, P and K compared to non-inoculated control plants (Etesami *et al*., 2009).Karnwal (2009) tested Fluorescent Pseudomonas isolates for their ability to produce indole acetic acid in pure culture in the absence and presence of L-tryptophan and found that for both strains, indole production increased with increases in tryptophan concentration. All the Rhizobium spp. isolated from Crotalaria sp. are found positive for IAA production, but the isolates differ significantly in auxin production depending upon the cultural conditions. The experiment indicates that Rhizobia can be used as bio enhancer and biofertilizer for wheat production as it can uptake more nutrients (N, P and K) by producing IAA and subsequently increases the plant root system (Etesami *et al.,* 2009). Among all the isolates maximum, amount of IAA produced by isolate from *C. retusa* (Sridevi *et al*., 2008). Independent of the origin (rhizosphere vs. phyllosphere), bacterial strains produced IAA, which accounts for the overall synergistic effect on growth of peas and wheat. The highest concentration of IAA produced by bacterial strain *P. fluorescens* and *Kocuria varians* (Egamberdieva, 2008; Ahmad *et al.,* 2005). While working on chickpea it found that all the isolates of *Bacillus*, *Pseudomonas,* and *Azotobacter* produced IAA, whereas only 85.7% of Rhizobium was able to produce IAA (Joseph *et al.,* 2007).

G. Cultivar responses to mulching and organic substances

Nader lettuce cultivar treated with Nitrobein grown on mulched soils gave the highest N content (tables, 17-20) in folded leaves (3.58%). Nader grown on mulched soil treated with nitrobein gave the highest unfolded leaves content of nitrogen (2.95%). Nader grown on mulched soil treated with Hupotass showed the highest stem content of nitrogen (4.38%). The highest Nitrogen content of folded base leaves (2.33%) observed in lettuce grown on unmulched soil treated with Hupotass. The vegetative growth parameters as well as sepal yield of roselle plant increased when seeds inoculated with Rhizobium and Azotobacter (Harridy and Amara, 1998; Hassan, 2009) or nitrobein, which a bio source of nitrogen. Inoculation of seeds with Azotobacter and Azospirillum in the presence of cattle manure resulted in improving both growth and yield. In most cases, all used treatments of cattle manure doses increased the N, P and K contents in roselle leaves in both seasons in comparison to that of control plants. In this concern, the highest values of these elements found by the treatment of 30 m3/fed., cattle manure in both seasons (Shaalan *et al.,* 2001).

Nader grown on bare soil treated with Rhyzobactrein manifested the highest (43.13 µg.g^{-1}) folded leaf content of potassium (tables, 21-24). The highest K of unfolded leaves (83.2 µg.g^{-1}) confined to untreated Nader grown on bare soil. The highest stem content of K (34.25 µg.g^{-1}) observed in Nader grown on unmulched soil treated by Rhyzobactrein. Untreated Nader grown on bare soil showed the highest K content of folded leaf base. Shaalan *et al.* (2001) Showed that the effect of bio-fertilizer on N, P and K contents of roselle leaves. The results were significant in the two seasons. In this connection, the highest content of N,P and K of roselle leaves was obtained by inoculating bio-fertilizer nitrobein at 1 kg /fed., + phosphorein at 1 kg /fed., in both seasons, followed by the treatment of phosphorein at 2 kg /fed., and then nitrobein at 2 kg /feddan. While the least content obtained from untreated plants in both seasons.

Nader grown on polyethylene-mulched soil treated with Hupotass manifested the highest Calcium content (809.75 µg.g^{-1}) of folded leaves (Tables 25-28). The highest Ca (2310 µg.g^{-1}) content of unfolded leaves observed in Paris grown on mulched soil treated with Rhyzobactrein. Nader grown on mulched soil treated with Nitrobein gave the highest stem content of Calcium (832.13 µg.g^{-1}). The highest calcium content of leaf bases (655 µg.g^{-1}) found in untreated Nader grown on bare soil. Calcium participate in many metabolic processes including detoxification, ion charge homeostasis, pH and signal transduction. Elevated [Ca^{2+}]cyt is necessary for signal transduction, a prolonged increase in [Ca^{2+}]cyt is lethal. Indeed, sustained high [Ca^{2+}]cyt is implicated in apoptosis, both during normal development, for instance in tissue patterning and xylogenesis and in hypersensitive responses to pathogens (Levine *et al*., 1996). To effect other responses, [Ca^{2+}]cyt perturbations must be either of low amplitude or transient. Transient increases in [Ca^{2+}]cyt can be single (spike), double (biphasic) or multiple (oscillations). Unique [Ca^{2+}]cyt spikes can be generated by delaying the [Ca^{2+}]cyt rise, or by altering the rate of change of [Ca^{2+}]cyt, the maximal [Ca^{2+}]cyt reached or the duration [Ca^{2+}]cyt is above a certain threshold. Oscillations can differ in their [Ca2+]cyt amplitudes, periodicity, or duration (Evans *et al*., 2001).

Nader lettuce cultivar treated with Nitrobein grown on unmulched soils gave the highest values of folded leaves content of Boron(16.1 µg.gl^{-1}). The highest B content of unfolded leaves (37.24 µg.gl^{-1}) detected in Marul grown on mulched soil treated Hupotass (Tables 29-32). The highest Boron content of stem (30.75 µg.gl^{-1}) coincided to untreated Nader grown on mulched soil. The highest B content of folded leaf bases (24.75) observed in Nader grown on bare soil treated with Rhyzobactrein. Boron assist Ca in cell wall building as it attract OH group of saccharides, participates in pentose shunt pathways, and of significance in nitrogen fixation. Brenchley and Thornton (1925) showed a major reduction in nodule number and in nitrogen fixation by inoculated boron-deficient faba bean. Vascular connections to the nodule reduced, and so was the number of bacteria that changed into bacteroid. The authors speculated that under boron deficient conditions, the symbionts might become parasitic. Results of this early study are consistent with the recent work by Bolanos *et al*. (1996). In boron-deficient pea nodules, the number of infected host cells was much lower than in sufficient controls. Host cells in boron-deficient plants developed enlarged and abnormally shaped infection threads, which frequently burst. Binding of the plant matrix glycoprotein to the cell surface of *Rhizobium leguminosarum* inhibited by the presence of borate in the incubation buffer.

The authors proposed that binding of matrix glycoprotein in the absence of boron might block the interaction between bacterial cell surface, and the plant membrane glycocalyx. Developing soybean root nodules were more sensitive to low boron nutrition than large fully developed nodules (Yamagishi and Yamamoto, 1994). Both development and nitrogen fixation of young nodules retarded after boron removal, while acetylene reduction rates remained unchanged in large nodules. The ratio of hydroxyproline to cell wall dry weight was fivefold lower in boron-deficient nodules than in boron-sufficient controls. The levels of hydroxyproline-rich covalently bound ENOD2 protein were extremely low in walls of boron-deficient nodule parenchyma cells, although the Northern blot analysis showed that the mRNA was present in both boron-sufficient and deficient nodules. The absence of the ENOD2 protein in the wall correlated with an irregular wall structure. The researchers concluded that a failure to incorporate the ENOD$_2$ protein in the absence of boron could lead to wall abnormalities that prevent proper formation of the O_2 barrier, which protects the dinitrogenase complex and allows symbiotic nitrogen fixation.

Untreated Nader grown on bare soil showed the highest Sodium (1.07 $\mu g.g^{-1}$) of folded leaves (Tables, 33-36). The highest unfolded leaves content of Na (1.99 $\mu g.g^{-1}$) observed in Nader grown on bare soil treated with Nitrobein. The highest stem content of Na (2.17 $\mu g.g^{-1}$) confined to untreated Nader treated with grown on bare soil. The highest leaf bases content of Na (1.27 $\mu g.g^{-1}$) found in Nader grown on bare soil treated with Nitrobein. The highest iron content of folded leaves (416.25 $\mu g.g^{-1}$) observed in Nader grown on mulched soil treated with Hupotass (tables 37-40). Nader grown on bare soil treated with Rhyzobactrein gave the highest iron of unfolded leaves (809.75 $\mu g.g^{-1}$). The highest stem iron (403.75 $\mu g.g^{-1}$) detected in untreated Nader grown on mulched soil. Nader grown on bare soil treated with Nitrobein manifested the highest iron content of folded leaf bases (373.75 $\mu g.g^{-1}$). These results suggested that Nader was the most potent lettuce cultivars capable to accumulate iron in its tissues, particularly when treated with organic substances. The aromatic amino acid-dependent expression of Indole-3-Pyruvate decarboxylase, which is a key enzyme in the production of indole-3-acetic acid (IAA) in rhizobacterium Enterobacter cloacae UW5, regulated by TyrR protein (Ryu *et al*., 2008). Siderophore biosynthesis is generally tightly regulated by iron-sensitive Fur proteins, the global regulators GacS and GacA, the sigma factors RpoS, PvdS, and FpvI, quorum-sensing auto inducers such as *N*-acyl homoserine lactone, and site-specific recombinases (Cornelis and Matthijs, 2002).

However, some data demonstrate that none of these global regulators is involved in siderophore production. Neither GacS nor RpoS significantly affects the level of siderophores synthesized by *Enterobacter cloacae* CAL2 and UW4 (Saleh and Glick, 2001). RpoS is not involved in the regulation of siderophore production by *Pseudomonas putida* strain WCS358 (Kojic *et al*., 1999). In addition, GrrA/GrrS, but not GacS/GacA, are involved in siderophore synthesis regulation in *Serratia plymuthica* strain IC1270, suggesting that gene evolution occurred in the siderophore-producing bacteria (Ovadis *et al*., 2004).

Table 17. Nitrogen percentages of folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td>Mean(C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td><td></td></tr>
<tr><td>0</td><td>2.88e</td><td>0.00</td><td>0.00</td><td>3.48b</td><td>0.00</td><td>0.00</td><td>1.06b</td></tr>
<tr><td>Hupotass</td><td>1.47h</td><td>0.00</td><td>0.00</td><td>2.68f</td><td>0.00</td><td>0.00</td><td>0.69d</td></tr>
<tr><td>Nitrobein</td><td>3.58a</td><td>0.00</td><td>0.00</td><td>3.36c</td><td>0.00</td><td>0.00</td><td>1.16a</td></tr>
<tr><td>Rhyzobactrein</td><td>2.98d</td><td>0.00</td><td>0.00</td><td>2.31g</td><td>0.00</td><td>0.00</td><td>0.88c</td></tr>
<tr><td>Mul*Cv (AB)</td><td>2.73b</td><td>0.00</td><td>0.00</td><td>2.96a</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">0.91b</td><td colspan="3">0.99a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">3.18b</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Hupotass</td><td colspan="2">2.07d</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Nitrobein</td><td colspan="2">3.47a</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">2.64c</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Cultivar means(B)</td><td></td><td colspan="2">2.84a</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">0.96c</td><td colspan="3">0.55f</td></tr>
<tr><td>Hupotass</td><td colspan="3">0.49g</td><td colspan="3">0.89d</td></tr>
<tr><td>Nitrobein</td><td colspan="3">1.19a</td><td colspan="3">1.12b</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">0.99c</td><td colspan="3">0.77e</td></tr>
</table>

Table 18. Nitrogen percentages of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	2.25a-e	1.85bcde	1.57de	2.71ab	1.82bcde	2.25a-e	2.07b
Hupotass	0.68f	1.56e	1.59de	2.49abcd	2.04a-e	2.57 abc	1.82b
Nitrobein	2.66ab	2.03a-e	1.71cde	2.15a-e	2.94a	2.95a	2.4a
Rhyzobactrein	2.39a-e	2.02bcde	1.87bcde	1.67cde	1.56e	2.02bcde	1.92b
Mul*Cv (AB)	1.99bc	1.87bc	1.68c	2.25ab	2.09abc	2.45a	
means (A)	1.85b			2.26a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	2.48a	1.84bc	1.91abc
	Hupotass	1.58c	1.8bc	2.08abc
	Nitrobein	2.4ab	2.49a	2.33ab
	Rhyzobactrein	2.03abc	1.79bc	1.94abc
Cv. means (B)		2.12a	1.98a	2.06a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	1.89bc	2.1bc
	Hupotass	1.28d	2.37ab
	Nitrobein	2.13bc	2.68a
	Rhyzobactrein	2.09bc	1.75cd1

Table 19. Nitrogen percentages of stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	3.14c	0.00	0.00	2.28d	0.00	0.00	0.9b
Hupotass	4.38a	0.00	0.00	1.42f	0.00	0.00	0.97a
Nitrobein	3.37b	0.00	0.00	1.83e	0.00	0.00	0.87b
Rhyzobactrein	1.5f	0.00	0.00	1.7e	0.00	0.00	0.53c
Mul*Cv (AB)	3.1a	0.00	0.00	1.81b	0.00	0.00	
means (A)	1.03a			0.6b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	2.71b	0.00	0.00
	Hupotass	2.9a	0.00	0.00
	Nitrobein	2.59c	0.00	0.00
	Rhyzobactrein	1.6d	0.00	0.00
Cultivar means (B)		2.45a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	1.05b	0.2f
	Hupotass	1.46a	0.47e
	Nitrobein	1.12b	0.61c
	Rhyzobactrein	0.5de	0.57cd

Table 20. Nitrogen percentages in folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	1.57d	0.00	0.00	0.88f	0.00	0.00	0.41c
Hupotass	1.59cd	0.00	0.00	2.33a	0.00	0.00	0.65a
Nitrobein	1.71c	0.00	0.00	1.01e	0.00	0.00	0.45c
Rhyzobactrein	1.87b	0.00	0.00	1.56d	0.00	0.00	0.57b
Mul*Cv (AB)	1.68a	0.00	0.00	1.44b	0.00	0.00	
means (A)	0.56a			0.48b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	1.22d	0.00	0.00
	Hupotass	1.96a	0.00	0.00
	Nitrobein	1.36c	0.00	0.00
	Rhyzobactrein	1.71b	0.00	0.00
Cultivar means (B)		1.56a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	0.52c	0.4d
	Hupotass	0.53c	0.78a
	Nitrobein	0.57bc	0.34d
	Rhyzobactrein	0.62b	0.52c

Table 21. Potassium (µg.g^{-1} dwt)content in folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.62bc	0.00	0.00	27.89b	0.00	0.00	9.08ab
Hupotass	25.34bc	0.00	0.00	27.25bc	0.00	0.00	8.77b
Nitrobein	24.07c	0.00	0.00	28.53b	0.00	0.00	8.77b
Rhyzobactrein	18.99d	0.00	0.00	43.15a	0.00	0.00	10.36a
Mul*Cv (AB)	23.75b	0.00	0.00	31.7a	0.00	0.00	
means (A)	7.92b			10.57a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	27.25 b	0.00	0.00
	Hupotass	26.3b	0.00	0.00
	Nitrobein	26.29b	0.00	0.00
	Rhyzobactrein	31.07a	0.00	0.00
Cultivar means (B)		27.73a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	8.87b	9.29b
	Hupotass	8.45b	9.08b
	Nitrobein	8.02bc	9.51b
	Rhyzobactrein	6.33c	14.38a

Table 22. Potassium (µg.g^{-1} dwt)content in unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	43.15bc	42.51bc	52.05abc	25.34c	55.23abc	83.2a	50.25a
Hupotass	52.05abc	52.69abc	37.43bc	24.71c	51.41abc	51.41abc	44.95ab
Nitrobein	36.79bc	39.97bc	25.98c	30.43bc	55.23abc	64.13ab	42.09ab
Rhyzobactrein	18.99c	36.79bc	32.34bc	28.52bc	45.69abc	47.6abc	34.99b
Mul*Cv (AB)	37.74bc	42.99bc	36.95bc	27.25c	51.89ab	61.058a	
means (A)	39.23a			46.91a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	34.24bc	48.87abc	67.63a
	Hupotass	38.38bc	52.05ab	44.42abc
	Nitrobein	33.61bc	47.6abc	45.06abc
	Rhyzobactrein	23.75c	41.24bc	39.97bc
Cultivar means (B)		32.49b	47.44a	49.27a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	45.9ab	54.59a
	Hupotass	47.39ab	42.51ab
	Nitrobein	34.24ab	49.93ab
	Rhyzobactrein	29.37b	40.6ab

Table 23. Potassium (µg.g^{-1} dwt) content in stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.62c	0.00	0.00	34.88a	0.00	0.00	10.25a
Hupotass	29.16b	0.00	0.00	25.34c	0.00	0.00	9.08b
Nitrobein	18.99d	0.00	0.00	24.71c	0.00	0.00	7.28c
Rhyzobactrein	18.99d	0.00	0.00	34.25a	0.00	0.00	8.87b
Mul*Cv (AB)	23.44b	0.00	0.00	29.79a	0.00	0.00	
means (A)	7.81b			9.93a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	30.75a	0.00	0.00
	Hupotass	27.25b	0.00	0.00
	Nitrobein	21.85c	0.00	0.00
	Rhyzobactrein	26.62b	0.00	0.00
Cultivar means (B)		26.61a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	8.87bc	11.63a
	Hupotass	9.72b	8.45bc
	Nitrobein	6.33d	8.24c
	Rhyzobactrein	6.33d	11.42a

Table 24. Potassium ($\mu g.g^{-1}$ dwt) content in folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	26.62ab	0.00	0.00	31.7a	0.00	0.00	9.72a
Hupotass	29.16a	0.00	0.00	25.98ab	0.00	0.00	9.19ab
Nitrobein	21.53bc	0.00	0.00	17.71c	0.00	0.00	6.54b
Rhyzobactrein	16.45c	0.00	0.00	28.52ab	0.00	0.00	7.49ab
Mul*Cv (AB)	23.44a	0.00	0.00	25.98a	0.00	0.00	
means (A)	7.81a			8.66a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	29.16a	0.00	0.00
	Hupotass	27.57a	0.00	0.00
	Nitrobein	19.62b	0.00	0.00
	Rhyzobactrein	22.48b	0.00	0.00
Cultivar means (B)		24.71 a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	8.87ab	10.57a
	Hupotass	9.72ab	8.66ab
	Nitrobein	7.18ab	5.9b
	Rhyzobactrein	5.48b	9.51ab

Table 25. Calcium ($\mu g.g^{-1}$ dwt) content in folded leaf responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	641.63b	0.00	0.00	425.38de	0.00	0.00	177.83b
Hupotass	809.75a	0.00	0.00	452cd	0.00	0.00	210.29a
Nitrobein	696.88b	0.00	0.00	378.88e	0.00	0.00	179.29b
Rhyzobactrein	496.88c	0.00	0.00	443.75cd	0.00	0.00	156.77b
Mul*Cv (AB)	661.28a	0.00	0.00	425b	0.00	0.00	
means (A)	220.43a			141.67b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	533.5b	0.00	0.00
	Hupotass	630.88a	0.00	0.00
	Nitrobein	537.88b	0.00	0.00
	Rhyzobactrein	470.31c	0.00	0.00
Cultivar means(B)		343.14a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	213.88b	141.79cd
	Hupotass	269.92a	150.67cd
	Nitrobein	232.29b	126.29d
	Rhyzobactrein	165.63c	147.92cd

Table 26. Calcium ($\mu g.g^{-1}$ dwt) content in unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	660c-i	1221.3c-e	528.8d-i	732.3c-i	233f-i	204.1ghi	596.6c
Hupotass	868.8c-i	888.8c-i	1090c-g	1540.8bc	83.5i	15.7i	747.9bc
Nitrobein	1175.5c-f	2930d	1116.3c-g	893.4ci	106.1hi	280.6e-i	1083.6ab
Rhyzobactrein	1116.3c-g	2310a	1055c-h	796.9c-i	38.8i	1403.8cd	1120.1a
Mul*Cv (AB)	955.1b	1837.5a	947.5b	990.8b	115.3c	476c	
means (A)	1246.7a			527.4b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	696.1bcde	727.1bcde	366.4e
	Hupotass	1204.8abc	486.1de	552.8cde
	Nitrobein	1034.4abcd	1518.1a	698.4bcde
	Rhyzobactrein	956.6abcde	1174.4abc	1229.4ab
Cultivar means(B)		973.0 a	976.4a	711.8a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	803.3bc	389.8c
	Hupotass	949.2b	546.6bc
	Nitrobein	1740.6a	426.7bc
	Rhyzobactrein	1493.8a	746.5bc

Table 27. Calcium (µg.g^{-1} dwt) content in stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	520.13e	0.00	0.00	596.75d	0.00	0.00	186.15d
Hupotass	602.25d	0.00	0.00	752.75b	0.00	0.00	225.83b
Nitrobein	832.13a	0.00	0.00	651.88c	0.00	0.00	247.33a
Rhyzobactrein	669.63c	0.00	0.00	523.25e	0.00	0.00	198.81c
Mul*Cv (AB)	656.03a	0.00	0.00	631.16b	0.00	0.00	
means (A)	218.68a			210.39b			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	558.44d	0.00	0.00			
	Hupotass	677.5b	0.00	0.00			
	Nitrobein	742a	0.00	0.00			
	Rhyzobactrein	596.44c	0.00	0.00			
Cultivar means (B)		643.59a	0.00	0.00			
Mulch* Treatment (AC)							
	0	Mulched	Unmulched				
	Hupotass	200.75d	250.92b				
	Nitrobein	277.38a	217.29c				
	Rhyzobactrein	223.21c	174.42e				

Table 28. Calcium (µg.g^{-1} dwt) content in folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	545e	0.00	0.00	547.13e	0.00	0.00	182.02d
Hupotass	649.63a	0.00	0.00	582.63d	0.00	0.00	205.38b
Nitrobein	578d	0.00	0.00	608.75c	0.00	0.00	197.79c
Rhyzobactrein	616.38b	0.00	0.00	655a	0.00	0.00	211.89a
Mul*Cv (AB)	597.25a	0.00	0.00	598.38a	0.00	0.00	
means (A)	199.08a			199.46a			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	546.06d	0.00	0.00			
	Hupotass	616.13b	0.00	0.00			
	Nitrobein	593.38c	0.00	0.00			
	Rhyzobactrein	635.69a	0.00	0.00			
Cultivar means (B)		597.81a	0.00	0.00			
Mulch* Treatment (AC)		Mulched	Unmulched				
	0	181.67d	182.38d				
	Hupotass	216.54a	194.21c				
	Nitrobein	192.67c	202.92b				
	Rhyzobactrein	205.46b	218.33				

Table 29. Boron (µg.g^{-1} dwt) content of Folded Leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	10.88abc	0.00	0.00	16.1a	0.00	0.00	4.49a
Hupotass	15.33ab	0.00	0.00	6.89c	0.00	0.00	3.71a
Nitrobein	10.28bc	0.00	0.00	9.85c	0.00	0.00	3.56a
Rhyzobactrein	11.86abc	0.00	0.00	9.17c	0.00	0.00	3.51a
Mul*Cv (AB)	12.09a	0.00	0.00	10.51a	0.00	0.00	
means (A)	4.03a			3.5a			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	13.49a	0.00	0.00			
	Hupotass	11.12a	0.00	0.00			
	Nitrobein	10.07a	0.00	0.00			
	Rhyzobactrein	10.52a	0.00	0.00			
Cultivar means (B)		11.3a	0.00	0.00			
Mulch* Treatment (AC)		Mulched	Unmulched				
	0	3.63a	5.37a				
	Hupotass	5.11a	2.3a				
	Nitrobein	3.43a	3.28a				
	Rhyzobactrein	3.96a	3.06a				

Table 30. Boron (µg.g^{-1} dwt) content of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	24.79b-e	22.26c-g	20.72d-g	26.46bcd	17.96fg	18.05fg	21.71b
Hupotass	27.87bc	23.63b-f	37.24a	19.91efg	17.77fg	17.99fg	24.07a
Nitrobein	29.24b	24.88b-e	20.81d-g	22.99c-f	17.94fg	18.07fg	22.32ab
Rhyzobactrein	27.1bc	23.08c-f	16.38g	9.77h	18.12fg	18.96 efg	18.9c
Mul*Cv (AB)	27.25a	24.46b	23.79b	19.78c	17.95c	18.27c	
means (A)	24.83a			18.67b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	25.62a	20.11bc	19.39c
	Hupotass	23.89ab	20.7bc	27.62a
	Nitrobein	26.12a	21.41bc	19.44c
	Rhyzobactrein	18.43c	20.59bc	17.67c
Cultivar means (B)		23.52a	20.7b	21.03b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	22.59bc	20.82cd
	Hupotass	29.58a	18.56de
	Nitrobein	24.98b	19.67cd
	Rhyzobactrein	22.19bc	15.62e

Table 31. Boron (µg.g^{-1} dwt) content of stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	30.57a	0.00	0.00	18.41bc	0.00	0.00	8.16a
Hupotass	25.56a	0.00	0.00	15.63cd	0.00	0.00	6.87a
Nitrobein	25.82a	0.00	0.00	20.68b	0.00	0.00	7.75a
Rhyzobactrein	12.08d	0.00	0.00	13.41cd	0.00	0.00	4.25b
Mul*Cv (AB)	23.51a	0.00	0.00	17.03b	0.00	0.00	
means (A)	7.84a			5.68b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	24.49a	0.00	0.00
	Hupotass	20.6b	0.00	0.00
	Nitrobein	23.25ab	0.00	0.00
	Rhyzobactrein	12.74c	0.00	0.00
Cultivar means (B)		20.27a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	10.19a	6.14bc
	Hupotass	8.52ab	5.21c
	Nitrobein	8.61ab	6.89bc
	Rhyzobactrein	4.03c	4.47c

Table 32. Boron (µg.g^{-1} dwt) content of folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	16.49d	0.00	0.00	19.53c	0.00	0.00	6a
Hupotass	20.64b	0.00	0.00	6.51h	0.00	0.00	4.53b
Nitrobein	13.28e	0.00	0.00	7.79g	0.00	0.00	3.51c
Rhyzobactrein	12.08f	0.00	0.00	24.75a	0.00	0.00	6.14a
Mul*Cv (AB)	15.62a	0.00	0.00	14.65b	0.00	0.00	
means (A)	5.21a			4.88b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	18.01a	0.00	0.00
	Hupotass	13.58b	0.00	0.00
	Nitrobein	10.54c	0.00	0.00
	Rhyzobactrein	18.41a	0.00	0.00
Cultivar means(B)		15.13a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	5.49d	6.51c
	Hupotass	6.88b	2.17h
	Nitrobein	4.43e	2.59g
	Rhyzobactrein	4.03f	8.25a

Table 33. Sodium (µg.g^{-1} dwt) content in folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	1.07a	0.00	0.00	0.67e	0.00	0.00	0.29a
Hupotass	0.72de	0.00	0.00	0.84c	0.00	0.00	0.26ab
Nitrobein	0.77cd	0.00	0.00	0.95b	0.00	0.00	0.29a
Rhyzobactrein	0.74de	0.00	0.00	0.77cd	0.00	0.00	0.25b
Mul*Cv (AB)	0.82a	0.00	0.00	0.8a	0.00	0.00	
means (A)	0.274a			0.267a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	0.87a	0.00	0.00
	Hupotass	0.78b	0.00	0.00
	Nitrobein	0.86a	0.00	0.00
	Rhyzobactrein	0.75b	0.00	0.00
Cultivar means (B)		0.81a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	0.36a	0.22d
	Hupotass	0.24bc	0.28bc
	Nitrobein	0.26cd	0.32ab
	Rhyzobactrein	0.25cd	0.26cd

Table 34. Sodium (µg.g^{-1} dwt) content in unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	0.99cde	1.44abc	0.99cde	0.99cde	0.99cde	0.99cde	1.07a
Hupotass	1.33bcd	1.01cde	0.74de	0.92cde	0.74de	0.92cde	0.94a
Nitrobein	1.78ab	0.53e	0.73de	1.99a	0.73de	0.83cde	1.1a
Rhyzobactrein	0.97cde	0.65de	0.91cde	0.82cde	0.91cde	0.82cde	0.84a
Mul*Cv (AB)	1.27a	0.91bc	0.84c	1.18ab	0.84c	0.89bc	
means (A)	1a			0.97a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	0.99bc	1.21b	0.99bc
	Hupotass	1.12b	0.88bc	0.83bc
	Nitrobein	1.88a	0.63c	0.78bc
	Rhyzobactrein	0.89bc	0.78bc	0.86bc
Cultivar means (B)		1.22a	0.87b	0.86b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	1.14a	0.99a
	Hupotass	1.03a	0.86a
	Nitrobein	1.01a	1.18a
	Rhyzobactrein	0.84a	0.85a

Table 35. Sodium (µg.g^{-1} dwt) content in stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	2.17a	0.00	0.00	1.81b	0.00	0.00	0.66a
Hupotass	0.67e	0.00	0.00	0.94d	0.00	0.00	0.27c
Nitrobein	1.89b	0.00	0.00	2.11a	0.00	0.00	0.67a
Rhyzobactrein	1.3c	0.00	0.00	0.94d	0.00	0.00	0.37b
Mul*Cv (AB)	1.5a	0.00	0.00	1.45b	0.00	0.00	
means (A)	0.5a			0.48a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	1.98a	0.00	0.00
	Hupotass	0.8c	0.00	0.00
	Nitrobein	1.99a	0.00	0.00
	Rhyzobactrein	1.12b	0.00	0.00
Cultivar means (B)		1.48a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	0.72a	0.6a
	Hupotass	0.22c	0.31bc
	Nitrobein	0.63a	0.7a
	Rhyzobactrein	0.43b	0.31bc

Table 36. Sodium (μg.g^{-1} dwt) content in folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	1.18ab	0.00	0.00	0.94bc	0.00	0.00	0.35ab
Hupotass	0.69d	0.00	0.00	0.89cd	0.00	0.00	0.26b
Nitrobein	0.99bc	0.00	0.00	1.27a	0.00	0.00	0.38a
Rhyzobactrein	0.99bc	0.00	0.00	0.87cd	0.00	0.00	0.31ab
Mul*Cv (AB)	0.96a	0.00	0.00	0.99a	0.00	0.00	
means (A)	0.32a			0.33a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	1.06ab	0.00	0.00
	Hupotass	0.79c	0.00	0.00
	Nitrobein	1.13a	0.00	0.00
	Rhyzobactrein	0.93bc	0.00	0.00
Cultivar means (B)		0.98a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	0.39a	0.31ab
	Hupotass	0.23b	0.29ab
	Nitrobein	0.33ab	0.42a
	Rhyzobactrein	0.33ab	0.29ab

Table 37. Iron (μg.g^{-1} dwt) content in folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	315.d	0.00	0.00	341.25c	0.00	0.00	109.38b
Hupotass	416.25a	0.00	0.00	368.75b	0.00	0.00	130.83a
Nitrobein	300e	0.00	0.00	350c	0.00	0.00	108.33b
Rhyzobactrein	323.75d	0.00	0.00	268.75f	0.00	0.00	98.75c
Mul*Cv (AB)	338.75a	0.00	0.00	332.19b	0.00	0.00	
means (A)	112.92a			110.73a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	328.13b	0.00	0.00
	Hupotass	392.5a	0.00	0.00
	Nitrobein	325b	0.00	0.00
	Rhyzobactrein	296.25c	0.00	0.00
Cultivar means(B)		335.47a	0.00	0.00

		Mulched	Unmulched
Mulch*Treatment (AC)	0	105ef	113.75cd
	Hupotass	138.75a	122.92b
	Nitrobein	100f	116.67c
	Rhyzobactrein	107.92de	89.58g

Table 38. Iron (μg.g^{-1} dwt) content in unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	397.5efg	534bcde	357.13fg	485def	553.75b-d	538b-e	478.23a
Hupotass	476.25efg	533.5b-e	355fg	676.25ab	557.5b-d	496.88c-f	515.9a
Nitrobein	602.5bcd	301.75g	375fg	488.75c-f	667.5ab	641.63bc	512.85a
Rhyzobactrein	475def	302g	379.5fg	487.5c-f	677.5ab	809.75a	521.88a
Mul*Cv (AB)	487.81b	418.81c	366.66 c	534.38b	614.06a	621.56a	
means (A)	424.43b			590a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	441.25cd	545.88abc	447.56cd
	Hupotass	576.25ab	545.5abc	425.94d
	Nitrobein	545.63abc	484.63bcd	508.31abcd
	Rhyzobactrein	481.25bcd	489.75abcd	549.63a
Cultivar means(B)		511.09a	516.44a	494.11a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	430.88d	525.58bc
	Hupotass	454.92cd	576.88b
	Nitrobein	426.42d	599.29ab
	Rhyzobactrein	385.5d	658.25a

3. Yield and yield quality

A. Lettuce responses to polyethylene mulched and bare soils

Lettuce plants grown on mulched soils manifested the best results (table, 41, 42, 48), since it substantially exceeded lettuce grown on bare soil in head fresh weight (21.16%), yield.m^{-2} (24.32%), and weight of unfolded leaves (39.49%). These results suggested that the adverse effects of high temperature in the root zone created in late summer by polyethylene mulch was overcame in the ensuing winter and spring. Therefore, insignificant differences observed in unfolded leaf numbers with significant differences in unfolded leaves weight. Abdel (2005)reported similar results in Paris Island lettuce cultivars grown in September, as compared to lettuce grown on November. Temperature significantly influenced leaf number during the first eighteen weeks, while cultivar only had a significant influence on the number of carrot leaves at weeks six and eight. The interaction between cultivar and temperature did not significantly influence the number of leaves at any stage, meaning that cultivars reacted the same to different temperature treatment (Manosa, 2011).

Lettuce grown on mulched soil apparently preponderate lettuce grown on bare soil (Tables 52, 53, 56, 57, 58) in terms of stem TSS (9.92%), TSS of folded leaf base (12.32%), dry matter percentage of folded leaves (11.67%), chlorophyll percentage in folded leaves (23.35%),chlorophyll percentage in unfolded leaves (23.35%)and chlorophyll percentage in folded leaves (11.34%). However, unmulched treatments preponderates its corresponding mulched (Table, 51) in TSS of folded leaves (32.51%).Other investigated traits showed insubstantial differences between mulched and bare soils influences on yield and yield quality. These results suggested that lettuce grown on mulched soil gave tenderer stem, folded leaf base. In contrast, folded leaves, where the tenderer folded leaves confined to lettuce grown on bare soil. Owing to their higher total soluble solids.

Table 39. Iron (µg.g^{-1} dwt)content in stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	403.75a	0.00	0.00	353.75c	0.00	0.00	126.25a
Hupotass	330d	0.00	0.00	350c	0.00	0.00	113.33b
Nitrobein	307.5e	0.00	0.00	370b	0.00	0.00	112.92b
Rhyzobactrein	331.25d	0.00	0.00	287.5f	0.00	0.00	103.13c
Mul*Cv (AB)	343.13a	0.00	0.00	340.31 a	0.00	0.00	
means (A)	114.38a			113.44a			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	378.75a	0.00	0.00			
	Hupotass	340b	0.00	0.00			
	Nitrobein	338.75b	0.00	0.00			
	Rhyzobactrein	309.38c	0.00	0.00			
Cultivar means (B)		341.72a	0.00	0.00			
Mulch* Treatment (AC)		Mulched	Unmulched				
	0	134.58a	117.92bc				
	Hupotass	110cd	116.67bc				
	Nitrobein	102.5de	123.33b				
	Rhyzobactrein	110.42cd	95.83e				

Table 40. Iron (µg.g^{-1} dwt) content in folded leaf base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	342.5c	0.00	0.00	361.25b	0.00	0.00	117.29a
Hupotass	362.5b	0.00	0.00	298.75e	0.00	0.00	110.21b
Nitrobein	285f	0.00	0.00	373.75a	0.00	0.00	109.79b
Rhyzobactrein	326.25d	0.00	0.00	360b	0.00	0.00	114.38a
Mul*Cv (AB)	329.06b	0.00	0.00	348.44a	0.00	0.00	
means (A)	109.69b			116.15a			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	351.88a	0.00	0.00			
	Hupotass	330.63c	0.00	0.00			
	Nitrobein	329.38c	0.00	0.00			
	Rhyzobactrein	343.13b	0.00	0.00			
Cultivar means(B)		338.75a	0.00	0.00			
Mulch* Treatment (AC)		Mulched	Unmulched				
	0	114.17b	120.42a				
	Hupotass	120.83a	99.58d				
	Nitrobein	95e	124.58a				
	Rhyzobactrein	108.75c	120a				

Since total soluble solids is almost nearly 95% sucrose which reflect juvenility in vegetative tissues and ripping degree in fruits (Abdel, 2011). Notwithstanding, plants performance highly dependent on temperatures. Six weeks after planting the highest number of leaves produced by plants at 26°C, significantly greater than those at 32°C. The leaf numbers at the 10 and 18°C treatments were intermediate to the high temperatures, but did not differ significantly from each other or 26°C treatment. At eight weeks, the highest leaf number again obtained at 26°C and this was significantly more than that produced at 10 and 32°C. Leaf number of plants at 10 and 32°C was significantly lower than at 18°C. During weeks 6 and 8, Nectar produced significantly more leaves than "Star 3002" but this trend did not continue. The highest number of leaves recorded at week 10 was at the 18°C treatment and plants at this temperature produced significantly more leaves than those at the 10 and 32°C treatments (Manosa, 2011).

B. Lettuce responses to organic substances

Application of organic substances positively affected the growth traits of lettuce plant (table, 41-59). Therefore, Rhyzobactrein highly surpassed untreated plants highly in head fresh weight (48.26%), yield per meter square (51.58%), number of folded leaves (32.82%), weight of unfolded leaves (6.46%). This treatment highly exceeded Hupotass in yield of square meter (16.13%), folded leaves number (34.78%), weight of unfolded leaves (10.85%). Rhyzobactrein highly surpassed nitrobein in number of folded leaves (11.35%). Rhyzobactrein possesses vast benefits for plant growth from nutrient mobilization, hormonal supplying, to defense from pathogens. It is well known that rhizosphere and soil microorganisms (PGPR) playan important role in maintaining crop and soil health through versatile mechanisms: nutrient cycling and uptake, suppression of plant pathogens, induction of resistance in plant host, direct stimulation of plant growth (Kloepper *et al.,* 2006). Maintaining biodiversity of PGPR in soil could be an important component of environment-friendly sustainable agriculture strategies. Some studies have demonstrated that agricultural practices affect the diversity and function of rhizosphere and soil microorganisms (Esperschutz *et al*., 2007; Sugiyama *et al.,* 2010). Organic farming differs from conventional agriculture in the production process and it relies on techniques such as crop rotation, green manure, and biological pest control to maintain the soil productivity instead of chemical fertilizer and pesticides (Zhengfei, 2005).

Yield Hupotass exceeded untreated (tables, 41-59) in head fresh weight and stem length(38.97 and 19.96% , respectively), stem diameter (34.91%), TSS of unfolded leaves and stem (76.86 and 16.53%), TSS of folded leave base (14.04%), dry matter percentages of folded leaves (19.75%), dry matter percentages of stem and folded leaf base (47.84 and 41.5%, respectively). Hupotass significantly exceeded Rhyzobactrein in stem length (12.06%), stem diameter (27.37%), TSS of stem (33.8%), TSS of folded leaf base (20.37%), dry matter percentages of folded leaves (53.41%), dry matter of stem (63.2%), and Dry matter percentages of fold leaf base (70.48%). Hupotass also exceeded Nitrobein in stem length (6.24%), stem diameter (26.32%), TSS of unfolded leaves, stem, base of folded leaf (60.5, 9.89, and 14.04%, respectively), Dry matter percentages of folded leaves, stem, folded leaf base (19.38, 58.4 and 50.42%, respectively). These results suggested the superiority of Hupotass most detected traits, particularly stem diameter. In general, the shortest and thickest stem reflects more head compaction. Owing to stem stunting, which elongates at unfolding late in spring to shift for reproduction stage (Abdel, 2012 Cd).The humic fractions namely humic acid, fulvic acid, and humin of the soil organic matter are responsible for the generic improvement of soil fertility and improved productivity (Kononova, 1966; Fortun *et al*., 1989). Humic acids known to possess many beneficial agricultural properties, as they participate actively in the decomposition of organic matter, rocks, and mineral, improve soil structure and change physical properties of soil, promote the chelation of many elements, and make these available to plants. They aid in correcting plant chlorisis, enhancement of photosynthesis density and plant root respiration has resulted in greater plant growth with humate application (Smidova, 1960; Chen and Avid, 1990). Zaghloul *et al.* (2009) studied the effect of foliar spray with potassium humate at rates 0.0, 0.5, 1.0, 1.5, 2.0, and 2.5 % K-humate on vegetative growth and some chemical constituents of *Thuja orientalis* L plants. They found that most criteria of vegetative growth expressed plant height, stem diameter, root length, fresh and dry weights of shoots and roots were significantly affected by application of aforementioned concentrations of K-humate under study, as well as chemical constituents content i.e. total soluble sugar content, (N, P, and K percentage content), essential oil % and essential oil yield/plant. All growth parameters and chemical constituents increased by increasing humic acid concentrations compared with untreated control. Therefore, humic acid may recommended for promoted growth parameters and possessed the best oil percentage in *Thuja orientalis* L plants.

Nitrobein apparently exceeded untreated (Tables 41-59) in head fresh weight (36.54%), yield per square meter (40%), weight of unfolded leaves (1.34%), and TSS of stem (6.05%). Nitrobein apparently bypassed Rhyzobactrein in TSS of folded leaves (27.37%),and dry matter percentages of folded leaves (28.51%). Nitrobein highly surpassed Hupotass in yield per square meter (7.26%), weight of unfolded leaves (5.52%), and TSS of folded leaves (25.12%). Inducible defense responses triggered by the foliar pathogen Pseudomonas syringae pv. Tomato DC3000 included the induction of root secretions such as L-malic acid that effectively recruited a PGPR strain, Bacillus subtilis FB17, in Arabidopsis roots (Rudrappa *et al.,* 2008). Second, herbivore attacks on plants trigger the induction of distinct resistance responses referred to as ―indirect defenses‖ (Baldwin *et al.,* 2006). In addition to the ―direct defense‖ reaction mediated by the de novo production of toxic secondary compounds against enemies, plants also defend themselves by releasing volatile organic compounds (VOCs) or extra floral nectar (EFN) to attract natural enemies (carnivores) of the herbivores AG. Third, as plant root exudates function as BG signaling molecules that affect the composition of rhizosphere microbial populations (Badri and Vivanco, 2009) certain rhizobacteria express antifungal associated genes such as the 2,4-diacetylphloroglucinol biosynthesis gene phlA. The expression of these genes in turn influenced by root exudates, which modulated by soil-borne fungal infections (Jousset *et al*., 2011)

C. Cultivar responses

Nader was the most potent lettuce cultivar as compared to other investigated cultivars (tables, 41-58). Thus, it categorized as the best in the sequence order (table, 41-59). Nader is the only cultivar gave heading percentages (100%), as compared to other investigated cultivars that showed heading percentages (0%). In addition to that this cultivar significantly exceeded Marul cultivar in head fresh weight (899.42%), weight of unfolded leaves (543.26%), stem length (164.18%), TSS of unfolded leaves (109.18%), dry matter percentage of unfolded leaves (82.31%), chlorophyll percentages of folded and unfolded leaves (68.27 and 44.91%, respectively). Nader exceeded Paris Island cultivars in head fresh weight (544.26%), weight of unfolded leaves (366.67%), stem length (165.39%), TSS of unfolded leaves (88.59%), dry matter percentage of unfolded leaves (55.38%), chlorophyll percentages of folded and unfolded leaves (22.77% and 14.96%, respectively). Paris cultivar came next in order it highly bypassed Marul in chlorophyll percentages of folded and unfolded leaves (37.07 and 26.05%, respectively). The worst cultivar was Marul as it exhibited the lowest results. Heading is recessive trait in lettuce, varying between cultivars. Environment also determines head folding substantially where leaves folding required 12°Cand no less than 15 unfolded leaves (Abdel, 2005). It found that unfolded leaves, particularly leaf bases facilitate the cupping of most inner newly generated leaves and force them to form the head, because the unfolding leaves alter red light to far red. Additionally, the faster folded leaves growing rate is the more compacted produced head (Wien, 1997).

D. Lettuce responses to mulching and organic substances

Lettuce plants treated with Nitrobein grown on mulched soil (Table 41-59) gave the best interaction results as it gave the highest values in head fresh weight (341.83g), yield per m^{-2} (1.77 kg), number of folded leaves (16.5), weight of unfolded leaves (166.5g) and chlorophyll percentage of folded leaves (32.8%). Lettuce benefited from mulching in regulating its adequate water requirements, particularly in its root shallow zone through reducing soil evaporation by black polyethylene mulch, eradication of weeds, and mineral availabilities. Singh *et al.* (2009) used of black polyethylene mulch plus drip irrigation of tomato *(Lycopersicon esculentum* Miller) at 80% evapotranspiration (ET) crop based on pan evaporation. They found maximum values in tomato yield 57.87 ton/ha, plant height, leaf area index, dry matter production, fruit weight and yield increased significantly with the use of drip irrigation alone and in conjunction with polyethylene mulch compared to surface irrigation alone or with mulch.

Maximum net returns (51386 Rs/ha) and benefit cost ratio (2.03) was found with drip irrigation at 80% ET coupled with polyethylene mulch compared to other treatments. Whereas, drip irrigation alone gave significantly higher fruit yield (45.57 ton/ha) compared with the surface irrigation (29.43 ton/ha).

Water-use efficiency under drip irrigation alone, drip irrigation with polyethylene mulch, and surface irrigation was 0.97, 1.23, and 0.42ton/ha^{-1}.cm^{-1}, respectively. Among different irrigation levels, drip irrigation at 80% ET resulted in higher net returns (34431 Rs/ha) and benefit cost ratio (1.76) in tomato. Drip irrigation besides giving a saving of 38% water resulted into 55% higher fruit yield compared to surface irrigation. Nitrobein helped in stresses remedy, it helped lettuce to overcome salt adversity imposed on lettuce. Urea, as a foliar spray, as well as phosphorein and nitrobein bio-fertilizers to lettuce plants were used to alleviate the damage effects induced by different levels of salinity (Younis *et al.,* 2008). Administration of nitrobein bio-fertilizer to the NaCl media led to significant increases in proline and glycine contents above the water control levels, but the amino acid content of NaCl-treated plants appeared consistently higher than that content in NaCl + nitrobein-treated plants. Additionally, supplemental addition of phosphorein to the salinized culture media induced significant increases in the contents of antioxidant compounds, throughout the experimental period. As compared with the saline control values, total ascorbate (ASA + DASA) and total glutathione (GSSG + GSH) contents were found either to decrease (with 4 and 6 mmhos NaCl) or to increase (with 8 and 10 mmhos NaCl) significantly in response to addition of nitrobein to the saline culture media (Younis *et al.,* 2009). Younis *et al.* (2009) found that the activities of superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APO) and glutathione reductase (GR) in the salinized lettuce plants fortified with the recommended dose of phosphorein or nitrobein. In general, such dose significantly up regulated above the salinized control levels; the magnitude of up-regulation being dependent on the concentration of NaCl, the stage of growth and on the enzyme under investigation. Many studies confirm the positive effects of humate on growth and yield of vegetables through the roles of humic and fulvic acid on cell metabolism. Sarir *et al.* (2005) revealed that using humic acids to induce growth in field crops by 28%. Matysiak *et al.* (2011) stated that humic and fulvic acids increased maize shoot weight by 40% after two foliar applications. They also showed chlorophyll content improvements in plant leaves as results of using extracts from algae, humic and fulvic acids, but the process of the pigments synthesis is closely dependent on the way of application of the mentioned substances. The strongest effect on the synthesis of chlorophyll was obtained after two foliar applications both with extracts from seaweeds and humic and fulvic acids. Moreover, increase in chlorophyll content reported in leaves after the application of extracts from seaweeds (Blunden *et al*., 1996).

E. Cultivar responses to mulching

Nader cultivar grown on mulched soil showed superiority over other dual interaction treatments (tables, 41-59). It gave the highest head fresh weight (688.75g), yield (4.13kg.m^{-2}), number of unfolded leaves (49.63), weight of unfolded leaves (327.13g). Besides, it superiority in terms of TSS of unfolded leaves (9.86%), TSS of stem (7.98%), TSS of folded leaf base (7.1%). Its dry matter percentages of folded leaves (10.05%), dry matter percentage of unfolded leaves (10.47%), stem dry matter percentage (8.63%), folded leaf base (8.53%) and chlorophyll percentages of folded leaves (36.13%) and chlorophyll percentages of unfolded leaves (57.24%).In general, cultivar responses to black polyethylene mulching are a translation to the capability of mulching in furnishing quite optimal conditions for root growth. The largest benefit from black polyethylene mulch is the increase in soil temperature in the bed, which promotes faster crop development and earlier yields (Hochmuth *et al.,* 2012). Earlier harvest is among the most important advantages of PE mulch application (Emmert, 1957), and the most commonly used PE mulch in vegetable production is black PE film of low density (Roe *et al*., 1994). However, during the last decade the industry has developed a variety of new formulations of colored, transparent, photodegradable, and photo-selective PE films for mulches (Lamont, 1993). Mulch acts as a barrier to the action of rainfall, which can cause soil crusting, compaction, and erosion. Less-compacted soil provides a better environment for seedling emergence and root growth. Mulch reduces rain-splashed soil deposits on fruits. In addition, mulch reduces fruit rot caused by soil-inhabiting organisms, because there is a protective barrier between the fruit and the organism (Hochmuth *et al.,* 2012).

F. Cultivar responses to organic substances

Nader lettuce cultivar treated with Rhyzobactrein (table, 41-59)gave the highest values in head fresh weight, yield per meter square, number of folded leaves, weight of folded leaves and weight of unfolded leaves (720g, 4.32Kg, 46.5g, 293.5g and 327.5g, respectively).There are numerous soil micro flora involved in the synthesis of auxin in pure culture and soil (Barazani and Friedman, 1999). The potential for auxin biosynthesis by rhizobacteria can be used as a tool for the screening of effective PGPR strains (Khalid *et al*., 2004). Accumulating evidence indicates that PGPR influence plant growth and development by the production of phytohormones such as auxin, gibberellins, and cytokinin. The effects of auxin on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory (Arshad and Frankenberger, 1991). Different plant seedlings respond differently to variable auxin concentrations (Sarwar and Frankenberger, 1994) and type of microorganisms (Ahmad *et al*., 2005). The strains which produce the highest amount of auxin i.e. indole acetic acid (IAA) and indole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop (Khalid *et al.,* 2004). Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth (Tsavkelova *et al*., 2007).

G. Cultivar Responses to mulching and organic substances

Nader lettuce cultivar (Table 41-59) treated with Nitrobein grown on mulched soils gave the highest values as compared to other triple interactions in fresh weight of head (885g), head yield per (5.31kg.m^{-2}), number and weight of folded leaves (49.5 and 327.5g), number and weight of unfolded leaves (140 and 405g), chlorophyll of folded leaves (47.25%).The diazotroph bacterial inoculation significantly increases the seed cotton yield, plant height, and microbial population in soil (Anjum *et al*., 2007). Double and triple combination of IBA, bacteria, and carbohydrates are more effective in increasing rooting capacity and more quality rooting in case of apple (Karakurt *et al*., 2009). Accumulating evidence indicates that PGPR influence plant growth and development by the production of phytohormone such as auxin, gibberellins, and cytokinin. The effects of auxin on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory. Different plant seedlings respond differently to variable auxin concentrations and type of microorganisms. The strains which produce the highest amount of auxin i.e. indole acetic acid (IAA) and indole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop. Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth. The isolates producing a large amount of IAA support the plant like *L. bescens* in adverse ecological conditions. The single and dual inoculation of *Rhizobium* and phosphorus (P) solubilizing bacteria with fertilizer (P_2O_5) significantly increase root and shoot weight, plant height, spike length, grain yield, seed P content, and leaf protein. Additionally, leaf sugar content of the wheat crop in a P deficient natural non-sterilized sandy loam soil and is 30-40% better than only P fertilizer for improving grain yield (Afzal and Bano, 2008). The P-solubilizing strains and the N_2-fixing bacterial strains have great potential in being formulated, and used as biofertilizers (Cakakc *et al*., 2007).Soil incorporation with the recommended rates of each of three bio-fertilizers, namely nitrobein, phosphorein, and potash, generally led to enhancement of the photosynthetic pigment contents of leaves in 30-day-old peanut and sunflower plants. Bio-fertilizer treatments stimulated net assimilation rates and plant growth indirectly via the production of growth promoting substances and bioactive substances such as hormones and enzymes. Enhancements were expressed as elevated total chlorophylls (a+b) and total pigments (total chlorophylls + carotenoids), particularly on application of potash in peanut and phosphorein or nitrobein, respectively in sunflower plants. Other workers also reported enhancement of photosynthetic pigments and efficiency, because of treatments with bio-fertilizers including nitrobein and phosphorein (Nijjar, 1990; Hassan *et al.,* 2005; Mostafa and Abo- Baker, 2010).

4. Seed productions

A. Lettuce responses to mulched and bare soils

Lettuce grown on mulched soil apparently preponderated lettuce grown on bare soil (tables, 60-66) in height of branches (13.64%), leaves number per stem (12.17%), number of flowered branches (47.17) seed yield per plant (107.13%), weight of 1000 seeds (20%), seed yield per square meter (107.11%) and floret number (46.19%). These results suggested that growing lettuce on black polyethylene mulched soil tended to improve the seed production and seed quality due to the availabilities of water, nutrient, and weed eradication achieved by covering. Abdel and Al-Juboori (2006) improved yield growth and bolting of onion on clear and black polyethylene mulched soils. They attributed the growth and bolting enhancement to the raised temperature at root zone brought about by mulching. However, in carrots high temperatures (18 and 21 °C) led to more terpenoid volatiles in carrots thus resulting in flavours such as; terpene, green, earthy, bitter and an aftertaste (Rosenfeld *et al*., 1998a; Rosenfeld *et al*., 1998b; Rosenfeld *et al*., 2002). Terpinolene, one of the terpenes, decreased with an increase in growth temperatures, but it probably only plays a minor role in masking the sweet taste of carrots (Simon *et al*., 1982; Rosenfeld *et al*., 2002). Despite the importance of terpenes for carrot flavour, little information is available on terrene biosynthesis in carrots (Hampel *et al*., 2005).

Table 41. Head fresh weight responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Head Fresh Weight(g)							
Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	537.5cd	77e	46e	415d	71e	44e	198.42b
Hupotass	657.5bc	148e	76e	585c	110e	78e	275.75a
Nitrobein	885a	80.5e	60e	447.5d	106e	46.5e	270.92a
Rhyzobactrein	675bc	79e	94.5e	765ab	99.5e	52e	294.17a
Mul*Cv (AB)	688.75a	96.13c	69.13c	553.13b	96.63c	55.13c	
means (A)	284.67a			234.96b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	476.25c	74d	45d
	Hupotass	621.25b	129d	77d
	Nitrobein	666.25ab	93.25d	53.25d
	Rhyzobactrein	720a	89.25d	73.25d
Cultivar means (B)		620.94a	96.38b	62.13b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	220.17cde	176.67e
	Hupotass	293.83abc	257.67bcd
	Nitrobein	341.83a	200de
	Rhyzobactrein	282.83abc	305.5ab

Table 42. Yield (kg.m^{-2}) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	3.23de	0.00 f	0.00 f	2.49e	0.00 f	0.00 f	0.95b
Hupotass	3.95bcd	0.00 f	0.00 f	3.51cd	0.00 f	0.00 f	1.24ab
Nitrobein	5.31a	0.00 f	0.00 f	2.69e	0.00 f	0.00 f	1.33a
Rhyzobactrein	4.05bc	0.00 f	0.00 f	4.59ab	0.00 f	0.00 f	1.44a
Mul*Cv(AB)	4.13a	0.00 f	0.00 f	3.32b	0.00 f	0.00 f	
means (A)	1.38a			1.11b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	2.86c	0.00d	0.00d
	Hupotass	3.73b	0.00 d	0.00 d
	Nitrobein	3.99ab	0.00 d	0.00 d
	Rhyzobactrein	4.32a	0.00 d	0.00 d
Cultivar means(B)		3.73a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	1.08bcd	0.83d
	Hupotass	1.32abc	1.17bcd
	Nitrobein	1.77a	0.9cd
	Rhyzobactrein	1.35abc	1.53ab

Table 43. Heading (%) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	100a	100a	100a	100a	100a	100a	33.33a
Hupotass	100a	100a	100a	100a	100a	100a	33.33a
Nitrobein	100a	100a	100a	100a	100a	100a	33.33a
Rhyzobactrein	100a	100a	100a	100a	100a	100a	33.33a
Mul*Cv (AB)	100a	100a	100a	100a	100a	100a	33.33a
means (A)	33.33a			33.33a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	100a	0.00b	0.00b
	Hupotass	100a	0.00b	0.00b
	Nitrobein	100a	0.00b	0.00b
	Rhyzobactrein	100a	0.00b	0.00b
Cultivar means (B)		100a	0.00b	0.00b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	33.33a	33.33a
	Hupotass	33.33a	33.33a
	Nitrobein	33.33a	33.33a
	Rhyzobactrein	33.33a	33.33a

Table 44. Tip burns (%) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hupotass	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrobein	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhyzobactrein	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mul*Cv(AB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
means (A)	0.00			0.00			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	0.00	0.00	0.00			
	Hupotass	0.00	0.00	0.00			
	Nitrobein	0.00	0.00	0.00			
	Rhyzobactrein	0.00	0.00	0.00			
Cultivar means (B)		0.00	0.00	0.00			
		Mulched	Unmulched				
Mulch* Treatment (AC)	0	0.00	0.00				
	Hupotass	0.00	0.00				
	Nitrobein	0.00	0.00				
	Rhyzobactrein	0.00	0.00				

Table 45. Bitterness (%) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hupotass	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nitrobein	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhyzobactrein	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mul*Cv(AB)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
means (A)	0.00			0.00			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	0.00	0.00	0.00			
	Hupotass	0.00	0.00	0.00			
	Nitrobein	0.00	0.00	0.00			
	Rhyzobactrein	0.00	0.00	0.00			
Cultivar means (B)		0.00	0.00	0.00			
		Mulched	Unmulched				
Mulch* Treatment (AC)	0	0.00	0.00				
	Hupotass	0.00	0.00				
	Nitrobein	0.00	0.00				
	Rhyzobactrein	0.00	0.00				

Table 46. Folded leave no.head^{-1} responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	33b	0.00	0.00	37b	0.00	0.00	11.67b
Hupotass	22c	0.00	0.00	47a	0.00	0.00	11.5b
Nitrobein	49.5a	0.00	0.00	34b	0.00	0.00	13.92ab
Rhyzobactrein	45.5a	0.00	0.00	47.5a	0.00	0.00	15.5a
Mul*Cv (AB)	37.5b	0.00	0.00	41.38a	0.00	0.00	
means (A)	12.5a			13.8a			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	35c	0.00	0.00			
	Hupotass	34.5c	0.00	0.00			
	Nitrobein	41.75b	0.00	0.00			
	Rhyzobactrein	46.5a	0.00	0.00			
Cultivar means (B)		39.44a	0.00	0.00			
		Mulched	Unmulched				
Mulch* Treatment (AC)	0	11c	12.33bc				
	Hupotass	7.33d	15.67ab				
	Nitrobein	16.5a	11.33c				
	Rhyzobactrein	15.17ab	15.83ab				

Table 47. Weight of folded leaves (g.head^{-1}) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	167.5b	0.00	0.00	170b	0.00	0.00	56.25a
Hupotass	148b	0.00	0.00	330a	0.00	0.00	79.67a
Nitrobein	327.5a	0.00	0.00	150b	0.00	0.00	79.58a
Rhyzobactrein	297a	0.00	0.00	290a	0.00	0.00	97.83a
Mul*Cv (AB)	235a	0.00	0.00	235a	0.00	0.00	
means (A)	78.33a			78.33a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	168.75b	0.00	0.00
	Hupotass	239ab	0.00	0.00
	Nitrobein	238.75ab	0.00	0.00
	Rhyzobactrein	293.5a	0.00	0.00
Cultivar means(B)		235a	0.00	0.00

		Mulched	Unmulched
Mulch*Treatment (AC)	0	55.83a	56.67a
	Hupotass	49.33a	110a
	Nitrobein	109.17a	50a
	Rhyzobactrein	99a	96.67a

Table 48. Unfolded leave no.head^{-1}responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	19b	16b	14b	20b	11b	19b	16.5a
Hupotass	17b	34.5b	32b	12.5b	20b	43.5b	26.58a
Nitrobein	140a	25b	23b	26.5b	21b	16.5b	42a
Rhyzobactrein	22.5b	22.5b	25.5b	29b	15.5b	21b	22.67a
Mul*Cv (AB)	49.63a	24.5a	23.63a	22a	16.88a	25a	
means (A)	32.58a			21.29a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	19.5b	13.5b	16.5b
	Hupotass	14.75b	27.25b	37.75a
	Nitrobein	83.25a	23b	19.75b
	Rhyzobactrein	25.75b	19b	23.25b
Cultivar means (B)		35.81a	20.69a	24.31a

		Mulched	Unmulched
Mulch* Treatment (AC)	0	16.33a	16.67a
	Hupotass	27.83a	25.33a
	Nitrobein	62.67a	21.33a
	Rhyzobactrein	23.5a	21.83a

Table 49. Weight of unfolded leaves (g.head^{-1}) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	290c	52.5g	33g	165de	51.5g	28g	130.33b
Hupotass	328.5bc	84.5fg	58g	140ef	84.5fg	55.5g	125.17ab
Nitrobein	405a	51.5g	43g	205d	59g	29g	132.08a
Rhyzobactrein	285c	58g	56g	370ab	58g	37g	138.75a
Mul*Cv (AB)	327.13a	61.63c	47.5c	220b	55.38c	37.38c	
means (A)	145.42a			104.25b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	227.5b	52cd	30.5d
	Hupotass	234.25b	84.5c	56.75c
	Nitrobein	305a	55.25cd	36d
	Rhyzobactrein	327.5a	42.25cd	46.5cd
Cultivar means (B)		273.56a	58.5b	42.44b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	125.17bc	81.5d
	Hupotass	157ab	93.33cd
	Nitrobein	166.5a	97.67cd
	Rhyzobactrein	133ab	144.5ab

Table 50. Stem length (cm) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>16.75bcd</td><td>6.7g</td><td>5.7g</td><td>13.5ed</td><td>6.05g</td><td>6.6g</td><td>9.22b</td></tr>
<tr><td>Hupotass</td><td>11.9ef</td><td>8.15fg</td><td>8.1fg</td><td>21.75a</td><td>8.2fg</td><td>8.25fg</td><td>11.06a</td></tr>
<tr><td>Nitrobein</td><td>21ab</td><td>6.05g</td><td>6.7g</td><td>19abc</td><td>4.5g</td><td>5.2g</td><td>10.41ab</td></tr>
<tr><td>Rhyzobactrein</td><td>18.5abc</td><td>6.8g</td><td>6.85g</td><td>16.25cd</td><td>5.75g</td><td>5.05g</td><td>9.87ab</td></tr>
<tr><td>Mul*Cv (AB)</td><td>17.04a</td><td>6.93b</td><td>6.84b</td><td>17.63a</td><td>6.13b</td><td>6.28b</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">10.27a</td><td colspan="3">10.01a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">15.13b</td><td colspan="2">6.38c</td><td colspan="2">6.15c</td></tr>
<tr><td>Hupotass</td><td colspan="2">16.83b</td><td colspan="2">8.18c</td><td colspan="2">8.18c</td></tr>
<tr><td>Nitrobein</td><td colspan="2">20a</td><td colspan="2">5.28c</td><td colspan="2">5.95c</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">17.34a</td><td colspan="2">6.28c</td><td colspan="2">5.95c</td></tr>
<tr><td>Cultivar means (B)</td><td></td><td colspan="2">17.33a</td><td colspan="2">6.53b</td><td colspan="2">6.56b</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">9.72b</td><td colspan="3">8.72b</td></tr>
<tr><td>Hupotass</td><td colspan="3">9.38b</td><td colspan="3">12.73a</td></tr>
<tr><td>Nitrobein</td><td colspan="3">11.25ab</td><td colspan="3">9.57b</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">10.72ab</td><td colspan="3">9.02b</td></tr>
</table>

Table 51. Stem diameter (cm) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>3.45abc</td><td>2.5c</td><td>2.8bc</td><td>5.4a</td><td>3.25abc</td><td>2.9abc</td><td>3.38b</td></tr>
<tr><td>Hupotass</td><td>4.6abc</td><td>5.1ab</td><td>5abc</td><td>3.7abc</td><td>4.35abc</td><td>4.6abc</td><td>4.56a</td></tr>
<tr><td>Nitrobein</td><td>3.7abc</td><td>3.7abc</td><td>4.25abc</td><td>2.75bc</td><td>3.25abc</td><td>4.abc</td><td>3.61b</td></tr>
<tr><td>Rhyzobactrein</td><td>3.15abc</td><td>3.45abc</td><td>3.35abc</td><td>3.65abc</td><td>4.15abc</td><td>3.75abc</td><td>3.58b</td></tr>
<tr><td>Mul*Cv (AB)</td><td>3.73a</td><td>3.68a</td><td>3.85a</td><td>3.88a</td><td>3.75a</td><td>3a</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">3.75a</td><td colspan="3">3.81a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">4.43ab</td><td colspan="2">2.88b</td><td colspan="2">2.85b</td></tr>
<tr><td>Hupotass</td><td colspan="2">4.15ab</td><td colspan="2">4.73a</td><td colspan="2">4.8a</td></tr>
<tr><td>Nitrobein</td><td colspan="2">3.23ab</td><td colspan="2">3.48ab</td><td colspan="2">4.13ab</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">3.4ab</td><td colspan="2">3.8ab</td><td colspan="2">3.55ab</td></tr>
<tr><td>Cultivar means (B)</td><td></td><td colspan="2">3.8a</td><td colspan="2">3.72a</td><td colspan="2">3.83a</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">2.92b</td><td colspan="3">3.85ab</td></tr>
<tr><td>Hupotass</td><td colspan="3">4.9a</td><td colspan="3">4.22ab</td></tr>
<tr><td>Nitrobein</td><td colspan="3">3.88ab</td><td colspan="3">3.33b</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">3.32b</td><td colspan="3">3.85ab</td></tr>
</table>

Table 52. TSS percentages of folded Leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>6.25de</td><td>0.00</td><td>0.00</td><td>10.5a</td><td>0.00</td><td>0.00</td><td>2.72a</td></tr>
<tr><td>Hupotass</td><td>5.5g</td><td>0.00</td><td>0.00</td><td>6.9c</td><td>0.00</td><td>0.00</td><td>2.07c</td></tr>
<tr><td>Nitrobein</td><td>6.15ef</td><td>0.00</td><td>0.00</td><td>9.4b</td><td>0.00</td><td>0.00</td><td>2.59b</td></tr>
<tr><td>Rhyzobactrein</td><td>6.5d</td><td>0.00</td><td>0.00</td><td>5.9f</td><td>0.00</td><td>0.00</td><td>2.07c</td></tr>
<tr><td>Mul*Cv (AB)</td><td>6.1b</td><td>0.00</td><td>0.00</td><td>8.06a</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">2.03b</td><td colspan="3">2.69a</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td colspan="2">Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td>0</td><td colspan="2">8.15a</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Hupotass</td><td colspan="2">6.2c</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Nitrobein</td><td colspan="2">7.78b</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="2">6.2c</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td>Cultivar means(B)</td><td></td><td colspan="2">7.08a</td><td colspan="2">0.00</td><td colspan="2">0.00</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td></td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td></tr>
<tr><td>0</td><td colspan="3">2.08de</td><td colspan="3">3.35a</td></tr>
<tr><td>Hupotass</td><td colspan="3">1.83f</td><td colspan="3">2.3c</td></tr>
<tr><td>Nitrobein</td><td colspan="3">2.05de</td><td colspan="3">3.13b</td></tr>
<tr><td>Rhyzobactrein</td><td colspan="3">2.17cd</td><td colspan="3">1.97ef</td></tr>
</table>

Table 53. Brix % (T.S.S) of folded leaf base responses to organic substance application in lettucecultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	6.45d	0.00	0.00	7.25c	0.00	0.00	2.28b
Hupotass	10.55a	0.00	0.00	5.05f	0.00	0.00	2.6a
Nitrobein	6e	0.00	0.00	7.65b	0.00	0.00	2.28b
Rhyzobactrein	5.4f	0.00	0.00	5.35f	0.00	0.00	1.79c
Mul*Cv (AB)	7.1a	0.00	0.00	6.33b	0.00	0.00	
means (A)	2.37a			2.11b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	6.85b	0.00	0.00
	Hupotass	7.8a	0.00	0.00
	Nitrobein	6.83b	0.00	0.00
	Rhyzobactrein	5.38c	0.00	0.00
Cultivar means (B)		6.71a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	2.15c	2.42b
	Hupotass	3.52a	1.68e
	Nitrobein	2cd	2.55b
	Rhyzobactrein	1.8de	1.78e

Table 54. TSS percentages of stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	6.5d	0.00	0.00	8.4c	0.00	0.00	2.48c
Hupotass	12.2a	0.00	0.00	5.15e	0.00	0.00	2.89a
Nitrobein	6.75d	0.00	0.00	9b	0.00	0.00	2.63b
Rhyzobactrein	6.45d	0.00	0.00	6.5d	0.00	0.00	2.16d
Mul*Cv (AB)	7.98a	0.00	0.00	7.26b	0.00	0.00	
means (A)	2.66a			2.42b			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	7.45c	0.00	0.00
	Hupotass	8.68a	0.00	0.00
	Nitrobein	7.88b	0.00	0.00
	Rhyzobactrein	6.48d	0.00	0.00
Cultivar means(B)		7.62a	0.00	0.00

		Mulched	Unmulched
Mulch* Treatment (AC)	0	2.17d	2.8c
	Hupotass	4.07a	1.72e
	Nitrobein	2.25d	3b
	Rhyzobactrein	2.15d	2.17d

Table 55. Dry matter percentages of unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	8.13b-f	7.85b-f	6.65c-g	9.94bc	6.95c-g	5.4fg	7.49a
Hupotass	16.25a	7.2c-g	5.1fg	8.19b-f	5.4fg	6.15efg	8.05a
Nitrobein	9.44b-e	6.4d-g	5.2fg	11.19b	5.5fg	4.05g	6.96a
Rhyzobactrein	8.06b-f	5.95fg	6.45d-g	9.63bcd	6.75c-g	5.35fg	7.03a
Mul*Cv (AB)	10.47a	6.85b	5.85bc	9.74a	6.15bc	5.24c	
means (A)	7.72a			7.04a			

		Nader	Paris	Marul
Cvs* Treatment Interaction (BC)	0	9.03bc	7.4cd	6.03de
	Hupotass	12.22a	6.3de	5.63de
	Nitrobein	10.31ab	5.95de	4.63e
	Rhyzobactrein	8.84bc	6.35de	5.9de
Cultivar means (B)		10.1a	6.5b	5.54b

		Mulched	Unmulched
Mulch* Treatment (AC)	0	7.54b	7.43b
	Hupotass	9.52a	6.58b
	Nitrobein	7.01b	6.91b
	Rhyzobactrein	6.82b	7.24b

Table 56. Dry matter percentages of stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	6.04cd	0.00	0.00	9.25b	0.00	0.00	2.55b
Hupotass	16.25a	0.00	0.00	6.38cd	0.00	0.00	3.77a
Nitrobein	5.56d	0.00	0.00	8.69b	0.00	0.00	2.38b
Rhyzobactrein	6.69cd	0.00	0.00	7.19c	0.00	0.00	2.31b
Mul*Cv (AB)	8.63a	0.00	0.00	7.88b	0.00	0.00	
means (A)	2.88a			2.63a			
		Nader		Paris		Marul	
Cvs* Treatment Interaction (BC)	0	7.64b		0.00		0.00	
	Hupotass	11.31a		0.00		0.00	
	Nitrobein	7.13b		0.00		0.00	
	Rhyzobactrein	6.94b		0.00		0.00	
Cultivar means (B)		8.26a		0.00		0.00	
Mulch* Treatment (AC)		Mulched			Unmulched		
	0	2.01d			3.08b		
	Hupotass	5.42a			2.13cd		
	Nitrobein	1.85d			2.9bc		
	Rhyzobactrein	2.23cd			2.4bcd		

Table 57. Dry matter percentages of folded leaf Base responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	6.63c	0.00	0.00	8.57b	0.00	0.00	2.53b
Hupotass	15.56a	0.00	0.00	5.94c	0.00	0.00	3.58a
Nitrobein	5.5c	0.00	0.00	8.75b	0.00	0.00	2.38b
Rhyzobactrein	6.44c	0.00	0.00	6.19c	0.00	0.00	2.1b
Mul*Cv (AB)	8.53a	0.00	0.00	7.36b	0.00	0.00	
means (A)	2.84a			2.45a			
		Nader		Paris		Marul	
Cvs* Treatment Interaction (BC)	0	7.6b		0.00		0.00	
	Hupotass	10.75a		0.00		0.00	
	Nitrobein	7.13bc		0.00		0.00	
	Rhyzobactrein	6.31c		0.00		0.00	
Cultivar means (B)		7.95a		0.00		0.00	
Mulch* Treatment (AC)		Mulched			Unmulched		
	0	2.21bc			2.86b		
	Hupotass	5.19a			1.98c		
	Nitrobein	1.83c			2.92b		
	Rhyzobactrein	2.15bc			2.06bc		

Table 58. Chlorophyll percentage out of pigments in folded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	31.6a-d	32.8a-d	19.4cd	33.85a-c	20.65b-d	19.95cd	26.38a
Hupotass	28.2b-d	31.3a-d	21b-d	24.5b-d	19.75cd	16d	23.46a
Nitrobein	47.25a	31.5a-d	19.6cd	22.35b-d	28.5b-d	15.75d	27.5a
Rhyzobactrein	37.45ab	23.6b-d	21.7b-d	34.45abc	23.4b-d	20.95b-d	26.93a
Mul*Cv (AB)	36.13a	29.81ab	20.43c	28.79ab	23.08bc	18.16c	
means (A)	28.79a			23.34b			
		Nader		Paris		Marul	
Cvs* Treatment Interaction (BC)	0	32.73abc		26.73abcde		19.68de	
	Hupotass	36.35abcde		25.53abcde		18.5de	
	Nitrobein	34.8ab		30.03abcd		1768e	
	Rhyzobactrein	35.95a		23.5bcde		21.33cde	
Cultivar means (B)		32.46a		26.44b		19.29c	
Mulch* Treatment (AC)		Mulched			Unmulched		
	0	27.93ab			24.82ab		
	Hupotass	26.83ab			20.08b		
	Nitrobein	32.8a			22.2b		
	Rhyzobactrein	27.58ab			26.27ab		

Table 59. Chlorophyll percentage out of other pigments in unfolded leaves responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	59.6a	45.05a-f	35c-f	35.4c-f	45.2a-f	39.8b-f	43.34a
Hupotass	59.65a	49.2a-e	33.25ef	47.4a-e	43.2a-f	28.4f	43.53a
Nitrobein	51.5a-c	50.65a-d	36.95c-f	44.6a-f	46.75a-e	40.15b-f	45.1a
Rhyzobactrein	58.2a	40.6b-f	34.25d-f	54.4ab	36.55c-f	35.6c-f	43.27a
Mul*Cv (AB)	57.24a	46.38b	34.86d	45.45b	42.94bc	35.99cd	
means (A)	46.16a			41.46b			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	47.5ab	45.13abc	37.4bcd			
	Hupotass	53.53a	46.23abc	30.83d			
	Nitrobein	48.05ab	48.7ab	38.55bcd			
	Rhyzobactrein	56.3a	38.58bcd	34.93cd			
Cultivar means (B)		51.34a	44.66b	35.43c			
		Mulched	Unmulched				
Mulch* Treatment (AC)	0	46.55a	40.13a				
	Hupotass	47.37a	39.68a				
	Nitrobein	46.37a	43.83a				
	Rhyzobactrein	44.35a	42.18a				

B. Lettuce responses to organic substance

Hupotass highly exceeded the untreated control (tables, 60-66) in seed yield per plant and seed yield per square meter (125.85 and 125.81%, respectively). Hupotass substantially bypassed Nitrobein in seed yield per plant and seed yield per square meter (144.81 and 143.48%, respectively). Hupotass highly exceeded Rhyzobactrein in seed yield per plant and seed yield per square meter (30.19 and 30.23%, respectively). Hupotass advantages possesses the capacity of holding the mineral including K and make them more available for plants, which enables lettuce to performed better growth and mitigates the stress adversities (Abdel, 2012; Abdel and Yaseen, 2012). Zaghloul *et al.* (2009) studied the effect of foliar spray with potassium humate at rates 0.0, 0.5, 1.0, 1.5, 2.0, and 2.5 % K-humate on vegetative growth and some chemical constituents of *Thuja orientalis* L plants. They found that most criteria of vegetative growth expressed plant height, stem diameter, root length, fresh and dry weights of shoots and roots were significantly affected by application of aforementioned concentrations of K-humate under study, as well as chemical constituents content i.e. total soluble sugar content, (N, P, and K percentage content), essential oil % and essential oil yield/plant. All growth parameters and chemical constituents increased by increasing humic acid concentrations compared with untreated control. Therefore, humic acid may recommended for promoted growth parameters and possessed the best oil percentage in *Thuja orientalis* L plants.

Rhyzobactrein substantially bypassed untreated (Tables 61-66) in seed yield per plant and seed yield per square meter (73.48 and 73.39%, respectively). Rhyzobactrein highly exceeded Nitrobein in seed yield per plant and seed yield per square meter (88.04 and 86.96%, respectively). Increases in the permeability of plant membranes was due to humate application resulted in improve growth of various groups of beneficial microorganisms, accelerate cell division, increased root growth and all plant organs for a number of horticultural crops and turf grasses, as well as, the growth of some trees, (Russo and Berlyn, 1990; Sanders *et al.*, 1990; Poincelot, 1993).

In addition to their beneficial N2-fixing activity with legumes, rhizobia can improve plant P nutrition by mobilizing inorganic and organic P. Many rhizobia isolates from different cross-inoculation groups of rhizobia, isolated from soils in Iran are able to mobilize P from organic and inorganic sources (Alikhani *et al.*, 2006). Conjunctive use of *Rhizobium* with Phosphate Solubilizing Bacteria (PSB) revealed synergistic effect on symbiotic parameters and grain yield of mungbeans. Phosphate solubilizing bacteria improves the competitive ability and symbiotic effectiveness of inoculated *Rhizobium* sp. in lentil under field conditions (Kumar and Chandra, 2008). Data recorded from tillage versus no-tillage experiment revealed more nodulation and leghaemoglobin content in no-tillage treatment (Sharma *et al.*, 2007). The single and dual inoculation *Rhizobium* and phosphorus (P) solubilizing bacteria with fertilizer (P_2O_5) significantly increases root and shoot weight, plant height, spike length, grain yield, seed P content, leaf protein. Besides, leaf sugar content of the wheat crop in a P deficient natural non-sterilized sandy loam soil and is 30-40% better than only P fertilizer for improving grain yield (Afzal and Bano, 2008). The P-solubilizing strains and the N2-fixing bacterial strains have great potential in being formulated, and used as bio-fertilizers (Cakmakc *et al.*, 2007).

Nitrobein apparently exceeded untreated (Tables 60-68) in branches number after chopping (29.78%).Nitrobein highly surpassed Hupotass in branches number after chopping (25.32%).Nitrobein apparently exceeded untreated in branch number after chopping (74.85%), leaf number on stem (26.15%). The growth and yield enhancement effect followed by supplementation of nitrobien in peanut and phosphorein in sunflower plants. The percentage increase in seed yield, compared to the corresponding controls were 122.03, 120.11, 176.62 in peanut and 149.22, 168.75, and 173.44 in sunflower for nitrobein, phosphorein and potash amendments, respectively. The oil content produced per plant also increased because of application of nitrobein, phosphorein, and potash in a similar trend to that obtained with biomass gain and seed yield. Generally, saturated fatty acid levels (palmitic, stearic and arachidic acids), were decreased and unsaturated ones, particularly the polyunsaturated essential fatty acids linoleic and linolenic were evoked with these bio-fertilizer amendments. Maximum increase in linoleic and linolenic acid exerted by phosphore in and nitrobein, respectively in peanut oil and by potash and phosphorein, respectively in sunflower oil (Ahmed and El-Araby, 2012).

C. Cultivar responses

Insignificant differences detected among cultivars where Paris and Marul gave values of 0.0 only Nader gave values over 0.0 (tables, 61-68).

D. Lettuce responses to mulching and organic substances

Lettuce plants treated with Hupotass grown on mulched soil (tables, 60-68) gave the best interaction results as it gave the highest values in weight of 1000 seeds, seed yield per plant, and seed yield per square meter (0.37g, 34.17g and 205g). Different plant seedlings respond differently to variable auxin concentrations (Sarwar and Frankenberger, 1994), and type of microorganisms (Ahmad *et al.,* 2005). The strains, which produce the highest amount of auxins i.e. indole acetic acid (IAA) and indole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop (Khalid *et al*., 2004). Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth (Tsavkelova *et al.*, 2007). The isolates producing a large amount of IAA support the plant in adverse ecological conditions (Giongo *et al*., 2007). The survival of bacteria in the rhizosphere as well as the root and shoot weight of wheat plants positively affected by the addition of IAA (Narula *et al.,* 2006). Originally isolated from the roots of the epiphytic orchid *Dendrobium moschatum*, the strains of Rhizobium, *Microbacterium, Sphingomonas,* and Mycobacterium genera are among the most active IAA producers (Tsavkelova *et al.*, 2007). Bio stimulant species of Pseudomonas and Bacillus can produce yet not well-characterized phytohormones or growth regulators that cause crops to have greater amounts of fine roots, which have the effect of increasing the absorptive surface of plant roots for uptake of water and nutrients. Rhizobia are the first group of bacteria, which attributed to the ability of PGPR to release IAA that can help to promote the growth and pathogenesis in plants (Mandal *et al.,* 2007). The IAA production is studied in Rhizobium strains associated only with a few legume hosts (Basu and Ghosh, 2001; Roy and Basu, 2004). Nevertheless, Sridevi and Mallaiah (2007) showed that all the strains of Rhizobium isolated from root nodules of *Sesbania sesban* (L) Merr. Produces IAA. The Rhizobium sp. isolated from the root nodules of common pulse plant *Vigna mungo* (L). Hepper is found to provide high levels of IAA to young and healthy root nodules (Mandal *et al*., 2007).

E. Cultivars responses to mulching

The best interaction treatment was Nader cultivar grown on mulched soil it showed the highest values and at least revealed non-significant difference with the highest values (tables, 61-68) in seed yield per plant, seed yield per square meter (61.88 and 371.25g, respectively), branches height (48cm), leaves number on stem (60).There are numerous soil micro flora involved in the synthesis of auxin in pure culture and soil (Barazani and Friedman, 1999). The potential for auxin biosynthesis by rhizobacteria can be used as a tool for the screening of effective PGPR strains (Khalid *et al*., 2004). Accumulating evidence indicates that PGPR influence plant growth and development by the production of phytohormones such as auxin, gibberellins, and cytokinin. The effects of auxin on plant seedlings are concentration dependent, i.e. low concentration may stimulate growth while high concentrations may be inhibitory (Arshad and Frankenberger, 1991). Different plant seedlings respond differently to variable auxin concentrations (Sarwar and Frankenberger, 1994) and type of microorganisms (Ahmad *et al*., 2005). The strains which produce the highest amount of auxin i.e. indole acetic acid (IAA) and indole acetamide (IAM) in non-sterilized soil, causes maximum increase in growth and yield of the wheat crop (Khalid *et al.,* 2004). Even the strains, which produce low amounts of IAA, release it continuously, thus improving plant growth (Tsavkelova *et al*., 2007).

F. Cultivars responses to organic substances

Nader lettuce cultivar treated with Hupotass gave the highest values (tables, 61-68) in seed yield per plant and square meter (70g and 420g).Most increases in growth, mineral content, and hormones seem to be brought by polyethylene effects on root zone, particularly, optimizing soil moisture at the most aerated shallow soil depth. The positive responses of growth, mineral and hormone contents can be attributed to the role of mulching in mitigating the root zone for root performance. Negreiros *et al.* (2005) found that yellow, brown, black, and silver films had a positive, though balanced effect on the yield of melon. Mulching not always expected to bring about soil temperature increase. Andrade Jr. *et al*. (2005) demonstrated that in warmer climates organic mulch (e.g. hay, rice hull) and black film have similar effects on lettuce yield. Differences in thermal and light conditions also affected marketable yield of celery, which consisted of the yields of stalks and blades (Siwek *et al*., 2007).

G. Cultivar responses to mulching and organic substances

Nader lettuce cultivar treated with Hupotass grown on mulched soils gave the highest values as compared to other triple interactions (tables, 61-68) in weight of 1000 seeds, seeds yield per plant and meter square (1.11g, 102.5g and 615g). Mulching seems to provide lettuce roots with nutrients, moisture, lowest pest competitions. Black plastic mulch is typically used for spring seeded crops because it increases soil temperatures about (2.8ºC) at a depth of (5 cm) and (1.7ºC) at (10 cm), compared to those of bare soil (Lamont, 2001). Black mulches have recently been shown to reduce weed growth. Black polyethylene mulch was found to be more effective in raising soil surface temperature which were about 2 and 5^{o}C as compared to clear polyethylene and bare soil, respectively (Abdel and Al-Juboori, 2006; Abdel, 2009).Soil incorporation with the recommended rates of each of three bio-fertilizers, namely nitrobein, phosphorein, and potash, generally led to enhancement of the photosynthetic pigment contents of leaves in 30-day-old peanut and sunflower plants. Bio-fertilizer treatments stimulated net assimilation rates and plant growth indirectly via the production of growth promoting substances and bioactive substances such as hormones and enzymes.

Enhancements were expressed as elevated total chlorophylls (a+b) and total pigments (total chlorophylls + carotenoids), particularly on application of potash in peanut and phosphorein or nitrobein, respectively in sunflower plants. Other workers also reported enhancement of photosynthetic pigments and efficiency, because of treatments with bio-fertilizers including nitrobein and phosphorein (Nijjar, 1990; Hassan *et al*., 2005; Mostafa and Abo- Baker, 2010).

Table 60. Branch number of plant after chopping responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	8b	0.00	0.00	5.5de	0.00	0.00	2.25b
Hupotass	6cd	0.00	0.00	8b	0.00	0.00	2.33b
Nitrobein	7bc	0.00	0.00	10.5a	0.00	0.00	2.92a
Rhyzobactrein	45e	0.00	0.00	5.5de	0.00	0.00	1.67c
Mul*Cv (AB)	6.38b	0.00	0.00	7.38a	0.00	0.00	
means (A)	2.13a			2.46a			
				Nader	Paris		Marul
Cvs* Treatment Interaction (BC)	0			6.75b	0.00		0.00
	Hupotass			7b	0.00		0.00
	Nitrobein			8.75a	0.00		0.00
	Rhyzobactrein			5c	0.00		0.00
Cultivar means (B)				6.88a	0.00		0.00
Mulch* Treatment (AC)				Mulched	Unmulched		
	0			2.67b	1.83cd		
	Hupotass			2bcd	2.67b		
	Nitrobein			2.33bc	3.5a		
	Rhyzobactrein			1.5d	1.83cd		

Table 61. Branch height (cm) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	56.5a	0.00	0.00	44c	0.00	0.00	16.75a
Hupotass	45bc	0.00	0.00	45bc	0.00	0.00	15b
Nitrobein	43.5c	0.00	0.00	42.5c	0.00	0.00	14.33b
Rhyzobactrein	47b	0.00	0.00	37.5d	0.00	0.00	14.08b
Mul*Cv (AB)	48a	0.00	0.00	42.25b	0.00	0.00	
means (A)	16a			14.08b			
				Nader	Paris		Marul
Cvs* Treatment Interaction (BC)	0			50.25a	0.00		0.00
	Hupotass			45b	0.00		0.00
	Nitrobein			43c	0.00		0.00
	Rhyzobactrein			42.25c	0.00		0.00
Cultivar means (B)				45.13a	0.00		0.00
Mulch* Treatment (AC)				Mulched	Unmulched		
	0			18.83a	14.67b		
	Hupotass			15b	15b		
	Nitrobein			14.5b	14.17b		
	Rhyzobactrein			15.67b	12.5c		

Table 62. Leaf number on stem responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	35.5c	0.00	0.00	64b	0.00	0.00	16.58c
Hupotass	70.5a	0.00	0.00	63.5b	0.00	0.00	22.33a
Nitrobein	61.5b	0.00	0.00	61.5b	0.00	0.00	20.5b
Rhyzobactrein	72.5a	0.00	0.00	25d	0.00	0.00	16.25c
Mul*Cv (AB)	60a	0.00	0.00	53.5b	0.00	0.00	
means (A)	20a			17.83b			
				Nader	Paris		Marul
Cvs* Treatment Interaction (BC)	0			49.75c	0.00		0.00
	Hupotass			67a	0.00		0.00
	Nitrobein			61.5b	0.00		0.00
	Rhyzobactrein			48.75c	0.00		0.00
Cultivar means(B)				56.75a	0.00		0.00
Mulch* Treatment (AC)				Mulched	Unmulched		
	0			11.83c	21.33b		
	Hupotass			23.5a	21.17b		
	Nitrobein			20.5b	20.5b		
	Rhyzobactrein			24.17a	8.33d		

Table 63. Responses of floret branch number to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>13f</td><td>0.00</td><td>0.00</td><td>20.5d</td><td>0.00</td><td>0.00</td><td>5.58c</td></tr>
<tr><td>Hupotass</td><td>42.5a</td><td>0.00</td><td>0.00</td><td>15ef</td><td>0.00</td><td>0.00</td><td>9.58a</td></tr>
<tr><td>Nitrobein</td><td>24c</td><td>0.00</td><td>0.00</td><td>21d</td><td>0.00</td><td>0.00</td><td>7.5b</td></tr>
<tr><td>Rhyzobactrein</td><td>26.5b</td><td>0.00</td><td>0.00</td><td>16e</td><td>0.00</td><td>0.00</td><td>7.08b</td></tr>
<tr><td>Mul*Cv (AB)</td><td>26.5a</td><td>0.00</td><td>0.00</td><td>18.13b</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">8.83a</td><td colspan="3">6.04b</td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td>Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td colspan="2">0</td><td colspan="2">16.75c</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="2">28.75a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="2">22.5b</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="2">21.25b</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td>Cultivar means (B)</td><td colspan="2"></td><td colspan="2">22.31a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td colspan="2"></td><td colspan="3">Mulched</td><td colspan="2">Unmulched</td></tr>
<tr><td colspan="2">0</td><td colspan="3">4.33d</td><td colspan="2">6.83c</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="3">14.17a</td><td colspan="2">5d</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="3">8bc</td><td colspan="2">7c</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="3">8.83b</td><td colspan="2">5.33d</td></tr>
</table>

Table 64. Weight of 1000 seeds (g) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>1.02a</td><td>0.00</td><td>0.00</td><td>0.81b</td><td>0.00</td><td>0.00</td><td>0.31a</td></tr>
<tr><td>Hupotass</td><td>1.11a</td><td>0.00</td><td>0.00</td><td>0.79b</td><td>0.00</td><td>0.00</td><td>0.32a</td></tr>
<tr><td>Nitrobein</td><td>1.09a</td><td>0.00</td><td>0.00</td><td>0.99a</td><td>0.00</td><td>0.00</td><td>0.35a</td></tr>
<tr><td>Rhyzobactrein</td><td>1.09</td><td>0.00</td><td>0.00</td><td>1.06a</td><td>0.00</td><td>0.00</td><td>0.36a</td></tr>
<tr><td>Mul*Cv (AB)</td><td>1.08a</td><td>0.00</td><td>0.00</td><td>0.91b</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">0.36a</td><td colspan="3">0.3b</td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td>Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td colspan="2">0</td><td colspan="2">0.92c</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="2">0.95bc</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="2">1.05ab</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="2">1.08a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td>Cultivar means (B)</td><td colspan="2"></td><td colspan="2">0.99a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td colspan="2"></td><td colspan="3">Mulched</td><td colspan="2">Unmulched</td></tr>
<tr><td colspan="2">0</td><td colspan="3">0.34ab</td><td colspan="2">0.27ab</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="3">0.37a</td><td colspan="2">0.26b</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="3">0.37ab</td><td colspan="2">0.33ab</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="3">0.36ab</td><td colspan="2">0.35ab</td></tr>
</table>

Table 65. Seed yield.plant^{-1} (g) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

<table>
<tr><td rowspan="2">Treatments</td><td colspan="3">Mulched</td><td colspan="3">Unmulched</td><td rowspan="2">Mean (C)</td></tr>
<tr><td>Nader</td><td>Paris</td><td>Marul</td><td>Nader</td><td>Paris</td><td>Marul</td></tr>
<tr><td>0</td><td>35c</td><td>0.00</td><td>0.00</td><td>27c</td><td>0.00</td><td>0.00</td><td>10.33bc</td></tr>
<tr><td>Hupotass</td><td>102.5a</td><td>0.00</td><td>0.00</td><td>37.5c</td><td>0.00</td><td>0.00</td><td>23.33a</td></tr>
<tr><td>Nitrobein</td><td>32.5c</td><td>0.00</td><td>0.00</td><td>25c</td><td>0.00</td><td>0.00</td><td>9.58c</td></tr>
<tr><td>Rhyzobactrein</td><td>77.5b</td><td>0.00</td><td>0.00</td><td>30c</td><td>0.00</td><td>0.00</td><td>17.92ab</td></tr>
<tr><td>Mul*Cv (AB)</td><td>61.88a</td><td>0.00</td><td>0.00</td><td>29.88b</td><td>0.00</td><td>0.00</td><td></td></tr>
<tr><td>means (A)</td><td colspan="3">20.63a</td><td colspan="3">9.96b</td><td></td></tr>
<tr><td colspan="3"></td><td colspan="2">Nader</td><td colspan="2">Paris</td><td>Marul</td></tr>
<tr><td rowspan="4">Cvs* Treatment Interaction (BC)</td><td colspan="2">0</td><td colspan="2">31c</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="2">70a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="2">28.75c</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="2">53.75b</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td>Cultivar means (B)</td><td colspan="2"></td><td colspan="2">45.78a</td><td colspan="2">0.00</td><td>0.00</td></tr>
<tr><td rowspan="5">Mulch* Treatment (AC)</td><td colspan="2"></td><td colspan="3">Mulched</td><td colspan="2">Unmulched</td></tr>
<tr><td colspan="2">0</td><td colspan="3">11.67b</td><td colspan="2">9b</td></tr>
<tr><td colspan="2">Hupotass</td><td colspan="3">34.17a</td><td colspan="2">12.5b</td></tr>
<tr><td colspan="2">Nitrobein</td><td colspan="3">10.83b</td><td colspan="2">8.33b</td></tr>
<tr><td colspan="2">Rhyzobactrein</td><td colspan="3">25.83a</td><td colspan="2">10b</td></tr>
</table>

Table 66. Seed yield.m^{-2}(g) responses to organic substance application in lettuce cultivars grown on mulched and bare soil

Treatments	Mulched			Unmulched			Mean (C)
	Nader	Paris	Marul	Nader	Paris	Marul	
0	210c	0.00	0.00	162c	0.00	0.00	62bc
Hupotass	615a	0.00	0.00	225c	0.00	0.00	140a
Nitrobein	195c	0.00	0.00	150c	0.00	0.00	57.5c
Rhyzobactrein	465b	0.00	0.00	180c	0.00	0.00	107.5ab
Mul*Cv (AB)	371.25a	0.00	0.00	179.25b	0.00	0.00	
means (A)	123.75a			59.75b			
		Nader	Paris	Marul			
Cvs* Treatment Interaction (BC)	0	186c	0.00	0.00			
	Hupotass	420a	0.00	0.00			
	Nitrobein	172.5c	0.00	0.00			
	Rhyzobactrein	322.5b	0.00	0.00			
Cultivar means (B)		275.25a	0.00	0.00			
		Mulched	Unmulched				
Mulch* Treatment (AC)	0	70b	54b				
	Hupotass	205a	75b				
	Nitrobein	65b	50b				
	Rhyzobactrein	155a	60b				
*Figures of unshared characters are significantly differ 0.05 level /Duncan taste							

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