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Research Article

Influence of seed priming with $PbSO_4$ and $FeSO_4$ on germination and seedling growth of cabbage under NaCl stress

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Citation

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Abstract

The impact of salinity causes nutrients imbalance and accumulation of toxic elements in plants which reduce water in filtration and plant growth. In present study seeds were primed with Lead acetate ($PbSO_4$) and Iron sulphate ($FeSO_4$) at two dose levels(100 and 200 ppm) and then treated with 4 control groups in different experiments like seeds without priming grown in fresh water, primed seeds grown in distilled water, only sterilized seeds without priming grown in distilled water, treatment of seeds without priming with different Sodium chloride (NaCl) concentrations (60mM, 90mM, 120mM) and experimental group primed seeds grown in different concentrations of NaCl salinity (60mM, 90mM, 120mM). All growth factors like seedling growth percentage, rate of germination, root, shoot length, bio moisture contents of root and shoot, fresh and dry weight of seedlings were observed. It was estimated that seeds without priming exhibited reduced growth under NaCl stress. Priming of seeds with $FeSO_4$ showed fairly better results whereas priming of seeds with $PbSO_4$did not show any significant improvement in growth parameters

Keywords: *Brassica oleracea*; Germination; $PbSO_4$ and $FeSO_4$; Salinity stress; Seed priming; Seedling growth

Introduction

Cabbage (*Brassica oleracea* L. var. *capitata*) is one of the most important vegetables grown worldwide and it belongs to the family Brassicaceae. The different cultivated types of cabbage show great variation in respect of size, shape and colour of leaves as well as the texture of the head [1]. The genus *Brassica* contains many species including (*Brassica napus* L.), mustard (*Brassica juncea* L.), cabbage (*Brassica oleracea* L.) and turnip (*Brassica rapa* L.) are commonly grown for vegetables, oils, condiments and fodder [2]. The genus comprises of approximately 30 wild species either belonging to wild taxa or have escaped cultivation [3]. It contains about 100 species, including the widely cultivated turnip, cabbage, cauliflower, broccoli, brussels sprouts, various mustards and weeds [4]. The species of this genus contain large amounts of fibers and vitamins especially the vitamin C [5]. Genus

*Brassica*is pharmacologically important as some species contain nutrients that have potential for anti-cancer properties like 3, 3'di-indolylmethane, sulforaphane, and selenium [6, 7].

Salinity is one of the major obstacles in crop growing areas throughout the world. Despite of extensive literature there is still controversy with regard to the mechanisms of salt tolerance in plants [8]. It is an issue that affects 6% of the World's land surface area or 12,780 million hectares (Mha) and secondary salinization from irrigation impacts 20% of irrigated land or 1474 Mha. According to the reports of United Nations, 20% of agricultural land and 50% of World cropland are salt affected. Salinity in soil or water is major stress and limits the crop production [9]. It starts at seed germination level, reduces nodule formation, retards plant growth and crops yield [10]. The plants that grow in saline soils have various ionic concentrations and compositions of dissolved salts**.** These concentrations alter due to changes in water source, evapo-transpiration, drainage, and solutes availability [11]. The establishment of seed/crop depends on the frequency and the amount of precipitation and the ability of the seed species to germinate [12].Salts inhibit seed germination and crop establishment [13]. Germination and seedling characteristics are the most viable criteria used for selecting salt tolerance in plants [14].

Poor crop establishment was considered as a major constraint for farmers. To control salinity or adverse environmental conditions, priming may be used for enhancing germination of seeded plants [15]. Priming is a controlled-hydration process followed by redrying that allows pre-germinative metabolic activities to carry on [16].

One of the most widely distributed heavy metals that is very toxic to plants is Lead (Pb) [17]. Pb affects mesophyll cells, pigment content and light and dark reactions of plants. It also interferes with nutritional elements of seedlings and thus leading to deficiencies or adverse ion distribution within the plant [18] as well as growth inhibition [19, 20].

In this context, an effort was made to investigate the effect of seed priming on germination and early seedling growth of cabbage and to find out a relationship between salt stress and growth.

Materials and methods

Experiments were carried out to investigate the effects of seed priming of *Brassica oleracea* var. *capitata* L. with $FeSO_4$ and $PbSO_4$ under different levels of NaCl concentrations following the method with slight modification as described by [21].

Seeds priming and experimental design

Seeds were surface sterilized with 70% ethanol for 30 seconds and then washed with distilled water. Seeds were then primed with two concentration levels of $FeSO_4$ and $PbSO_4$i.e, 100 and 200 ppm for 1hour and then dried. Germination period was studied in 4 control groups with different experiments like seed without priming grown in fresh water, primed seed grown in distilled water, only sterilized seed without priming grown in distilled water, treatment of seeds without priming with different NaCl concentrations and experimental group in which seeds were primed with $FeSO_4$ and $PbSO_4$ and then grown in different concentrations of NaCl salinity (60mM, 90mM, 120mM). Repeating each experiment 3 times 64 petri plates were prepared. In each plate 7 seeds were placed which were lined with filter paper and moisten with 10-12 ml soln. All plates were kept at 10-13°C for germination being the optimum temperature. Germination started after 36 hrs (with the emergence of radicle seeds were considered to be germinated).

Recording of data

Germination of seeds were counted after every 24 hrs and after 8 days of germination, germination percentage and germination velocity were calculated but root and shoot length, fresh and dry biomass of seedlings were determined after 15 days of sowing. Root, shoot length were measured by using the simple ruler. Fresh weight was obtained by using the electronics sartorius balance TE214S and after 24 hrs dry weight was determined in each case and percentage moisture content was calculated. The number of seeds germinated was counted on daily basis till the completion of germination % germination and speed of germination was calculated as described by [22].

Statistical analysis

The data was statistically analyzed using t-test and Pearson Correlation was found.

Results and discussion

Speed of germination

Speed of germination is strongly influenced by salinity. Among control groups highest rate of germination was recorded in seeds grown in distilled water without priming (424.6) than in fresh water (435.3) and very slow germination speed were recorded in seeds without priming grown in different concentrations of NaCl i.e., (460.3) in 60mM, (482.6) in 90mM and (510.8) in 120mM as shown in (Fig1).

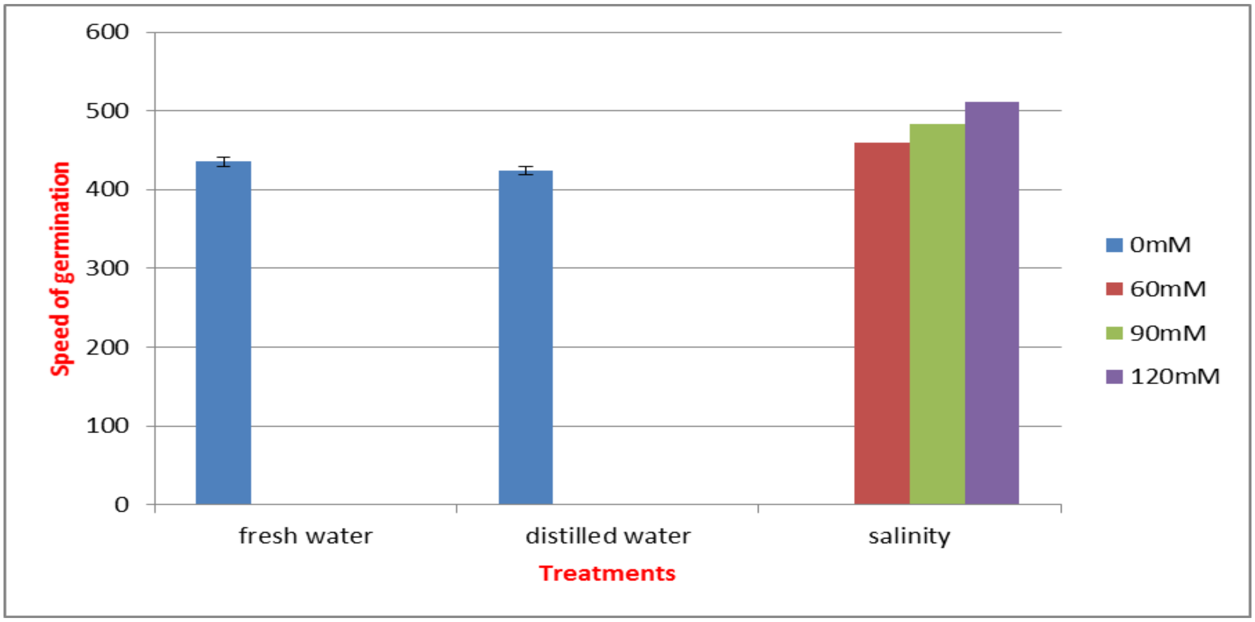

Figure 1. Effects on germination speed of *Brassica oleracea* under different control groups

When we compare $PbSO_4$ primed seeds germination speed at 100 and 200 ppm, its 200 ppm (493.1) showed lower speed than that of 100 ppm (480.4). But in case of $FeSO_4$primed seeds at 100 ppm concentration the speed of germination (368.9) was less as compared to that of 200 ppm (318.9). It was observed that $FeSO_4$200 ppm primed seeds showed highest speed of germination. The P(T<=t) value recorded in 100 ppm $PbSO_4$ was (0.0001) and (0.0003) in 200 ppm of $PbSO_4$, whereas priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.004) and(0.008) at 200 ppm. From the P(T<=t) value it was concluded that except 200 ppm of $FeSO_4$both nutrients showed significant effects on germination speed (Fig 2).

Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

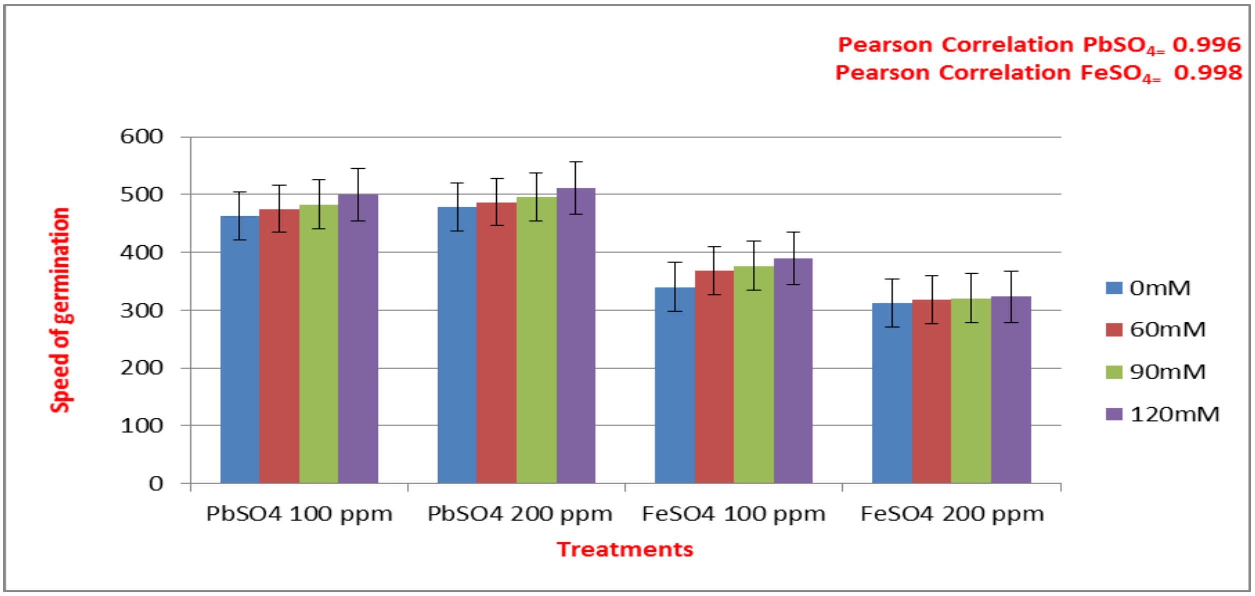

Figure 2. Effect of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on germination speed of *Brassica olereaca* under different levels of NaCl

Germination percentage

Among control groups the highest germination percentage was recorded in distilled water (91.7%) than that of fresh water (88.5%) and fairly low were recorded in 60mM (78.9%), 90mM (62.1%), and in 120mM (45.4%) levels of NaCl (Fig 3).

Distilled water > Fresh water > 60mM >90mM >120mM.

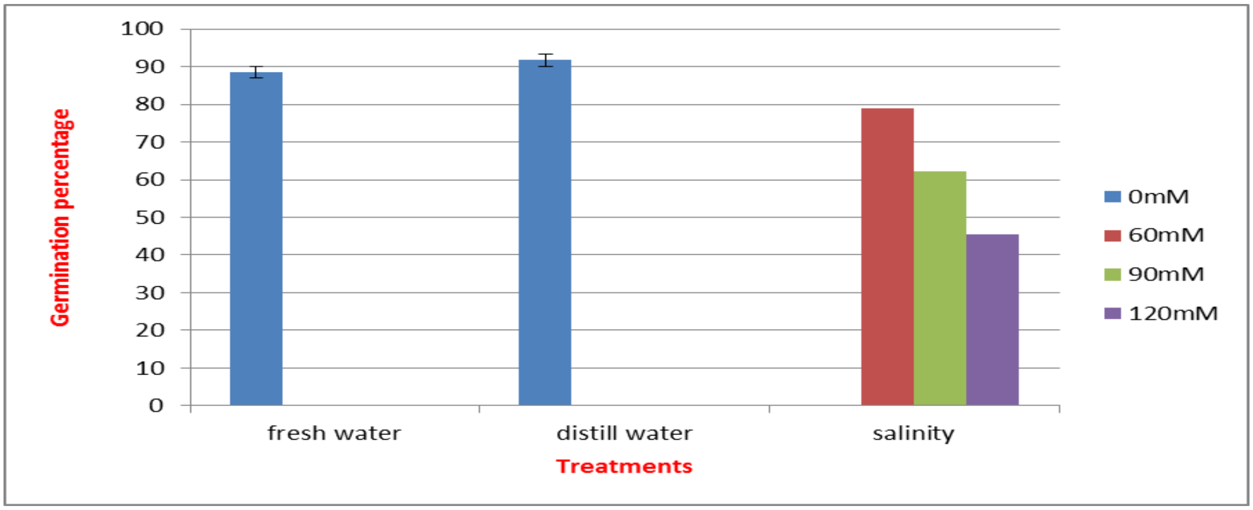

Figure 3. Effects on germination percentage of *Brassica oleracea* under different control groups

When we compare germination percentage of $PbSO_4$ at 100 and 200 ppm concentration, its 200 ppm showed lower germination percentage (60.02%) than that at 100 ppm (69.15%) but in $FeSO_4$ primed seeds at 100 ppm showed less germination percentage

(88.25%) as compared to that at 200 ppm (93.75%).When seeds were primed with $PbSO_4$ its P(T<=t) value was (0.0002) for 100 ppm and (0.0005) was recorded for 200 ppm of $PbSO_4$, and priming of seeds with $FeSO_4$ for 100 ppm gave P(T<=t) value (0.0001) and for 200 ppm (0.0003).From the P(T<=t) value it was concluded that 100 and 200 ppm ofboth nutrients showed significant effects on germination percentage (Fig 4). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

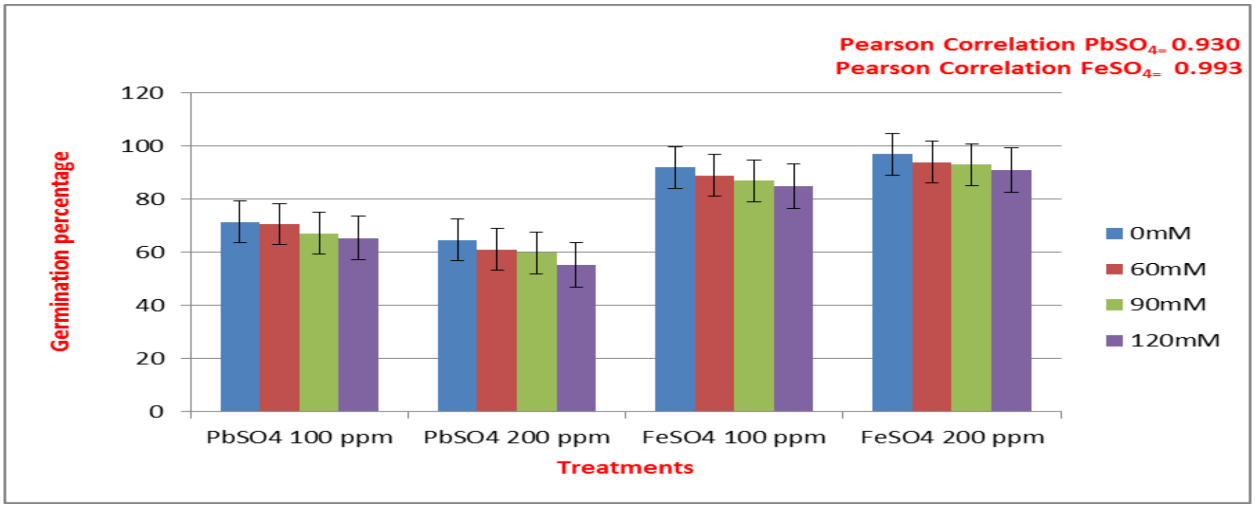

Figure 4. Effects of seed priming with different concentrations of $PbSO_4$ and $FeSO_4$ on germination percentage of *Brassica oleracea* under different levels of NaCl

Biomass moisturecontent or %age O.D weight of shoot

When we compare the %age oven dry weight of shoot in fresh and distilled water, in distilled water weight of shoot was higher (69.2%) than that of the fresh water (63.9%) and non-primed seeds grown in 60mM, 90mM and 120mM of NaCl concentrations had (57.1%, 40.9% and 28.1%) O.D weight of shoot respectively (Fig 5).

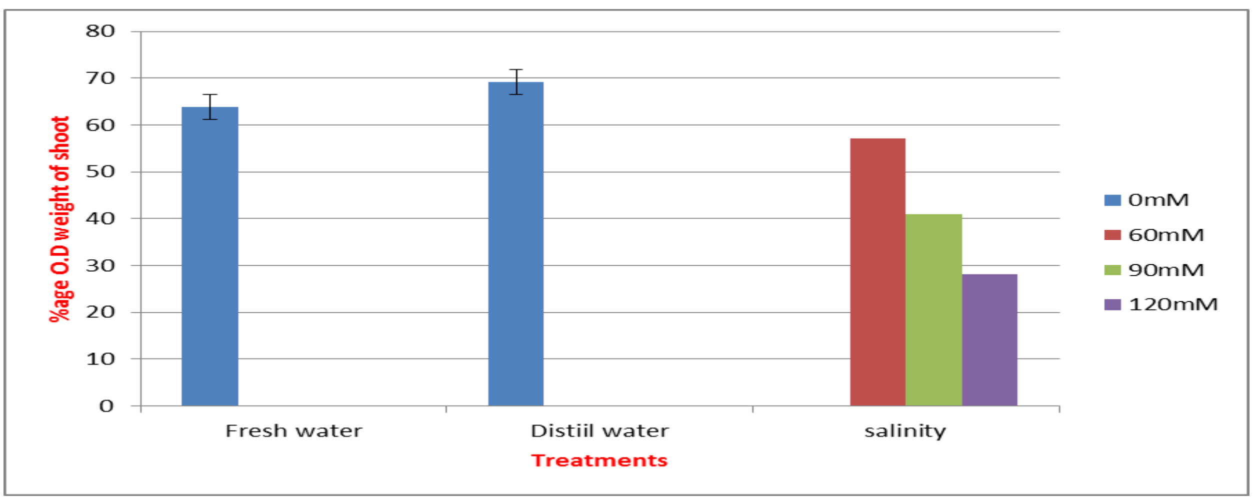

Figure 5. Effects on %age O.D wt. of shoot of *Brassica oleracea* under different control groups

The percentage of O.D weight of shoot of seeds primed with $PbSO_4$ at two concentration levels 100 and 200 ppm, 200 ppm showed lower O.D weight(63.5%) than that of 100 ppm (72.4%). Similarly $FeSO_4$ primed seeds at 100 ppm exhibited O.D weight shoot percentage (84.5%) little low as compared to that of 200 ppm (85%). It was also observed that $FeSO_4$ at 200 ppm showed highest percentage of O.D weight of shoot from all other nutrients primed seeds.The P(T<=t) value recorded in seeds primed with 100 ppm $PbSO_4$, its P(T<=t) value was (0.05) and (0.1) were recorded at 200 ppm of $PbSO_4$, while priming of seeds with $FeSO_4$ at 100 ppm concentration gave P(T<=t) value (0.38) and at 200 ppm (0.76).From the P(T<=t) value it was concluded 100 ppm of $PbSO_4$ showed significant effects on %age O.D weight of shoot, while 200 ppm of $PbSO_4$ and 100 and 200 ppm $FeSO_4$ showed non- significant effects (Fig 6). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

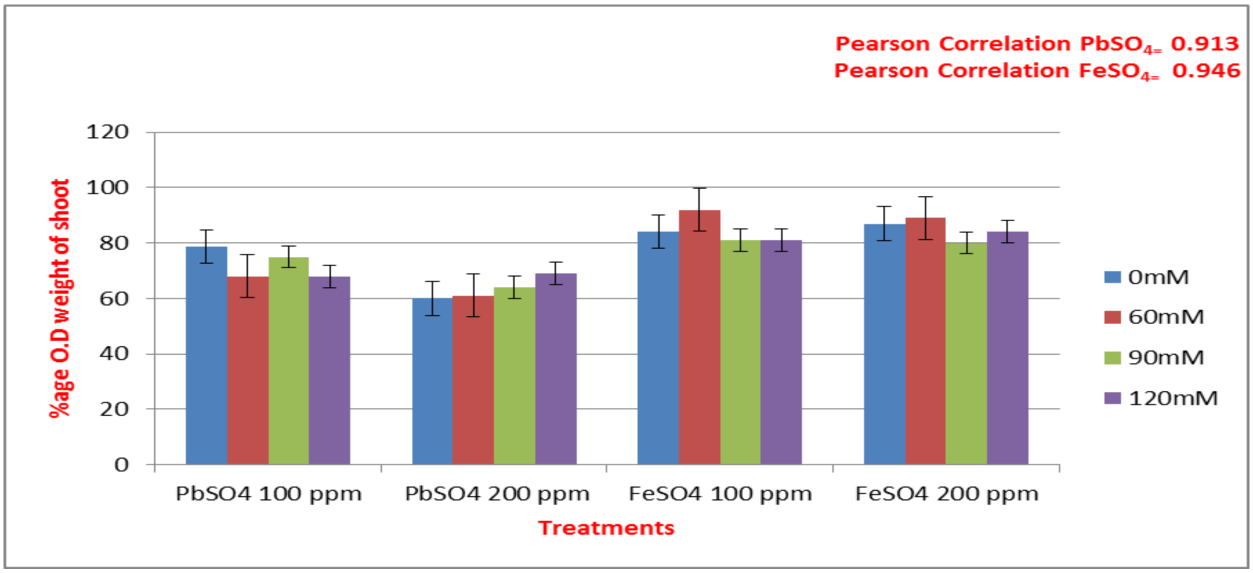

Figure 6. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on %age O.D wt. of shoot of *Brassica oleracea* under different levels of NaCl

Biomass moisture content or %age O.D weight of root

The results of %age O.D weight of root showed that roots grown without primingin fresh water had higher O.D weight (15.5%) than that of distilled water (6.8%). Similarly the %age O.D wt. of roots grown in 120mM NaCl without priming was higher (22%) than that of 90mM (12.4%), and 60mM (8.6%) (Fig 7).

The percentage of O.D weight of root of seeds primed with $PbSO_4$ 100 and 200 ppm, its 200 ppm showed lower O.D weight of root (35.1%) than at 100 ppm to be (42.45%). Similarly $FeSO_4$ primed seeds at 100 ppm showed lower O.D weight (7.5%) when compared with that of 200 ppm (9.1%). It was also observed that $FeSO_4$ at 200 ppm showed highest percentage of O.D weight of root.

The P(T<=t) value recorded in seeds primed with 100 ppm $PbSO_4$ its P(T<=t) value was (0.035) and (0.07) for 200 ppm, and priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.12) and at 200 ppm (0.25) . From the P(T<=t) value it was concluded that 200 ppm of both nutrients showed nonsignificant effects on%age O.D wt. of root (Fig 8). Data also explained the strong weak negative correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

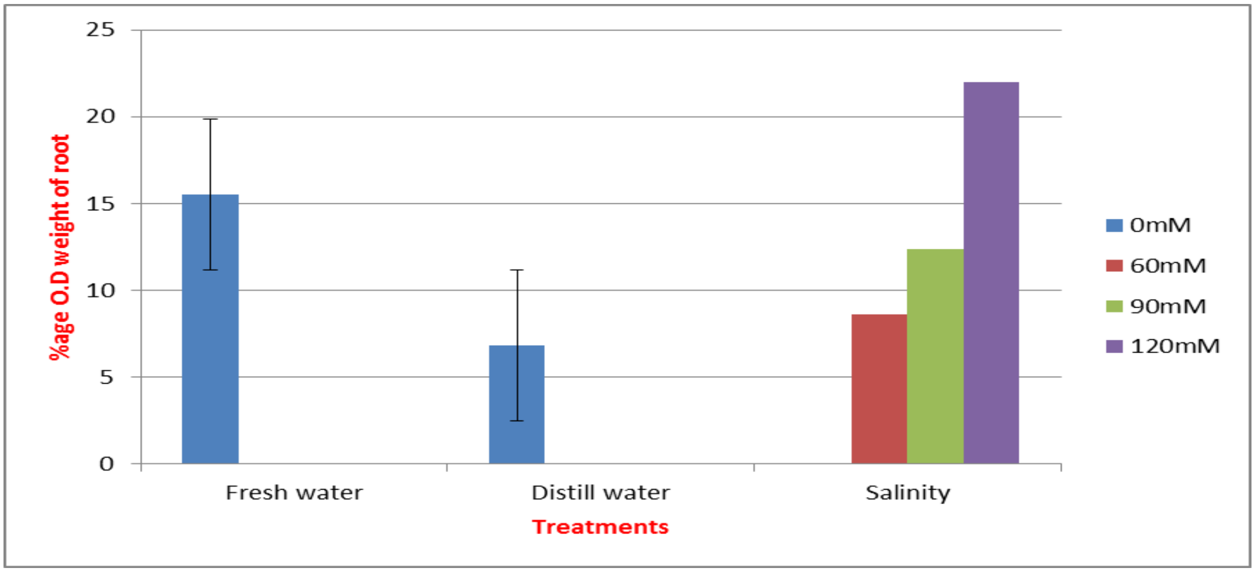

Figure 7. Effects on %age O.D wt. of root of *Brassica oleracea* under different control groups

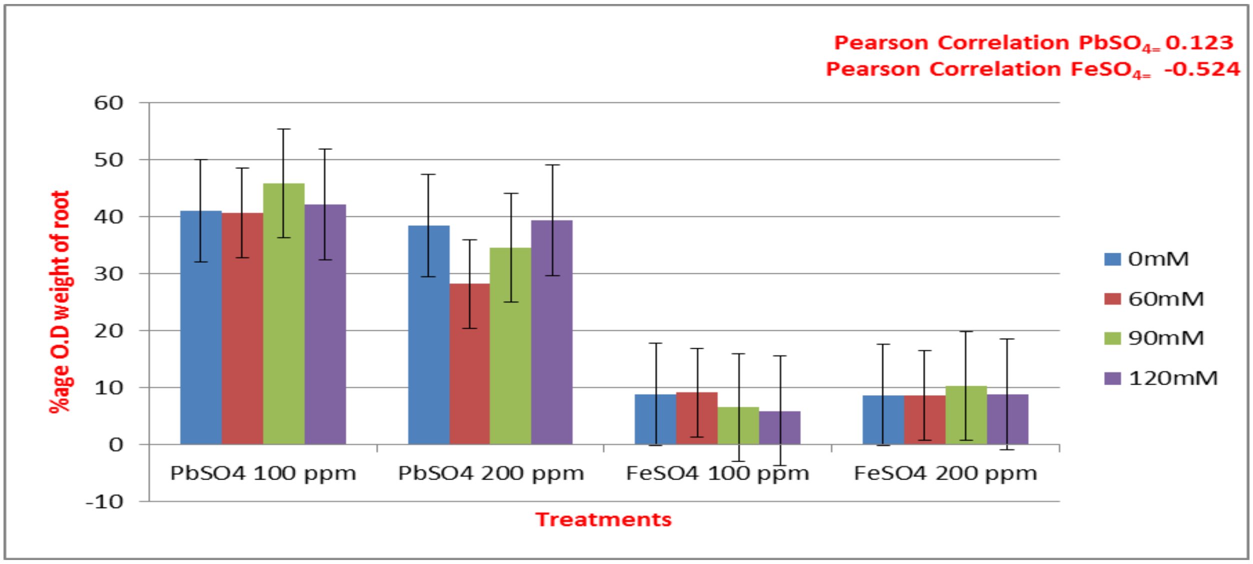

Table 8. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on %age O.D wt. of root of *Brassica oleracea* under different levels of NaCl

Seedlings fresh biomass of root (g)

In control groups the highest rate of fresh biomass of root was observed in distilled water (0.0434 g), fresh water (0.0394 g) and then in NaCl concentrations 60mM(0.0325 g), 90mM (0.0307 g) and 120mM (0.0282 g) with the lowest value (Fig 9).

Lower fresh weight was observed at 200 ppm (0.024 g) than that of 100 ppm(0.028 g) inseeds primed with $PbSO_4$.In $FeSO_4$ primed seeds, 100 ppm showed less fresh weight

(0.043 g) as compared to (0.045 g) at 200 ppm. The P(T<=t) value recorded in 100 ppm of $PbSO_4$ was (0.003) and (0.006) were recorded in 200 ppm of $PbSO_4$, and priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.017) and at 200 ppm (0.035).From the P(T<=t) value it was concluded that 100 and 200 ppm of both nutrients showed significant effects on fresh weight of root (Fig 10). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

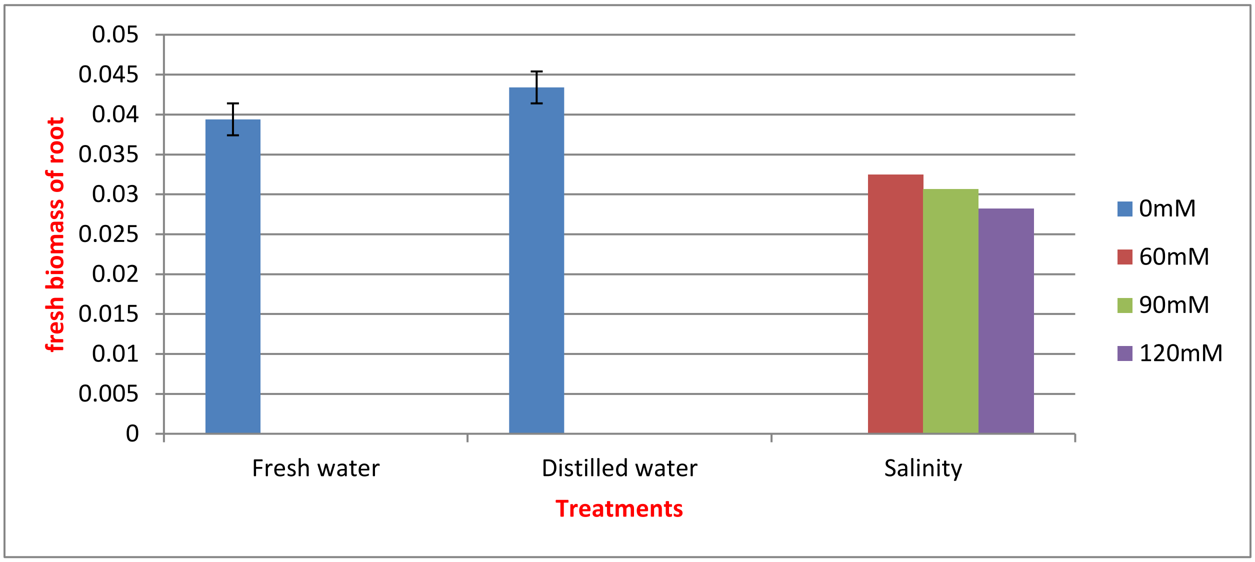

Figure 9. Effects on fresh biomass root of *Brassica oleracea* under different control groups

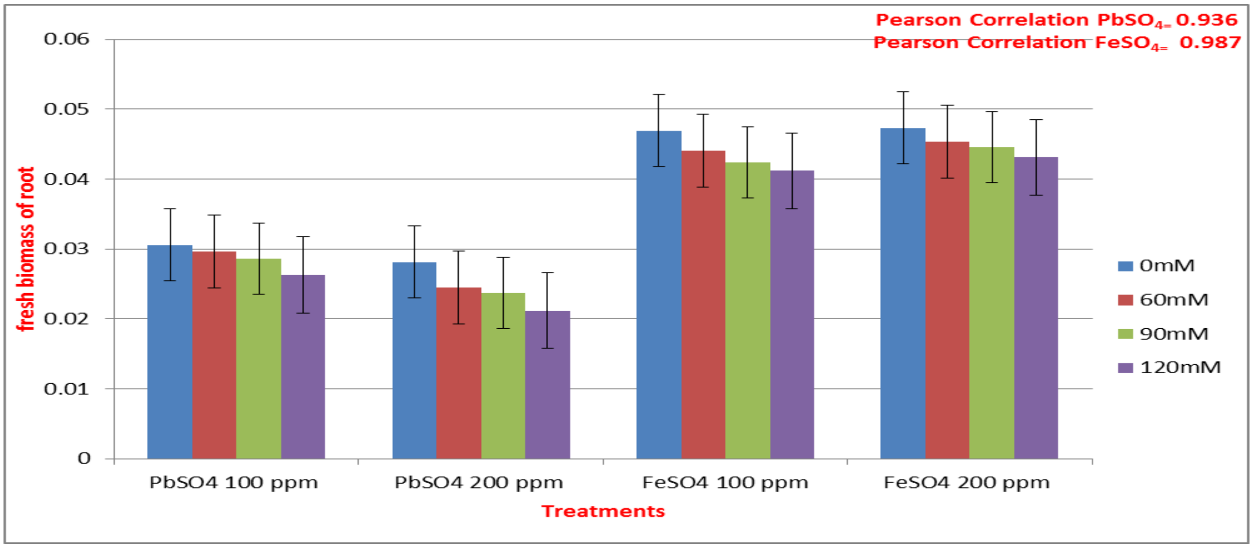

Figure 10. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on fresh sbiomass root of *Brassica oleracea* seedlings under different levels of NaCl

Seedlings dry biomass of root (g)

The dry biomass of root was considerably reduced than that of the fresh biomass but the distilled water biomass (0.0406 g) was still greater than that of the fresh water biomass (0.0341 g). Both fresh and distilled water

exhibited greater dry biomass of root seedlings as compared to tested three NaCl concentrations 60mM, 90mM and 120mM with 0.0299, 0.0274, and 0.0231g respectively (Fig 11).
Distilled water > Fresh water > 60mM > 90mM > 120mM.

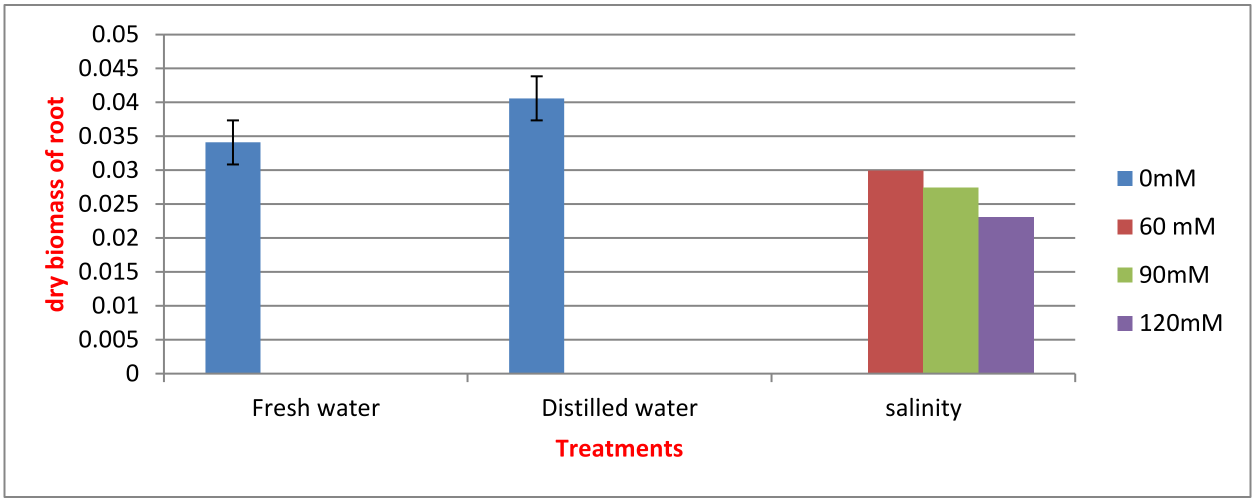

Figure 11. Effects on dry biomass root of *Brassica oleracea* under different control groups

When we compare the dry biomass of root seedlings with $PbSO_4$ priming at 100 and 200 ppm concentrations, then 200 ppm showed lower dry weight (0.018 g) than that of (0.020 g) at 100 ppm. $FeSO_4$ primed seeds at 100 ppm produced less dry weight (0.040 g) as compared to that of 200 ppm concentration producing little more biomass (0.041 g). The P(T<=t) value recorded in seeds primed with 100 ppm was (0.005) and (0.01) for 200 ppm of $PbSO_4$, and priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.018) and at 200 ppm (0.036)
From the P(T<=t) value it was concluded that 100 and 200 ppm of both nutrients showed significant effects on dry weight of root (Fig 12). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

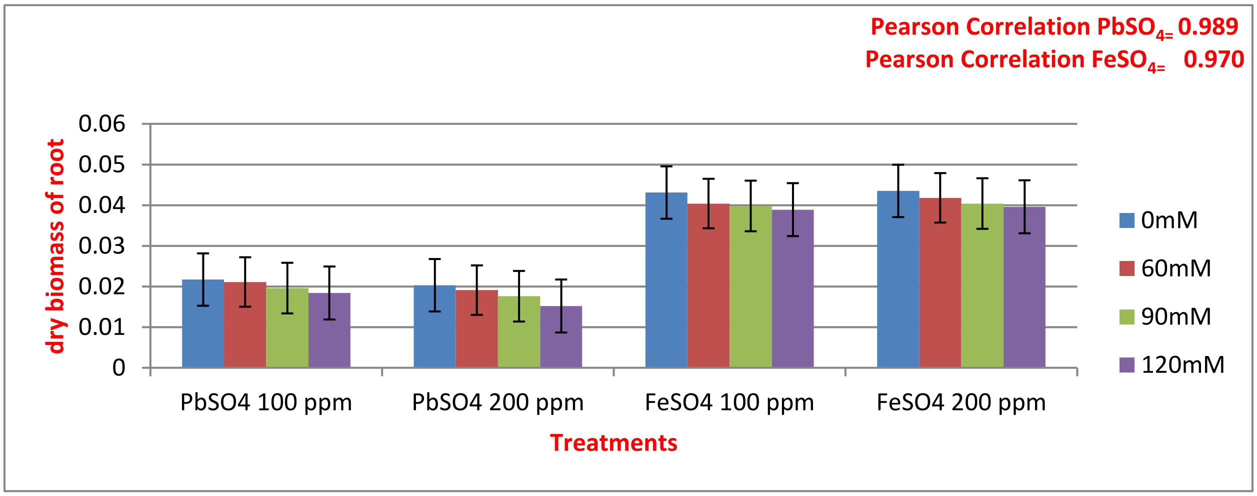

Figure 12. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on dry biomass of root of *Brassica oleracea* seedlings under different levels of NaCl

Seedlings fresh biomass of Shoot (g)
The fresh biomass of shoot of seedlings of seeds grown in distilled water (0.1662 g) was higher than that of fresh water (0.1433 g). Among non-primed seeds grown at different levels of NaCl(60mM, 90mM and 120mM), 60Mm exhibited higher fresh biomass of shoot (0.1149 g) followed by 90mM (0.1006 g) and 120mM (0.0882 g), Fig. 13 showing decreasing trend as Distilled water > Fresh water > 60mM > 90mM >120mM.

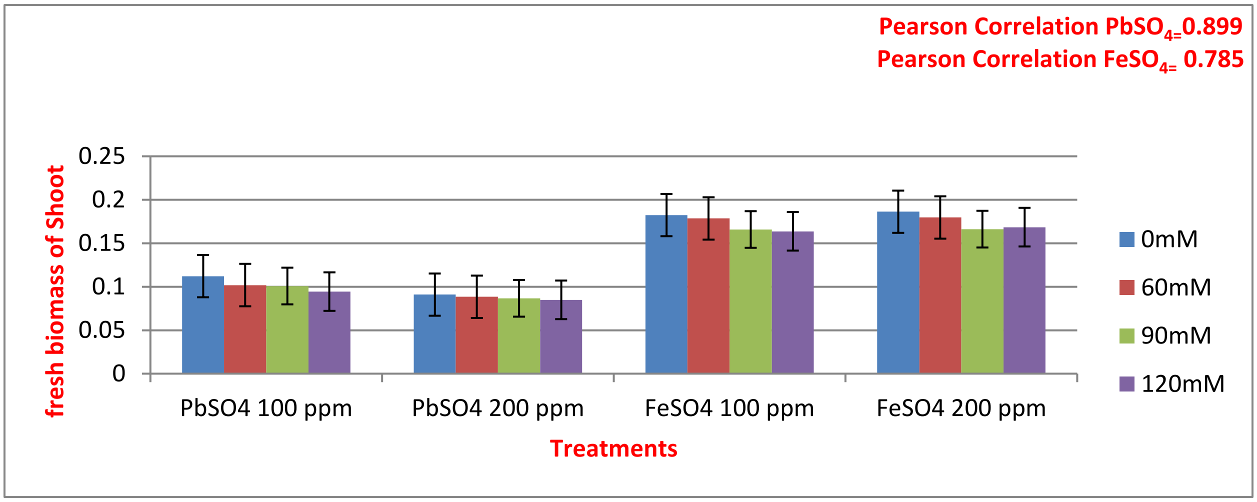

Figure 13. Effects on fresh biomass shoot of *Brassica oleracea* under different control groups

The fresh weight of shoot of seeds primed with $PbSO_4$ at 100 and 200 ppm concentrations, 200 ppm showed lower fresh weight (0.087 g) than that of 100 ppm exhibiting fresh biomass (0.103 g) considerably higher. In case of $FeSO_4$ primed seeds 100 ppm concentration showed less fresh weight (0.172 g) as compared to that of (0.175 g) at 200 ppm.
The P(T<=t) value recorded for $PbSO_4$ at 100 ppm (0.004) and (0.009) were recorded at 200 ppm, and whereas priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.048) and at 200 ppm (0.09).From the P(T<=t) value it was concluded thatexcept200 ppm of $FeSO_4$all nutrients showed significant effects on fresh weight of shoot (Fig 14). Data also explained the positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

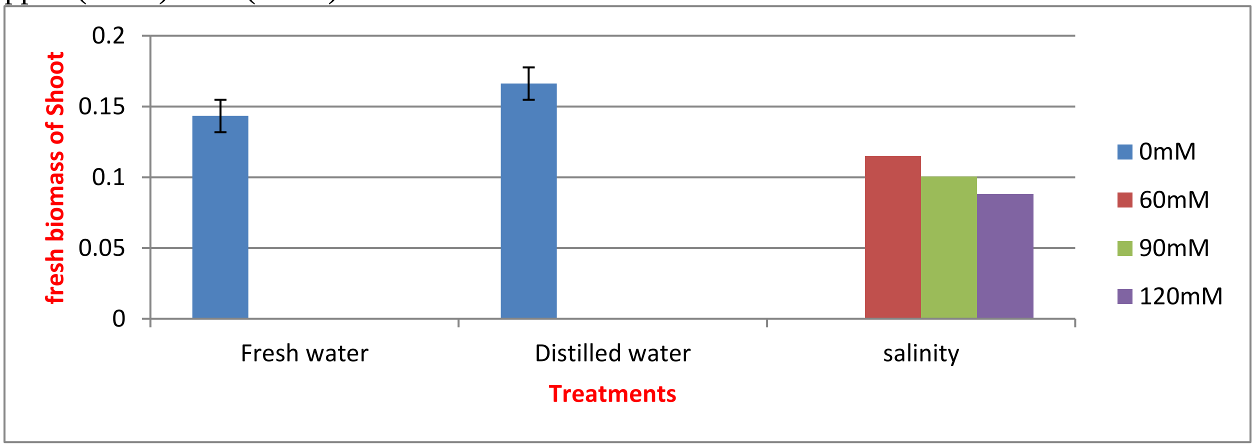

Figure 14. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on fresh biomass of shoot of *Brassica oleracea* seedlings under different levels of NaCl

Seedlings dry biomass of shoot (g)
The dry biomass of shoot was considerably reduced than that of the fresh weight. Results revealed that the dry biomass of seeds grown in distilled water (0.0982 g) was greater than that of the fresh water (0.0874 g) and it was subsequently reduced as (0.0831g), (0.0715 g) and (0.0688 g) at 60mM, 90mM and 120mM levels of NaCl respectively (Fig 15). The following decreasing trend was observed: distilled water > fresh water > 60mM > 90mM > 120mM.

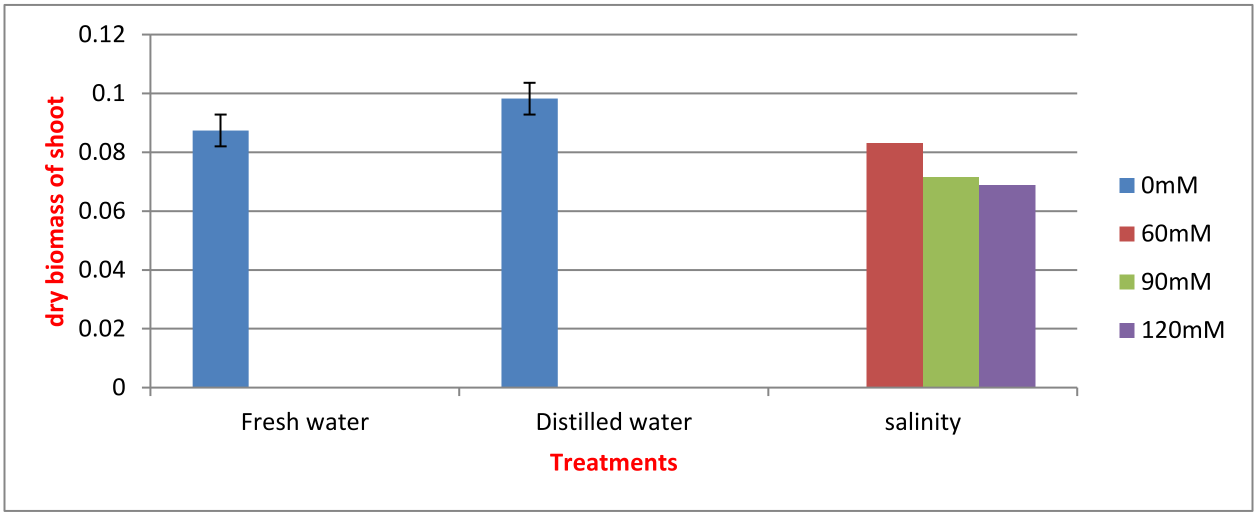

Figure 15. Effects on dry biomass shoot of *Brassica oleracea* under different control groups

The dry weight of shoot of seeds primed with $PbSO_4$ at two concentrations 100 and 200 ppm, its 200 ppm showed lower dry biomass (0.053 g) as compared to 100 ppm having dry biomass (0.059 g). But in case of $FeSO_4$ primed seeds at 100 ppm dry shoot weight was found as (0.093 g) little lower as compared to that of 200 ppm (0.094 g).
Seeds were primed with $PbSO_4$, its P(T<=t) value was (0.0001) at 100 ppm and (0.0002) recorded at 200 ppm while priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.027) and 200 ppm (0.055) .
From the P(T<=t) value it was concluded that both nutrients showed significant effects on dry weight of shoot (Fig. 16). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

Seedlings root length (cm)
A great change was observed in root length of seeds grown in fresh and distilled water. Root length of seeds grown in fresh water (4.713 cm) was greater than that in distilled water (3.683 cm). Similarly root length of non-primed seeds treated at 60mM NaCl (3.104 cm) was greater than that in 90mM (2.596 cm) and so on in 120mM (2.015 cm) levels of NaCl. Fig. 17 showing the decreasing trend: fresh water > distilled water > 60mM > 90mM >120mM.

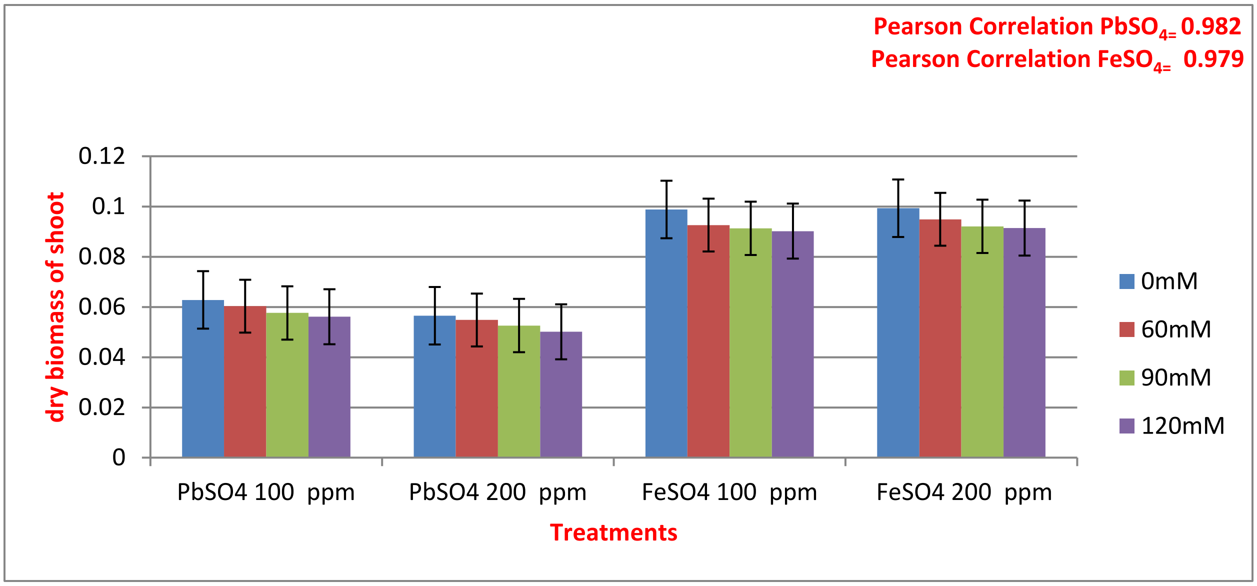

Figure 16. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on dry biomass of shoot of *Brassica oleracea* seedlings under different levels of NaCl

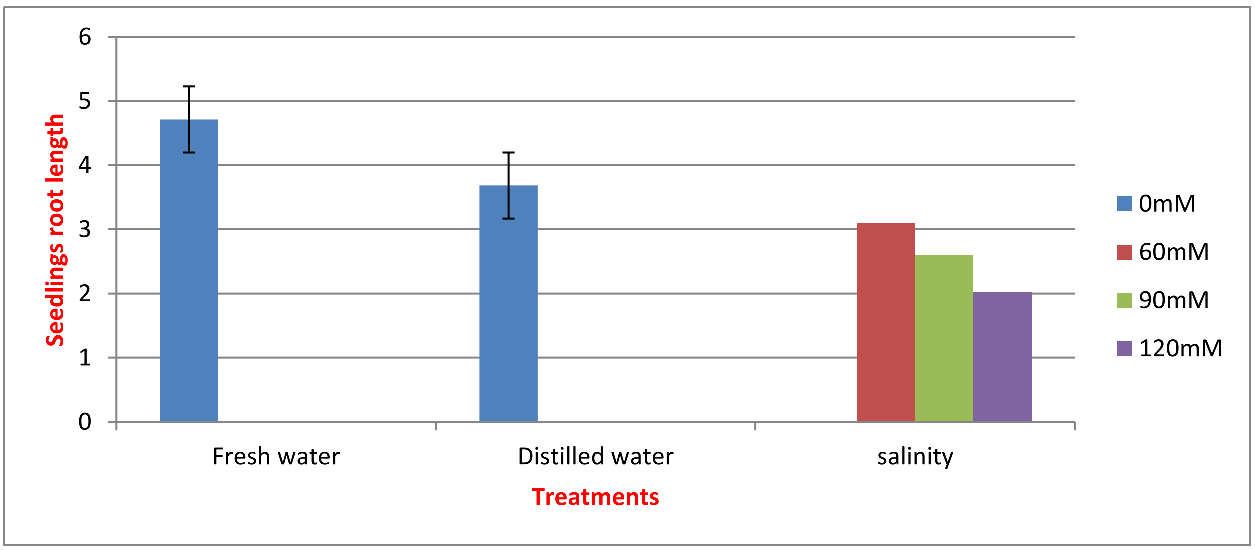

Figure 17. Effects on root length of *Brassica oleracea* under different control groups

When we compare $PbSO_4$ primed seeds root length at two concentrations 100 and 200 ppm, its 200 ppm showed (2.70 cm) lower length than that exhibited at 100 pspm as (3.02 cm). $FeSO_4$ primed seeds at 100 ppm also showed little lowers root length (5.23 cm) as compared to that at 200 ppm showing length (5.69 cm).

The seeds were primed with $PbSO_4$, its $P(T<=t)$ value was (0.003) at 100 ppm and (0.007) recorded at 200 ppm, and priming of seeds with $FeSO_4$ at 100 ppm gave $P(T<=t)$ value (0.044) and at 200 ppm as (0.089).From the $P(T<=t)$ value it was concluded thatexcept 200ppm of $FeSO_4$ all nutrients showed significant effects on root length (Fig. 18). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

Seedlings shoot length (cm)

Like root length, shoot length of seeds grown in fresh water also exhibited the highest value (6.446 cm) than that of the seeds grown in distilled water (5.968 cm). But shoot length of seeds grown in distilled water was greater than 60mM NaCl (5.432 cm), then 90mM (5.026 cm) and then 120mM (4.835 cm) of NaCl concentration. Fig 19, showing the trend in decrease of shoot length as: fresh water > distilled water > 60mM > 90mM > 120mM.

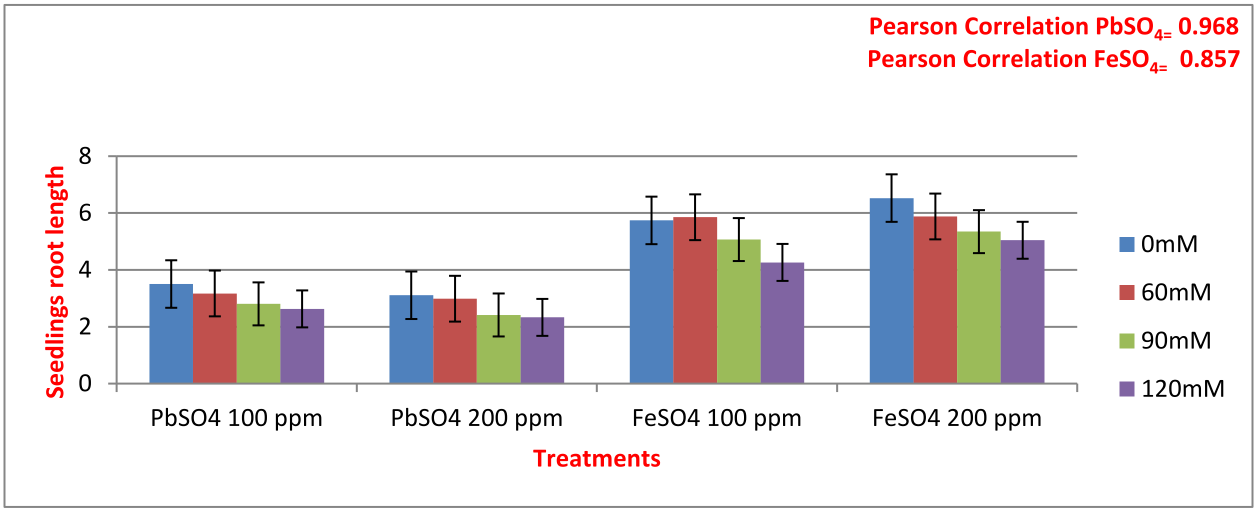

Figure 18. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on root length of *Brassica oleracea* seedlings under different levels of NaCl

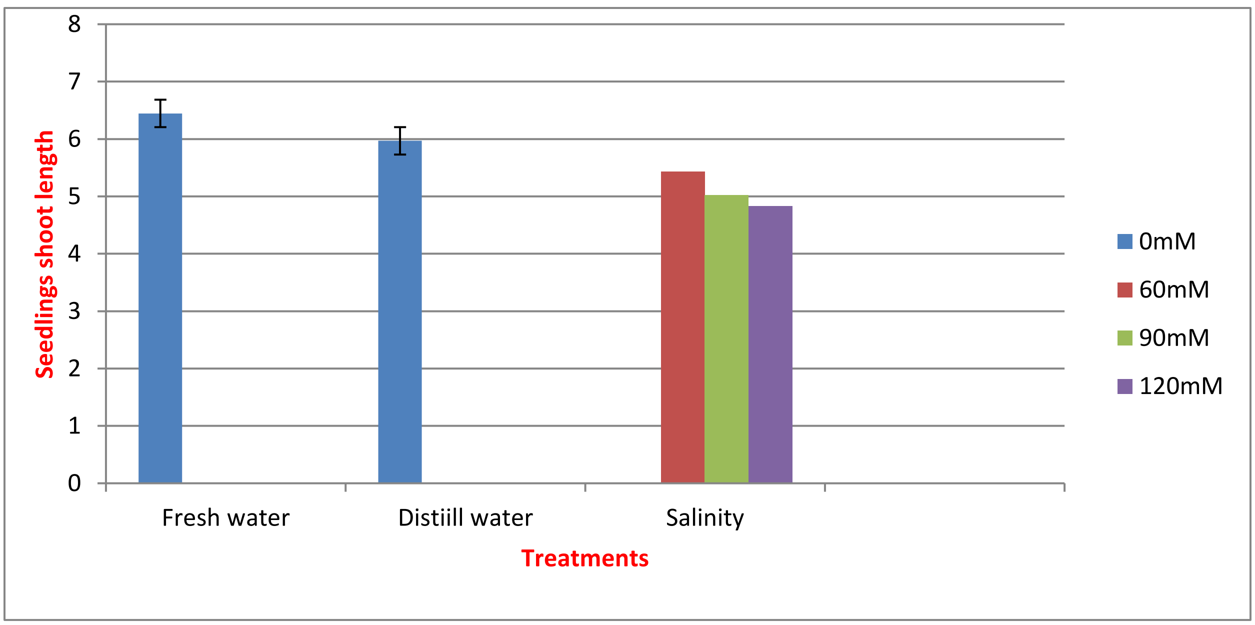

Figure 19. Effects on shoot length of *Brassica oleracea* under different control groups

When we compare the shoot length of seeds primed with $PbSO_4$ at two concentrations 100 and 200 ppm, its 200 ppm resulted in (3.85 cm) lower length than that of 100 ppm resulting in (4.74cm). In case of $FeSO_4$ primed seeds 100 ppm concentration showed lower shoot length as (6.42 cm) as compared with that at 200 ppm as (7.78 cm). P(T<=t) value of seeds primed with $PbSO_4$ was (0.018) and (0.037) were recorded at 100 ppm and 200 ppm respectively, and priming of seeds with $FeSO_4$ at 100 ppm gave P(T<=t) value (0.002) and at 200 ppm as (0.005). From the P(T<=t) value it was concluded that both nutrients showed significant effects on root length (Fig. 20). Data also explained the strong positive correlation between the two concentrations i.e 100 & 200ppm of PbSO4 and FeSO4 in this growth parameter.

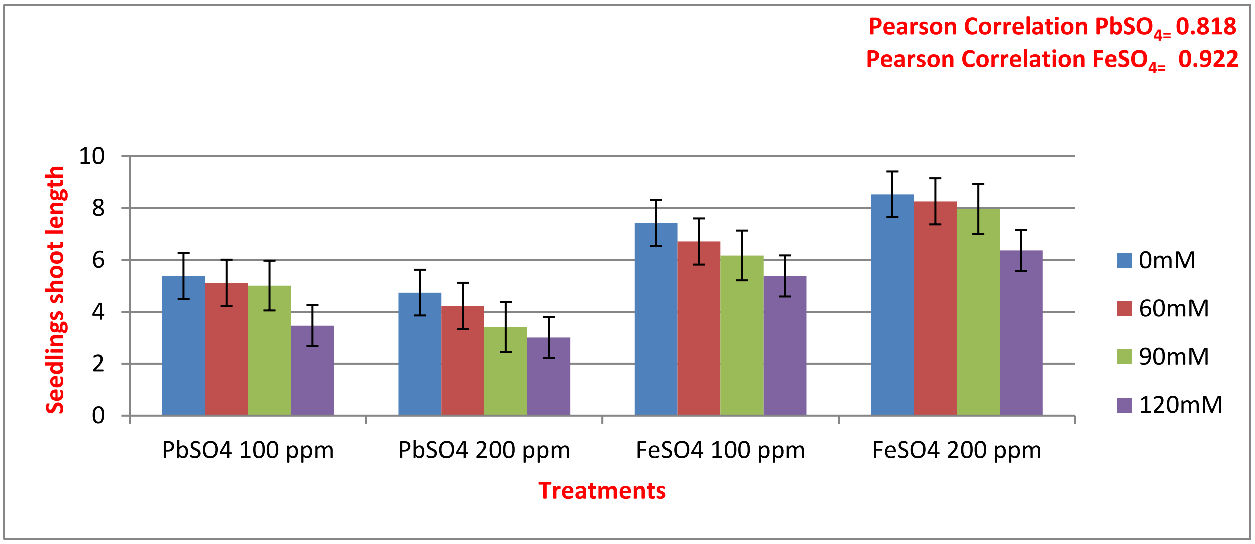

Figure 20. Effects of seeds priming with different concentrations of $PbSO_4$ and $FeSO_4$ on shoot length of *Brassica oleracea* seedlings under different levels of NaCl

The results of the present studies indicate that non-primed seeds grown under different salinity levels (60mM, 90mM and 120mM of NaCl) inhibit the germination speed and percentage. Similar decrease in germination speed and percentage due to salinity was also observed by [23]. It was also assumed that higher salts concentration hinders the absorption of water in germinating seeds and cause delay in germination [24]. In our study the highest germination percentage were obtained in control groups when compared with that of the results obtained from saline treatments and our results are in agreement with that of the findings of [25]. In another study germination percentage was highest in control groups as compared to that of saline conditions where it was reported low by [26]. Theyalso reported that increased salt levels caused great reduction in germination percentage. Another important parameterof plant growth is roots and shoots length. Our results demonstrated that the length of roots were more affected as compared to that of shoots and are in accordance with the findings of those of [27-29] who assumed that root length was more affected than shoot length by soil salts due to reason that roots are in direct contact with salty medium as compared to shoot of plants that's why root length considered as major indictor of stress for plants grown under salty conditions.

Our results also revealed that fresh and dry weight of shoot and root were adversely affected by different salinity levels. With the increasing salt concentrations,weight reduction in all nine grown vegetables was noticed by [30], hence our biomass results are inconformity to these results.

Micronutrients are vital for plant growth. To resist salinity and to improve the germination speed and percentage in plants grown under saline conditions we use the technique of nutrient priming of seeds. By this technique improvement in germination speed and percentage of plants can be obtained as primed seeds had better and faster germination than un-primed seeds **[31]**.

Among heavy metals, lead (Pb) is easily stored in soil and sediments. Since it is not vital element for the growthof plants yet it is absorbed and accumulated in plants **[32, 33]**. Table 1a showed that priming with $PbSO_4$ at both 100 and 200 ppm did not show any significant result on germination speed and other growth parameters. These results are in accordance with the findings of **[34]** who indicated that lead concentration at 10 micro mol/L reduced the seed germination, seedling growth and dry weights as compared to that of control.

In present findings seeds treated with $PbSO_4$ have shorten the roots and shoots length. It may be due to absorption of Pb in roots that would decrease Ca in root tips and thus cause decrease in cell division or cell elongation **[35]**.Pb also inhibits the growth of rice shoot due to its harmful effects on photosynthesis, membrane structure and permeability, mineral nutrition, water balance, and hormonal status as reported by **[36]**.Pb increased rates resulted in reduced growth of root and shoot when a comparison was made between 100 and 200ppm of $PbSO_4$ and control, the results indicated that 200 ppm retarded the growth **[37]**. In our findings shoot height was also shortened in seedlings of $PbSO_4$primed seeds (4.74cm, 3.85cm) seeds at the two concentration levels. Same phenomena in wheat shoot height was also reported with increasing Pb application by **[38]**.

Iron (Fe) has a great role in photosynthesis and plant growth regulation **[39]**.In present study germination speed and percentage was high in $FeSO_4$ primed seed. These results were supported by the findings of **[40]** according to which the application of spray of $FeSO_4$ on corn leaf showed considerable enhancement in chlorophyll concentration.

The germination speed and percentage is high in $FeSO_4$ primed seeds because the application of priming increases growth rate, possibly due to increase in photosynthetic activities and various plant metabolites that are responsible for cell division and elongation **[41]**. The deficiency of iron might be limiting factor for vegetative growth **[42]**.

In present study the highest mean dry and fresh weight of stems and roots were obtained in $FeSO_4$ primed seeds. Same results of highest mean dry and fresh weight of stems, roots and leaves of *Ocimumbasilicum*were obtained in the nano-iron chelated treatment as described by **[43]**. The present studies reveal that $FeSO_4$ primed seeds show best results. Other researchers are in agreement to **[44]** who reported that application of $FeSO_4$ increased seed protein and phosphorus concentration.

Conclusion and recommendations

It was concluded that salinity affects all the processes of seedlings growth from emergence of seedlings to seedlings root-shoot length and weight. To overcome adverse effects of salinity, nutrients priming of seeds through Fe showed best results on germination and seedling growth whereas priming of seeds with (Pb) did not show any improvement in these parameters.The present studies suggest that priming of seeds of Cabbage through micro-nutrients may be beneficial as it can enhance the speed rate or percentage of germination, increase salt tolerance, improve the micronutrient value of plants that may lead to increased micronutrient content of the seeds resulting in better nutrition of the crop progeny and also it is basis for future research in this field.

Authors' contributions

Conceived, designed the experiments and supervised the research work: AM Khan, Performed the experiments and wrote the article: I Dilshad, Helped in experiments and data analysis: S Iqbal, K Moatter, Proof read the article: SA Gilani.

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